Enhancing Community-Based Conservation, Education, and Recreation at Mount Ascutney

Environmental Studies 50
Dartmouth College
June 2016

ENVS 50

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Acknowledgements

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Executive Summary

From April to June 2016, the students of Environmental Studies 50 at Dartmouth College worked to develop a conservation and recreation management plan at Mt. Ascutney in Windsor, VT. Specifically, students researched and developed an environmental preservation and economic rejuvenation strategy for Mt. Ascutney. In 2015, the Trust for Public Land helped the Town of West Windsor, VT to acquire 468 acres of land protected by a conservation easement. The Town Forest offers substantial ecological and social benefits, including miles of trails available for recreational activities. For this project, Environmental Studies 50 students worked with a number of community members from the Town of West Windsor, Ascutney Outdoors, the Sport Trails of Ascutney Basin (STAB), and the Upper Valley Land Trust. In partnership with these organizations, students worked to co-develop a set of deliverables to meet the goals of their community partners, and to implement a new management plan that aims to positively impact revenue streams in the area while conserving Ascutney's natural beauty and reputation in the "Spirit of Vermont."

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Introduction

Report Outline

The students of Environmental Studies 50 at Dartmouth College worked closely with the members of the Mt. Ascutney Outdoors board, the administrators and boards of the Town of West Windsor, and local community members to figure out a plan for the future expansion and revitalization of Mt. Ascutney. In the introduction of this seminar report, we will introduce each of the sub-group topics and provide a brief description of each. We will then discuss the history of Mt. Ascutney to lay the groundwork of where the mountain has been, explain the current state of the mountain and the recent developments and infrastructure added, and lastly, lay the foundation for the future of the mountain.

Case Study Comparison of Existing Recreation

The first student group performed extensive case study research that could be applied to the understanding of Mt. Ascutney. The first section of this chapter details a framework for the analysis Mt. Ascutney's resources and organizational strengths and weaknesses, based on existing literature on successful mountain resort structure and components of mountain system theory. The second section describes the current user base of Mt. Ascutney based on rhetoric found in existing literature, as well as the University of Vermont Survey of backcountry skiers. The third section explains the implications of climate change on mountain tourism to highlight the importance of recreational diversification given the potentially diminishing future of the ski industry. The fourth section examines two scientific, peer-reviewed case studies of outdoor mountain recreation to determine the methodology used in later research of comparable mountains. In addition, the case studies serve to highlight challenges these mountains have faced

and management approaches they have used, which we can then apply to Mt. Ascutney. The fifth section examines four in-depth, regional case studies of mountain biking and ski operations in Vermont and New Hampshire. This section includes a cross-sectional analysis of the cases in order to gain a deeper understanding of in which areas Mt. Ascutney can grow, and what aspects they can leverage in the competitive market. The sixth and final section provides specific recommendations for the construction of a new lodge. In addition to design elements, this section addresses price estimates inferred from operation costs of surrounding businesses.

Basecamp Analysis

The second group worked with community partners to design a 'basecamp' lodge for Mt. Ascutney with the intention of creating a community space for hikers, bikers, skiers, and school groups. The basecamp will be a lasting face for the mountain and its full range of activities. The culminating deliverable is an extensive set of design recommendations including three site suggestions and eight sub-design topics to be given to Laura Farrell, one of the primary community members, to reference when compiling the final proposal to the community for the basecamp.

Assessment and Monitoring

The third group worked to formulate a comprehensive literature review to provide the community partners with more in-depth knowledge regarding summer and winter recreational activities as well as the impact of invasive species on mountain ecosystems. They also analyzed current monitoring protocols at various locations and worked to develop a set of Mt. Ascutney-specific monitoring strategies, along with suggestions for a general implementation timeline. As

data from potential monitoring strategies accumulates over time, their suggested monitoring strategies can be used to create benchmarks and carrying capacities that could be implemented to monitor and regulate user traffic at the mountain.

Communication and Education

The fourth group's project was divided into two sub-projects. The first was to create online web content that would help Ascutney Outdoors to better communicate with its existing users and potential new users. This group provided suggestions for Ascutney Outdoors to improve their website with the goal of rendering their website more user friendly and informative. This group also created a video that presented a series of compiled interviews with local experts and users of the mountain. The video emphasizes the unique aspects of the mountain: the natural history, geology, ecology, and local knowledge that make this mountain and community special.

The second sub-project worked with the local school to develop curricular material that would help teachers and after-school program coordinators utilize the resources the mountain has to offer both in and out of the classroom. Currently, the nearby K-6 school runs one after-school program on the mountain, and they are looking for ways to integrate it more fully into curricular and extracurricular education. This group focused on developing a set of lesson plans and activities that can be used at each grade level, and also developed more versatile activities for the after-school program that supports all ages in the K-6 program.

History

Mt. Ascutney has evolved as an outdoor recreation area since 1935 and provides economic, physical, and mental benefits to the surrounding communities of Brownsville and

West Windsor, Vermont. Locals feel a deep connection to the mountain and see its potential to become a valued mountain biking and backcountry skiing area not only for Vermont, but also for the larger New England community. Since the Mt. Ascutney ski area closed in 2010, a dedicated team of community members has formed, including Ascutney Outdoors, the Sport Trails of Ascutney Basin (STAB), the Upper Valley Land Trust, and members of the Town of West Windsor. These organizations share a common mission to reinvigorate the Ascutney Mountain recreation area. Indeed, over the course of Mt. Ascutney's history, the area has closed and reopened, had multiple owners, and has filed for bankruptcy multiple times. The new Ascutney leadership is hoping to reverse this trend.

Although there are many who love it, the Mt. Ascutney Ski Area has had a long history of financial hardship, changing leadership, and unfulfilled potential. In 1935 the United States Civilian Conservation Corps (CCC) and the Windsor Outing Club opened the 5,400 ft. Mt. Ascutney Trail for skiers. A decade later, Catharine Cushman, Bob Bishop, Dick Springer, Bob Ely, Robert Hammond, and Dr. Peter Patch, among others, helped develop the Mt. Ascutney Slopes. The operation continued to grow over the next five years adding more runs and rope tow lifts. Unfortunately, in 1950 following an unfavorable skiing season, Ascutney filed for bankruptcy for the first time.

In 1957, the new owner of the area John Howland founded Mt. Ascutney Ski Area, Inc., and with external funding allowed for installation of a T-Bar lift and snowmaking equipment. In 1964, Ascutney, then owned primarily by Walter Paine of the Valley News, expanded to include higher verticals, a new T-Bar, and a lodge. Ownership of the mountain continued to change hands until 1983, at which point the Mt. Ascutney Ski Area Corporation filed for bankruptcy for the second time. That same summer, Summit Ventures, Inc. purchased the mountain and

embarked on a 10-year plan, which included the development of new slope-side condos, chairlifts, and snowmaking capacity. However, the plan proved to be unsuccessful, and in 1991, Ascutney was forced to liquidate its assets.

Two years later, the Mountain reopened yet again under the ownership of Steve and Susan Plausteiner of Smugglers Notch. They invested millions of dollars into the area's expansion, but the success of the area did not outpace its growing debt. The Ascutney Ski area has remained closed since 2010, while neighboring mountains, such as Crotched and Whaleback Mountains, continued to grow and improve their operations. In 2013, Mt. Ascutney was auctioned to MFW Associates who, unable to reopen the ski area, had to sell the triple chairlifts to Pats Peak who removed them during the summer of 2014.

Current Status

Today, the Town of West Windsor owns Mt. Ascutney, and the land is leased to the non-profit organization, Ascutney Outdoors (AO). Ascutney Outdoors stems from a few committed local community members who are dedicated to "harmoniously managing, developing and protecting recreational, educational, and environmental assets of the West Windsor Town Forest and adjacent land on Mt. Ascutney, while maintaining affordable access for all, for their year round enjoyment." To this end, Ascutney Outdoors has implemented a rope tow for downhill skiing, opened the mountain to backcountry skiers, and has preserved the mountain bike trails in the adjacent town forest with the help of Sports Trails of Ascutney Basin (STAB). Ascutney Outdoors has been able to keep the rope tow and backcountry skiing open to the public for free, with charitable donations coming from those who can afford it. The mountain biking trails charge a small annual fee through the Vermont Mountain Biking Association (VMBA).

Today, Mt. Ascutney stands with promising prospects in downhill skiing, top-notch backcountry skiing, and regionally acclaimed mountain biking trails, which serve in addition to its phenomenal ecological diversity of plants and animals. We believe the future of Ascutney is exciting and bright: there are several projects in place to rebuild the mountain back up to surpass its previous successes and to increase public awareness of its greatness.

Future

Due to the unwavering support from a number of volunteers from the West Windsor and Brownsville communities, the future of Mt. Ascutney is bright. With a new rope tow in place and arguably some of the best mountain biking trails in the country, Mt. Ascutney has a lot of untapped potential for revamping its recreational activities. Additionally, plans to build a new "basecamp" lodge structure at the base of the mountain will give Ascutney a new face, and serve as a shared gathering space for members of the West Windsor and Brownsville communities. Furthermore, an assessment of the impacts of invasive species on mountain ecosystems and the role recreational activities play in their spread, will serve as a basis for the implementation of a cohesive monitoring program that aims to promote the conservation of the area's ecosystems. Plans to revamp Ascutney's marketing and communication strategies to better reach their existing and potential users will likely result in increased recreational and economic activity. Developing curricular material at local schools will also help teachers and after-school program coordinators utilize the resources at Mt. Ascutney and broaden their user base.

Chapter One

Development Through Existing Activities

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Chapter One: Development Through Existing Activities

1.1 Introduction

We examine Mt. Ascutney's existing outdoor recreation and tourism industry in the context of existing literature. We review the literature on mountain sport destinations, in order to situate our study of Mt. Ascutney within the broader research that has been done on mountain recreation and business development. Our ultimate goal is to answer the question, **"What can Mt. Ascutney do to create a comparative advantage by imitating the most successful organizational aspects of current competition while leveraging their unique resources and recreational offerings to revitalize the town of West Windsor?"** We worked with community partners to determine which concrete deliverables they wanted at the culmination of our project. The deliverables include:

- Collective comparison of regional mountain bike and ski operations.
    - Data collection on comparable operations' pricing schemes.
    - Suggestions to guide goals for next stages of development.
- Cross case analysis informed by an in depth literature review on sustainable tourism, outdoor mountain recreation operations, and impacts of climate change.

In this chapter, we begin by examining the academic literature on recreational tourist destinations in order to inform our suggestions for Mt. Ascutney. We then conduct a collective case study of regional mountain biking and skiing operations that highlights challenges and successful management strategies that could be instructive for Mt. Ascutney's development. In our cross case analysis, we pull from a variety of sources, including global case studies, academic literature, gray literature, and user surveys, to offer advice from existing examples for

broader insight for Ascutney's growth. Finally, we present suggestions for how Mt. Ascutney should proceed in its development plans in respect to their goals for current activities.

1.2 Background Literature

We designed our research process based on the work of Flagestad and Hope (2001) and Nepal and Chipeniuk (2006) in order to develop a better understanding of mountain recreation business models and to determine what mountain characteristics to emphasize in our case studies. Current academic literature offers several concepts that help analyze and identify key components of successful mountain recreation operations. We grounded our work in academic literature prior to conducting our collective case study, in order to generate reflective and meaningful research (Gardiner and Kroth 2014). Our work on Mt. Ascutney will build upon current thinking and rhetoric on aspects of mountain tourism by adding relevant research on small mountain recreation operations in the Northeast.

Flagestad and Hope (2001) provide a useful framework for thinking about the management and organization of mountain recreation tourist destinations. They begin by describing "sustainable tourism," defined by the World Tourism Organization as 1) improving the quality of life of the host community, 2) providing a high quality of experience for the visitor, and 3) maintaining the quality of the environment on which both the host community and the visitor depend. In order to sustain an economically fruitful business, leaders should also prioritize the opinions of the local community and the ecological sustainability of the area (Flagestad and Hope 2001).

We further manipulated a model from Muller to fit the case of Mt. Ascutney to depict the rationale, strategy, and goal of the development of mountain tourist areas (See figure X) (Flagestad and Hope 2001). The rationale for investment in development of the mountain

recreation at Mt. Ascutney is economic benefits to the town of West Windsor and to stakeholders in the project. These economic benefits, however, must be balanced by other goals that are important to our community partners including mental and physical health (chapter 2), sense of community (chapter 3), ecological sustainability (chapter 4), and environmental education (chapter 5). The ultimate goal for stakeholders such as Ascutney Outdoors, STAB, and Orange Lake, is to create long-term value at Mt. Ascutney balancing the satisfaction of recreational users of the mountain with nonmarket benefits to West Windsor residents and the environmental sustainability of the mountain.

Flagestad and Hope (2001) also discuss two different models of mountain management organization--the corporate model and the community model--which helped us distinguish Mt. Ascutney's business operation from those of much larger mountain resorts such as Killington. In the corporate model, one major corporation manages the mountain and run multiple for-profit business units such as restaurants, a ski school, and a ski rental shop (Flagestad and Hope 2001). This model is similar to the "Nodal center" approach, in which management is geared towards mass tourists, with a variety of amenities. (Nepal and Chipeniuk 2006). In the community model, on the other hand, various stakeholders help to organize the mountain recreation. Not-for-profits and the local government are often involved as well as other community businesses, such as hotels. These stakeholders must work together to balance objectives and distribute tasks, which may sometimes lead to a lack of coordination (Flagestad and Hope 2001). This model fits with the Frontcountry and Backcountry approaches to management where settings provide more nature-oriented and specialized activities that are desired by local recreationalists, especially those travelling with families (Nepal and Chipeniuk 2006).

Mt. Ascutney uses the community model. Although it is much different than the large scale corporate resort model, it can lead to an equally thriving business operation. An advantage of the community model is that it has stronger stakeholder involvement and attachment to the mountain area when compared to the corporate model (Flagestad and Hope 2001). As our community partners have expressed, the residents of West Windsor have a strong attachment to Mt. Ascutney and are committed to seeing it revitalized. A mountain that uses the community model could also perform better in terms of ecological and social sustainability, because the various stakeholders aim not only to make a profit but also to preserve the natural environment and improve the quality of life of the people living in the area (Flagestad and Hope 2001). Ecological sustainability is very important to many of the stakeholders of Mt. Ascutney who want to ensure their mountain operation is ecologically sustainable and minimized degradation with increased usage of mountain bike trails as well as backcountry skiing. The community partners hope to preserve the biodiversity on the mountain, provide nature education to the community, ensure the long term sustainability of the trails, and maintain the beautiful natural setting that the mountain provides.

Many other authors emphasize ecological sustainability in the long term viability of mountain recreation destinations. Nepal and Chipeniuk (2006) discuss the importance of monitoring the 'fragility' of the mountain's ecological processes and the stress put on these processes by increased recreational usage. Fragility is becoming more important with the impacts of climate change in the form of rising temperatures and changing precipitation patterns from El Niño effects. These changes are making the Winter season increasingly unpredictable (Bürki Elsasser and Abegg 2003). Decreasing snowfall will continue to impact the winter tourism

industry in Northeastern part of America. As a result, many resorts will need to adapt to ensure long term viability and sustainability (Beaudin and Huang 2014).

Besides sustainability, Nepal and Chipeniuk (2006) delve into some of the key aspects of mountain tourist destinations. The appeal of mountain recreation destinations is determined by multiple mountain characteristics which include ‘diversity,’ ‘niche,’ and ‘accessibility’ (Nepal and Chipeniuk 2006). We used these interrelated characteristics to determine how Mt. Ascutney fits into traditional metrics that are usually used to define mountains.

Mt. Ascutney is an extremely ‘diverse’ mountain because it has micro-variations in both physical and social aspects. Mt. Ascutney’s user base is highly diverse in terms of athletic ability, income, and hometown. The physical area of Mt. Ascutney is naturally diverse in its plant and animal life, as well as in the recreational activities it can support. Ascutney provides activities in all seasons, including frontcountry and backcountry skiing in the winter and mountain biking and hiking in the summer. The leaders of Ascutney Outdoors and STAB can capitalize on the diversity of the mountain resource to cater to users who are interested in a range of recreational activities and natural settings.

Multiple authors cite the importance of diversification in mountain tourism destinations both in order to create a competitive advantage as well as to combat the challenges posed by climate change (Palm 2000). Flagestad and Hope (2001) note that there are many mountain tourist destinations clustered throughout the country, which increases the importance of each mountain finding its particular competitive advantage. They define the “Resource Based View” of competitive advantage, as mountain tourism destinations deriving competitive advantage from the ownership of a valuable combination of resources (Flagestad and Hope 2001). Mt. Ascutney uses this resource based view, leveraging its stunningly beautiful natural area that has the

capacity to support a diverse range of activities and users. Similarly, Nepal and Chipeniuk emphasize the mountain characteristic 'niche' which can be defined as "the relative or absolute comparative advantage afforded by particular locations and areas for recreation activity specialization" (Nepal and Chipeniuk 2006, 319-20). It is imperative for Mt. Ascutney to find its niche within the greater network of mountain destinations in the north east by building upon its image as a mountain that fits with "Spirit of Vermont."

'Accessibility' is another crucial mountain tourist destination characteristic. Nepal and Chipeniuk explain, "difficult to access and relatively underdeveloped infrastructure within mountain regions have traditionally restricted the external linkages of mountain economies" (Nepal and Chipeniuk 2006, 318). Mt. Ascutney is working to rebuild their external linkages to the greater mountain tourism industry, however, currently they can be characterized by a fairly insular community. Accessibility can be defined as geographic accessibility as well as the accessibility of immediate use. The proximity to Interstate 91 and major population centers such as Boston and smaller urban areas such as Burlington may increase the perceived accessibility of the mountain, however it has not been proven to have a direct impact on increased use (Palm 2000). Easier access to remote backcountry skiing areas can help attract more users who are interested in a rustic, authentic Vermont experience.

Flagestad and Hope (2001) and Nepal and Chipeniuk (2006) helped us determine four important aspects to consider when conducting our collective case study on mountains that are similar to Mt. Ascutney. These characteristics are sustainability, accessibility, diversity, and comparative advantage. We return to these characteristics in our discussion and cross-case analysis.

1.3 Collective Regional Case Studies

1.3.1 Case Study Methodology

In order to answer the primary research question, "What can Mt. Ascutney do to create a comparative advantage by imitating the most successful organizational aspects of competition while leveraging their own unique resources and recreational offerings to revitalize West Windsor?" we conduct a collective case study. A collective case study focuses on a single topic using multiple sources to illustrate different approaches (Creswell 2007). We chose which cases to study based on Creswell's "purposeful maximal sampling" methodology, choosing cases that show different perspectives on the same activities in order to glean the most insight. After conducting an initial round of research, we decided to narrow our focus to Whaleback and Magic mountains for our skiing cases, and Kingdom Trails and Killington Mountain Biking Club for our mountain biking cases. Whaleback and Magic, although larger operations than Ascutney, offer insights into ski area management. Kingdom Trails and Killington Mountain Biking Club are similar to Ascutney in that they are part of the VMBA. However, there is variation across all three cases in terms of miles of trails, range of difficulty, and reputation.

The case studies of Whaleback, Magic, Kingdom, and Killington are bounded spatially and temporally. We identified mountains only in Vermont and New Hampshire within a one-hundred-mile radius of Mt. Ascutney. In the individual assessments of each mountain we focused only on the physical area of the mountain, not the surrounding area or towns. When researching the history of each mountain, we limited our study temporally by focusing only on the past five years.

We collect data on each of the mountains we studied from multiple sources including, information from mountain websites, social media pages, newspaper articles, images, and

interviews. We analyze this data holistically, describing many different aspects of each of the mountains we studied. Finally, we do a "cross-case analysis" of the four mountains, highlighting key themes, strengths, and weakness of each mountain. We compare these themes to Mt. Ascutney in order to make suggestions for future planning for existing recreation (Creswell 2007).

1.3.2 Whaleback Skiing

Whaleback is a small ski area located in Enfield, New Hampshire, easily accessible on I-89. Locals revere Whaleback for being a rootsy hill that offers a chance to enjoy terrain fun for beginner to expert skiers and riders at an affordable price. Whaleback caters to young racers in training, adult race leagues, and has a well-respected freestyle training program operated by accomplished athletes. However, after several bankruptcies in its 60-year history, it is still struggling to find its niche and a sustainable economic model. Its tenuous past has involved many forms in various attempts to achieve viability and success. In the era from 2005-2013 the focus was on offering a premier freestyle sports experience with planned construction of a state of the art indoor training facility in 2005-2006 under a new owner. Unfortunately, several investors pulled their financial commitments and a loan was denied. Fickle weather, on top of trying to offer more park features to an extra-local demographic, furthered the difficulties new ownership faced. Eventually debt caught up with the new ownership, and Whaleback closed after the 2012-2013 season, forcing current ownership to liquidate its assets prior to the land being foreclosed on (Conark 2015). In the summer of 2013, the non-profit "Upper Valley Snow Sports Foundation" (UVSSF) was formed and raised $200,000 to reopen the mountain for the next season, agreeing to run the mountain for a year, and purchase it for $650,000.

Whaleback offers 700 vertical feet accessible by a lift, routing skiers to 30 maintained trails, in addition to set routes for backcountry skiers to hike up. Whaleback is open for downhill skiing with lifts running Tuesday through Friday from 1:00 pm to 8:00 pm and weekends from 9:00 am to 4:00 pm charging $25 for a day pass. Whaleback has a formalized uphill skiing policy which allows for backcountry skiing at times when the mountain is not running. If users hike up the mountain they can ski for free. Whaleback suggests a donation through their website if you utilize the backcountry trails, but nothing is mandatory (Whaleback Mountain 2016). Whaleback is trying to expand this aspect of their offerings as they realize it growing in popularity beyond the gritty, dedicated locals.

Whaleback has a very impressive presence on social media, communicating openly with its followers in the local area. Whaleback's Facebook page has 3,600 people who have "liked" the page. The top of the page boasts a 4.6/5 star review based on 85 reviews. They post regularly, at least twice a month even during May. Their most recent post asks for local support for their capital fundraising campaign and is very transparent regarding the struggles the mountain faced during the El Niño season of 2015-2016. During the winter their posts offer snow reports and operation hours changes due to inclement conditions, this is a great way to alert potential users of the conditions before they travel to the mountain. Whaleback's Instagram page however is much more sparse, with one-tenth the following at 343 followers. Their posting here is also more infrequent and there has not been a post in the last 3 months. During the winter months, posts were more frequent and the same posts that were also uploaded through Facebook. Ascutney may be able to successfully implement a social media presence that alerts locals of interesting events, conditions, and communicates otherwise important information to their dedicated local users.

Rob Calhoun is a member of the board for the Upper Valley Snow Sports Foundation, the non-profit that owns and operates Whaleback Mountain. He is a self-proclaimed "business fixer" and has tackled many projects similar to Whaleback, taking struggling businesses and transforming them into success stories.

One of the major distinctions Rob made was the difference between Whaleback and Ascutney in terms of starting place when their respective non-profits took over. He stressed Whaleback was a "restart", whereas Ascutney was a "start-up." Whaleback never lost its major infrastructure the way Ascutney had lost its lifts and lodge. Rob talked about the acquisition price of any mountain in New England being much more than the price paid for the land, as things like long-term, delayed maintenance must be considered. In Ascutney's case, it seems as though there are many long-term maintenance operations, such as certifying the lift anchor foundations are up to code, that need to be completed on top of building new infrastructure.

Rob explained how Whaleback had briefly lost track of the core business and aspects of the mountain that made them who they are. He told stories of the first couple years after acquiring the mountain when much of the fundraising money went toward building a new porch on the lodge and refitting the kitchen inside. Rob warned against straying from the economic driving pillars of activity at the mountain, using this as an example where Whaleback focused too much on ancillary pieces instead of developing their core identity.

Rob attributed some of their more recent struggles to slow winters in terms of snow precipitation. Whaleback was only open 51 days in the 2015-2016 season instead of their targeted 90-95 days. Snows late arrival allowed for more work to be done in the offseason, however they lost nearly half their season, most importantly the holiday season. This loss really hindered their revenue stream and made it difficult to fundraise based off lackluster annual

performance. UVSSF is constantly fundraising and pre-selling next year's season passes to supplant the previous year's losses; perpetuating a vicious cycle that only becomes more vicious when weather is uncooperative. To assuage some of this harshness, Whaleback seeks contracts with local schools, Cardigan Mountain School and others, to use Whaleback as a training and racing site. This pre-contracted income helps pad losses in bad weather years and boosts influx of users in good weather years. Ski racing remains a major focus as the new general manager takes the reigns and alters Whaleback's vision.

The new general manager has emphasized that Whaleback cannot be everything for every person. Therefore, he is working to refine Whaleback's business to perform at top levels in its more narrow focus. For example, opening between Thanksgiving and Christmas is crucial to front-end load season and capture early season ski hype from families with children on break from school. Next is the focus on night-skiing, a unique offering, and the afternoon focus of middle and high school ski races. Finally, Whaleback has decided to move towards a "surface-lift" that allows users to gain access to 80% of the mountain. This is a financial decision as it is much cheaper to operate and insurance remains lower when patrons are not dangling in the air. It is believed by Rob, the new general manager, and the rest of the board that this narrowing of breadth will help Whaleback succeed in offering top-notch experiences in their activities of focus

1.3.3 Magic Mountain Skiing

Magic Mountain, founded in 1960, is a 1,700 ft. downhill ski area in Londonderry, VT. Due to a bad snow season, Magic closed in 1991 until a group of investors, now called Magic Mountain Management LLC, bought and revitalized the mountain in 1996. Although climate change poses challenges from unpredictable snowfall, Magic has run a successful ski operation, and has recently expanded to include snow tubing and uphill skiing. Magic Mountain now offers

43 trails accessible by six lifts, which cater to all levels of skiers. Skiers can purchase a day pass for $58 and a combined skiing and snow tubing pass for $70. Magic Mountain is a unique ski area that is beloved by many both in Vermont and throughout New England. Nathan Allen, for Ski The East, wrote in 2013 that what distinguished Magic from other Mountains is its steep terrain, uphill skiing policy, and vibrant local culture (Allen 2013).

In April 2016, Magic announced that a deal is underway with Ski Magic LLC to purchase and operate the mountain (Magic Mountain Facebook Page). Ski Magic LLC has plans to improve the chair lifts and snowmaking system. The announcement of the deal on Magic Mountain's website states that: "SKI MAGIC LLC is committed to keeping what makes Magic special: unmatched ski terrain in southern Vermont; a "throwback" skiing experience without the soul-crushing crowds found at mega-resorts; and, most importantly, a laid-back, welcoming ski community "vibe"—all while providing new capital to turnaround what has held it back over the years: reliable snow-making and lifts over a longer season" (Magic Mountain Resort, LLC 2016).

In the winter of 2015, Magic Mountain established a "Hike One Ride One" policy, which gives skiers who "earn their turns" by hiking up the mountain, one free lift ride. Magic Mountain Management LLC's press release from February 2, 2015 states: "Effective immediately, any uphill skier or split boarder who successfully climbs the 1,700 vertical feet to our summit will receive a complimentary token good for a single lift ride (limit one per day, valid only same day). Simply announce to the lift operator at the base that you intend to climb up, climb to the summit and our summit lift operator will give you a Free Turns token, which can be redeemed by the previously notified lift attendant for a free ride back up on the chairlift!" (Magic Mountain Resort, LLC 2015). Furthermore, insiders who know about the policy take advantage of the

mountain being closed Monday-Wednesday by hiking up the mountain and skiing for free with the mountain all to themselves (Reimers 2015).

In the warmer months, Magic Mountain is home to the TimberQuest zipline course. In 2012, Magic Mountain began a partnership with TimberQuest "to bring year-round challenge and adventure to its tree-lined slopes" (First Tracks!! Online Media 2012). TimberQuest provides multiple zipline courses as well as different levels of ropes courses (First Tracks!! Online Media 2012).

The Magic Mountain base lodge is home to Black Line Tavern, a restaurant and a full service bar. Companies or other large groups can rent the ski mountain or the TimberQuest area for the day, and then host a party at Black Line Tavern. The Tavern is open on Thursday through Sunday year round, and hosts apres ski live music every Saturdays during the winter. Black Line Tavern serves as a community gathering spot for skiers. Nathan Allen, in an article for Ski the East's website, writes, "Skiing can be a solitary sport and we often share the experiences of the day either on the chair or in the bar. The Black Line Tavern is one of the most vibrant ski lodge bars I have ever seen. Many of the customers seem to know one another, know the bartender" (Allen 2013). Allen quotes David Healy, one of the bartenders and an avid skier, saying "We all like to socialize, like to drink, and The Black Line Tavern is where it is happening" (Allen 2013).

Magic Mountain has a Facebook page, a twitter account, and an Instagram account. The Mountain uses its Facebook page, which has 7,647 followers, to post pictures and advertise events, with many posts throughout the winter months. The mountain's last post was on April 22nd. Magic's twitter, with around a thousand followers, similarly has many posts in the winter months, but fewer beginning in April. The Instagram account is used much less frequently, the last post being from 10 weeks ago.

Magic Mountain is frequently mentioned on MassLive.com, a local news site for western Massachusetts, which shows that Magic does have many out of state users. Magic is also a popular ski destination from Boston. Magic won best ski area in *Boston A-List*'s "Ski Slope Showdown" in 2014 (Boston A-List City Voter 2014) and 2015 (Burke 2015), and the results have not yet been released for 2016.

Magic Mountain has received many online reviews, and it is clear that the Mountain has greatly improved its operations within the last five years. In 2008, Skiing Magazine gave Magic a good review, highlighting some of its more interesting trails and backcountry access, but noted that "Some folks in southern Vermont have a "tragic" nickname for Magic Mountain because they think the 135-acre ski area—which has suffered closures and sketchy management in the past—deserves better" (Tuff 2008). More recently, however, Magic has been cited as one of the country's best mountains and compared with larger mountains on both the east and west coast. Outside Magazine's 2016 Ski Report calls Magic Mountain the "Powder Capital of the East Coast" (Reimers 2015). Unfortunately, 2016 was a very bad snow year for the east coast, and many news articles cover the poor conditions and how eastern ski mountains suffered this past season.

1.3.4 Killington Mountain Biking

While Killington Mountain Resort is primarily known as the largest ski area in the Eastern United States, earning the nickname the "Beast of the East," this case study will focus on the mountain biking at and around the resort. The Killington mountain biking operation was established 25 years ago and currently consists of 45 miles of lift-access downhill mountain biking. In comparison to other mountains in the area, "Killington has the highest start-off point of any mountain bike area in the state, with trails starting at its 4,241-foot summit, attainable by a

combination of the K-1 Express Gondola and pedaling" (Gardner 2015). In response to changing climate and subsequently shorter ski seasons, Killington Mountain resort has worked to increase summer month activities, spending "more than $3.5 million this year on non-ski attractions like the expanded, lower level mountain bike trails, a new $2 million "Alpine Coaster," a multi-level ropes course and a high-speed zip line" (Keck 2015). Killington has been investing greatly in the growth of mountain biking, designing three new beginner trails for the 2015-2016 season and implementing a "Learn To Ride" program for newcomers to the sport. Michael Joseph, a Killington spokesperson commented, "Summer operations, which is the mountain biking, the coaster and other activities, is up over 130 percent over levels last year. And that was growth we were expecting, from the size of the investment" (Keck 2015). As the resort continues to build trails they are able to leverage their relationship with the Town of Killington.

Killington resort has formed a partnership with the town of Killington in the development of Killington Mountain Bike Club (KMBC), established in mid 2014. Ben Colona, President of Killington Mountain Bike Club, explained the growth and development of this new program. In the past year and half, the club has exploded. By partnering with Vermont Mountain Biking Association (VMBA) and the State of Vermont, the club has established permits for trail expansion. The trails will be built along Kent Pond with the intent of connecting the Killington Resort routes with the rest of the community (Cudabac 2016). Kim Peters, Recreation Director for the Town of Killington explained in an interview with the Vermont Journal, "Over fifteen miles of mountain bike trails weaving through the forest will be accessible once the development is finished, providing a fun exercise with a priceless view through the lush forest landscape Vermont is so well known for" (Cudabac 2016).

There are three phases of this project, Phase 1 beginning in July 2016 consists of building two miles of completely introductory, machine made trails, meant to be non intimidating to a brand new rider. These trails will be wide and very smooth due to the machine made capabilities. The next two miles to be built in Phase 1 will be meant for "beginner riders" who are able to work up from the introductory paths. The Vermont Journal article explained, "Phase 1 of the project costs an estimated $100,000 - $120,000, and funding for the project will come from the Town of Killington, KMBC, grants and individual donations" (Vermont Journal 2016). Phase 2 and 3 are planned to be added in the next year with increasing build up of advanced cross-country trails. As the project continues to grow and expand there will be a need to maintain fundraising. Ben Colona explained that these manmade trails have become extremely popular and highly demanded by newcomers to the sport because of their width and smoothness, however Ben noted that they are much more expensive to create. After these trails are completed, little financing will be necessary as they will rely on volunteer efforts for maintenance, similar to the STAB model at Ascutney. With these trails, they are attempting to fill a new niche; a niche that currently has limited competition.

In a phone interview, Ben Colona explained, the fundraising strategy has been a priority from the beginning of operation conception. The newly developed KMBC has raised over $50,000 in grants and additional fundraising to establish a 501c mountain bike club operation. In addition to funding from VMBA the club has put on a series of events. The first series is called "Rolling Fatties" held in March of both 2015 and 2016. The event cost $50, which included a fat bike rental, 2 drink tickets, food, t-shirt, raffle tickets and a chance to win the Fat Bike. The event was co-sponsored by eight other local businesses and consisted of a ride down an easy road course down to Sushi Yoshi for drinks, dinner and celebration. The events were promoted

through the co-sponsors as well as on social media (Vermont Biking Association 2015). The raffle model proved to be very successful and contributed a large sum to the overall fundraising effort. In addition, they put on an event titled "Killington Up & Downhill Roll," in two iterations in October 2015 & 2016. The event was a relay-style race, with three riders on a three leg course. The event was advertised and explained primarily in a Facebook event, "Three person teams consisting of 1 road rider, 1 cross country rider, and 1 downhill rider can compete. The winning team members will receive a Killington 2015-16 Blackout Ski Pass!" (Killington Up & Down Hill roll Facebook Page 2015). Individual Riders were also welcome to join any leg of the race and prizes were awarded to the top individual riders. Again, the event was co-sponsored and supported by local businesses and had a registration fee of $30 per rider.

Ben explained, the club was put in place to fill the demand for a cross-country trail network in the local community. The goal of the club is to grow the mountain bike sport and support other VMBA associated trails to establish Vermont as the mountain biking hub of the east. As Killington is located in a centralized location in Vermont, they see themselves as having the ability to be the center of traffic flow to a variety of VMBA supported trails in the local area. They are taking an incredibly cooperative approach by welcoming all local Vermont partnerships in hopes that foster the growth of the mountain biking network in the North East.

1.3.5 Kingdom Trails Mountain Biking

Kingdom Trails, situated next to Burke Mountain Ski Area and located just a few hours from Boston, Massachusetts and Montreal, Canada, has developed into a renown attraction to the mountain biking community, now attracting avid bikers from all across the country. As mountain biking's popularity has increased over the years, Kingdom Trails has progressed similarly. Their users and members have continued to gradually increase throughout the years as Kingdom Trails

has continued to improve and create additional trails to match their demands. Unlike the other recreational mountains examined in this case study, Kingdom Trails' primary recreational focus is not downhill skiing. Instead, Kingdom Trails focuses primarily on adding to, maintaining and improving its mountain biking trails in the summer and its fat tire biking and backcountry skiing trails in the winter. Burke's ski area and Kingdom Trails have developed in conjunction with one another over the past couple of decades, and now provide a steady source of revenue for the town during all four seasons; in the winter months, the town relies on the population attracted by the ski areas while in the summer months, they rely on the demographic attracted through Kingdom Trails. The following section is the result of a phone interview with Mr. Tierney who volunteered his data for this study.

The Kingdom Trails mountain biking trail network is unique because the majority of its 100 miles of non-motorized trail network runs through the private property of 60 individual landowners. Initially, the town's citizens were reluctant to allow public recreation on their lands. However, once they realized the overall benefits for providing year-round recreational activities, they gradually began to allow the public use of their private lands. Kingdom Trails Association has received permission, in return for their services in maintaining the trail system, to run and operate the trails for public use and benefit. Since being afforded the opportunity through public funds and grants to hire Mr. Tierney as the first full-time employee in 2004, Kingdom Trails has added an additional 4 full-time members and has 17 seasonal employees as well, most of which are employed in the summer. According to Tim, Kingdom Trails' early development was hindered by the lack of a dedicated full-time staff. However, through the early support of government grants, donations and user revenues, Kingdom Trails has since hired a dedicated staff and seen an explosion in the expanse of their trails, popularity of the system and volume of

users. Furthermore, the addition of a full-time staff has allowed Kingdom Trails to conduct a number of studies and surveys to help guide the mountain's future development. The data they have collected through these studies over the years has been instrumental in further improving the Kingdom Trail's recreational experience.

According to Tim, Kingdom Trails developed in close conjunction with the town of Burke and its constituents. Burke's economy has historically been centered around winter-recreation, but the addition of Kingdom Trails and its mountain biking trails has proven to be a welcome complement, and in years when the weather significantly inhibits winter recreation, a welcome hedge to the local economy. The citizen's entrepreneurial nature has complimented Kingdom's development well, and a number of businesses associated with outdoor recreation have formed as a result of increased recreational activity in the area. Although initially concerned the added volume would affect Burke's small-town atmosphere, the town has adjusted well and successfully absorbed the additional tourist volume. More recently, development has showed no signs of slowing as Burke's recreational activities continue to attract more users, as more than twelve businesses have opened over the last two years specifically to cater to the mountain biking community; these have come in the form of lodging, restaurants and bike shops. Similarly, Mr. Tierney indicated that there are around 146 local homes being rented out to bikers that utilize Kingdom Trails, and on average they spend $135 per night on lodging. Additionally, he has recently identified a trend of people purchasing homes specifically because they are located next to a mountain biking hub, just as people have similarly tended to purchase homes for their proximity to ski resorts and golf courses in the past. Furthermore, Mr. Tierney noted outdoor recreation is relatively insensitive to broader economic conditions because of its low cost in relation to other touristic activities. He indicated that during the recession of 2008 and

2009 the town's tourism operations did not suffer nearly to the same extent as other industries and locations. On a similar note, Kingdom Trails has found success attracting users to the mountain by hosting events. However, as a further hedge against periods of low tourist traffic, they tend to plan these events during periods of time when they do not expect many incoming visitors to Burke.

According to Mr. Tierney, Kingdom Trails accommodates approximately 75,000 user visits during the mountain biking season. The mountain does require a small usage fee; day passes are available for $15, year-round individual passes for $75 and year-round family (same household) passes for $150 (Prices & Member Info 2016). Furthermore, in order to increase the accessibility and user friendliness for all demographics, Kingdom Trails began an all-day shuttle service to the top of the mountain with a $5 single user fee or a $20 all day pass. Day trail-use memberships are the largest source of revenue for Kingdom Trails, and when combined with annual memberships, have allowed the mountain to transform from an entity reliant on grants and public funding for survival to a largely self-sufficient organization. Annual memberships have continued to increase over the years, but over the past five years have remained relatively steady at around 3,200+ members. Currently, there are around 3,400 annual members, and the average member visits around 12 times per year. In general, the average stay for a Kingdom Trails visitor is 2.3 days, the average group size is 5, and the majority of its users come from within a 300-mile radius of the mountain. Furthermore, once someone visits Kingdom Trails one time, they often return again, with many visitors returning three to four times a year. A significant proportion of Kingdom Trails' tourists are from either Boston, Massachusetts or Montreal, Canada.

As briefly mentioned earlier, Kingdom Trails is widely regarded as a great trail system for more experienced riders, but Mr. Tierney has noticed a recent trend involving increased trips of families with children. To accommodate the increasing popularity of this demographic, Kingdom Trails plans to add to its portfolio or beginner and intermediate trails. Additionally, the average group size visiting the mountain currently averages at five people per group. These groups typically either come together, such as families, or convene in Burke from separate locations, as in a group of college friends. As a result of this trend, the mountain and businesses in the area have found success in creating group offerings. Although there are a number of mountain biking trail systems found throughout the New England region, Mr. Tierney and the staff at Kingdom Trails do not view comparable mountains as competitors. Instead, they believe that any additional tourist volume contributes to the growing popularity of recreational mountain biking as a sport, and as New England continues to develop as a hub for mountain biking, it will continue to attract visitors from increasingly distant locations. Mr. Tierney specifically noted the increasing number of tourists from Western locations, such as Colorado and Utah, in search of new adventures, and he believes the growth of long-distance tourists is essential for continued development of the region because they tend to have longer visits (around 5 days) and spend more money as a result. However, Kingdom Trails' relatively lax opinions regarding potential competitors may result from their dominant position within New England mountain biking.

Social media at Kingdom Trails predominantly utilizes Instagram, Facebook and Twitter. However, the extent to which they utilize the three varies quite a bit. Their Facebook page, Kingdom Trails Mountain Biking, has over 14,000 followers and their profile has been characterized as being "very responsive to messages" (Kingdom Trails Mountain Biking Facebook page). Their posts serve a variety of functions such as sharing news articles about the

mountain and members, upcoming events, trail updates and general informational posts. Kingdom Trails Instagram, @kingdomtrails, utilizes similar posts of photos and videos from the mountain and is updated quite a bit during mountain biking season, with regular posts at least a few times a week, but not nearly as frequently during the offseason. Their Instagram account has around 3,600 followers and quite regularly receives over 100 likes on posted pictures (Kingdom Trails Instagram). In addition to their Instagram page, they have a location on their website that automatically leverages and collects every Instagram post from their users that includes the hashtag "#kingdomtrails", and displays it on their website for public viewing. Although they are noticeably active on their Facebook and Instagram pages, the Kingdom Trails Twitter page is relatively dormant, with only 17 tweets since 2014 and only 373 followers (Kingdom Trails Twitter).

Although social media is a common tool utilized for attracting new users to any organization or activity, Mr. Tierney stated that he did not see that as the primary function for Kingdom Trails accounts. While useful for marketing campaigns, Mr. Tierney envisions the primary function of the mountain's accounts as a tool for connecting and engaging the mountains existing users and informing them about important events, trail updates and general information about the mountain and its trails. Tierney and his staff at Kingdom Trails have found the most effective way of attracting new users is through small-scale advertising on social media and highway rest stops, and more importantly, ensuring users enjoy a satisfying visit to the mountain so they expand the user base through word of mouth.

1.4 Cross-Case Analysis and Discussion

In this section we analyze Mt. Ascutney compared to our collective case study and our literature review of global cases. We return to the key aspects that we determined from our initial research: sustainability, accessibility, diversity, and comparative advantage. We use this analysis to offer our community partners key takeaways that can direct their goals for development.

1.4.1 Accessibility

In a study done on Backcountry Skiing & Snowboarding Management Strategy the most important factor of accessibility sought after by mountain users is a designated parking area for skiers at the base of the mountain. This was prioritized over informational signage and directional signage on the mountain (Cochrane 2014). Whaleback mountain, as discussed earlier, has limited backcountry skiing opportunities. However, there is ample parking area for the use of frontcountry skiers. Magic mountain has a parking area at the lodge at the base of the mountain, as well as a small hotel called the "Upper Pass Lodge" (Magic Website 2016). Currently Mt. Ascutney is known to be very accessible because of the well paved roads, parking lots at the base and at each trailhead, and signage. However, they can continue to improve with the construction of a gathering space which would allow for a stronger community information network.

Due to the nature of mountain biking as an effective means of transportation, parking lot distance from the trailhead is much less of a concern to mountain biking users. However, a survey conducted in the Manawatu region in New Zealand presented a series of findings related to planning and management of mountain biking trails that can be applicable to Mt. Ascutney (Mason and Leberman 2000). The desire for more accessible mountain biking trails for users to explore was highlighted in the survey responses stemming from the adventurous nature of the sport. This points to the reasoning behind Killington Mountain Biking Club's decision to build a

network of trails connecting all levels of expertise. Similarly, to make their trails more easily accessible and improve the user experience, Kingdom Trails has implemented a fee-based shuttle service to quickly transport mountain bikers from the bottom of the mountain to the top. Again, Mt. Ascutney can leverage their vast trail network and informative signage system on the trails to promote their accessibility in marketing and outreach materials.

A peer-reviewed case study of winter recreation areas in the French Alps reveals the importance of accessibility in terms of amenities, accommodations (Tuppen 2000). Tuppen (2000) writes that winter recreation tourists do not travel to a resort in the Alps for the sole purpose of skiing; tourists want to have access to other activities, as well as good restaurants and bars. In terms of accommodations, Tuppen (2006) writes that visitors to the ski resorts in the French Alps complain often that developers sold so many apartments as second homes, that many of the apartments close to the slopes remained idle for most of the year. They said that there were not enough well-located apartments available for rent and not enough hotels. As Nepal and Chipeniuk (2006) discuss, mountain tourist destinations should try to mitigate conflicts like these between local residents and amenity migrants. Finally, the authors suggest that developers in the French Alps should focus on improving the accessibility of the resorts by increasing highway access and parking areas (Tuppen 2000). Nepal and Chipeniuk (2006) also emphasize the general importance of accessibility to sustaining mountain recreation businesses operations.

Mt. Ascutney is currently working on improving its amenities and accommodations. The collaborators in the development project are hoping to build a welcome center and warming station, discussed further in Chapter 3. Partners of Ascutney Outdoors should also examine whether there are enough hotel rooms and rental condos available through Orange Lake near the

slopes for increased traffic. In terms of accessibility of the trails, Mt. Ascutney hopes to, in the future, partner with Orange Lake to build a lift from the hotel to the base of the mountain.

1.4.2 Sustainability

As we have mentioned, ecological and economic sustainability of mountain operations will be increasingly important as climate change becomes a larger threat. Our community partners strongly emphasized sustainability at Mt. Ascutney in their decision making process. Furthermore, the model adapted from Flagestad and Hope (2001) (See Figure X "sustained value creation" figure), shows that ecological sustainability is actually an ingredient in economic sustainability.

Beaudin & Huang argue that changing trends in winter temperatures will heavily reduce snowfall and will ultimately lead to shorter ski seasons, increased capital costs and decreased profits. Pickering finds, "warmer years resulted in reduced natural snow cover, reductions in duration of ski season, increased reliance on snowmaking, decreased visitation and increased running costs for ski resorts" (Pickering 2011, 777).

There has been a significant decline in the number of viable ski areas on the North East in the past several decades. As seen in Figure X, the number of viable ski resorts in Vermont and New Hampshire decreased significantly over the course of the decade; changing weather conditions has decreased the competitiveness in the New England ski industry as many of the smaller resorts have simply failed or have been bought out and made part of larger ski resorts (Beaudin and Huang 2014). A 2001 study done by Palm found that 700,000 fewer tourists visited ski areas in New Hampshire and Vermont in years with lower snowfall compared to the years with the most snowfall (Palm 2001). Even this year, an article in the Boston Globe stated "...industry representatives and tourism officials in Maine, New Hampshire and Vermont

acknowledged business had shrunk substantially" and are waiting to hear final reported numbers (Adams 2016). Beaudin & Huang performed a detailed study of New England ski resorts from 1970-2007, and found larger resorts with more open lifts, more open trails and availability of snowmaking equipment are all associated with higher probability of long-term success. (Beaudin and Huang 2014).

As a result, ski resorts will have to start making much more snow than previously in order to maintain and prolong their ski season. Both Whaleback and Magic Mountain have snow making capabilities. However, these operations are only viable when temperatures are cold enough for long periods of time and there is access to a non-depletable water source to produce the snow.

1.4.3 Diversity

To combat the implications of climate change, mountains can, and are being forced to, adapt. As Beudin and Huang explain, "adaptation can be technological, such as investing in snowmaking equipment and slope development, or operational, such as creating diversified revenue streams by offering a variety of services beyond ski related activities in all seasons" (Beaudin and Huang 2014, 57). As seen in Figure X (climate change adaption strategies diagram), there are many different adaptation strategies for mountain resorts and communities to consider. It is becoming clear that lift ticket sales can no longer be the main source of revenue for the ski mountains, and they need to prioritize the diversification of both its activities and user base outside of the ski area. "President of Ski Vermont, the state's largest ski industry trade association, says resorts across the state have been investing big in recent years in off-season attractions" (Keck 2015); Many mountain resorts are adapting by expanding their business to be year round by installing zip lines, ropes courses, dirt biking tracks, frisbee disc golf and

expanded hiking trails as well as repurposing lodges to make it more attractive for their locations more attractive for hosting events (Bagley 2015).

The mountains we studied all took different approaches in diversifying. Killington Mountain Resort has expanded its offerings by adding activities that occur in all four seasons. Their activities include a golf course, mountain bike park, fat bike rentals, scenic gondola rides, a hang gliding ride called the "Skyeride," a grand spa, and an adventure center which includes disc golf, as well the "Beast Mountain Coaster" (Killington 2016). They have also formed a strong partnership with Killington Mountain Bike Club to provide their users a more diverse offering for mountain biking opportunities. Magic Mountain has partnered with TimberQuest Parks, which offers ziplining courses at the mountain from June through October (TimberQuest Parks 2016). Kingdom Trails, although not directly associated with the ownership of Burke Mountain's ski resorts, developed as an offseason compliment to the town's winter activities. Furthermore, Kingdom Trails has encouraged fat tire biking and backcountry skiing in the winter to diversify the seasonality of its organization-specific offerings. Conversely, Whaleback Mountain is choosing to narrow their focus. Rob Calhoun explains the new approach stating, "we cannot be everything for every person" (Rob Calhoun 2016). Whaleback is attempting to succeed by executing front country skiing at a high level, and relying on partnerships with local schools and race leagues to do so. Mt. Ascutney is in a good place to leverage the diversity of their existing offerings through events that promote their front country skiing as well as mountain biking. It is, however, unrealistic to think that Mt. Ascutney can rapidly expand its offerings through development of major infrastructure projects that would allow it to compete with the unique offerings at Killington and Magic.

Diversity of trail offerings at mountains is important for attracting all levels of users and catering to different users' preferences. Both ski and mountain biking areas should ideally provide a mix of manmade and natural trails, as well as a diversity of terrain. Mountains should also aim to provide trails for beginner, intermediate and expert users. Mason and Leberman (2000) conducted a survey of mountain bikers in New Zealand, which revealed the five most important features of mountain biking. These features were 1) skill challenge 2) exercise/fitness workout 3) exploration of new areas 4) physical challenge 5) riding/socializing with friends. In addition, the respondents noted their favorite riding conditions included "forested areas with a mix of uphill and downhill on single tracks with some technical difficulty" (Mason and Leberman 2000, 108). A survey by Cochrane (2014) showed that the backcountry skiers prefer ungroomed, heavily wooded terrain. The survey also highlighted that back country skiers want mountains to have specified backcountry ski zones that offer a variety of options for different user levels (Jonson 2014). All four of the cases we studied understand they should prioritize the development of a variety of trails when looking to expand, although each mountain has a different reputation and is able to fill a different niche.

There is also diversity in the user base of the mountains we studied. It is important to understand the current user community at Mt. Ascutney in order to direct how Mt. Ascutney should aim to be perceived by users, both current and future. Nepal and Chipeniuk (2006) define three user groups of mountain recreation destinations: local recreationalists, amenity migrants and tourists. 'Local Recreationalists' are those who pursue a variety of outdoor recreation in their area. They are categorized by long-term permanent residents who often have a strong sense of place and are firmly rooted in their community. 'Amenity migrants,' usually consist of second-home owners or new permanent residents who have moved to an area because of the natural and

social amenities found in that place. They develop a sense of place through experience, which may be similar to local residents, and therefore often have a high degree of communal life participation (Nepal and Chipeniuk 2006). The last group is 'tourists,' who are categorized by those who participate in short term outdoor recreation. This group does not typically become involved in the community.

At Mt. Ascutney there is a current user group of local recreationalists who feel strongly connected to the mountain as well as some amenity migrants that travel from other parts of New England and even the country. The tourist population is relatively low, however there may be room to expand into this user group in the future with a partnership with Orange Lake Hotel. The majority of the users surveyed lived in Vermont, but those who did not say they were willing to drive upwards of three hours to access Vermont backcountry skiing terrain (Cochrane 2014).

In thinking about user expansion it is also important to consider the potential conflicts that may emerge as the mountain evolves. Local residents, especially those that have lived in a place long-term often times can have mixed feelings about tourists and amenity migrants who come in and "drive up property values, increase prices for use (especially lift ticket prices) and compete with locals for recreational space" (Nepal and Chipeniuk 2006, 322). There is also the concern of socioeconomic conflict arising from the differences between the low-to-middle income locals and amenity migrants who may buy out properties or exert influences that are unappreciated by the existing local community (Nepal and Chipeniuk 2006). Mt. Ascutney has an extremely loyal local user population and a vibrant local culture. At the same time, they hope to attract more users from a broader geographical radius, our community partners emphasize that civic engagement and the character of the local community must remain strong.

1.4.4 Comparative Advantage

Lastly, we noted that each mountain has defining characteristics that are unique and help position them to succeed in the saturated market for mountain recreation areas in New England, each attempting to win over customers and devoted users. For each mountain we studied, including Mt. Ascutney, we assessed its competitive advantage and the niche it fills by asking the crucial question, "What makes this mountain special?" Ultimately, this question led to answering our research question "What can Mt. Ascutney do to create a comparative advantage by imitating the most successful organizational aspects of current competition while leveraging their unique resources and recreational offerings to revitalize West Windsor?"

In backcountry skiing, Ascutney is well-renowned and highly regarded as a premier destination in New England. Of the mountains we studied, only Killington topped Ascutney in its vast backcountry offerings. However, Killington's access to backcountry trails and glades are mostly through it's lift system, meaning lift tickets are still necessary. Furthermore, many users emphasize that they have chosen to avoid the expensive, well-maintained larger mountains such as Killington and Stowe in favor of a cheaper, more natural alternatives (Cochran 2014). In this way, Ascutney has carved a unique niche for itself by offering top-notch backcountry skiing for free. One of Ascutney's main advantages is its low operating costs because they do not have any employee wages to pay. Therefore, Ascutney is able to cater to a wide range of users, and prides itself on its affordability. Even if Ascutney strongly recommends a donation, their skiing value proposition would still be higher than Killington's and Magic's.

In mountain biking, Mt. Ascutney is well-known in the New England region for its wide variety of natural trails. Currently, however, the mountain is associated primarily with intermediate to expert level trails, and this connotation can discourage beginners or those new to

the mountain from making the trip. In fact, Mt. Ascutney does offers some beginner level trails and is planning on creating more. The mountain should target their marketing towards clarifying their trail offerings and bolstering their image as a family friendly, diverse mountain biking area. At the same time, it is crucial for Mt. Ascutney to ensure their marketing efforts do not alienate their existing user base. Although Ascutney has not reached the same level of notoriety as the region's leading mountain biking destination, Kingdom Trails, it has the ability to offer the same quality of mountain biking trails, but without the larger crowds that swarm to Kingdom Trails during the season. Additionally, Ascutney is in a relatively accessible location in comparison to the remoteness of Kingdom Trails, with just a couple hours of travel time to Boston, and a number of surrounding small towns and communities.

Tuppen (2006) writes about the advantages and disadvantages of small mountain in the French Alps, which can be applied to Mt. Ascutney's position compared to other mountain in the northeast. Smaller mountains cannot compete with the larger ones in terms of facilities and tend to consistently have poorer ski conditions resulting from their lower altitudes. Tuppen (2000) suggests that smaller resorts should diversify and offer more activities besides just skiing. He writes that smaller resorts can even have an advantage over larger ones because they have more vibrant local cultures which appeal to more visitors. In this vein, Mt. Ascutney cannot compete with larger ski resorts, like Killington, in the Northeast and so it should focus on advertising the wide range of summer and winter outdoor activities it already provides. Mt. Ascutney should continue to communicate itself as a diverse, affordable, recreation area with a vibrant local culture.

1.5 Takeaways

This section aims to finally answer our overarching research question, "What can Mt. Ascutney do to create a comparative advantage by imitating the most successful organizational aspects of current competition while leveraging their unique resources and recreational offerings to revitalize West Windsor?" Based on our comparisons of Mt. Ascutney with regional mountain biking and skiing operations, combined with insights from global case studies and surveys of mountain bikers and backcountry skiers, we have come up with key takeaways that will be useful to Mt. Ascutney as it continues to develop.

- Diversification of recreational activities: *Mt. Ascutney has already diversified as it currently offers mountain biking, hiking, backcountry skiing, and snowshoeing. Mt. Ascutney should continue to focus on providing activities year round, not just in one season.*
- Development of a "family friendly" mountain: *Mt. Ascutney is currently viewed by users as a challenging mountain biking area. It should aim to provide trails that cater to a wide range of user levels, in order to attract beginners as well as experts. This will require marketing the mountain as family friendly, and may require building new trails to that end.*
- Accessibility of trails via lifts: *Mt. Ascutney already has a rope tow, which they plan to continue to maintain and keep free. In the long run, Mt. Ascutney should work on adding a lift from Orange Lake to the base of the mountain to improve the accessibility of the trails to visitors staying in the hotel or condos. Our community partners have also expressed a hope that they can add a poma lift, which will open up access to more skiing trails.*
- Implement a "suggested donation" to support operating expenses: *As Mt. Ascutney continues to expand its operation, by adding lifts and attracting more users, a greater level of maintenance will be required, which will in turn increase operating expenses. In order to cover these expenses, Mt. Ascutney should build more donation boxes around the ski area and have a <u>strongly</u> suggested donation, which puts social pressure on users*

to pay for access to the mountain biking and skiing trails. Our community partners have suggested a $15 or $20 donation, which is still far less than any large scale ski resort or lift-access mountain biking area.

- Expand amenities and increase community gathering by building a base camp: *Mt. Ascutney has plans to build a base camp (discussed in Chapter 3), which will provide a place for skiers and mountain bikers to rest and gather after their day on the trails. Mt. Ascutney can also hold events at this basecamp. Strengthening of the recreational user community will be important for increasing satisfaction of users and their loyalty to Mt. Ascutney.*
- Market Mt. Ascutney with the taglines "Spirit of Vermont" and "Vermont as it Used to Be": *Our community partners have emphasized they want Mt. Ascutney to remain a rustic, casual, affordable mountain that celebrates outdoor recreation. They do not want to attract too many tourists, as they believe it is important that Mt. Ascutney continue to provides its users with the experience of biking and skiing alone in nature. Mt. Ascutney hopes to attract dedicated users, and should improve its marketing and public outreach to do so. Mt. Ascutney should market itself as a mountain that embraces the "Spirit of Vermont" and "Vermont as it Used to Be." As this chapter has revealed, there is demand for this type of community-mountain atmosphere in the mountain biking and skiing communities.*

1.6 Conclusion

Mason and Leberman (2000) argue that economically and ecologically sustainable tourism is only possible in instances where community preferences are valued. The authors highlight the importance of "iterative planning," in that after each stage the plan should be able to adapt and change; managers need to be le able to learn how to be most effective in terms of goals, objectives, and actions of the policy on the community. The overwhelming answer to the survey question "Do you think the sport of backcountry skiing/riding is important to Vermont (ex.for Vermont's economy, health and wellness, etc.)?" was yes (Cochran 2014). Many locals

believe sustainable tourism is crucial for Vermont's economy, especially for increasing traffic in local restaurants, bars, and shops. One of the qualities that our partners stressed to us regarding Mt. Ascutney was its charm for those who hold it dear. We want to be able to improve Mt. Ascutney's current activities without losing touch with the small mountain, "Spirit of Vermont" feel. With strategically planned next steps, constantly focusing on economic and ecological sustainability while providing the best experience at a reasonable price, Ascutney has the potential to truly become a modern version of Vermont as it used to be.

Chapter Two

Non-Market Health and Wellness Benefits

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Chapter Two: Non-Market Health and Wellness Benefits

2.1 Introduction

We examine the non-market benefits of outdoor recreation and activity that can be used by the community in future grant proposals and arguments for the vitality of the mountain. We work with our community partners to determine the deliverable of an in depth literature review of non-market benefits to be used in the grant process.

This chapter outlines the non-market benefits associated with preserving recreational space and natural landscapes. Recently, the scientific community has begun to delve into the non-economic impacts of outdoor recreation and recreational development. Thus far, the evidence has overwhelmingly produced positive outcomes associated with increased recreational space, activity, and outdoor exposure. In addition to the economic development benefits, academics have empirically proven investments in outdoor recreation and preserving natural landscapes have a number of benefits—physical, mental and social—towards improving the region's population's overall health and wellbeing. In addition to the health and wellness benefits, natural ecosystems provide mankind with a number of ecosystem services that serve to offset anthropogenic pollution.

As mentioned above, outdoor recreation and experience provide measurable physical and mental health and wellbeing benefits. However, unless tangibly portrayed in economic terms or the number of beneficiaries, land managers, companies, politicians, society and important policy makers often make decisions without fully realizing their real benefits and consequences (Bonn, Rebane and Reid 2009). To account for these differences, Boyd created Green GDP—a financial account for valuing nature's services, excluding goods that are already captured by GDP—

because the benefits provided by a healthy, natural environment are simply too large and important to be left off of national accounting (Boyd 2007).

2.2 Physical Health Benefits

In 2008, the Sustainable Development Council (SDC) determined that the percentage of green space, defined as an area of grass, trees or other vegetation set apart for recreational or aesthetic purposes in an otherwise urban environment, is positively associated with their perceived general health. Additionally, people living in areas with high levels of greenery are three times more likely to be physically active and 40% less likely to be obese than those in low-greenery areas (SDC 2008). As America continues to become more urban, the resources endowments offered by rural areas, like open spaces, natural amenities, and small town values, become increasingly valuable (Deller et al. 2001). Furthermore, many of the health problems currently straining the government's already thinly-spread budget can be directly or indirectly improved by healthy green space. After all, nature is a drastically cheaper alternative and minimizes potentially negative side effects from prescription drugs. The World Health Organization defines wellbeing and health as a positive physical, social and mental state and a state of complete physical, mental and social well-being and does not merely imply the absence of disease or infirmity (SDC 2008). If the health of a government's constituents is in fact important to it, as is expected, then investing in the preservation of existing, and healthy, sustainable development of potential, recreational spots should be of high priority to local and state decision makers, especially considering the increasing challenges facing society with stress-related diseases (Velarde, Fry and Tveit 2007).

In 2006, over 56 million Americans, or roughly over 1/6 of the population, participated in trail-based activities (Coalter et al. 2010). As with any form of physical exercise, there are a

number of positive health benefits associated with outdoor recreation. Regular, moderate-to-vigorous physical activity has been found to improve physical health by reducing risk factors for disease. It has been found to provide positive impacts on the cardiovascular, musculoskeletal, metabolic, endocrine, and immune systems. Further, it can mitigate and prevent the risk of diabetes, certain cancers, hypertension, high cholesterol and osteoporosis (Coalter et al. 2010). In general, those who regularly participate in sports and outdoor activities self-reported significantly higher levels of general health than non-participants. These same participants were found to have increased VO_2 (maximum volume of usable oxygen), reduced risk factors for cardiovascular disease, decreased body weights, BMI and body fat percentage, and lower resting blood pressure. Furthermore, studies have shown that participation in physical activity is more important than its duration or intensity. Therefore, improving access to and quality of existing natural recreational areas should take high priority (Coalter et al. 2010). In a Dutch study, they found that a 10% increase in greenspace in the living environment can lead to an overall decrease in health complaints equivalent to a five year reduction in age (SDC 2008). Mountain/hill walking, in particular, present a relatively unique form of activity in which prolonged duration and varying intensities can place exceptional demands on the recreational participants (Coalter et al. 2010).

2.3 Mental and Psychological Benefits

In addition to the more obvious benefits associated with recreation and physical activity, there are also a number of less obvious psychological and social benefit associated with landscapes and their potential for use. Landscapes alone, without being used, have the potential to promote mental wellbeing through attention restoration, stress reduction and generation of

positive emotions. Abraham, Sommerhalder and Abel developed four characteristics of environments that provide restorative capabilities (Abraham, Sommerhalder and Abel 2009):

1. Enables people to distance themselves from their daily lives
2. Attracts people's attention without being exhausting
3. Enables the constant discovery and interaction with new things
4. Aligns with the intentions of their users

Interestingly, in order to benefit from the restorative powers of natural landscapes, it is not even necessary to venture into the wilderness. When humans view natural landscapes, they immediately, and unconsciously, release emotional reactions that significantly affect their stress recovery, a concept known as biophilia; visual confrontation has shown a restorative effect to viewing nature on mental fatigue in students and patients (Frumkin 2001). Furthermore, views of a natural landscape have been found to promote people's ability to express positive emotional feelings like joy and satisfaction more easily. Similarly, direct contact with nature provides opportunities for exploration, personal development and well-being, and stimulating feelings of relaxation, autonomy and competence. Furthermore, physical activity has been associated with reduced stress anxiety and feelings of depression, improved mood and self-esteem, and better overall cognitive functioning (SDC 2008). In particular, leisure and recreation were found to benefit the elderly more than any other demographic. For the elderly, regular physical activity can lead to enhanced reaction time in males, better cognitive function in males, and superior motor performance in women (City of Burlington Parks and Recreation Department 1993). The most likely beneficiaries of improved or increased physical activity or recreation are those with low self-esteem, physical self-worth and body image. In terms of self-esteem improvements,

younger peoples were found to have obtained the largest benefit, but in terms of mood improvement, middle age demographics improved the most (Coalter et al. 2010).

2.4 Social Benefits

Although limited in comparison, there is also sufficient literature on the social benefits of increased greenspace and outdoor recreational opportunities. In addition to the physical and mental aspects of physical activity, hill-walking generally involves an aspect of social engagement. Interaction with nature improves social well-being through aspects of social integration and the collective experience of nature(Abraham, Sommerhalder and Abel 2009). Moreover, increased physical activity and exposure to the natural environment has a deep effect on those on the fringes, or most vulnerable, within society. For example, Frumkin found that emotionally disturbed children and adolescents, bereaved individuals, rape and incest survivors, and patients with cancer, terminal diseases, PTSD, addiction disorders, and other ailments have experienced what's been termed "wilderness rapture", feelings of increased self-awareness, feelings of awe, wonder and humility, a sense of comfort in connection to nature, increased appreciation of others, and a feeling of renewal and vigor (Frumkin 2001). Furthermore, studies have shown systematic differences between individual youths in how, when and where they spend time, particularly away from home, may partly determine their likelihood of delinquent activity. The more bonds an individual has with society, the less he will be inclined to transgress legal and social norms and commit delinquent acts. Therefore, by encouraging further social integration through outdoor recreation, the State can effectively strengthen the bonds between community members and discourage delinquent activity and crime (City of Burlington Parks and Recreation Department 1993).

2.5 Conclusion

Clearly, as evident from the large body of published, peer-reviewed, academic articles, there are distinct and tangible benefits to preserving greenspace and the natural environment. By improving access to greenspace and measures to further protect natural greenspace for future generations, States can effectively improve the physical, mental and social well-being of their constituents. Additionally, although greenspace provision may require the use of public funds, the ultimate benefits, in terms of increased general health and well-being and the retention of public funds originally meant for these purposes, should far outway the initial investment costs. It is our hope that Ascutney and its community members may leverage the information provided in this chapter when applying for grants or public funding because the mountain's potential for providing a stimulus to the local economy and benefiting the health and well-being of users, both local and visiting, is substantial.

Chapter Three

Basecamp

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Chapter Three: Basecamp

3.1 Introduction

After acquiring 468 acres of land associated with the former Ascutney Mountain Resort, the Town of West Windsor, VT desires to create a community space near the base of the existing mountain. Mt. Ascutney provides outdoor enthusiasts with hundreds of miles of trails that are used for a variety of recreational activities including mountain biking, hiking, snowshoeing, and skiing. In working primarily with the Town of West Windsor, as well as Ascutney Outdoors and the Sport Trails of Ascutney Basin (STAB) organizations, it is clear that all stakeholders in this project wish to build a new lodge structure that would serve as a multi-purpose space for visitors of Mt. Ascutney. Our community partners are primarily concerned with gaining a better understanding of the value of building a lodge, the most appropriate and affordable construction design, and the general financial and physical barriers associated with this kind of project.

To gain a better understanding of the goals and deliverables desired from our community partners, we initially met with a variety of stakeholders associated with this project. We met briefly with Jim Lyall, who is involved with both Ascutney Outdoors and STAB; Martha Harrison, who works for the Town of West Windsor; Steve Crihfield, a finance-oriented member of Ascutney Outdoors board; and Laura Farrell, an engaged community member who has been very involved with the project since its conception. After meeting with the above-mentioned community partners, it was decided that Laura Farrell would serve as our "point-person" and primary contact moving forward on the lodge aspect of this project. We co-developed a set of deliverables and objectives that meet both the goals of the community partners, as well as our goals as researchers.

With this in mind, the construction of a new lodge at the base of Mt. Ascutney will serve as a multi-purpose space, a community meeting area, an educational space, a multi-sport support shop, and an events center. Our community partners are primarily concerned with building a lodge that will increase recreational and educational activity at Mt. Ascutney, impact revenue streams in the surrounding community, and serve as a face for the mountain. Additionally, our community partners are interested in designing a sustainable structure that can easily be built upon in the upcoming five years. In June 2016, our community partners involved with Ascutney Outdoors will be meeting with the Town of West Windsor, VT to propose one, three, and five year plans regarding the lodge construction and design. Initially, we worked with our community partners and proposed three possible locations for the construction of the lodge. As a group, we provided insight into the best location and creative design options for construction. After conducting a great deal of research, drafting proposed design ideas (Figures 1-3), and a series of meetings with our community partners, we were able to agree upon a final design idea that will be proposed.

To best serve our community partners, facilitate their goals, and provide them with beneficial insight, we are looking at the costs and benefits of this undertaking, primarily the market costs associated with the lodge construction. We are currently in the process of evaluating a number of market metrics that will facilitate their construction decisions. To best provide recommendations and inform the decisions of our community partners, we are looking at the design plans and building layouts of similar lodges in the area, and how factors like population, square footage, recreational activities, and events hosted, have impacted the layout and design of these existing lodges. Specifically, we are researching ways to maximize heating efficiency, minimize water usage, and make the lodge space as multi-functional as possible with

the given physical and financial limitations. As a final deliverable, we will determine the most sustainable and cost-effective ways to meet the desired lodge outcomes as determined by our community partners, and present the final design in detail to the West Windsor and Brownsville communities.

3.2 Methods

3.2.1 Place-Based Planning Approach

When developing a method for working with our community partners to provide beneficial design and construction ideas for a lodge at Mt. Ascutney, we found taking a place-based planning approach to be the most appropriate and effective. Place-based approaches can be necessary factors in landscape planning and design (Kruger and Williams 2007). When working on these kinds of design projects, using place-oriented approaches are often more effective than using traditional market-based decision frameworks, which often lead to under-representations of the values people often associate with nature and place (Kruger and Williams 2007).

Place-based concepts recognize that "understanding emotional ties and symbolic meanings of environments" are critical in landscape design and construction (Kruger and Williams 2007, 83). Sense of place is said to be "socially constructed through experience," and extends beyond its tangible uses (Kruger and Williams 2007, 84). For place-based planning to be most effective, it is necessary to understand what it is about a particular location or environment that people value and care most about. This includes recognizing the "emotions, experiences, benefits, and satisfaction people experience in places" (Galliano and Loeffler 1999, 8). As a result, place-based planning activities and approaches are often participatory and collaborative.

In addition to simply understanding what it is about a place that people value and care most about, it is important for researchers to gain an understanding for place attachments and the

factors that influence these attachments, in order to make the most informed decisions regarding land management and participation in planning processes. When these elements are understood, place-based planning can result in a number of positive outcomes for both the researchers and community members. Some of these favorable outcomes include:

- Empowering community members to build a sense of community;
- Engaging community members in activities;
- Building relationships and trust;
- Engaging in mutual learning;
- Holistic planning;
- Incorporating a broader range of meanings and perspectives into planning;
- Creating "a more equitable, democratic way of defining, expressing, and valuing places" (Cheng et al. 2003, 89).

Moreover, a "one-size-fits-all" approach is not practical, and place-based planning processes recognize the "uniqueness of each landscape and situation" (Kruger and Williams 2007, 86).

Keeping these concepts in mind, we worked in collaboration with our community partners to gain a better understanding for how our partners value Mt. Ascutney, and the various factors that make Ascutney a unique place. Through multiple visits to the mountain and interviews with both our community partners and other members of the West Windsor and Brownsville communities, we engaged in participatory research that provided us with insight into the ways people value the mountain, the general sense of community at Mt. Ascutney, and the importance of building a lodge structure to facilitate community engagement.

3.2.2 Process

At the outset of our communications with our community partners, our group focused on aiding our partners in drafting plans for developing potential future recreational activities at Mt. Ascutney. Through our conversations with our community partners, it became apparent to us that the most important and imperative future development at Mt. Ascutney is the construction of a lodge. Our initial project was centered on providing our community partners with an explanation of the market and non-market costs and benefits of building a lodge.

During a subsequent meeting with our community partners at the Mt. Ascutney site, we became aware of the timeline on which the AO board was working for building the lodge. The timeline for putting forward plans for a basecamp coincide with our class parameters. We learned then that the AO board was planning to submit one, three, and five year plans to the Town of West Windsor, VT in early June, 2016. Our partners explained to us that it would be more helpful if we refocused our work around helping them to design the plan which they would submit to the town.

With this development in our project, we turned to drafting three different Basecamp designs to submit to our partners, as well as providing a brief analysis of each design. We brainstormed three general designs and, with the go-ahead from our community partners, fleshed them out. This step required extensive consideration of the user needs for the basecamp. We considered the question: What should the basecamp provide to each person that comes to Mt. Ascutney? The three plans were sketched and comparative analyses were compiled.

In discussion of the preliminary analysis, we decided on the exact plan the community partners wanted to pursue to submit to the town in June 2016. We then turned our attention to drafting a design plan and more in depth analysis of the final design idea.

The final stage of our project took the basecamp design and expanded it to consider every question we had the resources to address. In this stage, executed significant research on specific sections of the basecamp. As described in the results section, we focused on heating efficiency, windows, toilets, multi-purpose space design. Our main goal was to provide as much information to our community partners as possible to enhance the design proposal. This stage included extensive research using online construction resources and experts involved in the basecamp project.

3.2.3 Three Main Base Camp Designs

As per our community partner's request, we defined three main lodge designs. The initial plan the Ascutney Outdoors board drew for the new Basecamp was appraised at $75,000, falling comfortably within the budget of $100,000. Our community partner asked that we contribute a new perspective to their current discussion and generate ideas with respect to how to best design the new basecamp at the base of Mt. Ascutney. Laura Ferrell explained the current layout and key components to consider in our design ideas. There are, for example, a few modifications to the area that are certain: 1) there will be a new cell tower built near the existing original base camp, 2) there will be a new water storage facility built adjacent to the original base camp, and 3) the existing timing tower across from the old-old lodge will be demolished. Furthermore, the company building the new cell tower would be responsible for paving a new road that conveniently wraps around the old-old lodge from behind up to its front. This road can act as a pick-up/drop-off route for mountain users and the lot at its base has been approved as a parking area for approximately 30 cars. We also learned that the snowcat storage facility that borders this road will remain intact for future years.

Our first design idea (Figure 1) for the new base camp was to build a two-storied building that would be situated one-story above the ground that the original base camp sits on, and extend back over the hill that slopes down to the newly planned parking lot, where it would sit two stories above the parking lot. This design will connect the new parking lot to the Basecamp and create a clear, inviting flow into the building from the rear entrance. This design allows for plenty of space for housing the different planned purposes for the Basecamp. However, this increase in space will be tentative on cost with consideration to their budget of $100,000.

Our second design idea (Figure 2) was to build a new, yet more simple, single story Basecamp approximately the same size as the original structure, shifting the site to face more directly south and allowing for more efficient use of passive-solar energy. Laura explained how important passive-solar energy is to them for efficiency. A more simple design would limit future expenditures and usages of electricity and heat and likely fall within their budget of $100,000.

Our third design idea (Figure 3) was to incorporate a smaller structure at the site of the original Basecamp with a Welcome Center at the foot of the existing parking lot. Laura explained, they received approval for a building at the foot of the large parking lot. However, during our most recent site visit with her, we came to the conclusion that this would not be the most viable location for a new Basecamp. That said, we recognize that this may be an advantageous location for a smaller Welcome Center that helps direct people parking to the other facilities on the mountain.

We generated these three designs because we believed the aspects of all three could be combined to yield a best-possible solution with consideration to AO's budget for the building.

Figure 1: Design 1 for Mt. Ascutney Basecamp. This design features a single, two-story, structure on the site of the "old-old" lodge.

Figure 2: Design 2 for Mt. Ascutney Basecamp. This design features a single structure on the site of the “old-old” lodge and an extended parking lot to improve accessibility.

Figure 3: Design 3 for Mt. Ascutney Basecamp. This design features a Welcome Center by the parking lot and a Warming Station for skiers at the base of the rope-tow, where the "old-old" lodge is.

3.2.4 Specific Design Components

In order to provide our community partners with a creative and rigorous set of design recommendations, we broke our analysis into sub-sections within each of the three major designs. Each of the three major lodge design plans consisted of a set of very specific recommendations. The focus areas of these suggestions were co-determined with community partners based on their interests for the lodge and our group's strengths. The design categories

we addressed include: sustainable design elements, educational space, multi-purpose recreation support, potential sources of revenue, probable cost, and signage.

To provide sustainable design ideas, we considered the potential for passive solar power on each of the three lodges. The passive solar analysis included a complete weighing of the economic costs and benefits as well as a consideration of the feasibility of such a design element at each of the three potential lodge locations. In addition, we researched other sustainable feature options such as compostable toilets. These options were sorted into low, mid, and high-level pricing in order to provide our community partners with a comprehensive range of options to help in the decision making process.

The sustainable design recommendations incorporate heating and water needs of each of the three designs. This analysis considered the possibility of capturing excess heat from snow blowers and benefits of different degrees of building insulation. In this section we proposed strategies to reduce water usage.

A potential educational space is important to our community partners because it would bring more school groups to the mountain. To address the feasibility of such a space we considered the impact of two educational space design options. First, we considered including a classroom space in the Basecamp. Second, we considered installing an educational display that informs visitors about the local species of Mt. Ascutney, appropriate mountain usage, and local history. We considered options to make the space functional for all the different activities that are offered at Mt. Ascutney. We assessed the support needs for mountain biking, hiking, and skiing and suggest ways of making the lodge amenable to all those needs.

We also assessed potential sources of revenue from the Basecamp. This section includes an analysis of a café in the lodge and partnerships with local businesses to sell supplies and

merchandise. We also executed an extensive cost analysis. In order to provide the most complete and rigorous cost analysis, we researched general costs of our ideas and met with the volunteer architect, electrician, plumber, and builder to get specific appraisals.

Finally, we will meet with our community partners to develop signs for the lodge. This signage will impact the overall messaging of the lodge and its usability.

3.3 Results and Design Ideas

3.3.1 - Basecamp Design

The final Basecamp design is a two building complex that is made up of a Welcome Center located at the parking lot and a Warming Station located at the base of the rope tow, currently where the "old-old" lodge is situated. This design meeting the main goals of our community partners, allows for maximum functionality, and minimum construction costs.

The Welcome Center, shown in Figures 4 and 5, will be located next to the main parking lot. This building will have an office, changing space, a restroom, storage, heating, a cot for ski patrol and first aid, ticketing, maps, and information about Mt. Ascutney. This building will serve as an entry point for skiers, bikers, hikers, and school groups. Any one who wishes to use the mountain will be able to find appropriate information at this location.

The Warming Station, shown in Figures 6 and 7, will be located at the base of the mountain, near the rope tow. This building will provide a gathering space for visitors and will allow them to spend more time at the mountain. The primary function of this space is flexible. The design allows it to be used as a rest place for skiing, biking, and hiking. School groups can use it for class. Community members can hold meetings. This open space requires very little designing, but the opportunity to bring community into the same physical space at the mountain is very important.

Figure 4: Outside view of the Welcome Center.

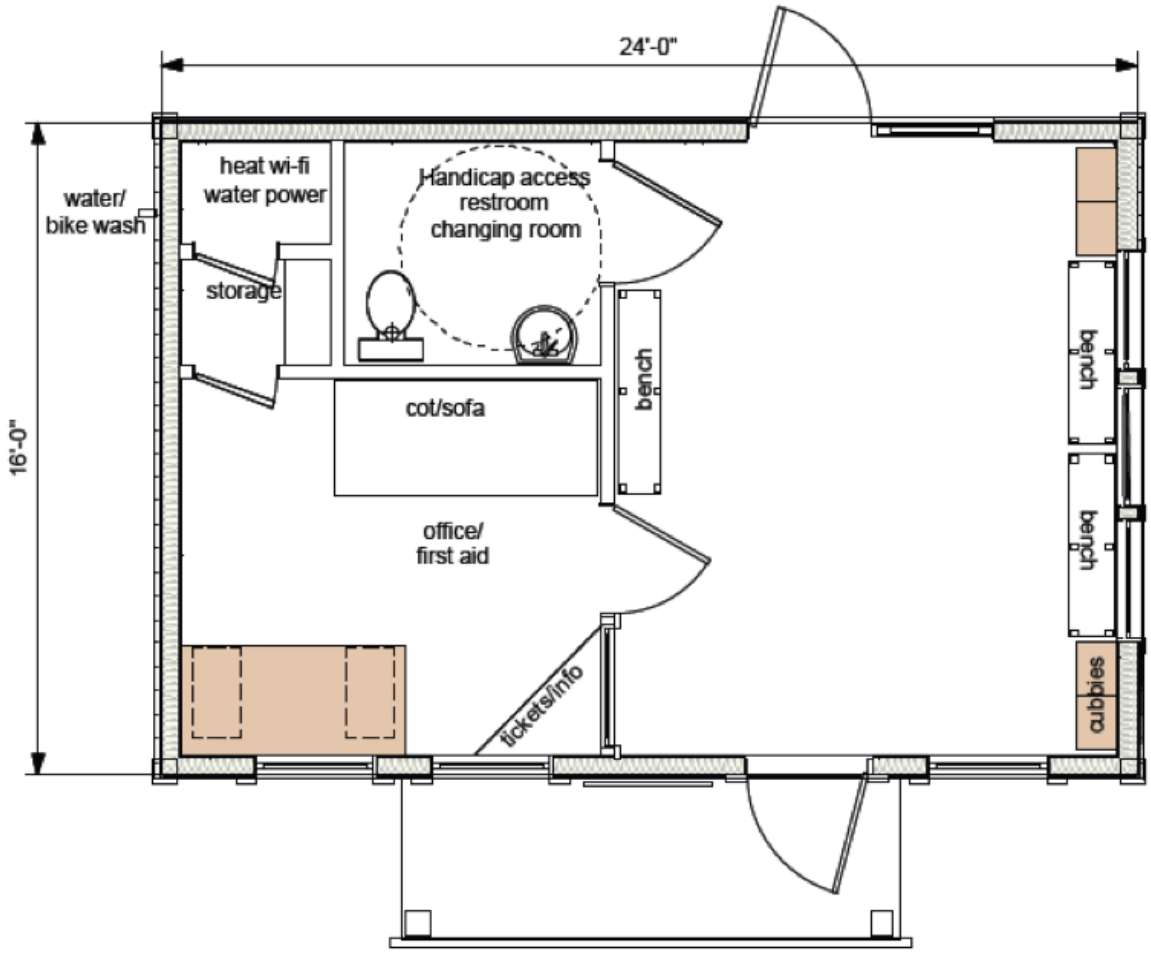

Figure 5: Welcome Center floor plan.

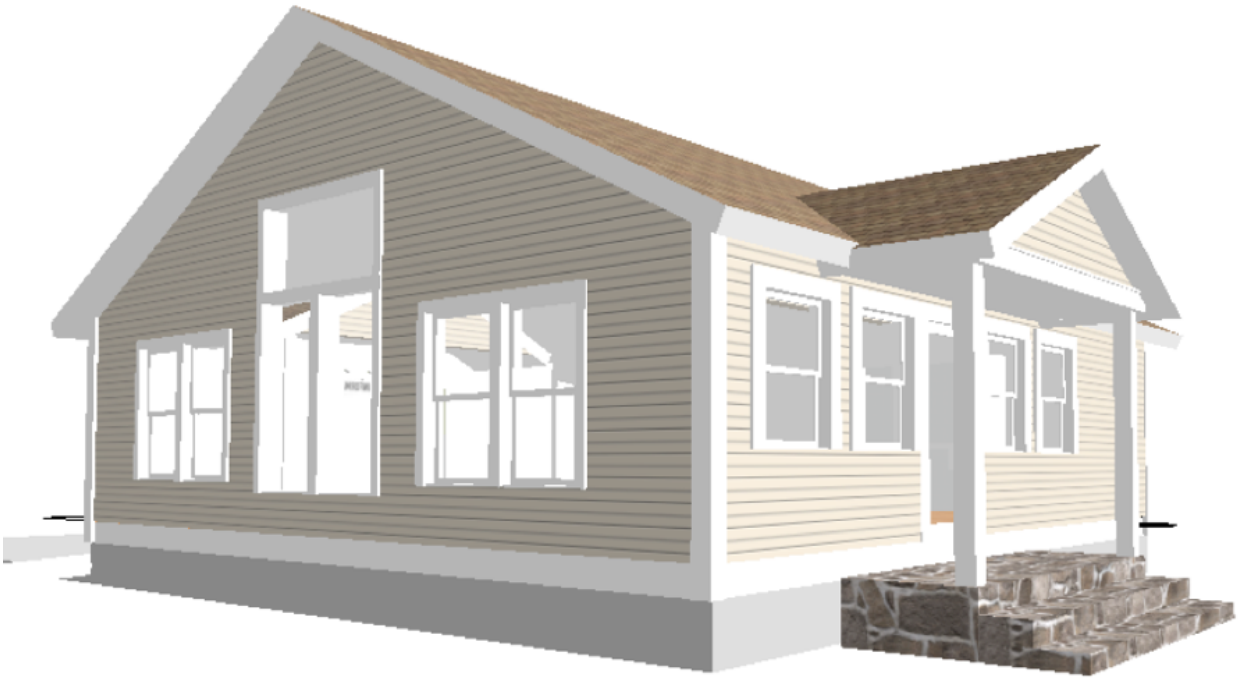

Figure 6: Outside view of the Warming Station.

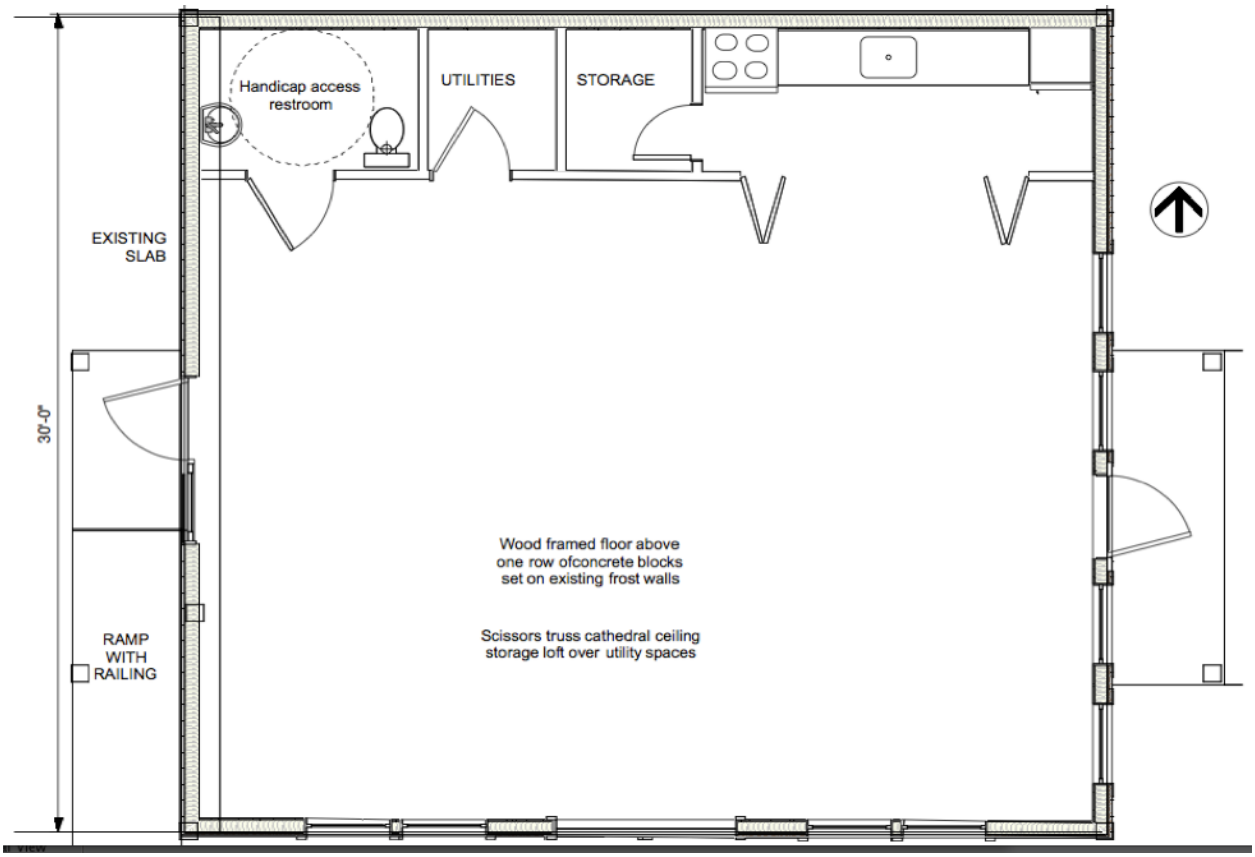

Figure 7: Floor plan of the Warming Station.

3.3.2 Sustainable Design Goals

Our designs seek to meet the various needs enumerated by our community partners, including the affordability of the basecamp and longevity of the basecamp's lifetime. We believe that incorporating sustainable design elements will aid in the achievement of these goals. Furthermore, the inclusion of sustainable design elements will render the Basecamp "greener" and as such is in line with the mission of the conservation easement. We recommend the community partners consider the following:

- Position the Warming Station such that it has a similar orientation to the sun as the old-old lodge
- Install superior insulation in the Warming Station in the future

- Employ water use minimizing toilet facilities

3.3.2.1 Maximize Heating Efficiency

We identified the heating of the building to be an element that can be designed to maximize sustainability. Following a discussion with Laura, we determined two primary ideas to consider in enhancing the heat efficiency of the new Basecamp. The first of these is the use of passive solar heating. The old-old lodge, which is still standing, is built facing south, the ideal orientation for absorbing the sun's rays, and thus the building captures the sun's energy through its windows. Because this positioning is ideal for capitalizing on free passive solar, we recommend that the new Warming Station be built in a similar fashion. As such, the sun will naturally warm the Warming Station, thus minimizing both heating costs and the Warming Station's potential ecological footprint from the use of traditional heating methods (e.g. electric heaters).

The second element to consider is insulation. If the new base camp is well insulated there is potential to minimize the amount of heat the building requires. Our discussions with Dartmouth College's FO&M employee Todd French and with the community partners made it clear that the Welcome Center and the Warming Station will be prefabricated buildings, as these were 1) used in Todd's estimates (discussed below) and 2) options that fit within the board's budget. As such, the insulation factor of both the Welcome Center and the Warming Station at the time of construction will be that of the material of the prefabricated building.

While it may not be in the board's current budget to include additional insulation in the buildings, we believe it would be valuable to do so in the future. Below is a table that outlines a building's heat loss via its respective components and recommendations of methods of insulation

for each component. We recommend using the table to inform which areas to focus on in terms of future installation and how to address the loss of heat through these components.

Finally, the two most viable options for heating the buildings are a direct vent wall furnace, made by Rinnai, and an in-ceiling HVAC system (French 2016). The Rinnai system is small, wall mounted, and relatively inexpensive, costing roughly $1,500. One Rinnai system would be needed for each of the individual structures. The downside to the Rinnai system is the space that it takes up. Considering the relatively small size of both the Welcome Center and the Warming Station, having a wall-mounted unit could occupy a considerable amount of valuable space. The in-ceiling HVAC system saves space but costs significantly more ($4,000 per building). However, an in ceiling HVAC unit would be more flexible for future expansion and would provide the spaces with air conditioning for summer events (French 2016).

Building feature	Heat loss (%)	Target U-value (EPC Band B)	Possible solutions
Walls	35 %	0.15	Cavity, internal or external wall insulation
Windows and doors	15 %	1.6	Double/triple/secondary glazing / shutters and curtains
Roof	25 %	0.10	Pitched, warm deck or cold deck roof insulation
Floor	15 %	0.15	Floor insulation
Gaps, cracks, draughts	10 %	N/A	Draughtproofing >> ventilation with heat recovery

Table 1: heat loss through building elements, target insulation levels and insulation solutions

SuperHomes 2016

3.3.2.2 Minimize Water Usage

In addition to maximizing heat efficiency, our designs aim to minimize the buildings' water usage. One way this can be achieved is the installation of toilets that do not require water. The community partners identified both composting toilets and porta-potties as a viable possibilities for use at the Welcome Center and Warming Center. After consulting with Nick Reo, we also analyzed the costs and benefits of installing waterless urinals in the centers.

Waterless Urinals:

The US Army Corps of Engineers recognizes waterless urinals as "environmentally friendly" and identifies several savings opportunities the installation of waterless urinals provides (Stumpf 2006, 1). As their name suggests, waterless urinals are urinals that do not require flushing and thus do not require any water. Rather, waterless urinals capitalize on the fact that 96% of urine is composed of water, thus there is no need to flush extra water in eliminating urine from the fixture (Bristow, Fisher, McClure). As such, the installation of waterless urinals can lead to massive water savings of up to 45,000 gallons per year (Stumpf 2006). This in turn not only reduces a building's water usage, but also minimizes the building's water-related expenditure. Waterless urinals also have the potential to reduce a building's electricity costs as there is no flushing mechanism in place, such as an automatic sensor, which requires electricity. In addition waterless urinals also have minimal maintenance costs (Stumpf 2006). It is estimated that the purchase of a waterless urinal has a payback time of ½ - 3 years (State of Massachusetts 2008).

Waterless urinals also provide several other user benefits. It has been reported that waterless urinals improve restroom hygiene (Bristow, Fisher, McClure). This could be because there is no need to touch a flush handle (State of Massachusetts 2008). This could also be the

case because the lack of water in the urinal bowl means that bacteria do not have ample opportunity to manifest in a wet environment. One study found that waterless urinals have about half the amount of bacteria on their surface as do conventional urinals (State of Massachusetts 2008). In addition, the installation of waterless urinal has been successful in an a public recreation facility similar to Mt. Ascutney. A waterless urinal was installed at MA State Parks/Dubuque Heritage State Park as a retrofit project and is used on average by ~12 males (State of Massachusetts 2008). The urinal is cleaned once a week by the facility staff members who were trained to do so by reading the pamphlet distributed by the urinal manufacturer (State of Massachusetts 2008). It was noted that the facility has found the "use and maintenance" of this urinal to be "wholly positive" (State of Massachusetts 2008, 31).

Below are projected costs and savings of waterless urinals. We determined that these costs and savings can be applied to this project due to similar anticipated toilet-use traffic. We assume that use/day/male of Mt. Ascutney will be the same as what is detailed in the tables below.

Table 1. Potential Savings for an Elementary School

School days	Gallons/ flush	Flushes/ day	Flushes/ year	Gallons/ year	Water & sewer cost/1000 gallons	Waterless Urinal First Cost Savings	Annual Savings		
							Water	Maint.	Total
180	1.0	450	81,000	81,000	$ 5	$384	$405	-$31	$374
180	3.0	450	81,000	243,000	$ 5	$384	$1215	-$31	$1184

Bristow, McClure, Fisher

TABLE 4. PURCHASE PRICES FOR WATERLESS AND FLUSH URINALS

BRAND	DURAVIT	FALCON/ SLOAN	WATERLESS	ZEROFLUSH	REGULAR FLUSH URINAL - AMERICAN STANDARD INC.	AUTOMATIC FLUSH URINAL - AMERICAN STANDARD, INC.
Price of Urinal Fixture	$626.50 (retail on web)	$240	$393 - 408	$399	$206.38	$204.10
Price of Ancillary Parts and Equipment	$104[110] for high pressure flushing adaptor				$83.56 ea Flush Valve: Sloan Valve 180-1 Royal Urinal Flushometer	$278.37 ea Sloan Auto Flush Valve: Sloan Valve 8186 G2 Optima 1.5 gal
Total Purchase Price	$730.50	$240	$393-$408	$399	$289.94	$482.47

State of Massachusetts 2008 (Table 4 does not take installation costs into consideration)

TABLE 5. ANNUAL WATER AND SEWER COST SAVINGS

	SMALL OFFICE SCENARIO	LARGE OFFICE SCENARIO
Number of Males	25	1,000
Number of Urinal Uses/Male/Day	3	3
Number of Days of Urinal Use/Year	260	260
Number of Urinal Uses/Year	19,500	780,000
Gallons of Water Per Use (i.e. Per Flush) Avoided [1]	2	2
Gallons of Water Saved/Year	39,000	1.56 million
Estimated Water and Sewer Cost Savings/Year [2]	$500	$21,000

[1] Most waterless urinals save one to three gallons of water per use, depending on the model of flush urinal being replaced. Two gallons per use was used as an average.
[2] Water and sewer fees vary from community to community in Massachusetts. Further, some communities use a flat rate structure, some use an ascending rate structure and some use a flat fee. For simplicity, the combined water and sewer flat rate of $9.95/hundred cubic feet charged by the Town of Brookline, MA was used to calculate cost savings.[111] There are 748 gallons per hundred cubic feet.

Note: The number of urinals in the small office and large office scenarios are not listed in this table because the annual water and sewer cost savings do not depend explicitly upon the number of *urinals* present in the small office or in the large office. They depend upon the number of urinal *uses*, which is driven by the number of males in the office, by the number of urinal uses/male/day and by the number of days/year that the office is in use. Further, the number of urinals in a building may be influenced by the building configuration (e.g. number of floors, number of restrooms) as well as by the number of male occupants. Therefore, the number of urinals in a given building may not correlate precisely with usage.

State of Massachusetts 2008

TABLE 6. ANNUAL MAINTENANCE SUPPLY COSTS FOR WATERLESS URINALS[112]

BRAND	DURAVIT		FALCON/SLOAN		WATERLESS		ZEROFLUSH	
Cost/Cartridge or Insert	Not Applicable		$35		$4.95		$28.50	
Cost - Liquid Sealant	$2/100 ml [1]		No charge - comes with cartridge		$14.40/qt/15,000 - 20,000 uses		No charge - comes with drain insert	
Cost - Daily Surface Cleaner	$6/19 oz bottle [2]		$39 for 12 Surface Cleaner Refills [4]		Not applicable		Not applicable	
Total Annual Maintenance Supply Costs	Small Office [3]	Large Office [3]	Small Office [5]	Large Office [5]	Small Office [5]	Large Office [5]	Small Office [5]	Large Office [5]
	$48	$1,848	$105	$4,683	$27	$1,222	$37	$1,652

[1] 100 ml of liquid sealant is used to refill the urinal trap each time it is flushed out. Duravit recommends flushing the trap every month or 3,000 uses, whichever comes first. In both the small office and large office scenarios, flushing traps every month would be appropriate, assuming all urinals get equal use.

[2] The US Army Corp of Engineers did not record prices for daily surface cleaning products. This is a 2008 price obtained from Duravit USA.[113] No information was available on how long a 19 oz. bottle of daily surface cleaner might last. Therefore, the annual cost of the recommended daily surface cleaner is NOT included in the Total Annual Maintenance Supply Costs for the Duravit urinal, leading to an underestimate of annual costs for this brand.

[3] For the Duravit technology, the Total Annual Maintenance Supply Cost assumes that there are 2 urinals in the small office scenario and 77 urinals in the large office scenario (i.e. about 1 urinal for each 13 males in each case). Each urinal trap is flushed each month, and 100 ml ($2 worth) of liquid sealant is used to refill the trap after flushing.

[4] 2008 price obtained from Pokorny Associates, the Sloan Valve Co. representative for Massachusetts.[114] Adequate information was not available on how long a Surface Cleaner Refill might last. Therefore, the annual cost of the recommended daily surface cleaner is NOT included in the Total Annual Maintenance Supply Costs for the Falcon/Sloan urinal, leading to an underestimate of annual costs for this brand.

[5] For the Falcon/Sloan, Waterless and ZeroFlush technologies, the Total Annual Maintenance Supply Cost is **not** based upon the number of urinals in the small and large office scenarios. For these technologies, maintenance protocols call for cartridge replacement and/or the addition of liquid sealant after a certain number of urinal uses. Therefore, annual cartridge and liquid sealant costs are based upon the annual number of urinal uses expected in the small and large office scenarios.

State of Massachusetts 2008

Composting Toilets:

Composting toilets take advantage of the natural process of decomposition rather than the use of water and septic treatment systems (Franey). The most evident benefit of a composting toilet for the Warming Center is that they do not require any water, and therefore do not require that the building be attached to water piping systems or a sewage system (Franey). As such, the water bills of the center will be minimal, if not entirely negligible. Composting toilets have the potential to reduce the water consumption of some households by 25%, therefore, we anticipate that the use of composting toilets in the Warming Center would result in significantly less water use than would the use of conventional toilets (Berger 2011). Furthermore, because the composting toilets are not connected to sewer systems, they do not run the risk of polluting natural water sources with excess nitrogen, an issue that has been prevalent in New England as of late (Franey).

Additionally, composting toilets fit well within the parameters of Vermont's waste management policies. The state of Vermont does not outline any specific composting toilet design requisites and also permits the on-site deposition of the waste from the toilets (Franey). This eliminates any waste transportation costs that may have been necessary considerations in this project. Furthermore, facilities in Vermont have used composting toilets with success. Cobb Hill Co-housing, for example, did not experience any significant issues with the composting toilets that were installed. This outcome seems promising with respect to this project (Franey). The one identifiable problem that arose was the clogging of Cobb Hill's greywater septic system, but an expert has speculated that this was due to the "overdesign of the septic system" (Franey). Considering the simplicity that underpins the designs of the Welcome Center and Warming Center, we do not anticipate this to be an issue at Mt. Ascutney.

With these benefits considered, it should be noted that there are many costs associated with composting toilets. The monetary cost of installation of composting toilets can vary according to respective manufacturers. In order to minimize costs, however, it is possible for building owners to build their own composting toilets. This is particularly relevant for the Warming Center given budget restraints (Berger 2011). The costs of composting toilets also include maintenance. The specific maintenance protocols of the units will vary by manufacturer, but there are standardized protocols to which one should adhere to in order to maintain the hygiene of the facility. A simple solution of water-diluted vinegar or citric acid can be used to clean the toilet seat and stronger chemical-based cleaners can be used to clean elements of the restroom such as doorknobs and sink fixtures (Berger 2011). In addition, what is known as "bulking material," (paper, wood chips, sawdust), must be added to the compost pile in the unit both to aid the composting process and to minimize the release of foul odors (Berger 2011). Lastly, the waste matter must eventually be removed the toilet (ideally in a composted form). It is thus evident that consistent investment in maintenance of composting toilets is necessary, particularly if there is a high volume of toilet traffic, to ensure that the units are both fully functional and hygienic.

Furthermore, additional measures may need to be taken to ensure that the waste is entirely decomposed and thus that all pathogens are eradicated. There must be very specific conditions (with relation to oxygen concentration, heat, etc.) in order to ensure the complete decomposition of the waste (LetsgoGreen.com). An example of such measure is the creation of a covered compost heap of a volume of at least 1 meter (Berger 2011). If such a heap is created on the mountain, one must take into careful consideration its location in order to minimize patron exposure to odors and bacteria. In addition, a compost heap would ideally by "turned" after two

weeks and thus someone would need to be assigned to complete this task (Berger 2011). However, we do not recommend the creation of a compost pile, as heap piles are not efficient in cooler climates such as Vermont (Berger 2011).

Porta-Potties:

Another possibility for an on-site toilet is a porta-potty. The cost of porta-potties is dependent on the company from which the installation is purchased or rented. If Ascutney Outdoors were to purchase a porta-potty, they would have to pay the up-front cost, be responsible for maintenance (e.g. cleaning, re-supplying hand sanitizer), and be responsible for waste disposal. If AO were to rent a porta-potty, they would have to pay rental costs over specified time periods. However, with rental, they would likely not be responsible for maintenance other than basic upkeep, and would not be responsible for waste disposal, contingent on the rental agreement. The number of porta-potties that will need to be purchased or rented depends on the average number of patrons who will use the facility in a given number of times per day.

Furthermore, frequently used porta-potties tend to excrete unpleasant odors. This is particularly true if the installation is not cleaned frequently, if many people use it, and if the weather is warm (e.g. during the summer). Another consideration is the aesthetic of a porta-potty, the plastic, rectangular structures are somewhat incongruous with wooden structures of the Warming Center and Welcome Station and the natural scenery of the mountain. While this would not prevent patrons from utilizing the porta-potties (unless the odor proves to be a serious deterrent), the presence of the porta-potties might impact patrons' impression of the facility as well as the overall branding of the mountain. That being said, porta-potties provide an identifiable environmental benefit that overlaps with a significant cost benefit in that they do not

require the use of water. Depending on the company used, the savings from the lack of water use may be greater than or equal to the cost of renting a porta-potty. If the board decides to proceed with the use of Porta-Potties, we suggest referring to the following website for guidance: http://www.portapotty.net/rental/.

3.3.3 Multi-Purpose Space

The majority of space in both the Welcome Center and the Warming Station will be devoted to multi-purpose, open rooms. The Welcome Center will have a 14 ft by 16 ft open space and the Warming Station will be a 20 ft by 30 ft open room. These spaces will serve the mountain community's wide range of needs. The open space in the Welcome Center will be designed to give visitors a place to meet, relax, and prepare for their outings. The functional goals for the Warming Station, as defined by our community partners, are

- Educational space for after-school programs and class trips
- Meeting space for Ascutney Outdoors and other organizations
- Community events

3.3.3.1 Classroom space

A classroom space in the lodge would attract school groups to Mt. Ascutney from around Vermont and New Hampshire. The lodge will have a large multi-purpose area that serves as a gathering space for visitors. There need not be substantial changes to the core design of this room, but if it is also marketed as an educational space for local school groups, elementary schools in the area can use Mt. Ascutney for recreational and educational field trips. It is important to engage young children with nature, to teach them an intrinsic value of nature and teach them about the ecological systems at work on Mt. Ascutney. A multi-purpose classroom in the lodge would give school groups a home base on their field trips. They could have an

introductory lesson there, meet with ecologists and naturalists before heading out to the mountain, and would provide an indoor place to have lunch and debrief. A classroom space would not be challenging or expensive to incorporate but would increase the accessibility of Mt. Ascutney to younger users.

The physical needs for a classroom space include: chairs, tables, projector, projector screen, and cubbies. These items can be purchased in waves. Full price estimates for these items can be seen in Table 1. We recommend investing in chairs, tables, and cubbies for the opening of the building and waiting to purchase and install a projector and screen until the construction and more immediate needs have been met. The projector and screen can be included in the three-year fundraising campaign and improvement plan.

3.3.3.2 Meeting Space

The Warming Station will be able to host meetings of up to 50 people. The space would be especially useful to Ascutney Outdoors and STAB where they could host board and general meetings. Meeting space requirements are the same as the classroom requirements except for the need for cubbies. Our recommendations for furnishing the meeting space are similar to those for classroom functionality. Begin by purchasing tables and chairs and later invest in a projector and screen.

3.3.3.3 Community Event Space

The basic setup will allow a range of events to be held at the Warming Station. There will also be a kitchenette in the Warming Station that would open up the possibility of having food at the events.

Product	**Cost (in dollars)**
Projector Screen	120-250
Projector	600-2000
Chairs	17/chair
Tables	100/table
Stove (Wood)	650-700
Stove (Gas/Propane)	1050
Stove (Electric)	25-150
Bike Rack	170-500
Outdoor Trash Can	215-885
Ski/Snowboard Rack	200-600
Refrigerator	600-700

Table 1: Add on appliances for the Warming Station.

3.3.3.4 Recommendations

1. Purchase chairs (30 stackable and cheap) and tables (5) for the opening of the Basecamp.
    1. Store these in the Warming Station by leaving them out in a neutral set up so that they can be used throughout the year. For events that require open space, they can be stored in the storage building or moved to the Welcome Center. For events that require specific chair and table set ups, they can easily be rearranged.
2. Install cubbies in the Warming Station and Welcoming Center.
3. Invest in a projector and screen as part of the three-year plan - Include this as a specific donation option (i.e. “Donate to enhance the educational and recreational function of the Warming Station”).

3.3.4 Educational Installation

The interior of the Welcome Center could include a permanent or rotating installation to educate visitors about invasive species on the mountain, local culture and history, and explain proper trail usage. This installation could include art by locals and take on a secondary beauty, or decorative, purpose. The installation could also be very scientific and include contrasting sketches of local and invasive species. If the lodge is built out of local materials, there could be signs around the structure pointing out what each material is, where it comes from, and its journey to the lodge.

3.3.5 Warming Station Features

A primary function of the Warming Station is to provide necessary support and comfort to skiers. As the Warming Station will be constructed at the base of the main skiing mountain, it will be most easily accessed by front country skiers. The structure should provide a place to warm up between runs, allow non-skiers to watch skiing, and offer skiers supplies to perform emergency maintenance.

3.3.5.1 Heating

In order to make the mountain more accessible, the Warming Station will provide a heated rest place to skiers. Currently, Mt. Ascutney is very attractive to locals who can come, use the rope tow or backcountry ski, and go home to get warm and comfortable after. However, this limits the range of people who choose to come to the mountain. If there is a place to for skiers and watchers to congregate, people will spend more time at the mountain. Consider, for example, a family in which one parent skis and with an older child and the other parent skis with a younger child. The second pair can do a few runs on the rope tow and then watch the older pair from the Warming Station. Allowing a space of mountain-users to relax will encourage a greater

sense of community because it increases visibility and communication between mountain-users. As skiing is a winter sport, heat is essential to this type of space. The section on construction costs addresses the type of heater we recommend for this building.

3.3.5.2 View of Skiing

The Warming Station will have a idyllic view of the ski slope, specifically the rope tow. The structure will be constructed on half of the slab of the old-old Lodge. This slab is oriented so that one side is facing the maintain. As discussed in the section on passive solar energy, the south-facing wall will have large windows to maximize passive solar heating. The south-facing wall is also the wall that faces the mountain. Therefore, the large windows on the south-facing wall will provide wide views of the mountain while also meeting the needs for passive solar heating.

3.3.5.3 Multi-Purpose Recreational Support

Within the lodge, our community partners would like to promote outdoor recreation by providing visitors with a support shop to facilitate their recreational activities. This will primarily serve as a repair and tuning station for mountain biking and skiing, the two most popular activities pursued by visitors at Mt. Ascutney. This support area will also likely include a small shop that will sell spare parts and other complementary products to visitors requiring assistance while engaging in recreational activity at Mt. Ascutney.

3.3.6 Construction Analysis

Due to budget limitations and the importance of flexibility and future expansion, our community partners wanted to use previously fabricated (pre-fab) construction for both the Warming Station and the Welcome Center. A pre fab building will save costs as well as time, allowing for both structures to be in place and running in time for the next winter season. A

reliable quote for a pre-fab building, completely finished, is between $50 - $60 per square foot (French 2016). This would include the necessary indoor plumbing fixtures, including a handicap toilet to meet code specifications, a sink in the bathroom, as well as a sink in the common room for both the Welcome Center and the Warming Station. Both buildings will need to be equipped with handicap-accessible front stoops, which will cost roughly $2,000 each, including labor and materials (French 2016).

The Warming Station's current specifications are for a single story building of 960 sq ft that will sit atop the foundation of Ascutney's old-old lodge. Placing the building on the old foundation will be cost efficient, allowing AO to avoid the costs associated with laying a new foundation, as well as connecting the building to plumbing, water, and electricity (French 2016). Based on the pre-fab quote we received, our estimate for the cost of the fully equipped pre-fab Warming Station is between $48,000 - $57,600.

We expect that the Welcome Center, although smaller, will have more up-front costs associated with its construction. The building will need to be connected to plumbing, electricity, and water. All three of these elements are in close proximity to the planned site for the structure, but labor for these will range from between $5,000 - $8,000 (French 2016). Next, the building will also need to to have a foundation laid before its construction, which we estimate will add between $10-$15 per sqft (total added cost between $3,840 - $5,760) (Todd French, 2016). These considerations bring the total estimated construction cost for the Welcome Center to between $28,040 - $36,800.

Finally, the greatest unknown when trying to estimate the up-front construction costs for the buildings is the potential labor needed for finishing the buildings. This would include labor for installing appliances, finishing the wood floors, painting interior and exterior walls. Our

recommendation for limiting these costs is to try to recruit either professional or semi-professionals that would be willing to donate their time by volunteering to help with the project. Luckily, a community partner has already found a demolition and cleanup expert that is willing to donate their time to help with the initial demolition of the old-old lodge as well as cleanup and site preparation for new construction.

When considering the the previously mentioned heating costs, our estimate for total up-front cost of the project ranges between $79,090 - $102,400. Realizing that the upper range of our estimate falls slightly outside of AO's budget for the project, we recommend increasing volunteer work to significantly limit the total cost of the project.

3.3.7 Operation Cost Assessment

The most significant operating costs for the Mt. Ascutney Welcome Center and Warming Station will be associated with both heating and electricity. Operating costs for heating each of the two buildings is highly dependent on the mode of heating chosen. In terms of operating costs associated with electricity, annual expenses can be estimated based on the appliances used and Vermont's average electricity price. Vermont's average price per kWh is $0.14. Using this figure in conjunction with a slew of appliances that both of the buildings might need, we tried to estimate the annual operating costs associated with electricity usage for the buildings.

Per Building Electricity Consumption by Appliance		
Appliance	Annual kWh	Annual Cost
Range Top Stove	120	$17
Refrigerator	492	$69
Satellite Dish / Cable Reciever	216	$30
Television	216	$30
Electric Oven	232	$35
Ceiling Fan	72	$10
Estimated lighting	120	$17
Coffee Maker	60	$8
Microwave	132	$18
Total	1660	$234
* Assumptions for electricity prices made based on Vermont average of $0.14 per kWh		
** https://www.efficiencyvermont.com/tips-tools/tools/electric-usage-chart-tool		

Table 2: Electricity Operation Costs.

3.4 Conclusion

The construction of a base camp at Mt Ascutney will continue to grow the community of people that visit the mountain and foster stronger bonds within the existing community. As the mountain settles into its new, public ownership, more people will come to engage with the various recreational options at the mountain. By building a base camp, our community partners hope to make the mountain more accessible and encourage visitors to spend more time leisure time there. The base camp will bring people together simply by providing an open, manuable space. There is a great sense of community already surrounding Mt Ascutney and its visitors and the construction of a base camp will provide that community with a physical home and foster the growth and strengthening of this community.

Chapter Four

Assessment and Monitoring

An Analysis of the Environmental and Social Impacts of Existing Recreational Uses at Mt. Ascutney and Recommendations for Monitoring Protocol

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Chapter Four: Assessment and Monitoring

An Analysis of the Environmental and Social Impacts of Existing Recreational Uses at Mt. Ascutney and Recommendations for Monitoring Protocol

4.1 Introduction

In this section we present a comprehensive review of the environmental and social ramifications of existing recreational uses, a strategy for monitoring the current and continued effects of those uses, and a set of suggestions for the potential development quantitative benchmarks for each existing recreational use. We reviewed literature on relevant recreational activities to provide a foundation for understanding the suite of possible impacts of recreation on the Mt. Ascutney region. We focused our review mainly on mountain biking and backcountry skiing, but also included hiking and other summer and winter traffic. Summer recreation primarily raises concerns about erosion, habitat loss or fragmentation, and wildlife disturbance. Erosion and habitat loss are also a risk of winter recreation, but the extent and severity of impacts to erosion depend more on the geography of the area and the individual behavior of the recreational user. At Mt. Ascutney, erosion and habitat loss is being monitored solely through trail observations and volunteer participation. These disturbances caused by recreational traffic make mountain recreation a vector for the introduction and potential spread of invasive species. The invasive species populations at Mt. Ascutney are currently manageable, however expansion of infrastructure, or increased user traffic may provide significant vectors for the expansion of future invasives.

To assess the social and environmental impacts of each of the primary recreational activities at Mt. Ascutney, we developed the following research questions: What are the most

cost effective and accurate techniques for assessing the various impacts of existing recreational uses? What is the quantitative "carrying capacity" for each recreational use with respect to ecology and recreational user perspective? How does each recreational use contribute to the introduction and spread of invasive species? Through work with our community partners, we developed concrete goals to compile a comprehensive literature review on the environmental and social consequences of the various existing uses at Mt. Ascutney, to develop adaptable monitoring protocols for each recreational use, and to propose strategies in order to facilitate the development of quantitative benchmarks in the future.

We suggest that Mt. Ascutney's monitoring strategies should target the proliferation of invasive species, degradation of vegetation, disturbance of wildlife, erosion, unintended expansion of trail, emergence of conflict between and within user groups, and user volume and concentration. These can be monitoring through the use of various volunteer-based, technology-based, and technical monitoring strategies. We also provide insight into the appropriate frequency of use, timeline of implementation, and areas of overlap between the suggested monitoring strategies. These suggestions are informed by our literature review on recreational impact monitoring strategies and case study analysis.

4.2 Review of Recreational Impacts

Our community partners made it clear to us that they desire a greater understanding of the "less obvious impacts" of mountain-based recreation. Therefore we reviewed the literature on relevant recreational activities -- those that are being hosted at Ascutney -- and their effects on mountain ecology. We considered mountain biking and backcountry skiing, as well as hiking and other seasonal traffic. We also considered the recreational experience, and compiled data on the potential ecological and social limitations of facilitating multiple recreational activities in the

same environment. Another component of our review includes impacts of recreation on the spread of invasive species. Our community partners have expressed that they have considerable existing data on the current presence of invasive species in the Mt. Ascutney area, but we conducted further research on recreation as a vector for invasives.

The following section includes a summarized review of the literature. Organized by seasonal impacts -- existing summer recreational uses and existing winter recreational uses -- as well as potential impacts of recreation on the introduction and spread of invasive species, this review draws from sources in the comprehensive annotated bibliography in Appendix B.

4.2.1 Impacts of Existing Summer Recreational Uses

The three most prominent summertime recreational uses of the Mt. Ascutney trail system-- pedestrian activities (including hiking and trail running), mountain biking, and horseback riding--all have associated environmental and social impacts, though the extent to which these impacts have been assessed in the existing academic literature varies significantly between and within use types. Mountain biking is of particular interest here, not only because it is the activity for which the Mt. Ascutney trail system is most esteemed, but also because it is often anecdotally associated with more severe impacts relative to the other forms of trail use.

Mountain biking is associated with several measurable ecological impacts. That mountain biking causes trail erosion is a widely known fact, but the literature suggests that rates of erosion are highest in severely sloped trail sections or when trails are wet (White et al. 2006). The White study also indicates that less experienced mountain bikers likely contribute more to trail erosion than their more experienced counterparts, due in large part to ill-timed braking and an inability to adhere to ideal trail lines. Theoretically, mountain biking generated erosion could lead to sedimentation in trailside waterbodies; however, there is a lack of existing literature to

substantiate this effect (Quinn & Chernoff 2010). While the the Mt. Ascutney trail system includes several stream crossings, the fact that most of the larger streams are transected by some form of bridge--as opposed to a streambed ford-style crossing--means that direct sedimentation potential is minimized.

Wildlife disturbance is one of the major concerns commonly associated with mountain biking. Disturbance by mountain bikers has been observed to intensify alert and flight responses of elk, relative to their baseline behavior (Naylor et al. 2009). Other large mammals, including deer, bison, and pronghorns, have been found to exhibit greater flight distances when disturbed by mountain bikers riding off-trail compared to interactions that occur when the rider is on the trail. Flushing distances, the distance an animal flees in response to an external disturbance, are greater when the interaction occurs in the morning relative to afternoon disturbances (Taylor & Knight 2003). The most prominent analysis of the effects of mountain bikers on songbird disturbance found that rates of nest abandonment by Golden-cheeked warblers were three times greater in study areas exposed to mountain biking (relative to study regions with no mountain bike traffic), but that the cumulative effect of mountain bike exposure on Warbler nesting and foraging behavior was likely "minimal" (Davis et al. 2010).

The most prominent consensus from the literature, is that mountain biking appears, by various metrics, to be no more impactful, and may even be less detrimental, than pedestrian or equestrian trail uses. For example, mountain bikers contribute to trail erosion to a similar extent as hikers or horseback riders (Quinn & Chernoff 2010). In a comparative experimental analysis of the effects of mountain biking and hiking on a subalpine grassland habitat, the impacts of mountain biking on vegetation cover reduction and vegetation trampling were found to be similar to hiking at all but the most concentrated studied levels of mountain bike and pedestrian

use (Pickering, Rossi, & Barros 2011). Mountain biking was also found to be no more disruptive to bison, pronghorn antelope, and mule deer than hiking or horseback riding in a study conducted in a grassland habitat (Taylor & Knight 2003). However, there are some limitations associated with applying the findings of the Taylor and Knight study to the Mt. Ascutney trail system. For example, the study indicates that wildlife flushing distance in response to disturbance by recreationists is contingent upon the vegetative context in which the interaction occurs, with interactions in highly vegetated areas being associated with longer flushing distances. We anticipate that the heavy forest cover of the Mt. Ascutney trail system, combined with the faster average rates and greater average distances of travel of mountain bikers relative to other users, may increase the rate of mountain biker-wildlife disturbance relative to other uses and geographic contexts.

While each summertime recreational use contributes to trail erosion, habitat loss, and animal disturbance, the existing literature suggests that the initial location and construction of the trails themselves has a much more significant long-term impact on erosion and habitat destruction than the form or magnitude of trail use (White et al. 2006, Quinn & Chernoff 2010). The literature is also clear that, even when trails are located and built in accordance with best environmental practices, constant oversight and maintenance is necessary in the long term to ensure that erosion is minimized. From our analysis, it appears that managers of the Mt. Ascutney trail system to-date have generally observed and satisfied the principles of conscientious trail design and consistent upkeep espoused by the literature.

The existing literature on interactions between the various categories of summertime recreationalists suggests that inter-user conflict is more a theoretical possibility than a widespread problem. A survey of hiker opinions on a New Zealand trail system shared by

mountain bikers and pedestrians found that hikers tend to view mountain bikers more disfavorably than mountain bikers view hikers. That said, the responding hikers indicated a 97% satisfaction rate with their experience in using the trail system, and that figure did not change appreciably when only the responses of those hikers who encountered mountain bikers were considered (Cessford 2003). There are factors that suggest this study may not be fully applicable to Mt. Ascutney, but that the relationship between mountain bikers and pedestrians should be no more disfavorable than the one described in Cessford. For one, Cessford examined a trail system that had only recently begun to allow mountain bikes; hiking had been the established and predominate trail activity in the decades prior. At Mt. Ascutney, by comparison, mountain biking is a much more established activity, and the various trail users have had more time to become acclimated to one another. Second, and correspondingly, Cessford only solicited the opinions of hikers. While that may be an appropriate study methodology in a situation where an established user group has recently been exposed to a novel recreational use, it is liable to provide a skewed perspective within a trail system where mountain biking has a similarly lengthy history to, and may be more popular than, hiking.

4.2.2 Impacts of Existing Winter Recreational Uses

Backcountry and frontcountry skiing are the most common winter recreational activities that occur on Mt. Ascutney. Until recently, backcountry skiing was only a fringe activity engaged by a small number of people (Sato, Wood, & Lindenmayer 2013), therefore there is not a significant amount of published literature regarding its ecological effects on the environment. However, the limited literature does suggest that most backcountry skiers ecologically damage the environment because they are unaware of the ecological effects backcountry skiing has on the environment. Most backcountry skiers are under the false perception that they leave no

impact on the environment because they use so much space, therefore decreasing their impact (Wrigley 2015). However, when implementing a high volume of backcountry skiers, the ecological effects are quickly multiplied (Wrigley 2015). In her thesis, Wrigley found that skier interactions dictated survival and behavior of interacting species. Human interactions were found to increase stress levels of wildlife and resulted in abandonment of their ideal habitats and acceptance of new habitats with less ideal resources, further impacting their survival. At Mt. Ascutney the backcountry skiing zone is characterized as a movable zone, to reduce the risk of significant ecological impact in an isolated zone. Future avoidance by users of marked wildlife zones in the backcountry will aid in the reduction of wildlife impact.

While backcountry skiing has its ecological impacts on the environment, the construction of ski slopes for frontcountry skiing is also detrimental. The installation of ski slopes is the main cause of environmental degradation to mountainside ecosystems, as it alters the structure, chemistry, moisture and temperature of the soil present (Meijer et al. 2014). Native flora is also eliminated or fragmented during construction (Ruth-Balaganskaya 2000) and difficult to re-grow once the soil has been altered. Frontcountry skiing increases erosion of the ski-way through compaction of the snow during winter usage (Eagleston & Rubin 2013). Because the snow is compacted by frontcountry skiers, it becomes denser therefore increasing the water content and inherently the runoff once the snow begins to melt. Ski lifts were also found harmful to native fauna, such as the black grouse, as population decreases were noted with increased proximity to ski lifts (Patthey et al. 2008). Additionally, a systematic literature search by Sato, Wood, and Lindenmayer found that the initial removal and modification of native vegetation was the predominant factor that initiated stress on native fauna due to habitat fragmentation. This search also noted that most ski resorts were currently operating without the proper implementation of a

biodiversity management processes or the consideration of ecological effects. Because Mt. Ascutney has had ski lift footings in place for many years, their presence would not present new ecological effects that hadn't already been pre-existing. However, future development of the skiway, such as the proposed flow trails, will definitely impact the surrounding flora and fauna. To prevent severe impact on the environment, monitoring of surrounding environment must be conducted to reduce impacts from construction.

Not all visitors and users understand the lasting impacts that their recreational activities leave on the environment. A 2007 study by Loubsky, analyzed survey results collected 1995 in Yellowstone National Park on visitor perceptions found that users were beginning to transition to a mindset that placed recreation before preservation. Through proper education of the users of Mt. Ascutney, this transition can be avoided, therefore maintaining the beauty of the mountain as well as the various recreational activities it has to offer for the community.

4.2.3 Potential Impacts of Existing Recreational Uses on the Introduction and Spread of Invasive Species

Mountain-based recreation as a whole can be considered a great disturbance to the natural ecosystem. The development of trails and skiways is a fragmentation of natural habitat, and the construction of roads, buildings and parking lots for recreational users also contributes to habitat destruction (Trombulak 2000). These disturbances have varying intensities and ranges, but disturbances in general are highly correlated with the spread of invasive species (Lozon 1997).

Disturbance also continues after the initial creation of recreational spaces. In theory, normal use of the trails and paths should not be increasingly damaging to the ecosystem, but excessive or inappropriate use can cause further degradation and can facilitate the immigration or expansion of invasive species. When users go "off-trail", habitat is disturbed, and native plants

are at risk for further damage. This type of damage can be caused by hiking, biking and/or skiing. Direct impacts include the removal of plant biomass, or the trampling or partial destruction of vegetation (Pickering 2007). Loss of topsoil is another concern when recreational traffic increases, or if trails are not maintained, and such a loss makes native species harder to maintain or re-establish (Ommeren 2001). This leaves open space for non-native species to colonize. Increasing traffic due to increasingly popular mountain recreation has had damaging effects on ecosystems, and the expansion of activities--and their corresponding disturbance to the ecosystem--is pushing invasives to higher altitudes (Pauchard 2009).

Mountain-based recreation also contributes to the spread of invasive species through vectors of car tires, mountain bike tires, hiking shoes and clothing. The expansion of recreation draws higher traffic rates, and with more cars driving through the area, invasive species are more likely to expand their seed dispersal ranges. Car tires can carry seeds from surrounding areas, and can move invasive species across ecosystems (Trombulak 2000). Bike tires have the same vector potential in the mountain trails themselves. Tires can carry seeds across trails and across disturbed areas, which facilitates non-native seed dispersal. Clothing is also a significant vector for the spread of invasives (Mount & Pickering 2009; Ansong 2014). Different clothing types and styles worn through areas have different dispersal abilities, and can contribute to differing rates of non-native expansion. (Mount & Pickering 2009). The indirect spread of invasive species can be monitored or reduced by mandating tire washes or encouraging regular bike cleaning (Trombulak 2000). This would combat dispersal of seeds through bikes and cars. To combat indirect dispersal through clothing, regulation of allowable clothing can be implemented to minimize the dispersal abilities of clothes worn in natural areas (Mount & Pickering 2009).

The feasibility of general invasive species management is largely dependent on the range and aggression of the species at the time of detection, but is possible from multiple angles. The initial detection of the species is crucial to the implementation of management strategies. With more resources allocated to species detection, managers could identify species at smaller populations and in turn lessen the extent of damages, increase the effectiveness of management, and decrease overall cost (Mehta et al. 2007). Once detection is established, integrated pest management can also be utilized as a form of biological control. This requires early detections, but can be sufficient and relatively cost effective as a means of pest management. In cases where the initial detection of invasives is delayed, chemical insecticides can also be used (Marten & Moore 2011). Citizen science models, like the Invaders of Texas, can be mobilized to train volunteers to detect and report invasive species (Gallo & Waitt 2011). This requires a large, highly organized volunteer base, extensive training, detailed field observations, and the use of an online mapping database, but can be an effective means to detect the arrival and dispersal of invasive species (Gall & Waitt 2011).

4.3 Proposed Monitoring Protocols for Existing Recreational Uses

4.3.1 Methodology

Our goal was to establish various monitoring protocols which could be applied to Mt. Ascutney to ensure the preservation of the natural environment despite the impact of recreational activities. We conducted our research by examining relevant case studies regarding pre-existing protocols in place. With the collected literature, we utilized the knowledge of our community partners to determine the best applicable protocols for Mt. Ascutney.

The development of these protocols and benchmarks in large part emerged from an application of the information collected in the literature review to the specific environmental,

social, and economic conditions of the West Windsor site. The overarching goal of these protocols was to determine the amount of each form of recreational use that the land can sustain in a given period before that activity yields intolerable environmental and social consequences. While invasive species impacts will be one element that informs our monitoring protocols, our partners have made clear that this topic should be only a constitutive element of the wider environmental impacts of existing uses. The partners were also interested in the ways that certain recreational uses may negatively affect one another. At what point, for example, does the amount of mountain bike traffic on the trails make hiking unrewarding or unsafe? We ultimately focus on developing strategies to cover six monitoring targets: user volume and concentration, conflict between and among user groups, damage to trails, disturbance of wildlife, degradation of vegetation, and the proliferation of invasive species.

The goal of our monitoring will be to identify a carrying capacity for the various aforementioned recreational uses *before* that carrying capacity is reached, which represents a deviation from the management strategies of other land trusts in the region (which have been able to identify a carrying capacity only *after* that limit has been breached). In other words, the goal is to identify the theoretical point at which environmental harms or social tensions would emerge, prior to their emergence. To that end, we have attempted to incorporate a degree of redundancy into our final monitoring framework: With the exception of user group conflict--the monitoring target that is likely to represent the most minimal problem--each of the six monitoring targets we examine is addressed by at least two distinct monitoring strategies. The intent of this redundancy and diversification of methodologies is to keep occurrences of trail, vegetation, and wildlife degradation and damage from slipping through the cracks. This larger goal, however, must be balanced with the technical, monetary, and temporal limitations of our

community partners. With this in mind, we have attempted to identify monitoring strategies that are cost-effective and relatively easy to implement.

4.3.2 Key Points from the Existing Literature on Recreational Monitoring

Both the methods within and results from the existing recreational monitoring literature provide useful insights for user management at Mt. Ascutney. Lynn and Brown (2003) used a survey to gauge what factors most negatively influenced hiker experiences at a small forested conservation region outside of Toronto. Their data indicate that litter and vegetation damage have the most and second most significant impact, respectively, on visitor perceptions. Trail erosion, the presence of fire rings, and trail extension and widening each had a more moderate impact on user experience. Trail muddiness was the factor that least affected visitor perceptions. Between 40 and 50% of respondents reported they believed they contributed more than "minimally or not at all" to trail erosion, trail extension, and muddiness. Just under a quarter expressed that they contributed more than "minimally or not at all" to tree and plant damage, while fewer than 15% stated they contributed to the creation of fire rings. The smallest percentage of respondents, less than 10%, reported that they contribute to the generation of litter. Note that visitors tend to be least likely to report that they contribute to those impacts that they perceive as most deleterious toward their own trail experience. Given the similar scale and vegetative setting of the studied conservation area relative to the Mt. Ascutney system, there are likely to be commonalities in visitor impacts and perceptions between the areas. That said, Lynn and Brown (2003) evaluated only visitors' perceptions of their own impacts, and it is therefore unclear from their data alone whether users' self-reported impacts aligned with the actual effects of their behaviors. The literature suggests there is reason to be skeptical of self-reported recreationist impacts: A survey of horseback riders, mountain bikers, and hikers at a Western

U.S. conservation area indicated that members of all user groups believed they could approach closer to large mammals without disturbing them than the biological data supported (Taylor & Knight 2003).

Within the existing literature on recreational area monitoring, a wide range of both predictive and observational monitoring techniques have been analyzed and evaluated. An analysis of erosion rates at stream crossing in a Southwestern Virginia recreational area utilized the Water Erosion Prediction Project (WEPP) erosion prediction model, with site-specific inputs derived from the National Soil Erosion Research Lab website. A major limitation of this technique, particularly for the Mt. Ascutney setting, is WEPP's lack of a "recreational trail" model type; "Forest Bladed Road" is the closest analogue for forecasting erosion (Kidd, Aust, & Copenheaver 2014); therefore, some modification of this model would be required for use at MA. A study of vegetation cover at Maine's Cadillac Mountain determined that remote sensing data at a medium or large spatial scale can be an effective tool for evaluating changes in vegetation within a wooded recreational area setting (Kim & Daigle 2012). Analyses of mountaintop visitor impact monitoring at sites in New York, Maine, and Vermont suggest that the laser-based transect method is a consistent and accurate means of evaluating soil loss. The same study suggests that GPS mapping of mountaintop visitors not only can be executed with minimal measurement errors, but also can reveal significant, impermissible off-trail movement that would not be revealed through other methods (Monz et al. 2010). Multiple studies also indicate that a geographical information system (GIS) can provide data useful for identifying vulnerable areas and adapting management strategies accordingly (Svajda 2016 and Akhbasinda & Bulut 2014).

Multiple studies also emphasize the importance of gauging and drawing upon user perceptions prior to and during the development of monitoring methodologies. An important first step for any management plan is the identification of limits of acceptable change (LAC) among the user base (Manning 2014 and Marion 1991). Because the success of most monitoring programs are contingent on some measure of public support and cooperation, it is critical that the final strategies adopted have first been vetted by the community. A second-best management strategy with full community support would likely be preferable to a theoretically ideal framework that received no public input (D'Antonio, 2010 and MacKay & Campbell 2004).

4.3.3 Case Study: Kingdom Trails in East Burke, Vermont

As aforementioned in Chapter 1 of the full report, Kingdom Trails is an interconnected trail system in East Burke, Vermont, with trails for all levels of abilities. With opportunities for mountain biking, cross-country skiing, and even snow biking, Kingdom Trails is a destination for summer and winter recreation. A largely volunteer-driven organization, Kingdom Trails' goal is to "encourage recreational use of the Northeast Kingdom that is ecologically sensitive and promotes the natural beauty of the region." Aside from volunteer support, Kingdom Trails has widespread support from the National Park Service, the Vermont Community Foundation, the Vermont Department of Forest, Parks and Recreation, the Connecticut River Valley Partnership Program, The Windham Foundation,Vermont Community Foundation, The Vermont Land Trust, Burke Area Chamber of Commerce, and KTA members.

To control user satisfaction and limit environmental degradation, Kingdom Trails restricts riding groups to a maximum of 10 riders, and requires that all riders must ride single file. This "lowers the impact on [the] trail system both physically and socially." Kingdom trails also prohibits users from bringing their dogs on the weekends in order to "ensure that the trails

remain a positive experience for all users and the natural resource is not unnecessarily impacted."

The trails at Kingdom Trails are groomed with a Tiddtech G2 groomer, and are maintained by an experienced trail crew. Again, Tim Tierney, Executive Director of Kingdom Trails, served as a source for further investigation into the trail monitoring and maintenance practices at Kingdom Trails, specifically their implementation of trail hardening.

Trail hardening can be done in various ways. Logs were commonly used in earlier trail hardening endeavors but using rock or gravel, or creating silt traps, reduces water flow complications, is much more durable, and looks more natural over time (Tim Tierney, pers. comm.). When a trail is hardened and raised above the surrounding natural resource, water can freely flow and be more easily displaced. Kingdom Trails intensified their trail hardening on primary access trails mainly due to increased commercial pressure to remain open during unfavorably wet conditions (Tim Tierney, pers. comm.). "To keep them open and minimize the impact/widening [of the trails] we knew we had to build bog bridges, or turnpike many sections. Turnpike is the term for raising the treadway with a durable rock based form (large rocks or gravel)" (Tim Tierney, pers. comm.). Tierney also stated that Kingdom Trails' trail management team was aware that "use, compaction, and slope all add to erosion or loss of vegetation. Through proper drainage, hardening and design [one] can greatly minimize the impact and change a carrying capacity of trails" (Tim Tierney, pers. comm.).

Kingdom Trails' decision to implement said trail hardening processes was informed by the evidence of deepening or widening of the trails due to wet areas. Kingdom Trails has the luxury of very compact trail system which *is* constantly monitored, however, Tierney stated that the scientific monitoring itself was not that helpful in the decision making process. Trail

hardening at Kingdom Trails has increased its recreational carrying capacity and has reduced future maintenance requirements. It has also increased the quality and popularity of the recreational experience by lessening the difficulty of the trails (Tim Tierney, pers. comm.). "Wooden hardening techniques such as bridges or puncheon (bog or plank bridges) do require constant monitoring and are a short-term solution but require less man-power to build" (Tim Tierney, pers. comm.) In order to avoid liabilities associated with various bridging techniques, trail can be compacted through the use of natural rock or aggregate material. This is the best long term solution according to Tierney, but requires more engineering and personnel and therefore yields a higher cost (Tim Tierney, pers. comm.).

A 2002 study conducted on-site at Kingdom Trails explored rates of compaction on newly established mountain biking trails and their relation to trail slope, crown cover, and soil type (Hale & Zwick 2002). The data revealed that trail compaction is curvilinear over time -- the most significant trail compaction occurs within within the first 6 weeks, and compaction levels off after about 8 weeks of average mountain biking traffic (Hale & Zwick 2002).

These findings have multiple implications for mountain bike management. Mountain bike trails compact quickly, but need to be monitored closely after stasis has been reached -- managers can choose to confine trails to existing tracks, harden tracks further, and/or educate riders to stay on track. It is also suggested that managers should limit access to tracks during prolonged wet conditions that put the trails at a higher risk for erosion. The study concludes that future monitoring activities at Kingdom Trails will incorporate: number of users -- with the use of counters; how a trail affects the surrounding vegetation; extent of recovery and subsequent acceleration of compaction; and continued monitoring of the relationship between compaction over time and slope, crown cover, and soil type (Hale & Zwick 2002). Today, Kingdom Trails

compacts their trails with a Yellowstone roller/compactor and a 2 Yamaha 4- stroke ProVK snowmobile to "ensure a quality [trail] base that will last through the season."

Trail conditions are consistently monitored and published to inform users which trails are available at any given time. Trails are closed if conditions are unfavorable or if excessive mud has increased the risk of trail erosion. Trailhub.org is an online search and communication tool used to connect users to local trail information including conditions and closures. This system of "proactive alerts" works to support decisions made by recreational organizations like Kingdom Trails, and aids in their enforcement to users. Despite the easy access to real-time updates on trail conditions, Kingdom Trails encourages a culture of self-regulated responsibility among users that promotes the awareness user's own impacts at all times, as well as the impacts of others. Their website prompts users to "be an ambassador for the sport – stay polite, educate other bikers, discourage bad behavior, follow the rules." As a good "trail citizen," users are encouraged to notice their impact and to not do anything that will "impede the future health of the trail system."

Similar monitoring strategies have already been adopted at Mt. Ascutney and could be implemented in the future. Ascutney trails and STAB already have an existing partnership with Trailhub.org which allows them to communicate with users on which trails are currently open and available. The adoption of similar technology for trail hardening would be an expensive endeavor, but could potentially speed up the process of trail maintenance through its mechanization.

4.3.4 Volunteer-Based Monitoring Methodologies

4.3.4.1 GPS Monitoring of Trail Usage and Effects

Trail monitoring practices have recently begun to utilize GPS technology to track visitor traffic. With the ability to track spatial and temporal usage, GPS tracking is a viable option to replace older monitoring trail use methods such as, digital trail counters or others methods that have been subject to inaccuracies. Implementation of GPS technology is simple and requires less training for a volunteer staff to operate properly. To collect data on a specific user's movement along the trail, volunteers will provide willing participants a GPS device that must be turned on and physically attached to the outside of their backpack at the trailhead. Throughout the duration of their trip, the visitor's location is recorded in 5 or 15 second intervals – depending on the GPS device. The recorded data notes the time, speed, direction and elevation of the user at each location point. An appointed volunteer staff must be present at each trail's exit to collect the visitor's GPS device at the end of their trip.

The GPS provides an accurate representation of the user's path along their trip. Therefore, if a user goes off trial, it is seen once the data is analyzed. Additionally, sites of high traffic can be observed and extrapolate zones in which resources may be heavily depleted from overuse. These sites may also indicate a decrease in visitor experience due to high traffic levels and conflict with other users. GPS data can also indicate the length of trip or high traffic by visitors at a particular site which may further indicate an off trail destination visitors are more inclined to visit, such as a nearby waterfall. Once analyzed, the data collected will indicate areas of repeated interest by visitors. Knowledge of these popular locations will allow park managers to intervene and apply management processes to reduce any harmful effects on the environment by users, such as erosion or destruction of vegetation.

The additional implementation of a survey initiated by volunteers at the trail exits, can supplement the data collected by the GPS. A survey can help understand a user's perception of

going “off trail” and the reasoning behind why they did or did not go off trail along their journey. GPS technology can also be used to observe winter recreational activities, such as backcountry skiing but is limited by the unit’s battery life. When placed inside backpacks to extend battery life because of the colder weather, data was unable to be collected due to the lack of satellite reception (D’Antonio et al., 2010).

Despite the wide range of information that can be collected through the GPS, there are limitations. The first being the aforementioned battery life and the resulting effects caused by extreme temperatures. Battery life limits the amount of data collected on a trip, because it ends with the life of the battery. The cost of individual GPS units may be considered a limitation for particular studies, in 2010, D’Antonio et al. paid $190/unit. Both D’Antonio et al. and Becco and Hallo recorded 100% return unit rates when GPS units were re-collected at the end of each visitors’ journeys, therefore reducing the need to continually purchase new units. Additionally current GPS technology is unable to differentiate between a user’s repeated visitation traffic, or if the user is stationary at a particular site for a given amount of time. If not differentiated, the data collected at a point where the user has stopped along the trail, may also be recorded as repeated visitations by the user over the allotted time. These issues can be addressed by “cleaning” the data so it is understood that the user did not travel significant distances in one location, given the time frame, but rather stayed in one consistent location (Becco & Hallo 2014). A trained staff would need to be present on site and knowledgeable on how to “clean” the collected data for it to be used by managing partners at Mt. Ascutney for future monitoring use. Finally, the most significant limitation of GPS technology is that it does not provide an accurate estimation of user traffic on the trail. Users can only be tracked when carrying the GPS devices, therefore to most accurately monitor traffic of the trails, all users must have a GPS device at all

times. Mt. Ascutney does not have the funds to provide every user with a GPS unit, nor do they have the informed on-hand staff with the ability to "clean" all the data that could potentially be collected.

4.3.4.2 User Surveys

Directly interacting with and soliciting the observations and opinions of users has the potential to pick up on emerging social tensions and developing patterns of trail use to an extent that other methods cannot. Furthermore, the consistent interaction between managers and users necessitated by certain survey methodologies can help to promote perceptions of trust and legitimacy among community members regarding the broader monitoring effort. While survey questions can be tailored to attempt to solicit user input on many, if not all, of our six monitoring targets, we look to surveys here with the intent of addressing only three of those targets: wildlife disturbance, emergence of conflict between and within user groups, and user volume and concentration. Each of these targets is well-tailored to monitoring via survey. Because it is technically demanding and potentially costly to assess wildlife disturbance through other monitoring methodologies, user observations can play the critical role of filling in the cracks for regulators when more technical monitoring efforts are unfeasible. Solicitation of user opinions is the most direct means of providing data on the nature of the relationships between user groups. Finally, intercept surveys are a useful means of verifying the data on user volume and concentration drawn from the online GPS services discussed below. Narrowing the survey scope to only a few specific target areas has the further advantage of rendering the survey more accessible to both subjects and analysts.

We have prepared a preliminary survey targeted at summer recreationists, which is provided in its entirety in Appendix B. The survey in its current form is limited to thirteen

questions, with the final query providing respondents the opportunity to list any potentially relevant information not covered in the multiple-choice portion of the survey. With the exception of this open-ended final question, the other twelve questions can be roughly divided into three categories based on the targeted monitoring area it seeks to address. Questions 1 - 3 solicit data on user volume and concentration. Questions 4a, 5a, 6a, and 7 - 9 attempt to ascertain how users' enjoyment of the trail system is affected by other user groups, with the final set of questions laying the groundwork for developing quantitative carrying capacities for each form of recreation based on user preference. Questions 4b, 5b, and 6b ask respondents to consider the impact of various forms of recreation on Mt. Ascutney's wildlife. This set of questions on wildlife impacts is somewhat ambiguous; it does not direct respondents to consider species-specific impacts or the particular nature of the impacts. The intention of this question set is not to provide explicit data for managers on when and which species are being affected by particular uses; indeed, existing studies (Taylor & Knight 2003) suggest that recreationists would not be able to accurately gauge the magnitude of their own and others' species-specific disturbances if asked. Rather, the intent here is to provide a foundation from which to plan and implement more technical wildlife monitoring methodologies. Note that respondents can also be prompted to describe estimated frequency of wildlife disturbance and any particularly significant wildlife interactions in the final, open-ended question, or additional species-specific questions can be added to the survey. Contingent upon the usefulness of the summertime recreationist survey and the associated challenges, trail managers may also consider drafting a survey geared toward wintertime users.

Of the myriad of available options for survey distribution, a combination of the intercept and web-based survey methodologies would appear best suited to the monitoring targets and user

characteristics specific to Mt. Ascutney. An intercept survey methodology would involve approaching trail users at a particular location--for the sake of maximizing sample size, either trail system entrances or trail intersections would likely be preferable--and administering the survey in person, either in written form or vocally. This methodology has the additional advantage of allowing data collectors to make note of respondents' tone and/or to engage in deeper dialogue with the respondents. Intercept surveying is not without its limitations: especially within the Ascutney system, where even heavy trail traffic days may see long gaps between user appearances, collecting an adequate number of responses may be difficult. Siting intercept areas at trail entrance parking lots, recruiting additional survey proctors, and diversifying survey administration times and dates may help maximize the number of responses. If a sufficient number of volunteer survey proctors can be recruited, intercept surveys can be less costly than other methods.

Compared to intercept surveys, web-based surveys have the potential to reach a larger number of respondents with less manpower required in the distribution process. The cost of web-based surveying varies depending on the service utilized, but selection of a survey software generally involves a trade-off between free services with fewer design options and analytical tools (i.e. Google Forms and Survey Monkey) and more feature-laden software with a regular membership fee (i.e. Survey Monkey Pro). The simplicity of our existing survey likely renders the use of fee-based survey distribution and analysis services unnecessary. Even the free web-based survey services provide some data collection and analysis features, which makes the analysis process more immediate and efficient relative to that of intercept surveys. However, as mentioned, a web-based survey distribution methodology lacks the personal connection between the resource management body and trail users that is inherent to an intercept survey.

Additionally, tracking down the relevant user groups online can be an opaquer process than simply approaching trail users in person. We suggest identifying listservs used by Mt. Ascutney recreationists-- such as that of the Vermont Mountain Bike Association--as a source of potential respondents. Links to the survey site can also be published on Mt. Ascutney trail maps and signage.

Given the benefits and limitations associated with both the intercept and web-based survey methodologies, we suggest implementing a combination of each. Such a scheme is unlikely to be cost-prohibitive if volunteer labor and free survey software is utilized. For the sake of analytical consistency, it is important for questions and response options to remain identical across survey types. Even then, it may be worth examining in the first year of data collection if there is a statistically significant difference in the responses of those surveyed in-person relative to those surveyed online when all other characteristics are controlled for; if such a difference exists, in-person and online data should be analyzed separately, or one method should be chosen over the other. Future experience will inform whether one method is sufficiently superior to justify abandoning the other.

4.3.4.3 Trail Monitors and Citizen Observers

Currently, in-person observation is the predominate and, in many cases, the *only* methodology for evaluating trail, vegetation, and wildlife disturbance and degradation at Mt. Ascutney. While the strategies discussed here seek to move Mt. Ascutney towards a more routinized and comprehensive monitoring framework, we recognize the significant role this in-person monitoring has served in the past, as well as the unique contributions it can continue to make in the future. In addition to his work on trail design and upkeep, Jim Lyall is the foremost authority on contemporary trail conditions, as well as one of the leading sources of information

on the sociopolitical dynamics and natural processes influencing the Ascutney trail system. He currently engages in trail condition monitoring and trail upkeep on a near-constant (weekly to monthly) basis. In terms of immediate considerations, more frequent communication between Mr. Lyall and the Upper Valley Land Trust would likely benefit the monitoring efforts of both parties.

Looking beyond the short-term, certain efforts should be made to secure and, if possible, expand his trail monitor role. Mr. Lyall's contribution to the trail system is significant enough that some methodology should be adopted for identifying a replacement pending retirement or any other reason for cessation of labor. The Upper Valley Land Trust has indicated that they are in a financial position to hire a summer intern; training the intern to perform some of Mr. Lyall's in-person monitoring tasks could make the trail monitor position more resilient, while also expanding the pool of individuals qualified to take on the role of full-time monitor in the event of retirement or if funding becomes available for additional full-time monitors.

The projected future role of trail monitors is left intentionally ambiguous here. This position should be viewed largely as a supplement to the other monitoring strategies discussed; it allows for the collection of more detailed data and the execution of upkeep tasks whenever and wherever the demand for those services might arise. That said, in-person trail monitoring is superior to the other strategies discussed here for a few select purposes. While other methods may be more adept at identifying and analyzing trends over time, trail monitors can more immediately identify and describe anomalous events, such as vegetation damage caused by a storm or evidence of wildlife disturbance resulting from a trail recreation event. Furthermore, of all the strategies described here, a consistent trail monitor presence is likely to be the most effective means of creating a relationship of mutual trust between trail managers and trail users,

while also encouraging the observance of trail system regulations. Finally, contributions by volunteer "citizen scientists" can help to supplement the on-the-ground monitoring work done by full-time or seasonal trail monitors. A more detailed description of the efforts being undertaken to develop such a volunteer monitor program can be found in Chapter 4.

4.3.5 Computer Technology-Based Monitoring Methodologies

4.3.5.1 Strava Global Heatmap and Strava Metro

Strava is a GPS-based phone application that allows pedestrians and cyclists to track the location, distance, and time of their workouts. In 2014, Strava Labs made available an online heat map, called the Strava Global Heatmap, that demonstrates relative rates of trail and road use worldwide by anonymously consolidating over 375 billion points of route data (circa November 2014) from over 170 million recorded rides and runs (circa April 2016) by all Strava users (http://labs.strava.com/heatmap/). Images of the Global Heatmap interface can be found in Appendix B.5. The mapped data can be used to evaluate relative rates of trail and road use at a fairly localized level. In 2015, Strava added a year-to-year comparison tool to their Global Heatmap, allowing users to examine discrepancies in rates of route use from 2014 to 2015. An image of this tool in use can be found in Figure 3 of Appendix B.5.

Observing both the popularity of the Global Heatmap and its quantitative limitations, Strava Labs responded by offering the Strava Metro data service (http://metro.strava.com/). Strava Metro scrubs all personal information linked to user data and provides subscribers with more detailed and quantitative data relative to what is offered in the Global Heatmap. This data allows for a more comprehensive analysis of use that encompasses time of day, day of week, season, and local geography dynamics. Unlike the Global Heatmap, Strava Metro is not a free service, and appears to be marketed towards research organizations operating in larger and

denser population centers, relative to the rural study area here. That said, Strava offers a free sample of Strava Metro data upon inquiry, which could be used to glean the situational effectiveness of this service (http://metro.strava.com/inquiry/). Additionally, because licensing costs for the Strava Metro service are based on "the number of Strava members in the requested geographic area," service fees in this case are likely to be manageable.

Preliminary evaluations of Global Heatmap data for the area surrounding Mt. Ascutney and the West Windsor Town Forest suggest that the mapping tool can be useful at such a relatively small and rural site. Figures 1 and 2 in Appendix B.5 demonstrate observable variations in rates of use among the different trails in the system. In order to roughly gauge the accuracy of the Global Heatmap data, we asked trail designer and monitor Jim Lyall to compare the indicated rates of trail use against his own personal assessments of trail popularity. The results indicate that the Global Heatmap data, in its existing form, may be limited in its analytical usefulness. Most significantly, Lyall notes that the heat map appears to overreport usage rates on difficult trails and underreport usage rates on the easier trails relative to what he would anticipate. For example, Hayride, one of the more popular and accessible mountain biking trails according to Lyall, barely registers on the heat map. This suggests either that Strava users are not bothering to record their activity on less strenuous trails, or that the trail users that utilize the Strava application skew toward the more advanced end of the spectrum. In either case, the Heatmap appears to have greater theoretical analytical potential than it has contemporary practical usefulness. The same can be said for the year-to-year comparison tool: Because of the small time range and lack of quantitative data points, it is virtually impossible to ascertain from the Global Heatmap alone whether yearly differences in trail use are the result of waxing and waning trail popularity (possibly due to overcrowding or damage), variable weather conditions

affecting the total number of rideable days, or simply an increase in the number of individuals using the Strava application.

Improving the usefulness of Strava as a monitoring resource would require a two-step approach. First, a survey of trail users must be conducted to determine the percentage of total recreationists utilizing the Strava application, as well as to explore whether there is any correlation between user skill level and/or trail preference and likelihood of Strava use. These findings can help illuminate the nature and magnitude of the inaccuracies in the existing dataset. Second, if Strava's usefulness is to be optimized, as many trail users as possible must be encouraged to consistently use the application when they ride or run on the trail system. This will likely require a delicate and sustained public outreach plan both to spread the message as extensively as necessary, and to assuage likely concerns among users about technological complexity or minimized privacy. Increasing the rate of Strava use is likely to make both the Global Heatmap and Strava Metro data more accurate and useful, but it would be accompanied by the probable economic tradeoff of increased Strava Metro licensing costs in subsequent years.

Note that if an effort to encourage Strava use among trail users is adopted and results in significant increases in the percentage of individuals using the application, the resulting mapping data could only be comparatively analyzed within the Mt. Ascutney/West Windsor Town Forest trail system; attempts to compare local heatmap data to usage rates from other regional trail systems would be invalidated by the fact that those other systems did not experience a similar technology recruitment effort. In other words, increased use of Strava software must not be confused for increased popularity of this trail system relative to others in the region. A popularity discrepancy may, in fact, exist, but the Strava Heatmap becomes an inappropriate tool for

quantifying that discrepancy when disparate technology recruitment efforts exist, as they would here.

Both the Strava Global Heatmap and Strava Metro have an additional inherent limitation that restricts the capacity of either to fulfill a comprehensive monitoring role. When utilized effectively, both can demonstrate--either relatively or quantitatively--rates of trail use at the local level, but there is no way to directly evaluate through Strava how these recorded rates of use correlate, if at all, with trail damage, wildlife disturbance, the spread of invasive species, and/or intergroup conflict. At best, the Strava Global Heatmap and Strava Metro must be recognized and utilized as two, potentially indispensably, useful, but nonetheless limited, resources within a wider toolbox of concurrent monitoring strategies.

4.3.5.2 Invasive Species Online Mapping Resources - iNaturalist.org and iMapInvasives

iNaturalist.org is an online community for naturalists, where people can document their personal observations of species and can share and discuss their findings with other users. iNaturalist.org allows for any user, regardless of experience or prior knowledge, to upload a photo to be validated and identified online. The online site acts as an encyclopedia of sorts, and allows users to edit, clarify and confirm other findings. iNaturalist.org has a corresponding GPS-based phone application that can be used to track and document findings in the field. The interface is primarily used as an educational tool to help users "become citizen scientists" and learn more about local species diversity. A great option for students of environmental science, iNaturalist is not a research-based or management-oriented interface. Not currently focused on invasive species, iNaturalist.org does not have the immediate feasibility to be used as a monitoring tool for invasive species. The site and phone application work as more of a global

species database that tracks the location of a singular occurrence. No metrics on species abundance, the origin of the species, or the species's impact are available. iNaturalist is available free online, but this excludes costs of community outreach. Along with low estimated monetary costs, iNaturalist does not warrant high resource demands. The application can be accessed and used by anyone, and its use for analytical purposes does not require technical training or expertise.

iMapInvasives is another online GIS-based data management system that can be used to identify invasive species. iMapInvasives also has a corresponding smart-phone application which is used to "assist citizen scientists and natural resource professionals" to protect natural resources from invasive species. This interface functions as a conservation and management tool more applicable for an audience of citizen scientist or wildlife experts, perhaps with a more expansive knowledge base on invasive species management. The phone application and online database requires accurate identification of invasives, which may pose a challenge for widespread encouragement of use. The general public lacks the ability to independently identify invasive species, suggesting that the implementation of iMapInvasives would require widespread education or an increased expert volunteer base. These would create limitations to the scale in which iMapInvasives could be utilized, but with educational outreach and/or the mobilization of a more extensive expert volunteer base could increase the feasibility of this strategy. Similar to iNaturalist, iMapInvasives is available free, but there may be costs involved with necessary outreach. Human resource demands are low in regards to small-scale use and analysis, but again, larger scale use would require public outreach to a group with a slightly more technical skillset.

Other improvements are also necessary to increase the potential of iMapInvasives to be used as an efficient management tool in the future. iMapInvasives only records individual

occurrences, which works well for species detection and identification, but does not work well when applied to tracking invasive species over spatial and temporal scales. There is potential for the utilization of further GIS technology or other spatial analysis tools in order to record, track and monitor the spatial range and size of the invasive populations.

4.3.6 Technical Monitoring Strategies

4.3.6.1 Vegetation Monitoring

Geographic Information Systems (GIS) is a computer-based system for "collecting, storing, analyzing, and displaying spatial information" (Chipman 2016). GIS can be a helpful technical monitoring strategy to track vegetation cover over time. With remotely sensed imagery, land managers can get ground cover visuals without needing to self-survey or be on-foot. Remotely sensed data can be used to compare vegetation cover over time, and can be compared to trail maps in order to track vegetation loss on or around recreational areas. This type of analysis could provide insight on the correlation between an increase in recreational traffic and an increase in vegetation loss.

Remotely sensed data can come from a satellite, an airplane, a helicopter, or an Unmanned Aerial Vehicle (UAV). Each source can collect various types of data in the form of lidar, sonar, multispectral, thermal, hyperspectral, and panchromatic imagery. Different sources produce images with different resolutions, or detail levels. High resolution imagery can be used not only to monitor vegetation, but also to track slope, elevation, depth to groundwater, and soil and bedrock type (Chipman 2016). Land managers can utilize GIS software to manipulate the collected imagery/data and produce clear representations of the current distribution of vegetation. Land cover classifications can be created, as well as a normalized difference vegetation index (NDVI) -- both of which can be used to track change and degradation of vegetation over time.

GIS can be an efficient, accurate means of monitoring vegetation, but its use comes with a hefty monetary cost. The U.S. Geological Survey (USGS) does not charge a fee for their Landsat satellite imagery, but often remotely sensed imagery providers charge high access fees for their data. The specific cost depends on the type of imagery or data, but generally lower cost options are lower resolution and therefore cannot be as productively used.

The use of GIS has the potential to greatly reduce human resource demands. Few individuals are needed in the collection of imagery, especially if the imagery is simply being purchased from a provider. Manpower demands would increase slightly, however, if the imagery was collected independently through the use of a personal UAV. This would require people to purchase, fly, and maintain the UAV, but would allow for more a specific, personalized process of data collection. Although the adoption of GIS technology would reduce demand for a larger monitoring team, the GIS work requires advanced technical and analytical skills for informative data analysis.

The use of remotely sensed data has the potential to be a viable option for vegetation monitoring at Mt. Ascutney. There is, however, a challenge due to dense canopy cover and multiple vegetation layers, which may prevent or hinder the discovery or monitoring of localized impacts at study sites (Kim & Daigle 2012). This can be combatted by the utilization of hyperspectral imagery or lidar data, which can still collect ground data by penetrating through the upper story (Kim & Daigle 2012; Svajda et al. 2016). The cost of access to this data is the most significant factor that must be more closely evaluated and considered in order to make direct recommendations for the adoption of GIS at Mt. Ascutney.

4.3.6.2 Trail Condition Monitoring

Monitoring of trail conditions utilizes strategies which predominantly observes changes associated with trail widening and soil loss. The widening of trails directly correlates with user traffic; increased traffic results in the outward expansion of trails. Additionally, as elevation increases, trail width decreases due to the increasing difficulty associated with increasing trail elevations (Svajda et al. 2016).

Using documented reference points, trail widening can be easily monitored over time, by measuring the distance across the trail where undisturbed vegetation meets either the flattened vegetation or the layer of topsoil on either end. Digital photographs and documented GPS locations ensure repeatable observations that can be conducted by an untrained volunteer staff for many years. Because trail width is linked to user traffic, trails at lower elevations and missing previously installed deterrents for users to go off trail, such as fencing or sunken rocks indicating a trail border, should be most heavily observed. Analysis of the data collected will inform management of where trails are expanding quickly into undisturbed vegetation. Using this knowledge to prevent further ecological damage, expansion can be halted by the implementation of natural trail borders such as rocks and logs.

Destruction of soil structures and trampling of vegetation eliminates the protective layer that prevents nutrient rich soil from eroding away. Once gone, nutrients in the soil must be restored which takes a significant amount of time and only leads to more erosion because a protective vegetative layer is unable to grow in the nutrient poor soil. Cross sectional area (CSA) analysis observes soil loss over time (Svajda et al. 2016). Cross sectional analysis is conducted using either temporary or permanent reference point to create a cross section of the trail. The implementation of stakes into the ground on both edges of the trail, act as temporary reference sites to create a cross section by the cord strung between the two stakes. Documentation of the

stakes is made to promote accuracy in future measurements, through the use of digital photographs and GPS coordinates (Svajda et al. 2016). Permanent reference points are created by drilling small holes in adjacent bedrock on both sides of the trail to establish points where a leveled laser may be placed to create a cross section of the trail (Monz et al. 2010). Once the cross section is established, both methods document the vertical distance from the cross section to the surface of the exposed soils in set intervals across the trail (Svajda et al. 2016; Monz et al. 2010).

Permanence of reference points increases the accuracy and consistency of data collected over time. However, these reference points are limited to locations with bedrock on either side of the trail. Temporary reference points are able to collect data at any location on the trail and are not limited to physical components of the environment. Despite the advantage of any location on the trail, temporary reference points will not be able to collect as precise data as set reference points will, as the stakes have the ability to be placed in slightly different locations each time data is collected.

Aside from the slight variations that may come from the data collected either using temporary or permanent reference points in CSA analysis, the quantity and general location of transects should be chosen in regards to expected user traffic (Monz et al. 2010). Trails with high visitor usage and common locations of off trail travel should be more heavily observed than locations with already pre-existing enclosures that may limit or discourage off trail traffic.

Predictive modeling is another option to monitor trail condition and erosion. The Universal Soil Loss Equation (USLE) was the first widely accepted predictive erosion model. The USLE predicts the soil loss per unit area per unit time by using the factors of rainfall and runoff, soil erodibility, slope length steepness and canopy cover. Also, the Water Erosion

Prediction Project (WEPP) is an agricultural erosion model that was later applied to forest and resource management. WEPP acts as an updated version of USLE by adding the hydrological and soil process factors when calculating soil loss. However, both models were found to consistently predict higher estimates of published erosion rates (Kidd, Aust, and Copenheaver, 2014). Despite the elevated calculations, both models reatained the ability to predict areas with the highest erosion potential.

Observations of trail widening and soil loss through CSA analysis are both potential options for trail condition monitoring at Mt. Ascutney. Both monitoring programs require the amount of time it takes a volunteer collecting data to walk from each observation location to the next. However, because both the USLE and WEPP models require a wide arrange of factors to compute the soil loss of a location, a larger and more technical staff will be required to spend a significant more amount of time when collecting data. Because of the time commitments, monitoring of trail widening and CSA analysis, are more productive methods for Mt. Ascutney to conduct trail condition monitoring.

4.3.6.3 Wildlife Monitoring

Evaluating disturbances to wildlife caused by the presence of recreationists, in addition to being a species-specific undertaking, tends to demand more technically complex strategies that often yield more ambiguous data relative to other monitoring targets. Because no wildlife monitoring strategy can quantify recreation's disruptive impact on all species, and because human resource and monetary constraints would render attempts to develop monitoring protocols for each of Mt. Ascutney's species unfeasible, it is necessary to restrict the focus of our monitoring efforts to a few biologically important and/or culturally esteemed species. Additional species may be considered pending future necessity and resource availability, but for this

analysis we limit our discussion to potential monitoring strategies for white-tailed deer (*Odocoileus virginianus*) and native perching bird species, particularly warblers and sapsuckers.

The species and species groups selected here as the targets of the initial wildlife monitoring scheme were selected based on several factors, including importance to the broader ecosystem, cultural and aesthetic significance to trail users, and monitoring feasibility. The last of these categories, monitoring feasibility, severely limits the number of Ascutney's large mammals that can serve as viable target species. While Ascutney's moose population is culturally significant and ecologically distinctive, it is simultaneously sparse and highly migratory, rendering any consistent monitoring methodology (with the exception of user survey data) untenable. As an apex predator, black bears are also environmentally important and culturally significant, but they, too, are sparse within the Ascutney region. The Final Forest Management Plan for the West Windsor Town Forest observes that the region "is not known specifically to be an important bear corridor" (McLane & Roe 2015, 40), and also notes that a 2011 inventory of the Town Forest yielded only two definitive signs of bear presence (McLane & Roe 2015). In short, while each of these species may be important to both the Ascutney ecosystem and trail visitors, their sparsity limits their capacity to be monitored through any other mechanism but recorded user observations. We instead turn to white-tailed deer, a species whose regional density is also likely low, given the relative paucity of edge habitat (McLane & Roe 2015), but which is significantly more common than either moose or bear. Our selection of perching birds--encompassing Ascutney's several species of warblers and sapsuckers--as the second monitoring target is based on the fact that monitoring methodologies for these species have already been implemented elsewhere, and that these "song birds" play an important role in the wilderness experience of trail users. By selecting both a large mammal and a group of small

birds as our initial monitoring target species, we also hope to expand our capacity to identify potential impacts across the breadth of the ecosystem.

4.3.6.3.1 White-Tailed Deer (*O. Virginianus*) Monitoring

One of the more promising monitoring methodologies for evaluating the stress levels of large ungulates that have been exposed to contact with recreationists is the analysis of fecal glucocorticoid assays (FGA). This technique has been used to quantify the stress levels of Manitoban elk (*Cervus canadensis manitobensis*) in South Dakota (Millspaugh et al. 2001) and Eastern moose (*Alces alces americana*) in northern Vermont. When mammals are exposed to external stressors, the activation of their hypothalamic-pituitary-adrenal axis results in the excretion of glucocorticoids, which can remain at elevated levels for up to a few hours after the initial disturbance occurs. Glucocorticoid levels can be analyzed from plasma, saliva, urine, and fecal samples. Because of its minimal invasiveness relative to the other options, fecal sampling is becoming increasingly popular. There are two prevailing techniques for fecal glucocorticoid analyses, the less financially prohibitive of which is the enzyme immunoassay (EIA) method. The major upfront cost associated with this technique is the necessity of purchasing or securing access to a microplate reader. The purchase of the antibody needed for the immunoassay analysis constitutes the most important long-term cost; EIA kits are available for purchase, but this route involves the additional technical requirements of validating the kits' reagents for use with *O. virginianus* (Sherriff et al. 2011). A more comprehensive description of the advantages and limitations of the multiple techniques for glucocorticoid extraction and analysis can be found in Sherriff et al. (2011).

Assuming the costs associated with FGA are found to be non-prohibitive, the effectiveness of its use will hinge on acknowledging its inherent limitations, as well as

accounting for the species- and site-specific characteristics of *O. virginianus* and Mt. Ascutney, respectively. It is important to note that gender, sample age, storage time, and storage method can all impact a fecal sample's glucocorticoid levels (Sherriff et al. 2011). Within the Mt. Ascutney system, collection sites can be oriented in such a way as to facilitate comparative analyses across the temporal and spatial dimensions. Feces collected at trailside sampling sites can be compared to feces in low- or no-traffic "control" sites. Note, however, that because glucocorticoid levels can remain elevated for relatively long periods after the initial exposure to stress, and because deer can travel long distances relatively quickly, the distance from the nearest trail is unlikely to be a perfect determinant of whether the collected feces originated from a deer that had not recently been exposed to an anthropogenic stressor. It should also be emphasized that feces collection and analysis should be a year-round endeavor insofar as financial limitations allow. The southern portion of the West Windsor Town Forest was designated by the state of Vermont as critical deer wintering habitat (McLane & Roe 2015), implying that interactions between deer and trail users will remain commonplace throughout the winter months. Because of the increased difficulties inherently associated with foraging in the winter months, analyzing the additional stresses placed on deer by wintertime recreationists may take precedence over summertime analysis if cost constraints limit the seasonal frequency of FGA. There should at least be few issues with securing adequate feces samples; the 2011 inventory of the West Windsor Town Forest noted "abundant [deer] feces" (McLane & Roe 2015, 39).

4.3.6.3.2 Perching Bird Monitoring

The strategies proposed here for monitoring Mt. Ascutney's multiple warbler and sapsucker species are adapted from the methodology employed in Davis et al. (2010). That study examined the effects of exposure to mountain biking on the behavior of golden-cheeked warblers

(*Setophaga chrysoparia*) in rural recreation areas outside of Austin, Texas. Elements of the Davis et al. study likely render a complete replication of its methods financially and temporally unfeasible in the Mt. Ascutney context. Due to the associated human resource, technical, and monetary demands, accurately mapping the territories and engaging in the color banding of individual male birds as Davis et al. did is likely untenable. However, it seems plausible that their visual monitoring techniques can be appropriated within the Ascutney setting. Davis et al. examined individual male birds within pre-determined sample sites for a minimum duration of 300 seconds per bird. Over that period, observers sorted the bird's behavior into one of nine categories: singing, preening, agonistic, mate guarding, perching (resting), locomotion (flying and hopping), foraging (searching, attacking, and food handling), and feeding fledgling, and time-out (any period when the individual was out of sight) (Davis et al. 2010, 467). The authors avoided data distortions caused by natural diurnal variations in bird behavior by making an equal number of observations at each site in the morning, at midday, and in the evening. The authors also assessed nesting success at any nests found within the data collection sites by installing a small camera as a means of evaluating whether at least one host young fledged (considered a "success"), whether an egg or host young was removed by a predator while the nest was active ("depredated"), or whether the male and female abandoned the nest for several days while host young or eggs were still in the nest ("abandoned") (*Ibid*, 468). Analyses of the impacts of exposure to recreationists were made based on the differences in individual male bird behavior and nesting success between the active trail and control sites.

Complicating data collection at Mt. Ascutney is the higher diversity of bird species, the denser vegetative coverage, and the range of different habitat types. The last of these challenges can be partially addressed by ensuring that an "active" sampling site and a "control" sampling

site differ only in that the former borders, or is bisected by,a trail; otherwise, factors like area, elevation, proximity to major water bodies, vegetation cover, and vegetation type should be as similar as possible between the sites. Because different warbler and sapsucker species tend to congregate at different elevations and around different vegetation types, a more complete perching bird monitoring scheme will involve multiple pairs of "active" and "control" sampling sites spread across the Mt. Ascutney system.

The monitoring strategy for each species described here depends on the identification of "control" sampling sites within the Mt. Ascutney system that receive minimal human traffic. While one may look to areas far removed from trails as inherently appropriate control sites, the possibility of unauthorized off-trail recreationist traffic means this assumption may not hold in practice. Analysis of Strava Heatmap, Strava Metro, and user survey data, as well as trail monitor observations, can help to determine whether planned control sites are, in fact, no- or low-human traffic areas.

4.3.7 Proposed Monitoring Strategies - Frequency, Implementation Timeline, and Areas of Overlap

Trail monitoring devices such as GPS technology will be effective in monitoring trail traffic and usage. Because data collection is limited to the number of volunteer users who are willing to carry along the GPS device during their trip, timing and frequency of data analysis is impacted by the volunteer base. Data should be collected daily, with monthly analysis of data collected during peak seasons. Consultations must be made with those involved in data analysis and collection at least on a monthly basis. The implementation of GPS data collection at Mt. Ascutney should be implemented once a volunteer base has been established. Until then, existing monthly trail monitoring reports should continue by Mr. Lyall and the promotion of future

citizen volunteer outreach should begin immediately. By the summer of 2016, a monitoring intern should be hired to further data collection regarding Mt. Ascutney. Development of a finalized trail monitoring program should continue over the next three years in order to establish a program in which trail monitors can either be added or replaced.

Of the monitoring strategies discussed here, the user survey is one of most feasible with respect to monetary costs and human resource demands in the immediate near-term. A preliminary summer use survey has already been prepared, and in-person distribution could, in theory, begin concurrent with the publication of this report. Additionally, adapting the survey to any of the several online survey distribution sites discussed in detail above would require only minimal further effort. Survey data should ideally be analyzed on a seasonal basis (i.e. Summer 2016 User Survey, Winter 2016-17 User Survey). Each broader seasonal analysis should include data from several collection dates, as well as the responses submitted over the course of the season via the online survey form. (Note first the potential issues with consolidating in-person and online survey responses discussed above.) The finalized data analysis, in addition to being used for benchmark setting and other management decisions, should also be shared--either in full or in the form of a truncated summary--with the general public. Disclosing this information will help to associate a sense of transparency and attentiveness with the management apparatus, and may also promote consistent or increased responses in subsequent iterations of the survey. Findings derived from the user surveys should be used as background for the other monitoring practices we have discussed, particularly the siting of songbird and cross-sectional area (CSA) study plots.

In-person trail monitoring is the most developed of the strategies we have proposed. Mr. Lyall's work is indispensable to the continued maintenance of the trail system and the health of

trail- proximate habitat. Those efforts should continue in their current form; our only notable recommendation here is for a more consistent line of communication between Mr. Lyall and the Upper Valley Land Trust (UVLT). However, action should be taken in the short-term to begin making the trail monitoring position more resilient over time. To this end, an intern should be hired as soon as is financially and managerially feasible in order to being supplementing and expanding upon the existing monitoring efforts. The technical and temporal burden on full-time trail monitors can be eased by recruiting volunteer observers--"citizen scientists"--from both the surrounding community and from Mt. Ascutney's soon-to-be-widening user base. A more detailed description of the strategies and timeline for such a recruitment effort can be found in Chapter 4.

The use of Strava online resources is another monitoring strategy that can be implemented immediately due to low financial, technical, and temporal demands. The Strava Heatmap interface, in its current form, can be an effective supplementary tool for identifying the most heavily-traveled trail sections in the Mt. Ascutney system. To make the Heatmap service even more useful, there should be an immediate push to encourage use of the Strava application among Mt. Ascutney's pedestrians and cyclists. In its early stages, this can be as simple as word of mouth recommendations, posters on trail entrance signs, or a small graphic on a website. The financial feasibility of licensing Strava Metro data should also be examined in the immediate short-term. While we had filed a request for sample Metro data through the Strava website, our inquiry was not returned by the time of this report's publication. In the event that Strava Metro is a financially feasible and technically useful tool, how often data should be analyzed will be contingent on the frequency with which new data is added. Data from the Metro tool can and should be cross-referenced against data and findings derived from the Strava Heatmap, user

surveys, and trail monitor reports. This data could be particularly useful for identifying areas to employ CSA analysis and for evaluating whether proposed "control" sites for wildlife monitoring are, in fact, free from human traffic.

Online mapping resources like iNaturalist and iMapInvasives can be utilized to monitor the spread and introduction of invasive species. In order to track, predict, and prevent the expansion of invasives, both interfaces should be formally analyzed on a monthly basis. Monthly analyses will allow users to compare observations over time, and identify any significant changes or expansions/invasions. Monitoring staff can also compare the recorded observations of both iNaturalist and iMapInvasives for further insight on the potential risks of expansion. Depending on the number of sightings recorded, the frequency of analysis may increase or decrease accordingly. In the case of Mt. Ascutney, the analysis of existing observational data from iNaturalist and iMapInvasives should be utilized immediately. The Mt. Ascutney monitoring team should start to encourage more widespread use of both interfaces through community outreach and public education, and should also begin to recruit and train iMapInvasives interns and other volunteer observers.

Geographic Information Systems (GIS) can be utilized as a technical monitoring strategy to track vegetation cover over time. GIS should be analyzed annually at minimum. Greater resource availability could allow for semi-annual or even quarterly seasonal analysis. This increased frequency would allow for intra-seasonal analysis, and would provide greater insight into the specific impacts of various recreational activities. More frequent use of GIS technology would also increase understanding of not only the spatial, but also the temporal distribution of vegetation disturbance/loss. It is unclear whether GIS can currently be utilized at Mt. Ascutney. Because of high monetary access costs, feasibility depends on whether the Upper Valley Land

Trust or Ascutney Outdoors has sufficient resources to implement a specific monitoring technique. If not currently available, it is also unclear as to how long appropriate resource development will take.

The use of cross-section area (CSA) analysis over time will provide a sufficient data set to observe soil loss or gain on trails due to user traffic. CSA analysis should be conducted twice annually at minimum, however higher frequency is preferred if possible. Consistent monitoring will require high manpower and is not limited to technical and analytical skill sets. If frequent monitoring is improbable, data should be collected once prior to the opening of trails in early Spring and once at the end of the season, in mid to late Fall. Because the quantity of observed transects should be determined based on user traffic, CSA should be implemented at Mt. Ascutney once specific trail locations of high user traffic have been documented. Dependent on the timeline of these established high traffic locations, CSA analysis should be implemented as soon as physically possible to create an immediate baseline data set to determine soil loss or gains over time.

As with most of the other technical strategies discussed above, monitoring of white-tailed deer and perching birds at Mt. Ascutney will likely be unfeasible in the near-term due to monetary cost and technical constraints. The analysis of fecal glucocorticoid assays (FGA), in particular, is a strategy predicated on the purchase or licensing of equipment and materials not immediately available to our partners, and this method also requires a degree of specialized technical skill that would likely necessitate a partnership with an external research body. Proposing a timeline for analysis itself would be of little use until these resources can be acquired and/or partnerships can be developed. Analysis of shifting behavioral patterns of perching birds in response to interaction with recreationists is a monitoring method whose short-

term implementation is more feasible, given the financial and human resources available. This technique requires an acute knowledge of the landscape and an ability to devote considerable time to observation more than it requires costly equipment or extensive technical experience. Perching bird analysis is primarily a mild-weather activity, and while it may not be feasible to finalize a monitoring strategy before Winter 2016-17, potential traffic-exposed and control sites can be identified in the coming months in preparation for the initiation of research in Spring 2017. Strava software, user surveys, and trail monitors' findings should be used to inform the timing and location of monitoring.

This overview demonstrates that there is no "silver bullet" monitoring mechanism. There are many potentially useful tools and strategies, each of which has clear theoretical and practical limitations. An effective comprehensive monitoring scheme will be one that balances these technical benefits and limitations with the human capital and monetary resources available to the community. None of these strategies individually is economically prohibitive. All, with the exception of the first, are already being used in the site-specific capacity described here, albeit to a much more minimal extent than what we recommend. The primary long term difficulty will be ascertaining the proper balance of resources to devote among these methodologies. Only accumulated experience will demonstrate the exact distribution of resources that is most effective for this site. A visual overview of which monitoring targets are intended to be addressed by which monitoring strategies is provided in Appendix B.7. A visual overview summarizing the monetary costs, human resource demands, proposed frequency of analysis, and rough timeline of implementation for each monitoring strategy is also provided in Appendix B.7.

4.4 Areas of Future Concentration

Given the lack of comparable cases of preemptive carrying capacity analysis and the unique user dynamics of the Mt. Ascutney/West Windsor Town Forest trail system, we will not be generating specific quantitative benchmarks, but will rather present strategies that can be utilized by community partners to create benchmarks in the future. Our community partners agree that precise numerical benchmarks are not currently feasible, and would be arbitrary at this point, but with our recommendations, more precise benchmarks can be developed in the future. Future benchmarks aim to generate a carrying-capacity of sorts to regulate recreational traffic and ensure the preservation of ecological integrity and user experience. Our community partners stressed the importance of incorporating user satisfaction into our benchmark recommendations, as visitor perception and experience is integral to the success of Mt. Ascutney.

4.5 Conclusion

The merging of the lower Mt. Ascutney trail system with the neighboring West Windsor Town Forest offers a unique opportunity to expand existing popular recreational activities while simultaneously preserving regionally unique ecosystems and species. Satisfaction of those concurrent ends will require a comprehensive understanding of the environmental and social ramifications of existing recreational uses, a strategy for monitoring the current and continued effects of those uses, and a set of initial quantitative and temporal benchmarks for each existing recreational use. Here we have attempted to address all of those needs.

A review of the existing literature suggests that the most popular summer and wintertime uses of the Mt. Ascutney area have numerous ecological and social effects, as well as ramifications for the potential spread of invasive species. Erosion, habitat loss, and wildlife disturbance are the primary concerns associated with the summer recreational uses of hiking/trail running, mountain biking, and horseback riding. While the type and magnitude of trail use has an

impact on the expression of these effects, the siting and construction of the trails themselves has the most significant long term environmental implications. Backcountry and frontcountry skiing are each associated with habitat loss and wildlife disturbance, but these effects are contingent upon geographic setting and skier behavior. The extent of invasive species proliferation at Mt. Ascutney is currently relatively limited and manageable, though existing recreational uses and poorly planned future trail creation could provide a vector for the expansion of invasives in the future.

Based on the major findings from our dual literature reviews, our case study, and an evaluation of the relevant existing monitoring methodologies, we recommend a comprehensive and overlapping monitoring framework to address the target areas of user volume and concentration, social tensions between user groups, the proliferation of invasive species, degradation of vegetation, disturbance of wildlife, and trail erosion and widening. These strategies include computer-based technologies in the form of Strava Heatmap and Strava Metro, as well as the invasives-targeting iNaturalist and iMapInvasives; volunteer-based strategies, including user surveys, in-person trail monitoring, and volunteer "citizen scientist" observers; and more technical monitoring efforts targeted at wildlife, vegetation, and trail disturbance. While each of these strategies might be technically, temporally, and monetarily feasible on its own accord, circumventing resource limitations will require an evaluation of which monitoring methods are most important and, thus, to which monitoring areas the majority of available funding and manpower should be distributed. We have attempted to ease this resource distribution burden by identifying monitoring techniques and tools that combine task and cost effectiveness.

Economic rejuvenation of the communities surrounding Mt. Ascutney through the creation of new infrastructure and the expansion of recreational opportunities is a primary goal of this overall analysis. However, observance and continuous development of the monitoring protocols articulated here is necessary if the existing recreational uses are to be maintained and the unique environmental features of the site are to be preserved in the long term.

Chapter Five

Education and Communication for Ascutney Outdoors

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Chapter Five: Education and Communication for Ascutney Outdoors

5.1 Introduction

Vision: To develop communication and educational platforms to promote community-based conservation, recreation, and education, as outlined in the town's report and conservation easement.

The West Windsor Town Forest is protected by a conservation easement, which requires all recreational activities to be managed in compliance with the terms of the easement. The town of West Windsor has signed a lease agreement handing over development and management of recreation and educational activities to the non-profit organization Ascutney Outdoors (AO).

Charged with developing and managing recreational activities while balancing the conservation mandates of the easement, Ascutney Outdoors must interact and engage a diverse set of users and visitors about responsible use of the property. Our group believed that such goal should be addressed in two ways: communication and education.

Communication is important to maintaining the current user base as well as to recruiting more users and volunteers. In order for communication to be effective, Ascutney Outdoor's print and digital communication must be concise, accessible, understandable, and tailored to multiple user groups. Therefore, we approached this communication project with the primary objective of drawing on user experience, "case studies, and communication theory to develop communication strategies and messages to help Ascutney Outdoors guide user behavior that aligns with the terms of the easement," (internal education) while simultaneously cultivating a "vision/brand" of Mt. Ascutney and the surrounding community for external marketing (to draw in new visitors).

Education is the second key component in realizing a vibrant, sustainable Ascutney. We decided to focus on education of elementary school children, since children will be the future

leaders, users, and volunteers of Ascutney. Through interviews with members of the Ascutney community and an extensive literature review, we have developed 6 learning objectives, which we hope will guide the town's K-6 school, Albert Bridge School, as it designs its outdoor education program.

5.2 Communication

This section on communication describes the following:

- Communication goals and our deliverables
- Communication theories that informed the project
- Interview Methodology
- The Deliverables
- Results and discussion

5.2.1 Summary of Communication Deliverables

In our initial conversations with community partners, they expressed their hopes of renovating the existing website with more engaging content. We brainstormed what would best fit the community partners' needs. After some thought, we decided that our deliverables would contain elements of both internal and external marketing so that Ascutney Outdoors could effectively keep the existing user base as well as reach out to other community members, surrounding communities, and the New England region. After a review of literature on communication theory, we decided that a video focusing on "testimonials" and the sense of place would best fit these goals. We also took photos that can be later used to make to renovate the existing website.

5.2.2 Literature Review - Communication Theory

Existing studies on communication point to the efficacy of video marketing (Appiah 2006; Hsieh et al. 2012). The usefulness of video in outreach and promotion rests on the multimedia effect: messages delivered through multiple media are more memorable (Hsieh et al. 2012). The multimedia effect rests on several different psychology theories, including the cue-summation theory and the dual-coding theory. Cue-summation theory compares single-channel communications (e.g. simple text) and multi-channel communications and posits that multichannel communications that "combine words with related or relevant illustrations will provide the greatest gain because of the summation of cues between the channels" (Severin, 1967). The dual-coding theory, which was pioneered by Allan Paivio in 1971 and has emerged as one of the most influential theories in psychology, states that the human mind works with two functionally independent stores -- verbal memory and image memory. One of the implications of this quality of our brain is that the chance that a memory will be retained and retrieved is greater when it is stored both verbally and visually, meaning that videos, which use these two stores of memory, are a great mode of information and entertainment. With the prevalence of smartphones, the popularity and accessibility of videos is increasing dramatically each year. YouTube is now more popular amongst 18-49 year olds than any single cable network (Heisler 2016). Considering academic studies that point to the effectiveness of multi-modal communication and the rising popularity of videos, our group decided to make a video for Ascutney Outdoors' website, which would improve its outreach ability.

We also believed that videos could best highlight community members' sense of place. Place attachment is an affective, cognitive bond between people and their environment (Stedman et al. 2014). Stedman et al., in their research of photo-based methods for understanding people's

attachment to place, emphasize that "communication of attachment and meaning via visual images is fundamentally different from that accomplished solely via text and/or numbers." (Stedman et al. 2014, 113). We believed that video interviews could give agency to those trying to communicate their relationship to Ascutney.

Our group decided to make interviews with community members, or "testimonials," a key component of the video content. Various studies, such as Appiah (2006), found that people are more likely to rate a product more favorably when a site contains audio/video testimonials, as opposed to just text/picture testimonials or no testimonials (Appiah, 2006). Again, the researcher emphasizes the role of multimedia communication.

Interviews also served as a form of storytelling, which Langellier and Peterson (2004) classify as a powerful form of communication. Our group envisioned our interviews to serve as a kind of "family storytelling" that these communications theorists talk about in detail in their book. The authors found family storytelling to be a communication practice with "power and effectivity…[a] means of storing family culture" (Langelier and Peterson 2004, 70). They also found that study participants considered "photographs...a website, and family videos...as aspects of content and their family narrative." While the members of the Ascutney community do not all have blood ties, we considered them to be a "family," because we noted a strong sense of community and connection in our initial conversations.

In helping to renovate the current website, our group also decided to focus on enhancing visual content (such as photos). Our decision follows studies that have found the use of graphics and multimedia to be an important factor affecting Overall Web Usability (OWU) (Nathan 2010). As graphics and multimedia, including animation, video clips, and background music,

make websites more attractive for people to visit, we have redesigned the website to incorporate more of these elements in addition to a video.

5.2.3 Interview Methodology

We interviewed community members that have had a profound relationship to Mt. Ascutney. The four people we interviewed were Laura Farrell, Erin Kershaw, Tii McLane, and Jim Lyall, who are actively engaged with the mountain. Laura Farrell is the Executive Director of AO, and the creator the Vermont 50 and Vermont Adaptive Skiing, which were both started in Ascuntey. Erin Kershaw is the director of The Climb, the town's fitness center. Tii McLane is the ecologist who recently wrote the forest management plan and ecological assessment of the mountain. Jim Lyall serves as a board member of AO and works extensively in trail design as a founding member of STAB, Sport Trails of Ascutney Basin.

We wanted our interviews to focus on people's relationship to the mountain, because in our initial conversations with community members and visits to the area, we got the sense that there was a strong sense of community built around Ascutney unlike in other bigger mountains such as Killington. Community members had also emphasized their vision of getting more towns people involved with the mountain.

As mentioned in the previous section, we believed that the video would give the community members a way to express their ties to Ascutney in a non-traditional (text & numbers) way. We also thought that it would also enable community members watching the video to understand their sense of place expressed in a different manner.

Therefore, our interviews with community members revolved around three questions that would help us highlight the relationship between people and Ascutney. They were:

- What is your personal relationship with Ascutney?

- What makes Ascutney special?
- Where do you see Ascutney in 10-15 years?

The interviews were semi-structured: while we made sure to ask the three main questions above, the interviews were conversational and we asked other questions that pertained to what interviewees said and to the theme of relationship to place.

We envisioned the video to be more geared toward surrounding community members. We wanted the video to work as a galvanizing force, one that would help bring people together and care even more for the mountain than before. We wanted to make community residents who have not had a close relationship with the mountain to become active participants. Our goal was to make a video that would interest the older and younger generations.

5.2.4 Communication Deliverables

5.2.4.1 "Ascutney Alive" Video

The video may be accessed via the Ascutney Trails webpage or by contacting Jim Lyall or Felicity Knight.

The backbone of our video is interviews. Rather than making a video that would be purely an advertisement, we decided to focus on highlighting the profound meaning that the mountain holds in community members' lives. What people said in the interviews gave great insight into their relationship with the mountain, and we felt that their words had the power to convey the specialness of the place in a way that a typical advertisement would not be able to do. Since Ascutney Outdoors has acquired a diverse array of photos and videos over the years, we decided to use them to enrich our video. Still images from "Ascutney Alive" appear below.


MOUNT ASCUTNEY
WEST WINDSOR, VT


ERIN KERSHAW
ASCUTNEY MOUNTAIN RESORTS


TII MCLANE
CONSULTING ECOLOGIST


JIM LYALL
SPORT TRAILS OF THE ASCUTNEY BASIN (STAB)

5.2.4.2 Photographs

We sought to add to the existing library of photographs. Our photographs come from two main events that took place over the course of April and May: Community trail work day and Fit Kids, an after-school program for students of Albert Bridge School, the local elementary school. Through these photos, we wanted to show the diverse interactions that people have with the mountain. An example photograph from a Fit Kids hike appears on the next page. All photos and videos taken over the course of this project were given to Jim Lyall and Felicity Knight.

5.2.5 Communication Discussion

Mt. Ascutney has held a special meaning in the lives of community members we have interviewed. The same sentiment could be observed in different generations, and the sense of community built around the mountain was a central theme. Laura Farrell emphasized how "the community of people in this area all have a tie to this place--all have a special memory to this place." She pointed to the incredible volunteer force as an example. She described how "people just came out of the woods to help" build the rope tow, even though none of them had prior experience of undertaking such a project. When asked to describe Ascutney in a word, she said after a pause, "community." Erin Kershaw echoed the sentiment. Talking about the conservation easement, she said it happened because "our community just really came together and purchased the mountain, and created it, and took it, and nurtured it." She calls Ascutney "magical" because of "the nature, the community...the sports." For Erin, the community cannot be separated from the nature and activities of Ascutney.

Community members also emphasized their deep personal relationship with the mountain. Laura Farrell said: "the most important parts of my adult life have happened here...meeting my husband here having our two little kids." Her nonprofit work, such as the Vermont Adaptive Ski and Sports, and the Vermont Fifty, both of which she created, came out of Ascutney. She talked about other community members' connection to the place: "There is this underlying passion, commitment, belief, and wanting it to survive. It is a surviving mountain. It is a survival. A lot of couple of the ski areas started here haven't survived but the mountain keeps surviving. And the interest and the passion for it keep surviving." Erin Kershaw, who is originally from Pennsylvania, said that it had been her "dream" to move to Ascutney and that she "hustled for 26 years to make it and live here." Tii McLane talked about the presence that the

mountain has had in her life since a young age, when she was growing up in Hanover. “Everywhere you go, you could see the mountain,” she said. In her adult life, working as a forester in Hartland, VT deepened this connection: “You couldn’t get away from the mountain...Everywhere you go, it was.”

All the interviewees talked about the specialness of Ascutney’s natural features that allow for various recreational activities. “There’s a lot that can happen here. I mean you can ski, you can hike, you can bike, you can ice climb, you can cross country ski, you can snowshoe...it’s made for multi uses and I think that’s what makes [Ascutney] special,” said Laura. Erin closely echoed this sentiment. She lists “gnarly mountain biking, hiking, backcountry skiing, trails just incredible” as some of the exciting activities at Ascutney. Jim explained how Ascutney’s diverse natural features are what gives the mountain its various set of activities: “ Each trail has a unique personality...One side, we’re on open ski slopes. On another, we’re in tight trees and amazing rock outcroppings, so it’s got a little bit of everything.” While Tii did not talk extensively about recreational opportunities, she did emphasize the incredible biodiversity of the mountain. She underscored the habitat biodiversity, how “there’s habitat for almost every animal you can think of,” because of its variation in elevation and location. She explained how the mountain is the southernmost range of northern animals and vice versa, and how it serves as a east-west corridor for large mammals.

Community members expressed hope and excitement about the conservation easement. Laura and Erin both used the word “forever” to describe the town’s purchase of the mountain. When asked about her vision for Ascutney in 10-15 years, Laura responded, “The mountain will be alive in 10 years. It will be very much alive. It’s gonna be kinda like the way Vermont used to be...it’s not gonna be this big fancy place but it is going to be very sustainable so that it will be

alive and can live. This mountain now that the land is purchased and conserved this is forever. This is forever. This isn't like a 5, 10, 20 year thing. This is forever. This goes way past my lifetime, and so we look at it in that way—that whatever we are doing and decide to do with conservation, education, recreation, events, is we have to figure that it's forever and sustainable." Erin enthusiastically described the easement in these following terms: "I like to think of this mountain as the comeback kid, if you will. This mountain has been through a lot of wear and tear, it hasn't been treated right, and it's been through a lot of abuse, and finally now the right puzzle pieces are in place...we just came together as a community to basically rebuild and nurture the mountain forever. We've got it now, we have it, we're ready to rock it." Tii pointed out the uniqueness of this particular conservation easement and praised the town for being a pioneer: " I think it's really significant that there's a conservation easement on this entire parcel...It's an unusual situation in this town to have so much land preserved…I don't know any other town that has this much percentage of the town preserved…it's a great pilot study for other towns and communities to look at."

5.2.5.1 Video Discussion

We hope that through our video, we were able to show the meaning that the mountain holds in people's lives. The interviews, written out in text, could be used in grant applications to highlight the importance of the place as Ascutney Outdoors work to secure grants. Because the interviews also function as "testimonials," they may make the video viewers to think of the mountain more favorably, as suggested by academic literature. We hope that the video will help in reaching out to the younger population that will be the next generation of the mountain's stewards.

We think that one or two other video(s) could be made to further help with rebranding and publicity, if Ascutney Outdoors so desires. A video that is more "commercial" in nature could be helpful in bringing in new users from outside the area (those who do not already know about Ascutney). The goal of this video would be to elicit excitement from the viewer; the video should include footages of backcountry skiers, mountain bikers, etc. -- a montage of activities and events that take place at Ascutney to attract visitors that have never been and/or heard of Ascutney.

We also see an opportunity in renovating the Ascutney Outdoors website. Drawing from literature described in detail in Section 5.2.2, we think that incorporating more graphics and multimedia elements into the current website would enhance the user experience.

We hope that the photos we took over the past two months will be a good addition to the existing library. Since AO already has a good collection of photos, we think that enhancements would come from improvements in organization and an increased use of photos. Since many photos of Ascutney are also taken by community members and are scattered, it would be also helpful to have a volunteer/hired photographer to continue to document the development and changes that take place at the mountain.

5.3 Education at Mt. Ascutney

5.3.1 Introduction

Research Question: How can Mt. Ascutney provide students with a place-based outdoor learning experience that will encourage natural literacy and scientific inquiry?

Albert Bridge School is a K-6 elementary school located centrally in the town of Brownsville, VT. The current school population is 84 students, mostly coming from the immediate Brownsville/West Windsor area. Located just a short walk from the base of Mt. Ascutney, Albert Bridge School is ideally situated to take advantage of the West Windsor Town Forest. During visits to the school, it became clear to us that teachers and program administrators place great value on the close proximity of the mountain and hope to integrate the mountain into students' lives more. Our goal was to develop materials that could be used both in the classroom and in the after school program.

5.3.2 Outdoor Education at Albert Bridge School

Currently the mountain is used primarily by the Albert Bridge School's Fit Kids program. Fit Kids is a new program at the school that brings kids outdoors to participate in a variety of activities, including organized team building activities, yoga, and hiking. The goal of this program is to improve students' fitness through access to the outdoors, taking advantage of the close proximity to Mt. Ascutney. Our contacts in the after-school program were able to provide us with anecdotal evidence of the impact that the Fit program has had on students who were less inclined towards school work. One of our contacts has observed "students that during the day time teachers might consider to be lazy, or disruptive in the class taking on more leadership quality roles amongst the younger students" (personal communication). Of one particular student, she noted that the program "has made him a more outgoing student and more into trying

new things" (personal communication). Clearly, the Fit Kids program already plays an important role in encouraging children to get outdoors and play organically, explore, and interact with each other while getting exercise. As a new program, it can only expand and find new and innovative ways to use the mountain.

5.3.3 Our Approach to Education

Building on our research from the literature, as well as our interviews with members of the Ascutney community, we determined six learning outcomes to be addressed when designing educational material for the school. In the following sections, we present each of the learning outcomes along with support from the literature. We then provide "strategies" for each section, which demonstrate how our lesson plans and activities will support those learning outcomes. Finally, we include, in the Appendices, resources that educators can use to guide their use of Ascutney as an "outdoor classroom". Recognizing that curricular design is the job of professional educators, we opted to draw on the literature and the abundant online resources on outdoor and nature-based learning, and adapt these resources to fit the natural environment of Mt. Ascutney. Our materials are not meant to constitute a comprehensive curriculum; rather, we aim to make use of available resources to develop a broad range of ideas that educators can pick and choose from to enhance the classroom experience using the mountain as an alternative learning environment.

5.3.4 Learning Outcomes of Outdoor Education - A Literature Review

Many terms used in the study of outdoor and nature-based education are used interchangeably; however, it may be helpful to define these terms in order to mark the distinctions between these concepts. *Environmental education* refers to a type of teaching that seeks to educate students on the environmental issues of the world and ensure that they have the

skills to address these problems (Athman 2003). Environmental education can encompass many different environmental issues. *Outdoor education* is using the general outdoor setting for educational purposes (Lugg 2004). *Experiential education* is "Learning in such a way that the actions being taken and the resulting learning outcomes are synonymous" (Howden 2012 p. 43). In other words, learning-by-doing. *Place-based education*, as its name suggests, is more specific to place, using a particular setting, such as a mountain (Mt. Ascutney) or a river as a context for educational experiences (Lieberman 1998). We drew from literature on all of these education types, and we hope that the learning experience at Mt. Ascutney can be a combination of all of them. In this chapter, we will use the term *place-based education* to refer to the ideal educational program at Mt. Ascutney, because we believe that this term best approximates the educational experience that we hope to create.

5.3.4.1 Sense of Place

Sense of place is a relatively new idea that has recently emerged as a learning outcome. Today, many scholars define sense of place as the combination of place attachment and place meaning that, put together, encompasses an individual's relationship to a particular place (Semken and Freeman 2008, Kudryavtsev et. al 2012). "Place attachment" is the degree to which an individual feels a bond with a particular place, and "place meaning" is the group of associations that one has with a particular place.

Several attributes of place-based education are laid out in Woodhouse and Knapp (2000). First, it is highly specific to the place and the content of teaching is derived from the particular natural and human features of the place. Second, it is multidisciplinary, encompassing more than just one subject. Third, it is experiential and hands-on. Fourth, it emphasizes learning for many purposes, not just for earning money or succeeding in the workplace. Fifth, it fosters connections

with the community. These basic principles are corroborated elsewhere in the literature (Semken and Freeman 2008, Krapfel 1999, Smith 2002).

Smith (2002) argues that this type of education can help to integrate students' learning into the goals of the community. Recognizing that there is often a divide between students' home and school lives, place-based learning seeks to bridge that gap. Semken and Freeman (2008) developed an index to measure place attachment and place meaning among students who had participated in an environment-based learning program in Arizona. They found that students who were involved in the program showed significant increase in both place attachment and place meaning, indicating that this program strengthened the students' overall relationship with the place.

Our interviews with community members revealed that place attachment and place meaning surrounding Mt. Ascutney are very strong. Focusing on sense of place as a learning outcome can help to foster this same strong place attachment and meaning among the younger generation.

Strategies:

- *Writing about place*
- *Nature journals (See Appendix C)*

5.3.4.2 Environmental Stewardship

Following on the heels of sense of place, environmental stewardship is another key outcome of place-based education. One of the main goals of outdoor, environmental, and place-based education is to facilitate stewardship of the land where learning takes place, and through

that facilitate a general environmental consciousness. Spending time in nature tends to enhance people's desire to protect the land. In a case study by Kennedy et. al (2010), an experimental place-based learning program helped to increase students' knowledge of nature and to better appreciate their natural surroundings. Teachers observed students becoming more aware of small-scale environmental problems, such as litter on the school grounds. Palmberg and Kuru (2000) found that students who had experience in outdoor activities exhibited a stronger empathetic relationship to nature than those who had less experience.They were able describe more acutely the impacts of humans on the environment and could relate to nature on a deeper level than those who had less experience. They also showed stronger moral judgements on behalf of nature; they were able to recognize actions that were good and bad for the environment, and showed strong emotional responses to those actions. We hope that by building sense of place among these students, they will feel a sense of responsibility to help meet the conservation goals of Mt. Ascutney.

With that in mind, we hope to connect the students with ongoing environmental stewardship initiatives. The students will learn first-hand how environmental issues are affecting the mountain. In this way, students will help to advance the conservation goals of the West Windsor Town Forest.

Strategies:

- *Collecting data on invasives to support the conservation goals of the West Windsor Town Forest (See Appendix C)*
- *"Tracks from the past" activity observing clues left over from past uses*
    - *Imagining what the mountain looked like during these different eras of Use.*

- *Climate change observations with Fairbanks Museum Community of Observers (See Appendix III)*

5.3.4.3 Cross-Discipline and Cross-Age Connections

The small size of Albert Bridge School, along with the majority of students remaining in the school all the way from K-6th grade provide opportunity to create continuity through each student's school experience, both from year to year and across subjects. In a place-based learning environment, Mt. Ascutney can be the common thread running through these students' experiences.

Eick (2012) provides an in-depth case study of a 3rd grade classroom in which the teacher used the outdoors for teaching both science and language arts. The teacher would often incorporate science lessons into language arts rotations. The author observed that when children were introduced to a topic in the science study part of the day, their interest would continue into other subjects of study; for instance, they would tend to check out books from the library on that topic, or the topic would show up more frequently in their writing. The teacher also worked to implement connections across grade levels; for example, teaching butterfly life cycles in second grade and butterfly plants in third grade (Eick 2012).

Strategies:

- *Multi-year monitoring projects that students can look back on and see change over time (See Appendix C)*
    - *This gives students a sense of ownership over their projects and impresses*

the idea of constant change. They will begin to notice that nature is not constant, and in fact changes over time.

- *Nature art activity (See Appendix B)*

5.3.4.4 Academic Performance

Integrating science and language arts can increase reading comprehension. A study by Wigfield et al. (2008) found that using science books in reading study boosted students' reading engagement and as a result, their reading comprehension. The books used in this study were all nature-related. This result gives support to the idea that giving students a meaningful context helps them learn reading and other academic skills.

Outdoor environmental education encourages students to push beyond the boundaries of traditional education, and provides advanced learning benefits. Uitto et al. (2006) studied 9th grade students in Finland and determined that out-of-school experiences contributed significantly to students' interest in a range of science topics. The implications for education are that incorporating more hands-on activities, which mirror the experiences that students would have outside of school, into the classroom, can help to increase students' interest in curricular material. Additionally, after-school programs can provide students with the crucial out-of-school experiences that in turn will increase their interest levels.

Another study found that participation in an outdoor adventure program had a positive impact on students' academic efficacy and motivation. Students who participated in the outdoor adventure program were more confident in their ability to do well in school than those who did not (Widmer 2014). This gives credence to the belief already held by many that outdoor experiences are positive influence on children's performance in school.

Well-designed place-based learning programs can improve students' performance on traditional measures of academic success. Lieberman and Hoody (1998) use a framework called Environment as an Integrated Context for learning (EIC) to evaluate the impact of environment-based education programs in schools across the country. This study, conducted in 12 states, 40 schools, and with 400 students and 250 teachers, found that students who had studied in an EIC curriculum outperformed those who had not on a number of measures, including GPA and standardized assessments. Teachers also reported improved behavior and attendance among students participating in EIC programs (Lieberman and Hoody 1998).

Strategies:

- *Incorporate outdoor learning into curriculum requirements (See "Suggestions for Further Work in this Area")*
- *After school programs as out-of-school experiences*

5.3.4.5 Health and Well-Being

A wide body of literature suggests that being in the outdoors has numerous positive benefits for health, and that increased outdoor education could help to solve the enormous childhood health crisis that we face today (McCurdy et al. 2010). Increased access to "green" outdoor recreation areas, such as parks, trails, and gardens, has been shown to increase physical activity in schoolchildren (Dyment and Bell 2008). Bell et al. (2008) found that proximity to parks and green spaces was inversely related to BMI scores over time. Another study showed that children that lived within walking distance of certain types of park and recreation facilities maintained healthier weights over time than those who did not (Potwarka et al. 2008). Although

these studies were conducted in urban environments, the basic finding, that access to outdoor play promotes healthy weight among children, applies in this context.

Beyond maintaining a healthy weight, outdoor activity has other deep and interconnected benefits. For instance, outdoor activity has been shown to decrease the prevalence of myopia, or nearsightedness, among children (Rose et al. 2008). Myopia affects 9.2% of children in the US and is linked to increased screen and reading time (McCurdy et al. 2010). The study found that more time spent outdoors decreased children's risk of myopia (Rose et al. 2008). There may also be more far-ranging effects of outdoor activity in "green" settings. In one study, "green" outdoor activities were shown to decrease the symptoms of ADHD among children, as reported by parents of these children (Kuo et al. 2004). Outdoor activity may also reduce the effects of childhood stress. A study by Wells and Evans (2003) found that children living in close proximity to nature showed less negative response to stress-inducing life events than those living away from nature.

After school programs can be particularly important in combatting the negative effects of increased screen time. The period after school is a crucial time of day when many children may tend towards watching television or playing on the computer at home, when they should be spending time outdoors. Our partners at Albert Bridge School reinforced this idea, remarking that since joining Fit Kids, students who spent much of their time at home playing on the computer had broadened their approach and willingness to try new activities.

Strategies:

- *Scavenger hunt for the Fit Kids program (See Appendix D)*

5.3.4.6 Higher Levels of Thinking

Experiential learning, particularly in nature, inspires critical thinking because it encourages children to revel in the complexity of the natural world, teaching them that nature is a constantly changing system, not a set of facts to be memorized. Waliczek et al. (2003) found that students who participated in an outdoor math and science program were engaged in high levels of thinking, as measured by Bloom's Taxonomy (see Appendix I), particularly the application and analysis levels. This is significant because "educators believe that students are rarely challenged in academic settings at the uppermost levels of synthesis and evaluation" (Waliczek et al. 2003 p. 686).

Another study found that students who took part in an environment-based education program over the course of a year improved their critical thinking skills, disposition towards using critical thinking, and overall academic motivation (Athman 2003). Critical thinking is "the process of purposeful, self-regulatory judgment that drives problem-solving and decision-making" (Athman 2003, 6). According to this author, critical thinking encompasses a range of skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Many of these skills are found at high levels of Bloom's Taxonomy. This study therefore corroborates the finding that students engaged in environment-based learning are engaged in high levels of learning.

These results are likely due to the experiential nature of environment-based learning. Engaging students with teaching strategies that feel relevant and connect them to their surroundings "takes advantage of students' natural interest in their surroundings and their desire to be valued by others" (Athman 2003,100). Outdoor science learning encourages students to consider the complexities of the natural world. Krapfel (1999) argues that children respond well

to teachers expressing the uncertainty inherent in any observation of the natural world. He writes:

> We are learning that repeated short experiences outdoors are best. It is better to go outside for one hour every day rather than on an all-day outdoor field trip once a quarter. There are two main reasons for this. One is that students' attention to their surroundings stays high throughout an hour trip whereas attention fades after a few hours. Second, repeated trips allow students a chance to get to know certain places well enough that they become sensitive to changes happening there. Repeated visits open up numerous opportunities for marking slow, subtle changes such as the changing diameter of a young tree or the eroding outside edge of a stream bend (p. 63).

Strategies:

- *Connections to citizen science and real-world projects such as the monitoring of invasive species (See Appendix C)*

5.3.5 Conclusion

In order to meet these learning outcomes, we designed educational materials that are experiential, directly connected to the outdoor environment at Mt. Ascutney, and overlap with the work of local organizations. The "Strategies" component of each section has given a brief description of how we chose to integrate that learning outcome into the deliverables. The materials referenced in "Strategies" section are found in much greater detail in the Appendix.

Our research has shown that the outdoor classroom serves as a multi-faceted learning environment that can be integrated into students' lives at all levels of education. This is in addition to the myriad positive health and wellness benefits of spending time in the outdoors.

These are facts that many educators already know based on intuition and experience. We hope that our work will help educators to take advantage of the outdoor education resources at their fingertips.

5.3.6 Suggestions for Further Educational Enhancement

We have provided a broad framework for developing a place-based curriculum at Mt. Ascutney. Currently, our recommendations can serve as resources that teachers are free to use if their curricular plans allow. A next step would be to thoroughly integrate these recommendations into the classroom at all levels of learning. This process would include assessing the state curricular requirements for each grade and developing lesson plans for particular teachers. It would require working closely with individual teachers, learning what they have already done and working with them to integrate the materials we have provided. Particular attention should be paid to creating continuity in learning, so that themes will carry across all grade levels, providing a long term educational experience in which Mt. Ascutney is the common thread.

Summary of Recommendations

The students of Environmental Studies 50 worked with community members from the Town of West Windsor, Ascutney Outdoors, the Sport Trails of the Ascutney Basin (STAB), and the Upper Valley Land Trust, to develop a conservation and recreation management plan at Mt. Ascutney in West Windsor, VT. The students focused specifically on developing strategies to enhance community-based conservation, education, and recreation on and around Ascutney. In partnership with these local organizations, the students developed a set of deliverables to meet the needs and goals of the community. These deliverables can be used to implement a new management plan aimed to positively impact revenue streams in the area, while conserving Mt. Ascutney's natural beauty.

First, we adopted a collective case study methodology to address how Mt. Ascutney could create a comparative advantage and spark regional economic growth by imitating the most successful aspects of competing regional mountains, while also leveraging the site's unique natural resources and recreational offerings. Relative to the frontcountry skiing operations at Whaleback, Magic, and Killington mountains, our analysis indicates that Mt. Ascutney is at present a significantly smaller and lower-cost alternative, and that moving from this existing market position would be impractical. In terms of backcountry skiing, however, Mt. Ascutney offers a breadth and difficulty level of terrain that is second only to Killington. Our analysis indicates that it would be both feasible and economically beneficial for Mt. Ascutney to significantly diversify the difficulty level of its trails, while retaining the expansiveness of the terrain. With respect to mountain biking, the trails at Mt. Ascutney currently skew towards a higher difficulty level and a more "natural" (as opposed to machine-built) track design compared to Kingdom Trails, Mount Killington, and the Killington Mountain Bike Club trails. Our market

analysis indicates that, as with backcountry skiing, the difficulty level of Mt. Ascutney's mountain bike trails can be significantly diversified, and it would also be beneficial to add some machine-built tracks to allow the mountain to better compete with other regional offerings. Overall, the case studies indicate that economic growth at and around Mt. Ascutney would be best served by promoting a perception of the mountain as the "Spirit of Vermont" and "Vermont as it Used to Be." By improving marketing, diversifying terrain, implementing a suggested donation, and constructing additional lodge and lift infrastructure, Mt. Ascutney can both retain its natural and cultural identity *and* improve its long-term economic solvency.

In addition to evaluating the economic factors and benefits associated with broadening Mt. Ascutney's recreational offerings, we also conducted a review of the existing literature to identify the myriad non-market--physical, psychological, and social--benefits associated with exposure to the outdoors. Potential physical health benefits include reduced rates of obesity and heart disease, lower instances of other illnesses, and reduced systemic healthcare costs. The wide range of psychological benefits encompasses better moods, improved self-esteem, and reduced anxiety and depression. Finally, counted among the social benefits are increased social integration, improved community cohesion, and lower rates of crime. This analysis suggests that expanding the recreational opportunities available at Mt. Ascutney has the potential not only to promote an economic boon for Brownsville, West Windsor, and other surrounding communities, but also to increase the general well-being of area residents.

Due to our community partners' ongoing interest in constructing a new lodge at Mt. Ascutney, coupled with the economic benefits our case studies suggest such infrastructure could bring, we engaged in an extensive analysis and review process of potential lodge location and design options. Since the existing lodge at Mt. Ascutney was destroyed by fire in 2015, the

community has lacked a viable multi-purpose space and source of revenue at the base of the mountain. While we initially considered three location options, after discussions with our community partners, independent research, and consultation with design professionals, we ultimately decided upon a proposal that incorporates two structures. In our final design, a welcome center, which will provide general information and office space, will be located at the western edge of the existing parking lot. A larger warming station will be positioned on the existing slab of the site's soon-to-be-demolished oldest lodge structure, which is currently being used as a storage shed for maintenance equipment. This structure will feature an open meeting area, workbenches for equipment repairs, bathrooms, and a small restaurant or snack bar. Both structures will incorporate sustainable design elements, with an emphasis on maximizing heating efficiency (through the use of passive solar and insulation) and minimizing water usage. Potential sources of ongoing revenue for the lodge structures include a small bike repair and/or ski tuning shop, limited rental services, and the aforementioned small restaurant or snack bar.

Because the economic rejuvenation strategies proposed here involve increased year-round recreationist traffic within the Mt. Ascutney trail system, we sought to develop a monitoring framework that could identify and mitigate social and environmental disturbances before they could threaten user enjoyment or the naturalness of the Ascutney environment. We first conducted a review of the existing literature on the impacts associated with the various forms of recreation practiced at Mt. Ascutney. While hiking, mountain biking, and horseback riding are all associated with trail erosion and widening, vegetation degradation, and wildlife disturbance, it is clear that trail design, construction, and upkeep tends to have a more significant impact on the long-term manifestation of these effects than recreational use type. Similarly, front- and backcountry skiing and ski area construction often cause habitat fragmentation, trail

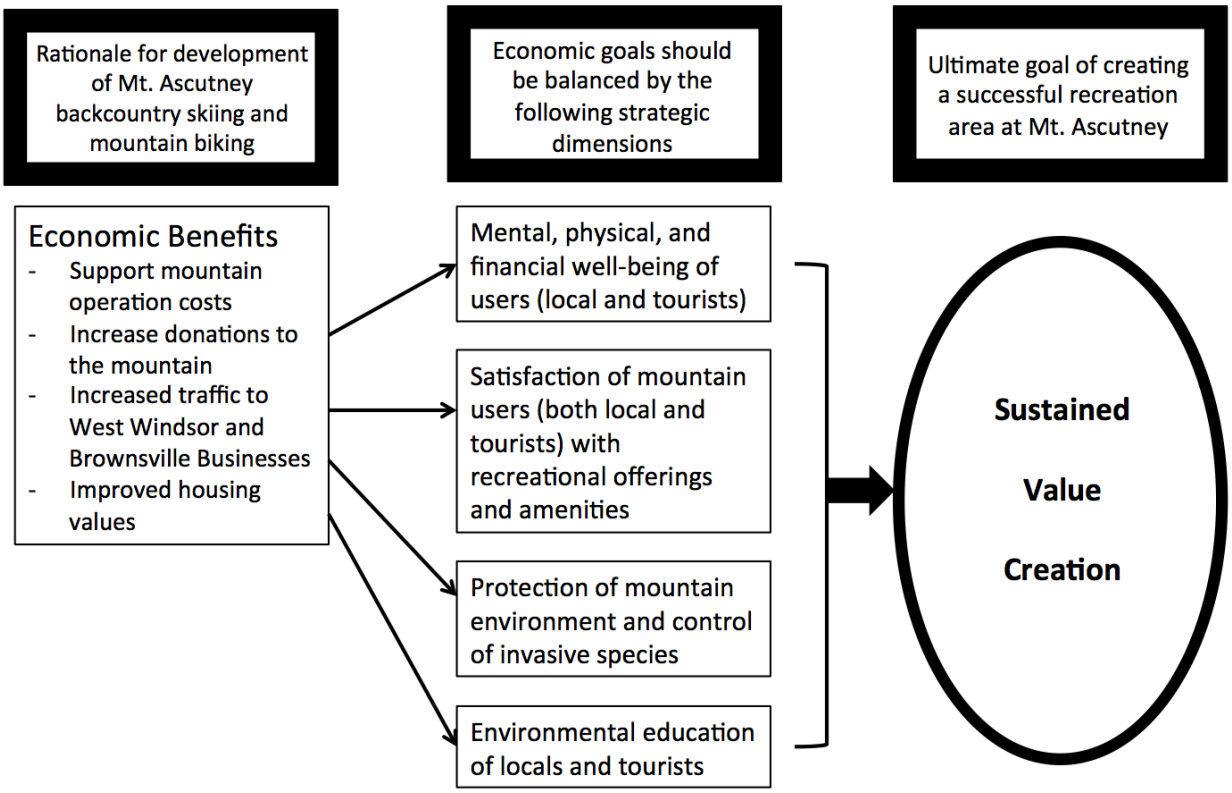
erosion, and wildlife disturbance. Both winter and summer recreationists tend to lack an understanding of the full environmental ramifications of their activity. It also appears that tensions between user groups are more an anecdotal issue than a practical concern. Finally, both winter and summer recreational uses are associated with the spread of invasive species through the distribution of seeds and the degradation of native vegetation, while trail construction creates the edge habitat through which invasive species often emerge and proliferate. We suggest numerous strategies--computer, technical, and volunteer- based--to address our six primary monitoring targets of user volume and concentration, tension between user groups, trail widening and erosion, vegetation degradation, wildlife disturbance, and the spread of invasive species. In selecting these methodologies, we considered not only their overall effectiveness, but also monetary, technical, and human resource demands. Moving forward, our community partners will need to begin collecting and analyzing data through the recommended protocols, developing user volume and seasonal limits based on the findings from that analysis, and consulting with the broader regional community to promote an ethic of respect for and participation within the monitoring framework.

Lastly, we sought to create educational opportunities and effective communication platforms for local residents. We identified how Mt. Ascutney might provide students from area schools with a place-based outdoor learning experience that promotes natural literacy and scientific inquiry. Specifically, we drafted lesson plans and examined after school activities that seek to encourage, in addition to a sense of place, environmental stewardship, cross-discipline and cross-age connection, increased academic performance, improved health and well-being, and higher levels of thinking. These lesson plans and after school activities incorporate simple data collection projects and the participation in citizen science programs (including the identification

and reporting of invasive species). We also sought to more broadly promote a participatory community ethic. The cornerstone of this effort was a photography portfolio of local residents engaging with the mountain and a video of prominent members of the community describing their personal relationship with the mountain, what they believe makes the mountain unique, and the trajectory they see the mountain's future development following.

Mt. Ascutney can fill a niche among New England small ski resorts as an affordable mid-size family mountain with extensive backcountry terrain in order to draw current and new users from the immediate area and further afield. Mt. Ascutney can plan for the future by expanding its operations and remaining flexible despite changing climate and weather conditions. A Basecamp can provide the community with a gathering space centered on recreation and shared appreciation for the mountain. Further development of their monitoring strategies, will eventually provide a model for recreational monitoring, in order to prevent adverse environmental impacts before they happen, monitor them while they are occurring, and provide up-to-date information on how users are impacting the mountain. Close proximity to a local primary school, Albert Bridge, allows Mt. Ascutney to serve as the heart of a place-based learning experience that will encourage natural literacy and scientific inquiry. Ascutney Outdoors can communicate with both established and new users by emphasizing the deep connection to place shared by the many individuals who have experienced the mountain. With the love and support of passionate community members, Mt. Ascutney has a bright economic and ecological future as a major Northeastern mountain.

Appendix A: Figures from Chapter One



Adapted from Müller (1994) and Flagestad and Hope (2001)

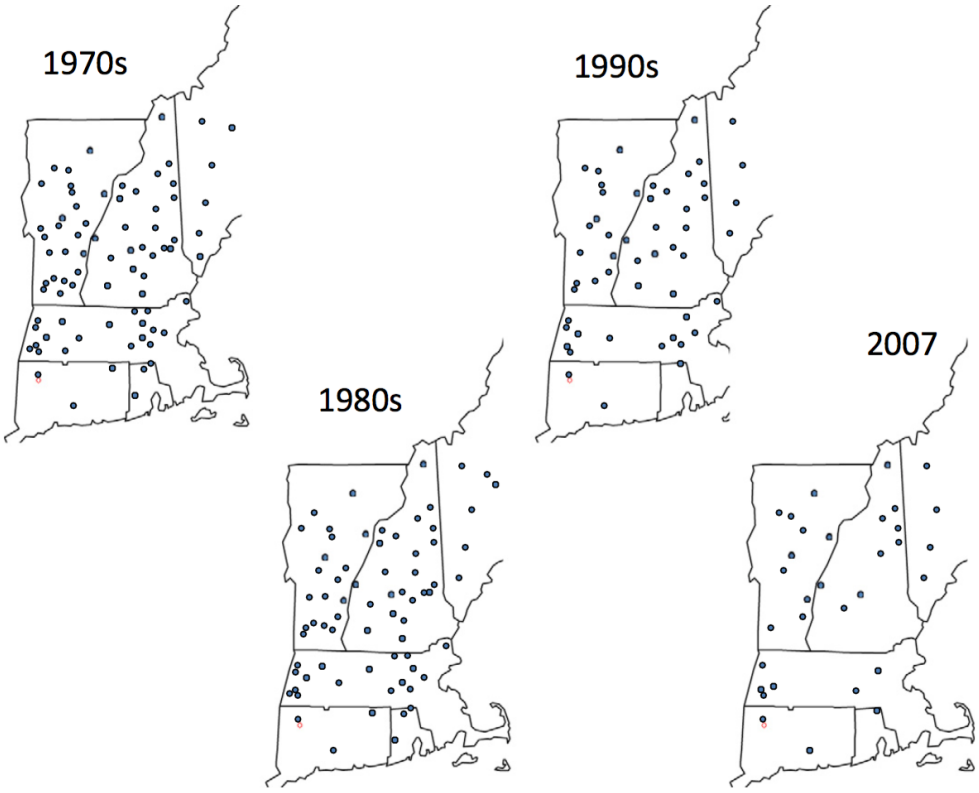


Fig. 1. Mapping of ski areas in New England over four decades.

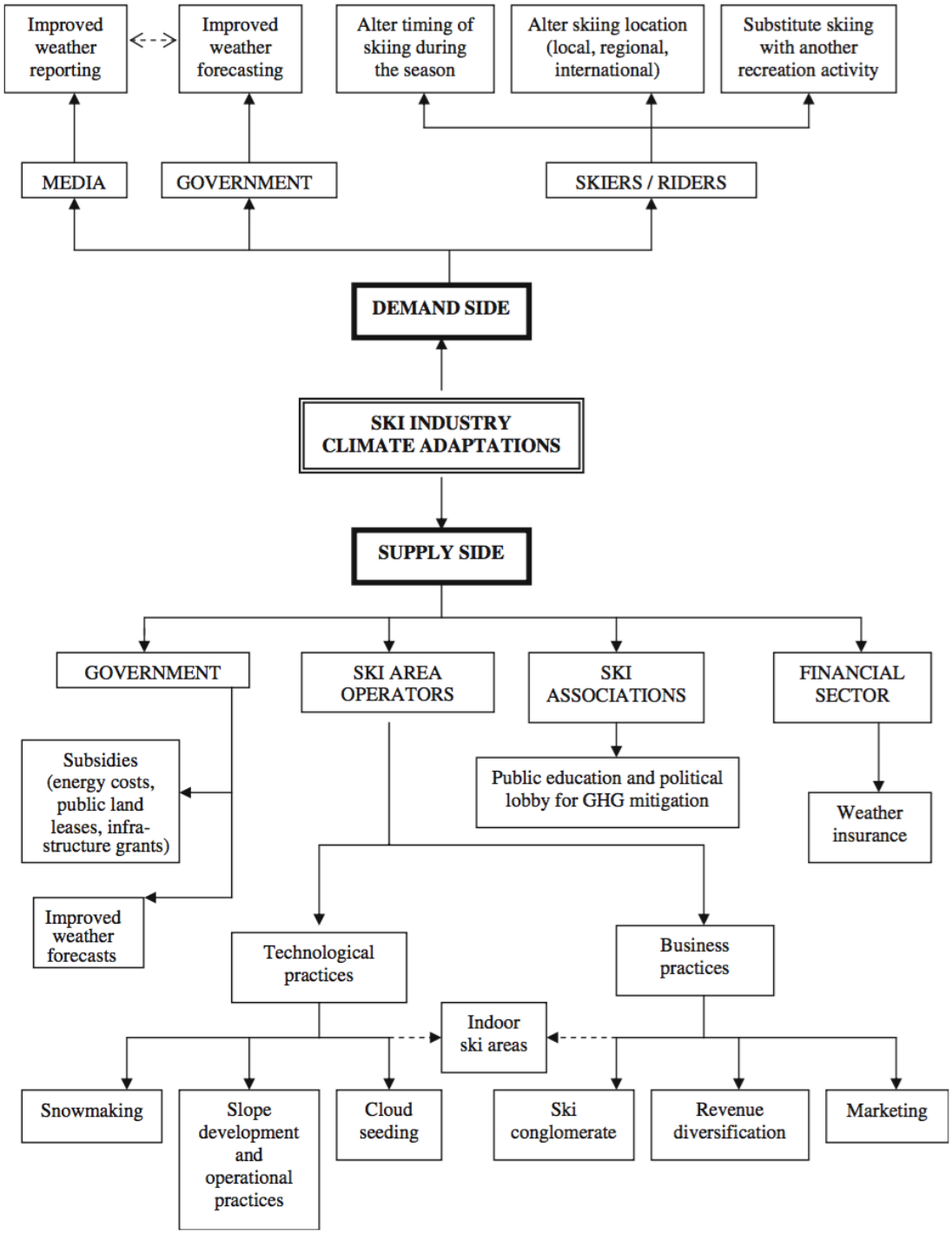
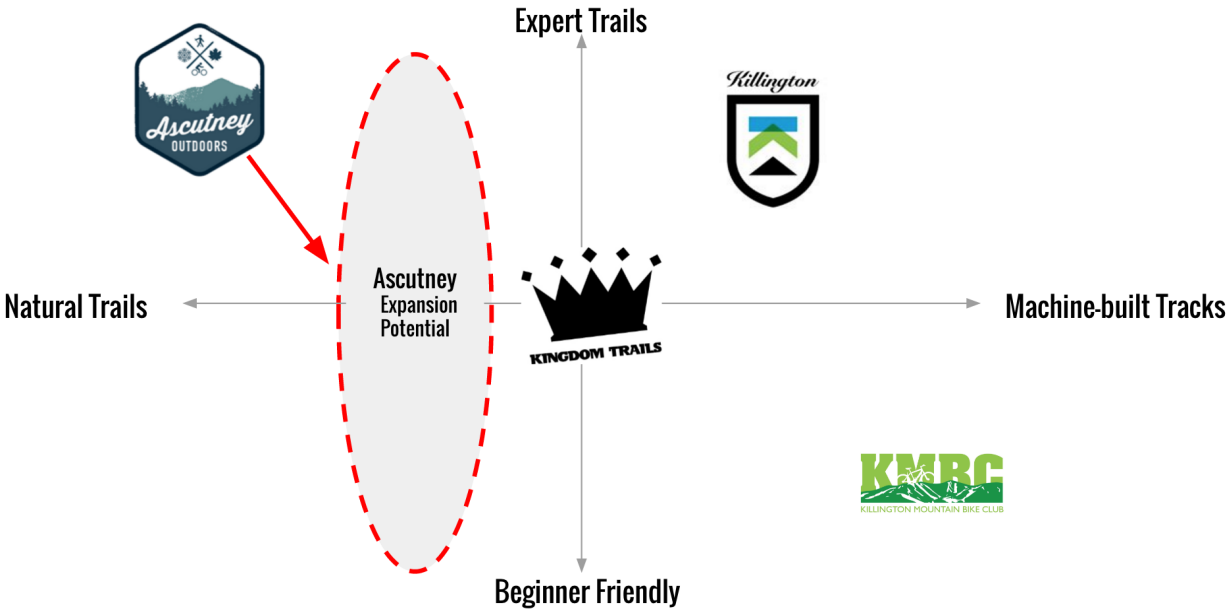
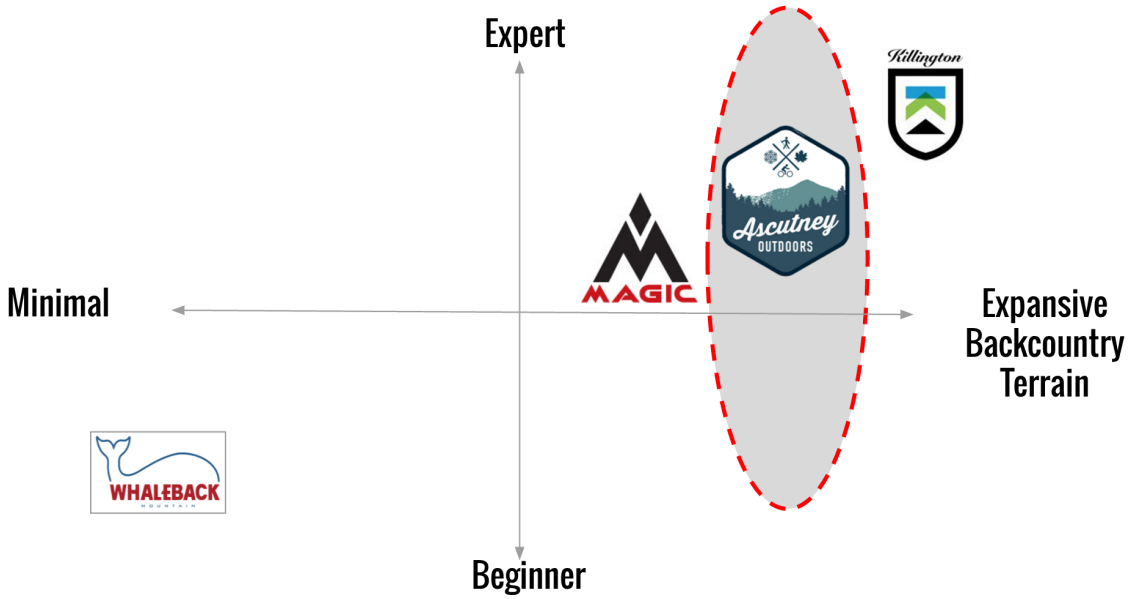


Fig. 1 Climate adaptation options in the ski industry

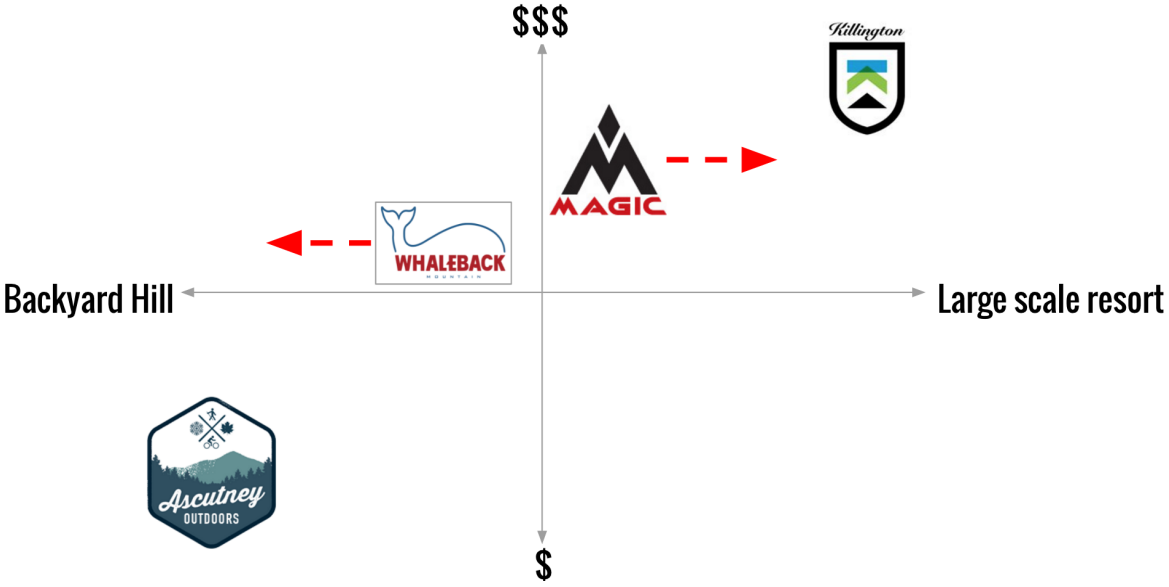
Market Composition - Mountain Biking



Market Composition - Backcountry Skiing



Market Composition - Frontcountry Skiing



Appendix B: Annotated Bibliography from Chapter Four

B.1 Summer Recreation

B.1.1 Monitoring

Kidd, Kathryn R., W. Michael Aust, and Carolyn A. Copenheaver. 2014. "Recreational Stream Crossing Effects on Sediment Delivery and Macroinvertebrates in Southwestern Virginia, USA." ***Environmental Management*** **54 (3): 505–16. doi:10.1007/s00267-014-0328-5.**

Improper trail design and/or inadequate trail management exacerbate erosive disturbances associated with trail traffic and approach runoff. There is evidence to suggest that horseback riding has a significantly greater (2-8 times) erosive impact on trails as hiking alone. The Water Erosion Prediction Project (WEPP) is an erosion prediction model designed for agricultural purposes that has been repurposed for use in a forestry and resource management setting. Necessary inputs for WEPP modeling are available on the National Soil Erosion Research Lab site. One limitation of the WEPP interface is its current lack of a "recreational trails" management type; the "Forest Bladed Road" management type is the closest existing correlate. Ford crossings, where trail users transit through the streambed directly or atop artificially placed boulders, are associated with significantly higher rates of erosion than culvert-type crossings in this study. The authors note it is likely these differences in erosion were more the product of disparate intensities of slope leading to the crossings--approaches leading to fords had an average slope of 9.1%, while approaches leading to culverts had an average slope of only 3.5%--than the unique features of the crossings themselves. Streambed material in the study streams primarily

consisted of sand and gravel. The study did not find a statistically significant reduction in macroinvertebrate populations downstream of stream crossings, but note that either a) there may be a long-term lag between the initiation of erosion and the diminishment of macroinvertebrate populations, or b) macroinvertebrates may respond to stream crossing erosion through behavioral change, rather than population reduction.

Kim, Min-Kook, and John J. Daigle. 2012. "Monitoring of Vegetation Impact Due to Trampling on Cadillac Mountain Summit Using High Spatial Resolution Remote Sensing Data Sets." ***Environmental Management*** **50 (5): 956–68. doi:10.1007/s00267-012-9905-7.**

Cadillac Mountain in Maine is a fragile subalpine environment that supports a large number of recreational visitors. In 2000, after noticing the significant negative effects of trampled landscapes, Cadillac Mountain introduced management strategies of physical barriers and visitor education to help protect threatened vegetation, decrease vegetation impact and enhance vegetation recovery. This case study evaluates the effects of their implemented management strategies. Remotely sensed data from 2001 and 2007 was used to compare vegetation cover between the study site (with management) and the control site. The results noted no significant difference between the mean rates of vegetation increase or decrease on the small scale (<30 m). The medium and large scale spatial extents did reveal a significant increase in the vegetation growth in the study site as opposed to the control site. This data suggested that human-induced vegetation impact zones should be examined at a larger spatial scale, mostly due to the open terrain characteristics of the mountain landscape. More detailed analyses of the vegetation characteristics were also suggested as means to more fully assess vegetation change dynamics.

This study presents the use of remotely sensed data as a viable option for vegetation monitoring at Mt. Ascutney. There is a challenge due to dense canopy cover and multiple vegetation layers, which may prevent or hinder the discovery or monitoring of localized impacts at study sites. This can be combatted by the utilization of hyperspectral imagery or lidar data. The cost of access to this data must be evaluated in order to make considerations for Mt. Ascutney.

Monz, Christopher A., Jeffrey L. Marion, Kelly A. Goonan, Robert E. Manning, Jeremy Wimpey, and Christopher Carr. 2010. "Assessment and Monitoring of Recreation Impacts and Resource Conditions on Mountain Summits: Examples From the Northern Forest, USA." ***Mountain Research and Development*** **30 (4): 332–43. doi:10.1659/mrd-journal-d-09-00078.1.**

The ecological impacts of tourism are widespread and are a significant management concern because of the ecological importance of mountain environments and their simultaneous high demand for recreation and tourism. The primary impact issues of this study include informal trail formation, vegetation disturbance, and soil loss. These impacts occur quickly, and the recovery time is often slow. Few studies have investigated recreational use patterns and impacts, specifically in high elevation summits. Monz et. al. report on the development and application of assessment and monitoring approaches to recreational impact on 3 study sites: Cascade Mountain in New York (low recreational development), Cadillac Mountain in Maine (high recreational development), and Camel's Hump in Vermont (middle ground of recreational development). This study evaluated the adopted management strategies of these three sites, namely the implementation of designated trails, ranger presence, informative signs, and fencing.

To address the primary impact issues, this study evaluated the use of summit land cover assessment, soil loss monitoring, and spatial patterns of visitor use. The summit land cover assessment revealed that various land cover types exhibit differential tolerance to disturbance, suggesting that relative changes in cover class over time can serve as a "sensitive indicator" of resource change due to recreational disturbance. Soil loss monitoring through the use of the laser-based transect method measures cross-sectional substrate profiles from various reference points. This strategy revealed itself to be an accurate and repeatable method for examining soil changes over time. Finally, the monitoring of spatial patterns of visitor use through the use of GPS mapping showed to produce minimal measurement errors and reveal substantial off trail traffic.

Monz et. al. concluded that a combination of said methods could be used to select and evaluate management actions, and could also be applied to carrying-capacity decision making frameworks. This would be highly relevant to the monitoring goals of Mt. Ascutney, but it must be considered that these techniques are highly labor intensive and require special equipment. A high level of accuracy and precision is needed for the application of these monitoring protocols, but some modifications may be feasible for Mt. Ascutney. Land cover assessments are most generalizable for the long term monitoring of recreational disturbance and long term ecological change. This strategy, along with the use of more inexpensive GPS units for visitor use monitoring could be utilized at Mt. Ascutney.

Svajda, J., S. Korony, I. Brighton, S. Esser, and S. Ciapala. 2016. "Trail Impact Monitoring in Rocky Mountain National Park, USA." ***Solid Earth*** **7 (1): 115–28. doi:10.5194/se-7-115-2016.**

Rocky Mountain National Park (RMNP) in Northern Colorado hosted 3.3 million visitors in 2012, and is a premier destination for mountain recreation. With 95% of the park designated as wilderness, RMNP faces negative impacts of trampling of vegetation and soil with their ever increasing flow of visitor traffic. This study applied impact assessment procedures to eight formal and informal trails to assess trail condition and determine the primary factors and potential connections. The trail condition indicators included trail width, trail slope alignment angle, trail grade, elevation, and trail surface composition. Trial widening and soil loss were identified as the most visible effects of trail degradation. Digital photographs, spatial data from GPS, and cross sectional area analyses were utilized to determine soil loss. This information, along with other statistical analysis revealed that increased visitor use is correlated with wider trails and soil loss. Erosion, however, was more highly influenced by track type and soil type than by visitor traffic or usage. Potential general management strategies include: the manipulation of level of trail use, the creation of trail borders, or education for visitors on how to decrease their impacts. These strategies are all relatively easy to implement and are relatively cost effective. Strategies to combat or prevent soil loss specifically are more challenging. The control of use levels is possible, but not popular with visitors, and may reduce profits or popularity due to frequent closures or limitations. High risk trails could also be identified and subsequently relocated, but such efforts may be inhibited by spatial restrictions or wilderness values. The time between maintenance visits could also be shortened, which is the least economic option, as this would impact visitation and would require more frequent closure of trails for work. GIS-based methodology was also discussed as a more effective option, including recommendations of lidar-derived terrain models to speed up data collection.

These general management strategies could be applied to Ascutney. More careful or more frequent monitoring of trail indicators could prove beneficial, and could be executed without extensive trail closure.

B.1.2 Mountain Biking

Callahan, Joshua. 2008. Erosion and trail building: A case study of the east tennessee state university trail system.ProQuest Dissertations Publishing.

Unlike the Mt. Ascutney/West Windsor Town Forest trail system, the East Tennessee State University (ETSU) trail system was originally designed for hiking, and was only later appropriated by mountain bikers. As such, much of the damage that occurred on the ETSU trail system was a product of this dissociation between the intended and subsequent actual trail uses.

Quinn, Michael, and Greg Chernoff. 2010. "Mountain Biking: A Review of the Ecological Effects." Rep. *Mountain Biking: A Review of the Ecological Effects*. Calgary, AB: Miistakis Institute.

The existing literature cited by the authors suggests that mountain biking contributes no more to trail erosion--and may, in fact, have a *less* significant impact--than hiking or horseback riding. The location and quality of the trail appears to have a much greater bearing on the magnitude of erosion that occurs than the type of recreational use that the trail experiences. With respect to the Mt. Ascutney site, the careful planning and construction of the existing trail network appears to have mitigated the chances that the potential erosion issues associated with mountain biking trail use will emerge. That being said, the literature makes clear the need for

constant oversight to address erosion issues early in their development. While the authors note that most studies indicate a positive relationship between native vegetation disturbance around trails and the establishment of invasive species, they point out that vegetation conditions vary radically between locations, and that it would therefore be difficult to apply the findings from one study to a distinct locale. Mountain biking impacts wildlife primarily by causing stress or disturbance, altering habitats, or through direct collisions between bikers and individual animals. While the former two impact types are the most significant, the fact that mountain bikers tend to travel quietly and at relatively high speeds raises their chances of collisions with large mammals that could be physically harmful (or even fatal) to either party. Mountain bike activity decreases animal activity in the vicinity of the trails on which the activity occurs, but it is not clear from the existing literature that mountain biking has a more significant disruptive impact than other forms of trail use. One concern regarding mountain biking on trails for which there is little available empirical data is the possibility that riding-generated erosion measurably increases sedimentation in trail-adjacent water bodies.

White, Dave D, M. Troy Waskey, Grant P Brodehl, and Pamela E Foti. 2006. "A Comparative Study of Impacts to Mountain Bike Trails in Five Common Ecological Regions of the Southwestern US." ***Journal of Park and Recreation Administration*** **24 (2): 21–41.**

As a general trend, concern with the ecological impacts of mountain biking expressed by other recreationist groups and natural resource managers has outpaced actual empirical findings regarding these impacts. The authors emphasize a finding noted elsewhere in the literature, that

the most significant environmental consequences of trail-based recreational uses occur during the construction of the trails themselves. The existing literature indicates that less skilled mountain bikers may contribute more substantially to erosion than their more experienced counterparts due to ill-timed breaking or an inability to remain on trail lines, but the authors ultimately echo the prevailing theme, that there is little to suggest that mountain biking has a more deleterious environmental impact than other trail-based recreational activities. Mountain biking is most likely to cause significant erosion or vegetation destruction when trail conditions are wet, or in steep uphill or downhill sections. The authors found that both trail incision and trail width tended to increase with trail slope. Their data also indicate that trails on which hikers and mountain bikers frequently meet tend to be wider, possibly as a result of the former stepping off the trail to allow the latter to pass.

B.1.3 Hiking

Lynn, Natasha A., and Robert D. Brown. 2003. "Effects of Recreational Use Impacts on Hiking Experiences in Natural Areas." ***Landscape and Urban Planning*** **64 (1-2): 77–87. doi:10.1016/s0169-2046(02)00202-5.**

In a study of trail users at a small, forested conservation area roughly 100 km west of Toronto, Canada, researchers using survey questionnaire data found that litter (1) and tree and plant damage (2) had the greatest and second greatest negative impact, respectively, on trail user experience. Trail erosion, the presence of fire rings, and trail extension and widening all had a more moderate, but still observable, impact on user experience. Trail muddiness had the least significant effect on user experience of all the impacts analyzed. Between 40 and 50% of

surveyed trail users thought they contributed more than "minimally or not at all" to trail erosion (49.8%), trail extension (47.6%), and muddiness (43.9%). Fewer felt they contributed any more than "minimally or not at all" to tree and plant damage (24.4%), and even fewer to the creation of fire rings (13.4%) or the generation of litter (9.8%). Note that users are least likely to say that they have a substantive role in exacerbating those impacts that most deleteriously affect their trail use experience. This study did not attempt to quantify the actual impacts of trail users on the various impact metrics, so it is unclear whether the users' self-reporting of impacts was accurate. There was no significant relationship between user gender, hiking experience, or education level and perceptions of impacts.

B.1.4 Comparative or Multi-Use

Cessford, Gordon. 2003. "Perception and Reality of Conflict: Walkers and Mountain Bikes on the Queen Charlotte Track in New Zealand." ***Journal for Nature Conservation*** **11 (4): 310–16. doi:10.1078/1617-1381-00062.**

The trail system in the study area included a high proportion of technical trails suited only to moderately or very experienced mountain bikers; a smaller amount of trails were more accessible and suited to riders of all skill levels. While there tends to be some perceived discontent between pedestrians and bikers exhibiting particular behaviors within a particular trail system, the author's review of the existing literature revealed very few reported cases of actual bike-on-pedestrian accidents. Hikers tend to view mountain bikers more disfavorably than mountain bikers view hikers. Existing studies indicate that many hikers interpret mountain bikers

as "conceptually indistinct" from motorized off-road vehicles. That said, there is a growing body of literature that suggests that the preferences and attitudes of mountain bikers and hikers with respect to trail use and the natural setting likely is not as distinct as is conventionally thought. The authors' survey of hikers on the Queen Charlotte Track indicated that the vast majority (97%) of hikers were satisfied with their visit to the trail system, and this figure did not decline significantly when the responses of only those hikers who encountered mountain bikers were analyzed. The survey data further indicate that older hikers tend to have stronger negative feelings toward mountain bikers than younger hikers. Note that only hikers were surveyed in this study, so the perceptions of mountain bikers towards hikers on the Queen Charlotte Track are not clear. While this study methodology may be appropriate for the Queen Charlotte trail system, where mountain biking is a new, less established, minority activity relative to hiking, mountain biking has a longer history and is relatively more popular within the Mt. Ascutney trail system. As mountain bikes are not being "imposed" upon existing hikers within the Ascutney system, a similar study conducted on the mountain should survey all major existing user groups.

Pickering, Catherine Marina, Sebastian Rossi, and Agustina Barros. 2011. "Assessing the Impacts of Mountain Biking and Hiking on Subalpine Grassland in Australia Using an Experimental Protocol." ***Journal of Environmental Management*** **92 (12): 3049–57. doi:10.1016/j.jenvman.2011.07.016.**

This study examined off-trail mountain biking at a nationally protected subalpine park area in southern Australia. While off-trail mountain biking is not legal in this region, the authors note that the practice is both relatively common and its effects less extensively studied that on-trail mountain biking. The experiments took place in a grassland habitat, which is clearly distinct

from the forested zones where many existing Ascutney trails are located, but which bears some similarities to the cleared grass areas of the former ski slopes. Researchers determined that both hiking and mountain biking damaged the subalpine grassland habitat, including reductions in vegetation height and total vegetation cover. A 50% reduction in the height of vegetation in a particular plot occurred after 75 mountain bike passes; after 500 passes, the vegetation was only 33% of its initial height. Some recovery in vegetation height had occurred two weeks after the initial passes, but the vegetation was still significantly shorter than its initial height. The 500 pass experiment yielded statistically significant changes in vegetation composition and species richness, but statistically significant effects were not observed at lower levels of use. A 200-pass test determined that riding a bike up and down a slope caused significantly more vegetation damage than riding across the slope. In fact, the impacts on vegetation of riding up and down the slope 200 times was found to have an effect more similar to riding across the slope 500 times than riding across the slope 200 times. Hiking also yielded significant reductions in vegetation height and cover. The effects of biking on these metrics were more significant than hiking in the experiments with a high number of passes, but the effects of hiking and biking on vegetation composition and species richness were similar at all use levels.

Pickering, Catherine Marina, Wendy Hill, David Newsome, and Yu-Fai Leung. 2010. "Comparing Hiking, Mountain Biking and Horse Riding Impacts on Vegetation and Soils in Australia and the United States of America." ***Journal of Environmental Management*** **91 (3): 551–62. doi:10.1016/j.jenvman.2009.09.025.**

The existing literature indicates that hiking is a significant vector in the spread of both human and plant pathogens. There is no existing literature indicating that mountain bikes can serve as seed vectors, but mountain bike tires can carry and distribute plant pathogens.

Taylor, Audrey R., and Richard L. Knight. 2003. "Wildlife Responses To Recreation And Associated Visitor Perceptions." ***Ecological Applications*** **13 (4): 951–63. doi:10.1890/1051-0761(2003)13[951:wrtraa]2.0.co;2.**

Mountain biking is an increasingly popular form of outdoor recreation, but conventional natural resource management literature assumes that mountain biking has a more significant negative impact on wildlife than other forms of recreation. In response to the presence of recreational land users, wildlife species tend to alter their feeding and reproductive behaviors, and may even avoid certain areas altogether, both of which have the potential to reduce the carrying capacity of a region. Some species have demonstrated a capacity to acclimate to repeated disturbance by recreationists; others have not. This study examined the responses of bison, pronghorn, and mule deer to hiker and mountain biker presence. The results indicated no significant differences in the species' responses to hiking and mountain biking. Animals studied tended to be more wary of recreationists approaching from above than those approaching from below. Deer exhibited greater flight distance when disturbed by off-trail recreationists relative to on-trail recreationists. In a survey of horseback riders, hikers, and mountain bikers, all groups of recreation users indicated that they could approach closer to the study species without disturbing them than the biological data supported. Those surveyed tended to assign blame for wildlife disturbance to some group other than recreationists. All species studied exhibited a greater tolerance for recreationists during the afternoon compared to early morning hours. One limitation

on this study's applicability to the Mt. Ascutney case is the fact that it was conducted primarily in an open grassland environment, whereas most of Mt. Ascutney is fairly heavily forested. The study's findings indicate that the vegetational context in which wildlife-recreationist contact occurs is an important determinant of the magnitude of the animal's flight response. The likelihood of an animal flushing in response to contact with a recreationist decreases significantly with increases in vegetation cover. In terms of management recommendations, the authors note that while animal response to an individual instance of contact with mountain bikers is not appreciably distinct from an instance of contact with a hiker, a mountain biker may nonetheless disturb wildlife more than a hiker if he/she covers more trail miles in an outing, and thereby increases his/her chances of engaging in multiple instances of contact.

B.2 Winter Recreation

B.2.1 Background of Winter Recreation

DeLong, Jeff. 2012. Climate change threatens winter recreation. *Reno Gazette - Journal,* April 17.

This article summarizes the significant impact that climate change has had on the amount of snow deposited annually that often allows for winter recreational activities to be carried out at ski resorts. With the decrease in the increase in temperature, there has been a rise in snow melt and therefore a decline in snow banks which are sought out by backcountry skiers. The decrease in snow due to climate change has reduced the skier attendance at ski lodges during winter

seasons. However, this transition to a warmer climate may allow for ski resorts to increase their summer recreation capabilities, to offset the economic losses during the winter seasons.

Scott, D., Dawson, J., & Jones, B. (2008). Climate change vulnerability of the US northeast winter recreation- tourism sector. ***Mitigation and Adaptation Strategies for Global Change, 13*****(5-6), 577-596. doi:http://dx.doi.org/10.1007/s11027-007-9136-z**

The effects of climate change have decreased the number of snow days and shortened the snow season for snowmobiling and alpine skiing activities in the Northeast. This article created a snow depth model to estimate the ability to continue winter recreational activities, using the factors of snow deposition, snowmelt and snow accumulation while also incorporating snowmaking efforts. In addition to snow depth, recreational activities in the winter are dependent on the economic situation of the ski resort or lodge. It was found that to support snow making operations it would require about 5-6% of the total operating expenses to produce snow. However at new warmer locations altered by climate change the expenses could increase significantly especially if there is no snow present.

Ski resort communities and surrounding towns will be most heavily impacted from the changes brought about by climate change. Winter recreation accounts for about $66 billion towards the US economy, which accounts for about 556,000 jobs in 2006.

B.2.2 Backcountry Skiing

Wrigley, Kathryn. 2015. "An Ecological Assessment of Gladed Ski Trails at Bolton Backcountry in Bolton, Vermont." PhD diss., University of Vermont

This thesis conducted a review on the impacts of backcountry skiing on the surrounding environment and 4 species native to the Bolton Backcountry area. Because most BC skiers do not fully understand their impact on the environment from their recreational use, interactions with wildlife were found to dictate their survival and behavior. Black bears were found to abandon their dens and cubs too if they had been scared or feared human interactions. Three species of birds native to the Bolton Backcountry were also found to prefer thicker brush and tree coverage as a preferential habitat, in the form of a non-fragmented forest. Both human and wildlife interactions and habitat fragmentation are impacts instigated by BC skiing.

The establishment of wildlife safety protocols will better manage the human and wildlife interactions that occur with backcountry skiing. A monitoring program should create limits of no ski zones to protect areas deemed habitable to bears, which would prevent bears from abandoning their dens in the future. Also, preventing skiers from expanding backcountry ski trails and glades would reduce forest fragmentation and allow for continued and future habitats of birds. In this thesis these suggestions were brought about by data collected through Habitat Sustainability Indices (HSIs) to assess the habitats of the existing bear and bird populations. Because backcountry skiing is highly correlated with the presence of ski lodges that already heavily fragment the forest on the resort side of the mountain it is important to prevent further stress to existing wildlife.

B.2.3 Front Country Skiing and Resorts

Eagleston, Holly, and Charles Rubin. 2012. "Non-Motorized Winter Recreation Impacts to Snowmelt Erosion, Tronsen Basin, Eastern Cascades, Washington." *Environmental Management* 51 (1): 167–81. doi:10.1007/s00267-012-9963-x.

While the impacts of skiing are lower than motorized vehicles, erosion rates can still be impacted. A study was conducted in Washington on the differences between the snow present on a ski trail and the untouched (control) snow off trail. The snow compacted from skiing had a lower depth and a higher density due to compaction. Because the snow was more dense, it had a higher water content and lasted 7 days longer than the control snow before melting and inherently creating more runoff. In addition to the compacted snow, the temperature of the soil beneath was found to also be colder than the soil beneath the control plot.

The large influx of water from the increased runoff of the compacted snow, increases the erosion of the trails once the snow has melted completely. Trail design is most important when reducing erosion. Factors to be included in efficient trails are: "fall line" alignments, no steep grades, enough drainage and gravel to harden treads.

Loubsky, Todd. 2007. Visitor perceptions of yellowstone national park: Ecological and social implications of winter recreation.ProQuest Dissertations Publishing.

This paper discussed a survey conducted in the winter of 1995 at Yellowstone National Park (YNP), on the perceptions of the visitors present in the park at the time. Visitors were analyzed on their perception of their recreational activities, to see if users were more on the side of preservationists or public enjoyment. The National Park System (NPS) was established to

promote the preservation of the scenic beauty of the US. From the survey, the 4 most common reasons people visited that winter was for the scenery, wildlife, photography and snowmobiling.

Most visitors enjoyed the preservationist aspects of the scenery and wildlife the most on their visit to YNP (75% preservationists, 12% public enjoyment). However, in regards to what they liked least about their visit, what they'd change about the national park and other thoughts, the difference between preservationists and public enjoyment was far less significant (38%, 28%; 39%, 20%; 17%, 7%). While it was found that the ideals of the preservationist had prevailed since the establishment of the NPS, the rise in public enjoyment may come to change those ideals in the near future.

I believe this data to be helpful to the preservation of Mt. Ascutney. Preservation of the trail system and the surrounding flora can be maintained if there are less misinformed individuals regarding what Mt. Ascutney stands for in terms of recreation. It should be understood that while the mountain is to be used for recreational purposes, its preservation should hold more significance than its recreational usage when looking towards the future.

Patthey, Patrick, Sven Wirthner, Natalina Signorell, and Raphaël Arlettaz. 2008. "Impact of Outdoor Winter Sports on the Abundance of a Key Indicator Species of Alpine Ecosystems." ***Journal of Applied Ecology*** **45 (6): 1704–11. doi:10.1111/j.1365-2664.2008.01547.x.**

Winter recreation significantly impacts the survival of surrounding fauna in terms of stress. Repeated disturbances by skiers often results in the creation of suboptimal habitats and a high stress environment that can impact an organism's survival functions and reproductive system. In this study, the alpine black grouse was specifically observed as an indicator species of

the timberline ecosystem. It was observed that the sole presence of the ski lift had a negative effect on the birds as they would not near the ski lift at all. Populations declined as proximity increased with the ski lift. Additionally, there was a reduced average population by about 36%.

This study ultimately suggested the implementation of no access zones for humans, to maintain the preservation of fauna such as the black grouse.

Ruth-Balaganskaya, Ekaterina, and Kirsi Myllynen-Malinen. 2000. "Soil Nutrient Status and Revegetation Practices of Downhill Skiing Areas in Finnish Lapland — a Case Study of Mt. Ylläs." ***Landscape and Urban Planning*** **50 (4): 259–68. doi:10.1016/s0169-2046(00)00067-0.**

As aforementioned, ski slope construction is highly responsible for surrounding ecosystem degradation. In this study at Mt. Yllas, it was found to be aesthetically displeasing to users with the presence of small green and brown patches where reseeding had been attempted to regrow the damaged patches of land on the ski slopes. Because a foreign grass species was used, the patches that had been reseeded looked significantly different from the existing native flora.

This study was not optimistic for the eventual success of unassisted recovery to the damage inflicted by the skiway. Therefore it was found in their conducted study that restoration could be achieved through the implementation of soil organic matter with adequate nutrients to provide for the native plants. This process would be aided by the use of mycorrhizal fungi in terms of nutrient distribution. Also, it would be ideal to use soils of similar compositions and structures from nearby locations throughout the restoration process.

Sato, Chloe F., Jeff T. Wood, and David B. Lindenmayer. 2013. "The Effects of Winter Recreation on Alpine and Subalpine Fauna: A Systematic Review and Meta-Analysis." ***PLoS ONE*** **8 (5). doi:10.1371/journal.pone.0064282.**

In this systematic literature search, articles on research pertaining to winter recreation and the consequential effects on biodiversity and ecological effects were analyzed. It was noted that overall biodiversity was lower in areas where winter recreation occurred. Deemed "resort infrastructure", these areas were found damaging to richness, diversity and abundance of species. The main factor of resort infrastructure that most significantly impacted biodiversity was the removal and modification of vegetation, which led to habitat fragmentation and ultimately stress on the organisms.

This literature search also noted that most operating ski resorts were operating without the proper implementation of biodiversity management processes or the consideration of ecological effects. This study argues the lack of implementation is a direct result of the failure of ecological effects to keep pace with the significant growth in the ski industry. At the time, only 27 of thousands of studies were found to suggest implementation of specific management protocols to address the rise in ecological issues. Sato, Wood, and Lindenmayer argue that the lack of studies in which management processes have been implemented has resulted in the failure to fully establish an overall protocol in which to best manage biodiversity amongst a resort infrastructure.

Schlochtern, Melanie P. Meijer Zu, Christian Rixen, Sonja Wipf, and Johannes H. C. Cornelissen. 2014. "Management, Winter Climate and Plant–Soil Feedbacks on Ski Slopes: a Synthesis." ***Ecol Res Ecological Research*** **29 (4): 583–92. doi:10.1007/s11284-014-1141-6.**

This synthesis found the implementation of ski slopes (the main cause of environmental degradation to mountain regions) caused physical disturbances to the soil and surrounding vegetation. The construction of a ski slope includes removal of original vegetation, machine grading the mountainside, grooming ski slopes during the winter season and implementation of artificial snow due to warming temperatures induced by climate change. These four factors ultimately impact the structure, chemistry, moisture and temperature of the present soil.

This article noted that while much research had been conducted about the changes in soil composition, no real methodologies or protocols have been suggested for implementation. Therefore, more in depth knowledge on the effects of climate change is deemed crucial for the understanding and eventual implementation of an effective system to adapt to changes in vegetation, soil and snow cover. This future monitoring system must also include the concept of dealing with invasive plants as their presence will grow with the warming climate. Finally this article suggests a "spatially explicit model" with the application of "structural equation modeling (SEM)" to identify specific causes and effects in terms of soil plant feedback.

B.3 Recreational Impact on Invasives

B.3.1 Direct Impacts

Anderson, Lucy G., Steve Rocliffe, Neal R. Haddaway, and Alison M. Dunn. 2015. "The Role of Tourism and Recreation in the Spread of Non-Native Species: A Systematic Review and Meta-Analysis." ***PLOS ONE PLoS ONE*** **10 (10). doi:10.1371/journal.pone.0140833.**

This systematic review and meta analysis looked at tourism as a vector for invasive species in terrestrial, marine and freshwater environments. Their results suggested that the

abundance and richness of non-native species are significantly higher in sites of recreational activity than in control sites. This was consistent across terrestrial and aquatic environments. Recreational areas with higher visitor numbers held significantly higher numbers of non-native species.

This is not directly applicable to Ascutney, as the tourism on which this analysis was focused was primarily remote habitats such as oceanic island, polar regions and biodiversity hotspots. Their results suggest the need for widespread biosecurity interventions--strategies that are of much larger scale than the necessities of management at Ascutney.

Lozon, J D, and H J Macisaac. 1997. "Biological Invasions: Are They Dependent on Disturbance?" *Environ. Rev. Environmental Reviews* 5 (2): 131–44. doi:10.1139/a97-007.

This paper was based upon a literature review that studied the relationship between the establishment of exotic or invasive species and ecosystem disturbance (human or natural). It was concluded and strongly supported that disturbance was associated with the spread of invasive species in over half of the case studies that were considered. Of those species that were dependent on disturbance, 97% of plant disturbance and 57% of animal disturbance were from human causes. It was also noted that "successful invaders" tended to have large native ranges, broad diets, short generation times, and high genetic variability, while vulnerable areas had characteristics such as: climatic match between host and source habitats, early successional state, absence of predators, and low diversity of native species. Overall, it was made clear that plant and animal invasions differ greatly, and that disturbance is much more often required by invasive plant species than by invasive animal species.

This study is relevant to our work because it reveals that human disturbances will likely have a high effect on the potential spread of plant invasives than on animal species. This could help us guide our protocol development, as it may prove more effective and efficient to focus on monitoring techniques to control invasive plant species instead of animal species.

Mcdougall, Keith L., Anzar A. Khuroo, Lloyd L. Loope, Catherine G. Parks, Aníbal Pauchard, Zafar A. Reshi, Ian Rushworth, and Christoph Kueffer. 2011. "Plant Invasions in Mountains: Global Lessons for Better Management." ***Mountain Research and Development*** **31 (4): 380–87. doi:10.1659/mrd-journal-d-11-00082.1.**

This paper discussed the trends mountainous regions have been facing of increased plant invasions due to climate change, increased anthropogenic land use, and other novel introductions. The paper then elaborated on a set of management case studies to identify common strategies for preventative actions. These strategies included: initial prevention because of potentially unmanageable rugged terrain, local to global networks to support increased awareness and better prioritization of management actions, identification of economic importance of management, the public acceptance and backing of management programs, and finally, considerations for climate change. It is made clear that the degree of plant invasion varies worldwide and across different regions, but these strategies are broad means to prevent severe invasive outbreaks.

This is relevant to our development of monitoring protocols for the control of invasive species on Mt. Ascutney. With these prevention strategies in mind, we can look at the problem from a multitude of angles, and use various case studies to develop the most effective management regimes.

Ommeren, Ron J. Van. 2001. "Species Composition on Reclaimed Ski Runs Compared with Unseeded Areas." *Journal of Range Management* 54 (3): 307. doi:10.2307/4003252.

This article looked at the coverage of native and non-native plant species on reclaimed ski runs. It compared reseeded areas to control areas, and found that a much higher amount of native species were found on the control plots, while there was more than five times a greater non-native presence in the reclaimed and reseeded areas. Overall species richness was lower in the reclaimed areas most likely due to a lack of native species regrowth. The maintenance of topsoil, the reduction of disturbance, and the retention of small islands greatly facilitated the reestablishment of native species. It was also concluded that the intensity of the initial disturbance played into the species composition and richness of the reclaimed and control areas. The more intense the initial disturbance, the more challenging the reestablishment of native species.

This article is relevant to our work in that it warns of the effects of harsh initial disturbances and their potential consequences with respect to invasive species. This may inform decision making about trail creation, habitat fragmentation, or other means of expansion on or around Mt. Ascutney.

Pauchard, Aníbal, Christoph Kueffer, Hansjörg Dietz, Curtis C Daehler, Jake Alexander, Peter J Edwards, José Ramón Arévalo, et al. 2009. "Ain't No Mountain High Enough: Plant Invasions Reaching New Elevations." *Frontiers in Ecology and the Environment* 7 (9): 479–86. doi:10.1890/080072.

This paper studies the phenomenon that invasive species have recently been expanding to higher and higher elevations in mountain ecosystems. These higher elevations have high conservation value and provide important ecosystem services, but are now facing an increased threat from invasives. This study identifies the four main drivers of plant invasion as: the preadaptation of invasives to abiotic conditions, natural and anthropogenic disturbance, biotic resistance of the existing community and propagule pressure. Higher elevations have historically been somewhat protected from invasions, as their relative isolation and harsher climate have discouraged colonization by non-natives. Recently, however, because of globalization, climate change, and the aforementioned drivers, invasive species are able to change ecosystem functioning at higher elevations.

This work is relevant to our project because it identifies mountain based recreation as a reason for the elevation expansion of invasive species. The construction of ski resorts and trails that branch up higher and higher into the mountain are pushing the anthropogenic disturbances upward. Because native mountainous plants are often slow growth with long life cycles, their recolonization rates are slow. This means that disturbances can have long lasting effects on ecosystem functioning, and can facilitate the spread and expansion of non-native species.

Pickering, Catherine Marina, and Wendy Hill. 2007. "Impacts of Recreation and Tourism on Plant Biodiversity and Vegetation in Protected Areas in Australia." ***Journal of Environmental Management*** **85 (4): 791–800. doi:10.1016/j.jenvman.2006.11.021.**

This paper was a case study that looked at the impacts of recreation and tourism on plant biodiversity in vegetated communities in Australia. Direct impacts included the removal of plant biomass or trampling or partial destruction of biomass. These direct impacts often included the

implementation of infrastructure, in which case native plants were removed and replaced naturally with invasive species or manually by the infrastructure itself. This implementation changes the local hydrology, soil quality, sedimentation rate and pollution runoff. Indirect effects included the spread of weeds from trails and roads by human clothing, shoes, etc., and the spread of a specific root fungus in Australia. Cars were also noted as a significant vector for weed seeds. These impacts were often severe and permanent, and an increase in such damage was correlated with an increase in tourism. The degree of damage also depends on the resilience of the plants themselves, the topography and hydrology of the land, and the climate zone. This article suggested that more research be conducted to better understand the potentially self-sustaining indirect consequences of tourism.

This is relevant to our project because it sheds light on some of the direct and indirect effects of tourism on mountain ecosystems. This article also discussed the potential for human traffic as a vector for the spread of invasive species.

Trombulak, Stephen C., and Christopher A. Frissell. 2000. "Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities." ***Conservation Biology*** **14 (1): 18–30. doi:10.1046/j.1523-1739.2000.99084.x.**

This paper explains the strong association between road development and negative impacts on biotic integrity. The seven main consequences of road construction on ecosystems include: species mortality due to construction, mortality from collisions with vehicles, modification of animal behavior, alteration of the physical environment, alteration of the chemical environment, the spread of exotic species, and increased use of areas by humans. Concerning effects on invasives, this article highlights that the construction of roads can produce

three mechanisms for the spread of invasives. First, they alter environmental conditions, land cover, etc., and contribute to hyper-fragmentation, which provides new habitat for invasives. The disturbance also removes or stresses the native species which puts them at a higher risk to be outcompeted by non-native species. Finally, these roads serve as movement corridors which facilitate their dispersal by wild or human vectors. In some rare cases, non-native species are intentionally introduced along roadsides to prevent erosion, but naturally there is a preferential distribution of invasive species along disturbed areas like roadsides.

This is relevant to our work because it highlights the ways in which the expansion of infrastructure to accommodate human traffic can directly and indirectly impact the spread of invasive species in an area. This information may help to inform future decision making on the building of new roads, driveways, parking lots, etc. in the Mt. Ascutney area.

B.3.2 Indirect Impacts

Ansong, Michael, and Catherine Pickering. 2014. "Weed Seeds on Clothing: A Global Review." ***Journal of Environmental Management*** **144: 203–11. doi:10.1016/j.jenvman.2014.05.026.**

This systematic quantitative literature review looked at the diversity and characteristics of species with seeds that can attach and be dispersed from clothing. Of the 449 species that were recorded on clothing, 391 were listed as invasive weeds. Their review suggested that seeds on the clothing of hikers could be carries an average distance of 13km, while people travelling via bike, car, etc. could travel significantly further. The factors that most affect seed dispersal

include: type of clothing, type of material, number and location of the seeds on plants, and seed traits (adhesive and attachment structures).

Ansong & Pickering provide a conceptual framework for aspects of seeds, environment and clothing attributes that influence human-mediated seed attachment and detachment/dispersal. They also discuss management suggestions to reduce seed dispersal by the vector of clothing. THe risk of introduction can be reduced by washing clothing, cleaning footwear, removing attached soil before entrance into protected areas, covering socks, avoiding Velcro fastenings, keeping pockets closed/zipped, avoiding walking through weedy areas.

For Ascutney specifically, these practices may be incorporated into educational programs or information guides provided to mountain visitors. Wash down facilities, or clear signage/instruction may also be implemented to reduce the spread of invasives by human clothing.

Beier, Paul, and Reed F. Noss. 1998. "Do Habitat Corridors Provide Connectivity?"
***Conservation Biology* 12 (6): 1241–52. doi:10.1111/j.1523-1739.1998.98036.x.**

This article conducted a review on a number of studies to investigate whether corridors enhance or diminish the population viability of various species. Some papers looked at demographic traits to find out the effects of particular corridors in particular landscapes, while others simply compared corridors to an isolated patch nearby. The study concluded that observations of animals in fragmented landscapes better demonstrate the conservation value of the corridor than do controlled experiments. Their final results were largely positive, as the "well-designed studies" suggested that corridors were good conservation tools. The only

negatives that were noted in the study were the potential for pests and other invasive species in corridor landscapes.

This is relevant to our work because it looks at the effects of habitat fragmentation on the population viability of various species. This study also revealed the potential impact of invasive species in both fragmented and newly connected landscapes.

Mount, Ann, and Catherine Marina Pickering. 2009. "Testing the Capacity of Clothing to Act as a Vector for Non-Native Seed in Protected Areas." ***Journal of Environmental Management*** **91 (1): 168–79. doi:10.1016/j.jenvman.2009.08.002.**

This study looked at the effects of various clothing types on seed dispersal. There is limited existing empirical data on clothing as a vector, but the experiments conducted concluded that human clothing not only increases seed dispersal, but also depends on the type of clothing worn. The study looked at various clothing types (socks, footwear, etc), and concluded that trousers, covered socks and alternative show fastenings picked up fewer seeds than did bare legs and shoelaces. This study also concluded that clothing acts strongly as a vector for the spread of invasive species. Human traffic along roadsides picked up the most non-native seeds, while walking off-trail picked up more native species. Suggested management strategies include brushing off clothing between places or habitats, and the adoption of clothing limitations to discourage seed dispersal.

This is relevant to our project because it suggests that setting clothing limitations or restrictions may have an impact on the control and management of invasive species. It also shows that the fragmentation of habitats, and the creation of new "edges" facilitates the spread of invasives via clothing as well.

B.3.3 Management Options for Invasives

Gallo, Travis, and Damon Waitt. 2011. "Creating a Successful Citizen Science Model to Detect and Report Invasive Species." *BioScience* 61 (6): 459–65. doi:10.1525/bio.2011.61.6.8.

This case study focuses on the Invaders of Texas, a citizen science program that trains volunteers, detects the arrival and dispersal of invasive species and reports them to their online statewide mapping database. The large volunteer base is organized into regional teams, or satellite groups, each with a volunteer leader in charge of managing local issues, organizing and conducting workdays, and acting as intermediaries between central coordinators and satellite members. Each satellite group is connected to a local network with local experts, and each satellite leader is in charge of recruiting volunteers and organizing citizen science training workshops.

Limited knowledge about the distribution of invasive species is a major concern for Invaders of Texas and other invasive species monitoring programs alike. Detailed field observations are recorded and include: the species, the date of the observation, the amount of time spent in the field, the GPS coordinates, the amount of disturbance, the patch type, the abundance of the species, a digital image and notes about the location onto a field data sheet.

This program is comparable to the Invasive Plant Atlas of New England, a similar citizen science program, and may be a feasible option for monitoring at Mt. Ascutney. This study concluded that properly trained citizen scientists can effectively detect and report invasives, which can contribute to higher level management and monitoring strategies. Citizen science

programs like the Invaders of Texas do require significant funding and full-time coordinators, but offer a successful and adaptable model for other states and areas to follow or adopt.

Marten, Alex L., and Christopher C. Moore. 2011. "An Options Based Bioeconomic Model for Biological and Chemical Control of Invasive Species." *Ecological Economics* 70 (11): 2050–61. doi:10.1016/j.ecolecon.2011.05.022.

This study created a general stochastic optimal control framework to analyze control strategies for the management of non-native hemlock wooly adelgid (*adelges tsugae*). With the goal to eliminate the current population and deter future reestablishment, Marten & Moore developed a continuous state programming model. Socially optimal control strategies often require more than single species, single control models can offer. Their framework relied on numerical methods to accommodate for multiple interacting species and account for uncertainty in temporal population dynamics. With the primary focus on integrated pest management strategies, their framework analyzed chemical and biological controls and their feasibility for long term management. Chemical insecticides were shown to be helpful when the detection of invasives was delayed, but the introduction of natural biological predators showed to be sufficient and more cost effective in the control of pest management.

The invasive species populations at Ascutney are currently under control, suggesting that chemical controls are likely unnecessary for current management practices at Ascutney. The primary concern with invasive species at Ascutney is to monitor and contain future expansion or introduction, suggesting that biological controls or forms of integrated pest management may be a possibility for future management plans.

Mehta, Shefali V., Robert G. Haight, Frances R. Homans, Stephen Polasky, and Robert C. Venette. 2007. "Optimal Detection and Control Strategies for Invasive Species Management." ***Ecological Economics*** **61 (2-3): 237–45. doi:10.1016/j.ecolecon.2006.10.024.**

This paper addresses the role of detection in invasive species management. Increased resources are suggested in order to better detect species at smaller population levels. This would also lessen the extent of damages and with respect to future control, would increase effectiveness and decreasing cost. To combat the prevalent difficulties with invasive species detection, Mehta et. al. present a detection model that captures discount rate, growth rate, population size, detection parameter, search costs, damages, control costs and the optimal search variable. With stochastic and dynamic elements, this model analyzes the optimal constant detection strategy, and concludes that it depends mostly on the "detectability" and biological relationships of each distinct species.

This model includes several assumptions that are important to understand when considering applications to Mt. Ascutney. The model assumes constant search effort which may not be feasible with the need for an active volunteer base year round. It also assumes a known distribution of the initial invasive population, which may be true for some species on Ascutney, but more uncertain for others. Finally, this is a single species model, which would need to be expanded to include prioritization across species if applied to Ascutney.

B.3.4 Other

Crooks, K. R., & Soule, M. E. (1999). Mesopredator release and avifaunal extinctions in a fragmented system. *Nature, 400*(6744), 563-566. doi:http://dx.doi.org/10.1038/23028

This study looked at the theory of "mesopredator release," which occurs when fragmentation reduces larger mammalian carnivores and leads to an expansion of smaller predators. Crooks makes the assumption that larger carnivores are sensitive to fragmented ecosystems and can be at a higher risk for extinction. As they expand, the smaller predators tend to prey more heavily on bird species, revealing the influence that habitat fragmentation has on avian species.

This is relevant to our project because it reveals some of the effects and consequences of habitat fragmentation on trophic cascades and species diversity.

Geffroy, Benjamin, Diogo S.m. Samia, Eduardo Bessa, and Daniel T. Blumstein. 2015. "How Nature-Based Tourism Might Increase Prey Vulnerability to Predators." *Trends in Ecology &Amp; Evolution* 30 (12): 755–65. doi:10.1016/j.tree.2015.09.010.

This study works to develop a framework through which to look at the effects of tourism on the behaviors of animals. In order to understand the behavioral changes and their impact on population fitness, this paper looked at domestication, urbanization and tourism. The domestication of animals, being the most significant behavioral change reduces animal's' sensitivity to environmental changes and threats, and selects for less wary, bolder individuals. Urbanization creates a "human shield" where predators generally avoid, which allows prey species to reduce their defenses and let down their guard. Finally tourism affects the behaviors of

animals through habituation, and if such behavior is correlated with genetic diversity, tourism may have a negative impact on genetic diversity, especially if the behavioral changes are affecting keystone species.

This is relevant to our work because it reveals the potentially negative effects of tourism on trophic cascades and ecosystem stability.

B.4 Sample Survey Questionnaire

1. Roughly how frequently do you use the trails at Mt. Ascutney/West Windsor Town Forest?

o More than once a week

o About once a week

o Between once every two weeks and once a month

o A few times a year

o Never

2. What recreational activity do you *most frequently* participate in while using trails at Mt. Ascutney/West Windsor Town Forest?

o Hiking or Trail Running

o Mountain Biking

o Horseback Riding

o Other (please describe)

3. What trails within the Mt. Ascutney/West Windsor Town Forest area do you use most frequently? (list up to 3 trails)

The following questions will draw upon your past experiences with other trail users at Mt. Ascutney/West Windsor Town Forest. If you do not feel you have had adequate interaction with any of the listed user groups to make an evaluation, please select the 'Insufficient Experience' option.

4.a. To what extent do you agree or disagree with the following statement:

"Hikers and trail runners do not negatively affect my experience while using the Mt. Ascutney trail system."

- o Strongly agree
- o Somewhat agree
- o Neutral
- o Somewhat disagree
- o Strongly disagree
- o Insufficient experience

4.b. To what extent do you agree or disagree with the following statement:

"Hikers and trail runners have a negative impact on the wildlife of the Mt. Ascutney region."

- o Strongly agree
- o Somewhat agree
- o Neutral
- o Somewhat disagree
- o Strongly disagree

o Insufficient experience

5.a. To what extent do you agree or disagree with the following statement:

"Mountain bikers do not negatively affect my experience while using the Mt. Ascutney trail system."

o Strongly agree

o Somewhat agree

o Neutral

o Somewhat disagree

o Strongly disagree

o Insufficient experience

5.b. To what extent do you agree or disagree with the following statement:

"Mountain bikers have a negative impact on the wildlife of the Mt. Ascutney region.."

o Strongly agree

o Somewhat agree

o Neutral

o Somewhat disagree

o Strongly disagree

o Insufficient experience

6.a. To what extent do you agree or disagree with the following statement:

"Horseback riders do not negatively affect my experience while using the Mt. Ascutney trail system."

o Strongly agree

o Somewhat agree

o Neutral

o Somewhat disagree

o Strongly disagree

o Insufficient experience

6.b. To what extent do you agree or disagree with the following statement:

"Horseback riders have a negative impact on the wildlife of the Mt. Ascutney region..

o Strongly agree

o Somewhat agree

o Neutral

o Somewhat disagree

o Strongly disagree

o Insufficient experience

Please complete the following statements:

7. The number of hikers/trail runners currently using the Mt. Ascutney/West Windsor Town Forest trails is:

o Appropriate, and the trail system could handle more hikers and trail runners without negatively impacting the user experience

o Appropriate, but if there were any more hikers and trail runners, using the trail system would become less enjoyable

o Inappropriate; there are currently too many hikers and trail users

o Insufficient experience

8. The number of mountain bikers currently using the Mt. Ascutney/West Windsor Town Forest trails is:

o Appropriate, and the trail system could handle more mountain bikers without negatively impacting the user experience

o Appropriate, but if there were any more mountain bikers, using the trail system would become less enjoyable

o Inappropriate; there are currently too many mountain bikers

o Insufficient experience

9. The number of horseback riders currently using the Mt. Ascutney/West Windsor Town Forest trails is:

o Appropriate, and the trail system could handle more horseback riders without negatively impacting the user experience

o Appropriate, but if there were any more horseback riders, using the trail system would become less enjoyable

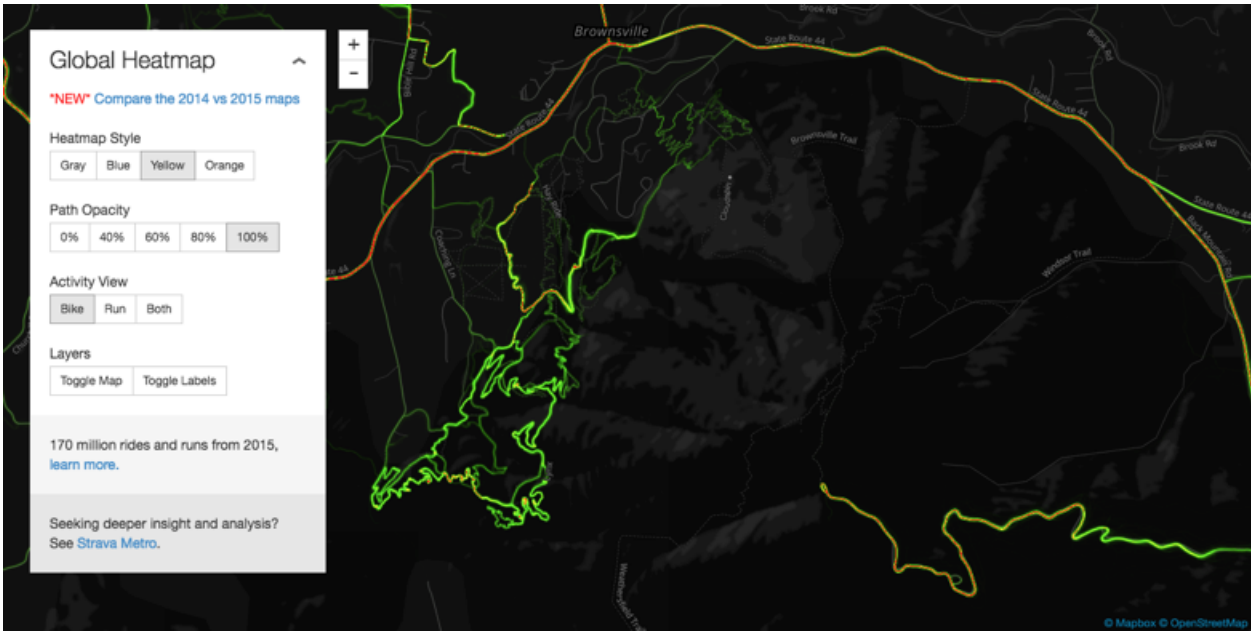
o Inappropriate; there are currently too many horseback riders

o Insufficient experience

10. Below, please feel free to provide any additional information about your use of the Mt. Ascutney/West Windsor Town Forest trail system that you feel might be relevant:

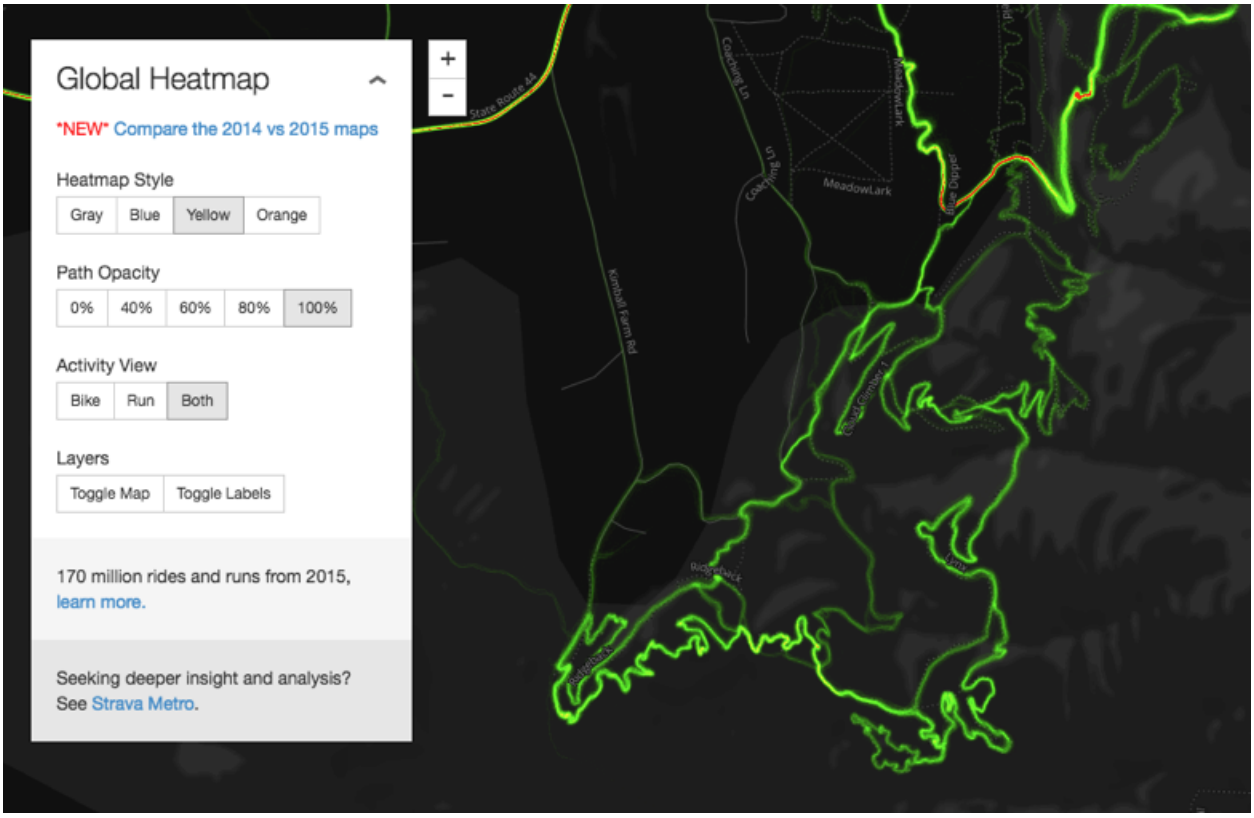
B.5 Sample Strava Global Heatmap Digital Monitoring Interface

B.5 Figure 1



Strava Global Heatmap interface, showing Mt. Ascutney/West Windsor Town Forest region. Brownsville is located at the top center portion of this image; the summit of Mt. Ascutney is located at the culmination of the long, single road extending from the lower right corner of the image. This view includes town and trail labels, and shows data only for cyclists who used the trails and roads in 2015. Note the "Strava Metro" link in the bottom left of the command panel; the site-specific feasibility of this tool is explored in detail in the monitoring methodologies section above.

B.5 Figure 2

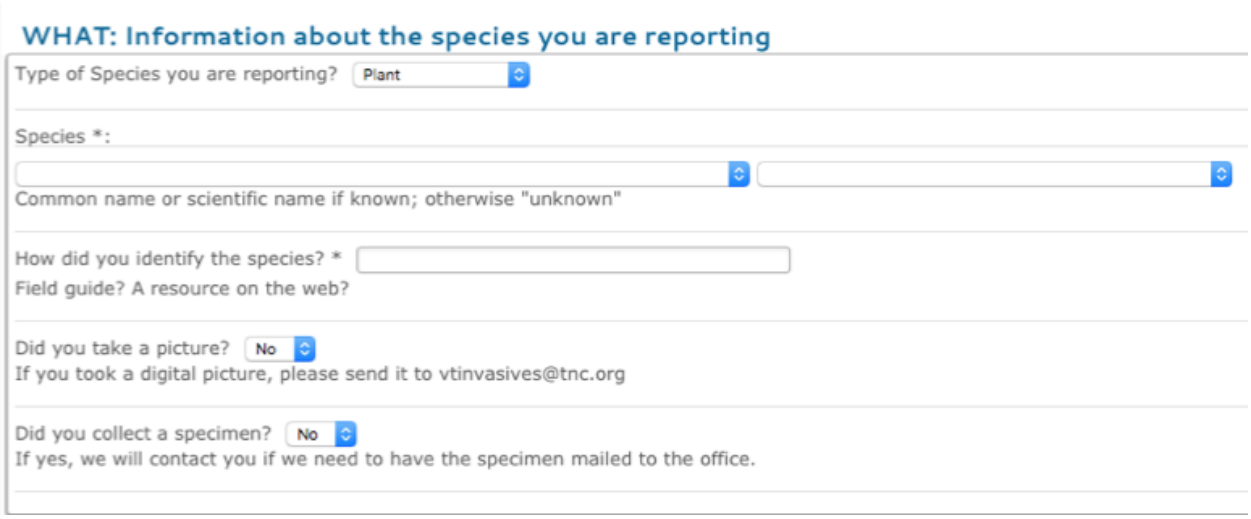


This is a closeup of Figure 1, *with an emphasis on the West Windsor Town Forest trails. While not all trails are labeled, enough are that the remaining, unlabeled trails can be easily identified through cross-consultation with either a physical paper or online Mt. Ascutney/West Windsor Town Forest trail map. Topographical information is not detailed, but the differential background shading roughly aligns with the contours of actual ridges and ravines. Note that no quantitative data is available from the mapping interface itself; differential coloration is indicative of* relative *differences in magnitude of use.*

B.5 Figure 3

This image demonstrates the year-to-year comparative tool. Trail data to the left of the arrow icon are from the 2014 calendar year; data to the left are from 2015. Currently, only data from 2014 and 2015 are available. This minimal year range severely limits the analytical usefulness of the comparative tool, as it is unclear from the map interface alone whether the discrepancies in use are the result of the waxing and waning popularity of certain trails (potentially due to overuse or damage), year-to-year variations in weather and trail opening dates, and/or simply an increase in the use of the Strava application among Mt. Ascutney/West Windsor Town Forest trail users. The "Yellow" heatmap style, used for the previous images due to its more observable gradations, is not available in the 2014 vs. 2015 comparative view.

B.6 Sample Invasives Species Digital Monitoring Interface



B.7 Monitoring Strategy Tables

[Following pages]

	MONITORING STRATEGY						
MONITORING TARGET	Strava Heatmap and Metro	iNaturalist and iMapInvasives	Wildlife Monitoring	User Survey(s)	Trail Condition Monitoring	Vegetation Monitoring with GIS	Trail Monitor and Volunteer Observers
Proliferation of Invasive Species		X					X
Degradation of Vegetation						X	X
Disturbance of Wildlife			X	X			X
Erosion and Unintended Expansion of Trails					X		X
Emergence of Conflict Between and Within User Groups				X			
User Volume and Concentration	X			X			X

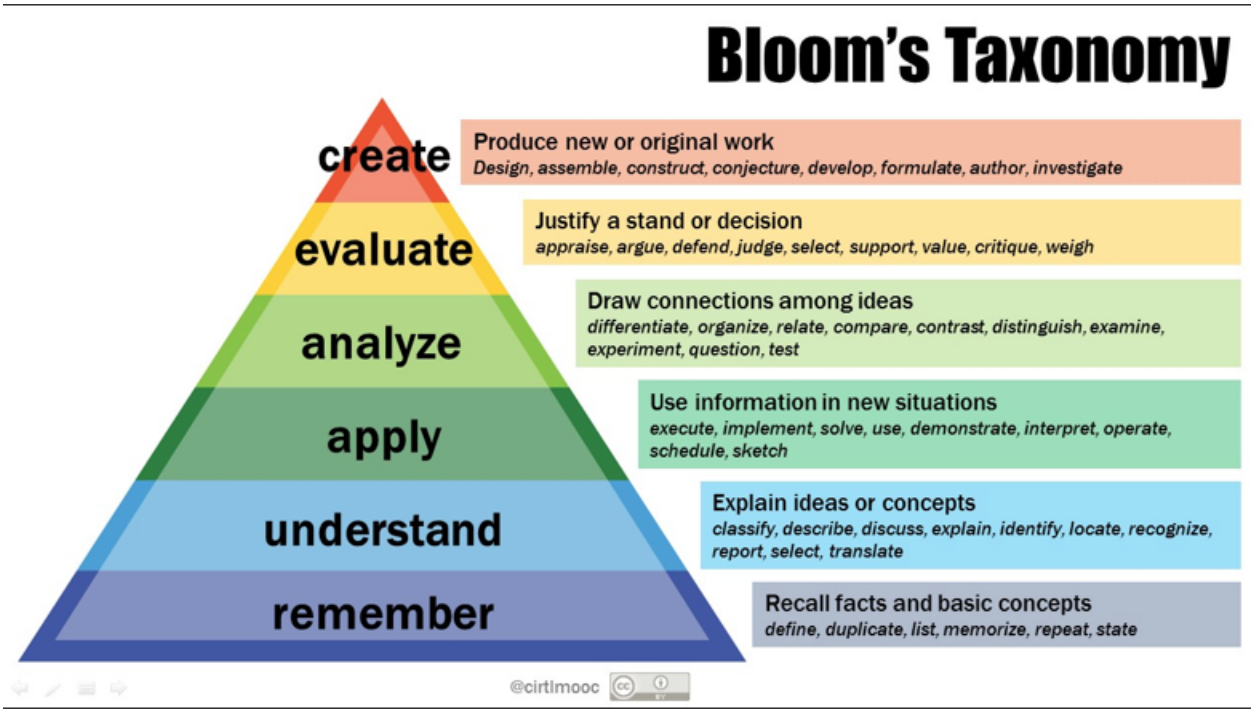
* Table indicates only direct relationships; Strava Metro, for example, will be used as a starting point for evaluating where and when to situate soil analyses and GIS studies, but is incapable of providing direct trail condition and vegetation degradation data on its own

		CHARACTERISTICS OF MONITORING STRATEGY			
MONITORING STRATEGIES		Estimated Monetary Costs	Estimated Human Resource Demands	Recommended Timing and Frequency of Analysis	Proposed Implementation Timeline
Strava	Heatmap	Available free online; excludes costs associated with public outreach to encourage Strava use	Lowest: analysis of visualization requires no technical training, minimal time; analyze in conjunction with trail monitor information	Annually: Timing, frequency of data updates dictates timing, frequency of analysis	Use existing Heatmap data immediately; begin working on public outreach to increase Strava use by end of 2016
	Metro	Licensing fee, contingent on number of Strava users in data analysis area	Low: more technical than Heatmap data; like Heatmap, effectiveness depends on large-scale recruitment of users to Strava app	Contingent on frequency with which Metro data is updated	If desirable, submit data request, pay licensing fee, and begin analyzing data immediately (Summer 2016)
Invasives	iNaturalist	Available free online; excludes costs of community outreach	Lowest: application use and analysis of user data requires no technical training	Monthly: Frequency of analysis will change based on experience with how often sightings recorded	Use existing iNaturalist observations immediately; begin encouraging public use, public education
	iMapInvasives	Available free online; excludes costs of community education	Low: somewhat more technical than iNaturalist; large-scale use would require public outreach and education	Monthly: See above; during monthly analysis, compare the record of observations between these two programs	Use existing iMapInvasives observations immediately; begin training intern(s) and volunteer observers

Wildlife Monitoring	White-Tailed Deer: High, costs associated with both technology and materials; Perching Birds: Low(er), primarily labor and site-marking materials	White-Tailed Deer: High, technical and scientific knowledge required; Perching Birds: Low(er), primarily observational	Both: Seasonal, with particular emphasis on white-tailed deer in winter and emphasis on perching birds from Spring-Fall	Unclear; determine whether UVLT has resources to implement specific monitoring technique immediately or, if not, how long resource development will take
User Survey	Survey development free; cost of distribution and analysis contingent on mechanisms chosen (online or in-person, volunteers or interns)	Development: Low Distribution: Depending on method, high manpower, low(er) technical skill Analysis: Low manpower, moderate technical skill	Annual survey, with data for each annual iteration collected on a monthly (at minimum) basis during peak use seasons (i.e. monthly, May-Sept.)	Begin distributing existing survey immediately online and in-person; begin development of winter uses survey if desired in preparation for Winter 2016-2017
Trail Condition Monitoring through CSA analysis	Low: Dependent on size of data collection staff and number of sites chosen for continued data collection and monitoring	Moderate/High: trail monitors will collect repeatable data at set location points along trails; data collection does not require strong technical and analytical skill set	Twice annually at minimum, higher frequency preferable if financially feasible: once prior to opening of season in early Spring, once at end of season (mid/late Fall)	Begin after identification of trail locations representative of the different trail user traffic; begin data collection at end of season
Vegetation Monitoring With GIS	High Access Fee: Depends on type of remotely sensed data (lidar, hyperspectral, etc.)	Data Collection: low manpower if purchasing imagery, higher if collecting independently Analysis: requires low manpower but strong technical and analytical skill set	Annually at minimum; increasing frequency to twice per use season (i.e. twice in Spring/Summer period and twice in Winter period) would allow for intra-seasonal analysis	Dependent on available funds

Appendix C: Educational Resources from Chapter Five

C.1 Bloom's Taxonomy



C.2 Key Educational Concepts about Ascutney

a. Geology

   i. Mt. Ascutney has a unique geological history. It is a "monadnock," meaning a mountain that stands above the surrounding terrain (McLane 2015). At the peak of the last glacier, 21,000 years ago, this area was covered with ice 1 mile thick (McLane 2015).

   ii. "120 million years ago, a volcano hopeful tried to come up through the native rock, and it didn't quite make it… as a matter of fact, it got stalled out about 7 miles below the earth. And because it was so far down, that molten lava very very slowly cooled and, as a result, formed a very unusual rock. Then, over the 120 million years, the native rock that it was coming up through gradually eroded away, and the harder rock, which was Mt. Ascutney, remained. It's pretty amazing to me that 7 miles of earth has eroded away and the rest of the earth has come up and replaced it. As a result, you have … what's called a ring dike that goes all the way around the mountain, which is the place where the harder rock protrudes up through the native rock, and you get some beautiful cliffs, and that's where quarries — that's always a fun hike, is to go to some of the quarries and see what they used to do with oxen and et cetera — but all around there there are waterfalls where the water has to come down over this steep rock outcropping, so it's a lesson in geology all in itself" (Interview with Jim Lyall, 5/13/2016).

b. Wildlife

   i. Mt. Ascutney is home to several unique natural communities not found anywhere else in the world.

c. Natural History

   i. Mt. Ascutney has seen many different uses throughout its history. There have been hiking trails on the mountain since 1825 (McLane 2015).

ii. People have been logging on the mountain for many years. Throughout the forest, evidence can be seen in the many stumps leftover from logging (McLane 2015).

iii. Signs of fire can be seen all over the mountain. Charcoal and burnt stumps indicate past fire events. Presence of fire-resistant tree species such as red pine indicates that a fire event happened in that area. (McLane 2015).

iv. There are two old stone quarries on the mountain. These quarries were used between 1808 and 1923 (McLane 2015). They are located along the "ring dike", a feature that rings the mountain, where the "new" rock protrudes through the older native rock (Interview with Jim Lyall, 5/13/2016).

v. Some of the areas of this land also used to be farmed. We can tell by looking at the types of grass that grow in particular areas. Small openings in the forest with grasses indicate that the land used to be a pasture (McLane 2015).

C.3 Writing About Nature

Adapted from: http://serc.carleton.edu/sp/mnstep/activities/26870.html

Learning objective: To introduce students to the practice of writing about nature, and to familiarize them with the routine or writing every day.

Materials
-Nature journals (1 per student)
-Pencils
-Various plastic lids (margarine and yogurt tops)
-Field guides or other way to ID plants

Instructions: Discuss with students why scientists use journals, what kinds of information goes in them, and the importance of the date and place on each page. Show where in the classroom we will always keep our journals and what we will write with.
Discuss behavior expectations of outside learning. Distribute the journals and have students turn to the first page and put the date and place.

Activity 1: Under the date have each student trace around a plastic lid designating the place they will draw. Go outside and let the students explore the designated area for a few minutes. Have them spread out and sit quietly and choose an object to observe (plant, tree, rock, etc.) Have them write 3 describing words about the object they are focusing on and draw the object. After 5 minutes have them switch places and try a new object. When finished, gather in a circle and have students try to identify what they drew from photos taken in the garden. Encourage them to name what they found and color it. Emphasize the place to keep these special journals. Repeat as often as desired. This can be done on the mountain or on the immediate school grounds.

Activity 2: Same as above, but students describe the location using all 5 senses: taste, touch, smell, sight, hearing. Return to the same place week after week to see how these observations change.

Activity: Nature Art
Adapted from ENVS 50 2015 project

Materials Needed:
- All materials found in nature

In Class: Begin class by telling the students that they will create their own piece of art using natural materials found at Mt. Ascutney. Show them pictures of art by Andy Goldsworthy and Robert Smithson as examples of art created in nature.

1. Ask the students to begin brainstorming art that they could create using items found in the forest around Mt. Ascutney.

2. Take the students out on the trails. Allow them to wander the trails and get inspiration from the natural materials. They should begin collecting what materials they will use and they can also continue to brainstorm along the way.

3. Once you have reached a predetermined location, allow students to spread out and work on their pieces.

4. Once everyone has finished, walk around and see everyone's piece of art. Ask students if they have a name for their piece.

C.4 Invasive Species ID Cards

Multiflora rose
Scientific name: *Rosa multiflora*

Where it is found: Along the edges of fields

The problem: Multiflora rose can form dense thickets where native plants can't grow[1].

Morrow's honeysuckle

Scientific name: *Lonicera morrowii*

Where it is found: Forests and fields

The problem: Honeysuckle crowds out native shrubs and seedlings, so they are unable to grow and regenerate the forest[2].

Japanese barberry
Scientific name: *Berberis thunbergii*

Where it is found: Can be found in a variety of environments, from open fields to wetland forests to forest edges[3].

The problem: It grows very thickly and crowds out native plants. Barberry infestations also increase rates of Lyme disease because ticks hang on the tips of shrubs[4].

Common buckthorn
Scientific name: *Rhamnus cathartica*

Where it is found: Forest edges and young successional forests

The problem: Common buckthorn can crowd out native plants. Birds and mammals feed on buckthorn, but they are not able to digest the berries, and so it does not benefit the animals in any way[5].

Invasives Photos
Multiflora rose
J. MIller, USDA Forest Service

Morrow's Honeysuckle
L. Mehrhoff, Univeristy of Connecticut

Common buckthorn
S. Kuebbing
http://www.eddmaps.org/ipane/ipanespecies/shrubs/Rhamnus_cathartica.htm

Japanese Barberry
1. L. Mehrhoff, University of Connecticut
2. http://www.se-eppc.org/manual/barberry.html

Sources
1. http://www.vtinvasives.org/sites/default/files/multiflorarose2011.pdf
2. http://www.vtinvasives.org/invaders/shrub-honeysuckles
3. http://www.eddmaps.org/ipane/ipanespecies/shrubs/Berberis_thunbergii.htm
4. http://www.vtinvasives.org/invaders/japanese-barberry-0
5. http://www.vtinvasives.org/invaders/common-buckthorn

Appendix D: Citizen Science Projects

Documenting Invasives with iMapinvasives

About iMapinvasives:

iMapinvasives is an online monitoring platform that seeks to document and provide resources for dealing with invasive species in several states where it has established programs. Vermont is one of those states. Anyone is eligible to have an account on iMapinvasives, but in order to enter data you must request and account and go through some trainings (http://www.vtinvasives.org/plants/report-it/volunteer). The website offers several levels of access, from 0-12. At Level 5, you can be a project leader, to establish a "project" in your area, so that other people with an iMapinvasives account who are submitting observations can indicate that their observation is a part of the project. We recommend that one person from the community become a Level 5 user and establish a project for Mt. Ascutney. Any teacher who is hoping to use data collection in the classroom should be at least a Level 3 user, giving them the ability to record infestations in the form of both points and polygons.

Activity: Mapping an infestation of invasives

Learning objectives: Learn how to identify invasive species, take down GPS coordinates, and identify the extent of an infestation of invasives.

Background: *What is an invasive species?*

An invasive species is a plant or animal that is found outside its native range (the place where it is supposed to live) that has the potential to cause harm to the environment or to humans. They can cause harm in many different ways. Most invasives are able to grow faster, longer, or bigger than native species, so they crowd out the native species, which are not able to grow. Some invasive species can be a home to animals that we don't want, such as ticks that carry Lyme disease. Invasives often spread by hitching rides on things that move from place to place, like people (on shoes and clothing), animals (in their fur) and bike tires. We can do our best to get rid of invasives by figuring out where they are, checking ourselves to make sure we are not spreading seeds, and getting rid of invasives that are already there.

Invasives found around Mt. Ascutney:

- Bush honeysuckle, Morrow's honeysuckle, multiflora rose, Japanese barberry, common buckthorn

Materials:

- Smartphone or GPS
- Paper maps or chart for GPS coordinates

Instructions:

1. Go out into the field and identify an infestation of invasives. This can either be a single occurrence, if you want students to just record points, or it could be spread over an area, if you want them to create a polygon that contains the whole infestation (more complicated). Have this location picked ahead of time, either by yourself or by contacting someone who spends a lot of time on the mountain.
2. Allow students to "discover" the invasive plants and identify them using the invasive ID cards.
3. If reporting a single occurrence: Have them stand right by the plant and hold a smartphone or GPS, and record the latitude and longitude coordinates.
4. If reporting an infestation: Have them walk around the patch and determine the boundaries, and take down coordinates at several points around the perimeter.
5. Alternative, if not using a GPS: Distribute paper maps and have them draw the location and extent of the infestation.
6. Have them count the number of individual plants in the infestation (if not too large)
7. Have students classify the infestation according to the iMapinvasives "cover class" index.
8. Optional: Using your iMap account, enter data. This could be done in a classroom setting, particularly with older students.
9. Choose specific locations to return to year after year to track the status of the infestation over time.
10. For more in-depth descriptions of different species, visit VT Invasives Gallery of Invaders and search by species: http://www.vtinvasives.org/invaders/images/plant_common

Neighborhood Bioblitz:

Activity: Conducting a Bioblitz (adapted from National Geographic: http://nationalgeographic.org/activity/neighborhood-bioblitz/)

Learning objectives: Conduct an in-depth exploration of the species in a particular area at Mt. Ascutney, describe biodiversity, present their findings.

Background: *What is biodiversity?*
Biodiversity is all the different kinds of living organisms found in a particular area. Biodiversity is very important to maintaining life on earth because many organisms depend on other species to survive.

What is a Bioblitz?
A BioBlitz is an event that focuses on finding and identifying as many species as possible in a specific area over a short period of time. At a BioBlitz, scientists, families, students, teachers,

and other community members work together to get an overall count of the plants, animals, fungi, and other organisms that live in a place. http://nationalgeographic.org/projects/bioblitz/

Materials: Paper and pencil, ropes or hula hoops, species identification cards, magnifying glasses, camera, paper map of the study area

1. Ask students to brainstorm some of the different types of organisms they might expect to find in their observations at Mt. Ascutney. Insects? Birds? Can they think of any particular species that they might find?
2. Put students in groups of two or three. Mark maps with where students will likely be. Have each student bring a notebook and pencil. Each group should have a length of rope or hula hoop to mark their study area. Also, give each group a hand lens, a clipboard with copies of the Species Identification Cards worksheet and, if possible, a digital camera. Explain that they will have time first for silent observation and then for team observation, during which they can communicate with one another.
3. Choose an area that is likely to have a high diversity of plants and animals. Fields and meadows are always a good place to start, because they tend to be home to many insects and birds.
4. Conduct the bioblitz.
    a. Give students the following guidance: First, for about five minutes, have students sit silently and observe their surroundings. In their notebooks, ask students to draw or describe in words any living things they see, hear, or smell. If they notice any animals, have them record notes on their data sheets or take a photograph if possible.
5. Before or after their silent observation, have students choose an area to study and place their hula hoop or rope to mark it. You will need to decide in advance how much they can move rocks or soil to look for species. A good general rule is that they can lift up a rock but will need to replace it where they found it. Ask students to avoid taking any species from the study site, and to be sure to leave the site as they found it.
6. As they conduct the bioblitz, have students mark their findings on a map of the study area and also put as much information as possible about species found on the Species Identification Cards worksheet.

7. Identify species.When students are finished with the inventory, move back into the classroom space. Have students consult expert resources, such as field guides, to identify organisms observed in the neighborhood bioblitz and add more information to their species identification cards—creating an inventory representing the diversity of the area studied.
8. Compile the results on a map and share data. Have students use large butcher paper and markers to create a map showing the distribution of various species within the study area. Have them cut out and attach the species identification cards to the map to visually display the concept of biodiversity for other students.
9. Discuss the findings. Discuss biodiversity within and among the areas students inventoried. Ask:

- *How many species were found?*
- *What species were found where?*
- *In what types of habitats were species found?*
- *What species were found near one another?*

Discuss any challenges encountered, such as sampling very small organisms or flying or crawling organisms, or physical factors such as rain and wind—and discuss possible effects on data. Students may determine that doing the inventory in the early morning, or during a warmer season, might bring different results.

Appendix E: Fit Kids Program

West Windsor Town Forest Scavenger Hunt
Time frame: Afternoon to all-day activity

Materials:

- Scavenger hunt checklist
- Pencils
- Printed map of Town Forest

Scavenger Hunt List:

1. Scat from any animal (bonus if you can identify which animal it is from
2. Invasive species–use Invasive Species ID cards (Appendix B)
3. Rocky ledges
4. Old quarry rocks
5. Choose 3:
    a. White pine
    b. Birch
    c. Maple
    d. Hemlock
6. Field
7. Moss or lichen
8. Squirrel or chipmunk
9. Larger mammal (deer, bear, porcupine, etc.)–not a dog
10. Dog
11. Butterfly
12. Stream
13. Mushroom growing on a tree
14. A really nice view
15. Boulder larger than a car
16. Fallen down tree

Hand out the checklists to all students. Split students up into groups, with one group for each adult supervisor. Each group should have a map. Students should mark on the map where they find each item on the list. Use the trail signs to pinpoint locations on the map. When everyone is back, discuss and compare where each group found everything. See if there are any overlaps, i.e. lots of mushrooms in this area, area with lots of one species of tree.

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