Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Benton County, Oregon

This community storybook was developed by Transtria LLC.

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Introduction

Creciendo en Salud is one of 49 community partnerships participating in the national *Healthy Kids, Healthy Communities* program of the Robert Wood Johnson Foundation (www.healthykidshealthycommunities.org). The purpose of this *Creciendo en Salud* project was to introduce systems thinking at the community level by identifying the essential parts of the Benton County, Oregon system and how the system influences policy and environmental changes to promote healthy eating and active living as well as to prevent childhood obesity. To accomplish this goal, community partners and residents participated in a group model building session and discussions. The group model building exercises were designed by staff from Transtria LLC and the Social System Design Lab at Washington University in St. Louis, Missouri as part of the *Evaluation of Healthy Kids, Healthy Communities* funded by the Robert Wood Johnson Foundation. These exercises actively involved a wide range of participants in modeling complex systems and provided a way for different representatives (e.g., government agencies, community-based organizations, universities) to better understand the systems (i.e., dynamics and structures) in the community (see the *Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook*, www.transtria.com/hkhc). Overall, the evaluation was designed to assess policy, system, and environmental changes as a result of the community partnerships' efforts to increase healthy eating and active living in order to reduce childhood obesity.

Benton County, Oregon: Background and Local Participation

Benton County, Oregon is located in the western portion of the state, in the Williamette Valley region (Figure 2). Benton County is the 11th largest county in Oregon with a total population of 85,579. Nearly two-thirds of Benton County residents live in Corvallis, approximately 20% live in unincorporated townships, rural farms, and rural residences (e.g. Monroe and Adair), and the remaining live in smaller towns including North Albany (pop. 7,258) and Philomath (pop. 4,584).

Benton County Health Department, Corvallis Parks and Recreation Department, and local nonprofit agencies formed the Creciendo en Salud (Growing in Health) partnership to improve the health status for youth and families in Benton County, Oregon, with a primary focus on lower-income children, Latinos, and children of seasonal farm workers. Benton County Health Department was the lead agency for the Creciendo en Salud partnership, but staffing and responsibilities were split between Benton County Health Department and Corvallis Parks and Recreation.

Although Creciendo en Salud was formally created as a result of HKHC funding, collaborations and informal partnerships focusing on healthy eating and active living existed for over ten years in Benton County. Created and funded in 2002, an interdisciplinary collaboration of Benton County departmental directors formed Healthy Active Community Environments. The group was tasked with addressing general policy and environmental changes, including the built environment, and its impact on the health of the community. The Healthy Active Community Environments partnership served as the impetus to seek HKHC funding and expand the county's efforts around healthy eating and active living. It continues to meet and receives Benton County general funds annually to support projects throughout the county. The BCHD director is a member of Healthy Active Community Environments, allowing the Healthy Active Community Environments and Creciendo en Salud to complement and support efforts across the county.

The partnership focused its efforts on primarily lower-income children and families, many of which are Latinos and children of migrant and seasonal farm workers, in the South Corvallis and surrounding unincorporated rural areas of Benton County. South Corvallis, once the industrial center of Corvallis, has seen substantial residential and commercial growth over the past decade and is now home to 6,780 residents with 42% of those persons living in households with incomes at or below 185% of the poverty level. Nearly 12% of South Corvallis residents identify as Hispanic/Latino.[5] The South Corvallis neighborhood is home to the Tunison neighborhood and Lincoln Elementary, populations specifically targeted by the partnership. Approximately, 36% of Lincoln Elementary students are Hispanic/Latino and 67.4% receive free/reduced lunch. South Benton County, including the City of Monroe, has a population of 3,808. Approximately 8.1% of south Benton County and Monroe residents identify as Latino, and 36.1% live below the federal poverty level.

Creciendo en Salud's Priorities and Strategies

The partnership and capacity building strategies of Creciendo en Salud included:

- **Community Engagement:** The partnership collaborated with many community organizations and residents to build trust and increase involvement among residents, particularly lower-income and minority populations, in policy development, advocacy, and community change.
- **Latino Engagement in Local Food Systems:** Benton County Health Department collaborated with the Oregon Food Bank and Western Oregon University to conduct community-based participatory research in Benton, Linn, and Polk counties to engage and involve Latinos in the local food system with the goal of improving access to healthy food.

The healthy eating and active living strategies of *Creciendo en Salud* included:

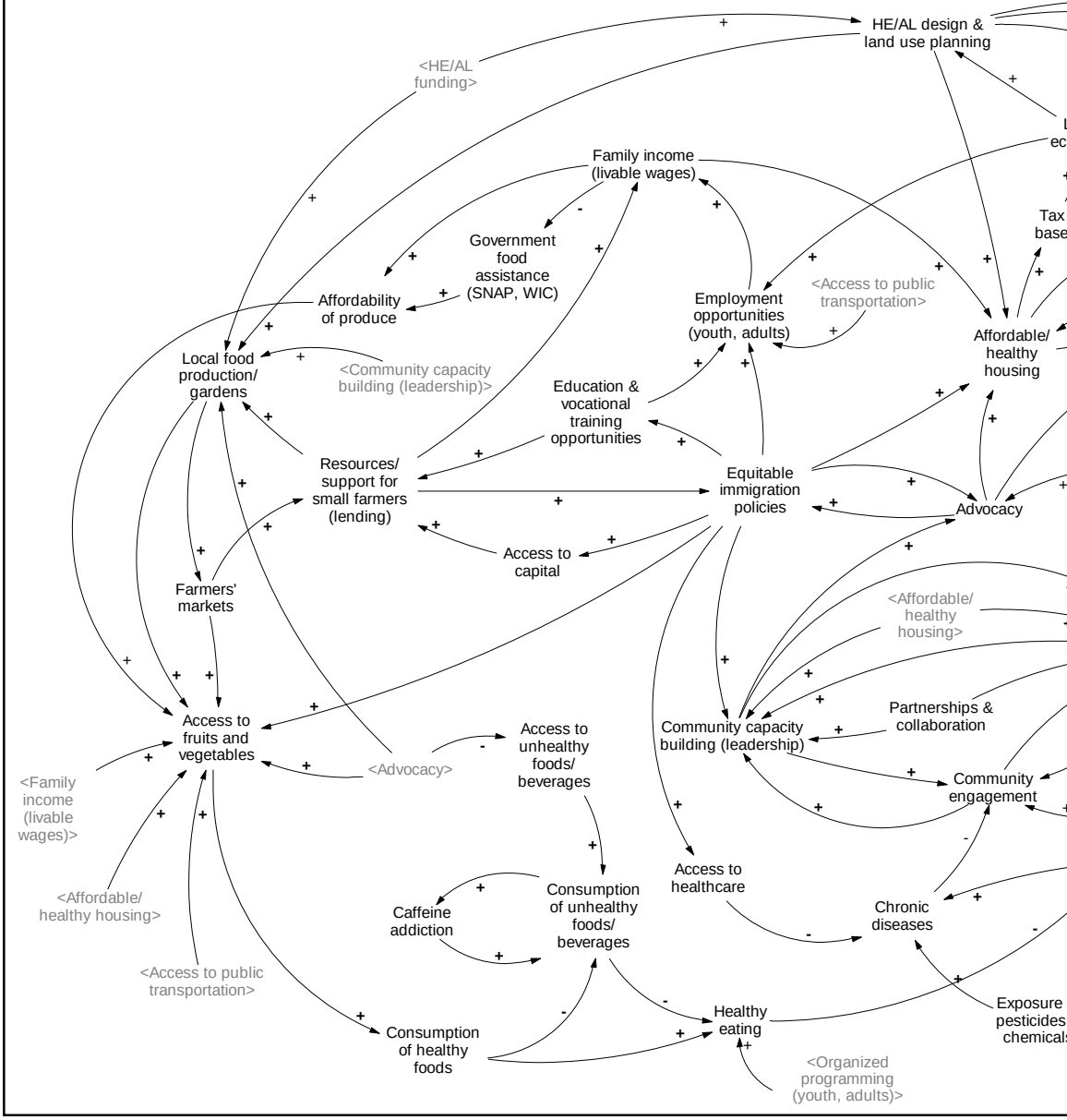
- **Parks and Play Spaces:** Creciendo en Salud worked to create new parks and play spaces and increase access to physical activity opportunities.
- **Healthy Eating:** The partnership worked to increase access to healthy food with policy implementation and community engagement around the local food system. Creciendo en Salud also partnered to support community garden efforts with a Community Garden Master Plan and new gardens throughout Benton County.
- **Active Transportation:** Creciendo en Salud focused on advocacy and community engagement to improve safe access to multi-modal transportation in South Corvallis.

For more information on the partnership, please refer to the Benton County case report (http://www.transtria.com/hkhc_case_reports.php).

Systems Thinking in Communities: Benton County, Oregon

"Systems thinking" represents a range of methods, tools, and approaches for observing the behaviors of a system (e.g., family, community, organization) and how these behaviors change over time; changes may occur in the past, present, or future. Figure 1 illustrates a system of policies, environments, local collaborations, and social determinants in Benton County, Oregon that influence healthy eating, active living, and, ultimately, childhood obesity. This system and the dynamics within the system are complicated with many different elements interacting.

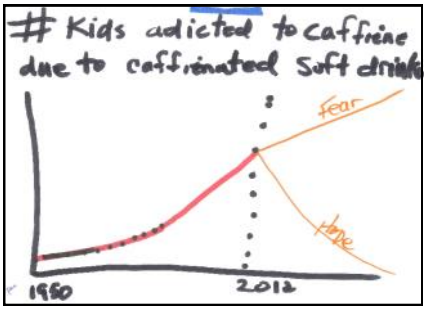
Figure 1: *Creciendo en Salud* Causal Loop Diagram



Models, such as Figure 1, provide a way to visualize all the elements of the system and their interactions, with a focus on causal relationships as opposed to associations. Through the model, specific types of causal relationships, or feedback loops, underlying the behavior of the dynamic system, can be identified to provide insights into what is working or not working in the system to support the intended outcomes (in this case, increases in healthy eating and active living, and decreases in childhood overweight and obesity). In system dynamics, the goal is to identify and understand the system feedback loops, or the cause-effect relationships that form a circuit where the effects "feed back" to influence the causes.

Group Model Building

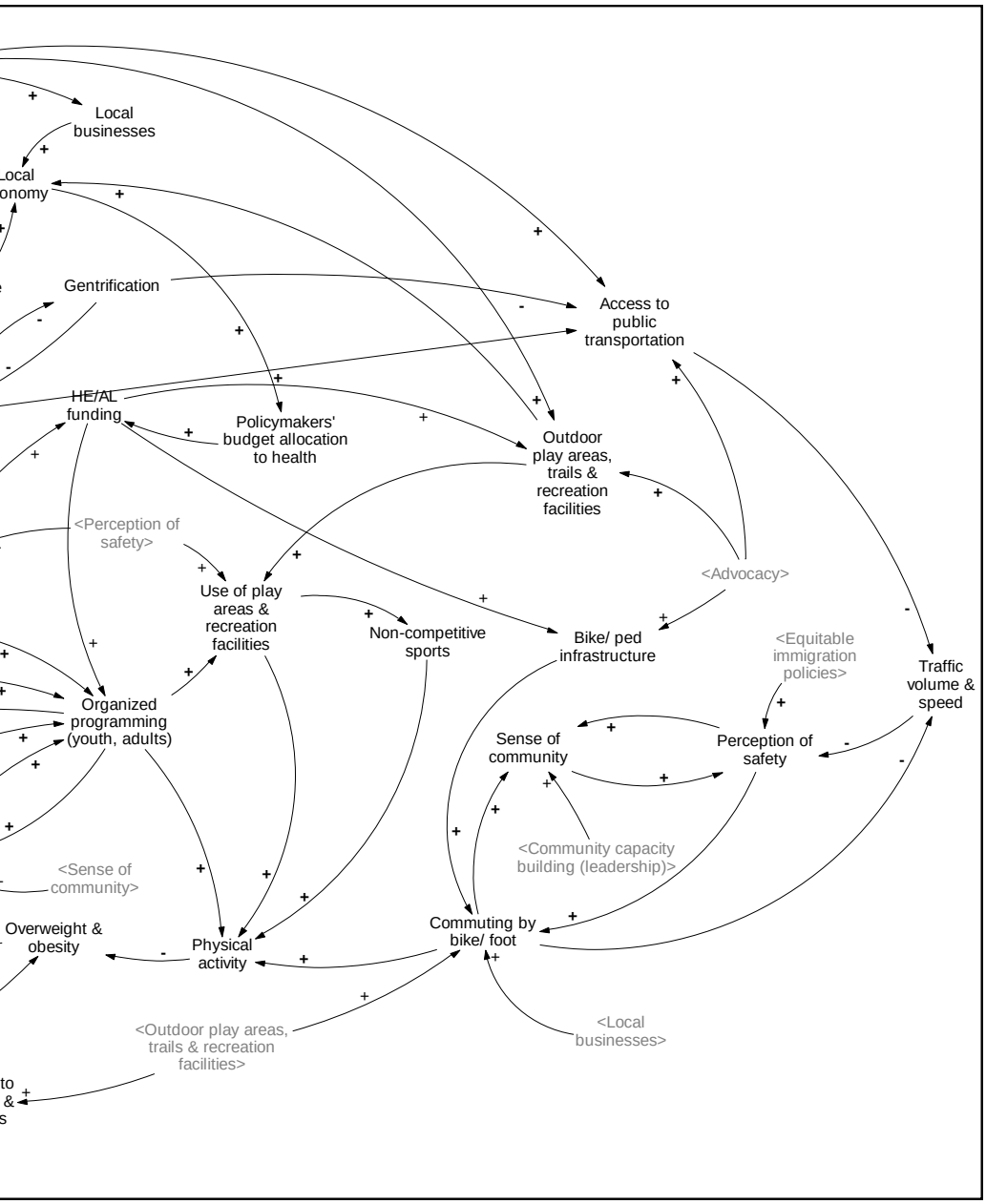
Members of the *Creciendo en Salud* partnership participated in a group model building session in June, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives from government agencies, community-based organizations, universities and advocates. The group model building session had two primary activities: 1) a Behavior Over Time Graph exercise; and 2) a Causal Loop Diagram (or structural elicitation) exercise.



<u>Behavior Over Time Graphs</u>

To identify the range of things that affect or are affected by policy, system, and environmental changes in Benton County related to healthy eating, active living, and childhood obesity, participants designed graphs to name the influences and to illustrate how the influences have changed over time

(past, present, and future). In this illustration, the number of kids addicted to caffeine due to the availability of caffeinated soft drinks has increased since 1950 to 2012 with the hope that the availability of caffeinated beverages and the number of kids addicted to caffeine will change and decrease into the future (see behavior over time graph top right). Each graph is a tool to increase the use of common, specific language to describe *what* is changing in the community as well as *when*, *where*, and *how* it is changing. The graphs capture participants' perceptions of the influence, or variable, and through the graph, the participant tells their story. These perceptions are based on actual data or evidence, or they are part of the participants' lived experience.



Causal Loop Diagram

To examine the relationships among the variables from the behavior over time graphs, participants worked together and with facilitators to develop a causal loop diagram. In Figure 1, the words represent variables of quantities that can increase and decrease over time (i.e., the behavior over time graphs). These variables are influenced by other variables as indicated by the lines with arrows. The lines with arrows represent causal relationships - this is what is known about the system and how it behaves.

For instance, there are many feedback loops influencing or influenced by organized programming for youth and adults in this causal loop diagram. One feedback loop is: organized programming (youth, adults) → community engagement → community capacity building and leadership → organized programming (youth, adults). A second feedback loop is: organized programming (youth, adults) → community capacity building and leadership → advocacy → healthy eating and active living funding → organized programming (youth, adults).

What is important to notice in these examples is that there are two different feedback loops interacting simultaneously to influence or to be influenced by organized programming (youth, adults). Some variables may increase organized programming (youth, adults) while other variables limit organized programming (youth, adults). Determining the feedback loop or loops that dominate the system's behavior at any given time is a more challenging problem to figure out, and ultimately, requires the use of computer simulations.

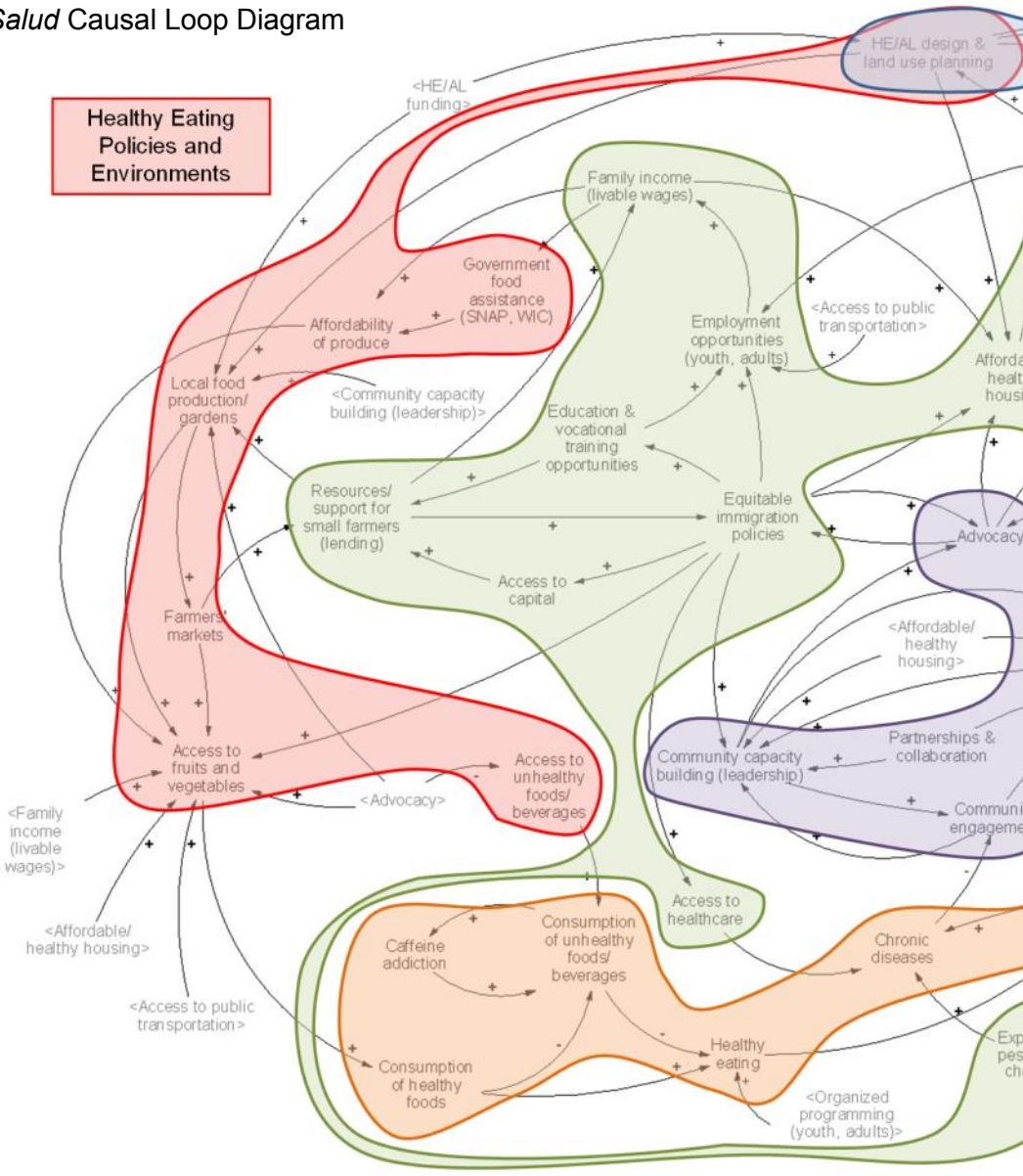
Based on this preliminary work by the *Creciendo en Salud* partnership, this "storybook" ties together the behavior over time graphs, the participants' stories and dialogue, and feedback loops from the causal loop diagram to understand the behavior of the system affecting health in Benton County, Oregon and to stimulate greater conversation related to Benton County's theory of change, including places to intervene in the system and opportunities to reinforce what is working. Each section builds on the previous sections by introducing concepts and notation from systems science.

Causal Loop Diagram for the Childhood Obesity System

The causal loop diagram (CLD) represents a holistic system and several subsystems interacting in Benton County, Oregon. In order to digest the depth and complexity of the diagram, it is helpful to examine the CLD in terms of the subsystems of influence. Because of this project's focus on healthy eating, active living, and childhood obesity, this system draws attention to a number of corresponding subsystems, including: healthy eating policies and environments (red), active living policies and environments (blue), health and health behaviors (orange), partnership and community capacity (purple), and social determinants (green).

From the group model building exercises, several variables and causal relationships illustrated in Figure 2 were identified within and across subsystems. This section describes the subsystems in the CLD.

Figure 2: Subsystems in the *Creciendo en Salud* Causal Loop Diagram



Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., local food production/gardens), food distribution and procurement (e.g., government food assistance SNAP, WIC), and food retail (e.g., farmers' markets). During the behavior over time graphs exercise, the participants generated eleven graphs related to policy or environmental strategies (e.g., farmers' markets) or contexts (e.g., affordability of produce) that affected or were affected by the work of *Creciendo en Salud*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

Active Living Policies and Environments (Blue)

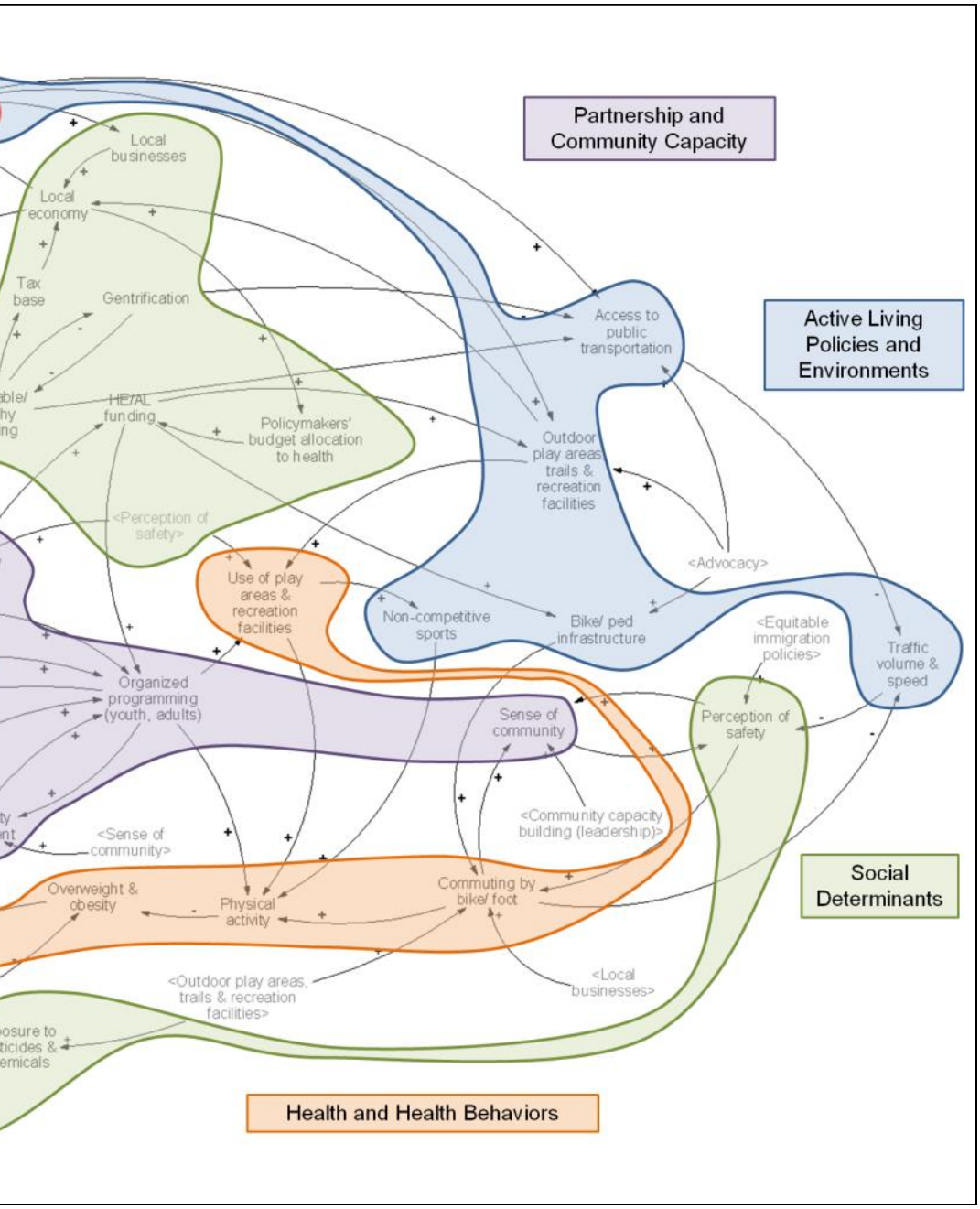
The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed ten graphs related to policy or environmental strategies (e.g., pedestrian and bike infrastructure) or contexts (e.g., non-competitive sports) that affected or were affected by the partnership's work.

Health and Health Behaviors (Orange)

The subsystem for health and health behaviors includes health outcomes (e.g., obesity), health behaviors (e.g., healthy eating, physical activity), and behavioral proxies or context-specific behaviors (e.g., caffeine addiction, , use of play areas and recreation facilities).

Partnership and Community Capacity

The partnership and community capacity subsystem refers to the ways communities organized and rallied for changes to the healthy eating and active living subsystems. For instance, *Creciendo en Salud* partnership collaborated with many community organizations and residents to build trust and increase involvement among residents, particularly lower-income and minority populations, in policy development, advocacy, and community change. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as organized programming.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., employment opportunities, family income, tax base) and psychosocial influences (e.g., affordable and healthy housing, gentrification) in the community that impact health beyond the healthy eating and active living subsystems. In order to achieve health equity, populations and subgroups within the community must have equitable access to these resources and services.

Each one of these subsystems has many more variables, causal relationships (arrows), and feedback loops that can be explored in greater depth by the *Creciendo en Salud* partners or by other representatives in Benton County, Oregon. Using this CLD as a starting place, community conversations about different theories of change within subsystems may continue to take place. For instance, these participants identified interest in understanding more about the relationships among organized programming, community engagement, and outdoor play areas, trails, and recreation facilities.

The next sections begin to examine the feedback loops central to the work of *Creciendo en Salud*. In these sections, causal relationships and notations (i.e., arrows, "+" signs, "-" signs) from Figure 2 will be described to increase understanding about how systems thinking and modeling tools can work in communities to increase understanding of complex problems that are continuously changing over time, such as childhood obesity. At the end of this CLD storybook, references to other resources will be provided for those interested in more advanced systems science methods and analytic approaches.

Healthy Vending/Farmers' Markets in Parks Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the Creciendo en Salud CLD (see Figures 1 and 2) are highlighted in Figures 3-8. While the CLD provides a theory of change for the childhood obesity prevention movement in Benton County, Oregon, each feedback loop tells a story about a more specific change process.

Causal Story for Feedback Loop

Story A: In this case , the story is about the healthy vending and farmers' markets in parks (green highlighted loop in Figure 3). Participants described how with more local food production and gardens, there is an increase in the number of vendors at the farmers' markets. With more farmers' markets, there is an increase in the resources and support for small farmers, which increases equitable immigration policies. In turn, with more equitable immigration policies, the healthy eating and active living advocacy efforts also increase, which continues to increase local food production and gardens.

Story B: While the preceding story reflected a positive scenario for Benton County, Oregon, the same feedback loop also tells the opposite story. With less local food production and gardens, there is a decrease in the number of vendors at the farmers' markets. With less farmers' markets, there is a decrease in the resources and support for small farmers, which decreases equitable immigration policies. In turn, with less equitable immigration policies, the healthy eating and active living advocacy efforts also decrease, which continues to decrease local food production and gardens.

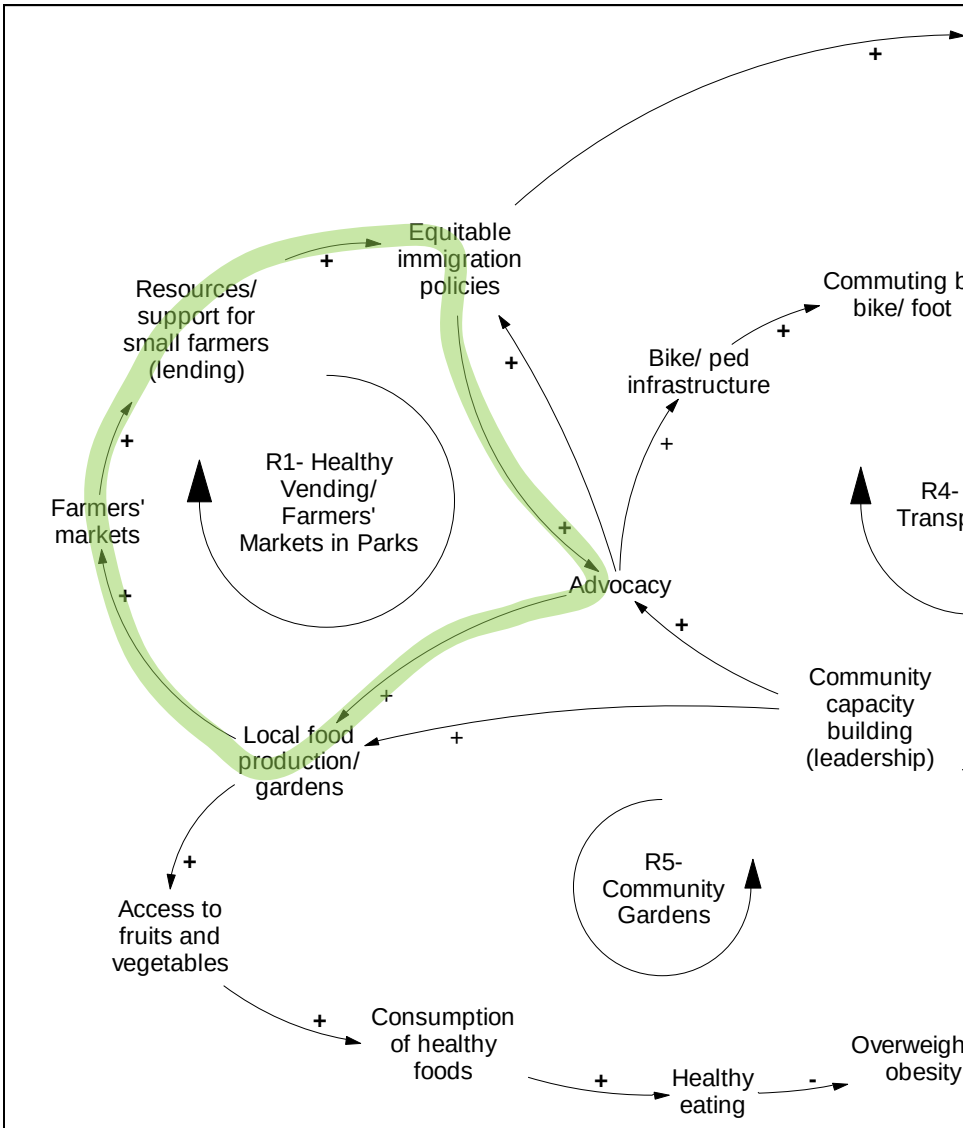


Figure 3: Healthy Vending/Farmers' Markets in Parks Feedback Loop

Reinforcing Loop and Notation

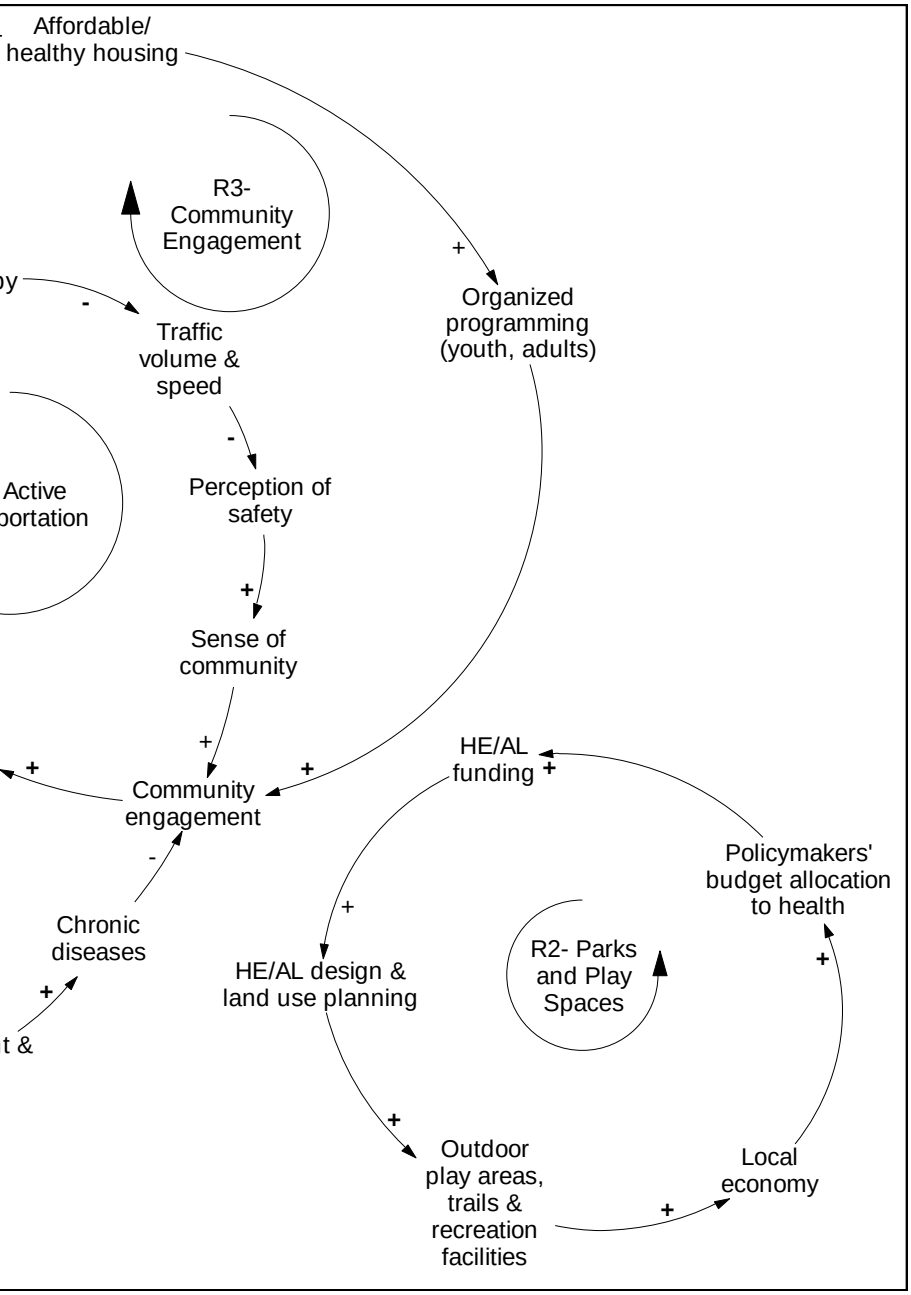
These stories represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing/balancing loop (see "R1— Healthy Vending/Farmers' Markets in Parks" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These variables change over time and are influenced by other variables as indicated by the arrows. Each arrow represents a causal relationship, and the plus and minus signs on the arrows indicate whether or not the influence of one variable on another variable (1) increases/

"It's my understanding that [support for small farmers] has been decreasing dramatically over time, but my hope is that it will change by increasing participation in farmers' markets, making farmers' markets more accessible to everyone will increase the demand for the farmers, making their work more viable and attracting new farmers back to their profession." (Participant)

adds to (plus or "+" sign), or (2) decreases/removes from the other variable (minus or "-" sign). These signs are referred to as polarities.

In a reinforcing loop, the effect of an increase or decrease in a variable continues through the cycle and returns an increase or decrease to the same variable, respectively.

Looking specifically at the "+" or "-" notation, a feedback loop that has zero or an even number of "-" signs, or polarities, is considered a reinforcing loop. Balancing loops, with an odd number of "-" signs in the loop, are another type of feedback loop.

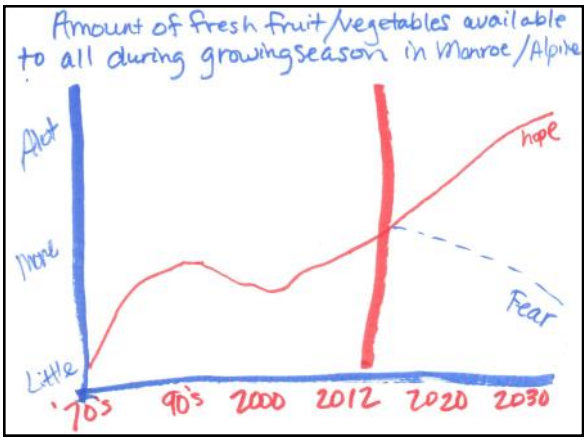


In isolation, this reinforcing loop represents a virtuous cycle in Story A as these assets positively support one another, or a vicious cycle in Story B as these challenges perpetuate a downward spiral. Yet, the influence of local food production and gardens likely levels off at some point. To understand what specifically leads to the leveling off of local food production and gardens, it may be helpful for the partners in Benton County, Oregon to consider other variables that influence or are influenced by local food production and gardens. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 2), and the other loops and causal relationships can have an impact on the variables in this loop.

<u>System Insights for *Creciendo en Salud*</u>

Participants identified an increase in the amount of fresh fruit and vegetables available to all during growing season since 1970 to 2012 with the hope that the availability of fresh fruits and vegetables will continue to increase into the future as existing farmers' markets expand and new farmers' markets emerge (see behavior over time graph bottom right).

From the systems thinking exercises, several insights can inform the healthy vending/farmers' markets in parks strategy, including:



- Strategic partnerships to engage residents in advocacy initiatives stimulate support and funding from city government agencies.
- When equitable, sustainable developments demonstrate success in model communities, they can be translated into new or improved developments throughout the region.

Parks and Play Spaces Feedback Loop

Given the introduction to feedback loops and CLD notation in the previous section, this discussion of the feedback loop highlighted in orange in Figure 4 expands on the concepts and notation, and highlights parks and play spaces.

Causal Story for Feedback Loop

Story A: In this case, the story is about parks and play spaces in Benton County. Participants described as more outdoor play areas, trails, and recreation facilities are available, there is an increase in the local economy. With an improved local economy, there is also an increase in the policymakers' budget allocation to health, which increases the availability of healthy eating and active living funding. In turn, as there is more funding, there is also an increase in the healthy eating and active living design and land use planning that takes place as there are more funds available for design and planning, which also increases the outdoor play areas, trails, and recreation facilities that are available.

Story B: Alternatively, as less outdoor play areas, trails, and recreation facilities are available, there is a decrease in the local economy. With a decrease in the local economy, there is also a decrease in the policymakers' budget allocation to health, which decreases the availability of healthy eating and active living funding. In turn, as there is less funding, there is also a decrease in the healthy eating and active living design and land use planning that takes place as there are less funds available for design and planning, which also decreases the outdoor play areas, trails, and recreation facilities that are available.

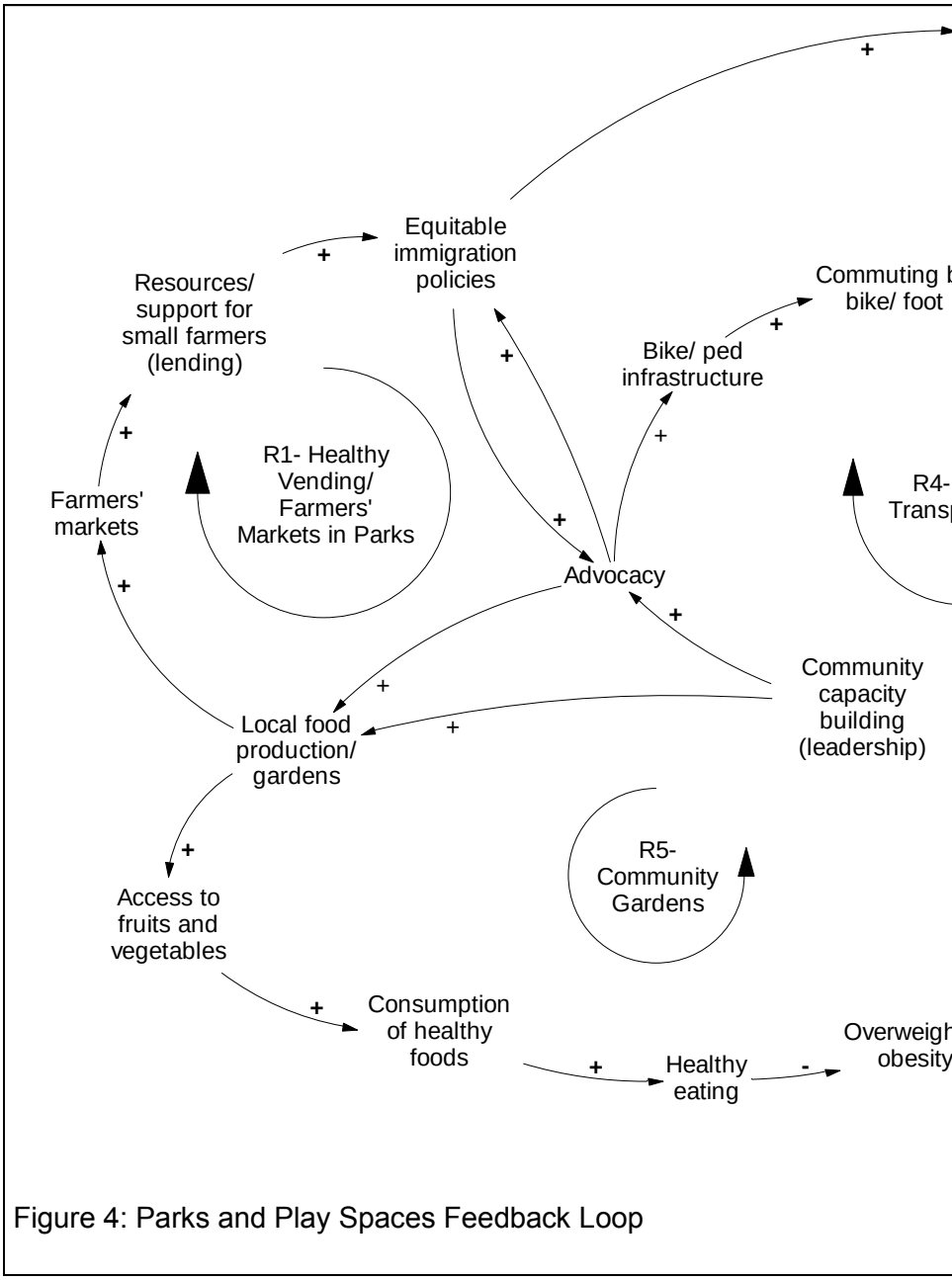


Figure 4: Parks and Play Spaces Feedback Loop

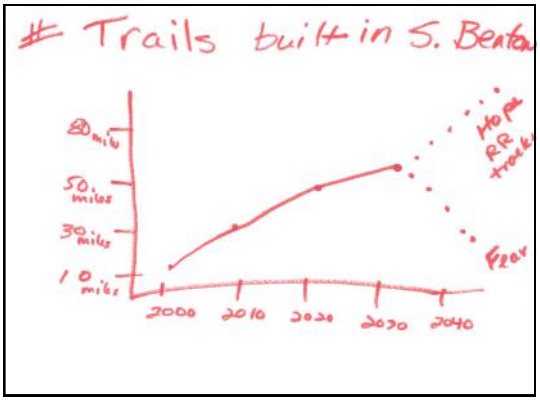
Reinforcing Loop and Notation

Similar to the healthy vending/farmers' markets in parks loop in Figure 3, this loop has all "+" signs or polarities and is a reinforcing loop (see R2—Parks and Play Spaces in Figure 4).

Some of these causal relationships may have more immediate effects (e.g., policymakers budget allocation to health influence on healthy eating and active living funding) and other relationships may have delayed effects

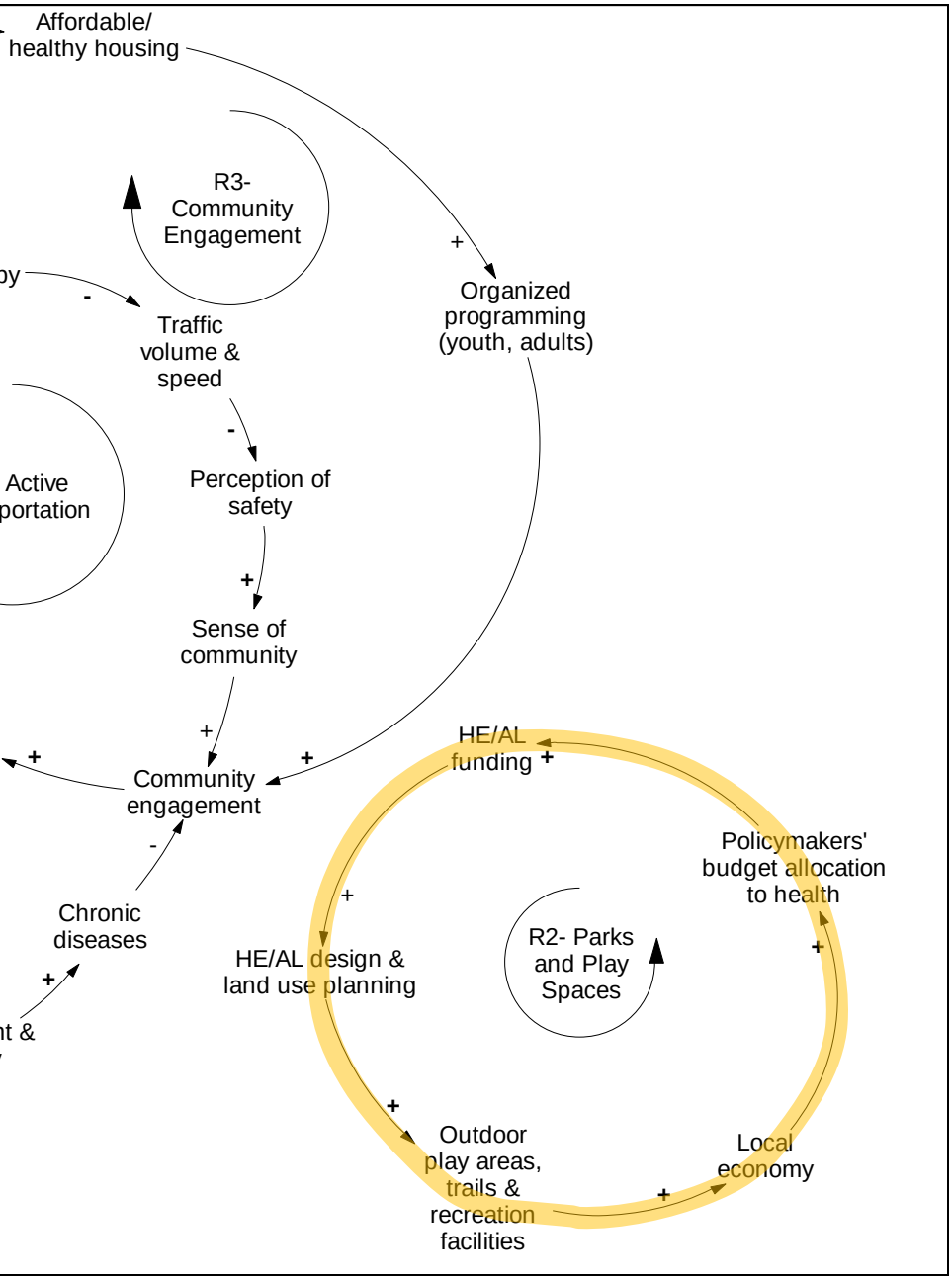
"Crystal Lake Park has been redesigned and soccer fields were built, which is great. There's also Tunison Park which has been redeveloped. But my hope is that through grants and funding and partnership we can get a covered play area for the winter so that children have a place to be active and not be wet and get out of the house. But my fear is that, because of budget cuts that we have and other things, that we'll just stay the same for these facilities." (Participant)

(e.g., outdoor play areas, trails, and recreation facilities influence on local economy). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).



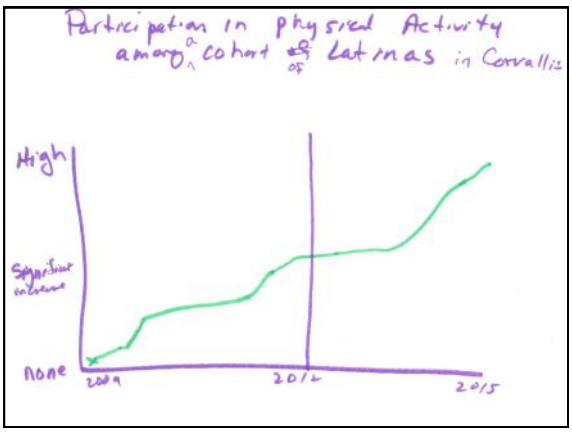
<u>System Insights for *Creciendo en Salud*</u>

In the behavior over time graphs, participants identified the number of trails built in South Benton as increasing since 2000 to 2012 with the hope that the number of trails will continue to increase into the future (see behavior over time graph top right). Similarly, participants described a increase in the participation in physical activity by a cohort of Latinas in Corvallis since 2009 to 2012 through the HKHC efforts. The hope is that with continued engagement and efforts to involve the minority community, the participation of Latinas in Corvallis and other areas in physical activity will continue to increase into the future (see behavior over time graph bottom right).



System insights can inform the partnership's next steps with parks and play spaces, including:

- Parks and play spaces that facilitate both opportunities for physical activity and resident interaction and engagement support sustainability of the quality of these spaces by increasing collaboration of local partners that can generate resources to invest in these spaces.
- "Upstream" efforts to increase community and social engagement in order to draw the attention of policy– and decision-makers to the importance of health-centered community design leads to increases in access to safe parks, trails, and outdoor facilities.



In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What are the optimal numbers and types of public recreation facilities for a neighborhood or urban area?
- What public recreation facilities are used by what groups in the community (e.g., children, adolescents, people in poverty)? Are surrounding residents more or less active?

Community Engagement Feedback Loop

Highlighted in blue in Figure 5, the community engagement feedback loop represents one of the *Creciendo en Salud* strategies to increase partnership in Benton County, Oregon.

Causal Story for Feedback Loop

Story A: With more community engagement, there is an increase in community capacity building and the number of leaders in the community. With more community capacity building, there is an increase in advocacy efforts towards healthy eating and active living initiatives. As there is more advocacy, there are more equitable immigration policies, which increase affordable and healthy housing for all residents. In turn, more affordable and healthy housing increases the organized programming for youth and adults — particularly in lower income areas — there is time to focus on programming. With greater organized programming, there is an increase in the number of residents engaged and involved in healthy eating and active living efforts.

Story B: Alternatively, with less community engagement, there is a decrease in community capacity building and the number of leaders in the community. With less community capacity building, there is a decrease in advocacy efforts towards healthy eating and active living initiatives. As there is less advocacy, there are less equitable immigration policies, which decrease affordable and healthy housing for all residents. In turn, less affordable and healthy housing decreases the organized programming for youth and adults — particularly in lower income areas — there is no or less time to focus on programming. With fewer organized programming, there is a decrease in the number of residents engaged and involved in healthy eating and active living efforts.

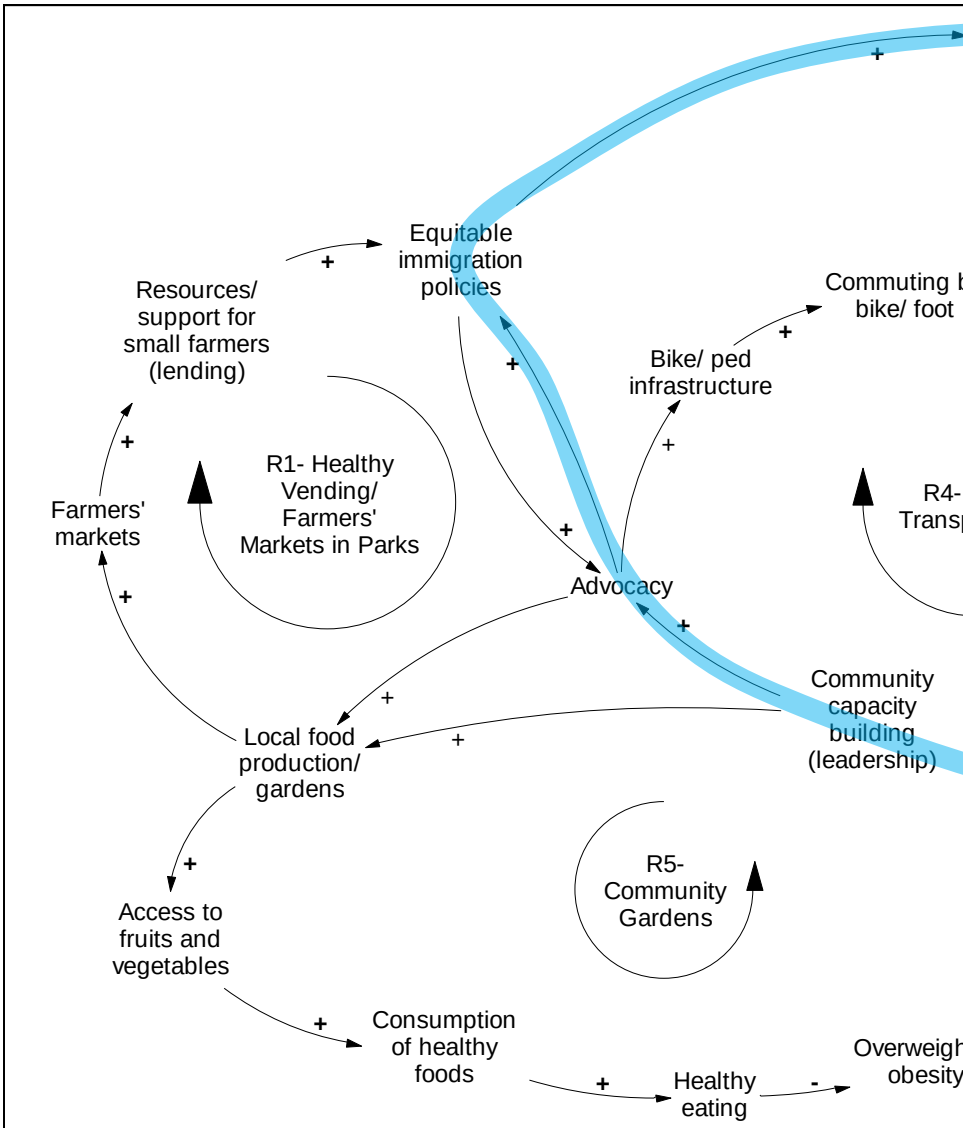


Figure 5: Community Engagement Feedback Loop

Reinforcing Loop and Notation

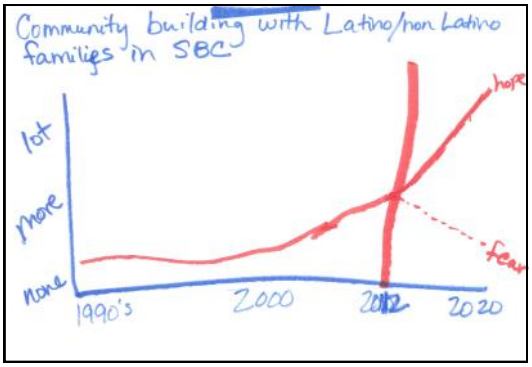
Similar to the previous loops, this one also represents a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., community engagement influence on community capacity building), and, potentially, delayed effects (e.g.,

"I work with Latino families in parenting classes and we just got a Zumba class going at the American Legion, and I was just recognizing that it was for Latino women, but there's a lot of women in general that need to get together and just do that. So if we could do some community building with classes that are combined. Maybe have a major shift of English-speaking to help non-English-speaking families to get to where they want to be." (Participant)

equitable immigration policies influence on affordable/healthy housing).

System Insights for *Creciendo en Salud*

In the behavior over time graphs exercise, participants described a slight increase in the community building with Latino and non-Latino families in Benton County since 1990 to 2012 with the hope that community building will continue to drastically increase into the future



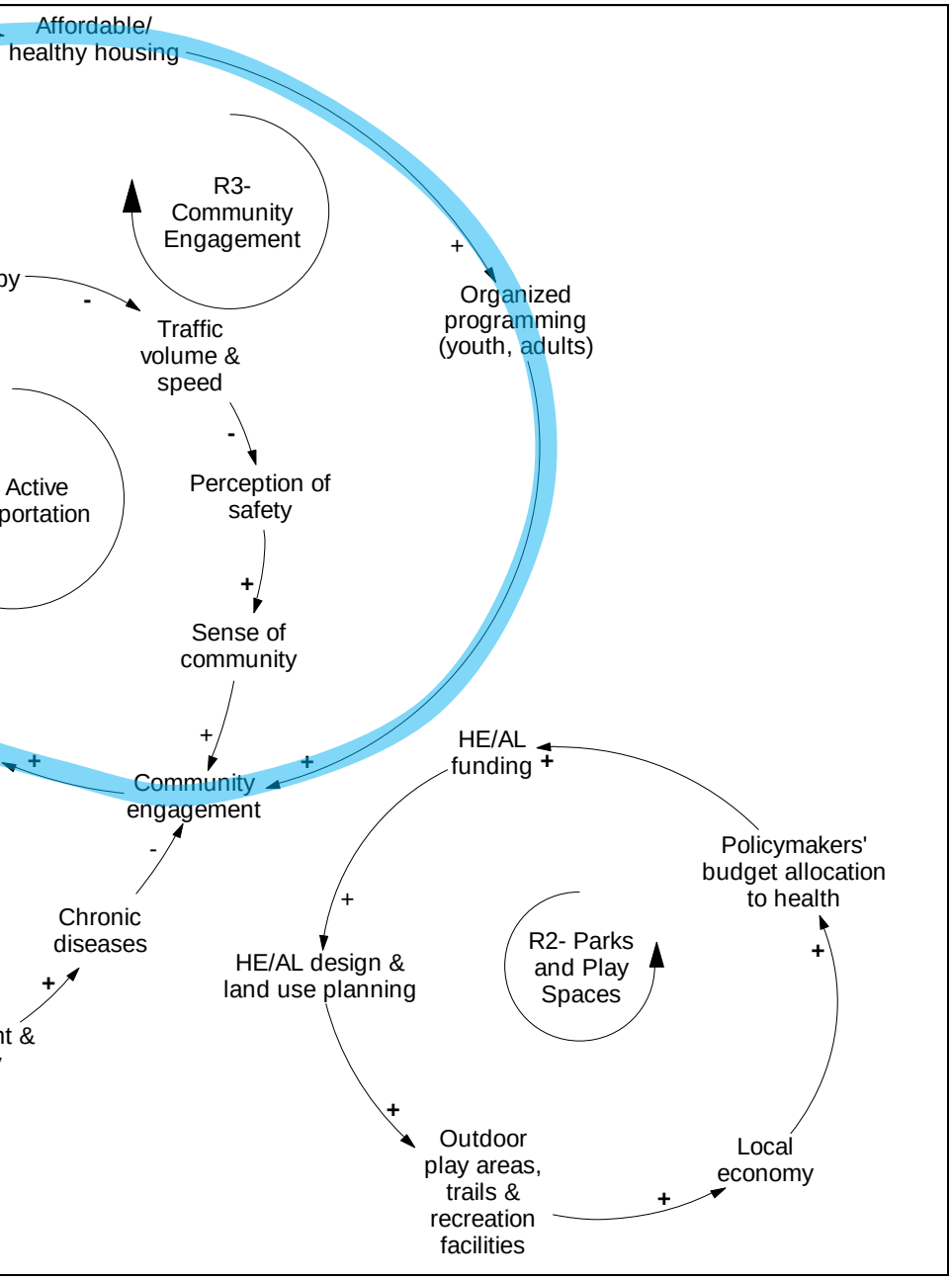
(see behavior over time graph at the top right). Participants also identified a an increase in the cost of housing since 1960 to 2012. The hope is that the cost of housing will decrease into the future making homes more affordable (see behavior over time graph bottom right).

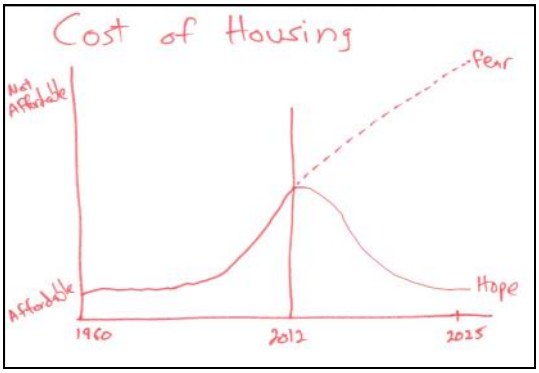
System insights for the partnership's community engagement efforts include:

- Incorporation of efforts to increase community knowledge and empowerment generates more community engagement to bolster advocacy efforts (e.g., programmatic and promotional efforts to complement policy, system, and environmental changes can enhance overall advocacy).
- Building partnerships and relationships with developers who prioritize equity, sustainability, and practicality (e.g., mixed-income housing, greater population density, mixed commercial and residential land use, affordable housing) improves residents stability, both geographically and economically.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What types of partnerships increase resident engagement and participation in advocacy?
- What is the influence of an increasing number of advocacy initiatives in the community and community knowledge and empowerment?
- What are the appropriate types and numbers of organized programming to support healthy eating or active living among youth and adults?





Active Transportation Feedback Loop

Highlighted in red in Figure 6, the active transportation feedback loop represents one of the *Creciendo en Salud* strategies to increase active living in Benton County, Oregon.

Causal Story for Feedback Loop

Story A: With more bike and pedestrian infrastructure, there is an increase in the number of people commuting by bike or foot to work or running errands. With more residents commuting, there is a reduction in traffic volume and speeds since less cars are on the road. With a decrease in traffic volume and speed, there is an increase in the perception of safety from residents, which also increases the sense of community. In turn, a greater sense of community increases community engagement. With more community engagement, there is an increase in community capacity building and the number of leaders in the community. With more community capacity building, there is an increase in advocacy efforts towards healthy eating and active living initiatives, which increases pedestrian and bike infrastructure.

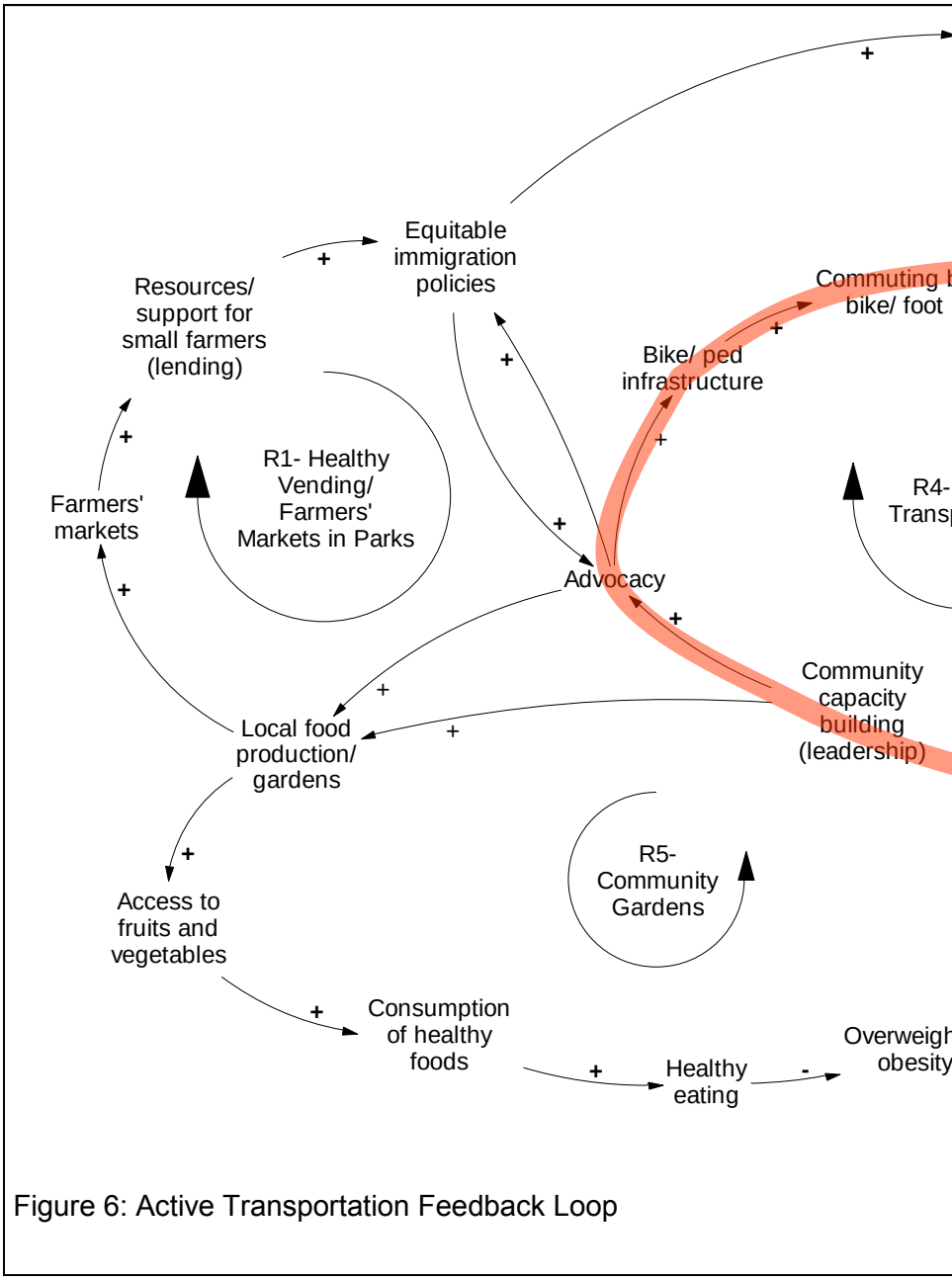


Figure 6: Active Transportation Feedback Loop

Story B: Alternatively, with less bike and pedestrian infrastructure, there is a decrease in the number of people commuting by bike or foot to work or running errands. With less residents commuting, there is an increase in traffic volume and speeds since more cars are on the road. With an increase in traffic volume and speed, there is a decrease in the perception of safety from residents, which also decreases the sense of community. In turn, less sense of community decreases community engagement. With less community engagement, there is a decrease in community capacity building and the number of leaders in the community. With less community capacity building, there is a decrease in advocacy efforts towards healthy eating and active living initiatives, which decreases pedestrian and bike infrastructure.

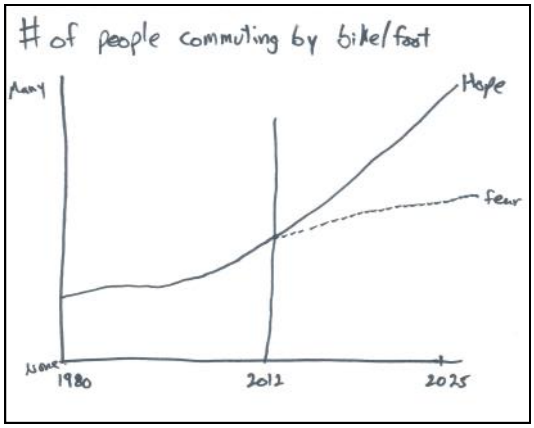
Reinforcing Loop and Notation

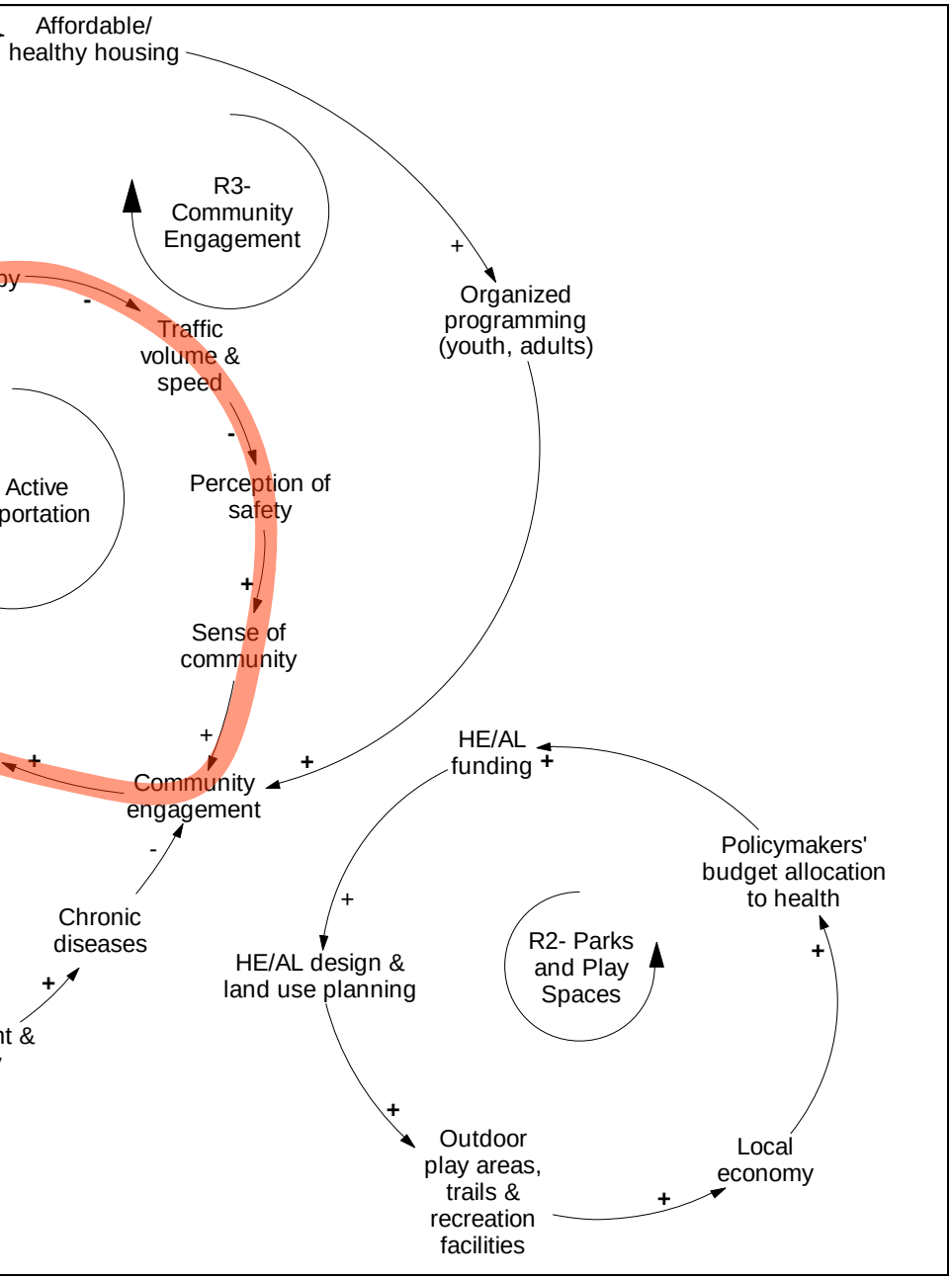
Unlike the previous loops (see Figures 3-5), this loop has two "-" signs or polarities; since this is an even number it is still a reinforcing loop.

"I think back in the day people felt quite safe walking and running from South Corvallis to get downtown; 99 wasn't as busy. Today it's terrifying to cross 99, and we don't have safe paths to get downtown. My hope is through the CIT process, through safer paths and maybe ODOT reducing speed limits on 99 , that folks will be able to access downtown Corvallis on foot." (Participant)

System Insights for *Creciendo en Salud*

In the behavior over time graphs exercise, participants described an increase in the number of people commuting by bike or foot since 190 to 2012 with the hope that the number of people commuting by bike or foot will continue to increase into the future (see behavior over time graph top right). However, participants described a decrease in the amount of funding available for pedestrian and bike infrastructure projects since 1980 to 2012 with the hope that this will change and more funding will be available for pedestrian and bike infrastructure into the future (see behavior over time graph at the bottom right).



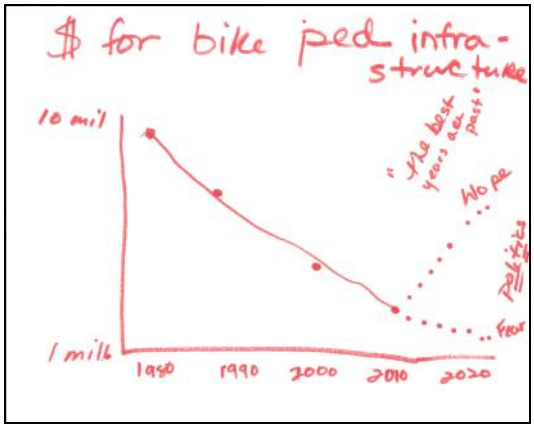


System insights for the partnership's active transportation efforts include:

- Infrastructure for pedestrians and bicyclists increases the number of families being active together; sidewalks and bike lanes — along with traffic calming and other safety measures — create opportunities for families to chose active rather than sedentary transportation modes.
- Increasing perceptions of safety plays a major role in maintaining urban density and increasing active transportation.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- How do residents' perceptions of safety influence their use of motorized vehicle for transportation?
- What streets have accommodations for pedestrians, bicyclists, and drivers?



Are they safe for all users? What is still needed (e.g., traffic calming measures, more sidewalks and bike lanes)?

- What types of trips are made by car, bike, and foot in communities? Who is using the current active transportation infrastructure and who is note (e.g., adults, children)?

Community Gardens Feedback Loop

Highlighted in yellow in Figure 7, the community gardens feedback loop represents one of the *Creciendo en Salud* strategies to increase healthy eating in Benton County, Oregon.

Causal Story for Feedback Loop

Story A: With an increase in local food production and gardens, residents have more access to fruits and vegetables in the community. With greater access to fruits and vegetables, there is an increase in the consumption of healthy foods, which increases healthy eating. As healthy eating increases there is a decrease in overweight and obesity, which also decreases chronic diseases. With less chronic diseases, there is more community engagement as people see the value of working on healthy eating and active living initiatives. In turn, with more community engagement, there is an increase in community capacity building and leadership, which also increases local food production and gardens.

Story B: Alternatively, with a decrease in local food production and gardens, residents have less access to fruits and vegetables in the community. With less access to fruits and vegetables, there is a decrease in the consumption of healthy foods, which decreases healthy eating. As healthy eating decreases there is an increase in overweight and obesity, which also increases chronic diseases. With more chronic diseases, there is less community engagement. In turn, with less community engagement, there is a decrease in community capacity building and leadership, which also decreases local food production and gardens.

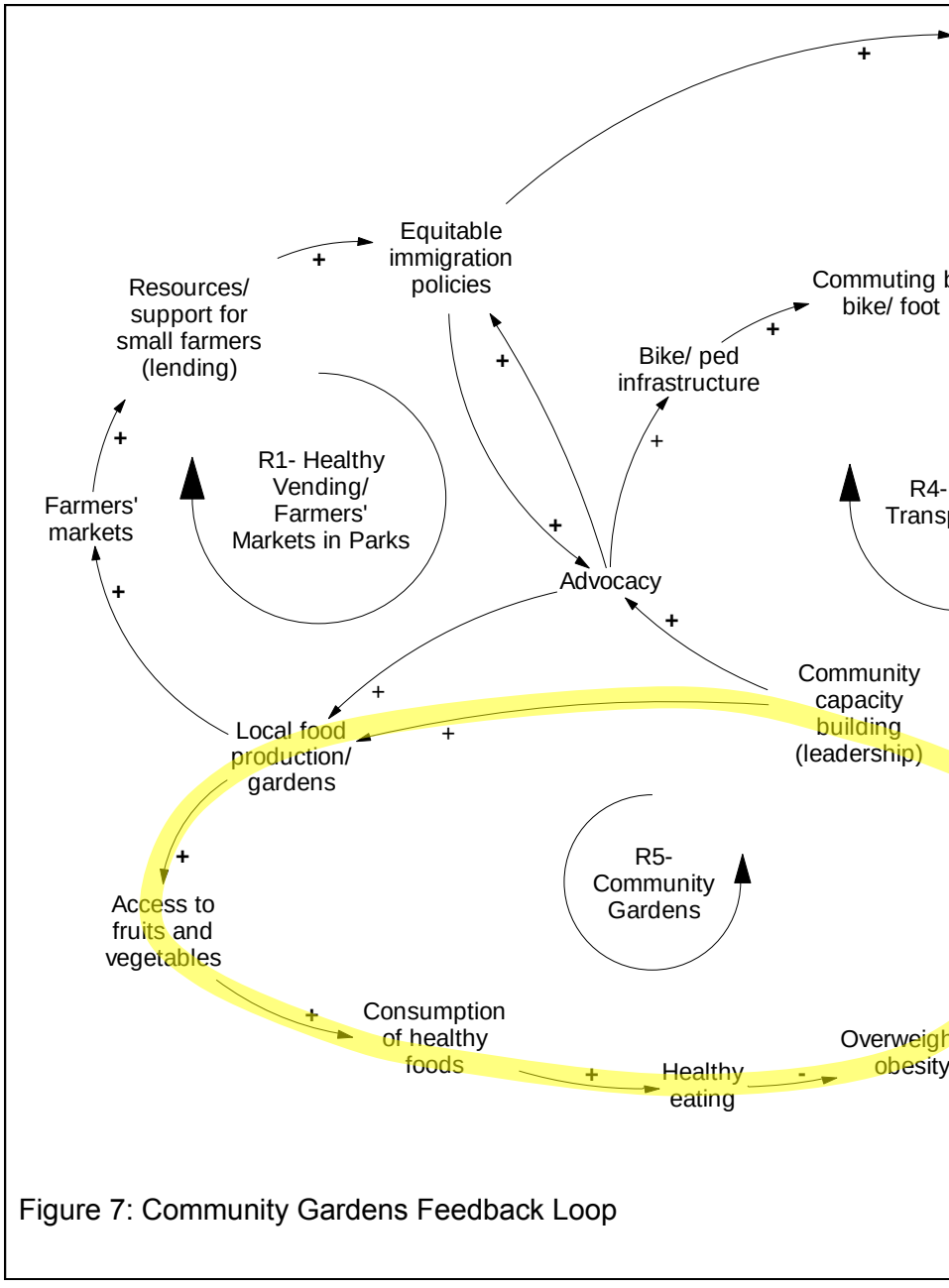


Figure 7: Community Gardens Feedback Loop

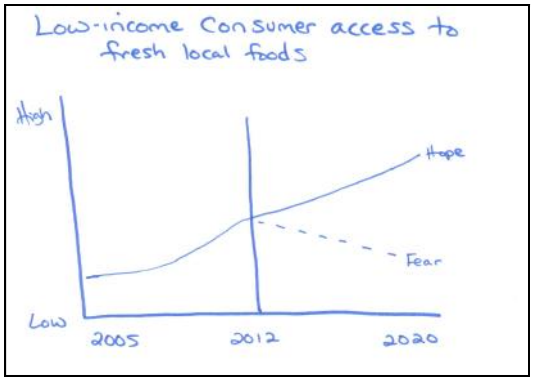
Reinforcing Loop and Notation

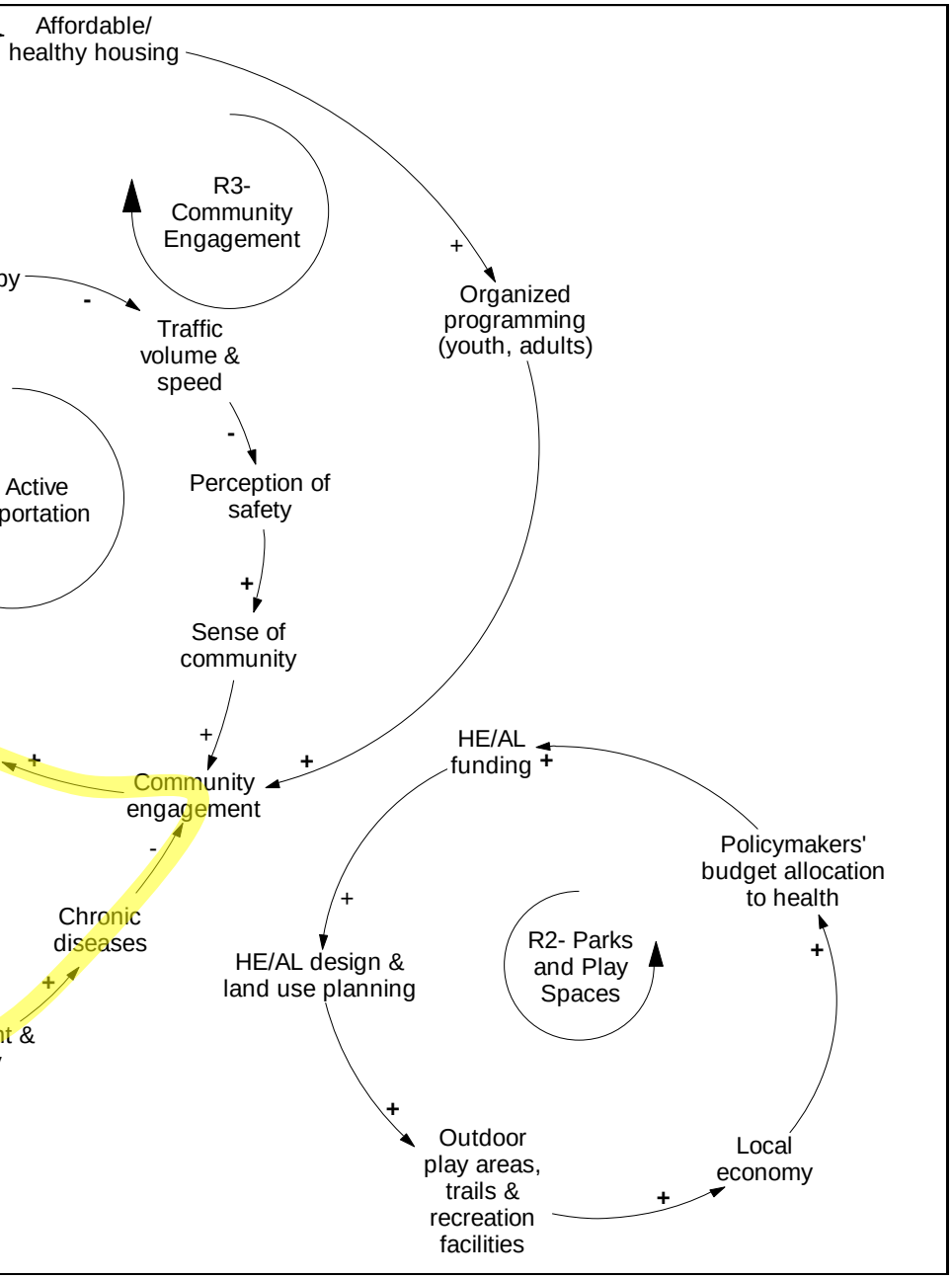
Similar to the previous loops (see Figure 6), this is a reinforcing loop with two "-" signs or polarities. In addition, it includes causal relationships representing more immediate effects (e.g., local food production influence on access to fruits and vegetables), and, potentially, delayed effects (e.g., healthy eating influence on overweight and obesity).

"My perception is there's a slight drop-off recently with people growing their own food. My hope is that it keeps on going up and my fear is that it continues to go down. And I think there are a lot of reasons for it. But more and more I think people don't value their time towards growing and producing their own food, and also there's a lot of pressure from the government, but that's something different. Big agribusiness and things like that, they've disincentivized people not to grow their own food." (Participant)

System Insights for *Creciendo en Salud*

In the behavior over time graphs exercise, participants described an increase in the access to fresh local foods for lower-income consumers since 2005 to 2012 with the hope that lower-income consumers will have more access to fresh local foods into the future (see behavior over time graph at the top right). Additionally, participants also described a decrease in the number of families growing their own food since 1900 to 2012 with the hope that the number of families growing their own food will change and increase into the future (see behavior over time graph at the bottom right).



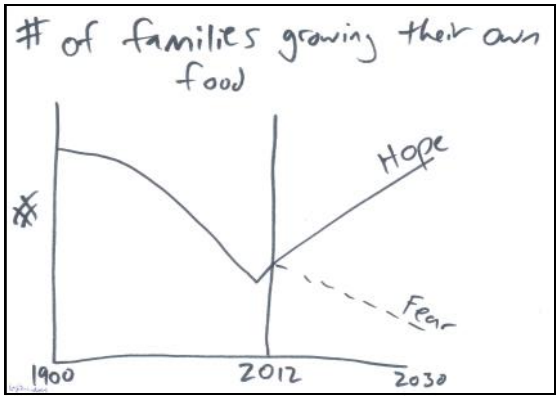


System insights for the partnership's community garden efforts include:

- Community gardens and urban agriculture designed to enhance youth and community engagement can focus on learning about native fruits and vegetables as well as agricultural practices of ancestors; this engagement also connects youth and community residents to other programs and services available in the community.
- By focusing on gardens and small farms, communities stimulate civic engagement and community organizing to increase support from city council.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

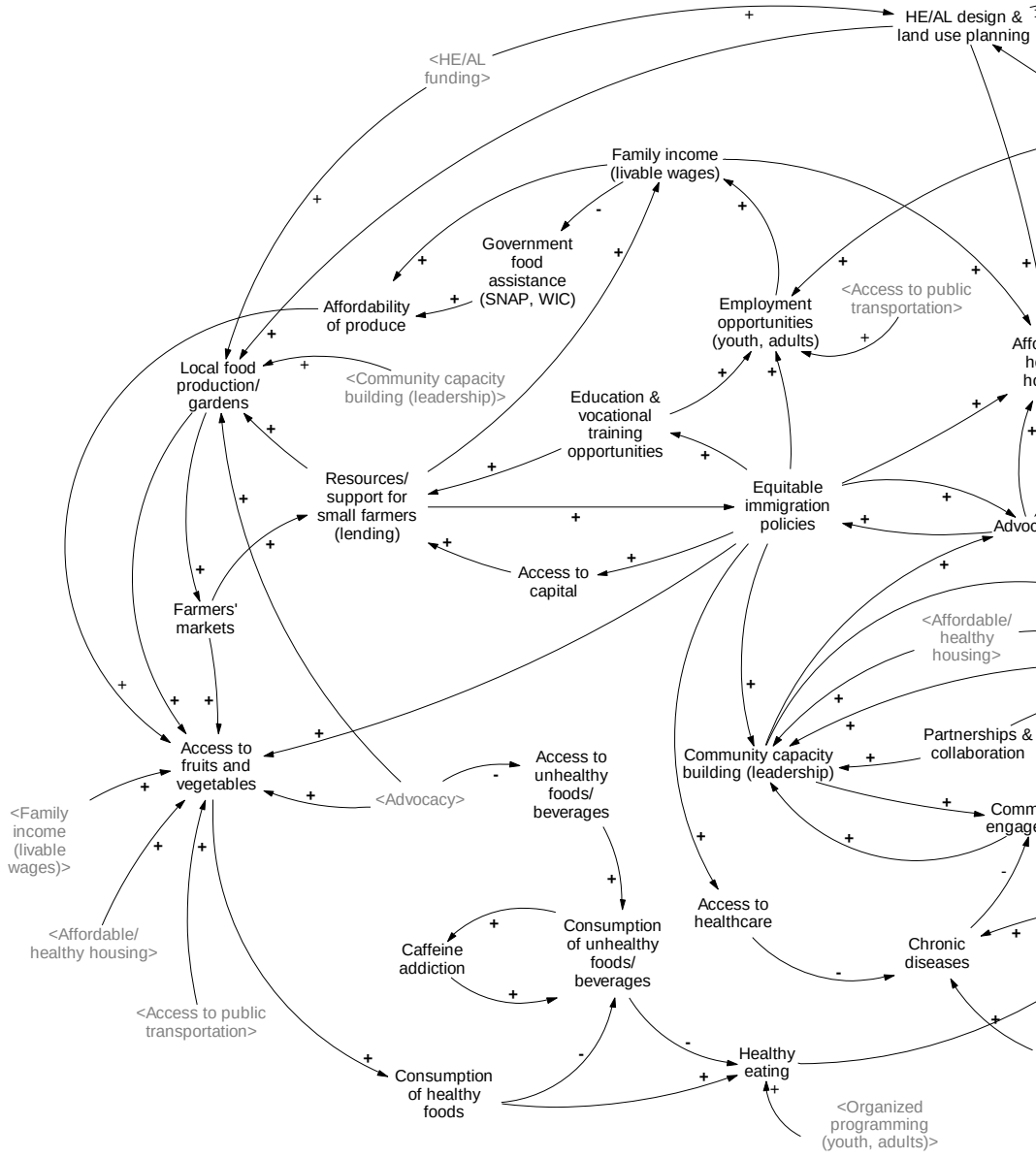
- What is the optimal number of school or community gardens for a neighborhood?
- What is the potential for local food production given the availability of vacant lots available for agriculture? What development patterns will sustain the ability to meet these food production requirements into the future?
- What healthy foods and beverages are most likely to be purchased and consumed in communities? Does this vary by subpopulation?



Opportunities for Systems Thinking in Benton County, Oregon

This storybook provided an introduction to some basic concepts and methods for systems thinking at the community level, including: causal loop diagrams, variables and shadow variables, causal relationships and polarities, reinforcing feedback loops, and balancing feedback loops, among others. For the *Creciendo en Salud* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Benton County causal loop diagram as well as six specific feedback loops corresponding to the partnership's primary strategies.

Figure 8: *Creciendo en Salud* Causal Loop Diagram



This causal loop diagram reflects a series of conversations among partners and residents from 2011 to 2013. Some discussions probed more deeply into different variables through the behavior over time graphs exercise, or causal relationships through the causal loop diagram exercise.

This represented a first attempt to collectively examine the range of things that affect or are affected by policy, system, and environmental changes in Benton County, Oregon to promote healthy eating and active living as well as preventing childhood overweight and obesity.

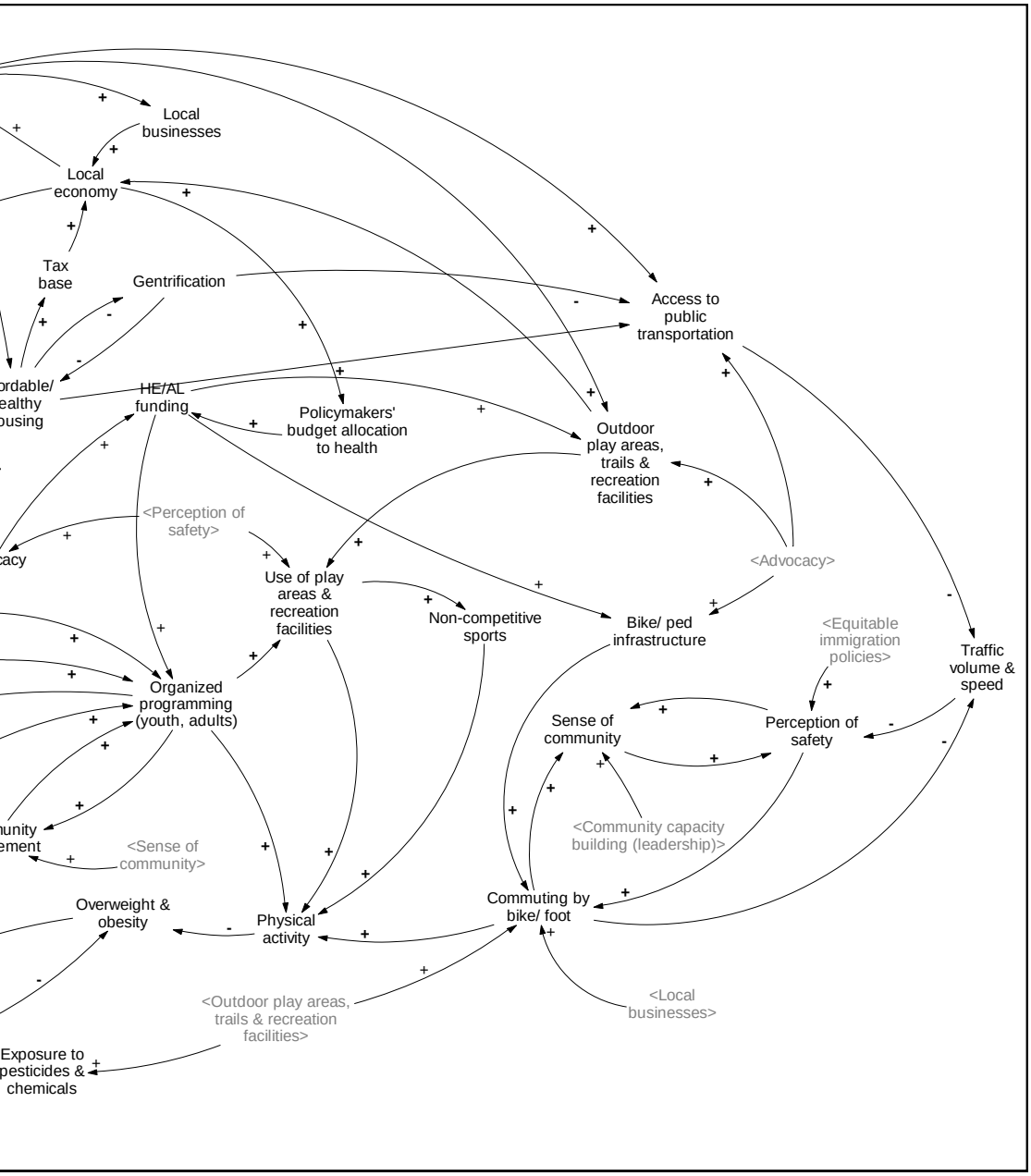
Yet, there are several limitations to this storybook, including:

- the participants represent a sample of the *Creciendo en Salud* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;
- the behavior over time graphs and the causal loop diagram represent perceptions of the participants in these exercises (similar to a survey or an interview representing perceptions of the respondents);
- the exercises and associated dialogue took place in brief one- to two-hour sessions, compromising the group's capacity to spend too much time on any one variable, relationship, or feedback loop; and
- the responses represent a moment in time so the underlying structure of the diagram and the types of feedback represented may reflect "hot button" issues of the time.

Much work is yet to be done to ensure that this causal loop diagram is accurate and comprehensive, for

example:

- having conversations to discuss existing feedback loops to ensure that the appropriate variables and relationships are represented accurately;
- reviewing the behavior over time graphs (see also Appendix E) to confirm that the trends reflect common perceptions among residents and compare these trends to actual data;



- revisiting variables removed because they were not part of feedback loops, including screen time, healthy vending, urban sprawl, fear-inducing media, school PE & policies, alcohol, tobacco, & substance use, cost of gas, agribusiness, local food processing infrastructure (freezing, canning, milling), school foods made from scratch, sugar sweetened beverage policies, fast food restaurants; and
- starting new conversations about other variables (behavior over time graphs exercise) or relationships (causal loop diagram exercise) to add to this diagram.

In addition, different subgroups in Benton County may use this causal loop diagram to delve in deeper into some of the subsectors (e.g., healthy eating, active living) or feedback loops, creating new, more focused causal loop diagrams with more specific variables and causal relationships.

Use of more advanced systems science methods and analytic approaches to create computer simulation models is another way to take this early work to the next level. The references section includes citations for resources on these methods and analytic approaches, and it is necessary to engage professional systems scientists in these activities.

Please refer to the Appendices for more information, including:

- Appendix A: Behavior over time graphs generated during site visit
- Appendix B: Photograph of the original version of the *Creciendo en Salud* Causal Loop Diagram
- Appendix C: Original translation of the causal loop diagram into Vensim PLE
- Appendix D: Transcript translation of the causal loop diagram into Vensim PLE
- Appendix E: Behavior over time graphs not represented in the storybook

References for Systems Thinking in Communities:

Group model building handbook:
Hovmand, P., Brennan L., & Kemner, A. (2013). Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook. Retrieved from http://www.transtria.com/hkhc.

Vensim PLE software for causal loop diagram creation and modification:
Ventana Systems. (2010). Vensim Personal Learning Edition (Version 5.11A) [Software]. Available from http://vensim.com/vensim-personal-learning-edition/

System dynamics modeling resources and support:
Andersen, D. F. and G. P. Richardson (1997). "Scripts for group model building." System Dynamics Review 13(2): 107-129.

Hovmand, P. (2013). Community Based System Dynamics. New York, NY: Springer.

Hovmand, P. S., et al. (2012). "Group model building "scripts" as a collaborative tool." Systems Research and Behavioral Science 29: 179-193.

Institute of Medicine (2012). An integrated framework for assessing the value of community-based prevention. Washington, DC, The National Academies Press.

Meadows, D. (1999). Leverage points: places to intervene in a system. Retrieved from http://www.donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

Richardson, G. P. (2011). "Reflections on the foundations of system dynamics." System Dynamics Review 27 (3): 219-243.

Rouwette, E., et al. (2006). "Group model building effectiveness: A review of assessment studies." System Dynamics Review 18(1): 5-45.

Sterman, J. D. (2000). Business dynamics: Systems thinking and modeling for a complex world. New York, NY: Irwin McGraw-Hill.

System Dynamics in Education Project. (1994). Road maps: A guide to learning system dynamics. Retrieved from http://www.clexchange.org/curriculum/roadmaps/

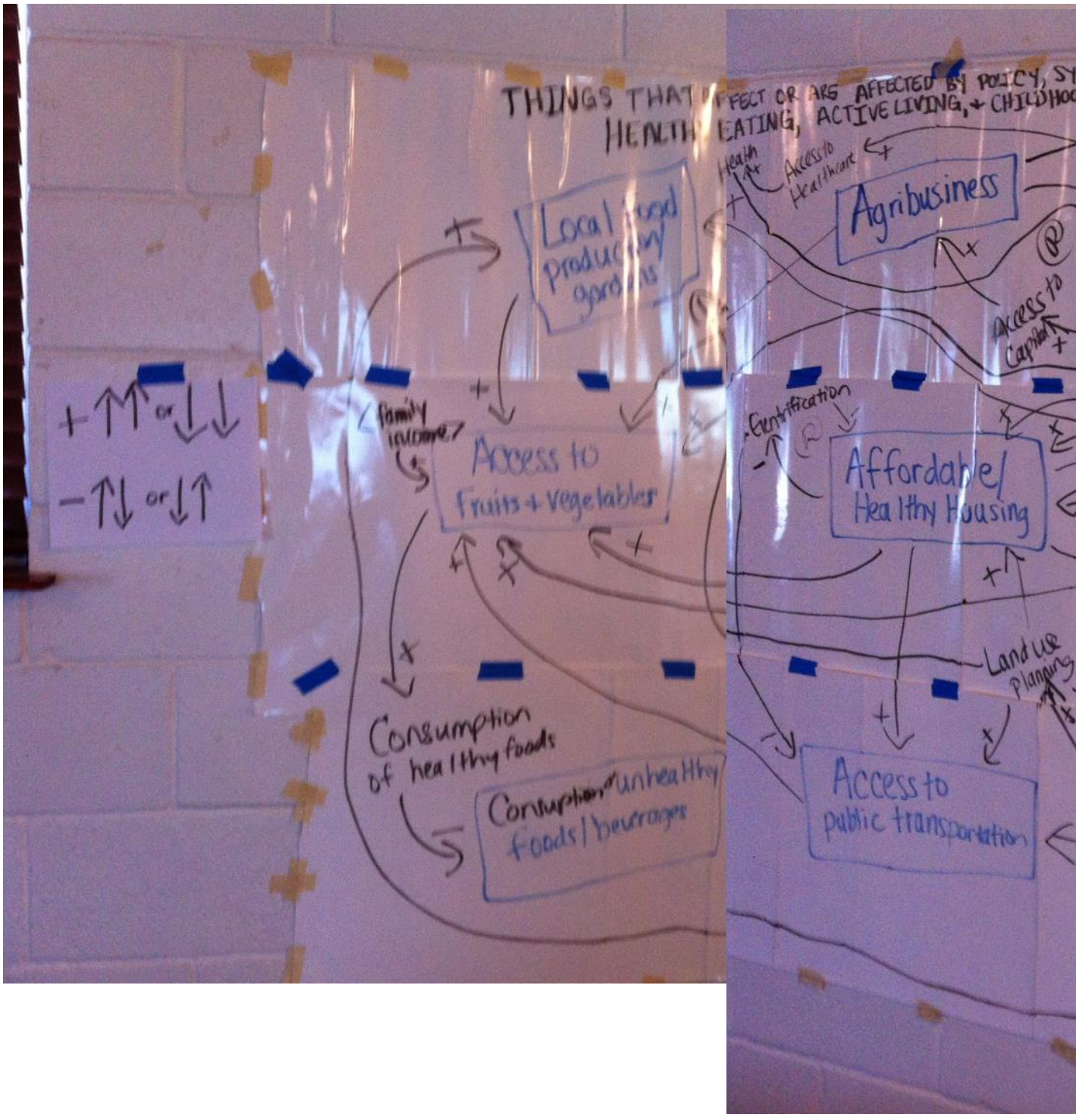
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

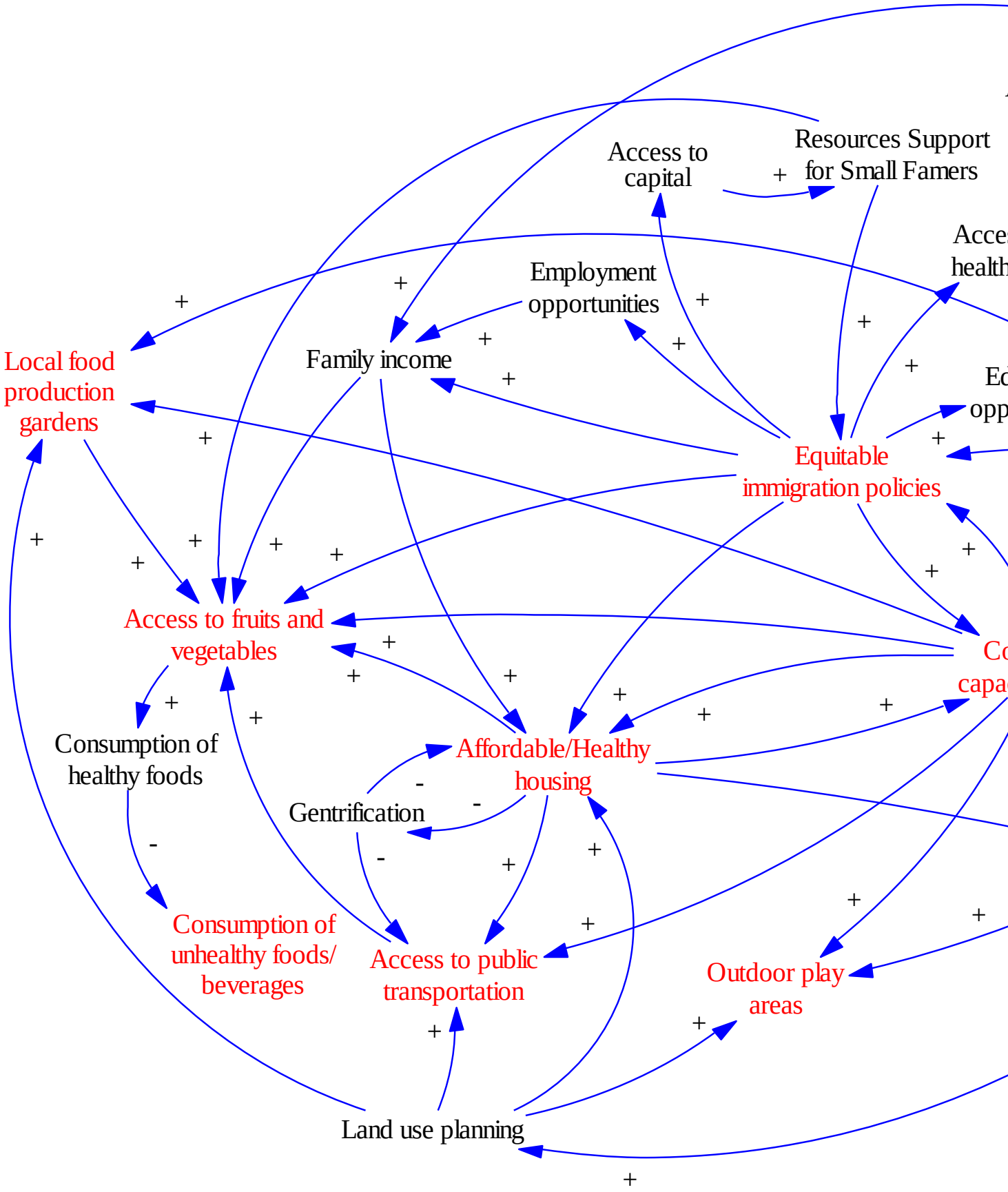
Benton County, Oregon: *Creciendo en Salud*	
Categories	**Number of Graphs**
Active Living Behavior	6
Active Living Environments	4
Funding	1
Healthy Eating Behavior	1
Healthy Eating Environments	10
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	0
Partnership & Community Capacity	2
Policies	5
Programs & Promotions (Education and Awareness)	4
Social Determinants of Health	6
Total Graphs	**44**

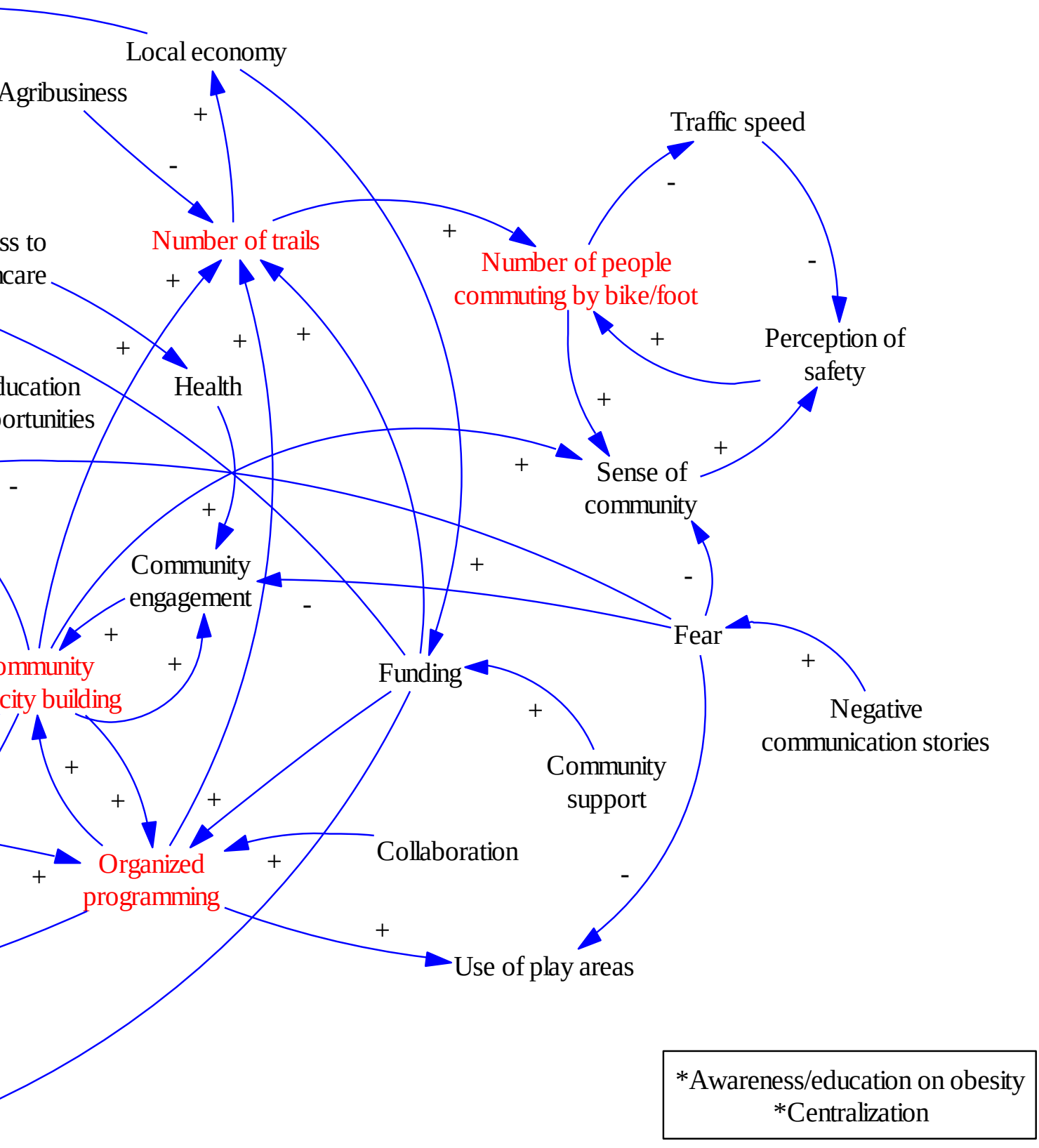
Appendix B: Photograph of the Original Version of the *Creciendo en Salud* Causal Loop Diagram



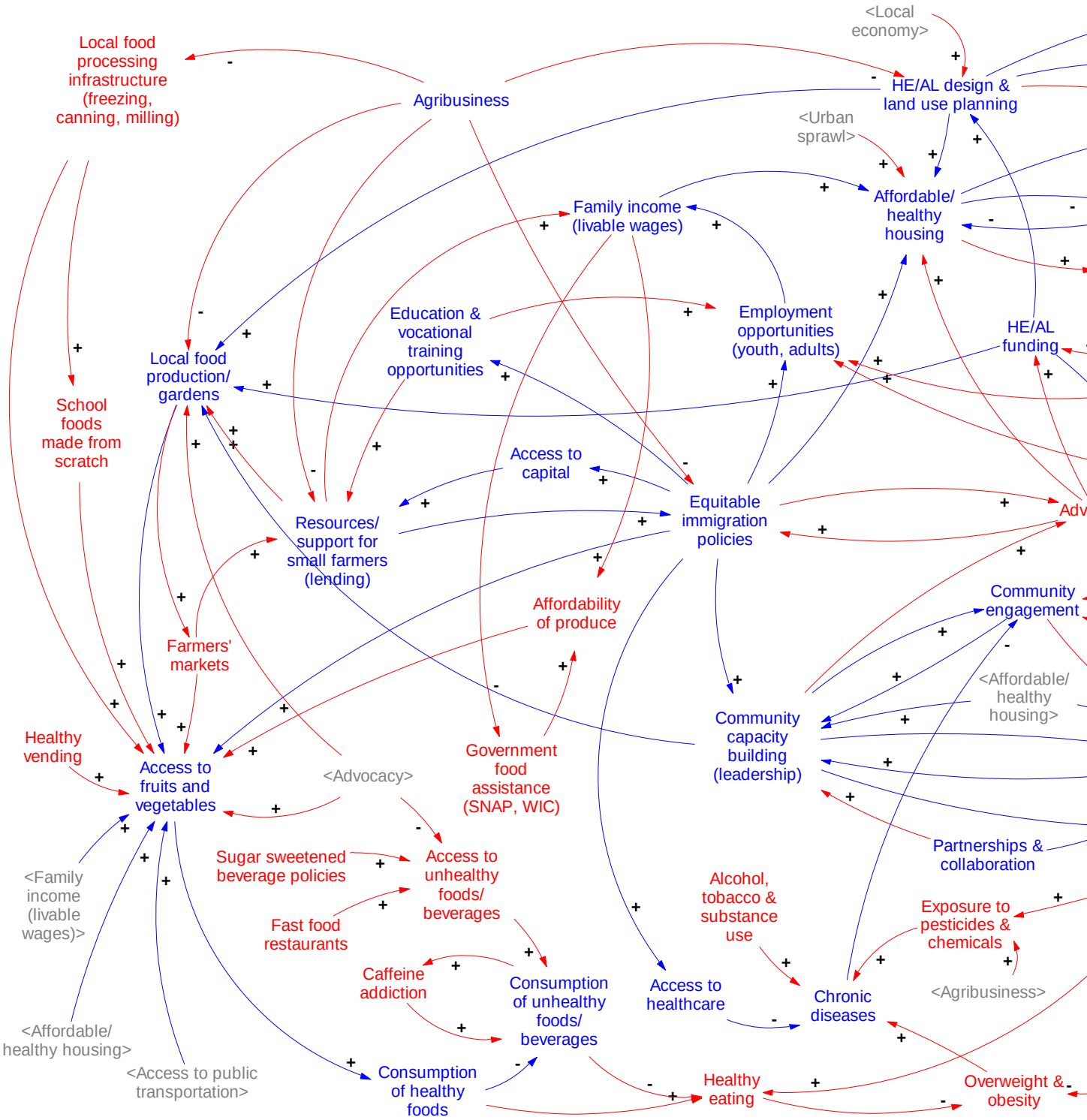

ENVIRONMENT CHANGE IN YOUR COMMUNITY
employment opportunities
education opportunities
# of trails
Local economy
Negative Communication Stories
Equitable Immigration policies
family income
Community Engagement
# of people Commuting by bike/foot
Fear
traffic speed
Community Capacity Building
Perception of Safety
Outdoor Play Areas
Use of Play areas
Sense of Community
Community Support
Collaboration
Organized Programming
Funding
Awareness/ Education on obesity

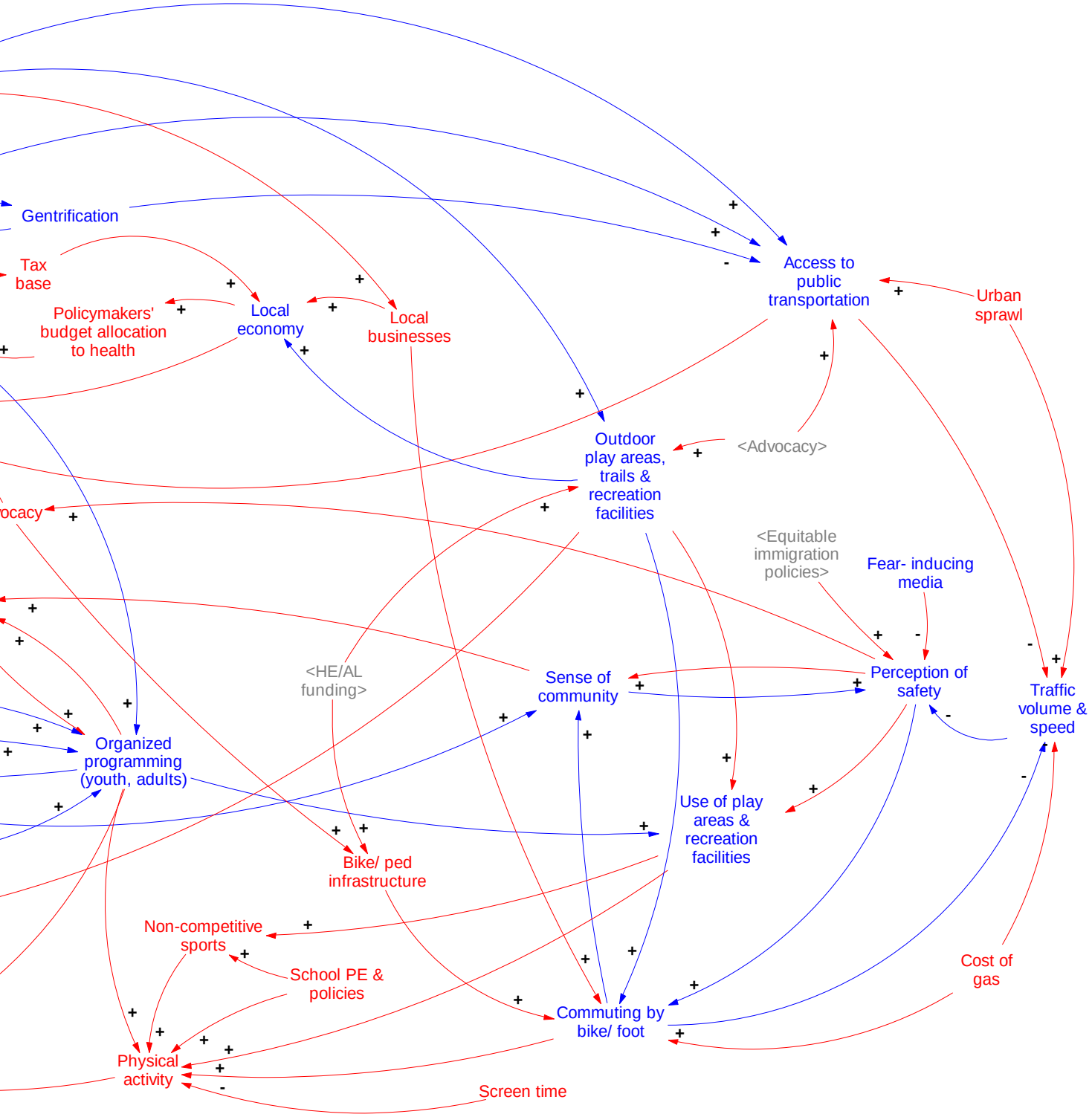
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



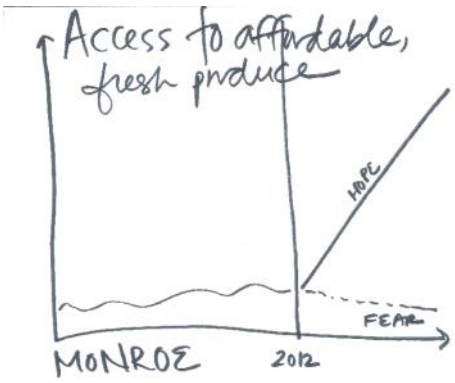

Local economy
Agribusiness
Traffic speed
Number of trails
Number of people commuting by bike/foot
Perception of safety
Health
Sense of community
Community engagement
Fear
Funding
Negative communication stories
Community support
Collaboration
Organized programming
Use of play areas
*Awareness/education on obesity
*Centralization

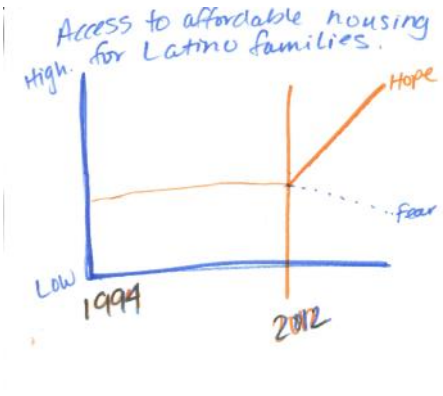
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

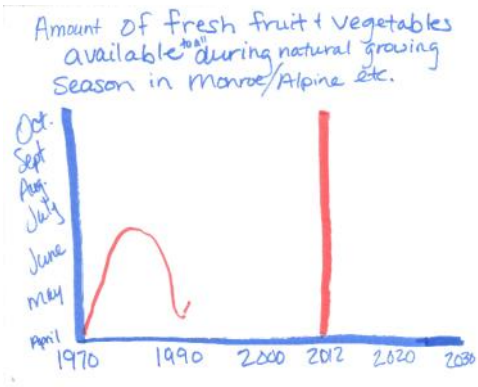


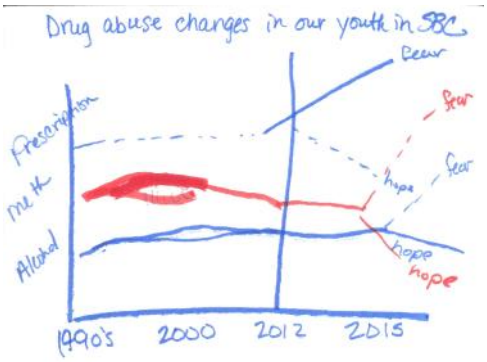

Gentrification
Tax base
Policymakers' budget allocation to health
Local economy
Local businesses
Access to public transportation
Urban sprawl
Outdoor play areas, trails & recreation facilities
<Advocacy>
ocacy
<Equitable immigration policies>
Fear- inducing media
Perception of safety
Traffic volume & speed
<HE/AL funding>
Sense of community
Organized programming (youth, adults)
Use of play areas & recreation facilities
Bike/ ped infrastructure
Non-competitive sports
School PE & policies
Cost of gas
Commuting by bike/ foot
Physical activity
Screen time

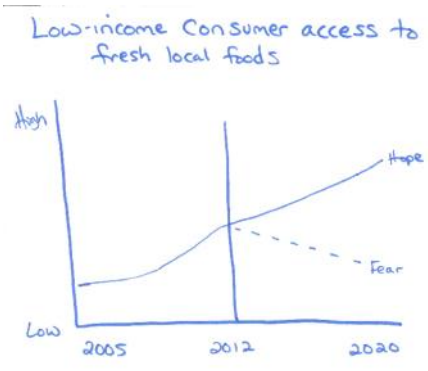
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

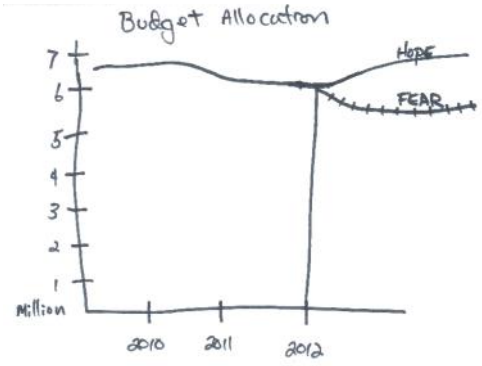


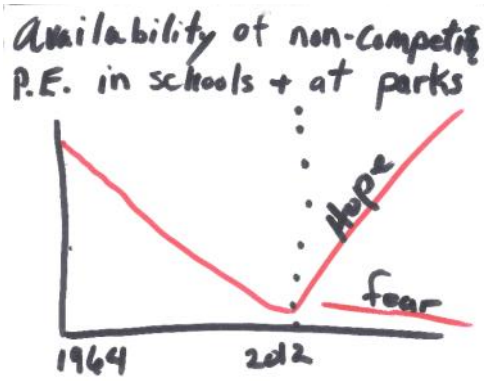


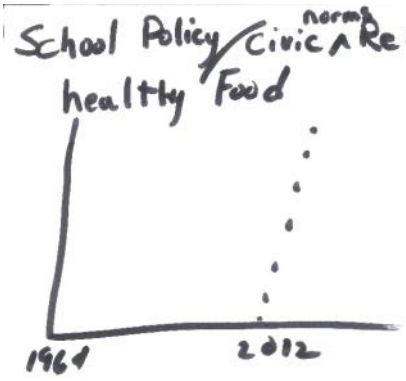


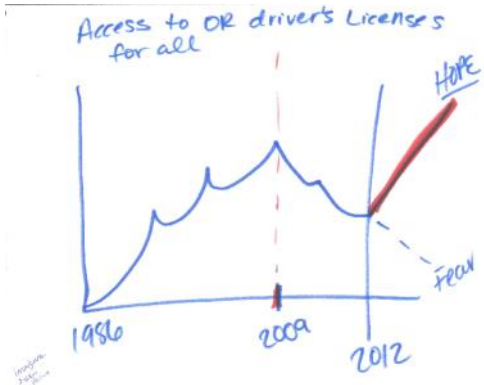


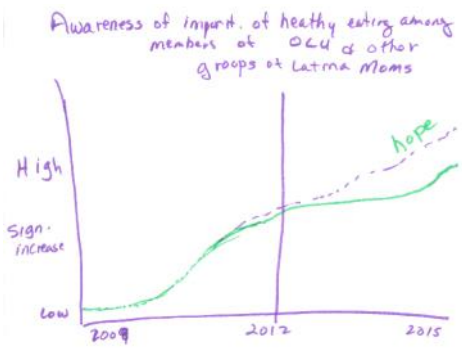


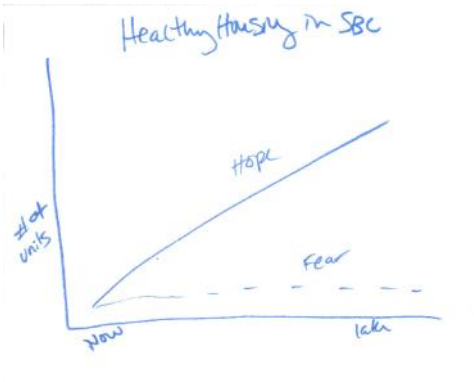


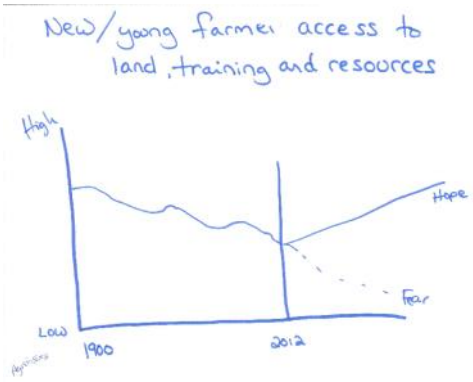


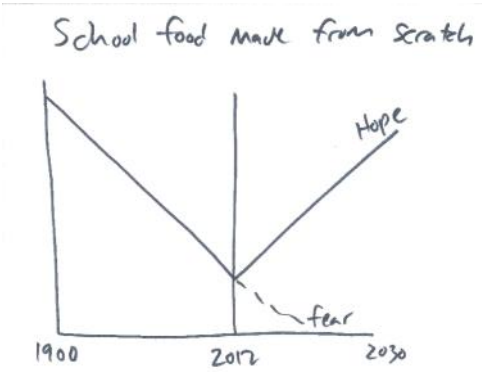


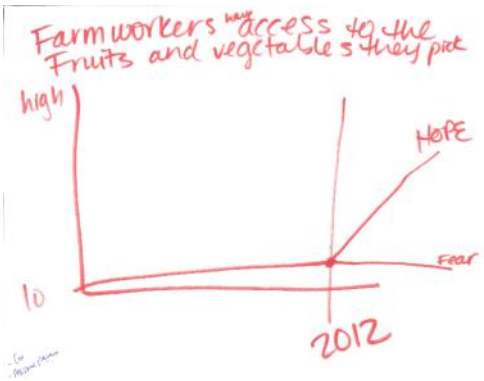


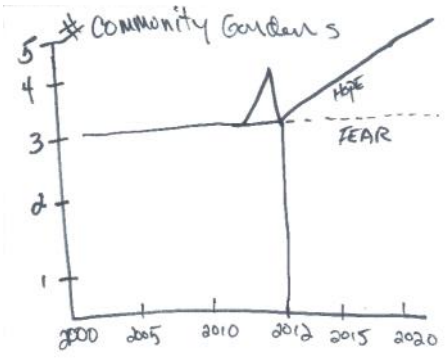


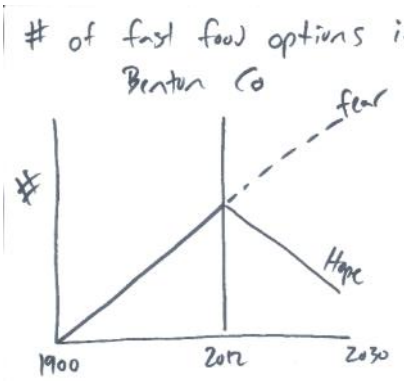

Healthy Housing in SBC
# of units
Hope
Fear
Now
later

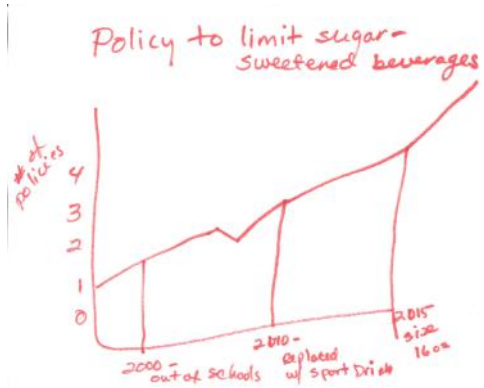

New/young farmer access to land, training and resources
High
Low
Hope
Fear
1900
2012

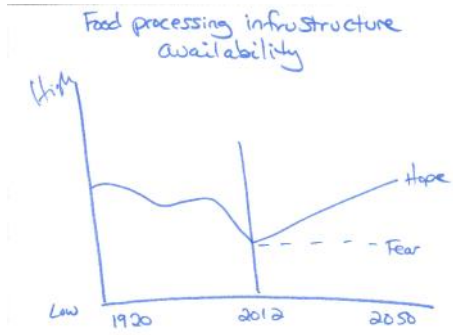

School food made from scratch
Hope
fear
1900
2012
2030


Farmworkers access to the Fruits and vegetables they pick
high
low
HOPE
Fear
2012

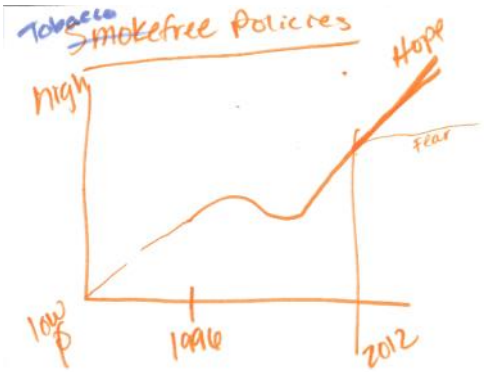

Community Gardens
5
4
3
2
1
HOPE
FEAR
2000
2005
2010
2012
2015
2020

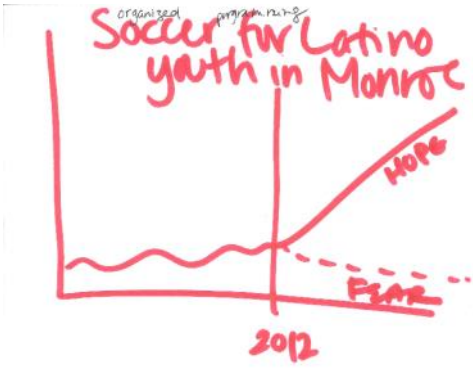

# of fast food options in Benton Co
#
fear
Hope
1900
2012
2030

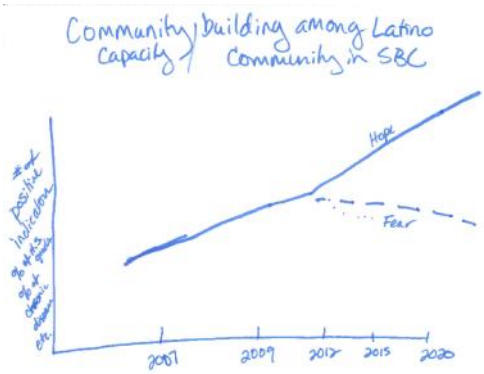

Policy to limit sugar-sweetened beverages
# of policies
4
3
2
1
0
2000 - out of schools
2010 - replaced w/ sport Drink
2015 size 16oz

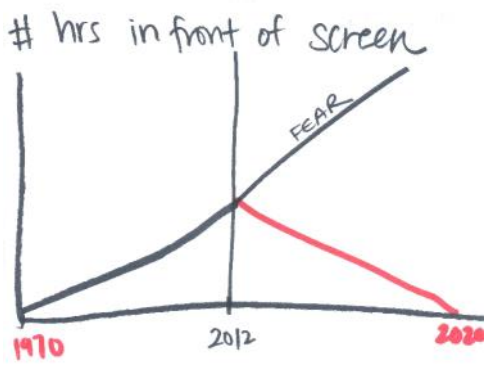

Food processing infrastructure availability
High
Low
Hope
Fear
1920
2012
2050

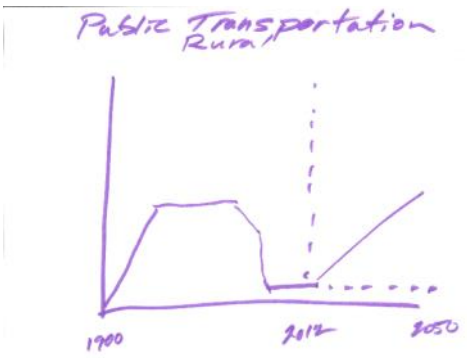

Local Food Production
100%
0%
1900
2012
2050

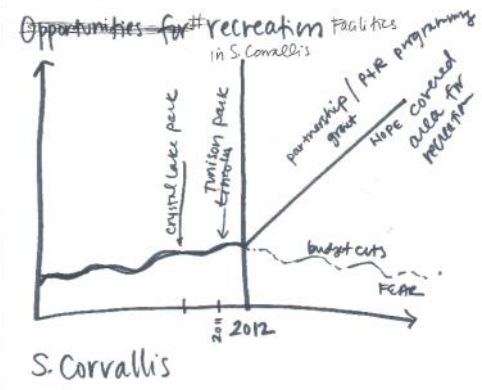

Tobacco Smokefree Policies
high
low
Hope
Fear
1996
2012


organized
Soccer for Latino youth in Monroe
HOPE
FEAR
2012

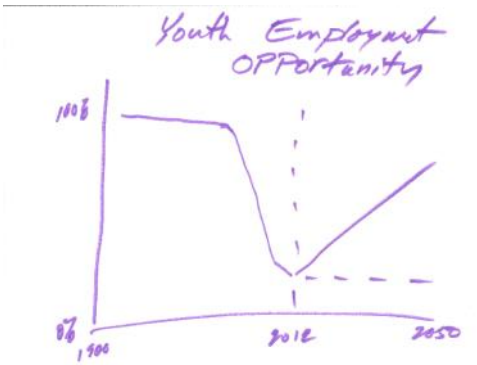

Community Building among Latino Community in SBC
Capacity
Hope
Fear
2007
2009
2012
2015
2020

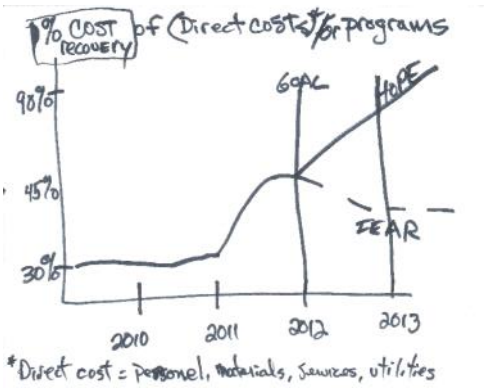

hrs in front of screen
FEAR
1970
2012
2020

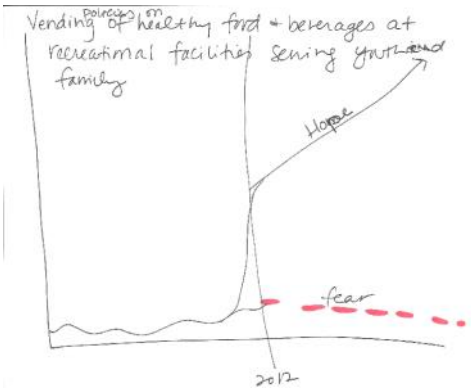

Public Transportation
Rural
1900
2012
2050

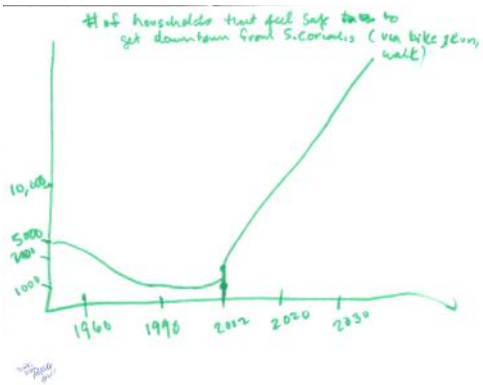

Opportunities for # recreation Facilities
in S. Corvallis
crystal lake park
Dunlap park
partnership / P4R programming
grant
Hope covered
area for
recreation
budget cuts
FEAR
2011
2012

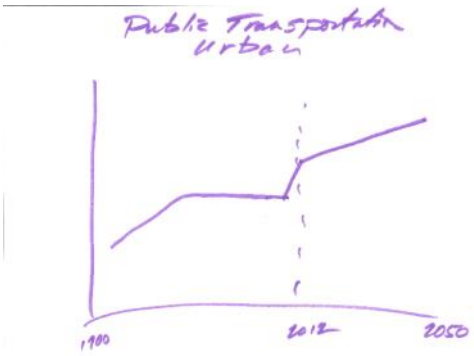
S. Corvallis

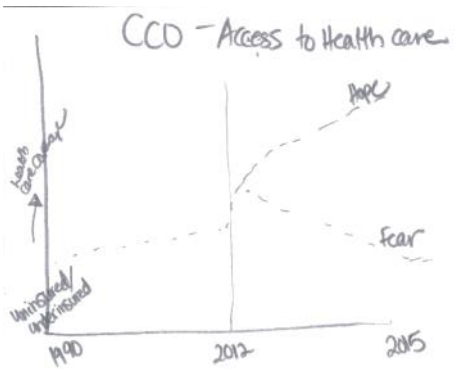

Youth Employment
OPPortunity
100%
1900
2012
2050


% COST RECOVERY of Direct costs* for programs
90%
45%
30%
GOAL
HOPE
FEAR
2010
2011
2012
2013
*Direct cost = personnel, materials, services, utilities

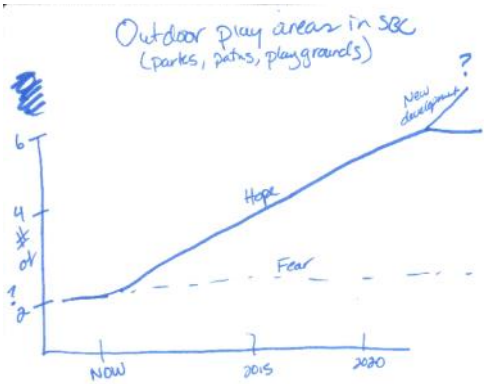

Vending policies on healthy food + beverages at
recreational facilities serving youth and
family
Hope
fear
2012


# of households that feel safe to
get downtown from S. Corvallis (via bike, scoot, walk)
10,000
5,000
2,000
1,000
1960
1990
2012
2020
2230


Public Transportation
Urban
1900
2012
2050


CCO - Access to Health care
Hope
Fear
1990
2012
2015


# of farmers making a living Wage.
# of farmers
Hope
Fear
Early
1900's
2012
2025


Outdoor play areas in SBC
(parks, parks, playgrounds)
New development
Hope
Fear
6
4
1/2
NOW
2015
2020


Rural Grocery/Retail
100%
0%
1900
2012
2050