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Sustainability Science and Solutions

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Trexler Hirn

Perspectives of Sustainability Actors in an Outdoor Recreation Economically Dependent Community:

A Qualitative Case Study assessed with Strong and Weak Sustainability

Examiners: Associate professor, D.Sc. (Agr. & For.) Mirja Mikkilä
Professor, D.Sc. (Tech.) Lassi Linnane

ABSTRACT

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Keywords: strong sustainability, weak sustainability, active sustainability actors, outdoor recreation, qualitative content analysis, COVID-19

An emergent design qualitative case study investigation is performed interviewing ten active sustainability actors in the research setting of Vail, Colorado, USA guided with the central research question of “*what are the sustainability perspectives of the Vail outdoor recreation economically dependent community?*” Following the outbreak of the global COVID-19 pandemic an additional research question investigating what is most important for sustainability in the community emerged and was answered with typed response. The perspectives revealed from the active sustainability actors were presented through the five identified themes of cultural changes, sustainable destination, energy efficiency, waste reduction and transportation. The prevailing theme is that attitudes towards sustainability are changing as the effects on the local society are becoming more pronounced and the vulnerability of the community to disturbance on both local and global levels.

The sustainability perspectives were then assessed against strong and weak sustainability frameworks. Natural capital, if considered on a local or global scale, is declining, and the community is not strongly sustainable. The assessment of weak sustainability further reveals produced capital has been consistently growing representing exponential trends, and long-term resilience is challenged by the dynamics of human capital and social capital systems. Specifically, the resources directed to extreme affluence consumption strongly challenges the resilience of the whole community as exemplified by an unexpected event such as the global COVID-19 pandemic.

Future research is suggested to focus on social and human capital systems to counter the prevailing trend of exponentially growing produced capital with increasing disturbance of natural capital while emphasizing the basis of natural capital's cultural value in the research setting.

Acknowledgements

I still find it to be a strange thought that within our present understanding of biology, all life on Earth is descendent of a common ancestor. I would first like to acknowledge the physical forces of the Universe which led to the arrangement of matter in a life-generating manner and for the subsequent evolution on Earth which has gifted me this life at this specific point in space and time. I am continually in awe of such simple beauty.

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In Ruokolahti, 08.08.2020

Trexler Hirn

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LIST OF SYMBOLS

Abbreviations

AMI	Advanced Metering Infrastructure
CAC	Eagle County Climate Action Collaborative
CAP	Eagle County Climate Action Plan
ERWSD	Eagle River Water and Sanitation District
EVAS	Eagle Valley Alliance for Sustainability
GRNSS	Gore Range Natural Science School
ICUN	The International Union for the Conservation of Nature and Natural Resources
IPCC	The Intergovernmental Panel on Climate Change
<i>Kh</i>	Human Capital
<i>Kn</i>	Natural Capital
<i>Kp</i>	Produced Capital
<i>Ks</i>	Social Capital
OHV	Off-Highway Vehicle
PPM	Parts Per Million
SD	Sustainable Development
UN	United Nations
WWF	World Wildlife Fund

1 INTRODUCTION

Our home planet Earth operates as a single, massively complex yet adaptive system. The Earth-life system is driven by interactions of energy and matter expressed through varied and diverse scales earth-subsystems such as cells, organisms and ecosystems (Vernadsky, 1926; Lovelock, 1979; Steffen, 2020). One subsystem of our Earth-life system is the evolving and adapting society of our human species, *Homo Sapien*.

The most recent generations of the human species, roughly since 1750, has experienced an astounding rate of change in almost every aspect of life, culture, composition and commerce (Steffen et. al., 2015b). There are many ways to characterize such change, with one such manner being arithmetically suggesting exponential trends. Human population, for example, has increased from 700 million people in 1750 to 7.7 billion in 2020 with an average growth rate of ~1% and a peak growth rate of 2.1% in 1962 (Haub, 2011; World Population, 2020). Additionally, over this period primary energy use per year has increased with an average growth rate of 1.5% with our present primary energy demand per year being 157.5 PWh in 2015, over 27 times greater than in 1750 (Smil, 2017). Often in western cultural narratives of this recent history, this rapid rate of change has been marked by mechanical inventions and innovations - the scientific and technological progress of recent generations. Some examples of life-altering technologies introduced since 1750 include the steam engine, flush toilet, gas turbine, electric battery, printing press, Portland cement, light bulb, internal combustion engine, telephone, toilet paper, radio, airplane, plastic, sonar, television, electron microscope, atomic bomb, solar panel, rockets to space, computer, internet, cellphone, CRISPR cas9 gene editing. . .

Such recent and remarkable technological progress in combination with the human population growth it supports is not without consequence; Earth is a single, complex system and energy is neither created nor destroyed. The manner energy within earth-life systems has been channeled through recent generations of humanity has rapidly disrupted and destabilized a general state of homeostasis on earth and within the life it harbors. The relatively stable geoclimatic conditions of the Holocene have been shaken by the growth of man leading to the emergence of a new epoch, the Anthropocene (Steffen et. al., 2007; Dizro

et. al., 2014; Lewis and Maslin, 2015). In a cosmic irony, the consequential disruptions of our recent human progress threaten the very foundations of our civilization's viability which have supported such progress.

As outlined in the 1992 World Scientists "Warning to Humanity" penned by over 1,700 top academy scientists, impacts from our recent human activity has created grand challenges across **atmospheric** (stratospheric ozone depletion, air pollution, acidified precipitation), **water** (ground water depletion, fresh water scarcity, water pollution), **oceanic** (acidification, declining fish stock, pollution), **soil** (declining fertility, increasing erosion), and **forest** (severe deforestation, fragmentation) systems in addition to **biodiversity loss** (decline in species abundance and richness) and global scale **climatic change** (Kendall et. al., 1992).

Anthropogenic climate change, a phenomenon driven by an increase in heat energy retained in Earth's climatic system due to significant and rapid emissions of greenhouse gases since the pre-industrial era simplifies, yet summarizes the overarching, consequential threats of recent humanity (IPCC 2014). Atmospheric carbon dioxide concentration, for example has increased over 45% from a pre-industrial concentration of 280 parts per million (ppm) to 415 ppm resulting from the 2,040 Gt CO₂ emitted since industrialization. Threats from climate change not only include acute severe weather events, prolonged droughts and flooding, and sea level rise, but also a trigger of Earth's sixth mass extinction event (Ripple et. al., 2017; Steffen et. al., 2015a).

The general trends of the above outlined environmental disruptions can be traced to the onset of the industrial revolution (often cited as 1750), however, industrialized human impacts on earth systems have significantly accelerated since 1950 (Steffen et. al., 2015b). The latter half of the twentieth century has "without doubt seen the most rapid transformation of the human relationship with the natural world in the history of humankind" (IGBP, 2004). The changes in the human relationship with the natural world have been intimately related to the significant changes in developing and globalizing human society following the resolution of WWII. These changes have predominantly manifested by technological change and increasing per-capita consumption facilitated by complex, growth dependent economic systems (Habel et. al., 2020). In other words, technologically enabled increasing per-capita

consumption is identified as the single greatest impact factor of modern humanity on the rest of earth-life systems.

A meta-review of consumption and impact patterns by Wiedmann et. al. concluded that affluence, specifically super-affluent consumers drive consumption norms (2020). Such a conclusion is substantiated with an assessment of many psychological, behavioral, sociological and economic relativities and dependencies at play. Simply put, the access and ability of affluence is desired and pursued by less affluent as the consumption levels of the affluent continue to strive for more to further distinguish from the less affluent (Kallis, 2015). This has been a hallmark of the consumption culture in the great acceleration of impact since 1950.

Despite growing awareness in recent decades of the threats to, and consequences of the recent course humanity has taken by global business and governance, humanity has failed (with the exception of stabilizing stratospheric ozone depletion) to make significant progress in addressing the numerous environmental challenges our society has created (Ripple et. al., 2017). Nevertheless, there are many people and institutions actively working to address the grand challenges we face with sustainable transitions – long-term, multidimensional, and fundamental transformations of humanity’s sociotechnical systems (Markard et. al., 2012). These transitions are driven by active sustainability actors, someone who, in his or her professional or private role, actively advances the sustainability agenda (Koistinen et. al., 2019). An active sustainability actor is intentionally involved in furthering societal sustainability transitions to balance the human sub-system within our earth-life system.

1.1 Context of this study

This Master’s thesis aims to describe and contextualize the sustainability perspectives of active sustainability actors within the mountain destination community of Vail, Colorado, USA. The present community originated from the founding of Vail ski resort in 1962 and Town of Vail in 1966 to serve as a [international] leisure outdoor recreation destination. The spirit of the founding vision is supported by both the current resort operator, Vail Resorts, which is “the premiere mountain resort company in the world and is a leader in luxury,

destination-based travel at iconic locations” and the Town of Vail has a vision to be “the Premier International Mountain Resort Community” (Vail Resorts, 2020; Town of Vail, 2020).

The inception of the community is in line with the affluence driven acceleration of industrialized human impact since 1950. The community was founded for and is dependent on outdoor recreation and ecotourism, specifically directed for high volumes of high net-worth visitors. In this context, the community can be viewed as a niche community within the socio-technical landscape of western society. Its recent inception and economic basis serve the high affluence consumption steering the consumption patterns industrialized human society.

The purpose of this case study is to begin to describe and understand the sustainability perspectives of the community as conveyed by a sample of active sustainability actors working within the community. This is done by a qualitative case study investigation. The compilation of perspectives will then be considered in the context of sustainability science along strong and weak sustainability frameworks. The strong and weak sustainability analysis of the represented perspectives is intended to demonstrate and potentially inform possible sustainability directions of the community.

1.1.1 Research Questions

The central research question (CQ) guiding this inquiry is *what are the sustainability perspectives of the Vail outdoor recreation economically dependent community?* This comes from a personal curiosity relating to how my home community intends to sustain itself. The phrasing “outdoor recreation economically dependent” was chosen to expand the notion I understood to be the “Vail Ski Community.”

This central question is guided by the following sub-questions.

- 1) *What has the sustainability approach been?*
- 2) *What are the goals and future outlooks of sustainability in the Valley?*
- 3) *How strongly or weakly are environmental, social and economic perspectives considered?*

An additional, fourth sub-question emerged in response to the onset of an unprecedented globally disrupting event, the COVID-19 pandemic. Following my departure from the research setting, the community succumbed to a COVID-19 epidemic. I questioned whether the data collected related to sub-questions 2 and 3 would maintain relevance. This inspired a fourth sub-question *what is the most important aspect of sustainability for the community?* that was addressed in an additional mode of inquiry. The additional question asked was as follows, in the context of addressing the onset of the global coronavirus pandemic, specifically with the epidemic felt on a local scale, what is the most important aspect of sustainability for the community?

2 THEORETICAL BACKGROUND

The premise that the interactions between human, environmental and engineered systems present challenges for sustaining human society and the integrity of the environmental foundation of human life, has led to the emergence of scientific discipline Sustainability Science.

2.1 Sustainability Science

At its core, sustainability science is driven by the question “how does the earth, its living biota and our human species work?” (Kates, 2000) while being applied to timely, emergent and fundamental questions related to the character of interactions and their possible limits between nature and society, ultimately with the goal of sustaining humanity (Kates, 2001, Clark and Dickson, 2003, Swart et al., 2004). The discipline aims to address this core question with the place-based study of systems interactions, including lags and inertia, between biological, geophysical, social and technological sciences with the defined place, the system boundary, spanning from local to global scales (Kates 2001).

Questioning the limits or risks of such drastic change in the interest of Society have been characteristic of this era of history. Often, these limits have been questioned in terms of competing rates, with the undertone of the First Law of Thermodynamics conveyed in the assumption that Earth’s resources are finite. Such reasoning was notably illustrated in 1798

by Thomas Malthus in *An Essay on the Principal of Population*. The essay warned the geometrically [exponentially] growing industrially supported population (due to decreases in mortality while maintaining high birth-rates) would outpace the arithmancy [linearly] expanding food production systems. Malthus argued checks must be in place to hold the population within resource limits.

This line of reason was expanded upon half a century ago in the 1972 publication *Limits to Growth* (Meadows et al., 1972) which presented the findings of a computer simulation modeling the relationships of five variables: population, food production, industrialization, pollution, and consumption of nonrenewable natural resources. Two of the three scenarios modeled presented an overshoot and collapse pattern, further raising questions about the nature of 20th century economic growth and long-term prosperity.

2.1.1 Sustainable Development

These questions were addressed by leading global institutions including the United Nations (UN), The International Union for the Conservation of Nature and Natural Resources (IUCN) and the World Wildlife Fund (WWF) which sought a solution to balance the economic needs of developing society with the viability of the supporting social and environmental systems. What resulted was the formulation of the policy guiding concept of sustainable development. Two reports from the 1980's, *The World Conservation Strategy* (ICUN, 1980) and *Our Common Future* (WCED, 1987), were the key to the formation of the concept of Sustainable Development (Paul, 2007).

The World Conservation Strategy published by IUCN defined conservation as “The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations” and development as “the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life . . . For development to be sustainable it must take account of the social and ecological factors as well as economic ones: of the living and non-living resource base, and of the long-term as well as the short-term advantages and disadvantages of alternative actions.”

The World Conservation Strategy was followed seven years later by a UN appointed World Commission on Environment and Development's (WCED) report *Our Common Future* which presented a solution for global policy makers – Sustainable Development. The report's definition of sustainable development, arguably the most commonly applied definition is as follows:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987).

In regard to the questioning regarding limitations on human society and development *Our Common Future* (also referred to as The Brundtland Report) clarified, “the concept of sustainable development does imply limits – not absolute limits but *limitations imposed by the present state of technology and social organization on environmental resources* and by the ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make the way for a new era of economic growth” (emphasis added).

While *Our Common Future* identifies development and the environment should be harmonized with the undertones of needs *versus* resources and the short *verses* long term, sustainable development has evolved to be considered in terms of three dimensions: environmental, social and economic (Kuhlman, 2010; Paris and Kates 2003; Kates 2005; SEC 2005; Mebratu, 1998; Gibson, 2006). Often in discussions related to sustainability such as in a triple bottom line framework for corporate sustainability these are considered at three independent entities. These three dimensions, however, have a cosmic interdependence (Figure 1) (Mebratu, 1998).

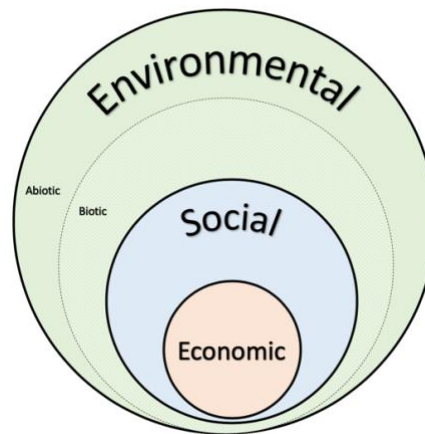


Figure 1. Three dimensions of sustainability (adapted from Mebratu, 1998)

The economic dimension is nested within human society, likewise, human society is nested within the biotic functions of the planet (which is grouped with the abiotic environmental system to simplify the model). The economy is not a system independent of society, likewise, human society is not a system independent of the ecological functions of earth. Additionally, the environmental bounds beyond human society, while not in direct interaction with human society can be influenced by n^{th} degree ($n > 1$) interactions, similarly, society can be indirectly influenced by economic dimensions.

2.1.2 Environmental Economics: Strong vs Weak Sustainability

A second core consideration, in addition to the three dimensions, that had evolved in sustainable development discourse is the premise of strong versus weak sustainability (Kuhlman, 2010). Strong and weak sustainability consider the relationship of different forms of capital in order to have a capital stock sustained. Capital can be distinguished into four categories: produced, human, social and natural capital. Produced capital (Kp) (also referred to as man-made capital) is what most consider 'capital' and is necessary for the production and consumption of goods and services. The depreciation of produced capital is offset with new investment. Human capital (Kh) is the economic value of skills, experience and knowledge within people while social capital (Ks) is defined as the horizontal and vertical social networks that facilitate coordination and corporation for mutually beneficial collective action. Natural capital (Kn) is the network of environmental functions or ecosystem services gifted by nature (Hanley et. al., 2013).

Strong Sustainability

Strong sustainability considers natural capital; sustainability is achieved when the natural capital stock is non-declining. Weak sustainability, by comparison, considers the total capital stock ($K=Kp+Kh+Ks+Kn$) and sustainability is achieved when the total capital stock is non-declining. Embodied in these definitions are the situational assumptions which crafted them.

Strong sustainability contends that sustainability is achieved when the total stock of environmental assets is sustained. How the total stock of environmental assets, or natural capital is defined or considered, however, determines the implications of the strong sustainability paradigm (Neumayer, 2013; Dietz, 2007). Natural capital can be understood as the network of environmental functions or ecosystem services. The Millennium Ecosystem Assessment (2005) for the World Resource Institute defines ecosystem services in four categories. These include:

- 1) provisioning services such as food, water, timber, and fiber
- 2) regulating services that affect climate, floods, disease, wastes, and water quality
- 3) cultural services that provide recreational, aesthetic, and spiritual benefits
- 4) supporting services such as soil formation, photosynthesis, and nutrient cycling (MEA, 2005).

Strong sustainability is achieved when the aggregate of environmental functions or ecosystem services are sustained.

The concept of strong sustainability has been applied through two schools of thought (Dietz, 2007; Neumayer, 2013). The first contends the value of natural capital must be sustained, allowing for functional substitution of natural capital, leading fallacies related to elasticity of substitutability. The second is natural capital needs to be sustained in physical terms, so function remains intact (Dietz, 2007). Determining the conditions for maintaining functionality is often done by defining series of thresholds that must not be crossed, essentially defining a minimum standard for functionality. Strong sustainability, therefore, can be viewed as the space delimited by series of thresholds of these environmental functions or ecosystem services (Kuhlman, 2010).

On a global scale this has led to the development of the Planetary Boundaries framework which quantifies the “safe operating space for humanity” across nine critically qualified boundaries: climate change, biodiversity loss, biogeochemical (nitrogen and phosphorus cycle), ocean acidification, land use, freshwater, ozone depletion, atmospheric aerosols, chemical pollution (Appendix 1) (Rockström et. al., 2009; Steffen et. al., 2015). Of the nine boundaries four have been transgressed; the transgression of one or more boundaries could be “deleterious or even catastrophic due to the risk of crossing thresholds that will trigger non-linear, abrupt environmental change within continental to planetary-scale systems” (Rockström et. al., 2009). The conceptual framework behind planetary boundaries, a safe space between delimited thresholds, can be applied to smaller, regional or local scales, however the quantitatively defined boundaries are not intended to scale. Thresholds would need to be specifically calculated for the system in question.

Weak Sustainability

Weak sustainability traces its origins to neoclassical welfare economics. The findings and rhetoric of *Limits to Growth* implied a transition to no-growth economics, and was presented at a time when the post WWII economic growth was slowing, further hindered by the oil shocks in the 1970’s. The prospect of no-growth economics was contested by growth theory economics for the defense of neoclassical consumer-dependent economics and for the early advocacy for neoliberal expansion (Neumaymer, 2013). Growth theory economics in the 1970’s aimed to analyze the conditions that could guarantee constant consumption per capita under the presence of finite natural resources (Solow, 1974; Stiglitz, 1974; Dasgupta and Heal, 1979; Hartwick, 1977; Slow, 1986; Gutes, 1996). A series of economic models were introduced which displayed relationships between natural capital, human capital and produced capital (referred to by classical economics as land, labor and capital) the conditions for which the total capital stock ($K=Kn+Kp$) would not decrease allowing for constant consumption. Presented as the Hartwick savings rule, constant consumption could be maintained if the difference between price and marginal cost of non-renewable resource exploitation was reinvested into produced capital. The Hartwick savings rule of growth theory economics was foundational to the development of the weak sustainability index

presented by Pearce and Atkinson (1993), an indicator for weak sustainability assessing intergenerational equity.

Weak sustainability can be applied as an indicator presented by the Weak Sustainability Index but is also operational in concept. However, either in concept or viewed more stringently as an indicator, there are two foundational assumptions that are glossed over. The first assumption is that utility depends only on consumption. The environment, therefore, can only be considered as a source for production without also having an intrinsic value for the state of the environment considered. The second assumption is that there is a high degree of substitution between different forms of capital. Sustainability sciences most often consider the substitution between natural and produced capital (Klaassen and Opschoor 1991; Gutes, 1996). To fully address substitutability across total capital stock, one would also need to go into the intricacies of relationships between human capital and social capital, and their dynamics with produced and natural capital.

Within the sustainability science discipline, however, it is considered that natural capital has diverse functions within the economy and can vary in their criticality for economic function, as well as their criticality for environmental function (the ability of non-economic and socially utilized natural capital to self-sustain). Substitution may alter risks associated with complementary or co-dependent forms of capital which can only be properly accounted for with sufficient uncertainty (Figge, 2005). To increase the precision of certainty there have been attempts to qualify critical and non-critical natural capital (natural resources). Examples include distinguishing renewable and non-renewable resources or defining critical natural capital by its irreversibility, uncertainty and degree of loss aversion. The intricacies of identification and categorization pose a monumental challenge for robust models (Pearce and Anderson, 1993; Gutes, 1996; Kuhlman, 2010). These intricacies and their unknown magnitudes provide layers of uncertainty; risk resulting from the elasticity of substitutability may not properly be determined.

Overall, there is grand uncertainty regarding the foundational assumptions of weak sustainability. Weak sustainability came from a context with a cultural-economic system designed to emphasize the value of produced capital for that system. It has not developed

robust value and risk metrics for other forms of capital. Nevertheless, weak sustainability is employed as a concept to gauge sustainability.

Overall, strong sustainability provides a theoretical framework for emphasizing the foundation of social and economic function is natural capital and the network of ecosystems encompassed. Weak sustainability provides a theoretical framework that expands the focus horizon from the function of natural capital to include the dynamics of human capital, social capital and produced capital. Historically in practice, however, weak sustainability has been functionally reduced to the dynamics between natural capital and produced capital.

2.2 Axiological Disclosure: Contextualization for this point in History

As the individual conducting qualitative research the context of my axiology influences how I am exposed to and understand information. The values, especially in an academic sense, that I cultivated during a liberal arts collegiate education in the United States inspired my direction of post-graduate studies into earth-system sustainability sciences. On a metaphysical level I find a humbling value that in the unknown vastness of the Universe, the complex network of energetic flows of Earth continue to evolve life, specifically, our existence as advanced multi-cellular organisms.

As for our point in the Universe, Earth is the third planet from the sun in our solar system. The local interstellar cloud which our solar system is situated is in Orion's arm of the Milky Way Galaxy which itself is within the Virgo Supercluster. The Virgo Supercluster comprises less than 1/1000th of the observable universe and is in a point in the universe which is understood to be at least 13.8 billion years old and continually expanding.

Earth is 4.6 billion years old and has harbored life for at least the past 3.5 billion years (Schopf et. al., 2017). Advanced, multi-cellular sexually reproducing life, however, has inhabited our planet for the past 900 million years. During this time there have been oscillating periods of biotic growth, diversification and extinction. There are five recorded mass extinction events, with our present form of mammalian dominated large terrestrial life

emerging from the most recent Cretaceous-Paleogene extinction event 66 million years ago (Ward, 2006). Of these surviving mammals, the great apes diverged 20 million years ago.

Our specific species, *Homo sapiens*, diverged from the *Homo* genus 500,000 years ago with behaviorally and cognitively modern *Homo sapiens* emerging 50,000 years ago (Mounier and Mirazón, 2019). In this time our species has evolved to yield greater energetic returns on energy invested through the creative use of natural resources (*Kn*), tools (*Kp*), acquired skills (*Kh*) and social collaboration (*Ks*). Our species experienced a marked transition from hunter's and gathers to sedentary agriculture communities coinciding with the dawn of the Holocene, the present interglacial period, roughly 12,000 years ago. This transition to domesticating plants and animals generated an energetic surplus for humans allowing for the acceleration of culture and formations of civilizations. In such time civilizations have risen and fallen generating learned and unlearned knowledge, experience and organizations of commerce and economy (Diamond, 2010). In the better documented years since 3000 BCE, development ushered advances in agriculture, increasingly complex social divisions of labor and means of exploitation, and advancement and complexity of tools (Mebratu, 1998). In concert with these processes, was a shift in societies' relationship to "nature," the expression of exclusively masculine symbols of divinity, and to subjugation of society by patriarchal control over women's reproductive and sexual status (Gottlieb, 1996).

This present point in History accessible through academia has not been shaped without significant Abrahamic religious and philosophical cultural influence which echo the demands of Genesis 1:28, commanding man's dominion over the living earth. A notable, under-represented turning point in recent western-perspective world history was the series of mid-15th century doctrines issued by Pope Nicholas V known collectively as the Doctrine of Discovery. The first of which *Dum Diversas* was issued in 1452 granting permission to King Alfonso V of Portugal "to invade, search out, capture, vanquish, and subdue all Saracens (Muslims) and pagans whatsoever, and other enemies of Christ" and to "reduce their persons to perpetual slavery... to convert [their lands] to his for use and profit" (Nicholas, 1452). The following papal bull documents comprised a series pressing theological encouragements and justifications for the European expansion and conquest of non-Christian lands and their people (Charles and Rah, 2019).

These patterns of justified projected supremacy were integral to the colonization and exploitation of the people and natural resources in Africa and the America's through the Atlantic triangle slave trade. These events normalized a drastically skewed economic relationship of energy invested (through *Kh*, *Ks*, and *Kn*) and energy returned in production (*Kp*). Codified narratives were used to exploit social capital systems to organize systematic abuses of human capital for general extraction of distant natural capital resources and subsequent channeling of produced capital economic enrichment to the Church and supporting political bodies. These behaviors aided the foundation for how the mercantile and developing capitalist economy valued different forms of capital, leading to industrialization and development.

For example, academia's broad claims about human psychology, behavior and social dynamics, those which are used to understand dynamics within human and social capital considerations in present society, are knowingly inadequate. Such claims are drawn from a thin, culturally homogenous sampling of our species' whole. Top scientific journal studies are published with samples drawn from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies with strong implicit understanding across disciplines that these are standard subjects and are representative of the species (Henrich et.al., 2010). A contextual quote from this paper illustrates the unique behavioral and physiological context of present modern society in contrast to our evolutionary history:

For the vast majority of its evolutionary history, humans have lived in small-scale societies without formal schools, governments, hospitals, police, complex divisions of labor, markets, militaries, formal laws, or mechanized transportation. Every household provisioned much or all of its own food; made its own clothes, tools, and shelters; and – aside from sexual divisions of labor – most everyone had to master the same skills and domains of knowledge. Children typically did not grow up in small, monogamous nuclear families with few kin around, nor were they away from their families at school for much of the day.

Such components of my axiology are shared to give a sense of how the cultures in growing consumer society are from such origins that have been consequently disconnected from the magnitude and severity of exploitative uses of capital allowing a delirious relation to produced capital available for consumption.

3 METHODOLOGY

3.1 Empirical Methodology

This thesis is a qualitative case study of the sustainability perspective of active sustainability actors in the outdoor recreational community of Vail, Colorado, USA.

Qualitative research, as defined by (Denzin & Lincoln, 2011) is:

a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them.

As a student and a researcher this is my first endeavor in the field of qualitative research. The purpose of the master's thesis, as defined by LUT is to demonstrate knowledge of a scientifically and societally important topic while displaying an ability to work independently (2019). This research is of my own, independent design. In terms of the scientific process, I contend this thesis in it of itself is an experiment intended to expand inquiry, collaboration and considerations between spheres of public, private and educational systems relative to my situation within them.

3.1.1 Rationale for this study

I undertook this case study exploring a ski and outdoor tourism community in the United States for the topic of my thesis for the Master's degree program of Sustainability Science and Solutions at Lappeenranta-Lahti University of Technology in Finland to address a curiosity regarding the context of my life relative to earth-life systems.

Simply, the motivation for this study is a result of an ongoing social constructionist approach (Lincoln and Guba, 2000) of my personal life to gain a deeper, multi-level, multi-

dimensional understating of the world in which I live. This evolving construction of my reality is concurrently evolving within a transformative philosophical understanding. That is, the purpose of knowledge construction is to aid people and improve society, thus knowledge should be applied forth in transformative action (Fay, 1987; Heron and Reason, 1997; Mertens, 2003; Denzin and Lincoln, 2011, Creswell 2013).

I was born in Vail and was actively raised in the research setting until the age of 15 when I became a part-time community member for the pursuit of academic interests on the East Coast of the United States. Following the completion of undergraduate university studies and resulting from the socially constructed understanding of my world I intended to apply knowledge transformability, so I moved to Finland for a Master's degree program in Sustainability Science and Solutions. During which, I was spatially and socially disconnected from the Vail Community and research setting for 16 months. The studies and scientific coursework during this period primed me to approach my home community with nuanced perspective upon a six week return in early 2020, coinciding with the beginning of the thesis period in the degree program.

The opportunity for fulling the intent for a Master's thesis, conveying knowledge of a scientifically and societally important topic, while providing value for myself, LUT University and the researched community presented itself with this return to home in the form of a case study of my home community (LUT, 2019).

This case study, as it stands in this thesis, is bound within a postpositivist interpretative framework. This means that while my axiology influences the nature of the observed and interpreted phenomena, such bias is presented, detected and corrected to deliver a valid and reliable account of the scientific inquiry.

3.2 Research Setting and System Boundary

The research setting is the extension of the mountain community formulated around the outdoor recreational economy rooted in Vail, Colorado. The primary research question is *what are the sustainability perspectives of the Vail outdoor recreation economically dependent community?* For this case study the central system the boundary is defined around is the outdoor recreational centric community. Defining the boundaries of this community,

however, are a matter of perspective. The perspective can be cultural, geographic, even historical. The system boundaries for my approach to this case study rely on these perspectives. The actors interviewed, however, possess different perspectives in relation to the community resulting in the referred to community or action occurring outside the defined boundary. Because of the qualitative nature of this research, the below defined system boundary will be considered pliable and informative, yet outlying perspectives will be conveyed when appropriate and the distinction beyond the system boundary will be noted.

First, there is a historical perspective, that of the formation of a ski resort in 1962 and the following incorporation of the town in 1966 which is expanded in section 3.3.1. The subject of this case study is the outdoor recreational community that has evolved and results from the founding of the ski resort. From this perspective the *function* of Vail Ski Resort is integral to the community.

Second, there is a geographic perspective. The geographic boundary for the research setting extends beyond the Vail town limits Figure 2 and includes the “upper valley” of Eagle County in the local vicinity of the two ski resorts, Vail and Beaver Creek, roughly the valley west of Wolcott. Geographically this area includes the Gore Creek watershed. The headwaters originate approximately 25 km (15 miles) up stream in the Gore Creek mountain range with Gore Creek and Black Gore Creek. It also includes the Eagle River watershed from roughly downstream of Redcliff to before Wolcott. The geographic boundary is within the White River National Forest and contains public and private lands including designated wilderness areas. This geographic area reflects the human settlement and growth patterns that evolved from the development of Vail ski resort in 1962 which is situated in the mountain range between Gore Creek and Eagle River. Certain perspectives convey information related to Eagle County, Colorado which extends beyond this outlines geographic boundary and includes the towns of Eagle, Gypsum, Redcliff, Bond, McCoy and El Jebel as well as further unincorporated populations.

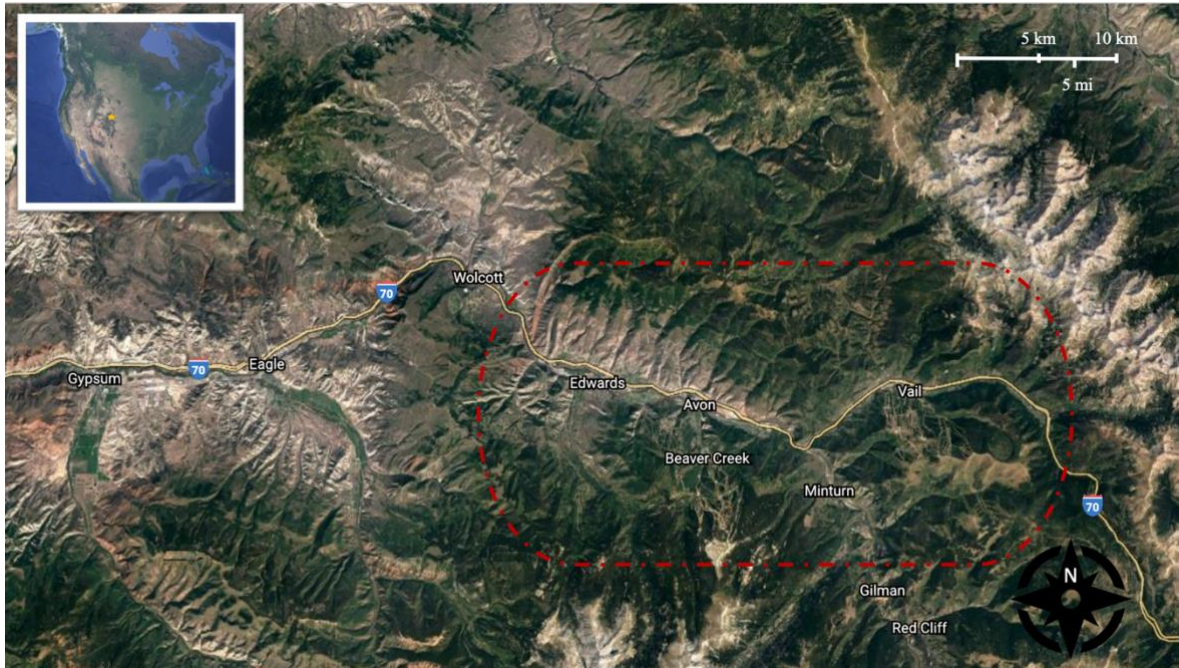


Figure 2. Geographic boundary of research setting. (Google Earth 2020)

The cultural boundary of the “*Vail outdoor recreation economically dependent community*” being studied is needed in addition to a loose geographic boundary. To begin the “Vail outdoor recreational community” includes the people involved in outdoor recreation in the defined geographic boundary. This includes four main classes: year-round local residents, guests (i.e. tourists, visitors), second homeowners (from Denver/front range, out-of-state or international) and seasonal workers. Within this community, there is the community economically dependent outdoor recreation which is, in this study, understood to be the year-round local residents. Not all of the year-round local residents economically reliant on recreation in the geographic boundary reside within the geographic boundary. Many reside in the “down valley” Eagle County in the municipalities of Eagle and Gypsum.

In total, Eagle County has an estimated population of 56,000 residents in 2020 and is projected to maintain growth to 77,000 in the next thirty years (the county had a population of 22,000 in 1990) (DOLA, 2020).

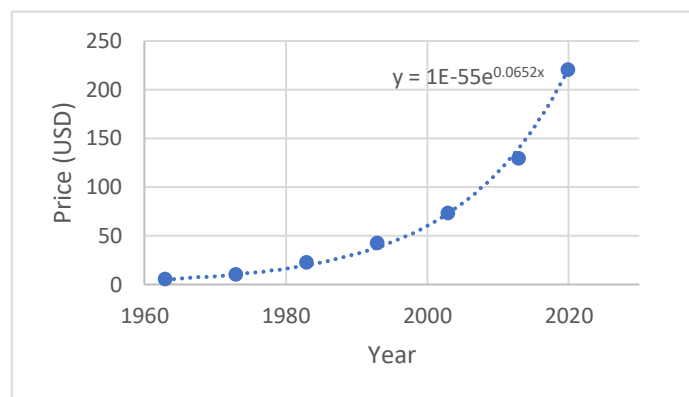
3.2.1 Ski Resort Industry

Vail, Colorado is located on the west side of Vail Pass in the Gore Creek Valley on acquired from the Ute Native American Tribe. Prior to 1940, when Highway 6 was completed over

Vail pass connecting Summit County with Eagle county, the Gore Creek Valley was one of the more remote valleys in the Colorado high country (Philpott, 2013. p 130). At this time the valley was home frontier ranchers. In 1942, twenty-three kilometers (fourteen miles) south of Vail the United States Army constructed Camp Hale, a training facility for what became the 10th Mountain Division, training elite mountain soldiers for World War II. During training missions, a soldier Pete Seibert identified the mountain which today is known as Vail to be ideal alpine skiing terrain. Following the war, Pete Seibert was approached by Earl Eaton, an Eagle County native with the prospect of developing the mountain into a ski resort. Their vision was aided by the planned construction of I-70 replacing Highway 6 over Vail pass which was completed in 1978 (CDOT). The duo founded Vail Associates and began raising capital and purchasing land along Gore Creek. They were granted a permit from the US Forest Service in 1959 and began the resort development after final approvals in 1961 (Philpott, 2013. p 128). Vail Ski resort opened in December of 1962 with a one-day lift ticket of \$5. In the 2019-2020 the window one-day lift ticket price was \$219 (Table 1).

Table 1. One-day lift ticket price for Vail not adjusted for inflation. Annual increase averages 6.52% growth with r2 of 0.997. Source: archive snow.com

Year	Price (USD)
1963	5
1973	10
1983	22
1993	42
2003	73
2013	129
2020	219



The ski resort is now owned and operated by Vail Resorts (formally Vail Associates) which has been a publicly traded company on the New York Stock Exchange since 1997, owns 36 resorts internationally in addition to Vail and is headquartered in Broomfield, Colorado. Vail Resorts, according to their corporate website is “the premiere mountain resort company in the world and is a leader in luxury, destination-based travel at iconic locations,” their product

is “the great outdoors” and their mission is “Experience of a lifetime”. The Eagle County ski areas Vail and Beaver Creek directly employ approximately 4500 people.

3.2.2 Utility Services

Electricity services in the research setting are provided by Holy Cross Energy (hence after Holy Cross). Holy Cross is a cooperative corporation owned by the service members and serves the Eagle River and Roaring Fork River Valley communities (out of the system boundary but includes Aspen, another high-end luxury mountain destination).

Water and sanitation services in the research setting are provided by Eagle River Water and Sanitation District (ERWSD), a local government responsible for the public water systems.

Natural gas services are provided by Xcel Energy and Black Hills Gas.

Waste is collected by three service providers, Vail Valley Waste, Vail Honeywagon and Waste Management with the landfill and recycled materials recovery facility owned and operated by Eagle County. Additionally, Vail Honeywagon operates an organic waste composting facility opened in 2018.

3.3 Data Collection

Data for this case study was collected in two phases, a result of the emergent design of this study (Creswell, 2013; Marshall & Rossman, 2010) and includes three forms of formal data including interviews, documented response and volunteered documents which were complemented by my observations while in the research setting. The first phase was planned along the original study design and were a series of personal interviews with sustainability actors in the Vail community. During some interviews, specific local context documents were volunteered to complement and contextualize their perspective. A second phase of data collections was added following the outbreak of the COVID-19 pandemic which, beginning in March, had indications of significantly disrupting the society and economy of the research setting. In response to the onset of this disruption, a second phase of data was collected in response to the emergence of Q4.

Interviews for the first phase of data collection were conducted in the month between January 14, 2020 and February 12, 2020 beginning with an interview discussion with a sustainability actor credited with pioneering sustainability and environmental educational initiatives in the upper Eagle Valley. Through this interview the actor gave an overview of their personal efforts and recommended an extensive list of further actors to contact and interview. I made an effort within the one-month time period I was physically present in the research setting to contact and coordinate interviews with the suggested actors. All of the actors that responded to initial contact (n=15) were willing and forthcoming for interviews, however my personal limitations interfered with the ability to interview all of the suggested actors resulting in eight interviews. Actors who were interviewed first gave verbal consent for study which was later formalized with signed letters of consent providing more complete detail of the research question. In addition to the snowballed suggestions, I made contact with three individuals within Vail Resorts' corporate management giving "unofficial/unapproved" insight to the corporate operations in addition to and beyond their sustainability direction. If privileged information was shared it will not be revealed, these conversations enhanced my insight with the economic operations of the industry. The perspectives of these three individuals are combined into a ninth actor profile. Also, due to the recommendation of multiple members of the Vail outdoor recreational community the Vail Valley Mountain Trails Association was interviewed to gain insight of sustainability considerations for outdoor recreation outside of the operations of Vail Resorts. Perspectives from a total of ten sustainability actors are assessed (Table 2).

Table 2. Interviewed active sustainable actors

Affiliation	Interview	Corona Response (Q4)
Non-Profit Director; Academic	In person	No
Recreational Industry Sustainability Manager	In person	Yes
Public Sustainability Coordinator	In person	Yes
Public Sustainability Educator	In person	Yes
Recreational Non-Profit Director	In person	Yes
Non-Profit Sustainability Director	In person	Yes
Non-Profit/Public Climate Action Manager	In person	Yes
Service Industry Energy Efficiency Administrator	Telephone	Yes
Public Industry Sustainability Coordinator	In person	Yes
Recreational Industry Corporate Manager Matrix	In person*	No

Interviews, with the exception of one, were conducted in person. The interviews were free form conversational with the intention of having the actor reveal their informed perspectives, often through the context of the professional position. As an interviewer, I mainlined a loose mental matrix framework of environment, social, economic and water, food, energy, ecology for topic transitions. I took detailed hand-written notes of the conversational interviews which were then typed up and expanded to more deeply reflect sentiments and expand antidotes revealed in the interviews. The one interview not conducted in person was over the phone, after personal contact with the actor was made following a short, undocumented discussion. All interviews ranged between one and two hours and reflected the actor's perspectives, often in relation to their employment, but not as spokespersons for their place of employment. Any documents or supplemental materials referenced or suggested

pertaining to the research site brought up or volunteered in these interviews were collected as well. These documents include; the Eagle County Climate Action Plan, The Actively Green Standard, The Mountain Ideal Standard, Love Vail Restore the Gore pamphlet, Town of Vail 2009 Sustainability Plan, Vail Resorts EpicPromise Progress report, Holy Cross Energy emissions report, Eagle River Water and Sanitation Sustainability Highlights and the 2018 Vail Mountain Master Plan which are all publicly accessible.

The second phase of data collection was conducted between March 31 and April 14. This was in the form of a direct typed response to Q4. The second phase of data collection was conducted approximately three weeks after the Colorado Governor declared a state of emergency due to COVID-19 on March 10, 2020. (Ziegler, 2020). At the time of the second round of data collection, Eagle County was the county with the highest case rate per 100,000 people in the state of Colorado 537.7 as of April 2, 2020 (CDPHE, 2020) and the county with the 7th highest case rate in the United States as of April 2, 2020 (NYT). The county relative to the United States acted swiftly and achieved the highest testing per-capita in the United States in the first week of May (Miller, 2020).

3.4 Data Analysis

Data analysis was performed in a spiral manner informed by Miles and Huberman (1994) and was conducted manually without the use of a computer coding program. In addition to the interview notes, field note reflections were recorded to ethnographically contextualize the research environment. The hand-written interview notes were typed and expanded to reflect sentiments and expand antidotes revealed in the interviews. The referred to sections of the volunteered documents were compiled and considered extensions of the interviews for the analysis. Upon the early readings of the full typed interview notes a short list of themes and impressions were recorded per each interview. A short, written summary of the initial impressions was recorded. The data was then compiled into a single file and assessed with themes highlighted and recorded in the margins. The frequency and contextual relationship of the emerging themes were recorded.

A compilation of nine themes was created, which was then condensed to five themes. One of the themes, cultural changes, is unlike the other four. It underlies the approach to the other four themes and was referred to with such frequency it merited its own distinction as a theme.

3.5 Evaluation of Reliability and Validity

Reliability and validity of the results were determined by review from the actors interviewed. The results section was sent via email to actors for verification and to ensure perspectives were reliably presented. Nine actors responded and a few quantitative figures were adjusted but the content was widely reviewed as an accurate depiction of the sustainability perspectives in the community.

The interpretation of the strong and weak sustainability conveyed by the perspectives was not reviewed by any external party and constitutes my own analysis.

I feel compelled to note from my own pre-understanding of the research setting that there is a community contact bias with whom I interviewed. There is a, within the scope of this thesis, an undefined social segregation within the residential community between non-Latino and Latino residents. According to the US census 21% of Eagle County is Latino, yet no actor interviewed represents this population (US Census, 2018).

4 RESULTS

CQ: What are the sustainability perspectives of the Vail outdoor recreation economically dependent community?

- 1) What has the sustainability approach been?*
- 2) What are the goals and future outlooks of sustainability in the Valley?*
- 3) How strongly are environmental, social and economic perspectives considered?*

Emergent Themes

The interviews revealed five emergent themes: cultural changes, sustainable destination, energy efficiency, waste reduction, and transportation presented in Figure 3. Of these five themes, the three themes energy efficiency, waste reduction and transportation are point focus areas for the community’s sustainability actors while the theme sustainable destination has a more comprehensive focus. The theme of cultural changes is more aloof of a theme. It was a general sentiment that the attitudes of local residents and governments have been gradually shifting, especially over the past two decades, with a greater awareness of environmental impacts of the local behaviors and culture and the climate vulnerability of the community’s economy and lifestyle. The theme of cultural changes was woven through the perspective’s actors shared and functions as a link between the three point-focus themes and the fourth wholistic ambition to be a sustainable mountain destination. The mosaic of actor’s responses revealed a loose chronological timeline of the past two decades in the community which will serve as a refence before engaging with the emergent themes.

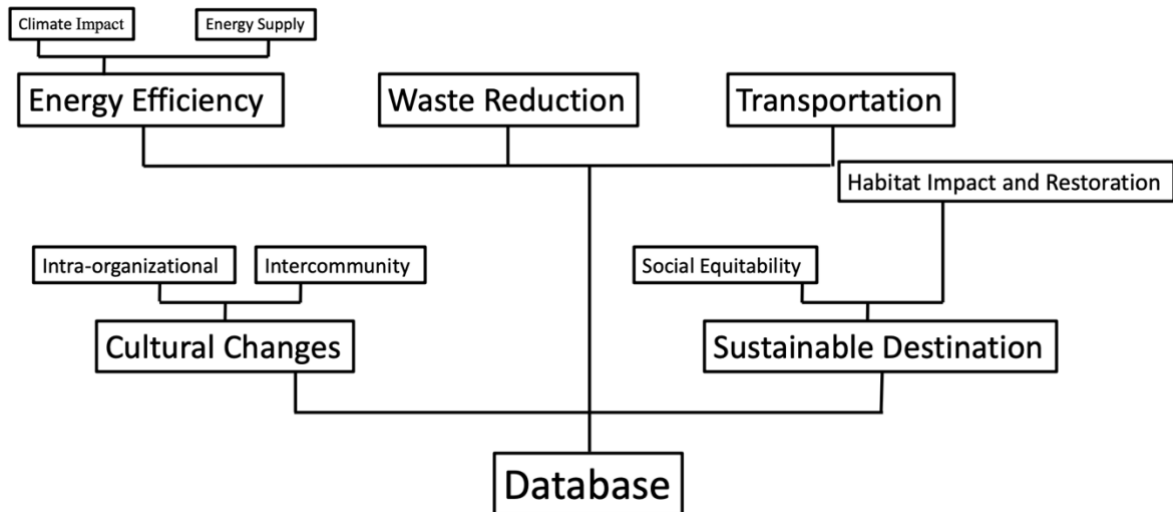


Figure 3. Tree diagram of emergent themes.

Community engagement began gradually increasing in the early 2000’s. This was primarily cited with educational outreach efforts especially around ecosystem health, and some beginning energy efficiency measures. In the late 2000’s and early 2010’s momentum increased with local governance and organizational boards of directors steering for more progressive, long-term directions and implementing sustainability plans to balance economic

strategy with environmental impact. Much of this was driven by the vulnerability of the outdoor recreational economy in the face of climate change in addition to local ecological damage. Responses expanded educational outreach, diversified energy efficiency measures and added focus to waste reduction and transportation measures. Vail Resorts outlined their Echo corporate sustainability platform in 2008 focusing on environmental stewardship, charitable giving and community engagement. The momentum for sustainability and environmental initiatives have increased in the 2010's. The year 2015 was pivotal for widespread community support for progressive efforts. In 2015 Vail and Beaver Creek ski resorts hosted the FIS Alpine World Ski Championships which was viewed by multiple actors within the sustainability community as an opportunity to market the benefits of sustainability efforts to both the local residents and guests on an international stage. In 2015, the Eagle County government initiated work on the Eagle County Climate Action Plan which targets an 80% reduction of 2014 level greenhouse gas emissions by 2050 with 25% reduction in 2025. Also, in 2015 Holy Cross began to phase in advanced metering infrastructure (AMI) to all members allowing a transition to a progressive, more resilient electricity grid. In 2017 Vail Resorts expanded its corporate sustainability strategy introducing EpicPromise: Commitment to Zero Net Operating Footprint by 2030 consisting of three pillars of zero net emissions, zero operational waste to landfill, and zero net operating impact to forests and habitat.

4.1 Cultural Changes

The most intersectional and comprehensive theme that emerged is best attributed to cultural changes. The actors expressed shifts or changes in culture, attitude, behavior, and motivation related to sustainability. It was articulated that such cultural changes are needed to fulfill the ideas embedded within Town of Vail vision. A vision that is “to be the Premier International Mountain Resort Community, by providing high quality of life and experiences for both residents and visitors. This is achieved through environmental stewardship, world-class recreational, cultural and educational opportunities, a strong year-round economy, diversity of housing, and superior infrastructure. The Town actively seeks input and cooperation from the community and its neighbors to ensure fulfillment of its vision” (Vail, 2007). Many of these cultural shifts were related to educational outreach efforts and specific

cultural changes were primarily manifested on intra-organizational levels. Inter-community attitude shifts were also acknowledged.

4.1.1 Education and Outreach

A pervasive theme echoed by the majority of sustainable actors is the need and strategy for education and outreach to enhance awareness and shift cultural behaviors. The earliest time periods referenced were the late 1990's with the need for place-based education and a greater connection to the local mountain ecology and energy efficiency measures. These factors, in part, led to the formation two non-profits. Gore Range Natural Science School (GRNSS) served as the scaffolding for many of educational outreach endeavors in the community spanning from school children to forming partnerships for environmental change and Eagle Valley Alliance for Sustainability (EVAS) brought a focus to energy efficiency advising and waste reduction and diversion. In 2010 GRNSS rebranded as Walking Mountains Science Center (hence after Walking Mountains), followed by a merge with EVAS.

Walking Mountains was broadly referenced as an organization and central authority for many of the community's sustainability efforts. The actors within the Town of Vail environmental department, the Eagle County Climate Action Plan, Holy Cross Electricity, Eagle River Water and Sanitation District and the ski industry highlighted the role of Walking Mountains. In addition to the role Walking Mountains plays through culture enhancing place-based educational outreach and ecological awareness directed at local schoolchildren, residents and visitors alike, it is an agent for cultural changes across the landscape of local organizations. Actors referenced four main roles of Walking Mountains: an energy efficiency advising program with facilitation of a local "Actively Green" accreditation, facilitating the Eagle County Climate Action Plan (CAP) through the Climate Action Collaborative (CAC), a municipal solid waste reduction program and facilitation of the "Mountain IDEAL sustainable destination standard" (expanded in sections 4.3, 4.4, 4.4, 4.2 respectively).

Education and outreach are a core strategy for sustainability initiatives within the community. Actors commonly referenced their roll in educating and increasing awareness of the needs for, and benefits of sustainability measures to members of their organization, local

businesses, community members or guests. The breath of what is to be communicated with the education and outreach is represented in the following four themes: energy efficiency cost and climate benefits; waste reduction hierarchy; ecosystem, habitat and proper recreational behaviors, and effective mobility. The range of outreach events include regular events such a Town of Vail's Lunch with Locals and a sustainable film series by Walking Mountains and or emergent events such as information booths at large event gatherings. Electronic communications, especially across social media platforms are increasingly used. The importance and need for community outreach and education is further communicated by published documents. Specifically, the first point in the CAP and the Restore the Gore action plans are for education and outreach and the third component of the Mountain IDEAL standard is education. Additionally, most documents are published in both English and Spanish to be linguistically accessible to the whole community.

Within the theme of shifting culture through education, it was echoed that the guest and specifically second homeowners where not only the hardest demographic to reach, but were the most resistant and even disrespectful towards outreach efforts. This was openly hypothesized to be a result of second homeowners wanting the environment to continue to serve a specific aesthetic and function despite the shifting needs and views of the local community. The approach for addressing second homeowners has been more successful if intermediaries such as property managers, contractors and landscapers are well informed and equipped to implement better practices.

Also, in relation to outdoor recreation, specifically on public lands and in wilderness areas, the attentive need for proper education for how to recreate in the ecosystem was prevalent. Such outreach includes "leave no trace" etiquette, proper trail use, and awareness of fragile ecosystem components. This comes in response to greater recognized and compounding disturbance from increasing human presence in the ecosystem, and the intricacies of the ecosystems being culturally unfamiliar.

Overall, the need for education and outreach was communicated to give understanding and support for the community culture to more deeply value sustainability on short and long-term horizons.

4.1.2 Intra-Organizational Changes

Intra-organizational changes were described with shifting attitudes towards reducing environmental impact of the organization. Much of this was a result of actors having influence in implementing cultural shifts such as waste source separation for paper, plastic and most recently organic materials, or advocating and influencing mobility behavior such as carpooling, periodic work from home or public transportation. Specifically, work-place lunch-in type seminars were commonly cited for broad wellbeing outreach. This also alluded to a pattern of some business and organizations intrinsically noticing the need for greater sustainability actions and responding by diverting greater resources to create or expand environmental sustainability specific departments.

Cultural changes within organizations are not without resistance. There were attitudes reflecting the inconvenience of shifting behaviors, especially related to mobility and waste reduction. One actor highlighted that even upper level managers in their organization were resistant to changing their ways in regard to waste reduction. Much resistance was subdued following a retreat for managers where one activity was the manual sorting and weighing of the event's trash, giving some perspective to the magnitude of their collective waste. Despite this exercise, while the managers did support waste reduction efforts, changing transportation behaviors feels impractical, partially because the lack of convenient alternatives to private passenger cars.

Within the resort industry there was a deep echo of a concerning change in work culture in recent years. The work culture of the mountain towns was shifting to be more "corporate." That is services and operations felt pressured to be more fiscally and growth focused and more "city like, opposed to mountain like." Workplace morale was reported to be questionably low from entry-level to mid-level managers. The underlying theme behind the lower morale was that the relaxed mountain culture, both the living and working culture, were being streamlined. There is increasing pressure in the workplace due to growing performance expectations adding to increasing background pressures employees experience

beyond the workplace such as housing, healthcare and living expenses. It was suggested often university educated seasonal workers from financially stable domestic and international families were targeted for employment because their financial stability could subsidize living costs. It was also suggested there is untapped insight, education and experience within the workforce. Just compensation for shifting workplace expectations such as comprehensive benefits, adequate housing subsidies or fitting wage were cited to be economically unviable. This is in contrast to capital available for achieving ambitious environmental goals, which are willingly funded and supported on principal instead of financial return. These cultural changes, expressed positively or negatively, were attributed to the growing size of the shareholder directed, data-driven industry where “growing pains are inevitable.”

4.1.3 Inter-Community

Auxiliary to the focused scope in the research setting, actors addressed growing coordination with other mountain communities on sustainability efforts. They noted this increased especially after the development of the Mountain IDEAL which applies well to other outdoor recreational economically dependent mountain towns. Examples include Jackson, WY, Park City, UT and Breckenridge, CO.

A common agent across many destination towns is Vail Resorts as a resort operator. The company has 37 destinations globally and company, through their EpicPromise goals, can transfer applicable strategies while supporting with technology (*Kp*) for improving sustainability. Their role extends beyond linking their destination communities, but also having sway with corporate partners to achieve their commitment.

4.2 Sustainable Destination

It was well iterated and understandably self-evident that a key theme conveyed by sustainability actors is in fact sustaining the mountain culture and lifestyle of the research setting. Longer term economic and environmental planning for the mountain community was initiated in the late 1990’s with the Town of Vail specifically introducing an action plan in 2007 and environmental sustainability plan in 2009. The intention was managing economic growth and accompanying capital investments (the “two-billion-dollar facelift” of

the “aging” village in the 2000’s) with the assets provisioned by the mountain environment in a manner that equitably supports the community. However, the dominant narrative has been the balance of economy and environment while the social means of facilitating the relationship less robustly supported.

The value that founded and continues to drive the destination-based outdoor recreational economy is intrinsically rooted in the ecological services of the mountain environment. Broadly described, the economic model of the research setting is driven by the financial simulation from high end luxury tourism; the resorts are marketed to be premier international mountain destinations targeting a large volume of high net-worth customers. Much of the esteemed value for guests come from the aura of “pristine mountain wilderness” which enhances and adds value to a given experience. The local residents facilitate this relationship stimulated by the financial in-flow while themselves appreciating the mountain environment and recreational lifestyle. It is reported by the Colorado Department of Local Affairs that tourism accounts for 60% of Eagle County’s economy (2019).

Maintaining this model supported the development and certification of Vail as a sustainable destination recognized by the Global Sustainable Tourism Council in 2017. In the process of the certification, the community recognized needs that are unique to mountain destinations and crafted a certification standard specific to mountain towns, the Mountain IDEAL standard. This process is intended to help spread sustainable mindsets and actions to similar mountain tourism communities.

4.2.1 Habitat Impact and Restoration

While the economic model of the research setting is dependent on the mountain environment, the local ecology is disturbed by the introduction and expansion of developed human activity. Over the years different ecological issues have taken precedence. Notably in the early 2000’s there was widespread attention to a pine bark beetle infestation which aside from ecological consequences and fuel loading for wildfire, threatened the mountain aesthetic and destination desirability. The dominant concerns being presently addressed are stream health and sensitive habitat designation and protection.

The watershed health in the research setting is being negatively impacted by two main factors, pollutants from land use and urban runoff. The referred to pollutants from land use included introduction of non-native species for aesthetic landscaping and golf courses and the pesticides, herbicides and fertilizers used for such landscaping. Urban runoff includes historical development which altered meandering beaver dammed streams and swamplands to directed streambeds (Figure 4) and the presence of impervious surfaces which channel pollutants such as road grime and trash into waterways. These impacts contributed to the classification of Gore Creek which runs through the Town of Vail and feeds into the Eagle River as an impaired waterway under Colorado's Department of Public Health and Environment 303(d) listing.

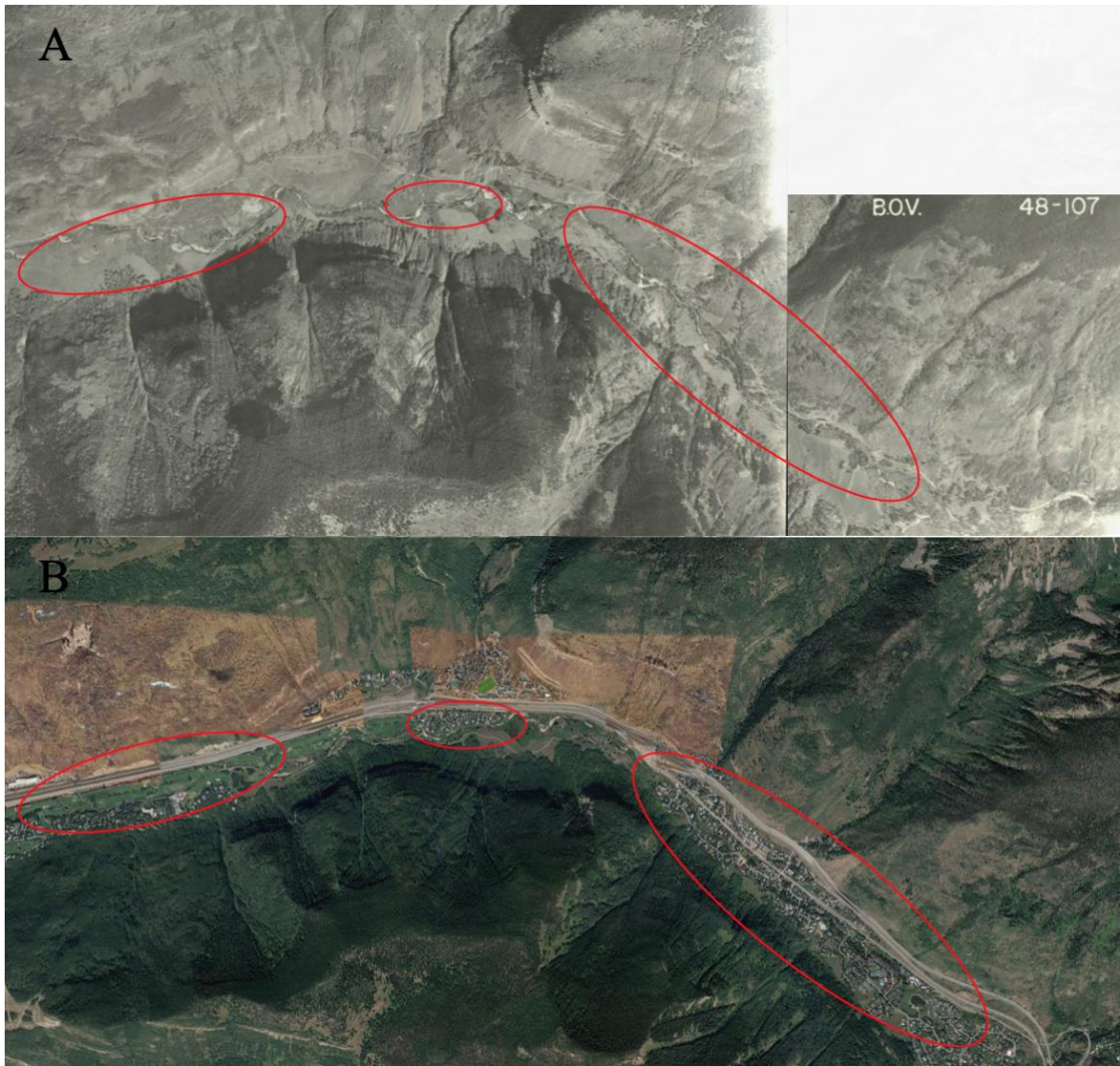


Figure 4. East Vail with actor referenced human development stream diversion. A) Aerial photograph from 1939 (Jerry Crail Johnson Earth Sciences & Map Library). B) Google Earth ©2020

The 303(d) listing of Gore Creek was a significant motivator for the Town of Vail to act and restore the stream health. In 2015, the Town introduced Gore Creek Water Quality Improvement Plan which was followed by the Restore the Gore initiative backed with and \$8.5 million-dollar budget. The restoration efforts include education and outreach, implementing best management practices on public lands, advising private landowners and annual stream health monitoring. Outreach has been most effective when directed at landscape contractors instead of homeowners. In addition to improvement in public land management, infrastructure improvements for filtering urban runoff at major spillways have begun to be designed and constructed. The actions taken have shown signs of recovery. The next hurdle is an ordinance for mandated compliance on private property. While the specific

actions of the Town of Vail were elaborated, multiple sources confirmed similar awareness and actions being implemented down valley in the Eagle River watershed.

While stream health restoration was a dominant theme, actors highlighted a second growing concern, the growing human impact of recreation. The research setting is experiencing both growing numbers of visitors and residents. There are more people recreating and there is a concern for catering to the specific needs of recreators without inflicting further damage on the mountain ecosystems. Increase in recreation is reported on summer recreational trails both in (hiking) and out (mountain biking and OHV) of Wilderness boundaries, river and fishing traffic, and winter ski and snowmobile touring outside of the ski resorts. To prevent overuse on existing trails, new trails are being developed but must be carefully planned so as to not disturb sensitive habitat such as wild game calving regions. The current approach is to identify locations for recreational hubs in order to condense the human recreational impact. Expanding within the developed ski resorts is a probable solution, but the publicly traded nature of the resorts requires financial return to shareholders for such development. Reducing non-resort related trail expansion is not within the scope of the EpicPromise zero operating impact on forests and habit. Presently, as an alternative, the prospect of pay-to-play recreational permits is being investigated to expand from OHV use to all recreational use to contain recreational use while funding maintenance and restoration efforts. This is part of a broader conversation across Colorado through the Colorado Tourism Office.

4.2.2 Social Equitability

A pervasive theme within actualizing a sustainable destination is social equitability within the mountain community. The highlighted contrast is that of second homeowners and low-income local residents in access to housing. Affordable housing has been an ever-evolving challenge drawing attention for the past two decades. Actors acknowledged the complexity of the issue and that it is not within their area of expertise. One with previous experience with destination real estate outright told me to avoid the issue all together because its beyond understanding. A tangible housing component mentioned is that the Town of Vail is funding a deed restriction program with the goal of 1,000 housing units being added to deed restriction for local residents or workforce by 2027.

While high net-worth guests and second homeowners strongly support the local economy, when it comes to more wholistic sustainability goals including meeting emissions reductions in the CAP, they are “not paying their fair share.” They may be paying in money, but not in behavior. An example of this is the approximate 2.1% of electricity meters are homes greater than 5000 ft² (465 m²) contribute nearly a quarter of electricity revenue which is an “underpayment” in Holy Cross’ goal of reducing energy demand. This point is amplified with the speculation that such homeowners occupy such homes less than two months out of the year.

On the other end of the spectrum, there are challenges aiding low-income residents. A deterring factor, such as for income qualified energy efficiency capital improvement subsidizes, is the need for legal federal tax paperwork so undocumented low-income immigrants do not apply.

4.3 Energy Efficiency

Energy efficiency has been a growing focus in the community over the past two decades. Efforts have been primarily focused on residential energy consumption via heating and lighting, driven through education and outreach. In preparation for the 2015 FIS world championships a local “Actively Green” certification standard was introduced in 2013 via Walking Mountains to more formally expanded and reward energy efficiency measures, branching into the commercial sector. The program is quickly growing with 62 business certified, 130 working towards certification while consulting support, data collection and information sharing is increasing. Energy efficiency measures have been voluntary, without energy efficiency regulations in local building codes. The shifting attitudes of the community and local governance in alignment with the CAP are expanding departments and resources in order draft and introduce residential and commercial energy efficiency regulation.

Vail Resorts between 2008 and 2012 was able to reduce its energy demand by 10% and continues to work for increased energy efficiency. Specific to the ski industry, over two thirds of operational energy use is for snowmaking. While the region is known for excellent snow conditions, increasing climate variability is closely related to economic stresses. Snowmaking increases reliability and buffers economic fall out, but at a heavy energetic

cost. In 2019 Vail snowmaking was upgraded significantly improving energy efficiency; energy saving were negated by a 77 ha expansion of snowmaking coverage.

Related to energy efficiency is water use and water efficiency. The narrative is currently shifting. The predominant water saving information was directed at exterior water use, most often towards aesthetic landscape irrigation in order to prevent hydrologic losses in streamflow related to legal issues of Colorado River watershed water rights. Indoor water use previously was not given much attention because over 95% returned to the system. The energy demand for pumping and treatment, however, are now being more closely monitored and the strategy is shifting for more holistic water demand reduction to achieve energy and treatment chemical demand reductions. The processing for water treatment, too, is being optimized after being challenged to reduce energy use while maintaining high water standards. The system is being upgraded with in-time energy monitoring for pumps, compressors and instruments to further inform system optimization. The initial driving force was a Holy Cross peak shedding trial.

The peak shedding trial notified high demand users such as the ski resorts, hospitals, and water treatment facilities 24 hours in advance of an anticipated critical peak event and were provided a \$1/kWh rebate for electricity demand shedding from a calculated baseline. The financial incentive took hold and operators found innovative energy saving solutions. In the context of the ERWSD this was achieved without affecting water quality. After a one-year trial with high demand users, Holy Cross expanded the program in 2020 to all members to allow for business and residential peak shedding.

4.3.1 Climate Impact

The 2014 Eagle County Energy inventory presented within the CAP states the per-capita GHG emissions of Eagle County are 28% greater than the Colorado average, which itself is above the United States average. To contextualize globally, in 2014 the United States had the fourth highest GHG emissions per capita of the twenty highest carbon emitting countries in the world (UOCS, 2020). The climate impact of the energy use in the community has been a motivating factor for energy efficiency improvements with growing intensity since the mid 2000's. This followed the growing awareness of the vulnerabilities of the outdoor

recreational economy, specifically citing inconsistent snowpack, drought, and wildfire affecting winter and summer economic activities. The awareness of climate vulnerability led to organizational changes in the ski resorts, a progressive board of directors and direction for Holy Cross and local governance evaluating decisions on longer time horizons to maintain the economic model. Much of these efforts were occurring without broad recognition by the community.

One of the most significant developments referenced was the adaptation of the CAP in 2016 and the strategic organization of the Climate Action Collaborative (CAC) in 2018 that followed. The CAC, facilitated by Walking Mountains to oversee realization of the plan, an 80% decrease in 2014 level GHG emissions by 2050, has so far been a successful and monumental step to organize and coordinate a network of wider spread local sustainability actors. The zero net emissions pillar of Vail Resorts' EpicPromise contributed significant inertia and support to local actor's efforts and the corporation was referenced as an "invaluable partner for achieving local goals."

4.3.2 Energy Supply, Electrification and Natural Gas Infrastructure

Before the formalization of the CAP, Holy Cross was in motion to diversify and decarbonize their electricity supply which in 2014 contributed 39% (546 kt CO₂eqiv) of Eagle County emissions with the goal of 70% renewable energy by 2030. Following the CAP this was advanced to 2025 and is on track to be realized at least three years early. The factor limiting 100% renewable energy is adequate storage options for intermittent renewables. Embedded within this strategy, as the utility moves away from coal as the dominant energy source, is to, one, sell less electrons, two, control when those electrons are being used and three, do this while increasing the resilience of the electricity grid. Resilience is rooted in the development of locally distributed energy resources (DERs) and increasing solar and wind renewable energy with battery storage to allow for a future vision of localized micro-grids. It is a desired transition for organizations currently purchasing renewable energy credits to install some form of local generation capacity.

Energy for electricity, however, accounts for only 14% (761 MWh) of Eagle County energy use with natural gas accounting for 29% (1,632 MWh) and transpiration fuels for 57% (3,150

MWh) (CAP, 2016). A common theme echoed in regard to energy efficiency is the need for electrification. Both the electrification of present utility gas infrastructure which serves 69% of homes and the electrification of transportation (addressed in section 4.5).

The electrification replacement of natural gas is focused on high demand commercial accounts; however, a formal strategy was not present. That is a key focus of the Climate Action Collaborative, to devise a strategy for the coming decades. Transitioning away from the built natural gas infrastructure is further challenged by the exceptionally low cost of hydraulically fractured natural gas in Colorado and the powerful regional natural gas lobby.

Vail Resorts will likely lead this infrastructural transition with substantial capital investments in the next decade. Such investments are needed to meet their goal of zero net carbon emissions by 2030 by converting resort owned lodging facilities from natural gas to electricity.

A significant challenge unique to the Town of Vail referenced in regard to electrification is the natural gas snowmelt system for the approximate 1.8 ha of heated streets in Vail Village and Lionshead. Presently, an alternative snowmelt system such as electrified ground source heat pumps is considered cost prohibitive.

Resources for residential electrification are becoming more abundant with outreach to contractors and homeowners about the ability to electrify heating with air-to-air and ground source heat pumps.

4.4 Waste Reduction

Actors recalled waste reduction efforts coming into greater effect in the late 2000's. The focus was on municipal solid waste (MSW) diversion with a growing shift to waste prevention; actors did not specifically address construction and demolition waste. The Town of Vail, for example, started a recycling program in 2007 that began with educational campaigns for businesses and residents and was later mandated by a 2014 Recycling Ordinance. In the seven years leading to the ordinance, the educational campaign was directed at hotels, residential housing, special events and outreach to local school children.

There was a building code and infrastructure hurdle that needed to be overcome before the ordinance with many commercial operations not designed to have space for differentiated landfill waste and recycling receptacles.

The waste diversion rate in the Town of Vail has increased from ~9% with the program initiation to ~25% in 2019, with the diversion rate in Eagle County being 20%. Embedded in the CAP is a goal for 30% diversion by 2030 for Eagle County. Precision in data resolution on municipality and commercial/residential scales across the research setting is a focus area in the coming years with needed coordination across the three waste haulers operating in the research area.

Combined outreach and diversion actions were introduced at special events beginning in the later portion of the 2011 Vail summer farmer's market season with the introduction of a Zero Waste campaign supported initially by EVAS (later by Walking Mountains). The Zero Waste concept supports waste source separation (organic compost, co-mingled recycling and landfill) to large public events. A driving force for continued support of Zero Waste events is the value they bring to the image of the mountain resort towns. The marketable image is an embedded component of the sustainable destination theme (expanded in section 4.2).

Zero Waste receptacles were originally staffed by volunteers and are now supported by paid Walking Mountain interns. The number of Zero Waste events has grown with mandates by local municipalities and support from non-profit partnerships for a total of 93 Zero Waste event days in 2019. Additionally, organic waste diversion has been supported locally with a composting facility operated by one local waste hauler, Vail Honeywagon, which became operational in 2018.

Introducing and expanding organic waste compost is a result of multi-industry collaborative efforts. Innovative collaboration is underway such as investigating sludge from wastewater autothermal thermophilic aerobic digestion as starting material for the industrial compost and optimizing commercially collected organic waste content. These innovations are working towards a circular organic material cycle, with incentive for expanded end markets

for compost. Local organic waste diversion is being focused on commercial operations but is available for paying, subscribing residents at drop locations.

The concept of Zero Waste has been further enhanced and supported with the ski resort operations in line with Vail Resorts' Epic Promise. Food services at the resort follow a similar employee conducted source separation while capital investments are supporting front-end waste reduction such as shifting from disposables to durables and using the corporate size to leverage waste reduction with supply partners such as condensed packaging for retail. With the expansion of waste reduction mentalities municipalities, event organizers and the ski resorts have been shifting focus and behaviors to waste reduction on the front end; less material in need of disposal.

Zero Waste events have drawn cultural recognition and have activated behavioral changes in locals and recurring guests with the ability to self-separate; however it is still a common reaction to be inconvenienced by needing to separate waste at such events by some patrons, even when waste is being separated for them.

4.5 Transportation

Transportation fuels were responsible for 57% (3.15 GWh) of Eagle County's energy use and 30% (418 kt CO₂eqiv) of GHG emissions 2014 (CAP, 2016). The perspectives related to transportation were focused around reducing the total energy use in mobility, specifically by decreasing the reliance on internal combustion private cars and trucks. Traffic in the community has been increasing and has been accommodated by infrastructure expansion including parking structures, new underpasses and traffic circles. The goal, however, is to reduce this trend - to reduce vehicle miles traveled and to electrify remaining transit. Reducing vehicle miles traveled is targeted with public transit, ride-sharing and human modes of transit. It was also desired to investigate the possibility of utilizing the currently dormant, Union Pacific-owned rail line in the Eagle River Valley for commuting means.

Eagle County has an existing regional public transit service, ECO transit, which serves the Eagle Valley corridor into Vail and Leadville while Vail, Avon and Beaver Creek operate free in-town bus services. ECO transit recently transitioned to new management with the

goal to increase ridership and convenience for the community; a survey to inform this direction is being launched in 2020 under the CAP. The free bus service in Vail is a long-standing characteristic of the town and maintains a commitment to frequency and convenience. Vail Transit will be testing electrification with the introduction of four early production battery electric busses scheduled for Fall 2020.

Voluntary behavioral changes in mobility patterns, specifically carpooling, have been encouraged in the community for the past two decades. Technology is aiding this campaign with the introduction of a carpooling app in the mountain region designed to target traffic from Colorado's population center in the front range to the mountains. Municipalities and business have also taken their own initiatives to encourage carpooling or non-motorized transit. While some community members have shifted their mobility behaviors, the prevailing theme is such behavioral changes are inconvenient and necessitate a more appealing alternative.

Capitalizing on the active recreational lifestyle, there is a push to substitute car travel with human modes of transit, specifically biking and e-biking at least in the summer months. In 2011 the Town of Vail introduced the SolePower Green Commuting Challenge, a free summer contest encouraging Eagle Valley residents and organizations to replace motor-driven trips with human-powered trips. The challenge provides information about fuel cost savings and emissions reductions for participants and community. The town of Avon introduced a bike share service in 2017 and Vail will be introducing an e-bike share service in 2020 connecting East Vail to West Vail. Holy Cross in the fall of 2019 began offering \$200 rebates for e-bikes that are used to offset vehicle miles. Through the Climate Action Collaborative, the goal for 2020 is to strategize connectivity between town and regional bus and light mobility services throughout the geographic spread of the community.

Electrified mobility is encouraged with the strategic installation of charging infrastructure supported by Holy Cross. The Town of Vail for example, at the end of the 2019/2020 ski season will expand from six charging stations in the parking structures to 22 including a level 3 480 V super charger. Visitor accommodations are also expanding charging infrastructure. For residents, Holy Cross members are offered free level 2 240 V electric

vehicle chargers while the auto-dealerships in Glenwood Springs (95 km, 60 miles) west of Vail offer subsidies on electric vehicles resulting from the Volkswagen emissions settlement. Holy Cross is working with local municipalities along the I-70 corridor to install DC fast charging stations.

4.6 COVID-19

Q4: In the context of addressing the onset of the global coronavirus pandemic, specifically with the epidemic felt on a local scale, what is the most important aspect of sustainability for the community?

In response to being asked “what is the most important aspect of sustainability?” during the onset of a global pandemic which triggered a near complete economic shut-down in the research setting, actors centered around a common point, resiliency. Actors reported the consequences for sustainability efforts are likely to extend beyond the cancelation or postponement of environmental events and infrastructural projects. The ski resorts and general tourism were closed by order of the Governor. In the research setting the ski resorts employ up to 5,000 people which were laid off or furloughed, with hundreds of seasonal workers pushed out of the valley behind the visitors. In the absence of tourism, electricity demand dropped 8-10%, yet actors observed many commercial buildings were not equipped to lower energy demand via an “idle mode” while unoccupied.

Such a sudden and significant shut-down exposed the vulnerability of the local economy, especially when tourism accounts for 60% of Eagle County’s economy. While the tourism dependent economy dwindled, the recreational environment brought significant value to the residents. While social distancing and sheltering at home, community residents took refuge in local mountain recreation. The rules for recreation changed to accommodate for the uncertainty of the healthcare system in pandemic. Groups, high risk activities and backcountry travel were discouraged, but safe, socially distant outdoor recreation was culturally encouraged. For many residents the ability to recreate outdoors brought pronounced mental health benefits in trying times, speaking to the intrinsic cultural value of the local environment to the community.

While the shutdown, on the one hand, highlighted the continued need for environmental sustainability efforts to mitigate risks such as climate change to maintain the research setting's economic model, on the other more emphasized hand, the shutdown exposed the failings of social sustainability. The great imbalance of social equity in the community was exposed. The onset of the pandemic brought citizens' focuses lower on Maslow's Hierarchy of needs; survival and safety became the focus for a much broader portion of the community. The lowest income groups in the valley were suspected to be the hardest hit financially while having the least means of preparing for and coping with the intricacies of the pandemic. Such distress brought attention to the lifeline necessities in the community including housing, healthcare, long term food sourcing and access to mobility. It also addressed how it would be a challenge for many in the community to pursue environmentally conscious decisions if they are prioritizing survival. A general sentiment expressed is crisis planning goes farther when there are less holes in need of filling before the crisis. Actors are optimistic this disruption will catalyze efforts for creative innovation for the sustainability of the community.

5 DISCUSSION

The Brundtland definition of sustainable development which has been guiding sustainability science research since 1987 is understood as meeting the needs of the present without compromising the ability of future generations to meet their needs. Qualifying sustainability for sustainable development has been a theoretical practice in academic and policymaking settings which has diverged into frameworks for weak and strong sustainability. Strong sustainability emphasizes the foundational value of natural capital's provided ecosystem services, and sustainability is achieved when these services do not decrease. Weak sustainability considers the sustainability of the total capital stock and sustainability is achieved when the total of produced capital, natural capital, human capital and social capital is non-diminishing. In practice, weak sustainability has often been simplified to consider produced and natural capital.

The results from actor interviews (depicted in Section 4) will be referred to as the sustainability perspectives. The case study of the sustainability perspectives of the Vail outdoor recreation economically dependent community provides a situation to assess the

application of strong and weak sustainability frameworks. An analysis of the sustainability perspectives can provide insights to how the community's development is and is not sustainable across the three dimensions of sustainability (Figure 1). The analysis of the results will first consider the strong sustainability perspectives in the community which will be followed by an assessment of the weak sustainability perspectives imbedded within the community. Finally, the two frameworks will be compared to reveal an informed outlook of the sustainability direction of the community.

5.1 Strong Sustainability:

Strong sustainability approaches focus on natural capital, and environmental sustainability. A significant demographic of sustainability actors interviewed were actors specifically focused on environmental sustainability. Their positions, and structure of work cater to strong sustainability - the preservation of natural capital. To begin an assessment of strong sustainability it is informative to consider how natural capital is understood by the research setting. There are two forms of natural capital that are considered, local natural capital from within the research setting and natural capital external to the setting which will be considered as global natural capital.

5.1.1 Local Natural Capital

The active preservation of form and function of the natural capital within the research setting is a critical component of the sustainability perspectives. The local ecosystem services referenced in the perspectives are the provisions of drinking water, the supporting services of local habitat and the cultural services for recreation and place-based education. Additionally, minor provisions from wild game and community garden agriculture were mentioned in interviews but can be categorized under cultural services because they are auxiliary provisions. Overall, the utility of the natural capital local to the research setting is derived from the cultural services provided by the topography and the appearance of healthy habitat.

Strong sustainability approaches are present in regard to maintaining local natural capital's services. The most concrete action referenced is the Restore the Gore initiative which defines a minimum standard threshold for stream health. The defined standard is to not qualify as an

impaired waterway according to the Colorado Department of Public Health and Environment's multi-metric index. While in its present state the waterway is not impaired to a degree that affects drinking quality (provisions), it is a strain on the ecosystem and stresses the ability for the ecosystem to support and sustain its function and health. The awareness that the waterway is impaired also decreases the cultural value of a pristine mountain environment. The goal of Restore the Gore can be interpreted as the mitigation of aquatic stresses induced by human development and produced capital while not removing human occupancy in the ecosystem. It serves to maintain confidence in the cultural services and to maintain supporting service functions.

The EpicPromise notion of restoring equivalent habitat function as is impaired by resort expansions also represents strong sustainability. Underlying this stance is the present level (2017) of local natural disturbance is the minimum acceptable level, anything beyond such a level must be accommodated for. The support for why the 2017 level of disturbance is the minimum acceptable level is not in a context of historical ecological function. Rather it implies an evolving corporate sustainability approach which recognizes the need to apply strong sustainability on local levels while not compromising the historical economic benefits from disturbing habitat function.

Similarly, strong sustainability can be viewed in the perspective of maintaining critical habitat function and big game population numbers concerning future real estate and recreational developments. In this instance, there are attempts to distinguish critical natural capital, or a satisfactory level of natural capital function to accommodate further development of produced capital, though the specific methodologies were not articulated. This point concedes the whole ecosystem will face increased disturbance and fragmentation, but strategic planning should preserve, or at least decrease damage to remaining critical sites.

These applications of strong sustainability towards local natural capital illustrate the preservation of a disturbed ecosystem function. All three examples define some form of a threshold that may not be transgressed, but each threshold is lenient to increasing human disturbance. These thresholds are closest related to the mountain ecosystems supporting services. Although this can be interpreted as maintaining a degree of supporting services to

provide sufficient cultural services. It can be noted that the thresholds are designed relative to an already disturbed environment as there is not reference to data from before development.

5.1.2 Global Natural Capital

Strong sustainability is evident when global natural capital stock is considered. The main strong sustainability consideration reported was not transgressing the atmospheric thresholds for GHG emissions as determined by the IPCC. The community's commitment to the climate mitigation strategy embodied in the CAP supports a global level strong substitutability threshold. Before the CAP was initiated work for the energy efficiency, waste diversion and transportation themes were underway applying aspects of global scale strong sustainability. Examples include concerns relating to the availability of finite resources and the overwhelming of the environment's ability to handle novel wastes in air, soil, freshwater and oceans. The central focus, however, was not transgressing the threshold for Holocene climatic homeostasis in relation to increasing GHG emissions.

Early energy efficiency efforts were motivated by mitigating climate change, reducing the air and water pollutant load, specifically from coal power plants and security of economic fuel resources. The core focus on waste diversion was reducing the demand driving expanding virgin resource exploration and extraction, while drawing attention to processing energy savings. Transportation was incentivized by reducing fuel costs, resource dependency and operating pollution including air quality, highway runoff and noise disturbance. The marketing and outreach for these themes didn't necessarily convey the strong sustainability motivation and would, for example, highlight monetary economic savings.

The most solidified strong sustainability approach is the CAP containing quantitatively defined goals of an 80% reduction of 2014 level GHG emissions by 2050, and 25% by 2025 allows for a measuring of the described goal. The CAP addresses the IPCC approach to global climate action efforts represented in the 2015 Paris Climate Accord by focusing on emissions from within Eagle County. The rhetoric of the CAP and the community support of the plan suggest GHG emission mitigation for the intent of not crossing a climatic

threshold which would have negative consequences of natural capital disturbance in the research setting.

The CAP is in the correct direction for such a goal, however the complexity of the GHG emissions trends transgressing the threshold is not captured with downscaling or disaggregating to non-planetary scales (Steffen et. al., 2015). For example, the emissions considered in the plan do not account for emissions external to the research setting necessary to support the produced capital within the research setting.

5.2 Weak Sustainability

First, it must be noted that the first assumption of weak sustainability is that the environment can only be considered as a source for production without also having an intrinsic value. In the research setting the environment serves a limited role in being a source for production, with much of the value granted to the local environment being intrinsic as determined by the cultural value of the mountain environment. Therefore, the mathematical model of the Hartwick savings rule applied for weak sustainability does not hold in this context. Accordingly, there could not be conditions for being weakly sustainable, unless the culture of the research setting shifted to remove any intrinsic value from the local environment.

In spite of the violation of the first major assumption behind weak sustainability, capital in the research setting can be considered within weak sustainability frameworks. This addresses the substitutability of different forms of capital, which will be addressed in concept. Generally summarized in the perspective, local natural capital must be disturbed to allow for the development of produced capital. The exact economic theories moderating the development of produced capital in the research setting, while beyond the scope of this research, align with growth theory neoliberal capitalism. Considered together this represents the context behind the development of weak sustainability - accommodating the exponential growth of produced capital. Since the initiation process of Vail ski area, produced capital in the research setting has grown. The scope of this research does not contain quantitative data specific to the historic trends of total produced capital stock, but growth is reflected in the expanding population, growing developed area footprint, growing visitor numbers, lift ticket pricing and development and renovation of infrastructure. The local natural capital has

undergone disturbance (the quantification of such, too, is beyond the scope of this research) to accommodate for the growth of produced capital, with some threats for loss of function being accounted for by strong sustainability approaches.

The economic model of the research setting is based on tourism and is financially supported by large volumes of high net-worth customers coming to experience the international mountain destination. The historic approach of development in the research setting is reflective of tradeoffs between natural (local and external) and produced capital with an assumed understanding such tradeoffs could remain sustainable while observing growth across many dimensions. Specifically, the community was founded by applying produced capital to commodify the local natural capital for cultural services in a manner that supports increasing financial return.

Increasing financial return is cornerstone for the research setting's economic model, which culturally extends beyond the publicly traded nature of Vail Resorts and is representative of growth economics. Revenue from visitation to the area is needed to finance provisions. Local natural capital plays a minor role for provisions aside from drinking water. The majority of provision resources such as food or building materials come from natural capital beyond the research setting. While the supply chains of these resources were not considered within the perspectives, the lack of resiliency due to the external dependency was addressed in light of COVID-19. If financial revenue decreases from a decline in tourism and associated industries, the viability of the residential community in its present form is greatly threatened. Community planning including the CAP addresses maintaining the outdoor recreational model to mitigate such threats, but attitudes indicate a shift to include adaptation strategies implying altering the economic form of the outdoor recreational model.

The research setting does not have a metric in place for the substitution and elasticity between produced and natural capital, accordingly, it was not provided whether the total capital stock (in this instance $K=Kp+Kn$) is sustained, growing or declining. The perspectives provide points of focus for sustainability in the community. The present and historic scale or value of produced capital and natural capital are not within the scope of this research nor that of human capital and social capital. However, an informed, yet speculative

estimation of elasticities may be deduced from the perspectives to address weak sustainability across the total capital stock (in this argument $K=Kp+Kh+Ks+Kn$). Table 3 presents references to each form of capital deduced from the sustainability perspectives (Section 4).

Table 3. References to the total capital stock deduced from actor’s sustainability perspectives. This table should be used for illustrative purposes and is not comprehensive nor complete of the total capital stock in the research setting.

Produced Capital	Human Capital	Social Capital	Natural Capital								
<p>Ski Resort areas: cut runs and trails, lifts, grooming machines, snowmaking, restaurants, etc.</p> <p>Recreation: golf courses, hiking/biking trails, OHV trails, river parks</p> <p>Mobility: Interstate, highways, roads, underpasses, exchanges, parking structures, airport, fueling stations, charging stations, cars, trucks, busses</p> <p>Towns: retail villages, lodging centers, housing, vacation homes, snowmelt systems</p> <p>Water: purification and wastewater treatment, distribution network, pumping</p> <p>Energy: electric grid distribution, DERs, solar, natural gas</p> <p>Waste: Landfill, composting, material recovery facility, collection network</p>	<p>Outdoor recreational service economy: lodging, food service, cleaning, outdoor experience operations</p> <p>Construction, landscaping, property managers, real estate, cleaning services</p> <p>Education [primary, secondary, higher ed, visitor place-based]</p> <p>Population increase</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>1960</th> <th>1990</th> <th>2020</th> <th>2050</th> </tr> </thead> <tbody> <tr> <td>5k</td> <td>22k</td> <td>55k</td> <td>77k</td> </tr> </tbody> </table>	1960	1990	2020	2050	5k	22k	55k	77k	<p>Country/local government</p> <p>Private networks – Intra-organizational structures, coordination beyond research setting</p> <p>Non-profit networks – cross sector coordination, CAC</p> <p>Digital communications media</p> <p>School District</p> <p>Social inequity, segregation</p>	<p>Mountains, forests, rivers, brushlands</p> <p>Provisions: water, game</p> <p>Regulatory: snowpack</p> <p>Cultural: diverse recreational value</p> <p>Supporting services: ecology</p> <p>Stream health – Restore the Gore</p> <p>Sensitive habitat, game populations</p>
1960	1990	2020	2050								
5k	22k	55k	77k								

The perspectives reveal that in recent decades environmental and social risks have been increasingly identified and acknowledged and the robustness of past considerations for the sustainability of the economic model (the ability of the needs of future generations in the research setting to be met) are increasingly questioned. This is drawn from the shifts embodied by the cultural changes and more progressive strong sustainability efforts. Additionally, the perspectives indicate the elasticity and substitutability of social capital and human capital within the total capital stock are not a dominate focus in the narrative which is centered around produced capital and environmental impacts. This is telling of the resiliency of the total capital stock, with the scale of which being exposed by an unexpected,

presumed to be outlier event found in the early stages of COVID-19. The following will be an attempt to interpret references to the total capital stock ($K=Kp+Kh+Ks+Kn$) represented in Table 3 to assess the weak sustainability of the research setting.

Produced capital was referred to in the expanding footprint of the tourism industry and residential populations, and the associated development accommodating each including transit infrastructure, new home and neighborhoods, hotels, and commercial centers. The monetary considerations of produced capital in the research setting skewed to favor high net-worth consumers such as the availability of vacation homes but limited affordable housing. Produced capital was also referred to by pending or needed new technologies to reduce environmental impact. This may summarize much of the future direction in the perspectives. The energy efficiency strategy is supported with new renewable energy and DER production technologies, AMI, and electrification. The future outlook for transportation also looks to new technologies with electrified infrastructure.

Such technologies such as electrification processes are especially focused on reducing impacts on global natural capital by meeting cross sector emission reduction goals while new installation of urban and highway runoff infrastructure is to reduce impacts on local natural capital. The overall effectiveness of relying on new technology may be limited as demonstrated by Xiao et. al. which outlined how affluence-associated consumption outpaces technological improvements addressing environmental degradation (2019). Such an example can be found in the significant energy efficiency improvements of the new snowmaking infrastructure, but the increased area of coverage did not decrease the energy demand. The implication for this concept applied to the research setting is new technologies would need to be employed with reduction in consumption culture, which points to social and human capital dimensions. This was conveyed as an undertone where the new, effective and efficient technologies to be employed in the research setting must also be accompanied with certain behavioral changes to be effective in reducing environmental impacts. Such social capital systems are underway as exemplified by the early success of the Holy Cross peak shedding trials.

The future perspective for waste management does include components of new produced capital such as the composting facility, or improved data collection of waste type and origin, but is more dependent on behavioral change which is achieved through social and human capital means.

Education and outreach including collaboration via sustainable destination motivations represent social capital structures in place to address consumption culture. The coordinated environmental sustainability actions of private, non-profit and local government is presented as dynamic and growing in strength. Specifically, this trend is representative of cross sector coordination to address strong sustainability aspects addressed above. Not only are more organizations in the community creating or expanding environmental departments, their efforts are corporative. Walking Mountains plays a vital role in facilitating the social capital collaboration of these environmentally focused initiatives within the advising of Actively Green, CAC and their general outreach strategies. Additionally, the network of coordination has created avenues to expand insights to similar mountain communities beyond the research setting. This represents a strengthening in the dynamics between social capital and natural capital.

The persistent focus on active education and outreach the past few decades indicates the still present need of improving social capital avenues to expand the connection with proper produced capital technologies and natural capital impacts through diverse means of human capital. Essentially this entails evolving from consumption culture. The continued need to improve forms of education and outreach to a state which would achieve the intended degree of awareness and response suggests there are systemic shortcomings of social capital elasticity with other forms of capital. The increasing success of technological outreach such as through social media, however, supports diversifying social capital avenues to improve total capital stock elasticities. In this example such avenues are made possible by innovative forms of technology (Kp) from global level production.

The perspectives illustrate the social capital networks addressing strong sustainability such as environmental departments, community coordination programs and public-private partnership are in place and improving. The perspectives also allude to a lack of continuity

with social equity efforts. For example, two demographics which appear to be farthest away from embracing cultural shifts and behavioral changes are the high-end guest clientele the lowest socio-economic class. For the clientele, change is an inconvenience and affects the perception of their luxury vacation. For this reason, certain outreach is avoided to as to not disrupt the value of the destination community's product. The lowest socio-economic class, by comparison, do not have the resources to behave more environmentally minded, but their situation in the research setting demands higher levels of consumption. This represents a weakness in the social capital dimension linked to consumption patterns of the produced capital, inevitably this has consequences for performance of human capital, and is at the underlying consequence of natural capital, locally and externally.

While not in the immediate focus of the perspectives, labor and wealth dynamics were suggested to be skewed, specifically illustrated by the contrast of second homeowners and lower-class community residents. Represented within the theme of cultural changes was the indication of turbulence in the human capital and social capital dynamics of resort operations. The general impression is the work demand from human capital is not compensated adequately either by monetary exchange, produced capital or enhanced equity in social capital systems. The socioeconomic inequity in the research setting and the conveyed dynamics within resort operations suggests the produced capital and associated economic growth in the research setting is subsidized by unjustly compensated human capital. A reasonable means of accounting for this subsidy is from discontinuities with social capital.

An additional component alluded to but not expanded upon by any actors is the racial segregation in the community. There was reference to undocumented immigrants which do not qualify for energy efficiency subsidies and publishing documents in English and Spanish, but the social and economic dynamics between the Latino and non-Latino community was not addressed.

Potential implications impeding the long-term sustainability of the community from inequitable social dynamics were referenced in response to COVID-19. This includes the response to economic uncertainty being human capital reductions through furloughed

workers and job-loss. Such responses were for the preservation of produced capital. This suggests the economic system perceives a greater dependency on produced capital than on human or social capital raising questions of the substitutability of capital. In the absence of increasing produced capital, is the total capital stock non-decreasing? Or is a non-decreasing total capital stock dependent on increasing produced capital suggesting decreases in other forms of capital?

5.3 Conclusions

Assessing the sustainability of the research setting according to the perspectives of active sustainable actors raises the question of “are the needs of the present being met without compromising the future ability to meet said needs?” To answer this question, the perspectives are analyzed within strong sustainability and weak sustainability frameworks. The above assessments of strong and weak sustainability will be summarized.

5.3.1 Strong Sustainability

Assessing the local natural capital stock through strong sustainability suggests the defined needs of the present are predominantly supported by the cultural and recreational services. There is concern these services may not be able to be met in the future due to inconsistent snowpack, drought or wildfire resulting from climate change. However, it is maintained that the present needs of the cultural services must be met with some degree of decline of other ecosystem services as suggested by the leniency of minimum thresholds. The needs of the present culture interacting with the cultural services includes growing local and visitor population and increasing produced capital and developed footprint. The cultural expression decreases natural capital intactness and the ecosystem’s ability to support itself even in light of efforts to contain disturbance. In the context of the community, the declining services of local natural capital are understood to be acceptable as long as the cultural services can be present. This is the underlying nature of the defined local thresholds, not affecting the cultural services of the local natural capital. In such a manner one could qualify the strong sustainability approach to local natural capital as sustainable. The function of cultural services can be present with declining natural capital. However, there is much greater uncertainty when considering all ecosystem services suggesting local natural capital is not strongly sustainable.

Similarly, such is present in regard to global natural capital. The threat of a decreasing function of global natural capital is present and understood. Steps are in place to mitigate a decrease in global natural capital function to a degree, with the primary focus directed at one planetary boundary, climate change. The CAC is focusing action along the specific atmospheric GHG concentration strong sustainability threshold. However, in the CAP mitigation strategy indirect and external emissions are not accounted for meaning the metrics being judged for the guiding threshold are not comprehensive of the causes that would transgress the threshold. The risk of unknowingly transgressing other thresholds due to and incomplete centralized focus on one threshold is understood. The primary goal in the CAC's early years is to construct a broader network of concerted action by sustainable actors. As the network continues to develop, the CAC intends to expand from the founding focus of GHG emission mitigation to address additional sustainability aspects. It is understood that the needs of the present are being met in a manner that jeopardize the future ability for needs to be met.

Overall, assessing the strong sustainability within the perspectives when applied to local natural capital or to global natural capital indicates the functions supporting present needs are declining and are thus vulnerable to not meeting the needs in the future. Along a strong sustainability framework, the community is not sustainable; natural capital is declining.

5.3.2 Weak Sustainability

The mathematical basis of the Hartwick savings rule cannot apply in this context due to the culture of the research setting suggesting a degree of intrinsic value for the environment. Therefore, the following conditions for any constant or increasing consumption (Kp) cannot hold to represent anything that is sustainable. However, there are many insights that can be attained by extrapolating the status of the total capital stock from the perspectives for a conceptual assessment through a weak sustainability lens. Produced capital is increasing, the resiliency and effectiveness of human and social capital structures are making certain advancements but have a lot of room for improvement and natural capital is declining. The relationship of the increasing produced capital to the rest of the total capital stock must be considered in a manner that it too can be maintained in the future. Along this consideration it appears the ability to be weakly sustainable is not certain in its present form. A complete

assessment according to a weak sustainability concept would require more comprehensive research specifically addressing greater detail of each aspect of the total capital stock.

If the local environment had no intrinsic value, a basis of its cultural services, the value of the increasing produced capital would need to be greater than the declining natural capital and the discrepancies of social and human capital in a manner that could be maintained into an intergenerational future. Representative of a social capital disparity, the value of the produced capital is directed and more available to guests and residents of higher socioeconomic standing and is less accessible and equitable to many residents or potential visitors of lower socioeconomic standing. The social capital means of increasing the equitability of produced capital must be further improved. This can also be applied to the social capital means of reducing or reversing a decline in natural capital. This concept may then need to be applied to altering the forms of produced capital in place which contribute to declines in natural capital. The means of achieving this could be accomplished through new approaches in human capital, meaning specific labor practices employed to decrease the impacts of in place produced capital.

The overall need for altering the relationship of produced capital and natural capital through improved social and human capital embodies the active focus on education and outreach. Education and outreach certainly have influenced these dynamics, but the continued need for them suggests the overall landscape had not significantly changed. But this is further challenged by growing numbers of residents, visitors and development. Weak sustainability has an origin in supporting an argument for constant consumption. The pattern employed in the research setting is increasing population which, if held at constant per-capita consumption would suggest increasing consumption as represented by increasing Kp . Overall, this implies a greater degree of social capital means likely needing to employ more diverse and innovate forms of human capital to reduce or reverse declines in natural capital while managing more equitable balance in the value of produced capital.

The onset of COVID-19 highlighted the basic survival vulnerabilities including housing, healthcare, and access to mobility as well as long term resilience including eco-tourism economy, food and material sourcing. COVID-19 further expressed chronic social

sustainability challenges exacerbated by extreme and inequitable economic disparities. Additionally, the epidemic reinforced the intrinsic cultural value of outdoor recreation.

5.3.3 Implications

As determined by an analysis of the perspectives gathered from active sustainability actors in the research setting, the research setting is not sustainable in accordance to strong or weak sustainability frameworks. This does not mean that the society is not presently viable, rather it suggests the present needs in the research setting are increasingly unlikely to be met by future generations in the research setting. Certainly, there is an ability for the research setting to become sustainable within strong and weak frameworks, but both would require significant shifts in socioeconomic culture, the basis for which is already underway with the improving social capital networks embodied by initiatives such as the CAC.

In my observations, the economic culture of the research setting may be the most significant hinderance for being strongly and/or weakly sustainable. The economic culture of the research setting caters to affluence as supported by serving a high volume of high net-worth clientele. The general economic culture represents growth economics which is a form of exponential growth. As the economy grows at a desired constant rate, so do the impacts, at an ever-increasing magnitude. Furthermore, the research setting illustrates an extremity of a prevailing pattern within modern developed society - affluence drives environmental impacts by determining consumption norms (Wiedmann et. al., 2020). Affluence has greatest access to produced capital thus their cultural patterns are more aligned to produced capital than less affluent. Embedded in this trend, the value of produced capital is relative to the culture of affluence, not the values of the human, natural and social capital needed for production.

The research setting, positioned as a premier mountain destination, caters to high-end luxury destination travel. In other words, it indulges extreme affluence. The cultural value for this economic model allows for local concerns regarding human capital, social capital, and natural capital to be in conflict with produced capital and social systems serving extreme affluence. This is echoed in many points related to inequitable behaviors and expectations for consumption patterns. The paradox being, the residents of the community

need financial subsidy from catering to extreme affluence to be viable. The economic stress triggered by the tourism shutdown resulting from COVID-19, and the lack of equitability in how residents were able to respond highlights this point.

The community could likely increase the effectiveness of their sustainability initiatives by addressing how the economic culture interacts with affluence. Certainly, this is a point for further investigation to substantiate, but the target clientele, those of extreme affluence, likely have a great and rather far reaching influence of many means of production for produced capital. In other terms, the desire for high volume of high net-worth implies visitors with a lot of capital. There could then be put forth an altered economic strategy which still maintains access to the cultural services of outdoor recreation, but in a manner that shifts equitability within the research setting, but also the manner in which the visiting capitalists are empowered to innovate for the purposes of increasing the sustainability of their capital stock.

Essentially, sustaining the common cultural value of the place based outdoor recreation in the research setting for residents and visitors could be utilized as a means for reversing the trend where affluence drives consumption norms and the declining capital stock. The concepts behind Vail as a sustainable destination with information and strategy sharing could be further employed by innovative means of social and human capital related to strategic collaboration with visitors. This would be counter to the general approach conveyed of not addressing behavioral changes in guests, and rather use the access to capital of visitors to expand sustainable socio-technical transition.

Such could be achieved by a change in the operations of the educational and outreach systems, represented by broader roles of the local human capital. Within the resort industry, for example, it was suggested there are many over educated workers for the guest service positions they fill. Their educational talents could be utilized in addition to the services they provide. Such shifts, however, would be contrary to the principal of luxury which is enjoyed excess. Essentially, transforming the present culture of catering to extreme affluence with high, luxurious consumption is necessary to support more equitable and balanced relationships between the total capital stock within the research setting.

6 LIMITATIONS, FURTHER RESEARCH

The active sustainable actors were interviewed based on convenience and proximity sampling as detailed in section 3.3. The actors largely represented environmental sustainability efforts. As with any research, insights are limited by results and results are limited by sampling method. The overview of sustainability actions in the research setting is conveyed, but deeper intricacies of sustainability actions considered or being taken could be revealed with more robust sampling. Specifically, the detail of the results could be enhanced with actors from the Eagle County government and the Town of Avon, the Eagle County transit authority, at least one of the local waste haulers, Vail Health, the Eagle County School District, a food service provider, and a natural gas utility. Such detail would provide more context for illustrative examples of weak and strong perspectives represented in the community.

Specifically, regarding strong sustainability, the present environmental accounting for the research setting is focused within the boundary of Eagle County, or within the boundary of resort operations. Externalized impacts are not accounted for and should be a focus of future research. For example, the existing CAP addressing the global GHG emissions climate change strong sustainability threshold could be expanded to include externalized emissions necessary to support the consumption within Eagle Country. This could be achieved with life cycle (LCA) assessments of historic and proposed produced capital including residential and commercial buildings, transportation and landfilled waste. This would give insight of pollutant loads (GHG or other determined impacts representing the remaining eight planetary boundaries) necessary for the production and decommissioning of produced capital employed in addition to those assessed in their use phase.

Additionally, as the analysis of the perspectives reveals, weak sustainability is hindered by social sustainability discontinuities. The actors are focused on environmental sustainability (applied strong sustainability) which has been more intimately tied to economic compromise of produced capital for local ecological concerns or global environmental concerns; social sustainability is not within their primary focus. Further investigation is needed to dissect the intricacies of social sustainability embedded within human and social capital dynamics.

Given the historical and cultural context of the research setting, not only being newly formed and increasingly developed since the 1960's but also the deeper history of North America there are social dynamics which, when addressed, question the implications of maintaining such dynamics.

An additional limitation is not having representation of the Latino community in the research setting. There is an implicit culture of segregation and of racial prejudice in the research setting which was not addressed and certainly would inform social capital dynamics.

Finally, in reference to the perspective disclosed in my axiology, I question how the patterns of energy exchange which have played roles in shaping present social systems of consumption are amplified to earth-system scales. This case study is of a community system is operating within a culture of supremacy and domination of affluence (not to be taken as ad hoc attacks, but rather sociological expression). This is a call to expand upon the basis of earth system sciences which identifies earth as a single, complex system. Within this system, is the human subsystem. Sustainability science questions the boundaries of the human system to the earth system. Embedded with the human subsystem are many diverse forms of social organizations with varied relationships to energy. On a smaller scale of the spectrum, are community level social organizations, which this case study begins to address. Understanding dynamics within such smaller scale systems, and their interaction to larger systems to inform appropriate directional responses of could be informed by further qualitative investigations of the people comprising the system. Such qualitative investigations of the humanities should be structured in a manner to understand the experiential nature of people and presented in a manner to map the systems in place and resulting from such experiences. Such could be achieved with a more deliberate bridge to the hard sciences. This could inform energy exchange dynamics of past and present systems on a lived experience level which could be compared to the same dynamics represented monetary-economically. I anticipate such would reveal foundations of energetic exploitations that are presently experienced today, yet are ignored due to inertia of systems of development based on such ignorance.

7 SUMMARY

A qualitative case study of emergent design was conducted interviewing ten active sustainability actors in the research setting of Vail, Colorado, USA. The case study was guided with the central research question of “*what are the sustainability perspectives of the Vail outdoor recreation economically dependent community?*” and presents the sustainability perspectives of active sustainability actors in the community. Following the outbreak of the global COVID-19 pandemic an additional research question emerged probing what is most important for sustainability in the community and was answered with typed response.

A content analysis of the active sustainability actors’ perspectives revealed five emergent themes: cultural changes, sustainable destination, energy efficiency, waste reduction and transportation. Cultural changes encapsulate the prevailing theme that attitudes towards sustainability are changing in response to active education and outreach campaigns and is expressed within organizations and between similarly situated outdoor recreation communities. Sustainable destination expresses the ability to maintain desirability as a destination community while supporting the local community by reducing and restoring degrading habitat and improving social equitability in both economic terms and in achieving environmental targets. Energy efficiency presents a process of reducing global climate impacts by increasing the efficiency of residential and commercial infrastructure and improving the energy supply sourcing while increasing electrification of systems. Waste reduction highlights the shifting behaviors of municipal solid waste with increasing attention to reducing landfilled waste and improving recycling and organic waste separation. Transportation was focused around reducing climate and pollutant impacts of internal combustion engine transit with improved public transit, light mobility and system electrification. Overall, it was conveyed the effects of consumption on the local society are becoming more pronounced as is the vulnerability of the community to disturbance on both local and global levels. COVID-19 exemplified challenges specifically with social sustainability in the research setting.

The sustainability perspectives were then analyzed with strong and weak sustainability frameworks, assessing the sustainability of natural capital (Kn), and the sustainability of the total capital stock as defined by produced capital (Kp), human capital (Kh), social capital (Ks), and natural capital (Kn). The assessment of strong sustainability revealed responses to a continued pattern of declining local natural capital resulting from growing numbers and intensity of human activity by implementing and enforcing specific thresholds of satisfactory ecosystem health. Local natural capital has substantial cultural value for the research setting expressed through outdoor recreation. The perspectives also reveal actions are being taken towards global natural capital by addressing one planetary scale threshold of climate change represented in the Eagle County Climate Action Plan targets of reducing direct greenhouse gas emissions 80% by 2050 and 25% by 2025 from 2014 level emissions. While considered on a local or global scale, natural capital is declining and the community is not strongly sustainable. The assessment of weak sustainability reveals Kp has been consistently growing representing exponential trends, while natural capital is declining and long-term resilience is hindered by diverse and dynamic Kh and Ks systems. The social capital networks are growing in directions that can support transformations in the dynamics of Kp , Kh and Kn , however the greatest hinderance is the sociocultural value of affluence driven consumption of luxury and excess. The resources directed to extreme affluence consumption strongly challenges the resilience of the whole community's socioeconomic range. Especially in the face of an unexpected event such as the global COVID-19 pandemic, the community is vulnerable to disturbance, which earth-systems sciences have been warning will occur with increasing intensity with the present relationship of energy dynamic of the human system in relation the rest of the earth-life system.

Future research is suggested to focus on Ks and Kh systems to counter the prevailing trend of exponentially growing Kp with increasing disturbance of Kn while emphasizing the basis of the cultural value of Kn .

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APPENDIX

Appendix 1: Nine planetary boundaries. Boundaries for processes in red have been crossed. Table recreated from Steffen et. al. (2015)

Earth System Process	Parameter	Proposed Boundary	Current Status	Pre-Industrial Value
Climate Change	(i) Atmospheric carbon dioxide concentration (PPM by volume)	350	415	280
	(ii) Change in radiative forcing (W/m ²)	1	1.5	0
Rate of biodiversity loss	Extinction Rate (species/million species per year)	10	>100	.01-1
Geochemical: Nitrogen Cycle	Amount of N ₂ removed from the atmosphere from human use (millions of tons/year)	35	121	0
Geochemical: Phosphorus Cycle	Quantity of P flowing into the oceans (millions of tons/year)	11	8.5-9.5	~1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean Acidification	Global mean saturation stat of aragonite in surface sea water	2.75	2.90	3.44
Global Freshwater Use	Consumption of freshwater by human (km ³ /year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis	To be determined		