Ecological and Community Resilience: Income Diversification and Plant-Based Trade in the Alexander Skutch Biological Corridor

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Abstract:

This investigation describes the ways that people and plants relate in the Alexander Skutch Biological Corridor (ASBC), Costa Rica, and explores the potential for these relations to be managed by the *campesino* communities to generate both social and ecological resilience over time, for mutual benefit. Community resilience in the ASBC has been affected by declining coffee yields and limited options for livelihood diversification. A large part of supporting community resilience is in the creation of new and diverse livelihood opportunities in the ASBC. Therefore, this project explored plant-based community capitals as a way to assess community resources that could be engaged to support livelihood diversification. Following the measurement of these community capitals, desire for and feasibility of a local market were investigated to further ascertain if the communities residing in the ASBC would support the creation of a local market, a Transition Initiative that would simultaneously uphold ecological protection principles held in the Corridor and provide stability for household livelihoods. The findings suggest that participation in a Transition Initiative local market could support community resilience through introducing diverse livelihood options in the ASBC. The following paper is comprised of three involved parts. Firstly, conservation in the tropics is discussed considering the historical, ecological, and political situation in the tropics in order to contextualize this project into larger global events. Next, a summary of the key theoretical elements that guided the independent research project will be presented. The four theoretical elements engaged are (1) Social-Ecological Systems (SES) with a specific focus on social participation at the human community level, (2) Vulnerability, (3) Resilience, and (4) Ethnobotany. Finally, the independent research project will be laid out and discussed.

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1. Foreword

"O Tiger-lily," said Alice, addressing herself to one that was waving gracefully about in the wind, "I wish you could talk!"
"We *can* talk," said the Tiger-lily: "when there's anybody worth talking to."
(Lewis Carroll)

1.1 Personal Reflections

Having always felt at my healthiest, happiest, and most centered when outdoors, it was a natural progression that my interests, education, and employment would gravitate towards experiences that focus in the realm of nature. Getting to know the great outdoors through personal experience brought a companionship quality to my connections to nature. I can remember my father teaching me to climb a tree at age 7- showing me the feel of bark on bare feet, and how to test my weight on a branch to see if it would hold me. I spent many afternoons in the crowns of old maples and oaks, thinking, dreaming, and loving. Even now I can feel the gentle sway of the branches and the view of my surroundings, so different a perspective.

I can also remember the first time I fell in love with winter. As a generally cold (temperature) person, going outside on freezing days was always a production. Hats, gloves, long johns, and layers of fleece were needed before I could go out and enjoy the mounds of snow that piled up outside my door in Buffalo, New York. As I got older, spending time outside became the occasional toboggan and cocoa, and winters were spent more indoors. Then came the winter I was an environmental educator- one where Buffalo received record amounts of snow. As an environmental educator, I took students snowshoeing every day. We followed animal tracks found in the snow, got to know the winter plant landscape through bark alone, and came to appreciate a well-built quinzee. Only one day of school was canceled that season (tough folks!), so I was in it to win it. Winter became a new adventure, one where life was still

being lived, very much awake with potential for connection out-of-doors. At the spring thaw I realized I loved winter, and being outside in it had new meaning for me.

Then there was a walk alone in the woods where I came across (almost tripping over!) a young faun, lying alone in a pile of autumn leaves. Its small body was curled up, mellow and camouflaged, waiting for its mother to return with food. I sat at a respectful distance with it, both of us keeping company and enjoying the day while checking each other out. Quiet and curious, we seemed to share a great moment together, reflecting on our place there.

Wading into a cool pond, to the sounds of green frogs echoing like banjos across the still water; Running through hot sand to cool my feet in the crashing ocean waves; Wading through tall meadows picking wildflowers to braid into flower crowns for my mother; Eating wild strawberries until my mouth was stained red; Cicadas so loud they made up a full summer symphony; Even scratching a mosquito bite and remembering a late night hike; It's these beautiful moments and many more that formed a solid part of my heart as I've spent time on this Earth, a part that has beat strongly with love for the world I am in.

As a grateful member of life-hood on Earth, a deep care and desire to protect these areas was fostered, in much of the same way I care for the loved ones that make up my family. While change is a natural part of life, I've seen great destruction of many of the places I've loved because of decisions made by humans. With global ecological change being driven by anthropocentric decisions- out of greed as well as necessity-I wanted a way to better understand the possibilities of supporting current measures that are functioning in opposition to ecological degradation. Through a winding path that only life could offer, this love and motivation led me to the Faculty of Environmental Studies at York University, and the

development of my Plan of Study focused on the interactions between people and the world they are a part of.

The Area of Concentration of my Plan of Study within the Masters of Environmental Studies degree is entitled Conservation Ethnobotany. It focuses on the interaction between people and plants in the many ways that they are connected and intertwined in life. This focus intends to look at these intersections for the purpose of bringing consideration, value, and conservation attention to otherwise ignored life forms. How often are plants given attention without 'use' being attached to them? Moreover, how 'useful' must these plants be to humans before they are considered? Plant species are deemed important on the basis of being critical habitat, food sources, or provisional resource potential, rather than by the intrinsic right of these plants to be. It was these questions and sentiments, along with my particular interest in sharing a voice with those who speak more 'plant' than anything else, which brought me to focus on the botanical world. Rather than work exclusively against the plants-for-human-use paradigm, I felt compelled in my Plan of Study to examine these intersections to better understand how they developed, why they formed, what they meant in a larger life picture, where they were happening, and with whom they were occurring. Through this insight, the goal was to use this knowledge to understand the ways in which conservation aims could be built into existing relationships, and transform these anthro-botanical connections into ones that held longevity, respect, and perhaps even love. While this endeavor centers specifically on plants and cultures, it also engages other life forms as I believe all life is holistically connected.

As a key part to my Plan of Study, this Major Research Paper engages the components for research that make up the basis for my master's inquiry, while also identifying potential for

growing theories that I have encountered so as to better serve communities that I care about. The relationships between plants and culture, environmental education, and tropical ecology are all explored in this paper, effectively synthesizing the mechanisms of learning that inform my academic adventure. The overarching theme and inspiration of my Program of Study has been biological conservation, identifying creative ways that interdisciplinary study can add value to the global attention being paid to address detrimental environmental change. The completion of this paper will greatly add to my understandings of how theory can be developed and applied to support innovative conservation efforts.

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2. Introduction

You wear a suit that I can see
Resplendent green of worldwide peace

But as that piece turns fiery red
It takes a different shape instead

One of greed and push and drive
That leaves our home left but alive

Burnt and roasted, sun-kissed toasted
World supported, market hosted

I don't blame you and I don't blame me
But how do we change a crashing sea

Open doors, said to be good
But they haven't worked out like they should

I feel your pain, I can relate
They say that's wrong, from a richer place

I bleed red, and so do you
Colonial powers have touched me too

If we're all in this the way I see
I have to be strong for those that Be

For the workers, mothers, uncles and aunts
But also for my dear kindred plants

We share a lot more than space aquí
More than air, earth, and bee

One heart, one soul, one breath, one life
Oh wild flora, I share your strife

What introduction would suit your needs
It must be one that plants a seed

And so, for now I'll introduce
A friend, an ally, a tempting juice

A fella life form from 'round the way,
A tí, teamo, el café.

Maris Grundy

2.1 Outline of the Major Research Paper

The following paper is comprised of three involved parts. Firstly, in the face of major global change, a rationale for focusing conservation initiatives in the tropics is discussed by way of considering current prioritization concepts. Along with this, a brief framing of the historical, ecological, and political situation in the tropics in general is discussed in order to contextualize this project into larger global events. Following, an introduction to the specific ecological and biological elements that exist in the study area will be presented. Next, a summary of the key theoretical elements that guided my independent research project will be discussed. The four theoretical elements engaged are (1) Social-Ecological Systems (SES) with a specific focus on social participation at the human community level, (2) Vulnerability, (3) Resilience, and (4) Ethnobotany. Social-Ecological Systems emphasizing a community-level focus outline the importance of balancing a holistic view of problem-solving with relevant, achievable, and place-based action plans. Vulnerability and resilience are related in a multitude of ways, and are presented as the challenge and response to this research query, including the many ways they coevolve together. The specific vulnerability that brought about this research project will be presented as the motivation for the project's focus. Resilience as a multifaceted concept will be explored as a useful tool supporting both social and ecological sustainability, and strength. Ecological conservation and social conservation are interdependent, and therefore working on one means working on both. As the saying goes: healthy land, healthy people (traditional Aboriginal Australian saying). Ethnobotany will be briefly discussed as a methodological frame and influencing scope of the project. Finally, the independent research project will be laid out and discussed. This investigation describes the ways that people and plants relate in the

Alexander Skutch Biological Corridor, Costa Rica, and explores the potential for these relations to be managed by the community to generate both social and ecological resilience over time, for mutual benefit.

Much of the theoretical and applied literature surrounding this topic as it applies to rural farming communities did not specifically address communities that have independently chosen to participate in large conservation initiatives. Current literature covers top-down hierarchical models of conservation areas, whereas the Alexander Skutch Biological Corridor differs in that the initiative to designate and maintain status as a biological corridor came from the community itself. Therefore, the wellbeing and resilience difficulties that arise from the dual goals of ecological and social conservation are both borne by the community itself- giving great challenge but also great strength to the possibility of addressing local problems with local solutions. Furthermore, this self-motivated community initiative potentially exists as a part of a larger network of community cohesion that could be utilized to further benefit inhabitants of the Alexander Skutch Biological Corridor. The original research portion of this project presents a case study that could be applied to many agriculture-based communities in the tropics, as it reflects many characteristic elements of social-ecological systems found in Latin America and beyond.

It was important to enmesh this research in an anti-oppressive and self-conscious approach. Therefore, to address systematic bias in developing conservation objectives, this research project attempted to work with community members, benefitting from their assistance shaping and defining the research process in ways that best served their communities, while simultaneously keeping the objective one of balanced health in both social

and ecological systems. This paper enters the global scenario at a point where dependences are deeply entrenched, and politics reflect disparity on multiple levels. There is great hope, however. Much like the complexities of a rainforest in Costa Rica, there exists space for creativity and growth even following harmful and altering events.

2.2 Contextualizing the Tropics

2.2.1 Tropical Conservation

Change, alteration, disasters, and extinctions are all important parts of the functioning of the Earth; the Earth is dynamic. What causes concern is the rate at which the Earth is changing, and the associated implications for the future viability of species biodiversity. Species biodiversity is the driving force behind life on Earth, as everything is connected. There is a great unknown regarding the consequences of species extinctions, especially that of plants. In the past approximately 10 million years, since life's origin on Earth, there has been no greater rate of species extinction excepting the major changes at the end of the Paleozoic and Mesozoic eras. "It has been postulated that the present rate of global species extinctions is 400 times faster than the rate in the recent geologic past, and that this rate is rapidly accelerating" (Plotkin, 1995, pg. 148). An active and adaptive way to address issues of rapid environmental degradation is through conservation. Conservation is an interdisciplinary approach to thinking about identifying and saving important biodiversity by involving ecological, social, economic, and other key situational elements (Soulé, 1985). This interdisciplinary process allows for great modification of conservation methodologies to best fit the individual conditions of each challenge. This place-based focus is well suited for success, as it takes into account place-based relational elements that can be best understood within a situational context.

Conservation is an important issue around the world, and it is a challenge to prioritize or stress urgency in specific areas. There are many causes that draw attention to multiple points on the globe (or around it). Methods of choice range greatly, from those who prioritize working in one's 'back yard', to those who feel there are areas of the world that deserve priority based on location of key biodiversity. After working a great deal locally on issues of conservation, a course trip to Costa Rica brought personal consciousness to both an exquisite environment, but also one that gained my attention. This place is the Alexander Skutch Biological Corridor (ASBC), a place that was designated as important habitat by the community itself. Throughout the trip, I felt attachments to both the people I met there, as well as the unique environments that I was living in. I was interested in focusing my research on this landscape as a way of contributing to the biological and social communities that so openly welcomed me. Furthermore, these communities who had personally focused their efforts on designating the ASBC a biological corridor illustrated the type of engagement and action from the community level that I think has great power to bring positive change to plant and human relationships.

Beyond personal reasons, in what ways are the tropics a worthy place to focus on conservation undertakings? Found 25˚ north and south of the equator, the tropics contain the largest expanses of virgin habitat, the richest cores of endemism and the greatest species diversity (Sodhi, Brook, and Bradshaw, 2007; Plotkin, 1995). This concentration of biodiversity provides many of the essential life functions that keep our world healthy. Biodiversity is essential to global well-being, as all species depend on each other to survive. "One of the most striking features of high-diversity tropical systems is the complexity of interactions among species. Each tropical species seemingly is involved in a complex web of parasitism, predation,

mutualism, competition, and so on" (Krohne, 1998, pg. 502). Therefore, when biodiversity is lost or altered past repair, the ripple effects will affect a great number of other life forms on Earth. Moreover, it is still uncertain what the long-term effects of mass biodiversity loss are.

The tropics make up a significant portion of the '25 biodiversity hotspots' designated by Myers et al. (2000) in their seminal work regarding conservation priorities. This designation is based on the presence of "exceptional concentrations of endemic species [,] experiencing exceptional loss of habitat" (Myers et al., 2000, pg. 853). While these hotspots include only 0.5% of the Earth's land surface, they account for 20 percent of the world's species (Krohne, 1998). Mesoamerica, therefore including Costa Rica, was chosen as a biodiversity hotspot because it comprises at least 0.5 percent of all plant species worldwide, as well as being under threat from irreversible environmental change. Threat was measured through habitat loss, and designated as areas that have lost 70 percent or more of primary vegetation. The usefulness of this approach is in understanding that there are limited global resources to address staggering biodiversity loss. As a result, this approach gives an opening point to begin working on conservation measures. Critics of this methodology felt that it excluded environments 1) equally at risk but that house relatively fewer species, such as arctic habitats, as well as 2) excluding all marine habitats. However, identifying the tropics as an area with high biodiversity coupled with high risk is an important justification to focus conservation attention there.

Global 200 is an alternative conservation-priority approach developed by Olson and Dinerstein in 1998. This approach aimed to get a more comprehensive look at areas that are at risk of biodiversity loss. Beyond the endemism and habitat loss criteria used by the biological hotspot theory, Global 200 attempts to identify representative habitat types that contain

important biodiversity and ecological processes (Olson and Dinnerstein, 1998). To determine conservation priority, the Global 200 first breaks up the globe into terrestrial, freshwater, or marine realms, and secondly, into major habitat types. Following this, the authors identified which smaller ecoregions within these larger realms exhibited distinctive biodiversity-measured as uniqueness, species richness, endemism, and unusual ecology or phenomenon. From this, a list was made of the 200 places around the world that represent distinct and varying ecosystems at risk. Although this approach includes greater reaching areas, the tropics, again, fall solidly within the Global 200 framework. Many marine, freshwater, and terrestrial areas from the tropics were found to be distinctive, and those within the parameters of this research project were further categorized as vulnerable (Table 1, Ibid., 1998, pg. 503).

Therefore, ecologically speaking, the tropics are at once an important ecological hub and also at great risk. What will happen if current systems experience loss that permanently alters the very nature of the systems themselves? For the many species that inhabit the tropics, this has had or could have permanent effects from which they can never recover. While understandings of complex systems functioning are the focus of much inquiry, understandings will develop, switch, and evolve due to the dynamic nature of complex systems. Following is a brief history of the ecology of the tropics, to contextualize the current state of tropical ecosystems, and how change has and can affect these systems when conservation is not a consideration.

2.2.2 Tropical Ecology and Biodiversity

The tropics and tropical ecosystems evoke images of lush jungles, teeming with green plants and wild animal species that are staggeringly numerous. These ecosystems can actually vary greatly but they do share several important characteristics. Tropical ecosystems contain an astounding amount of biodiversity because of a long history of adaptation and co-evolution caused by specific conditions. A fundamental rule of ecology is that the types of plants that will grow and thrive in an area rely on the type of substrate (soil) present paired with the availability of water.

The tropics receive more rain than any other place on Earth. Due to the direct sunlight received at the equator, much of the moisture present in the tropics heats, rises, and eventually cools. After water droplets in the air cool, they condensates and fall in the form or rain- in mass amounts. Therefore, water is readily available. In terms of tropical soil, it is very old. The area surrounding the equator "did not experience the glaciations of the Pleistocene that generated the newer soils found in more northerly or southerly regions" (Krohne, 1998, pg. 656). As a result, the soil has undergone great weathering over time and much of the nutrient content supplied by the bedrock has been released, leading to currently nutrient poor soil. Without bedrock to regenerate the nutrient supply in soil, the soil relies on the biomass that falls from forest plants to replenish its nutrients. This necessity is complicated several factors, one being the high temperatures and abundant moisture that cause decomposition to occur rapidly. When decomposition occurs very quickly, organic matter disappears before it can be changed into usable substrate. Furthermore, the great volume of rain that falls in the tropics carries the remaining nutrients in the newly made soil away from where they fall. Tropical soils are also,

generally, acidic. This acidity comes from the type of clay soil that makes up tropical soils, one which cannot exchange nutrients well to begin with, but also one that develops due to extreme weathering from the rapid decaying process mentioned above.

It should be mentioned that soils of the tropics-like soils all over the world- are not uniform, and vary greatly in their type and their fertility. For the purpose of this research project, I've focused on rain forest soils, as they are what make up the study area of this endeavor. Also of note: even within one forest, soil conditions can exhibit variability. The rationale of understanding tropical soils as generally acidic is useful here, as it does accurately describe the soil condition of the study area as well as play a proven role in the dynamic of this particular ecosystem.

So how do these lush 'paradises' form, if the soil is unable to provide a stable source of nutrients? Over millions of years tropical plants have evolved complex mechanisms of storing nutrients in their leaves, stems, roots, and other plant parts (Vandermeer and Perfecto, 1995). Plants, therefore, have evolved using a multitude of strategies that uniquely fit themselves into a survival niche within the rainforest. Most other species mirrored this type of diverse and unique development as well. This has created great diversity and significant specialization, which paired with the productivity of a warm climate and water availability has led to the tropics housing the greatest amount of biodiversity across the globe. Biodiversity scientists are in agreement of this as fact, however no one theory is able to comprehensively explain exactly why this is the case. What is known is that in a one hectare plot in Michigan researchers found 8 species of trees, while in the same size plot in Nicaragua they encountered 200 species of trees. "Entomologists netting insects in Kansas found 90 species of insects, whereas applying

their nets in the same fashion in a rain forest in Cost Rica they found 545 species…In the Americas, bird species increase approximately five-fold from midlatitudes to the tropics" (Vandermeer and Perfecto, 1995, pg. 23). The biodiversity in the tropics, as reasoned above, is able to function within complex arrangements of specialization and niche. Therefore, the dynamic nature of ecosystems causes great change and shifts in the stable states of rainforests, also exhibiting the ongoing introduction and exit of species. This creates a strong system, resilient to change, and one that can undergo extreme conditions without collapse (think hurricanes). What these vibrant forests cannot absorb and grow from is the alteration that comes from changing these landscapes to a point that the species within them cannot fulfill their specific niches, causing the whole intricate web to breakdown.

2.3 The Evolution of Agriculture in Latin America

2.3.1 Traditional Communities and Food Sustainability

Intertwined with these tropical life systems are human societies, living closely with the land and participating in the dynamics of these ecosystems. This is specifically true for traditional cultures that live off the land. Traditional societies are those considered to be functioning outside of modern systems of capitalist production, and that "have long-lasting and stable relationships with their surroundings. In other words, they tend to be well…adapted to their environments" (Wirsing et al., 1985, pg. 303).

The lives of traditional communities affect and are affected by the land in many ways. Dependence on forest resources, and land needed for agriculture can translate to small-scale land change. This connection to land is essential for food security to feed traditional/rural/sustenance communities. Slash-and-burn or swidden agriculture was

practiced (and still is) by many traditional societies. This is done by felling the existing vegetation in an area, and after the vegetation dries, burning it until it is ash. The thought behind this practice is to release the nutrients being stored in the vegetation and allow them to go back to the soil, quickly. Next, crops are planted in the soil, now nutrient rich from the ash. Planting continues in the same spot for a number of years but over time soil fertility declines because the nutrients from the felled plants are depleted. When the soil is no longer productive, the area is left fallow and another area is chosen. During this fallow time, the land is managed to promote growth of beneficial plants, allowing for regeneration of organic material, soil fertility, and biodiversity. This also supports the system and allows for repeated use of an area. The management of a fallow cycle allows farmer to experiment and try new techniques, encouraging flexibility and adaptability to needs while still partaking in a traditional method. Learning to work with the landscape is a key part of this type of growing and can be sustainable (by allowing for recovery of the system), if practiced at scales needed to feed smaller populations (Perfecto et al., 2010).

Scale is a significant element to understanding the sustainability of swidden agriculture. Practiced on a larger scale, swidden agriculture contributes to deforestation and can have harmful effects on the sustainability of that system. Estimates of land cleared by peasant farmers ranges from 7 million to 20 million hectares each year (National Research Council, 1993). While significantly less land cleared than by methods to be described later in this paper, with less forest to use, growing population, and further land development, this method of sustenance will become less and less viable. Further complicating this method of food stability, traditional societies living closely with the land have suffered histories of displacement and

disconnection to traditional lands as well as undergone unwilling relocation to lands with poorer soils and smaller claims. Growing on these lands is a challenge. Less productive soils and smaller places to grow, in turn, leads to food insecurity and poverty; a central fact that loops back to environmental degradation, resource depletion, and stress and collapse of traditional societies (Amechi, 2010; Swinton et al., 2003; Mabogunje, 2002).

In many places in Latin America and the tropics, sustenance swidden agriculture still occurs, although it is being pressured to change more and more from global connectedness and changing ecological, social, political, and economical pressures. Following is a brief history of how this pressure began in the 'New World'.

2.3.2 Columbus Arrives in the Americas

When Columbus landed in the Americas in 1492, he not only brought the restrictions and oppression of colonization, he also brought cultural methods of land and resource use that would forever change the environment of the 'New World'. This would come to have a great effect on the traditional societies living in the Americas, as well as on the relationships of agriculture and biodiversity. In Europe, industrialization of agriculture occurred when populations were becoming concentrated in cities and required a steadier food supply. Agricultural practice met this requirement by converting forests to cropland and transforming into capitalist agriculture, characterized by intense land use and abandonment of local place-based knowledge of farming cycles. Quantity was championed, and to achieve more, capitalist farming methods welcomed scientific agriculture and forestry. Inventors, entrepreneurs, scientists, and farmers developed new ways of growing single species crops in order to

maximize yields and minimize costs. Naturally, intensive monocrop farming methods used in Europe depleted soil fertility, and European powers looked elsewhere for new lands to use. The Americas became one of the savior lands that the European colonizers turned to in order to continue with intensive agriculture. Seeing the lush tropical ecosystems of the New World misled colonizers to understand the land as fertile and prime for farming enterprises. Coupled with the warmth and year-round rain, the colonizing nations hoped to turn tropical places into factory farms to provide resources from them. At first, the virgin soils that existed following clear cutting of rainforests produced high yields, and pleased colonizers. This clear cutting disrupted and destroyed the specialized connections within tropical forests. Alongside biodiversity, local people were subjugated to this industrial system and cultures were lost, harmed, or permanently changed in the name of progress. "In most places, monocrop plantations replaced tropical and subtropical forests of enormous biodiversity. Sugar, cotton, tobacco, and later, coffee, cacao and banana plantations were great engines of social and biological change" (Perfecto et al., 2009, pg. 39). Even with this 'successful' first effort, soil unproductiveness began to haunt the newly developed farmlands due to the character of tropical soils. As crop instability grew, landscapes continued to be transformed by the addition of agricultural fertilizers, pesticides, and other chemicals in an attempt to replicate the original productivity of tropical farms (Ibid.). Forest clear cutting expanded in attempts to find more fertile soil, and vegetation was burned in an attempt to release the nutrients in the cut biomass back into the earth. This process persisted with the growth of technology 'advancements' adding to the ecological degradation wreaking havoc on tropical ecosystems. The more these monocrop farms were pushed, the more they responded negatively. Pests, poor crops, dead

soil, worker distress, and a popular awareness growing regarding the instability of current systems (Rachel Carson's Silent Spring was a notable example) were all to be thanked for shedding light on the instability of capitalist agriculture. "The consequences of this trend are yet to be fully appreciated, but analysts the world over are in agreement that the loss of biodiversity in general and specifically in agro-ecosystems, is somewhere between severe and catastrophic" (Ibid., 2009, pg. 59).

While general consensus noted that these unsustainable systems were caused by deleterious agricultural applications and that traditional systems had been more sustainable, global economic and political systems have allowed these practices to remain in place almost identically in current communities in the tropics. The Third World tropics are fully embedded in First World global industry. Forests cleared for farming large monocrops very much still exist, as seen in the fields owned by Dole, DelMonte, Chiquita, Standard Fruit Company, and United Fruit Company in Costa Rica and other places, for example. This is more startling when understood alongside the knowledge that Costa Rica has one of the highest proportions of land under protection, yet 73% (four million hectares) of land is covered in agroecosystems, managed forests, and human systems. Furthermore, much of the land covered by agroecosystems is currently or is being transformed into high-input monocultural systems. Recently we have come to understand that indirect biodiversity losses through agricultural transformation in this system might be large." (Vandermeer and Perfecto, 1995, pg. 131).

Alongside the natural biodiversity argument that supports resistance to capitalist agriculture development and resulting land change, there are also the land-connected societies to consider, societies who inhabit these regions and feel the changes affecting their cultures

and lives. "Perhaps most importantly, on the specialized farms, the old knowledge of how to adapt and how to integrate the various elements of Nature in a system capable of maintaining fertility was lost" (Perfecto et al., 2009, pg. 41). The connection to place, land, and sustenance is a cultural element not included in industrialized agricultural systems as it serves no purpose to further yields. In addition to the essential provisions of sustenance, shelter, and resources, natural systems and biodiversity are also an important basis of culture. "Biodiversity provides strong aesthetic, moral and spiritual benefits…Human cultures, knowledge and religions are strongly influenced by nature" (Sodhi et al., 2007, pg.49). Pre-contact with colonizing nations, traditional societies in Costa Rica found gods and goddesses in the natural world around them. In art found from pre-Colombian time, reflections of agriculture in ritual, carvings of animals on ceremonial artifacts, and food-plant based carvings in jade were found at burial sites exhibiting the important and close spiritual role that the natural world provided (Eisenlauer, 1983). Furthermore, even following colonization as models of agriculture were negotiated and changed, the Latin American *campesino* culture has strong ties to the land. *Campesino* describes a rural peasant farmer in Costa Rica (or elsewhere in Latin America), and includes implications of membership and activism surrounding *campesino* issues. The *campesino* movement is centered on four central, interrelated beliefs. Firstly, innovation and experimentation occurs on local scales and is shared between farmers. Secondly, protection of the environment is a critical element within *campesino* agroecosystems, where limiting factors are dealt with internally so as to keep the system healthy. Thirdly, the movement shares a vision of farmer-led independence and sovereignty over land choices. Finally, members of the *campesino* movement "are motivated by deeply held beliefs in the divine, in family, in nature

and community" (Holt-Giménez, 2001). This culture has a strong history in Latin America and is directly threatened by systems of commercial farming that do not consider the farmer, farmer culture, or surrounding environment as a part of the success of their farm. Conservation of natural spaces in the tropics supports more than biology, it also supports cultural conservation.

Knowing that environmental systems in the tropics are valuable and unique, as well as an integral part of cultural systems, the tropics are an important place to focus attention. Furthermore, the threat of instability from changing systems can create scenarios that make living as people currently do, impossible. At what point is a reversion impossible? Is there a way to manage current conditions as to stay away from these thresholds? How can conservation be applied in an effective and supportive way?

3. Study Area

The Alexander Skutch Biological Corridor (following referred to as ASBC or 'the Corridor') is located at the foothills of the Pacific slope of the Talamanca mountain range in Costa Rica. The ASBC was designated a biological corridor in 2005. The appointment stemmed from a community-driven effort that included inhabitants of the ASBC, Nongovernmental Organizations, the Tropical Science Center of Costa Rica, and the Faculty of Environmental Studies at York University, Toronto.

The Corridor is connected to Chirripó National Park to the northeast, which in turn continues into La Amistad, a biosphere reserve that is shared with Panama. Running through the Corridor is the Peñas Blancas River, and also located there is Las Nubes- a rainforest donated to York University by Dr. Woody Fisher, a private owner- and Los Cusingos, the Neotropical bird sanctuary and former home to the Corridor's namesake, ornithologist Alexander Skutch. As a part of the larger Mesoamerican Biological Corridor Project, the ASBC helps to connect linked biological corridors from Mexico southeastward through Central America. This connectivity is essential for migration and dispersal of species, as well as protection of these biodiversity-rich areas.

The ASBC is comprised of three life zones. The first two run along the pre-mountain elevation of 1,000-2,000 meters, with an average temperature of 24 degrees Celsius. The first zone within this altitude is a moist semi-evergreen forest, found at the foothills of the Talamanca Mountain range. It receives an average annual precipitation of 2,000-4,000 millimeters. The second found at this elevation is a seasonal semi-deciduous forest found at the slopes and ridges of the Talamanca Mountain range, receiving between 4,000-7,000

millimeters of rainfall annually. At the mountain elevation of 2,000-3,000 meters, the average temperature is much cooler at 12 degrees Celsius. This forest is considered cloud forest (low altitude evergreen forest) and receives 3,600-7,500 millimeters of rainfall per year and forms on the upper slopes of the Talamanca Mountain Range (Canet, 2005).

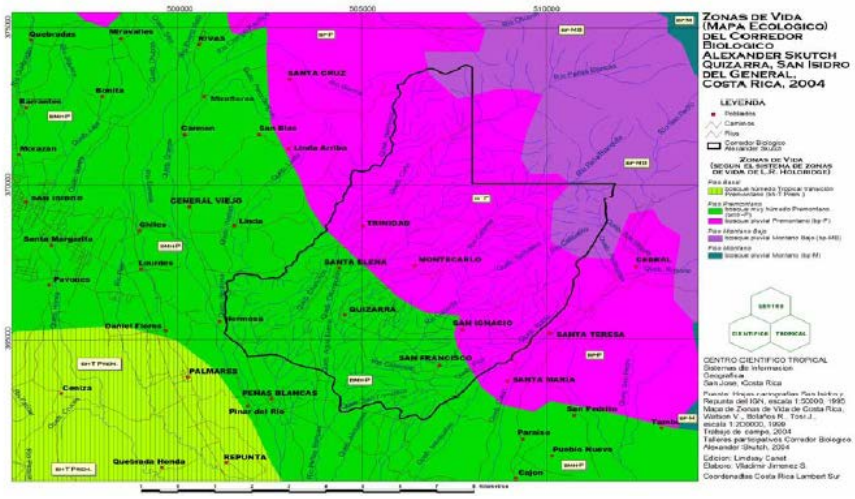


Figure 1. Life Zones in the ASBC (Canet, 2005)

Pairing warm temperatures and significant rainfall, the biodiversity within these forests is substantial, housing many endemic, rare, and vulnerable species. Based on a botanical inventory conducted in the Corridor, 48 of the 80 species of bromeliads named in the field guide *The Bromeliads of Costa Rica (Morales, 1998)* can be found in the ASBC (Canet, 2005). Birds also make up a large part of the biodiversity of the Corridor with 414 species, or 48% of all the bird species found in Costa Rica. The great presence of bird species has drawn birding tourists to the ASBC, and is a main force for developing more ecotourism opportunities for local communities. In the same biological inventory, carried out by the Tropical Science Centre, 17 of the 133 mammal species in the Corridor are CITES protected, 11 are endangered, and 5 are endemic to the Talamanca region (Ibid., 2005). The biodiversity within the ASBC illustrates the

immense complexity of tropical ecosystems. This complexity is also affected and intertwined with social/human elements as well.

The ASBC is politically contained within the province of San José in the canton of Pérez Zeledón. It is comprised of eight principal *pueblos* (used to describe towns, but significantly unique as it also implies communities of common people living there. Therefore it will be used and understood as such in this paper): Santa Elena, San Francisco, Quizarrá, Montecarlo, Santa María, San Ignacio, Trinidad, and Santa Martá (following collectively referred to as 'the Community' as membership of the ASBC is seen in these communities as a common identifying cultural element). Together, there are 2,182 people living in the Corridor, with just over half being women (5o.2%).

Población de las comunidades del CoBAS.

Comunidad	N° hombres	N° mujeres	Total
Santa Elena	415	410	825
Quizarrá	150	169	319
Montecarlo	112	119	231
San Ignacio	47	46	93
San Francisco	245	243	488
Santa Marta	NR	NR	NR
Santa María	116	110	226
Trinidad	NR	NR	NR
Total	**1085**	**1097**	**2182**
NR: No reportado Fuente: MAG y ASOCUENCA 2004.			

Table 1. Populations of the *pueblos* in the ASBC (Canet, 2005)

According to a study conducted by the Ministry of Agriculture and Livestock and Asociación de Productores para el Desarrollo Integral de la Microcuenta del Río de Peñas Blancas de Pérez Zeledón (ASOCUENCA, or Growers Association for the Integral Development of

the Micro Loans of the Peñas Blancas River), the main source of income in the Corridor is small-scale coffee growing. In this same study it was revealed that 50% of the ASBC is primary or succeeding forest, while the other 50% is used for agriculture for sugarcane and livestock, in addition to coffee (MAG & ASOCUENCA, 2004). In most households, men work in the fields and women work as *Ama de Casa*, or head of household. (This title is used in the original Spanish in this paper, as it implies a positive livelihood element that is missed by translations). In addition to agriculture, livelihoods consist of various activities including construction, sewing, baking, hospitality for foreign visitors, and various services. Incomes in the Pérez Zeledón region are modest, and households are greatly affected by unstable coffee crops and international coffee prices (Sick, 2008).

The great majority of people inhabiting the Corridor are *campesinos* (referring to a small-scale farmer who lives in a rural area, works closely with the land, and makes a living from this work. It is important to use this distinctive term, as the larger social structure and history that it represents is important to the study of the ASBC). The *campesino* families living in the ASBC have lived there since about the 1930s, before which the land was the traditional territory of the Talamanca Indian people. Also currently living in the ASBC are indigenous Ngöbe people from Panama who came as field workers during harvest time and have settled there. The *campesino* families that inhabit the Communities of the ASBC identify with farming as a way of life and not just a source of income.

4. Social-Ecological and Community Level Systems Theory: An Integrated Approach

The essential intent of this research is to contribute to the sustainability and well-being of the participating research communities in the Alexander Skutch Biological Corridor. Sustainability implies the future viability of the *campesino* lifestyle entailing the health the people, the land, and other associated living communities and well-being means a quality of living for social and ecological systems that is without life-threat and extreme hardship (Wasylycia-Leis et al., 2014).

To actualize the goals of this project, both scale and focus are important concepts. The scale used is one of a Social-Ecological System where both social and ecological elements work inseparably from each other. The overarching Social-Ecological System examined in this project is the Alexander Skutch Biological Corridor in its entirety, made up of various living and non-living populations present. These populations function in their own realms and smaller subsystems, as well as forming constituent parts (components) of the larger Social-Ecological System as a whole. Social-Ecological systems are dynamic and in constant flux, and therefore this understanding itself must be flexible and adaptive. The use of a Social-Ecological scale establishes a holistic understanding of the system's larger functioning as well as illustrating the complex ways that components affect, respond, and interact with each other.

There are many influential agents of change in Social-Ecological Systems (predator/prey dynamics, for example); however the human element is distinctive because of the presence of intentionality and long-term planning that can consciously involve the system as a whole. Intentional change of Social-Ecological Systems must come from the deliberate actions of human communities, a resource that can be activated to create specific change. This human-

action parameter is the focus of mobilizing action that can influence movement towards sustainability and well-being of all communities in the ASBC. This focus allows for the development of distinctive and realistic goals that can be applied to altering and supporting the particular system.

To pursue this scale and focus, this paper will follow the writing of Berkes and Ross (2013) and synthesize Social-Ecological Systems Theory and intentional action by human communities, into one integrated concept. This is essential because the systems as well as the individual constitutional components are important parts of usefully addressing issues in the research study area. Here, Social-Ecological Systems will be defined, followed by a discussion of human community engagement and participation. Subsequently, a model will be devised that incorporates these two elements into one useful concept for addressing sustainability of rural agricultural communities.

4.1 Social-Ecological Systems

A Social-Ecological System (SES) is a linked human (social) and nature (ecological) system (Binder et al., 2013). While Social-Ecological Systems engage these two discrete systems, they are more than just the sum of the two (Berkes et al., 2012). SESs are nested and multi-leveled, meaning that both social and ecological systems exist and function individually, as well as simultaneously existing as a part of the comprehensive meta-system. "Changes in one domain of the system, social or ecological, inevitably have impacts on the other domain. It is not possible to meaningfully understand the dynamics of one of the domains in isolation from the

other" (Walker and Salt, 2006, pg. 31). These systems are also complex and adaptive, meaning they function on multiple scales and are constantly changing (Folke, 2006).

Rural agricultural communities live closely with the land and many are largely resource-dependent, making SES functioning an important scale of focus. These strongly linked human and ecological systems are constantly involved in adaptive and evolving cycles (Lake, 2013). The *campesino* cultures in Latin America exemplify the type of cultural and ecological development that unites people to land and land to people. *Campesino* culture is deeply entwined with agricultural tradition and cannot be separated from it; the two do not exist outside of each other. Therefore, the use of a Social-Ecological System title is appropriate to reflect "the idea that human action and social structures are integral to nature and hence any distinction between social and natural systems is arbitrary" (Adger, 2006, pg. 268). This type of systems view is important to sustainability research because it acknowledges the human involvement in disturbance, both as a part of the problem and as a potential agent of resolution.

Imbedded in the functioning of a SES is the necessary survival of individual system components, and the interactions and involvements between these components. Therefore, the endurance of the system must be understood as the sustainability of the conjoined components as well as the system as a whole. No SES exists in a vacuum; there are many influencing changes and forces both within and outside of a delineated SES. When forces impose pressure on or within a SES, it is considered a disturbance and affects the sustainability of the SES. A Social-Ecological System is sustainable if the SES is able to maintain its

characteristic component-diversity, cycles, services, and utility when subjected to normal systemic disturbances (Beilin et al., 2012).

A system functioning as 'normal' does not imply that there is benefit for all components, or even for the system itself. It is important to note that the normal functioning of a SES can include undesirable characteristics, present in the larger system or a part of a specific component. These undesirable characteristics can keep the system functioning as it normally does, while simultaneously harming the system or specific components. For instance, in working with a *campesino* related SES, the system itself could reinforce elements of poverty or resource depletion that are culturally linked within the feedback of the system. As a result, if the system is to be improved, it is equally as important to understand functioning of the SES as a whole as it is give attention to the smaller components that make it up.

4.2 Community Focus

As noted above, a Social-Ecological System is seen as a unified entity where all parts are involved, interacting, adapting, and changing over time. Supplementing the usefulness of systems thinking, focusing on human communities allows action at the human level to be addressed. This focus is important because it ascertains what is currently in place to deal with issues of sustainability and wellbeing. Community social focus nods to human consciousness and the resources and abilities that exist within the system. This type of thinking has had wide application in social issues of disaster and health management and has been found useful when looking at systems where elements are very interconnected and therefore deeply affected by events of change, such as with *campesino* communities and the surrounding environment

(Berkes and Ross, 2013). Community focus allows for further information about not just how things are functioning, but the ways that they are and what that means for quality of life for elements within a system.

SES descriptions and analysis explain the overall system, but do not offer a measure of what's in place in order to affect change within the system. The human community is one component of a SES, one component that carries intentionality, long-term thinking, and potential for collectivity. When focusing on community potential within a SES, purposeful action possibilities are able to be considered. The goals of community processes tend to be practicable and achievable, and therefore action-oriented and realistic (Ibid., 2013). This results from acknowledging the resources, abilities, and also limitations of the community. By focusing on the human component of SESs, human communities can come together on action items and can activate capacity already inbuilt in the community.

4.3 Integrated Social-Ecological-Community Systems

Conceptually combined, Social-Ecological Systems that engage analysis of human community potential create a new way of understanding and approaching systems with an inherent response and action initiative. This joining of scale and focus: (1) sets the stage for comprehending what components act for or against the system, what dynamics exist that are essential to continuation of the system, how feedback is received in the system, what disturbances are present, and (2) what can be activated by the community to influence and manage change in the system, what barriers or challenges face activating change in the system, important cultural elements that are a part of the system, and importantly, where action can

begin. This crafts a holistic method of looking at both the system and its components and also initiates a plan for executing action. As an integrated concept this view can be effectively applied to the specifics of a situation with a formula for addressing community issues. Therefore a Social-Ecological System considered at the community scale essentially considers the holistic SES along with human action potential. This term will encompass the creation a foundational approach to sustainability research that connects theory with action so that more may be achieved from this research.

In the following sections, vulnerability and its partner-concept resilience will be discussed from the perspective of sustainability within integrated Social-Ecological Systems and community action potential.

5. Vulnerability

Vulnerability was originally developed as an ecological concept that has been adapted over time and found great value in its application to social-ecological systems. "Vulnerability derives from the Latin word *vulnerare* (to be wounded) and describes the potential to be harmed" (Lei et al., 2014, pg. 611). Vulnerability conceptualizes the strength of human and environmental conditions with the objectives of both meeting the needs of society and also sustaining the life support systems of the planet (Turner II. et al., 2003). It intrinsically recognizes the need of analyzing Social-Ecological Systems as one cohesive system, supporting that these things inherently affect each other. Vulnerability, like many developed concepts, has a plurality of definitions based on need and application within interdisciplinary fields. This plurality developed from the broad application of vulnerability in many theoretical traditions and the resulting debates and multiple uses of the term (Miller et al., 2010). The conditions these definitions have in common are: 1) vulnerability's relationship to resilience through adaptive capacity (to be discussed further in the next section), 2) vulnerability as a condition in relation to hazards/stresses, and 3) recognition of change/harm possible resulting from vulnerability (Ibid, 2014; Gallopín, 2006; Adger, 2006; Turner II. et al., 2003).

Addressing the second and third conditions mentioned above, Turner II. et al. outline a definition for vulnerability as "the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor" (2003, pg. 8075). Hazards are threats to a system, with implied negative consequences. Perturbation and stress are differentiated by where they originate and how they are experience by the system. Perturbations are major spikes in pressure felt by a system

that are separate from the normal dynamic in which a system operates. They generally develop externally to the system. Examples of perturbations include things like tsunamis, forest fires, or disease epidemics. Stress occurs within the normal range of variability in a system originating from within and continuously applying pressure to the system over time. Stress is exemplified by things like soil degradation, population growth, or climate change. Finally, risk captures the outcome and magnitude of harm following exposure to a hazard (Turner II. et al., 2003).

Vulnerability is a useful concept in approaching matters of Social-Ecological Systems because it allows for identification of potential or current hazards both within and outside of a system. It can also predict possible risk to the system based on system characteristics. However, to address these risks, the boundaries of the system must be known in order to know at what scale change will be most effective. Systems do not operate alone nor separate from larger and smaller systems that involve them. For instance, a rural community can be looked at as a distinct Social-Ecological System with influences identified as coming from within the system or coming from outside the system. From a different perspective a SES is also functioning within larger political (regional, national, etc.), social (cultural, religious, etc.), and ecological (watershed, etc.) systems, among many. On a smaller scale, there are local dynamics that differentiate distinct groups, boundaries, and dynamics. These could be geographical (nearness to a stream), interest (recreation clubs), or financial (resources), among many other associations as well. What this means is that any given SES simultaneously holds membership in multiple scales, on multiple levels. Therefore, when applying vulnerability theory, users must specifically delineate their scope while also acknowledging the dynamic nature of systems (Gallopín, 2006). The issue of scale exhibits one example of the intrinsic complexity of SESs.

Vulnerabilities can be felt on multiple levels for multiple reasons and can occur simultaneously to other important events.

Livelihood vulnerability applies Vulnerability Theory to the interaction between livelihoods and exposure to stresses or shocks. This framework is often used for both economic crises as well as natural disasters (Bacon, 2005). Livelihood differs from generic indicators of wealth or poverty in that it is considered a means of living, including both tangible and intangible elements, as well as how people make that living meaningful in the larger picture of life (Ibid.). The cultural element allows for valuation of assets beyond monetary value and gives a more complete picture of assets and coping strategies. In many rural communities, there are complex webs of connection between social and ecological elements as well as between social actors in the system. These connections are important parts of understanding livelihood vulnerability because they add to the profile of response strategies available for coping with hazards or responding to risk. "Intangible assets, such as kin and friendship networks, are often the most important relationships that households mobilize to reduce vulnerability" (Ibid., pg. 501). There are a diverse collection of elements at play. In comparison to financial vulnerability, using livelihood vulnerability creates more holistic picture where existing assets are taken into account, therefore exhibiting a more realistic sketch of how an element of a SES will fare when exposed to hazards. In single-industry communities where livelihoods are similar, such as rural agricultural communities, the sustainability of livelihoods is tied inseparably to community sustainability. Community can be understood as the sum of individual households and therefore household livelihoods make up community livelihood (Broderstad and Eythórsson, 2014). Whole communities undergo group hazards and feel

similar disturbances and impacts. This is essential when addressing vulnerability with action, as discussed further in this paper.

Using vulnerability theory to appreciate current livelihood states within a system allows for the identification of specific hazards and risks, and therefore creates the ability to focus on action to adapt or change the system. Understanding leads to informed decision making against possible hazards and risks. "Risk and perturbation in many ways define and constitute the landscape of decision-making" (Adger, 2006, pg. 269). Grasping the forces and potential outcomes of hazards allows those affected by it to alter the associated risks. Identifying hazards is a powerful tool for making decisions to alter the course of associated risks.

Hazards affecting coffee farming in Latin America exemplify the vulnerabilities felt among many agrarian societies. Two of these hazards, specifically, have created challenges that left unaddressed could lead to poverty and environmental degradation (Mabogunje, 2002; Bacon, 2005). The first hazard is an ecological perturbation that has recently changed much of the possibilities and realities of coffee farming: the rust fungus, Roya. The second hazard is a systemic stress hazard in the form of single-crop dependent rural livelihoods and sensitivity to global market climates. Following, they will be discussed in relation to Latin America as they are the foundation upon which this project was inspired.

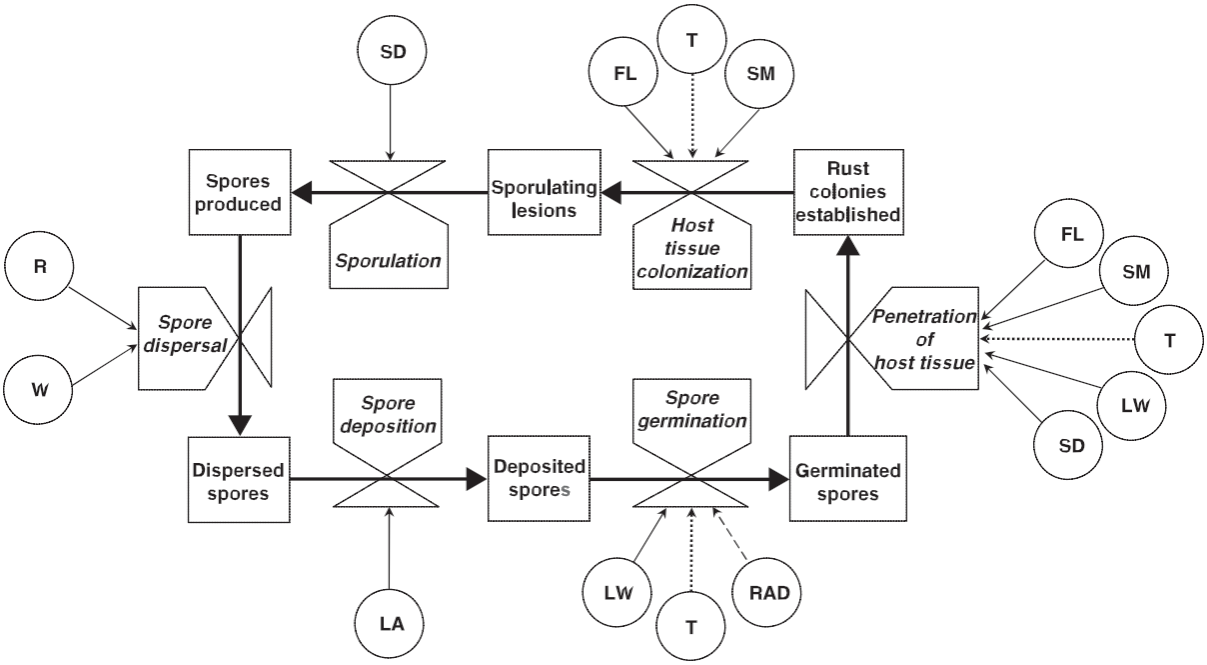
5.1 Roya- Rust Fungus

Rust fungus, known in Latin America by its Spanish name, Roya, is a pathogen caused by the fungus *Hemileia vastatrix*, an obligate parasitic fungus. Parasitic fungi bind themselves to a live host and use the energy and nutrients supplied by the host to survive. This type of fungus

is host-specific, meaning that it needs a specific type of plant in order to survive. *Hemileia vastatrix* targets coffee plants and particularly *Coffea arabica,* the source of higher-end coffee (as well as the type generally grown and produced in Latin America) (Bladyka, 2013; Avelino et al., 2012).

The *Hemileia vastatrix* fungus reproduces by spore spreading via wind or water over great distances, remaining viable for long time-spans including , for instance, the time it would take to travel across oceans (Avelino et al., 2012). There is still uncertainty regarding the full life cycle of *Hemileia vastatrix,* with many scientists in the field uncertain if the fungus spends part of its life developing on another host plant. However, the life cycle as physically seen on coffee has been well documented. "The main factors known to affect the life cycle of the fungus are wind, rainfall, leaf area, leaf wetness, light, temperature, fruit load, soil moisture and stomatal density" (Avelino et al., 2004, pg. 542). The fungus begins by colonizing the leaves of coffee plants, entering through leaf stomata, the pores that leaves use for gas exchange. Once it has permeated the leaf, *Hemileia vastatrix* presents as a yellow 'dust' on the underside of leaves. Over a short period of time, this yellow turns to an orange rust color from which rust fungus gets its name. The color is the visible mature spores of *Hemileia vastatrix*. The presence of rust fungus does not effectively kill the coffee plant, but rather causes senescence, or the leaves to fall from the plant. Once the leaves fall, the plant is unable to generate enough energy via photosynthesis to produce fruit (coffee). In extreme colonization plants may be killed, but generally this fungus has greater implications for the productivity of the plant (Bladyka, 2013). Below is a flow chart depicting the life cycle of the rust fungus *Hemileia vastatrix* with external influencing factors:

Figure 2. Coffee Rust Fungus Infection Cycle



*(Boxes, state variables; valves, processes(rates); bold arrows ,flows of individuals; circles, parameters(factors); thin arrows, effects of factors on processes. Nine factors are indicated on the flow chart: fruit load,**FL**; leaf area developed by the coffee tree canopy, **LA**; radiation intercepted by the coffee tree canopy,**RAD**; rainfall,**R**; soil moisture,**SM**; leaf wetness duration,**LW**; stomatal density, **SD**; air temperature,**T**; wind speed in the coffee tree canopy, **W**. Three categories of effects are distinguished: positive(solid lines); negative(dashed lines); or with an optimum(dotted lines). For example temperature, radiation and leaf wetness have an optimum shaped, negative and positive effect, respectively, on the process of spore germination; whereas stomatal density(and diameter of stomata) has a positive effect on the spore-production process). (Avelino et al. 2004, pg. 544)

The life cycle of *Hemileia vastatrix* is polycyclic, undergoing several cycles during the growing season, with overlap of these cycles possible (Rozo et al., 2012). This means that several life cycles of spores can be spread within the same coffee field. "A single spot of rust on a leaf can produce four to six generations of spores over a three to five month period" (Bladyka, 2013, Web). Spores will remain viable until conditions are right for germination. Similarly to coffee plant growth, development of rust fungi thrives under specific ecological settings determined by climatic conditions and amount of rainfall (Rozo et al., 2012). Germination of *Hemileia vastatrix* spores occurs within the range of 16 degrees to 30 degrees Celsius, with an optimal temperature of 24 degrees Celsius (Ibid). This overlaps with the optimum growing

conditions of coffee at a range of 15 degrees to 20 degrees Celsius (Clifford and Willson, 1985). Furthermore, *Coffea arabica*, the coffee type most susceptible to rust fungus, grows best under mid- altitudes that are sloped and receive substantial rainfall (Ibid). Again, these conditions favor rust fungus growth as well. There has been controversy over the effect of sunlight on Roya, with reports on both sides regarding the fungus favoring sun versus shade (Avelino, 2004). Below are two photographs showing *Coffea arabica* infected with the *Hemileia vastatrix* rust fungus*:*

Exhibit 1. (The left photograph shows early stages of the rust fungus, when it displays as yellow. The photograph on the right shows the rust fungus as it has matured and turned the characteristic 'rust' color. *Source: Wikipedia*)

5.1.1 History of Roya around the Globe

Roya is now "present in almost every coffee producing country in the world", and has been reported to have caused 30 percent losses of *Coffea arabica* globally (Rozo et al., 2012, pg. 732). In Latin America and the Caribbean alone there has been more than one billion US dollars' worth of damage since 2012 (USAID Press Office). On January 13, 2013 the Costa Rican government declared a state of emergency and enacted legislation to supply funds and research towards fighting Roya (Cressey, 2013). While Roya is not a new phenomenon, "this outbreak is the worst we've seen in Central America and Mexico since the rust arrived in the

region more than 40 years ago" (John Vandermeer, quoted in article by Cressey, 2013). It is estimated that the outbreaks in Latin America and the Caribbean will cause production to fall by as much as 15-40 percent in the coming years (USAID Press Office).

Roya was first encountered in Eastern Africa in 1861 but came to global awareness when it devastated crops in Ceylon (now Sri Lanka) a few years later (Hernández, 2005; Cressey, 2013). Uncharacteristically wet weather was blamed for the devastation, with over 90 percent of coffee crops being wiped out in the region. By the 1970s the fungus had reached the Americas, and in the 1980s Costa Rica saw the first outbreaks of Roya (Avelino, 2012).

In Costa Rica, "coffee cultivation is mostly intensive, with high crop densities (≥ 5000 coffee bushes/ha) and low shade tree cover" (Avelino et al., 2012, pg. 585). These monocrop, or single crop, coffee farms receive a great deal of maintenance inputs in the form of herbicides and pesticides. When a system needs external inputs, it means the system will not perform in the same way without the inputs. Reliance on inputs, therefore, means the system is vulnerable with the absence of these external influences. Agricultural systems that are structured to be homogenous, or nearly homogenous, exacerbate vulnerability by existing as a large concentration of plants with identical genetics, sharing susceptibility factors. When outbreaks of Roya occur in monocrop fields, the fungus is easily spread without other plant forms to intercept or interfere with the Roya reaching coffee plants. Furthermore, if the agricultural matrix surrounding the coffee field is open area (as could be the case with commercial agriculture and pasturelands), high-intensity Roya epidemics can easily reach the fields without being intercepted and bring associated deleterious effects (Avelino et al., 2012).

Changes in climate have also added to the prevalence and strength of Roya outbreaks. Warmer climates with changing rainfall accumulation affect weather conditions at higher altitudes, thus affecting coffee crops and Roya outbreaks (Rozo et al., 2012). Furthermore, isolated rare weather events also caused by climate change can contribute to disruptions in the typical tropical dry season and create environments more habitable to fungus growth and occurrences (Bladyka, 2013).

Current practices of rust fungus management include the selective breeding of resistant strains of coffee and the use of fungicides. While somewhat effective, both of these methods are complicated by several factors. Through cross breeding, the development of resistant strains of coffee has meant the need for less fungicide being sprayed on the crops (Cressy, 2013). Although resistant to *Hemileia vastatrix* the new strains of coffee have been found to host different strains of rust fungus and have not had the time to prove themselves a viable option for the long-term (Bladkya, 2013). In a study done by Kent University on resilient coffee strains in India, resistance to coffee rust was shown for about 10 years following exposure, but gradually lost resistance over time (Rodrigues and Eskes, 2009).

The other alternative, fungicides, are sprayed on coffee crops. Copper based fungicides are most commonly used in rust fungus management. This practice must be strictly timed, is labor intensive and therefore expensive, as well as having long-term negative effects on the surrounding environment. Copper sprayed as a fungicide has been shown to concentrate in the soil and transfer into plants, which can greatly harm health up through the food chain (Senkondo et al., 2014).

Research into alternative management methods are also being practiced in coffee growing regions. The introduction of 'hyperparasitic' fungi to coffee affected by Roya has been one such method. These hyperparasitic fungi are unique in that while they, themselves, are parasitic, they prey on other fungi. The white halo fungus (*Lecanicillium lecanii)* is one such fungus, naturally present in coffee ecosystems. In a complex web of specific mutualism between a type of ant (*Azteca instabilis*), green coffee scale (a type of soft scale insect), and white halo fungus there has been shown to be a contribution to the control over rust fungus. The white halo fungus has been getting a lot of attention because of these findings, but research is still new, and effectiveness of this approach must be further tested. However, this study does support the importance of natural biodiversity by exhibiting beneficial natural predation *within* a system (Vandermeer et al., 2009).

Roya presents a clear perturbation to the social-economical system of coffee agriculture, and has an effect on the vulnerability of coffee crops and livelihoods in Latin America and around the globe. The uncertainty of coffee yield and the worry for future health of the coffee ecosystems creates a real challenge for the farmers reliant on this cash crop. With expensive inputs, unpredictability of the larger coffee ecosystem, little science on the matter, and associated global economic trends pressuring these systems, the future viability to continue business as usual is questionable.

5.2 Global Coffee Markets

Economically, coffee rust fungus has devastated the supply from coffee growing regions around the world. There has been a 13.5 percent decrease in production and $500 million US

dollars loss in Central America alone. For Costa Rica, this means production is down to an estimated 1.4 million bags of coffee for the 2013/2014 harvest in comparison to the 2.1 million bags averaged yearly between 1990-2012 (International Coffee Organization, Monthly Coffee Report, pg.4). Falling prices around the globe suggest that coffee farmer revenue could fall by more than 50 percent overall from the 2010/2011 to the 2013/2014 harvest season (Bacon et al., 2014). Estimates are that over 350,000 jobs have been lost because of the latest Roya complications (International Coffee Organization, 2014).

While Roya presents a taxing and central hazard to coffee supply, is not the only force shaping global coffee trade. Even in the absence of the threat of Roya, coffee markets have proven to be unstable for many reasons. There are diverse pressures that operate within the global economy at the macro level, affecting international trade and global value chains (Barrientos and Kritzinger, 2004).

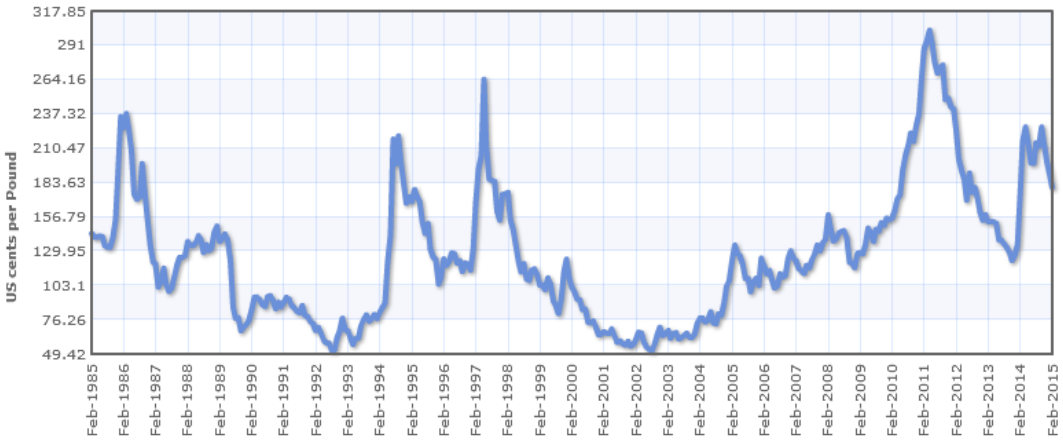
Many export markets in Latin America are comprised of ex-colonies, and have 'dependent' economies that are strongly affected by external powers and events outside of local control. Global buyers have great control over production, without direct ownership. This means that hazards and risks are felt at the production level, while economic rents are passed upwards (Ibid., 2004). "The history of most tropical and subtropical countries can, to a large extent, be written in rough form as a reflection of the rise and fall of basic export commodity prices" (Perfecto et al., 2009, pg. 120).

To address these global trade vulnerabilities a commodity trade agreement was developed in 1962 between coffee-producing and coffee-consuming countries that regulated global coffee trade and ensured protection and accountability by involved nations. The

International Coffee Agreement (ICA) was developed as a "set of international agreements that set production and consumption quotas and governed quality standards for most of the coffee industry" (Bacon, 2005, pg. 498). The ICA worked well to protect producing countries from international market pressures, as well as to standardize high quality products for importing countries. However, following disagreements in quotas and prices between importers and exporters, a lessened perceived threat of communism in Latin America by the United States, entry into the market by other coffee exporting countries around the globe, and increasing fragmentation in the market, the ICA broke down in 1989 (Ibid.). Following this dissolution of the ICA, producing countries lost much of their influence on the international market. While the ICA was reworked and reestablished in 2011, much momentum was lost for coffee producers, and prices plummeted.

Along with the effects of the ICA breakdown, shifting patterns in global coffee commodity chains including market liberalization, corporate fusion, and increasing production, have led to prices for coffee to be at an all-time low within the century (Bacon, 2005). Free market development beginning in 1990 also saw the longest period of low market prices for coffee ever recorded (1999-2004) with severely damaging consequences in coffee-producing markets (International Coffee Organization, 2014). These market-specific occurrences were in addition to general food market trends that caused instability of global food markets including increasing population, declining demand for stocks, rising energy prices, rising farm production costs, adverse weather, and export restrictions (Nonhebel, 2012). So while the coffee market saw an increase in price in 2011, it was shortly followed by another decline (International Coffee Organization, 2014).

Figure 3. International Coffee Prices for Arabica Coffee Beans (1984-2015)



(International Coffee Organization, World Bank, cited by www.indexmundi.com, 2015)

Currently, 70 percent of the world's coffee is produced by small scale family farms in 85 Latin American, Asian, and African countries (Bacon, 2005). Most of these producers live in poverty, while simultaneously caring for the important ecosystems and biodiversity that sustain life on Earth. In contrast, 56 percent of the global coffee trade is controlled by eight transnational export-import companies. This structure has led to declining prices paid to producers and producers now receive 33% less than they did when the International Coffee Agreement was first enacted (Bacon, 2004).

Coffee- and specifically the higher-end *Coffea Arabica* produced in Latin America- is a luxury good. Luxury goods require a mass market of people with high incomes that demand luxury products. Luxury items also need more resources for production than basic food menus (Perfecto et al, 2010; Nonhebel, 2012). As such, during global economic boom times, luxury items are in demand and producers are able to sell their goods in demand-driven markets and make a reasonable return. However, if buyers' incomes fall (as they did during the 2008 global financial crisis), the demand for luxury items is also reduced and global markets can collapse.

For luxury items such as cacao, coffee, and bananas, prices are generally highly responsive to relatively minor changes in demand (Perfecto et al., 2010). One reason for this strong connection is the lack of crop diversification. Many export oriented growth regions focus on a single cash crop, causing vulnerability to market fluctuations (Wasylycia-Leis et al., 2014). This growing method developed over time to answer demand, as well as competitively earn more money from cash monocrops. Economies in 'developed' nations are generally more diversified, and therefore are more buffered against changes in global markets, easily able to switch to stave off financial crisis. Economies that depend on a sole export crop for livelihood stability are more vulnerable to global price changes for export commodities, with often crippling economic consequences (Bacon, 2005).

Global conditions for coffee markets exhibit both perturbation hazards and stress hazards to the economic systems of producing countries. This has caused deleterious consequences as these nations continually cope with challenging circumstances coming from multiple sources. Furthermore, these nations have deep social traditions tied to agriculture, and as these systems are threatened by global market pressures, so are entwined cultural elements.

To address vulnerabilities, both from global market pressure as well as ecological disturbances, coffee growing nations have a multitude of management strategies that are enacted at varying points during the process of acknowledging and dealing with hazards. "Social units also have different coping capacities, which enable them to respond to the registered harm as well as to avert the potential harm of a hazard" (Turner II. et al., 2003,

Web). Identifying the areas where social communities can utilize their available resources to affect risk involves the partner concept of resilience, discussed in the next chapter.

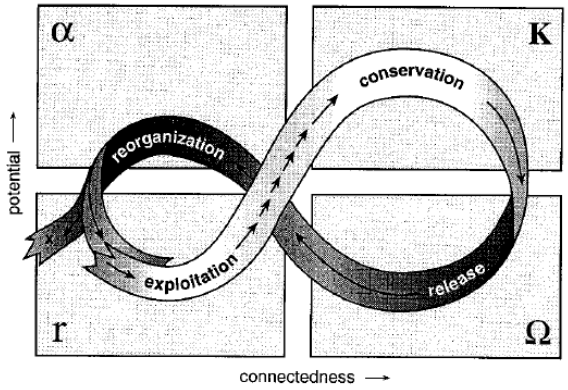
6. Resilience Theory

Resilience Theory, like Vulnerability Theory, originated in the natural sciences and especially in ecology (Miller et al., 2010; Folke, 2006; Gallopín, 2006). However, as the previous theories introduced, ecology does not exist in a vacuum. For that reason, resilience is best understood as a property of a complex adaptive system that is made up of essential functioning elements (Berkes et al., 2012). Defining systems in this way in 1973, C.S. Holling developed an integrative theory of complex systems functioning that was intended to address the much needed creation of applicable sustainability policy. In his seminal paper, Holling (1973) introduces the concept of 'panarchy', a complex adaptive multi-leveled system that is constantly evolving. Panarchy gives spatial and temporal structure to Social-Ecological Systems by describing stability states for the system, and the ways in which the elements are "interlinked in never-ending adaptive cycles of growth, accumulation, restructuring, and renewal" (Holling, 2001, pg. 392). Holling's panarchy did not assume a single stable state for a system, but rather described multiple stable states or 'attraction basins' that systems move towards and away from. When close or in these attraction basins, a system exists in a stable state and therefore in a desirable regime. As the system moves away from the attraction basins as a result of disturbance to the system, the system adapts, changes, and has potential for growth. This alteration can be viewed positively or negatively, depending on how the system copes with these disturbances (Ibid., 2001).

There are several dimensions to Holling's panarchy model that are key to understanding resilience. Firstly, panarchy models assume that multiple levels of systems-functioning are occurring on various scales, simultaneously. These varying scales interact and relate to each

other, slowing down processes in some cases and accelerating others. Secondly, these multi-tiered systems go through concurrent adaptive cycles with stages of conservation, release, reorganization and exploitation. A simple, one dimensional representation of an adaptive cycle is shown below. In true panarchy, this adaptive cycle would be occurring on several levels simultaneously with each level involving and affecting the others.

Figure 4. A One-Dimensional Adaptive Cycle



In this diagram, long arrows represent a rapidly changing situation, while short arrows show a slowly changing event. (Holling, 2001, pg. 394)

As a system moves through adaptive cycles, it will move towards or be situated within basins of attraction at the conservation stage, followed by disturbance at the release stage, leaving reorganization and exploitation as the space for creativity, change, and growth in the system (after which the system moves back into a conservation stage, and so on). Resilience fits into this equation as the ability of a system to undergo changes to state variables and the capacity of complex relationships to persist (Folke, 2006). This also involves the system's capacity to adapt into alternative and more desirable configurations when confronted with disturbance. Essentially, "resilience thinking provides a framework for viewing a social-ecological system as one system operating over many linked scales of time and space. Its focus

is on how the system changes and copes with disturbance" (Walker and Salt, 2006, pg. 38). Resilience is generally a positive concept, and emphasizes that while disturbance can be detrimental to a system's operation it also brings creativity, growth, and development to a system, often actually improving system resilience (Folke, 2006).

Since its development, Resilience Theory has found great use in its application beyond ecology in describing the relationship of systems to vulnerability and risk. It has been applied in disciplines such as development studies, disaster management, ecology, sociology, and others. For Social-Ecological-Community Systems, it can offer a lens to understand what stresses and shocks exist as well as capacities in place to deal with these hazards. This is useful for rural and resource-dependent communities because the capacity to understand resilience assets within the overarching systems can move internal elements beyond of the range of harm through informed action (Hanazaki et al., 2013; Wasylycia-Leis et al., 2014). Rural agricultural communities that are living closely with the land are a part of SES that can be exposed to multi-level social, ecological, and economic vulnerabilities (as described previously in the Vulnerability Theory section) and therefore benefit from managing their community resources to strengthen community resilience to address these hazards. Resilience describes how community members are active participants in the system and hold a level of influence over events in order to manage the resilience within the system (McManus et al., 2012). "Resilience is seen to be a strong fit for contemplating healthy and sustainable communities" (Wasylycia-Leis et al., 2014, pg. 483; concept also in Berkes and Ross, 2012).

To determine the effectiveness of resilience objectives, health and well-being provide measures of success for human and other living communities. The health of a community is

defined as the condition of a Social-Ecological-Community System where components are "organized and maintained in such a way as to promote both human and natural environmental well-being so that the community experiences relatively high levels of social support, a culturally acceptable standard of living, less rather than more inequality, and similar benefits that augment individual and social-well-being" (Berkes et al., 2012, pg. 281). Well-being, as a central concept of health, is further understood as the self-described satisfaction that community members feel in reaching their fundamental human needs, as outlined by Montoya and Drews (2006). These fundamental needs include organic, existential, and transcendental needs and exist as connected concepts. These measures act as the goals of community resilience, and provide places to focus attention in strengthening systems. They can also help delineate conservation goals in linked human-environment systems.

It is important to note, once again, that every theory comes with the asterisk that it cannot be all-encompassing. For instance, a SES that is considered resilient on one scale can have non-resilient elements present on another. Understanding how component parts are functioning doesn't mean that overall behavior can be predicted (Walker and Salt, 2006). Also, resilience can be harmful when a system's resilience becomes rigid and resistant to change, keeping it within an undesirable basin of attraction where growth or transformation cannot occur. Although these points are valid, Resilience Theory is effective for this project because it keys in on Social-Ecological Systems at the community level and employs a suitable and measurable scale for analysis, management, and action (Cassidy and Barnes, 2012).

Applying Resilience Theory to SESs allows the creativity and innovation of the panarchy to generate more desirable states following a disturbance to the system. Communities can

apply their resources during times of uncertainty to manage their position within the disturbance. Management of vulnerability is a key aspect of Resilience Theory, where members of a system can actively create or alter aspects of the system in order to change the trajectory of an occurrence or to push the system towards a desired state (Cinner et al., 2009). There is no one fixed, permanent situation, as SESs are dynamic by nature (Cassidy and Barnes, 2012). Instead, the focus is on a current desired state. The role of human agency in managing resilience allows for changing the system internally and/or externally to enter into a better state of being for communities within the system or for the system itself (Holling, 2001). When communities are able to manage and persist within the panarchy of SESs, it is considered community resilience. Defined by Magis, community resilience is "the existence, development and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability and surprise" (2010, pg. 401). Here, community health and well-being are described as the community members 'thriving', but is the same thing, in essence.

In relation to resilience, and furthermore as a part of the dynamic of resilience, the concepts of adaptability and transformation introduce conscious and active engagement by system actors to the theory of resilience. In other words, these two concepts are the applicable strategies that can be employed in a SES in order to achieve resilience when faced with new risks. Rather than achieve relative stability alone, these elements introduce innovation and creativity to the system to build what could be a better, more resilient system (Broderstad and Eythórsson, 2014).

When a system is trapped in an undesirable attraction basin, usually one in which the system's components are not able to function as they have in the past, the system must reconfigure in order to survive. This is when a system is in the release phase of an adaptive cycle. The capacity for reconfiguration is called transformation and describes when a system moves into a fundamentally new stability landscape with new basins of attraction. An example would be the collapse of a livelihood option such as agriculture and the subsequent transformation into eco-tourism as a new livelihood. In this new scenario there are new ways of living and new variables introduced, often transforming the whole panarchy (Walker et al., 2004). Transformation exhibits great creativity and strength in the face of life-altering events, however, it does not give choice for change. Instead, transformation is generally a response mechanism to external events. The type of community strength needed to intentionally transition into another panarchy often takes high community resilience in the first place.

As an alternative to transformation, adaptability remains within existing stability states, but also introduces new ones and applies change to how elements are interacting in the system (Walker et al., 2004). Adaptability is emerging as a major player in sustainability and Resilience Theory (Cassidy and Barnes, 2012; Gallopín, 2006). Also referred to as adaptive capacity, adaptability is related to resilience in that it enters at the social level in a panarchy and introduces the element of intentional management of vulnerability by actors in a system. Addressing vulnerability and supporting resilience, adaptability is considered a tool that is applicable *prior* to a system crash or crisis (Folke, 2006). This intentional action enhances the personal and collective capacities of its members to "respond to and influence the course of social and economic change" (Berkes and Ross, 2013, pg.6).

Adaptability can be strengthened through the building of community capacity on different dimensions. It represents the learning aspect of system behavior in response to stresses upon the system. By engaging community capacities, human actors can intentionally move into new stability states and avoid exposure to harm (Gallopín, 2006). To engage these community capacities, different resilience measures can be activated including community connectivity, livelihood flexibility, capacity to learn, existing assets (community capital), participation in decision making, and social support (Berkes and Ross, 2013; Wasylycia-Leis et al.,2014; Hanazaki et al., 2013; Cinner et al., 2009; Smit and Wandel, 2006; among others). As a grassroots approach stemming from the community, engaging community capacities allows for realistic action that fits in with current cultural, social, and ecological practices and inspires appropriately scaled solutions.

There are two approaches for action when identifying and using elements of resilience: specified resilience identifies resilience of what and to what, while general resilience looks at all aspects of the system including future stressors (Miller et al., 2010). These two concepts exist separately and also as involved and dependent forces. In order to distinguish which line across the spectrum between these two concepts is appropriate, vulnerabilities of the system must be identified and prioritized. In this way, actors can prioritize which elements are the most important to focus on based on current or future hazards. This exhibits the interplay between vulnerability and resilience. In community scale SESs these identifications are best if developed by involved communities so that action can practically address real needs of the community as place-based and specific (Smit and Wandel, 2006).

To know if resilience measures are successful, one can look at sustainability indicators for the community. The indicators for success of Social-Ecological-Community System sustainability are the security of livelihoods, survival of basic local institutions, maintenance of social identity, and continued health and flourishing of associated ecosystems (Broderstad and Eythórsson, 2014). These measures outline and define a resilient and sustainable SEC System, and are strategic goals for actors managing resilience. These measures address general resilience of the system, while also attending to specific resilience issues.

In summary, Resilience Theory provides a framework on multiple levels for assessing and acting upon the sustainability of SESs. Coupled with vulnerability, it identifies community strengths that can be engaged to address hazards while also showing places where communities can strengthen their resilience to address general vulnerability. Resilience also introduces adaptive and transformative initiatives that can be implemented within communities to engage agency that empowers communities to function in states of desired stability. Resilience gives a rhetoric for community health and well-being that can serve as a goal for community development. Finally, discussion of the resilience of SES has thus far focused on human agency in managing vulnerabilities. However, as has been noted previously, the active panarchy includes ecological elements that are intertwined in the functioning of the overall system. When social communities manage vulnerabilities through resilience measures, they also support the health and well-being of the entire system, without ecological compromise. There is a "correspondence between the health and the resilience of communities and their environments" (Berkes and Ross, pg. 13). Resilience is a theory that aims to encourage overall improvement through change and growth within.

Following is an applied approach of resilience where theory has been developed and applied to experiment with adaptability and transformation in the name of resilience.

6.1 Transition Culture

Transition Culture is a movement developed in the United Kingdom as a model for change addressing community sustainability through locally focused resilience building. Transition Culture was formally established in 2006 by Rob Hopkins after working with students to take principles of permaculture-working with natural ecosystems to find antidotes to modern anthropocentrically driven problems- and applying them to social, economic, and ecological issues in the community (Hamer, 2007). Hopkins and his students looked at the inevitability of peak oil and climate change alongside global reliance on oil and business-as-usual international policy and realized that this discord had to be addressed in order to avoid vulnerability on multiple levels and overall community collapse.

To address these challenges, Hopkins developed the concept of Transition, one where communities go through a number of 'sustainability transitions' to strengthen community resilience. These transitions incorporate community actors and engage them as agents of change. Transition approaches are "especially important when dominant 'solutions' (and the sociotechnical systems that deliver these) are locked in and contribute to unsustainable development" (Seyfang and Haxeltine, 2012, pg. 383). Transition ideals were manifested in the first Transition Town (TT), a community-wide plan for reducing energy use in Kinsale, Ireland. The project focused on relocalization efforts that encouraged movement away from fossil fuel use. Following the success of this project, the movement spread as other communities were

interested in the dual benefit of lessening resource use and strengthening the sustainability of communities.

In order to attain sustainability, Transition movements are involved with many local activities such as reskilling of communities, lessening needed energy consumption, localizing food production and trade, building new social networks, strengthening communication networks, encouraging community-led renewable energy initiatives, and building strong communities around sustainability actions (Ibid.). These activities allow communities to cultivate ecological, economic, and cultural diversity, prepare for future changes, encourage learning, and improve communication, all of which enhance resilience within SESs (Graugaard, 2012).

Although Transition models were developed to respond directly to peak oil and climate change-scenarios where change is necessary rather than wanted-many of the principle foundational models can be applied to many current challenges of community sustainability. (This is acknowledging, of course, that climate change and human forces are active in every facet of other relational conflict). "What the Transition Initiatives are finding is that when people get together to discuss and act in the world by creating allotments or rediscovering the skills that older people took for granted, a renewal of community takes place" (Brook, 2009, pg. 127). Community building engages the community assets that strengthen SESs and in turn support the sustainability, health, and well-being of the entire panarchy.

The benefits of grassroots innovations are that they inherently contain creativity and provide space for realistic resilience goals. This scale (grassroots/community) also allows those most familiar with the community to shape priorities and focus. At the SES scale, participants

are able to engage social resources which have been proven an effective method of building resilience. The growth of new infrastructure and practices supports communities during moments of disturbance or system failure (Seyfang and Haxeltine, 2012). It also frames future scenarios in a positive light, occupied with agency, management, possibility, and action. Communities are able to participate in creating their own future. "Transition towns therefore take the positive route of finding what we can do at a practical level. They also bring about the possibility to reconsider our values and our accustomed ways of living" (Brook, 2009, pg. 126). This addresses immediate needs while also shaping long-term objectives (Graugaard, 2012).

Much work has been done to develop local support for transitions to more sustainable living models, but few have identified developing nations as a place to implement them. Mostly, niche communities that are undergoing Transitions are relatively stable in their economic and educational base (Seyfang and Haxeltine, 2012). Growing from just two groups in 2006 (Kinsale, Ireland and Totnes, England), there are now over 1,107 Transition Initiatives in more than 43 countries. Of these Initiatives, the majority are found in Europe and North America, and none are in Central America (Transition Network, 2015). Developing this type of initiative in Central America could greatly bolster the resilience of communities feeling the effects of vulnerability from export-dominated economies and specifically those growing coffee.

Of the established TT initiatives, economic localization efforts have focused much of their attention of food production and food markets. In a national survey done of TTs in the United Kingdom, 40 percent described themselves as most active surrounding food and gardening. This percentage was substantially more than other areas such as waste (12 percent)

and energy (11 percent) (Seyfang and Haxeltine, 2012). This concentration points to the desire to alter current practices surrounding food production and consumption.

7. Ethnobotany

Ethnobotany is a relatively new discipline compared to classic academic disciplines such as philosophy, literature, or medicine. The term ethnobotany was first coined by University of Pennsylvania botanist John Harshberger in 1895. Ethnobotany is the study of plant and human interrelationships embedded in larger dynamic social-ecological systems (Alcorn, 1995). "*Ethno*" comes from the Latin for people or cultural group, and "*botany*" pertains to the science of plants (Turner, 1995). It is, therefore, a discipline "interested in the interactions between humans and plants, the dynamic process by which each [influences] and [holds] sway over the lives of the other" (Davis, 1995, pg. 43). Although the term and discipline are relatively new to academia, ethnobotany is an ancient study that has been practiced globally for centuries. As such, the study of ethnobotany dates as far back as plant and human interaction, for which a singular time cannot be firmly specified.

Records in ancient Greek writings by Dioscorides, a surgeon, date ethnobotanical practice back to 77 AD. Dioscorides' descriptions of plants and their habitats, medicinal use, harvest timing and technique, and recipes exhibit many of the same interests used in ethnobotany today (Davis, 1995). Even earlier, there are records from 1495 BC that show the Egyptian Queen Hatshepsut sending an official to collect fragrant trees to bring back for her mortuary temple (Lipp, 1995). The importance of plant and human interactions and relationships shows ethnobotanical practice throughout time and across worldviews. Reliance on plants for food, medicine, fuel, building materials, livestock pasture, spiritual uses, recreation, and much more has resulted in tightly woven human and plant lives. This is not a study of past interactions only, but also focused on present and future joint experiences.

As a discipline, ethnobotany developed through experimentation drawing methodology from anthropology, botany, chemistry, and conservation biology, among others. The interdisciplinary approach of enlisting skills from a diversity of subjects has allowed ethnobotany to address unique questions and issues that would have otherwise been overlooked or incomplete (Prance, 1995). Ethnobotany fully embraces social and ecological elements as bound together and is therefore an important frame to view SESs and is a well-informed research area for improving these systems. In many ways, ethnobotany acts as an essential part of a successful interdisciplinary mix when addressing issues of sustainability. It works alongside health, ecology, social, development, economic, and other approaches to create dynamic understandings of SESs and their constitutional elements.

So what are ethnobotanists researching? "The aims of ethnobotany are twofold: (1) to document facts about plant use and plant management and (2) to elucidate the ethnobotanical text by defining, describing, and investigating ethnobotanical roles and processes" (Alcorn, 1995, pg. 25). From this, ethnobotanists endeavor to appreciate how plant and human lives are altered by each other's co-existence through interacting processes (Ibid.). In this way, ethnobotany is both a documentary science, as well as a descriptive one.

Many of the results of ethnobotanical research have great application potential for informed change; ethnobotany has an inherent relevance for biological conservation. Ethnobotanical research understands the many links between plant and human worlds and therefore can communicate alternative value of biological elements by illuminating place-based cultural importance, as well as globally important plant-based knowledge and practices. Partnering with local people is one of the keys to successfully conserving natural spaces.

Working closely with communities, ethnobotanists learn a great deal from their research counterparts. Local knowledge has developed *in situ* over time and has benefitted from a deep place-based history of experimentation. For instance, "the Barasana Indians of Amazonian Columbia can identify all of the tree species in their territory without having to refer to the fruit or flowers, a feat that no university-trained botanist is able to accomplish" (Plotkin, 1995, pg.154). When knowledge is passed inter-generationally, values and management practices become part of culture and grow alongside local flora (Alcorn, 1995). A concentration on locally-informed knowledge paves the way for specific solutions with tried and tested practices, as well as existing alongside local cultures rather than upon them.

7.1 Awareness in Ethnobotanical Methodology

While much of the focus of ethnobotanical inquiry is on traditional and indigenous communities, ethnobotany –especially in the modern framing- is not limited to this scope as it is "the science of people's interaction with plants" without delineating what type of people (Turner, 1995, pg. 264). One rationale for working with traditional and/or indigenous groups is that many are living outside of the industrial global society and therefore maintain closer relationships with plants for everyday use (Alcorn, 1995). A great deal can be learned from cultures that retain traditional plant-use knowledge. However, in specifying this focus there is a danger of exploitation of participating communities. Traditional knowledge has been manipulated, in numerous instances, for benefit of pharmaceutical companies, commercial agriculture, business, land developers and others. A well-known example occurred in 1986 when an American man named Loren Miller tried to patent the plant *ayahuasca* (Quechua for

'vine of the soul') (Bennett, 2005; McKenna et al., 1995). The *ayahuasca* vine grows in the Amazon forest and has been used by local Yagua Indian shamans in Peru (one social group among others) for spiritual practices (Lipp, 1995). Contemporary use of the *ayahuasca* vine in Amazonia continues and contains a mix of diverse traditions including traditional guided experiences as well as introduction into *mestizo* folk medicine. Miller's attempts to patent his 'discovery' prompted outrage from the Coordinating Body of Indigenous Organizations of the Amazon and other social-justice groups (Bennett, 2005). While the patent was eventually denied, the rights and ownership over traditional knowledge is sacred to place and people and ownership, credit, and respect must always be given to the original sources of knowledge.

With this in mind, ethnobotanical methodology must be conscious of its interactions with traditional cultures and with global cultures in general. What this reveals is that researchers and participants must understand the research process as one of co-authoring and cooperation (Davis, 1995). One great benefit of being an evolving and forming discipline is the possibility at this juncture to develop a model of interaction and data sharing that intrinsically considers sovereignty, ethics, informed consent, and intellectual property rights, and establishes respect for participating groups (Harding et al., 2012). Anything less than equal treatment is unacceptable (Balick and Cox, 1996).

To address an issue that is both social and biological, and also to acknowledge that the research issues exist within a larger SES, ethnobotany as a method will bring a useful interdisciplinary lens with which to approach the research questions of this project, while simultaneously recognizing the co-authorship of the project.

8. Method

Information for this research project was collected through face-to-face interviews with participants in the Alexander Skutch Biological Corridor. In May-June 2014 106 interviews were conducted by a research team including the researcher, a research assistant, and a translator. As this project concerns community resilience and communities are understood to be made up of the households that comprise them, the unit of inquiry was a household. A household was defined as people living together full-time, in one dwelling. This unit of scale was chosen to reflect a shared unit of livelihood based on production and shared consumption. In the eight *pueblos* making up the ASBC, household livelihood is unified (based on governmental data and supported from participants' responses) and therefore vulnerability and community resilience of the SESs is felt at the household level. As mentioned by Cassidy and Barnes (2012), when SESs are confronted with hazards to sustainability, the consequences are more likely to be felt between households rather than within them. The household scale additionally allows for comparison between *pueblos* in the ASBC as well as within each *pueblo* itself.

Interviews were carried out in one of two ways. The majority of household interviews were conducted on participants' property in situ with their home gardens. This was designed to effectively collect as much information while in the presence of the involved flora to allow for recognition based on "anatomical, physiological, morphological, architectural, or ecological characteristics" (Thomas et al., 2007). For these interviews, permission was obtained to photograph the home property and plant life, including home gardens. The second method of interviewing took place at a muli-day community festival at which all of the *pueblos* of the ASBC were invited and participated. All interviews were conducted during the day, and were

generally between members of the research team and one household member. In a few cases, more than one household member participated in the interview, and note was made of both household member's demographic data. In these instances, it was generally intergenerational family members such as mothers and daughters. As the research scale concerned the household unit this did not detract from the research findings. Each interview was conducted orally in Spanish, and began with an introduction to the research framework and purpose of the study to obtain informed consent. The interviews were voice recorded for later reference, and handwritten notes were taken during the interview process. The interview lasted an average of 20-30 minutes, and if photographs were taken, an additional 15-20 minutes.

Interview households were chosen from the 4 most populated *pueblos* in the Corridor (Santa Elena, San Francisco, Quizzará, and Montecarlo), therefore including half of the *pueblos* and representing 85 percent of the population within the ASBC. The sample of households were chosen based on random walk and quota sampling, as the researchers were dropped off in different *pueblos* each day, and continued on foot. Furthermore, this method was chosen because of the small populations of each *pueblo* and the desired representative interview quota for each *pueblo*. The sample size was 106 households, with 79 female and 27 male participants. This gender bias was attributed to the time that interviews were held (generally during weekday workday hours), but added valuable content to the findings of this research project.

The interview questions themselves were structured to explore two related topics:

(1) What plant-based community capital (knowledge, skills, resources (physical production), and values) do people living in the ASBC have that could be engaged as adaptive capacity to support community resilience and sustainability?

(2) What interest and community capital exist to support a Transition Initiative of a local farmers market?

To address the first research enquiry, interview questions looked at the established as well as potential ability of participants to employ adaptive capacity measures to deal with the threats of *Roya* and unstable global coffee prices against sustainable household and community livelihoods. As was previously mentioned, the majority-held livelihood in the ASBC is coffee farming and therefore *Roya* and global markets have and can have a large effect on *campesino* communities. The ability of SES actors to manage resilience was measured as the adaptive capacity of the community (Folke et al., 2010). "Essentially, adaptive capacity is the potential to convert existing resources into useful strategies" (Marshall and Smajgl, 2013, pg. 89). This concept was operationalized by drawing upon multiple resilience studies to see the ways that adaptive capacity could be engaged through application of community capitals (Gallopín, 2006; Berkes and Ross, 2013; Smit and Wandel, 2006; Berkes et al., 2012; Lei et al., 2013; Broderstad and Eythórsson, 2014; Cassidy and Barnes, 2012; Plieninger et al., 2013; Adger et al., 2006; Walker et al., 2004, 2009; Folke et al., 2010; Montoya and Drews, 2006; and others). Community capitals (also called assets or community capacities) are made up of all of the diverse resources that a community has to engage and initiate change in order to manage resilience. This scope was important because it uses the local scale to build grassroots action,

appropriate for equal-benefit community sustainability. Much of the literature focuses on the key theme of flexibility and diversity in the long term success of applying community capitals. Using this focus, this research project then concentrated specifically on the community capitals that surround plants and plant-based trade. The rationale for this focus was that the *campesino* communities that live in the ASBC are specific actors in their SESs that work daily and directly with plants. Therefore, plant-based culture is an essential element of understanding the Communities of the ASBC.

The community capitals that were studied were **social** capital (networks, alliances, shared visions), **cultural** capital (collective identity, traditions, local knowledge), **human** capital (skills, capacities), and **natural** capital (biodiversity and life elements) (Montoya and Drews, 2006). These four dimensions centered on plant-based knowledge and home garden production, as well as projecting future will and desire to engage these dimensions further (Fazey et al., 2007).

Related to the first line of inquiry, the second part of this project was developed to ascertain the possibility of creating a local farmer's market where community members could trade the plant-based (and associated) goods that they might produce in their home gardens. Associated items were considered to be other items that were not of plant-based origin but would be traded easily alongside food items such as eggs, milk, cheese, meats, fish, etc. This added to the sustainability objective by identifying more key avenues for resilience building including security of access to healthy food, lessening the ecological footprint of the food sector, diverse livelihoods, network building, knowledge sharing, and secondary income generation. Farmers' markets also are important institutions for local people to share values

and build place-based community identity (Milestad et al., 2010). "A very large component of food sharing is about building community cohesion, social networks and social capital" (Hanazaki et al., 2013, pg. 162).

Modeled after Transition Initiatives in other parts of the world, the possibility of a local farmers' market was looked at in two ways. First, existing community capital was measured to see if there was enough of a base to support this initiative. Second, desire and will to instigate this project were measured to see if there was cultural support and acceptance of this idea.

These two related lines of inquiry focus on resilience thinking that states that the greater and more diverse the set of community capitals that are able to be engaged to address vulnerabilities, the greater range of flexibility and options available to support sustainability (Hanazaki et al., 2012). Moreover, as a connected panarchy, resilience building on one scale of the SES- in this case the community scale- can positively affect resilience on multiple other scales within the system (Berkes and Ross, 2013).

Interview questions were mixed and included both structured and open ended questions. The interview was broken into six parts. The first elicited demographic, livelihood, and household data. The second part concerned knowledge, use, and values surrounding plants. Part three looked at current production and sale of plant-based goods. Part four considered plant-based consumption and associated shopping items for the household. Specific measures of current purchasing priorities were noted in this section. Included were several questions that indicated food shopping priorities (cost, access, food choices, food types, etc.) in order to ascertain what elements would be important if carrying out the local market Transition Initiative. The fifth part concerned desire, willingness, and specific interest in the

formation of a local market in the ASBC. Finally, part six ended the interview with two open ended questions. These two questions allowed participants to invent their own desired output from the study, after understanding what type of data would be collected. These final two questions greatly supported the findings of this project, and exhibited creativity and potential for this and future studies. The full interview can be found in Appendix B.

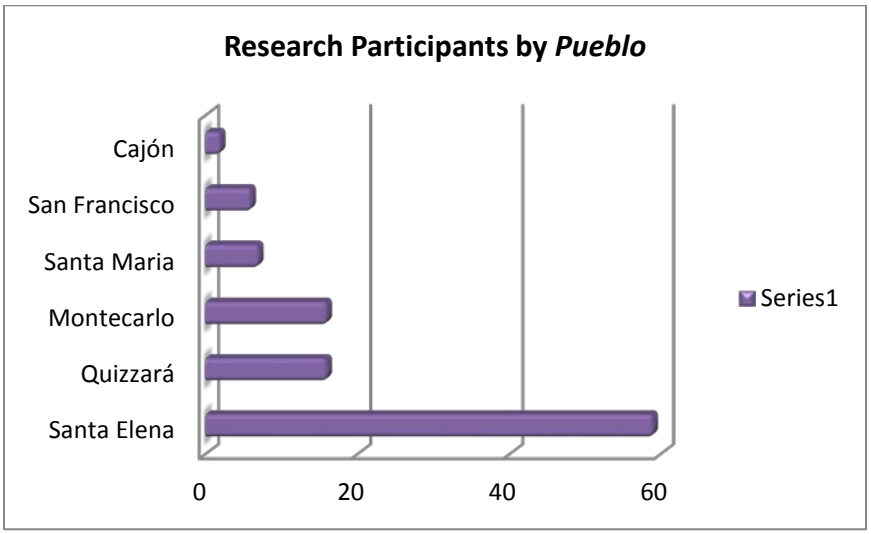
Research data was analyzed using qualitative techniques. For demographic data, participants were tallied separately by gender, age, and *pueblo* resided in. For subsequent data sorting, coding was used to uncover trends and patterns from responses, which formed categories of responses. If similarities appeared uncertain (not specifically the same answer), new categories were created. All of these processes were completed manually.

9. Findings and Discussion

9.1 Community Description

106 interviews were conducted with residents of the five most populated *pueblos* in the ASBC, including two members of a nearby *pueblo*, Cajón. The number of interviewees selected from each pueblo attempted to reflect relative proportion of the population of the ASBC (See Study Area).

Figure 5. Research Participants by *Pueblo*



Gender of participants was skewed, with 74.5% being women, and 25.5% being men. This does not reflect the actual gender balance of the ASBC, as the Corridor is represented by 49.7% men and 50.3% women (Canet, 2005). This difference was due to the time of day that interviews took place (during the weekdays and during common agricultural work hours) when many men were working the fields, and many of the women stayed home with their families. The implications of this gender bias will be further discussed later in this section, as it had important implications for findings. 21% of participants were under 30 years old, 56% were

between 31 and 60, and 23% were older than 61 years. Respondents' families were comprised of an average of 3.9 people. All respondents were of Costa Rican heritage, and all spoke Spanish as their first language.

Current personal livelihoods of participants ranged, with the most common being *ama de casa* (head of household) by a large margin, followed by seamstress, farmer, pensioner, construction worker, and financial support received from family. Many respondents noted their personal livelihood contribution functioned alongside coffee farming, which was observed to be the main source of household income and livelihood throughout the Corridor. Most people responded that they had been practicing their livelihoods for many years, if not the span of their entire working life. Alongside participant responses, the research team observed several at-home business ventures that were unreported during interviews, such as sales of makeup and clothing from catalogues. While these side businesses do make up a portion of the household livelihood profile, their contribution was not considered significant enough for participants to include as their main source of livelihood. The livelihood responses represented both a cultural division of labor in the home by gender, as well as reflecting the current availability (or unavailability) of alternative livelihood options in or near the ASBC. In terms of what this means for developing new and alternative livelihoods, more will be discussed further on in this analysis.

As more than half (61%) of interviews were carried out on participants' properties, researchers noted that physical house size was generally similar within and between *pueblos*, and a great majority had a home garden directly adjacent to their residences. The home

gardens generally contained edible, medicinal, and ornamental plants although some had larger agricultural plots for commercial growing bordering their homes.

9.2 Plant-Based Capitals

Community capitals, as mentioned in the Method section of this paper, are comprised of all of the diverse community resources that can be engaged to initiate change and manage resilience for groups of people. These capitals extend beyond financial resources alone and include the collective knowledge, skills, physical production and values of community members. For this project, working with *campesino* communities meant that participants' lives were and are deeply entrenched in agricultural and plant-based practices, so for the purpose of this study, community capitals surrounding plants, or plant-based capitals, were considered as a representation of the knowledge, skills, resources, and values held by the communities in the ASBC. Below, the findings for these plant-based community capitals are outlined.

9.2.1 Community Capital: Knowledge and Skills

Knowledge and skill surrounding plants and plant use were measured by asking participants to orally construct an exhaustive list of familiar plants, how they would categorize that plant based on its use, and what specific uses each plant held. Responses were classified based on plant-use categories developed by the researcher and based on studies with similar plant-use categorization (see Buchmann, 2009; Maroyi, 2009; Maroyi, 2013; de la Torre et al., 2012). Use categories were further delineated during interviews when participants described plant-use that fell outside of the initially created categories. Notably, the categories for plant-use were extended to include 'fruit' as a separate category from food. This differentiation was

established because a majority of responses designated fruit as separate from other categories, although there were cases where respondents categorized fruits as food, as well. Initially created plant-use categories were food, medicine, fuel, ornamental, building material, spiritual/cultural, recreational, and artisan materials. Following the completion of all interviews, fruit was added as a category, and fuel and spiritual/cultural use categories were removed because they were not used by participants. Many participants mentioned plants having more than one use and these were recorded in more than one plant-use category, if repeated. Table 1 below shows the frequency that a plant-use category was named by participants.

Table 2. Summary of use categories of plants in the Alexander Skutch Biological Corridor

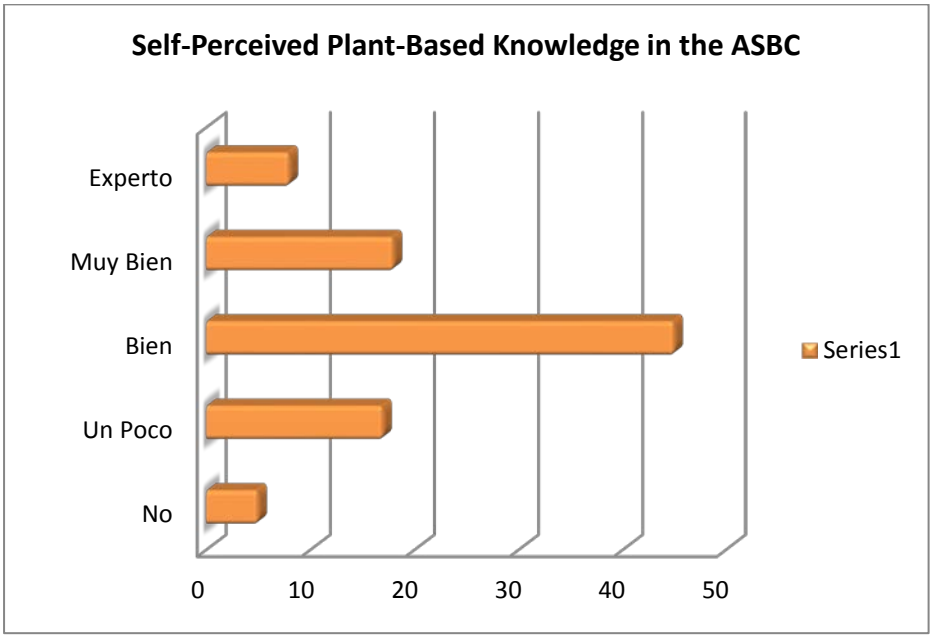
Plant-Use Category	**Number of Participants that described using plants in this way (out of 106 respondents)**
Food (*alimentos*)	100
Medicine (*medicinales*)	89
Ornamental (*ornamentales*)	62
Fruit (*frutales*)	56
Lumber/building material (*maderables*)	40
Other: pasture, shade, cash crops (*otro: pasto para ganado, sombra, para comercio en grande*)	7
Recreation: for birds (*recreacion: para aves*)	3
Art (*arte*)	1

While food, medicine, ornamental, fruit, and lumber were the four most prominently named plant-use categories, the most varied responses came from ornamental plants, and the

most descriptive plant use surrounded medicinal plant use. Participants that allowed a tour and photographs of the home garden following the interview often added new plants and plant uses as they observed and interacted with their plants. This confirms that while the study paints an accurate picture of plant-based knowledge in the ASBC, it is not exhaustive in its inclusion of plant types and uses. It also demonstrates the importance of recognition and memory related to interaction with plants. A full list of plant categories, plants, and plant uses identified by participants can be found in Appendix A.

Participants classified their present personal knowledge of plants as average, or slightly above average as shown in Figure 2, below. (*Experto*= Expert, *Muy Bien*= Very good, *Bien*= good, *Un poco*= A little, *No*= none).

Figure 6. Self-Perceived Plant-Based Knowledge



Participants' self-perception of plant-based knowledge measured their valuation of the role that their plant knowledge plays as a community capital. The fact that self-perceived

knowledge landed mostly at an average amount (and higher) indicates that participants understand that they have awareness of plants and plant use, but also acknowledge room for growth. When asked who participants felt knew the most about plants in their family, there was an equal split between men (49.7%) and women (50.3%) as the most knowledgeable. This shows that plant-based knowledge is perceived to be evenly distributed across gender. There was no specific age related trend in this matter, based on age categories used for this project.

9.2.2 Community Capital: Values and Interest

Participants were asked what they considered to be the most important plant or plants and responses were that all plants were important, food plants, medicinal plants, ornamental plants, lumber, as well as specific plants being named. In many instances where specific plants were named as being most important, the plants were linked to livelihood (specifically coffee and sugar cane) and were named as an essential source of household stability. Responses here indicated that plants are valued by the participating communities both intrinsically as well as for use-value. Sharing values is a cultural asset for community strength, as members stand behind shared values.

Next, participants were asked with what frequency they worked with plants, and if they did so, with what type of plants. This question gauged whether a plant-based initiative could be supported by current practices and habits. Moreover, it also was used to see where community interests in plants existed. The frequency that participants said they worked with plants was split between those who worked with plants each day, and those that did not interact with plants, or did so infrequently. There were several respondents that remarked that

their spouses (husbands) worked with plants every day (usually citing coffee as the plant), but that the respondent themselves interacted with plants less. Interestingly, while many women responded that they seldom worked with plants, they mentioned in subsequent questions that the household produced edible, fruit, or medicinal plants.

For homes that allowed a garden tour and photography following the interview, many participants shared that they were the main cultivator of the home garden. This finding suggests that 'interaction' with plants is often culturally ascribed to full-time livelihood as a farmer, while tending home gardens are not considered as 'work'. This could be due to the differing scales of production and monetary valuation of plant-based goods output. Furthermore, rarely were any commercially produced crops named as possible local trade goods later in the interview. Therefore there is both a great difference in how commercially produced crops and home produced crops are viewed, as well as a great potential for engaging home produced crops in a local market scenario. These responses suggest that without market overlap, these two separate production scales could be simultaneously successful. Also, although interaction with plants varied by participant, many expressed desire to know more about specific plant uses, therefore further exhibiting the potential to build avenues for future knowledge growth.

9.2.3 Community Capital: Resources

Households generally produced some plant-based resources. Every home was growing plants in or around their homes, varying in degree of size and intensification from potted plants on porches to large outdoor gardens under sun protective screens. Responses showed that participants by and large consumed or enjoyed these resources in the home (with the exception

of the cash crops coffee, sugar cane, plantain, and a few others), sold them to neighbors, or shared them with their neighbors for free. Only a few participants mentioned selling their plant-based goods outside of the *pueblos* in the Corridor. For instance, one interviewee cultivated orchids, which he sold to collectors around the world. Another made homemade wine that she brewed from a variety of fruits in her garden, which she sold at markets in nearby cities. A few participants also mentioned membership of womens' groups (AMUC (Asociación de Mujeres de Quizarrá) and COCOFOREST) that worked to improve the economic position of women in the corridor. They did this by collectively tending home and community gardens and selling their goods to the local school for lunches and by organizing homes to host foreign students and visitors through a hospitality collective. Members of these groups have been active in supporting women's causes in the corridor and mentioned interest in being involved in the local market initiative, as well.

Due to the time of day that most interviews took place, a great majority of participants were women. This gender bias acted to inform the research in unique and interesting ways. As the main tenders of home gardens were women, and much of the knowledge, skills, values, and resources described women's community capitals, it became evident that mobilizing these specific community capitals would mean empowering women to diversify or engage new household livelihoods, and at the same time not pressuring cultural change away from the established *campesino* culture of households and communities. The implications for women's role in a local market, specifically, are discussed alongside the general significance of a potential Transition Initiative in the next section.

The findings of local knowledge, shared value systems, information, traditions, skills, networks of people, and plant-based products shared by participants exemplify cultural capital that is valuable to strengthening community resilience in the ASBC in the face of *Roya*-related vulnerability. While there is no single stable state for an SES, the community capitals recorded above can be engaged to aid households in being flexible with their livelihood options during hard economic times and in coming to a state of stability. If households are able to engage their community capitals in the face of *Roya* shocks, the community at large will be more secure and more sustainable without having to drastically change the *campesino* culture that is so deeply entrenched in both land and people.

The following section looks at the application of the community's plant-based capitals to transition away from a food system that brings food and other plant-based goods from far away, to a local system that can sustain itself with homegrown production and consumption.

9.3 Transition Initiative: Local Market

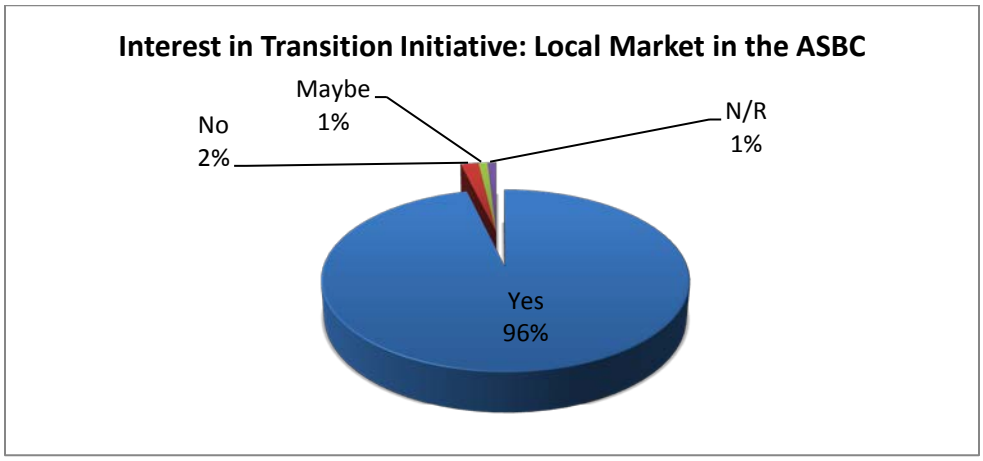
One of the key research questions that guided this project was of the existence of interest and community capital to support the creation of a local market as a Transition Initiative backing both social and ecological resilience. This question was an umbrella for the interview, and brought existing community capitals new meaning.

Prior to investigating interest in transitioning to an alternative food model, participants' current food consumption practices and priorities surrounding food and food purchasing were discussed to get a feel for what norms exist in the community. Participants were first asked to list what foods or goods were purchased most frequently. Resoundingly, families answered rice

and beans, followed by a variety of similar food items like oil, sugar, flour, corn meal, pasta, and many types of fruits and vegetables. With the exception of rice and beans (important and significant staples), many of the products named were also produced in the corridor from respondents' home gardens. Addressing access to rice and beans would be an important step to ensuring the sustainability of a local market as the primary shopping place. Next, participants were asked about food purchase habits. A majority of respondents made their regular food purchases at commercial retail stores. Other options shared were the farmer's market in San Isidro (about 30 minutes away by bus), the local corner store (*pulperia*), and buying from trucks that drove through the *pueblos*. Priorities for location of food purchasing were ease of access, quality, availability of organic produce, habit and familiarity, and most frequently, low costs. Knowing this information helps to inform what types of foci would be essential to the sustainability of a local market.

After understanding the existing framework of food-based transactions in the ASBC, attention was turned the question of interest in a local market in three specific ways. The first way asked participants outright if they would be interested in the development of a local market with goods being produced solely in the ASBC. As displayed in Figure 3, the response was decisively yes; participants supported the creation of a local market in the Corridor.

Figure 7. Participants' interest in Local Market



To substantiate this response, participants were asked what they would like to buy or sell if there was to be a local market. Although the main intent was for plant-based goods, as in a farmer's produce market, planning was left open to accommodate other non-botanical goods as well. The responses were varied and included everything from food, medicinal, and ornamental plants, to other goods and services that could exist well alongside plants. These other goods and services were things like hand-made clothing, dairy products, meats, and medicinal salves, among others. The thing all of these have in common is that they are all handmade items by community members. Services were also mentioned- for example hair styling and manicures.

Understanding desire to buy and sell was an important part of gauging whether demand and supply of specific goods were similar and fairly balanced. The findings confirm that there are great resources and production capacity stemming from participants' home gardens and existent skills that participants voiced they would like to employ as an supplementary source of income. In addition, many people stated that they would be interested in buying some if not all

of their *diario*, or shopping list, at the potential local market. Supporting motivations included the importance of supporting their neighbors, better quality of produce (compared to foods that have to travel far), and importance of organic, chemical-free produce. Table 2 shows a selection of responses as to why the creation of a local market was important to participants of the study.

Table 3. Participants were asked: "Why do you think it is important to create a local market?"

Original: Spanish	**Translation: English**
"Para que las mujeres trabajen. Sería bonito que se produce y se compre aquí." (15)	"Because women work. It would be nice for things to be produced and bought here."
"Seria más cerca y no tiene que ir al centro a comprar cosas." (23)	"It would be closer and you wouldn't have to go downtown to buy things."
"Fuente de ingresos para la comunidad" (28)	"Source of income for the community."
"Consumar verduras frescas y sin chemicas. Más fácil acceso." (29)	"To consume fresh vegetables without chemicals. Easier access."
"Porque para conocer los pensamientos y se conocer en comunidad." (34)	"To know the thoughts and to meet each other in the community."
"Porque queda cerca y hay más trabajo en la comunidad." (41)	"Because it's closer and there's more work for the community."
"Porque si tiene productos para vender, se va generando una mini empresa y tiene ganan y nada se hace con hacer y no vender." (47)	"Because if you have products to sell it would generate a mini company and you could earn money and if not, you would have no where to sell your goods."
"Es importante porque generan dinero a personas que tienen habilidades y no pueden vender lo que hacen." (48)	"It is important because it generates money for people who have skills and are not able to sell the things they make."
"Acá cuesta conseguir una fuente de trabajo para una mujer si no esta en preparación professional. Eso sería algo que se podría hacer estando en casa, sin descuidar otros deberes." (73)	"Here it costs to get a source of work for a woman if she doesn't have professional preparation. This would be something that could be done at home, without neglecting other duties."

As a third measure of assessing desire or willingness to enact a local market, the final interview question queried generally what participants would like to have done with the information collected in the interview process. This question was asked at the end of the interview when interviewees understood the type of information being asked and generated from the study. This question was important to the findings of the research because it reinforced views and support for a local market, re-established values surrounding plants, and also allowed participants to give insight into what type of endeavor might benefit the ASBC from the perspective of the Community itself. Table 3, below, exhibits the responses from this final open-ended question.

Table 4. Participants were asked: "What would you like done with the information that was collected in this study?"

Participant's responses for what they would like done with the collected plant-based information:	# of participants who supported:
Local market	39
Community learning centre	14
Medicinal plant book	14
Local plant nursery	13
Map of plant-based production in the ASBC	7
Build more community connections	4
Develop new business opportunities for women	3
Support conservation initiatives	2
Support local farmers	1
Build a local coffee shop	1
More research	1

This question evoked great direction for next-steps surrounding the research, in terms of what local people felt prioritized as needs for the Corridor. Responses were unanimously action-oriented, revealing that the community valued output that went directly back into the community rather than other options such as sharing findings with local government, or

academic sources. Participants generally responded that they would like to see the local-market Transition Initiative actualized, and added that it was important to "support and give benefit to the community". The realization of a local market was also supported by those wishing for more research and aid for farmers. In addition to support for a local market, another recommended initiative was for the establishment of a community learning center where people could come to learn about all types of plants and their uses. Plant nurseries for medicinal and ornamental herbs were named by many participants as well, with people wanting to learn more and also share what they know.

What all of these suggestions share is willingness to further community-building through additional learning, interaction, connection, and mutual support. Local markets can provide a structure for the supporting of this type of community building (Milestad et al., 2010). When communities engage their adaptive capacities they not only flex their community capital, they also greatly support the strengthening of community resilience and support ecological conservation as well. The first connection to resilience lies in the creation of a sustainable local economy. Local economies work to support resilience in a number of ways. Firstly, the ecological impact of local trade lessens the carbon footprint normally involved in growing and transporting food across long distances. It also manages the quality of produce, as consumer demand and personal relations can bring about high quality goods. Responses from the study showed many people's interest in quality, organic food, also helping to promote sustainable growing practices in the community. Many of the producers in the ASBC currently grow organic produce, so this initiative would engage the resources in a novel way, rather than requiring front-end investments in education or practice prior to commencement. A local market's

immediate accessibility provides a great entry point. Of the many beneficial components of this specific Transition Initiative, the advantages of leading with local organic markets are many. It is an accessible route, in which people alter their behaviors through actions practiced every week, if not every day. As a survival necessity, there is much support to stabilize food systems for the benefit of the people. In sustenance communities, time spent growing, harvesting, processing, and planning for food can be additionally utilized for better food sustainability[1]. Furthermore, aligned with the goals of the ASBC as a biological corridor, it has "been seen with small local food systems [that] instrumental motivations for consumption of local organic food translated into greater environmental awareness and ecological citizenship" (Seyfang and Haxeltine, 2012, pg. 395). This market could further promote identification as community ecological stewards, as well as bolster overall resilience of the SES.

From this research project, community plant-based capitals have been explored as a way to assess community resources in the face of livelihood instability among *campesino* farmers in the ASBC. Following the measurement of these community capitals, desire for and feasibility of a local market were investigated to further ascertain if the communities residing in the ASBC would support a Transition Initiative that would simultaneously uphold ecological protection principles held in the Corridor and provide stability for household livelihoods. Specifically, communities in the ASBC resilience have been tested by declining coffee yields and limited options for livelihood diversification. A large part of supporting community and livelihood resilience is in the creation of new and diverse opportunities in the Corridor.

[1] For the purpose of this Major Paper, 'food sustainability' is a term that is used to generally point to the idea that food and food systems should be able to continue over time in culturally significant and ecologically sound ways, also encompassing food sovereignty and food security.

Due to the female gender bias of respondents in this study, much of the information collected reflects the values and community capacities of women in the ASBC. In general rural women disproportionately bear the burden of poverty at times when households are vulnerable, such as they are from *Roya* (UN Women, 1995; United Nations, 2006). This fact, however, relies on the extent of adaptive capacities held by women (Ketlhoilwe, 2013). Women were generally the tenders of the home garden, growing the food, medicine, ornamental, and other plants for the household. Therefore, women held significant plant-based community capacity. While most female participants responded that their livelihood was as *ama de casa* and that their husbands' livelihoods were responsible for household income, women's knowledge, skills, and plant-based goods production are valuable assets that could be engaged to generate household and community resilience. If women were to sell their plant-based goods, skills, and services at a local market, the household livelihood profile could be diversified, bringing not only extra income but also greater stability in the face of *Roya* threat. Women's involvement in a local market builds social resilience by stabilizing households and creating connectivity networks for women to share their knowledge, skills, and products, as well as support each other during tough economic times (Buchmann, 2009). Partaking in a local market could assist the women of the ASBC to empower themselves socially and economically by introducing new entrepreneurial activities as well as further organizing existing efforts based on sustainable management of home gardens (Ketlyhoilwe, 2013). In turn, supporting the diversity of livelihoods for the household supports the resilience of the household and the larger community as a whole. A clear positive attribution to this model is that it employs knowledge, skills, and goods already practiced and produced by the household so it would not

exert added pressures on land resources and uses already established knowledge. Stated above, it also engages economically under attended members of the community; women.

Overall, support for the prospective local market was backed by participants' wants and needs as well as by existing community capital in the ASBC. Engaging community members- women, specifically- to use their knowledge, skills, and production from their home gardens as an additional source of livelihood at a local market has numerous positive possible outcomes for the sustainable resilience of ecological and social communities in the Corridor against the risks associated with monocrop industry.

10. Conclusion

10.1 Theoretical Implications

The research project was inspired by existing social and economic vulnerabilities in the ASBC resulting from the devastation of coffee crops by *Roya* rust-fungus and the negative effects that low harvests have had on *campesino* livelihoods. In addition to the vulnerabilities felt by households, there exist potential negative consequences to the entire connected social-ecological system, as poor harvests and instable incomes move the system away from a stable state. To address this instability, this project applied Resilience Theory through the measurement and growth of community capitals, and the possible introduction of a local market. Using the established connection between people and plants- founded through a history of agricultural livelihoods-the community assets measured reflected plant-based knowledge, goods, and services. Findings supported that plant-based community capitals were abundantly available to be managed to address vulnerability. This exhibits resilience of the communities in the Corridor, and supports both social and ecological sustainability, and strength.

Working at engaging resilience assets at the community level- where community is defined as the entire human population of the ASBC-was a useful scale for identifying, considering, and researching possible action options when addressing vulnerability. The usefulness of this scale was in understanding the power of social networks and connectivity as well as the power of local grassroots activism in addressing social-ecological issues.

These findings support theory suggesting that resilience assets activated at the community level is an effective tool to address vulnerabilities in social-ecological systems in rural areas.

10.2 Practical Implications

The practical implications of this study are the possibility of actualizing the local market Transition Initiative, as well as the possibility of carrying out the community supplied suggestions for the project, with the support of data recorded during the study. For the local market, the distribution, supply, and demand for plant-based goods and services found through this study present real and useful data that can be engaged to take the first steps towards creating a market, localizing trade, diversifying livelihood profiles for the household and engaging women's work in the home garden in new ways. Application of the information found in the study for other community suggestions- such as a learning centre, medicinal plant book, or map of plant-production in the ASBC – are also possible from existing information and would need resource and attention to become realized.

Furthermore, this project was carried out in a biological corridor, designated as such by the people who live there. This adds a challenge to stability because there are self-imposed rules about what can and cannot be done as options for diversifying livelihoods. Introducing diverse livelihoods through a local market engages resilience measures that still uphold the ecological protection measures of the Alexander Skutch Biological Corridor. It is possible to apply this model to other similar scenarios in Latin America and beyond.

10.3 Recommendations

As mentioned in the methods and findings section, interviews for this project were held during the day (generally between 7:30am-11:00am), at participants' homes. This timing was chosen to avoid the seasonal afternoon rains, as travel between homes took place on foot. The livelihoods of most men in the ASBC are in agriculture (coffee, sugar cane, and other crops), therefore the time of day and location of the interviews created a gender misrepresentation within the sample, exhibiting more women than men in comparison with the actual gender distribution of the Corridor. While the positive implications for a specifically female participant sample became clear throughout the project, the study could have benefitted from a more representative sample to include the knowledge and opinions of more men in the ASBC. To expand this study, recommendations would be to include interviews at varying times to support a more representative view of the Corridor. Alternatively, this study could be improved through a different focus of specifically women in the Corridor.

10.4 Future Directions for Research

The findings of this study strongly suggest that a local market is desired by the communities of the Alexander Skutch Biological Corridor, and furthermore that the priorities for food purchasing could be met by the creation of a local market (low prices, ease of access, organic food availability, and quality). Therefore, in order to apply the findings of this project and establish a local market, further studies could help set the foundation for beginning this process. Firstly, the planning and logistical elements of creating a local market would be an essential focus. What are important attributes of a local market? How would decisions regarding the local market be made? Who would have a say in directing the decisions? Where

would the market be held? How would the market function? When would it be held? How would transactions take place? A deeper look into the creation of a local market in the ASBC would be a good first step towards actualizing the local market Transition Initiative. Resources available from successful Transition Town Initiatives around the globe could be explored and activated to best focus this future research. With a clearer picture of the structure for a local market, steps could be made to begin the market.

Building upon the creation of a local market, further useful research could potentially surround the growth of women's groups in the Corridor and their involvement in the local market. As the findings of this study reflected women's roles as head of household and cultivators of the home garden among many others, there is the possibility of empowering women further by matching skills with opportunities created from the formation of a local market. This would be an additional community asset that could add to the resilience profile of the SES that is the Alexander Skutch Biological Corridor.

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Appendix A

Plant Lists by Use Category

Food Plants (*Alimentos*)

1. abufe
2. abuticaba
3. aguacate
4. Ajo
5. albahaca
6. amapola
7. anono
8. apio
9. arracache
10. aruguña no tiene sabor
11. ayote
12. azará (juice) (same as guayaba azará)
13. azúcar
14. banana (bmanano)
15. berrus
16. brocoli
17. cacao
18. Café
19. caimite
20. caimito
21. camote
22. caña
23. caña de azucar
24. canela
25. carambola
26. cas
27. cebollino
28. cebollo
29. chayote
30. chicano
31. chile dulce
32. chile dulce
33. chile picante
34. chiles
35. chino
36. chirasku
37. chiricana
38. chiritis
39. chirrcono
40. chiverres
41. chuca
42. cilantro (also called cilantro de castilla)
43. cocos
44. coliflor
45. Corteza
46. crollo
47. culantro coyote
48. diatono
49. ejote
50. esparagos
51. espinaca
52. Flor de itabo
53. fresas
54. frijol
55. grumichama
56. guaba
57. guanabana
58. guarimo
59. guatimo (for animals)
60. guaya
61. guayaba
62. guineo

63. guineo negro (también se usa para combatir anemia)
64. hinojo
65. indian coffee
66. inojo
67. jacote
68. Jarba
69. juanilama
70. lechuga
71. lichi
72. limón
73. limón agria
74. limón dulce
75. loroco
76. maíz
77. malanga
78. mamón
79. mamón chino
80. mandarina
81. manga
82. mango
83. mangustán
84. maní
85. manzana
86. manzana de agua
87. manzana de rosa
88. manzana de Washington
89. maracuyá
90. marañón (cashew) (para bajar azuqcar)
91. melon
92. melón de montaña
93. Menta
94. mora
95. mostaza
96. Ñame (miel y puro)
97. ñampi
98. naranja
99. naranjilla
100. nispero
101. olivo
102. oregano
103. Palma
104. palma Africana (para aceite)
105. palmas de coco
106. palmera (also ornamental)
107. Palmito
108. palo
109. papa
110. papaua de exportación
111. papaya
112. papija
113. pasto
114. pejibaye (peach of palm)
115. pepino
116. perejil
117. picante
118. piña
119. pipa
120. palma real (techos y aceite)
121. plátano
122. plutoro
123. puerro (tipo de).
124. quiwi
125. rábano

126. remoulacha
127. repollo
128. romero
129. sabila
130. sandía
131. Sandropoli
132. scripper tree (eat young leaves)
133. tiquisqiue
134. tomate
135. Tomatillo
136. tomillo
137. tucuico (para comida de pájaros)
138. uva caliente
139. uva tica
140. uvas
141. vainica de picadillo
142. vainica
143. yucca
144. yuplón
145. Zanabollo
146. zanahoria
147. zancolla
148. Zapata
149. Zapollo
150. zuqini verde

Medicinal Plants (*Medicinales*)

Plant name (common name, in Spanish):	Plant use and preparation if given:
1. 7 hierbos estomagos	
2. **ajenjos**	• For nerves.
3. **achiote**	• 3 seeds for ulcers used in fasting.
4. **ajo**	• Cough
5. **altamisa**	• For nerves
6. **amapola**	• Heat the flowers in tea, along with the herbs.
7. **anis**	
8. **apazote**	• For parasites
9. **árbol de canela**	
10. **azul de mata**	• Good for skin and hair • To prepare: make a bath from it • For strokes • Anti-inflammatory
11. **borraja**	• Heat it up

12. **café**	
13. **calzoncillos**	• *Note:* (passiflora biflora-underwear/m/f leaves look like underwear- use leaves by gender. • Good for kidney
14. **caña agria**	• Good for kidney
15. **canela**	
16. **cañera**	
17. **carambola** (starfruit)	• Used to lower blood sugar.
18. **carao**	• Prepare *carao* in warm milk (boil) to treat anemia.
19. **cebolla**	• Treats cough.
20. **cebolla morada con limón ácido**	• Used to treat liquid bones. • Blend to treat.
21. **chanten**	• Prepare with chamomile and mango. • Used to treat upset stomach due to inflammation.
22. **chayote**	• To prepare: take 6 leaves and boil them in a liter of water to make tea. • Use to treat stomach inflammation. • Used to treat headache. • Used to treat fever. • Leaves used to treat asthma.
23. **chile**	
24. **chirca** (yellow oleander)	• Heart medicine
25. **cinnamon sticks**	• Helps to stop vomiting.
26. **cipres**	• Make a bath to help with gland problems. • Mix with mango leaves.
27. **cola de caballo**	• Stomach ache. • Treats waist pain. • Prostate. • Bone pain.
28. **cucaracha**	• Used to reduce sugar in the blood. • Diabetes treatment-regulates blood sugar. • Stomach pains • Menstrual pains • Anti-inflammatory

	• To prepare: make a tea from the leaves.
29. **culantro castilla**	• To prepare: cook the roots and leaves with milk, then drink. • Treats anemia.
30. **culantro coyote**	• To prepare: cook the roots and leaves with milk, then drink. • Treats anemia • The roots can be used to treat colic babies.
31. **diente de león**	• Mix products (parts of the plant) and smoke them. • Use sap in stem to treat warts.
32. **dormilona**	• Use for toothache.
33. **escalera de mano**	• Use for rheumatism • Use for diabeties
34. **eucalipto**	• Use as a gargle for sore throat.
35. **flor incensia**	
36. **gavilana**	• Use for stomach ache. • Use for parasites. • Use for cholesterol. • Remedy for atomizing crops.
37. **guanabana**	• Use the leaves, steep in tea. • Good for health, in general. • Used to lose weight. • Used to combat cancer. • Used to treat diarrhea.
38. **guapinol**	• Supports prostate health.
39. **guyaba**	• Used for upset stomach. • Use the “cojollos”, or small heart or flower of the guayaba. • Use the leaves to treat diarrhea and for colon health. • The leaves are good for stomach health.
40. **heliotrope**	
41. **hierbabuena**	• Peppermint/spearmint • Used to treat stomach-ache. • Make a tea for stomach ache, can add bee’s honey. • Used as a colon anti-inflammatory.

42. **hilan hilan**	• Used to treat pain from rheumatism.
43. **Hoja de estrella**	• Use leaves.
44. **hombre grande**	• Used to de-worm. • Used to treat pancreatic issues. • Used to regulate sugar for diabetes. • Used to treat stomach ache and diarrhea. • Used to bring down fever. • To prepare: boil leaves and sticks in water to make tea.
45. **inciensa**	
46. **itabo (yucca)**	
47. **Jinocuabe (indio pelado)**	• Used to treat gastritis. • Used for colon health. • Diuretic for stomach parasites.
48. **insienso**	• Burn for aroma.
49. **jengibre**	• Anti- inflammatory. • To prepare for anti-inflammatory: cut up ginger and put in 90 proof alcohol. Let sit a couple of days and rub on inflamed area. • Used to treat sore throat. • Used to treat cough. • To prepare: brew in tea, with lemon and bee's honey. • Nickname: "the miracle"
50. **jengibre azul**	
51. **jengibre rosado**	
52. **juanilama**	• Used to treat stomach ache. • Used to treat menstrual pain. • Used to treat gastritis. • Used to treat wounds. • Used for infections, anti-bacterial. • Used to reduce inflammation. • Used to calm nerves. • Used to treat kidney infections. • Prepare in tea.

	• Prepare leaves in tea. • Anti-nausea/vomiting. • Used to treat diahrrea. • Colitis • Used for colon health, to treat infections of the colon. • Used to treat stomach-ache. • Anti-inflammatory for stomach. • Kills germs/antibiotic to treat infections. • Good for bladder health. • Used to treat headaches. • Used in cooking as a lemon flavor. • Mixed with mint for intestinal problems. • Used to treat spasms. • For losing weight, normalizing sugar levels, raise body defenses.
53. **juanilama con limón**	• Guanilama and lemon used together can be used to wash wounds- soak cloth and apply to wound.
54. **juanilama con zacate de limón**	• Guanilama with Zacate de Limón is used to treat stomach-ache. • Used to treat colon health. • To prepare: make tea.
55. **lengua de suegra**	• Used to purify air. • Used to purify lungs. • Used for allergies and asthma. • To use: just place indoors!
56. **limón**	• Source of vitamin C
57. **limón acido**	• To help regulate cholesterol.
58. **linaza**	• For cleaning and refreshing the stomach. • Used to treat stomach-ache. • Used to normalize high blood pressure.
59. **llantén /plantain**	• Used to help with indigestion. • Used to treat sore throat. • Used to treat stomach-ache and stomach problems. • Can be prepared with juanilama.
60. **maiz, pelo de mais**	• Corn silk used for kidney health.
61. **manzanilla**	• Used to treat menstrual pain. • Used to treat stomach-ache.

	• Used to treat infections. • Used to combat parasites. • Used to regulate cholesterol. • Used as an anti-inflammatory • Used to soothe colic babies. • Mix with cucaracha and rosemary, cook, and use following childbirth to clean and as an anti-inflammatory. • To prepare: make a tea.
62. **marihuana**	• The roots are used to treat asthma and cough.
63. **menta**	• Mixed with Juanilama: used to treat stomach-ache, stomach problems. • Used to flavor foods. • Used to treat stomach-ache/stomach pain. • Used to treat colitis. • Used to treat insomnia. • Used to treat gastritis. • Used to promote colon health and treat colon infections. • Used to treat nerves and promote relaxation. • Used to promote healthy digestion. • To prepare: steep leaves in hot water to make tea. Can add bee's honey to tea.
64. **mirra**	• Used as incense, aroma.
65. **mozote**	• Refreshes the stomach.
66. **naranja agria**	• To prepare: Make a tea of the small heart or flower of the plant. • To prepare: put leaves in a bath, with water or milk for children. • Used to treat insomnia. • Used to treat nerves. • Can be used for drinks and for salads.
67. **noni**	• Edible as a fruit. • Used for healthy skin and hair. • Used for weight loss. • Used to treat gastritis. • Used as an anti-cancer medicine.

	• Cures sicknesses/boost immunity.
68. **oregano**	• Used to marinate meat and food. • Used for cough. • To prepare for cough: cook in milk (or water) and drink. • Used for digestion and stomach ache. • Prepare a tea for relaxation. • Used to treat bladder and colon infections.
69. **ortiga** (nettle)	
70. **citronella**	• Used for cleaning.
71. jugo de **papa**	• Used to treat stomach pain. • Used to treat gastritis. • Used to treat colitis.
72. **papaya**	• Used to treat constipation. • Used to treat stomach ache. • Use leaves to make tea, and use as a laxative. • Leaf tea used to promote liver health.
73. **pichichio**	• Used to treat sinusitis.
74. **reina de la noche**	• Used to treat infection in the throat.
75. **romero**	• To treat migraines. • To prepare for migraines: 30 grams of rosemary in a liter of water, boil, then put in the fridgeto cool and drink 3 glasses per day. • Use for healthy hair (it is a vitamin for the cranium/skull). • Anti-inflammatory. • To prepare for anti-inflammatory: boil water with rosemary then wet cloths and apply to inflamed area. OR Mix with alcohol, allow to sit, and then use infused alcohol as a rub. • Heals and cleans wounds. • Used to increase circulation. • Boil in water and inhale for internal anti-inflammatory. • For ear aches, heat with lard.
76. **ruda**	• Used to treat earache. • To prepare for earache: mix with oil and apply. OR Prepare with garlic and apply. • Used to wash wounds.

	• Used for stomach-ache by drinking tea. • Used to treat rheumatism. • Tea used for menstrual blood circulation. Gargle tea. • Used to clean ovaries and as a douche. • Used to treat varicose veins in legs. • To prepare for varicose veins: put in alcohol (methyl) and rub on legs.
77. **Sábila**	• Anti-inflammatory • Heals wounds • Refreshes stomach. • Used to treat upset stomach. • Used to treat gastritis and stomach pains. • Treats skin burns. • Good for healthy skin/pores and hair (drink it). • Heals infections of the skin on the face. • Helps skin to tan following sun exposure. • Direct application: skin, hair, stomach, colon. • Good for colon health. • To prepare for gastritis: mix Coscarita (dried cacao husks) and Liqua (spirulina), remove the peel from the aloe and stir them all together with orange juice and liquor.
78. **saduco**	• Used to refresh the body.
79. **saliva**	• Used to treat stomach gas. • Used to treat colitis (inflammation of the colon and large intestines). • To prepare for colitis: cook a tea with saliva, guanilama, and mint. • Used to treat inflammations. • Used to treat headache. • Used to treat women's pains.
80. **salvia santa**	• Used to treat infection.
81. **Salvia virgen**	
82. **saragumdi**	
83. **sarangunar**	• Prepared in tea, used to treat burns and swelling.
84. **tilo**	• Tea used to calm nerves (also stomach

	nerves) and bring relaxation. • Used to treat rheumatism.
85. **tomillo**	
86. **toronjil**	
87. **tuna**	• Used for kidney health. • Used for reducing hair loss.
88. **vainilla**	
89. **veraneras**	
90. **virgato**	
91. **yantén**	• Used to treat gland infections. • Used to treat fever. • Used for stomach-ache.
92. **zabiola**	
93. **zacate de limón**	• Used to treat colds. • Used to treat bronchitis. • Used to combat cough and refresh lungs. • Used to treat asthma. • Used to treat swollen glands. • To prepare for cough: put plant sap in a tea, mix with ginger and bee's honey. Also: Heat plant and gargle tea.
94. **zaragumdi**	• Used for rheumatism. • Used for bone pain.

Ornamental Plants (*Ornamentales*)

1. ajillo
2. almendro
3. alta misa
4. amapola

5. amarillon
6. Amariuia
7. anturios
8. arañas (orchid)
9. asmi de mora
10. asromelia
11. ave de paraiso
12. azalea
13. azucenas
14. azulillo
15. bailana
16. bailano gigante
17. bailarina (cactus)
18. bananilo
19. bananito
20. baston de emerado
21. begonia
22. bomda (orchid)
23. brassias scaphiglottis (orchid)
24. bravo zorro (purple)
25. bulbophylym (orchid)
26. cactus
27. cala
28. calita
29. camaridium (orchid)
30. camaronsillo
31. cambiai
32. cameila
33. caña agua
34. caña India (vino)
35. canastilla
36. canidas (orchid)
37. caño India pequeña
38. cansol
39. cara de mola
40. catasetum (orchid)
41. catlleyas (orchid)
42. cerdro
43. chinas
44. chiritis
45. chirrite
46. chora
47. cipies(orchid)
48. cladio (orchid)
49. clavel
50. clavelon
51. clivia
52. cobija de pobre (poor blanket)
53. colcanas
54. corbata
55. cordilines
56. corneta
57. corona de cristo
58. crisantema
59. croquida blanco
60. crotos
61. cuantro vientos
62. dalia
63. dendrobium(orchid)
64. dose apostoles
65. dracaenas
66. elechon
67. eliconra
68. enredadera raspa morada

69. epidendrons
70. espirito santa (orchid)
71. eucaristia
72. flor de muerto
73. floxinia
74. galiottas polidota(orchid)
75. garrión
76. garrobo
77. geranio
78. gingebre rojo
79. ginger
80. gladiola
81. gladiolas camoron
82. gorrion
83. gualla morada (orchid)
84. guana (orchid)
85. guaria morada
86. guarianthes (orchid)
87. güitite
88. halapas
89. helecho
90. helecho arbolesentes
91. heliconia
92. hibrias
93. higuerilla (castor)
94. higuerón
95. hortensia
96. iris
97. jalapa (amarillo y morado)
98. jardines
99. jazmin
100. jazmin de cafe
101. jicara
102. jirasoles
103. juanita
104. labios de mujer
105. lagrimo de Maria (tears of Maria)
106. lantana
107. lantoro
108. licastes (orchid)
109. liria
110. lirio
111. lirios azara
112. lluvias de oro (orchid)
113. locaria
114. lorito
115. loteria
116. liririos
117. luzinia
118. macroclinium (orchid)
119. magnolia
120. mañana gloriosa
121. maravilla
122. mariposa
123. maro de tigre
124. masdevallias (orchid)
125. matrimonio
126. maxillarias (orchid)
127. moja pintada
128. narsiso
129. naturios
130. nazareno
131. nicatagua
132. notilias (orchid)

133. ocanstra
134. oncidium (orchid)
135. guarumo (also MEDICINAL)
136. orquideas
137. ortensia
138. osmunda (helecho that looks like a palm)
139. palma de pejiballe
140. palma
141. palmera fenix
142. palmeras
143. pama o crisamntema
144. papiro enano
145. parásitas (ephiphites)
146. pasculta
147. pasiflora (passion flower)
148. pastora
149. peniseton morado
150. perlo de oro
151. petunia
152. piña
153. pino
154. pinoeles
155. planillo
156. plantas tropicale
157. platanillo
158. pleurothallis (orchid)
159. pluma da indro
160. poda mono
161. pomas
162. prehistoria
163. raspa guacal
164. rastrata
165. reina de la noche (cortada y droga)
166. roble de sabana
167. rosa del monte
168. rosa muerto
169. rosa
170. rosa poma
171. rosado
172. roxinia
173. sabralies (orchid)
174. San Juan
175. sauce
176. sen
177. sobralujas (orchid)
178. sota caballo
179. speclynias (orchid)
180. stellis (orchid)
181. tabacón
182. teresita
183. tucuico (bird food)
184. uña de gato
185. uña de tigre
186. uruca
187. vandas (orchid)
188. varia de san jos
189. vegonerias sin flor
190. veranera
191. verdolaga
192. verengeras
193. vetulias
194. violeta insienso
195. violeta

196. vulcanas

197. zota (orillas de rios)

Fruits (*Frutales*)

1. abiu
2. aboticave
3. aguacate
4. ananas
5. anona
6. arazán
7. avio
8. aycte
9. azara
10. banano
11. cacao
12. café
13. caimito
14. carambola
15. cas
16. cereza pitanga
17. chayote
18. ciruela
19. coco
20. corcho
21. cruelus
22. dulce
23. durasno
24. flor de itabo
25. frambuesa silvestre
26. fresas
27. fruta de pan
28. fruta sagrada (la que combio el gusto)
29. grada
30. granadilla
31. guanabana
32. guapino
33. guava
34. guayaba
35. guayaba Peruana
36. guineo
37. guineo negro
38. guisara
39. guititi
40. higo
41. igos
42. jocote
43. limón
44. limón ácido
45. limón dulce
46. limonsillo
47. mamón
48. mamón chino
49. mandarina
50. manga
51. mango
52. mangustán
53. mangustino
54. manzana
55. manzana de agua
56. manzana de rosa

57. maracuyá
58. marañon
59. mecino
60. melocaton
61. melon
62. mora
63. mozote
64. naranja
65. naranja agria
66. nectarinas
67. níspero
68. nonis
69. palmas de agria
70. palmeras
71. pap miel
72. papaya
73. papaya
74. pejiballe
75. pera
76. peruana
77. piña
78. piña criolla
79. pipas
80. plátano
81. quiwi
82. rocotes
83. sagú
84. sandia
85. socolla
86. soncoya
87. supollas
88. toronja (grapefruit)
89. tucuico (for birds)
90. uva
91. yuplón
92. zapote

Lumber trees (*Maderables*)

1. acacia
2. aceituno (native tree)
3. aguacatón
4. almendro
5. amargo
6. amarillión
7. arrocillo (native tree)
8. aspabel
9. cacique (extinct)
10. campona (extinct)
11. caoba
12. carao
13. cardillne
14. caretigre
15. cas (native tree)
16. cascarilo
17. cedar
18. cedilla
19. cedro
20. ceibo

21. cenisaro
22. centizario
23. cerrillo
24. chancho blanco
25. chanta (native palm)
26. cipres
27. colorado (extinct)
28. cortez amarillo
29. corteza
30. cristóbal
31. despabel
32. dulce y amargo
33. el zota
34. ensino
35. eucalipto
36. fosforillo
37. guaba (native tree)
38. guachipelin (native tree)
39. guanacate
40. guariplilia (birds)
41. Guarumo (native tree)
42. guayacan
43. ira
44. irarosa (extinct)
45. jacarandas
46. jimocuabe (native tree)
47. lechocho
48. madero negro
49. magnolia
50. malinche
51. mana
52. maría
53. mayo (native tree)
54. mayo blanco
55. mayo colorado
56. melina
57. murta (birds like these)
58. nazoreno
59. pandanun verde
60. pino
61. pochote
62. quizarrá
63. roble
64. roble de sabana (oak)
65. ron ron
66. sota
67. taragua
68. teca
69. tiquizara
70. tiquizaro (extinct)
71. tirra
72. virino
73. wachipelin
74. yuró

Other/Miscellaneous uses (*Otros*)

(Grasses/ Pasture)

1. estrella

2. africana
3. caño
4. hueca
5. pasto para Ganado

(Shade)

1. paro
2. guaba
3. frutas de aves
4. cerillo
5. tucuico
6. mansanita

(Commerce)

1. café
2. poro
3. sota
4. palma aceitera
5. caña
6. café
7. platano

(Other)

1. papa ojo che casfaña
2. forio gus
3. San Miguel

Recreational Use for Birds (*Recreación Para aves*)

1. tucuico
2. murta
3. guariplilia

Art (*Arte*)

1. bambu (yellow and green)

Appendix B

Entrevista para el proyecto: *Comunidades y resiliencia ecológica: localización intencional del comercio de productos a base de plantas en el Corredor Biológico Alexander Skutch*

Informaciones para los participantes (antes de hacer la entrevista):

Me llamo Maris Grundy y soy estudiante en la Universidad de York, ubicada en Canadá. Estoy haciendo esta investigación para mi tesis de maestría en Ciencias ambientales. No hablo español perfectamente, así que una traductora me va a ayudar durante éste proyecto y usted la va ver conmigo. ¡Muchas gracias por estar aquí!

Mi investigación se llama *Comunidades y resiliencia ecológica: localización intencional del comercio de productos a base de plantas en el corredor biológico Alexander Skutch*, y tiene dos objetivos. El primer objetivo es de crear un mapa que identifica cuáles son las plantas que se utilizan en el corredor y para qué uso. Con esa información se va a poder establecer una red para entender lo que se produce con las plantas, y quien lo produce. Finalmente, este proyecto trata de descubrir si a los residentes del corredor les interesaría tener un mercado local para vender lo que producen en su casa y así tener más opciones de ingresos.

Durante el proyecto, hay un término recurrente que debe ser definido y aclarado. El término es "producto a base de plantas". Este término se refiere a cualquier planta que es útil o a cualquier cosa que se produce con una planta. En el caso de este estudio, este término cubrirá alimentos, medicinas, materiales de construcción, combustible, materiales de arte, uso espiritual o cultural y para el ocio, o cualquier otra cosa que se crea a partir de una planta que no entran en estas categorías. Si en algún momento durante el estudio no está seguro de si un producto es de origen vegetal, puede preguntarnos.

Entrevista para el proyecto: *Comunidades y resiliencia ecológica: localización intencional del comercio de productos a base de plantas en el Corredor Biológico Alexander Skutch*

Fecha:

Entrevista:

Dirección:

Parte 1: Información personal

1. ¿Cuál es su nombre?:
2. .Hombre / Mujer:
3. Edad:
4. ¿Cuántas personas viven en su hogar? :
5. ¿Cuál es su principal ocupación o fuente de ingreso? :
6. ¿Cuánto tiempo ha hecho esto? :

Parte 2: Conocimiento de las plantas

7. ¿Puede por favor hacer una lista de todas las plantas que usted conozca? :

8. De esta lista, explique qué uso tiene cada planta (alimento, medicamento, combustible, material de construcción, material de arte espiritual / cultural, ocio, otros) ** Nota para el entrevistador: vuelve a leer la lista y tome nota de los cuales se aplican para cada planta.*
9. ¿Con qué frecuencia trabaja con las plantas, y cuáles son?

10. ¿Qué plantas son las más importantes para usted, y por qué?

11. En una escala de 1 a 5, siente que conoce bien las plantas en su entorno?

    1 = no **2** = un poco **3** = bien **4** = muy bien **5** = como experto

12. ¿Quién en su familia sabe más acerca de las plantas?

<u>Parte 3: productos a base de plantas</u>

13. ¿De las cosas que usted produce, vende usted algunos de ellos fuera de su casa o las producen principalmente para consumir en casa?

14. Si usted vende los productos a base de plantas fuera de su casa, ¿dónde los venden?

15. Si usted vende los productos a base de plantas fuera de su casa, ¿por qué usted los vende en ese lugar?

Parte 4: Consumo

16. ¿Cuáles son los principales productos a base de plantas que consumen en su hogar, y para qué?

17. ¿Cuáles son los tipos de alimentos que usted compra más?

18. ¿Dónde compra la mayor parte de su comida? ¿Y por qué la compra allí?

Parte 5: El interés por un mercado local

19. ¿Estaría usted interesado en un mercado local para estos productos? ¿Por qué sí o por qué no?

20. ¿Si hubiera un mercado local cuáles son los productos que le gustaría comprar?

21. ¿Qué le gustaría vender si hubiera un mercado local?

Preguntas para concluir la entrevista:

22. ¿Hay algo en particular que le gustaría que se hiciera con la información que estoy recogiendo?

23. ¿Quiere dar otra información o hacer cualquier comentario?

Si usted está interesado/a en ser contactado acerca de un mercado local, puede dejar sus datos:

Teléfono:

Correo electrónico:

**** Finalmente, ¿me da permiso de tomar fotos de su casa, finca, huerta, y de usted?

Sí: ☐ **No:** ☐


THEY TRIED
TO BURY US.
THEY DIDN'T
KNOW WE
WERE SEEDS.
mexican proverb