Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Fitchburg, Massachusetts

This community storybook was developed by Transtria LLC.

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Introduction

Fun 'n FITchburg 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 *Fun 'n FITchburg* project was to introduce systems thinking at the community level by identifying the essential parts of the Fitchburg 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 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, businesses, schools) 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.

Fitchburg, Massachusetts: Background and Local Participation

Fitchburg, Massachusetts, located 50 miles west of the Boston metropolitan area, is home to 40,318 residents. Once a booming manufacturing center, the loss of the paper industry has heavily impacted Fitchburg's economy. Compared to the state of Massachusetts, Fitchburg has higher rates of single parent households with children under the age of 18, people living in poverty, children in poverty, and unemployment rates. In the face of these challenges, the Fitchburg government officials and staff, organizations, and residents have made healthy living a priority. The Fun 'n Fitchburg partnership has been recognized for their collaborative efforts to impact childhood obesity and healthy living in the community.

Fun ' Fitchburg was formed in 2009 as a result of HKHC funding and a Massachusetts Department of Public Health wellness grant, Mass in Motion. Mass in Motion and HKHC both focused on policy, systems, and environmental changes and so allowed the partnership to combine efforts. The goal of the partnership was to reduce obesity in Fitchburg through policy, systems, and environmental changes to impact opportunities and barriers to healthy eating and physical activity. The partnership served to not only provide structure to healthy eating and active living strategies, but also worked to connect key community members and partners. Initially workgroups were formed around the targeted neighborhoods (Cleghorn, Elm Street, and Green Acres), but transitioned to strategy specific workgroups as efforts spread beyond individual neighborhoods. The healthy eating workgroup focused on healthy vending and community gardens and the active living workgroup focused on safe routes to parks and schools. A communications workgroup was established in year three to serve as the public relations and communication branch of the partnership.

Fun 'n FITchburg's Priorities and Strategies

The partnership and capacity building strategies of *Fun 'n FITchburg* included:

- **Youth Peer Leaders:** The lead agency, Montachusetts Opportunity Council employed area youth to serve as Peer Leaders in the community. Originally primarily providing sex education to their peers, the partnership provided funding and resources to hire more Peer Leaders and expand their involvement to healthy eating and active living topics. Youth Peer Leaders became an integral part of the partnership, providing a youth perspective to their strategies. Additionally, the Peer Leaders assisted with the Health Impact Assessment, park cleanups, and presented assessment results to the Fitchburg Parks Board and Board of Health.

The healthy eating and active living strategies of *Fun 'n FITchburg* included:

- **Parks and Play Spaces:** Fun 'n Fitchburg collaborated with Fitchburg Parks and Recreation Department to institutionalize an Adopt a Park program for the City of Fitchburg. Sixteen of Fitchburg's 40 parks have been adopted by local organizations and residents. The Adopt a Park agreement commits the park sponsor to regular clean-ups, ongoing communication with the Parks Department, and the ability to complete minor landscaping and repair activities while the City of Fitchburg commits to providing signage, planning assistance, and clean-up equipment and tools. Under the guidance of the Fun 'n Fitchburg, the Fitchburg Parks Board adopted a healthy vending resolution and the Board of Health passed a healthy vending regulation that required all vending in public spaces to offer at least one healthy beverage and food item. The city's vendor approval process included a list of approved products to assist vendors in meeting the regulation. Language from the Board of Health regulation was then incorporated into Fitchburg school wellness policies. After school events must serve one healthy food and one healthy beverage item. The partnership is working to monitor the implementation of the vending policies in the schools. In collaboration with Fitchburg Housing Authority and Green Acre residents, Fun 'n Fitchburg implemented environmental changes at Green Acres' Big Field. Under the guidance of the partnership's five-year Big Field workplan, trees and brush were cleared for safety and visibility and a butterfly garden was created in a section of the field.
- **Community Gardens:** Prior to Fun 'n Fitchburg there were no community gardens in Fitchburg. The partnership, in collaboration with the City of Fitchburg and the community based organization, Growing Places, installed over 40 gardens throughout the city, including multiple beds on the Green Acres Village public housing property. The partnership also developed and implemented a formal community garden agreement and guidelines for the Green Acres gardens. Additionally, informal joint use agreements were established at several garden locations to provide the garden with water.
- **Active Transportation:** Fun 'n Fitchburg worked with Fitchburg Department of Public Works to adopt a Pedestrian Generator Checklist to help identify infrastructure needs for safer walking and bicycling, especially around parks and schools. The partnership continues to work towards a Complete Streets Resolution and Department of Public Works Administrative Policy.
- **Farmers' Markets:** The partnership, in collaboration with the Mayor, Parks Board, Community Health Center, and WIC, partnered with the Fitchburg Farmers Market Association to install EBT machines at two Fitchburg farmers' markets and to create a policy requiring all Fitchburg farmers' market vendors to accept WIC, senior farmers' market coupons, and SNAP benefits. Although these policy and environment changes are still in place, the partnership shifted their focus away from farmers' markets after year one of the HKHC project.

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

Systems Thinking in Communities: Fitchburg, Massachusetts

"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 Fitchburg, Massachusetts 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.

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.

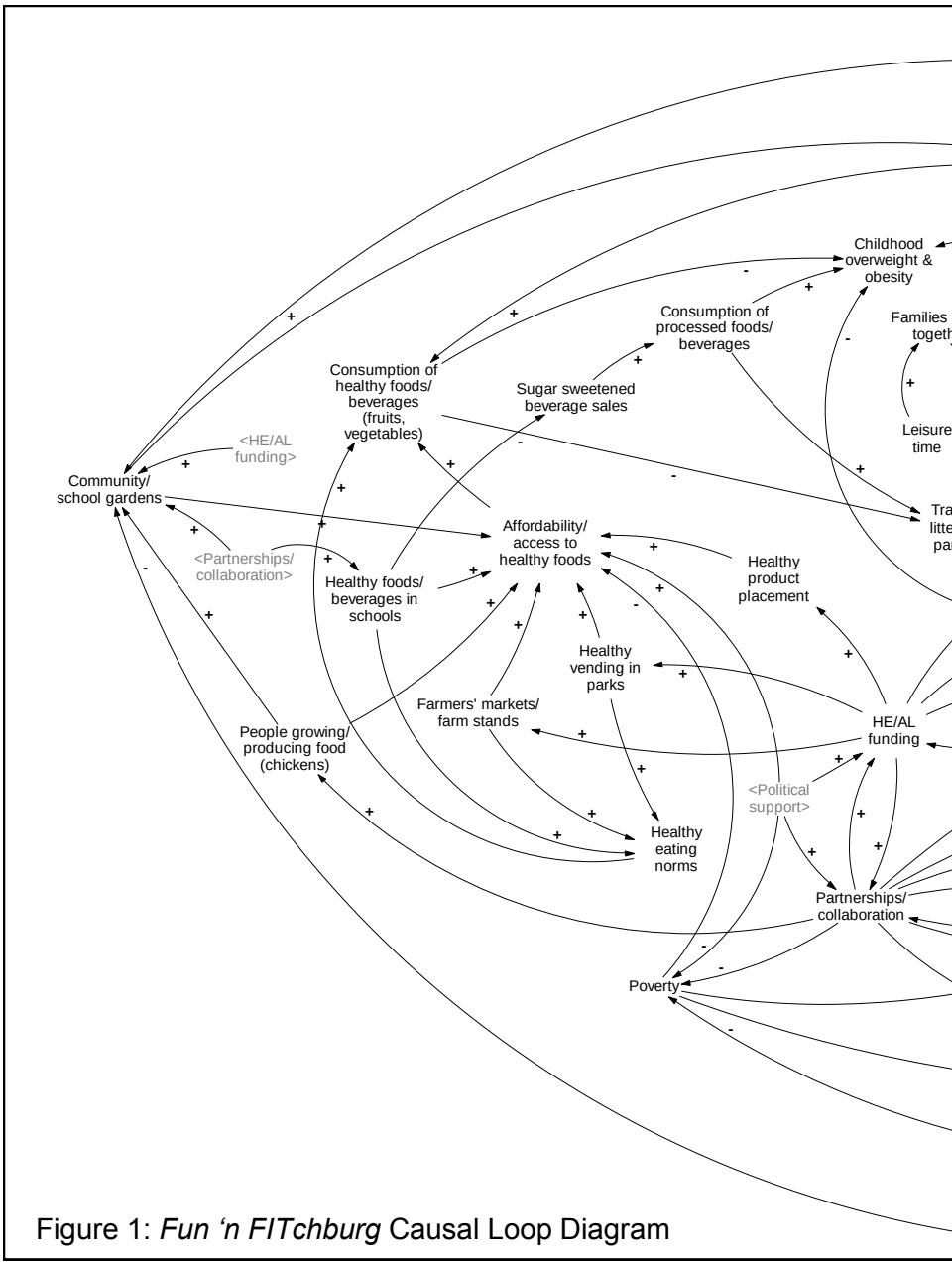


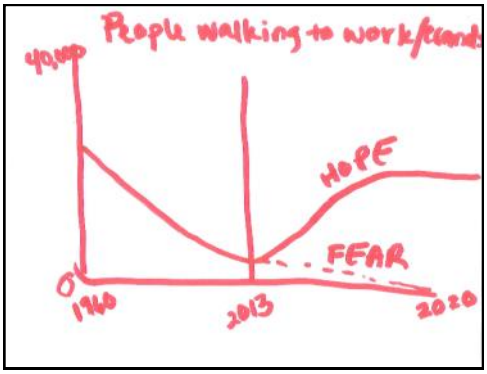
Figure 1: *Fun 'n FITchburg* Causal Loop Diagram

Group Model Building

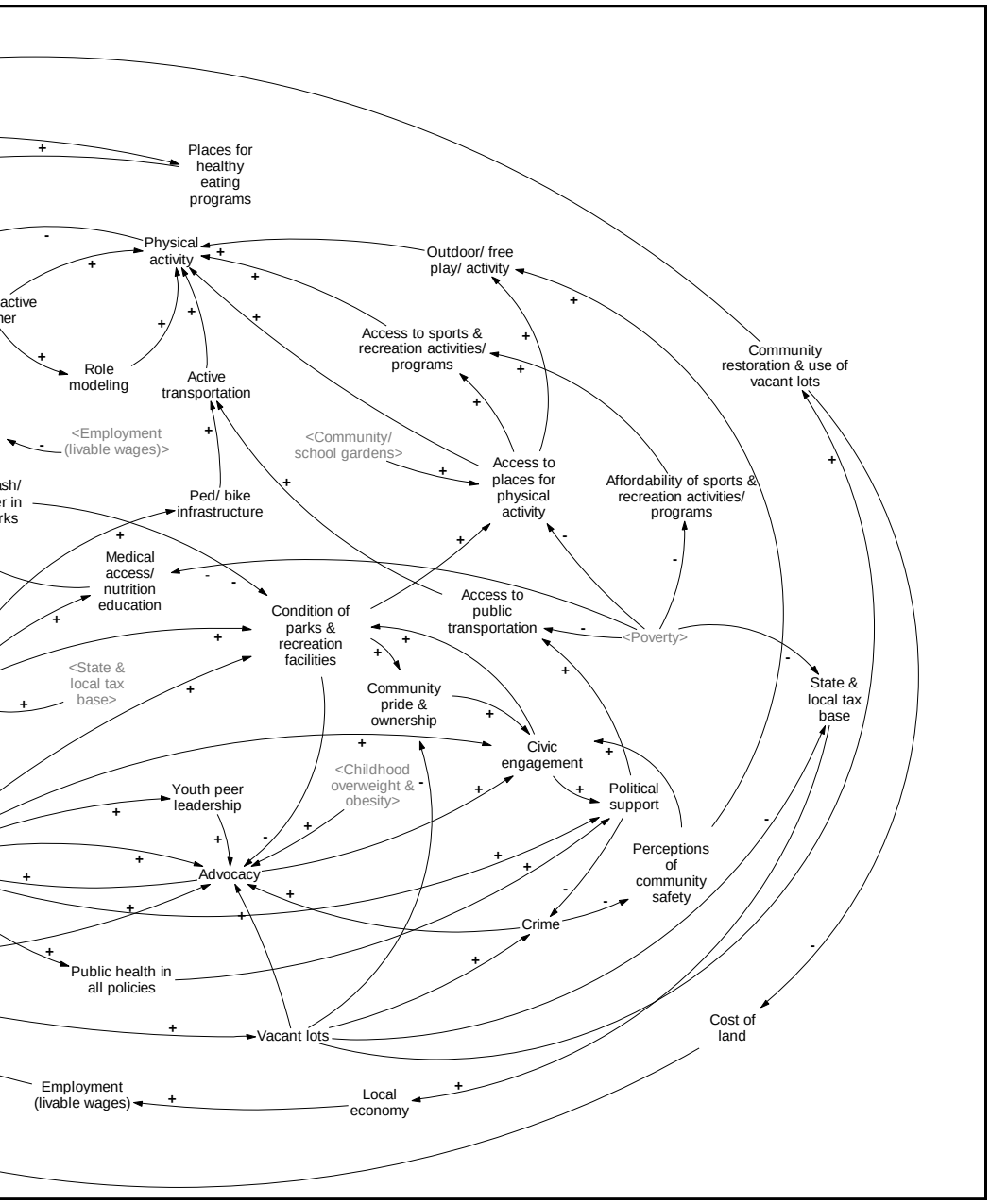
Members of the *Fun 'n FITchburg* partnership participated in a group model building session in April, 2013 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives from government agencies, community-based organizations, businesses, and schools. 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.

Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in Fitchburg 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 for the number of people walking to work and errands has decreased since 1960 to 2013 with the hope that the number of people walking to work and errands will increase into the future (see behavior over time graph bottom 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 the condition of parks and recreation facilities in this causal loop diagram. One feedback loop is: condition of parks and recreation facilities → community pride and ownership → civic engagement → condition of parks and recreation facilities. A second feedback loop is: condition of parks and recreation facilities → advocacy → partnerships and collaboration → condition of parks and recreation facilities.

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 condition of parks and recreation facilities. Some variables may increase or improve the condition of parks and recreation facilities while other variables limit or diminish the condition of parks and recreation facilities. 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 *Fun 'n FITchburg* 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 Fitchburg, Massachusetts and to stimulate greater conversation related to Fitchburg'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 Fitchburg, Massachusetts. 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.

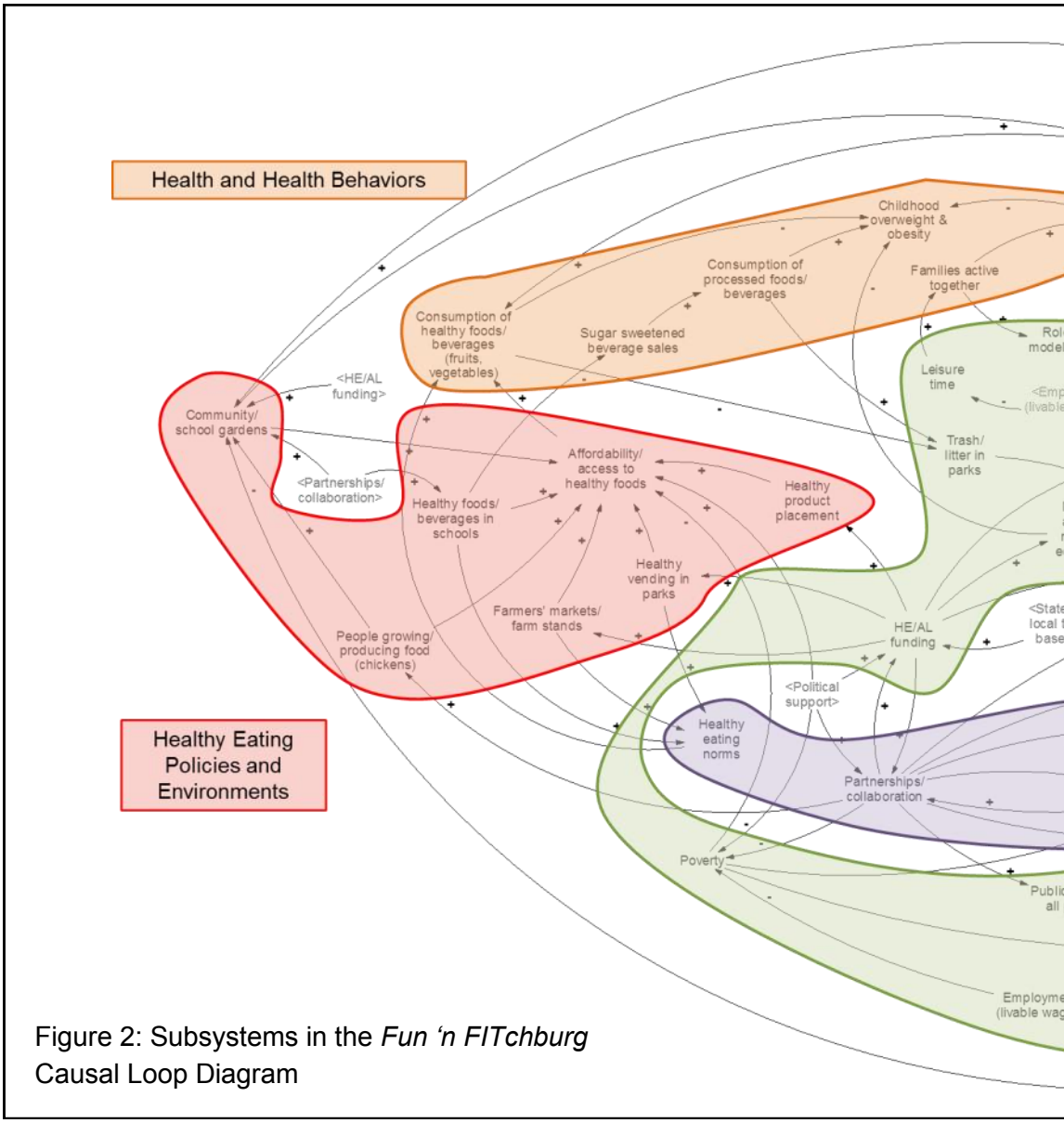


Figure 2: Subsystems in the *Fun 'n FITchburg* Causal Loop Diagram

<u>Healthy Eating Policies and Environments (Red)</u>

The healthy eating policy and environmental subsystem includes food production (e.g., community and school gardens), food distribution and procurement (e.g., affordability and access to healthy foods), and food retail (e.g., farmers' markets and farm stands). During the behavior over time graphs exercise, the participants generated 13 graphs related to policy or environmental strategies (e.g., healthy vending in parks) or contexts (e.g., people growing and producing food and raising chickens) that affected or were affected by the work of *Fun 'n FITchburg*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

<u>Active Living Policies and Environments (Blue)</u>

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 nine graphs related to policy or environmental strategies (e.g., pedestrian and bike infrastructure) or contexts (e.g., condition of parks and recreation facilities) that affected or were affected by the partnership's work.

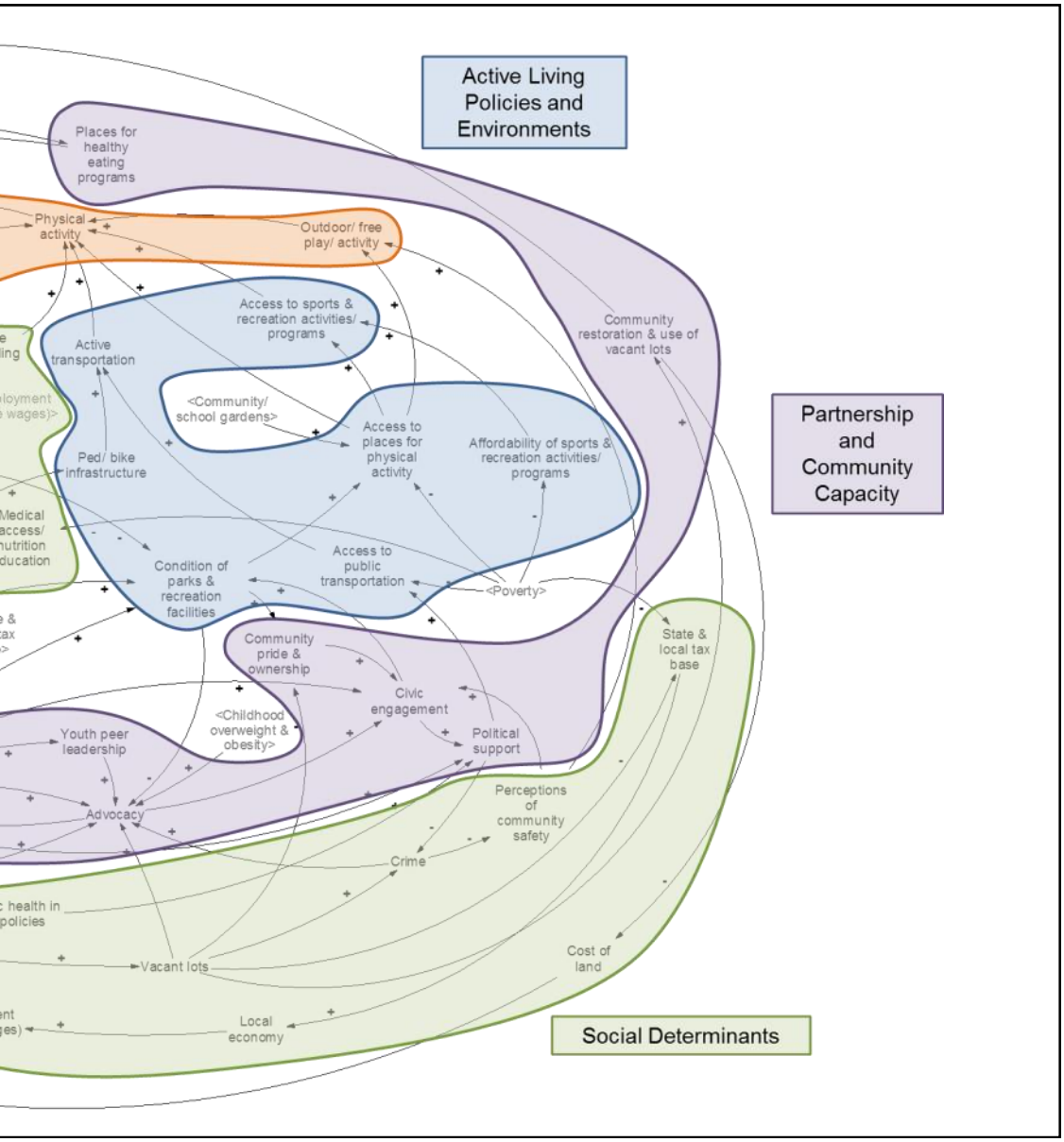
<u>Health and Health Behaviors (Orange)</u>

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., families active together, sugar sweetened beverage sales).

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, *Fun 'n FITchburg* worked with local youth to create a Youth Peer Leaders group that informed the work of the partnership. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as political support or places for healthy eating programs.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., local economy, employment, cost of land) and psychosocial influences (e.g., perceptions of community safety) 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 *Fun 'n FITchburg* partners or by other representatives in Fitchburg, Massachusetts. 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 partnerships and collaboration, advocacy, and access to places for physical activity.

The next sections begin to examine the feedback loops central to the work of *Fun 'n FITchburg*. 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.

Youth Peer Leaders Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *Fun 'n FITchburg* CLD (see Figures 1 and 2) are highlighted in Figures 3-7. While the CLD provides a theory of change for the childhood obesity prevention movement in Fitchburg, Massachusetts, 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 Youth Peer Leaders program, which engages youth in leadership opportunities for the *Fun 'n FITchburg* partnership (green highlighted loop in Figure 3). Participants described how more youth and peer leadership leads to more advocacy in the community. With more advocacy in the community, there is greater civic engagement, which also increases political support. With greater political support, there is more funding available for healthy eating and active living initiatives. In turn, more healthy eating and active living funding also increases partnerships and collaborations, which continues to increase youth and peer leadership opportunities.

Story B: While the preceding story reflected a positive scenario for Fitchburg, Massachusetts, the same feedback loop also tells the opposite story. With less youth and peer leadership, there is less advocacy in the community. With less advocacy in the community, there is a decrease civic engagement, which also decreases political support. With less political support, there is less funding available for healthy eating and active living initiatives. In turn, less healthy eating and active living funding also decreases partnerships and collaborations, which continues to decrease youth and peer leadership opportunities.

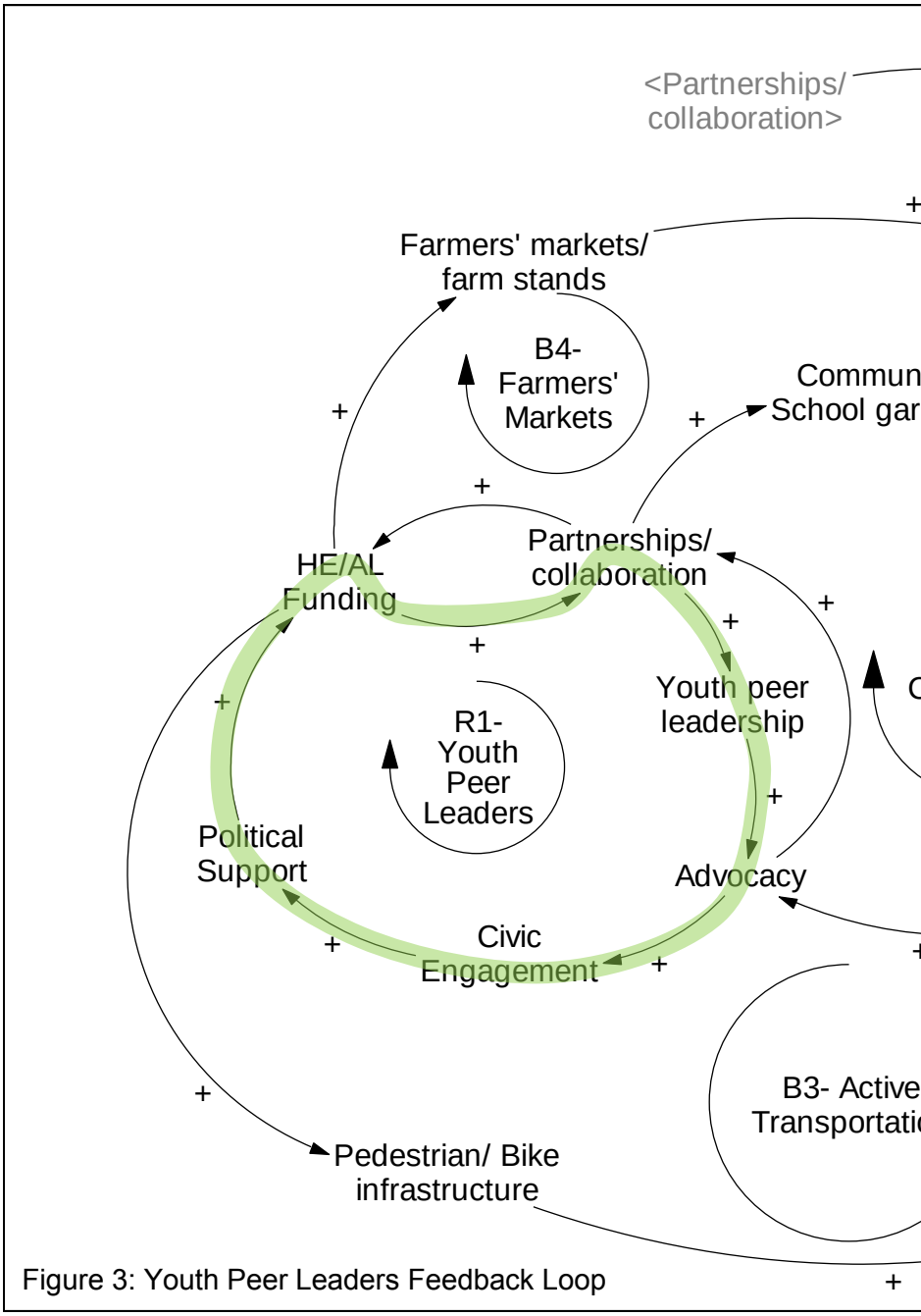


Figure 3: Youth Peer Leaders Feedback Loop

Reinforcing Loop and Notation

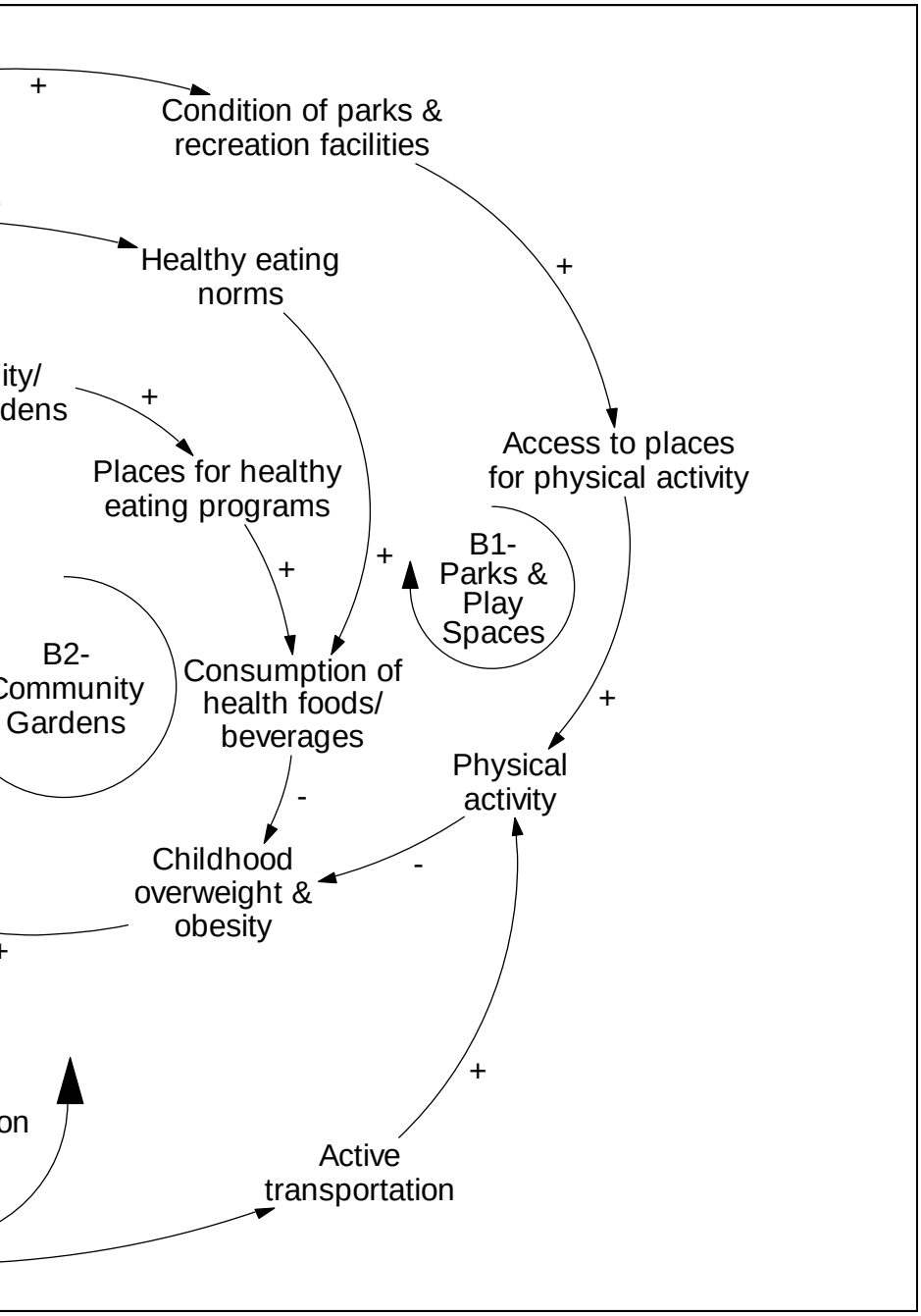
These stories represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing loop (see "R1 — Youth Peer Leaders" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These 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

"if not everybody's on the same page and working towards a common vision that none of this [work towards a healthy community] is going to get accomplished in the end. The big one is civic engagement. Another one is political support. Another one is funding." (Participant)

another variable (1) increases/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 and are referenced in the next sections.



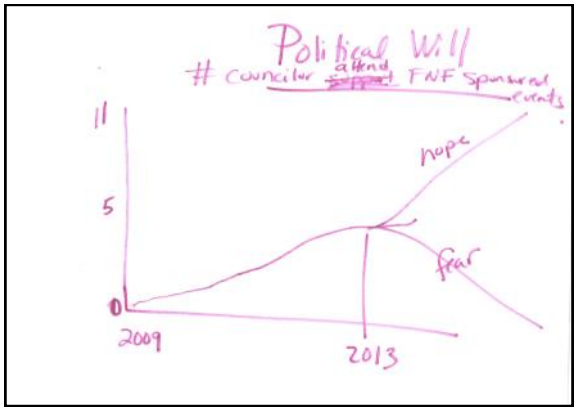
In isolation, this reinforcing loop represents a virtuous cycle in Story A as these assets positively support one another, or a vicious cycle in Story B as these challenges perpetuate a downward spiral. Yet, the influence of youth peer leadership likely levels off at some point. To understand what specifically leads to the leveling off of youth peer leadership, it may be helpful for the partners in Fitchburg, Massachusetts to consider other variables that influence or are influenced by youth peer leadership. 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 *Fun 'n FITchburg*</u>

Participants identified an increase in political will — specifically the number of councilors attending *Fun 'n FITchburg* sponsored events since 2009 to 2013 with the hope that political support will continue to increase into the future (see behavior over time graph bottom right).

From the systems thinking exercises, several insights can inform the youth peer leaders strategy, including:

- Strategic partnerships to engage residents in advocacy initiatives stimulate support and funding from city government agencies.



- Incorporation of efforts to increase youth engagement 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).

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. With more access to places for physical activity, there is an increase in physical activity levels among residents, which decreases childhood overweight and obesity. With less overweight and obesity, there is a decrease in advocacy efforts focusing on healthy eating and active living initiatives. As there is less advocacy, there is less partnership and collaborations forming. In turn, fewer partnership and collaborations decreases the condition of parks and recreation facilities, which decreases access to places for physical activity.

Story B: Alternatively, with less access to places for physical activity, there is a decrease in physical activity levels among residents, which increases childhood overweight and obesity. With more overweight and obesity, there is an increase in advocacy efforts focusing on healthy eating and active living initiatives. As there is more advocacy, there is more partnership and collaborations forming. In turn, more partnership and collaborations increases the condition of parks and recreation facilities, which increases access to places for physical activity.

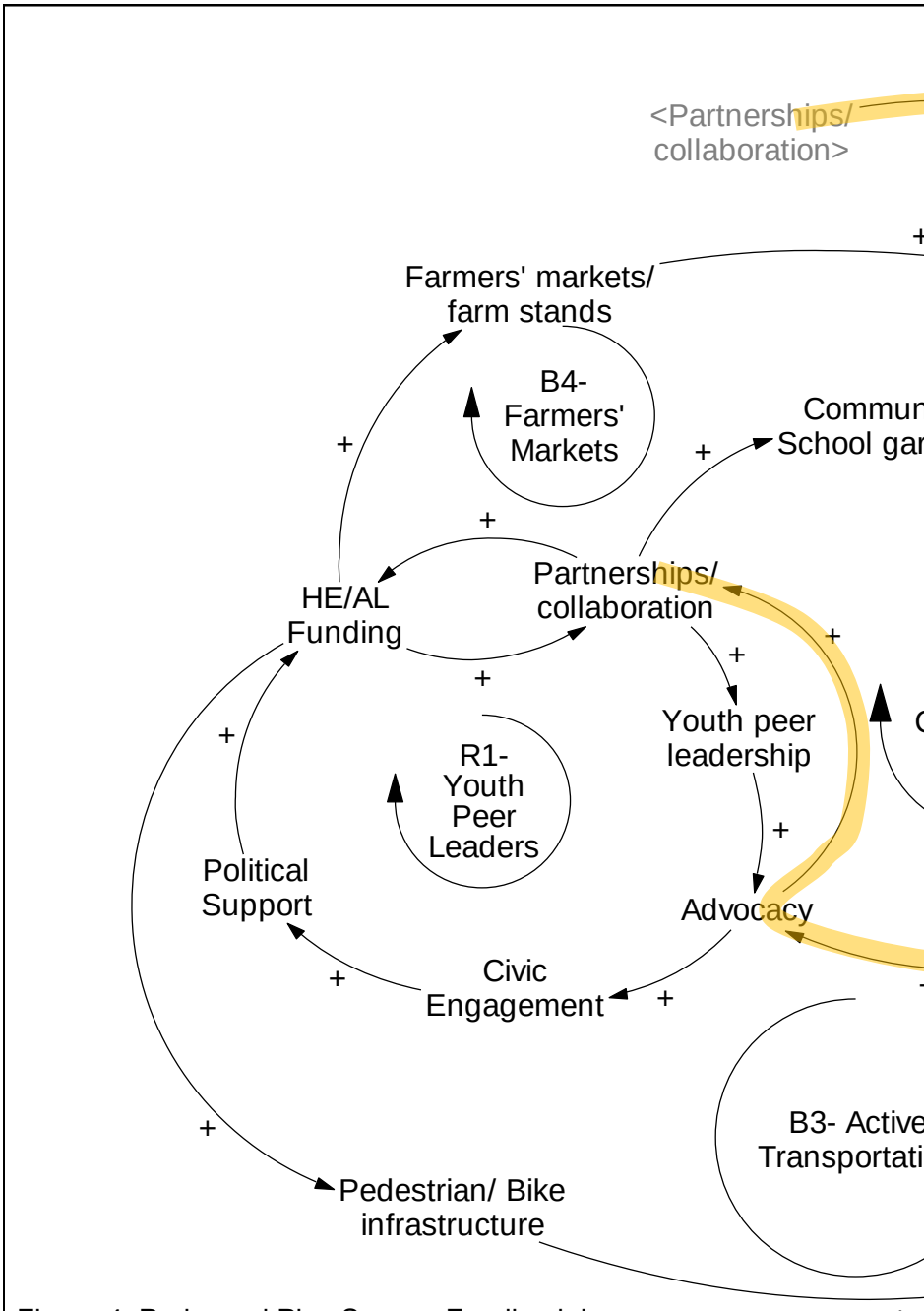


Figure 4: Parks and Play Spaces Feedback Loop

Balancing Loop and Notation

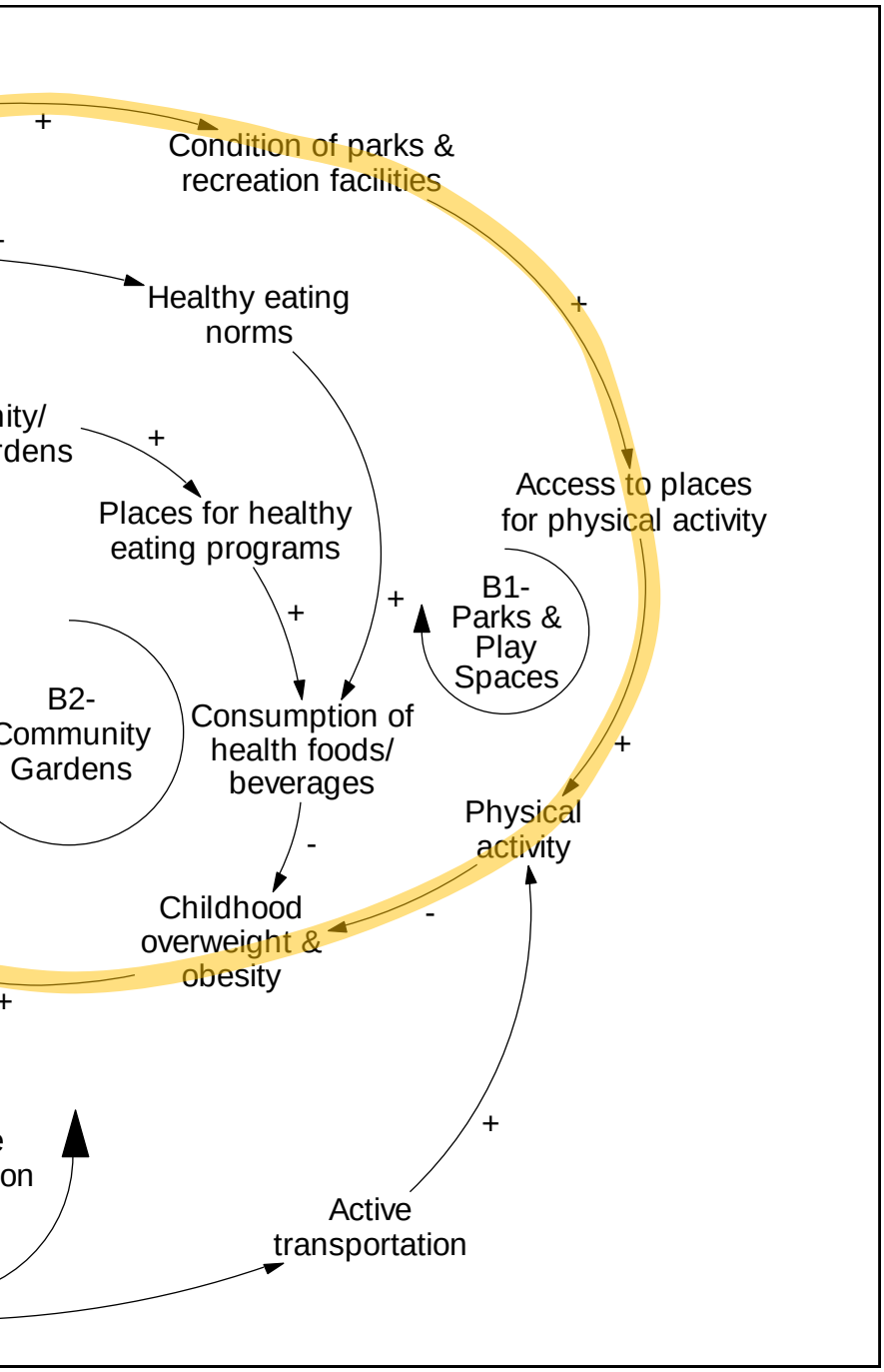
Unlike the parks and play spaces loop in Figure 3, this loop has one "-" sign or polarity; because this is an odd number, it is a balancing loop (see B1—Parks and Play Spaces in Figure 4).

In a balancing loop, the effect of the variables tend to create more of a stable trend over time, as opposed to one that is continually increasing or decreasing. This

"In 2004… my family was trying to get access to the parks, and you'd have to find a lot of different ways to find out where the parks even were in Fitchburg. I remember going on the website and we made a scavenger hunt of how many we could get to because there are so many; but there were a lot of perceived barriers. How safe are the parks? How well-lit are they at night? How clean are they?" (Participant)

effect continues through the cycle and returns a stabilizing influence to the original variable, respectively.

Yet, this loop, unlike the previous loop, is disconnected. Because this loop crosses over several of the other loops, it uses a shadow variable to keep the image from getting too messy with lots of overlapping loops. The shadow variable for partnerships and collaboration is presented in gray text with brackets on either side to show that it "shadows," or duplicates, the original partnerships and collaboration variable.



- What factors can increase employers' and policy-makers' attention to safe parks, trails, and outdoor facilities?
- What funds have collaborators successfully secured for parks and play spaces? How can these resources be sustained into the future?

System Insights for *Fun 'n FITchburg*

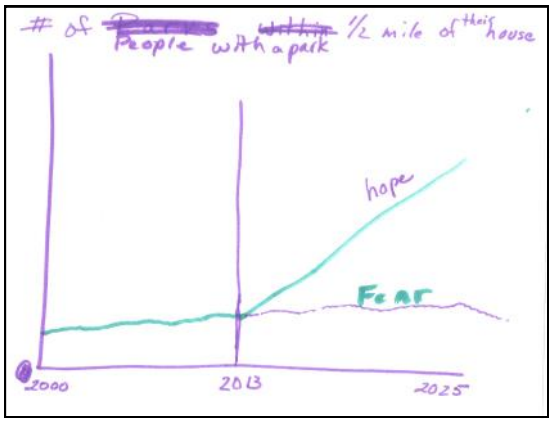
In the behavior over time graphs, participants identified no change in the number of people living within a 1/2 mile of a park since 2000 to 2013 with the hope that the number of people living close to parks will increase into the future (see behavior over time graph bottom right).

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

- Communities capitalize on local parks, trails, and recreation facilities as places to convene neighbors and community representatives to advocate for changes to support access to healthy eating and active living resources and services in the community; these are also good places to increase voter registration (e.g., booths in the park or along the trail).
- 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.

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

- Who lives within a one– or two–mile radius of safe, quality parks and recreation facilities? Who does not?
- What are the optimal numbers and types of public recreation facilities for a neighborhood or urban area?



Community Gardens Feedback Loop

Highlighted in blue in Figure 5, the community gardens feedback loop represents one of the *Fun 'n FITchburg* strategies to increase healthy eating in Fitchburg, Massachusetts.

Causal Story for Feedback Loop

Story A: With more community and school gardens, there is an increase in places to hold healthy eating programs (e.g., growing, cooking, and education classes). As there are more places for healthy eating programs, there is an increase in the consumption of healthy foods and beverages, which decreases childhood overweight and obesity. As childhood overweight and obesity decreases, there is a decrease in advocacy efforts focusing on obesity. With less advocacy efforts, there are fewer partnerships and collaborations forming. In turn, with less partnerships and collaborations, there are less community and school gardens being built in the community.

Story B: Alternatively, with less community and school gardens, there is a decrease in places to hold healthy eating programs (e.g., growing, cooking, and education classes). As there are fewer places for healthy eating programs, there is a decrease in the consumption of healthy foods and beverages, which increases childhood overweight and obesity. As childhood overweight and obesity increases, there is a increase in advocacy efforts focusing on obesity. With more advocacy efforts, there are more partnerships and collaborations forming. In turn, with more partnerships and collaborations, there are more community and school gardens being built in the community.

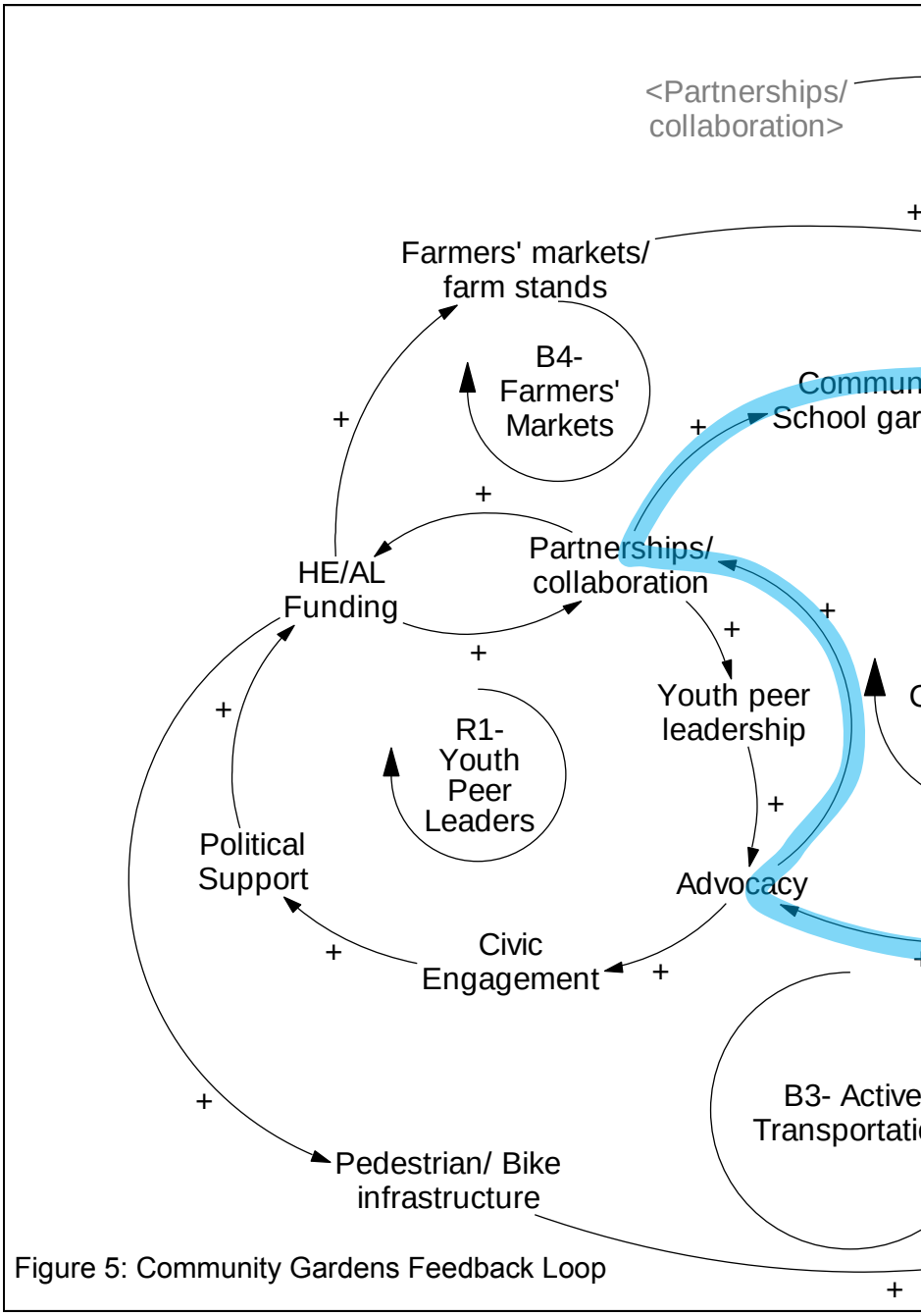


Figure 5: Community Gardens Feedback Loop

Balancing Loop and Notation

Similar to the previous loops (see Figure 4), this one also represents a balancing loop (one "-" sign).

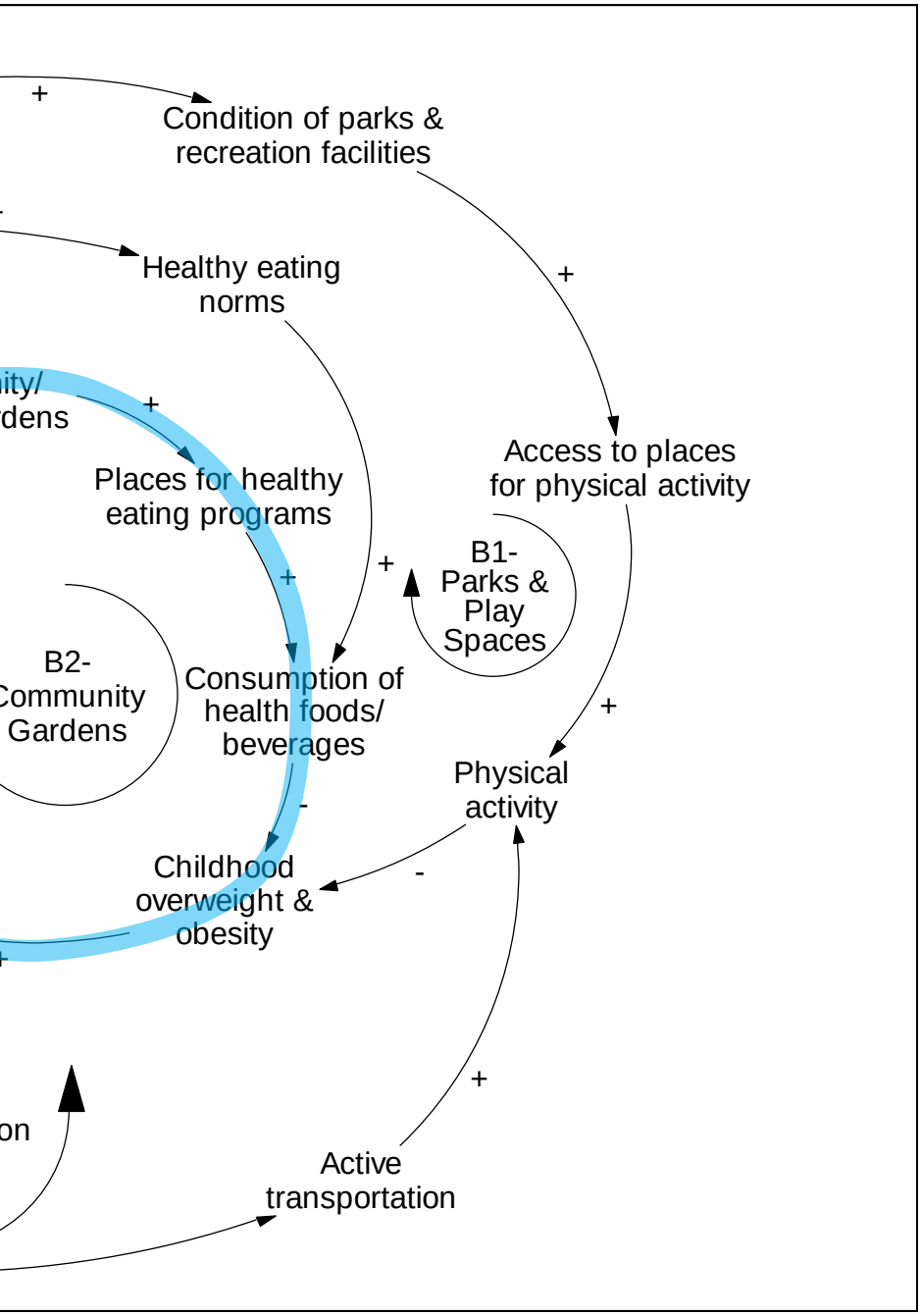
Some of these causal relationships may have more immediate effects (e.g., community and school gardens influence on places for healthy eating programs) and other relationships may have delayed effects (e.g., consumption of healthy foods and beverages influence on childhood

"In the last 10 years or so, here in Fitchburg, particularly because of these efforts and our group, we've seen a lot more people growing their own food. So my hope is that it's going to continue – that people are going to grow their own food, either in community gardens or schools are going to have their own gardens or people are going to grow their own food and keep their chickens. My fear is that [because of] regulations in Fitchburg, people are afraid having chickens or land use policies that don't allow community gardens, that [people growing their own food] will go down." (Participant)

overweight and obesity). Again, delayed effects are noted using two hash marks through the middle of the arrow line (not included here).

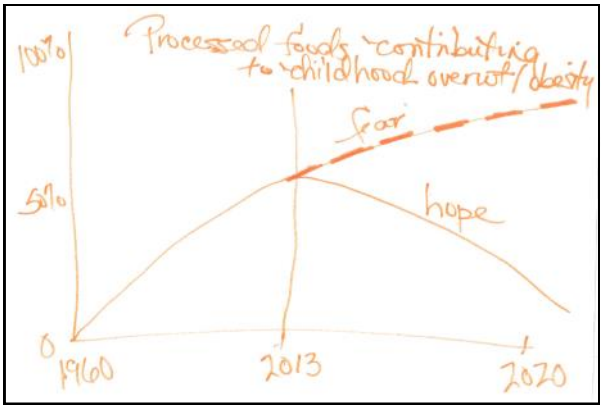
System Insights for *Fun 'n FITchburg*

In the behavior over time graphs exercise, participants described an increase in the amount of processed foods available that are contributing to childhood overweight and



for assessment and evaluation, including:

- What is the optimal number of school or community gardens or farms for a neighborhood or urban area?
- What types of partnerships increase resident engagement and participation in advocacy?

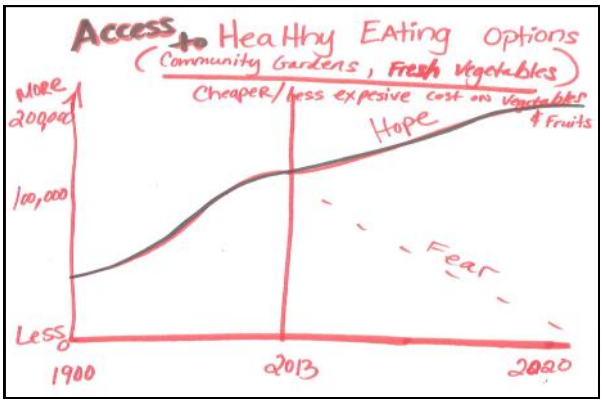


obesity in the community since 1960 to 2013 with the hope that the amount of processed foods will decrease into the future (see behavior over time graph top right). However, participants also identified an increase in access to healthy eating options through community gardens since 1900 to 2013 with the hope that access to healthy eating options will continue to increase into the future (see behavior over time graph bottom right).

System insights for the partnership's community gardens 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.
- Because increasing access to non-processed foods requires greater food preparation, partners must also build residents' skills and confidence in preparing healthy meals.

In addition to these insights, systems thinking can also help to pose key questions



Active Transportation Feedback Loop

Highlighted in red in Figure 6, the active transportation feedback loop represents one of the *Fun 'n FITchburg* strategies to increase active living in Fitchburg, Massachusetts.

Causal Story for Feedback Loop

Story A: With more pedestrian and bike infrastructure, there is an increase in active transportation, which increases physical activity. As more residents are engaging in physical activity, there is a reduction in childhood overweight and obesity. With less obesity, there is a decrease in the need for advocacy efforts targeting obesity prevention. As there is less advocacy, there is less partnerships and collaborations that are forming. In turn, less healthy eating and active living funding is available, which reduces the opportunities to create pedestrian and bike infrastructures.

Story B: Alternatively, with less pedestrian and bike infrastructure, there is a decrease in active transportation, which decreases physical activity. As fewer residents are engaging in physical activity, there is an increase in childhood overweight and obesity. With more obesity, there is an increase in advocacy efforts targeting obesity prevention. With more advocacy, there are more partnerships and collaborations that are forming, in turn, creating more healthy eating and active living funding, which increases the opportunities to create pedestrian and bike infrastructures.

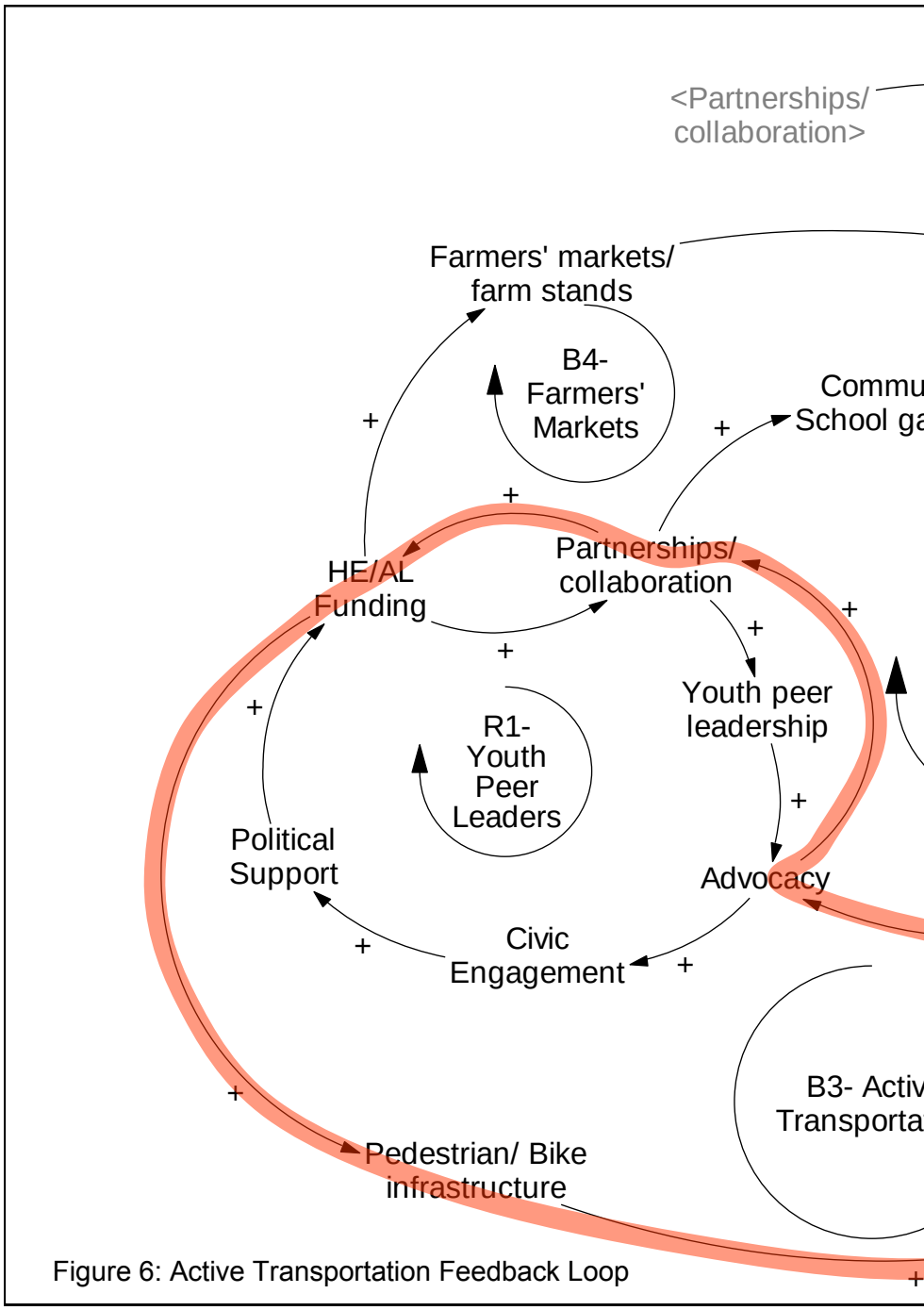


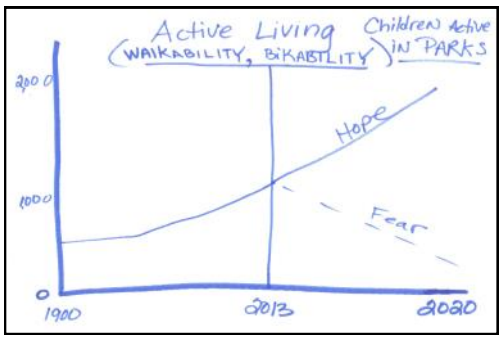
Figure 6: Active Transportation Feedback Loop

Balancing Loop and Notation

Similar to the previous loops (see Figure 4 & 5), this is a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., pedestrian and bike infrastructure influence on active transportation), and, potentially, delayed effects (e.g., physical activity influence on childhood overweight and obesity).

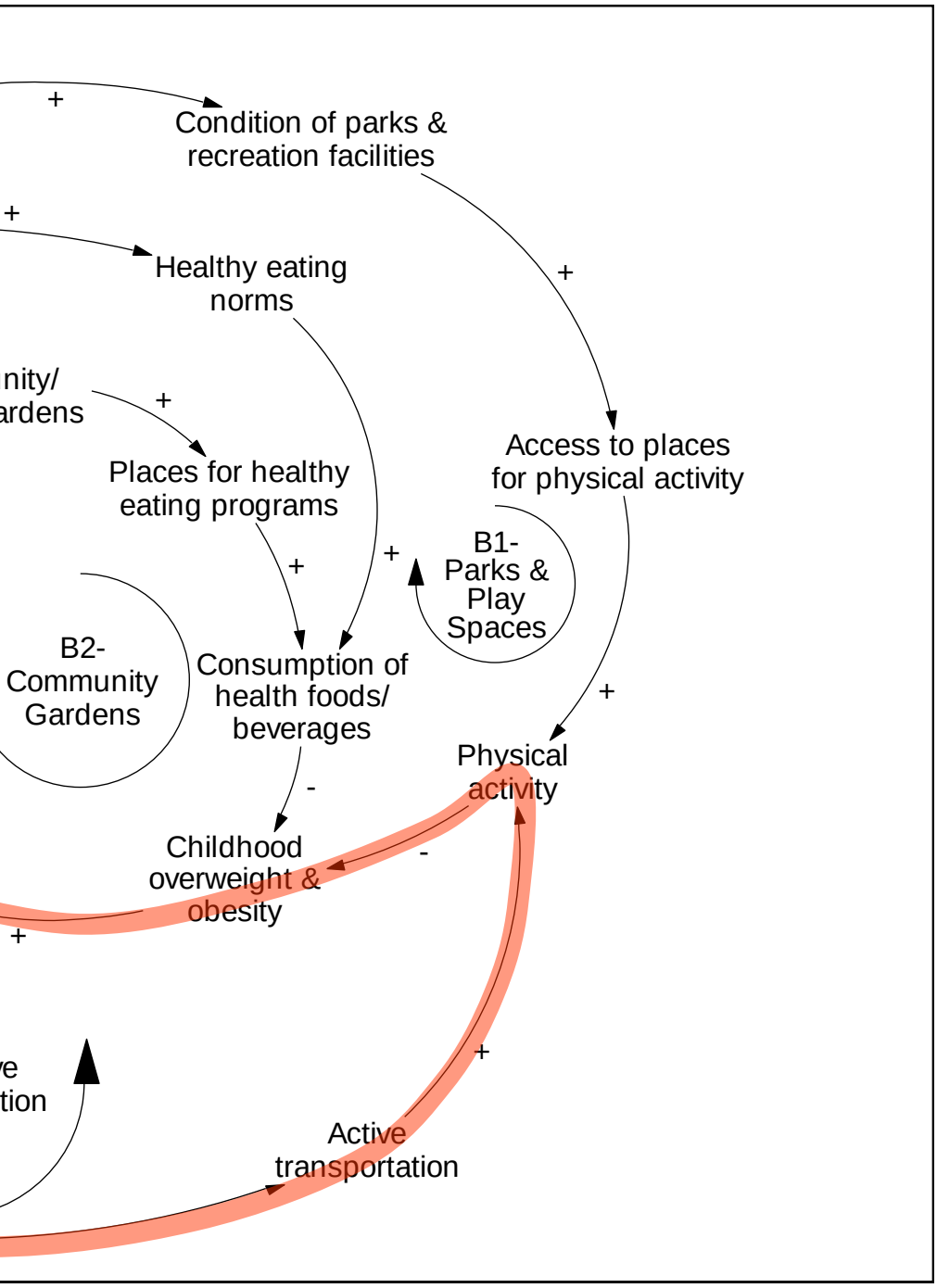
System Insights for *Fun 'n FITchburg*

In the behavior over time graphs exercise, participants described an increase in the activity — specifically walking and biking — that has been observed among youth in parks since 1900 to 2013 with the hope that the amount children walking and biking in parks will continue to increase into the future (see behavior over time graph bottom right).



Similarly, participants described an increase in funding that has been available to work on healthy eating and active living initiatives since 2008 to 2013 with the hope that funding will continue to increase and support healthy eating and active living initiatives into the future (see behavior over time graph bottom right).

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

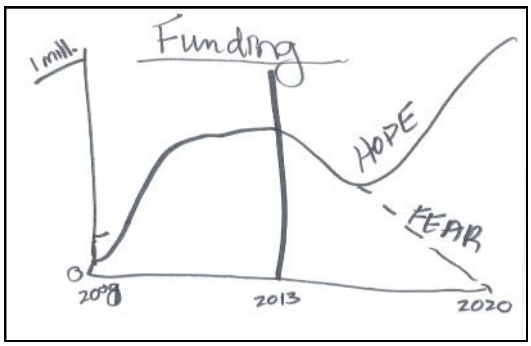


- The identification of trails, gulches, and greenways as pathways supporting safe walking and bicycling commutes reduces residents' driving trips and the amount of time kids spend sedentary in vehicles.
- Infrastructure for pedestrians and bicyclists increase the number of families being active together; sidewalks and bikes lanes — along with traffic calming and other safety measures — create opportunities for families to choose active rather than sedentary transportation modes.

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

- 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 care, bike, and foot in communities? Who is using the current active transportation infrastructure and who is not (e.g., adults, children)?
- What drives community collaboration when funding support is not available?
- What are successful funding structures to incentivize partnerships and collaboration?

"I know of people walking to work and running errands just as part of their daily routine, but I think that active living should just be integrated into everybody's life. I think that's such a disconnect today." (Participant)



Farmers' Markets Feedback Loop

Highlighted in yellow in Figure 7, the farmers' markets feedback loop represents one of the *Fun 'n FITchburg* strategies to increase healthy eating in Fitchburg, Massachusetts.

Causal Story for Feedback Loop

Story A: With more farmers' markets and farm stands in the community, there is an increase in healthy eating as a social norm, which increases the consumption of healthy foods and beverages. As there is more consumption of healthy foods and beverages, there is a decrease in childhood overweight and obesity, which decreases the need for advocacy efforts focused on obesity. With less advocacy efforts, there is a decrease in the partnerships and collaborations that are forming. In turn, with less partnerships, there is less funding available for healthy eating and active living initiatives, which decreases the number of farmers' markets and farm stands in the community.

Story B: Alternatively, with less farmers' markets and farm stands in the community, there is a decrease in healthy eating as a social norm, which decreases the consumption of healthy foods and beverages. As there is less consumption of healthy foods and beverages, there is an increase in childhood overweight and obesity, which increases the need for advocacy efforts focused on obesity. With more advocacy efforts, there is an increase in the partnerships and collaborations that are forming. In turn, with more partnerships, there is more funding available for healthy eating and active living initiatives, which increases the number of farmers' markets and farm stands in the community.

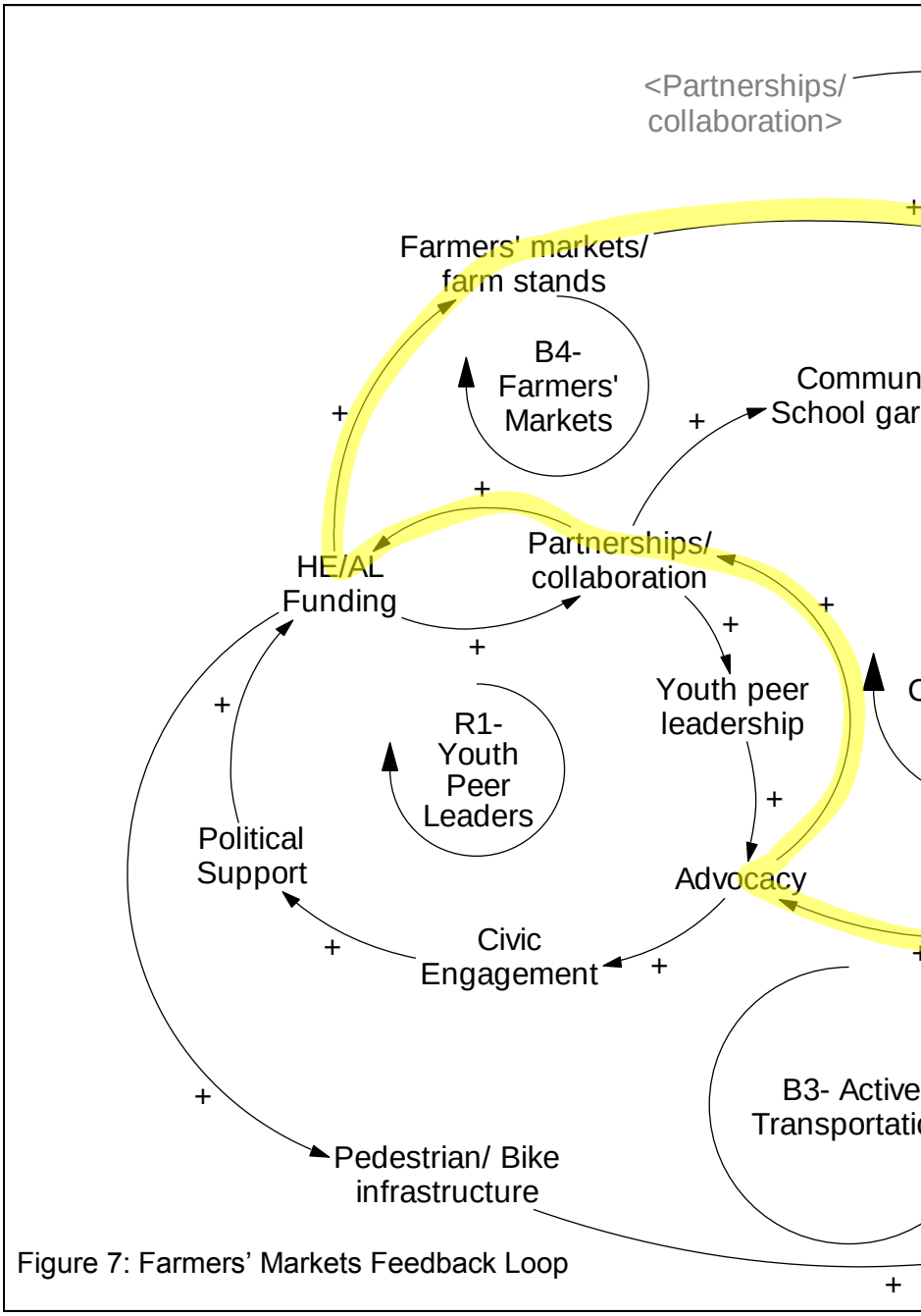


Figure 7: Farmers' Markets Feedback Loop

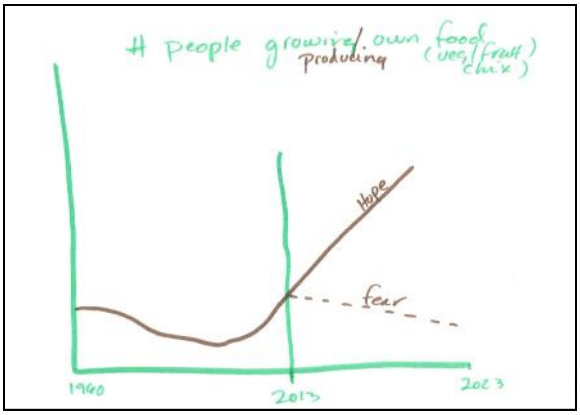
Balancing Loop and Notation

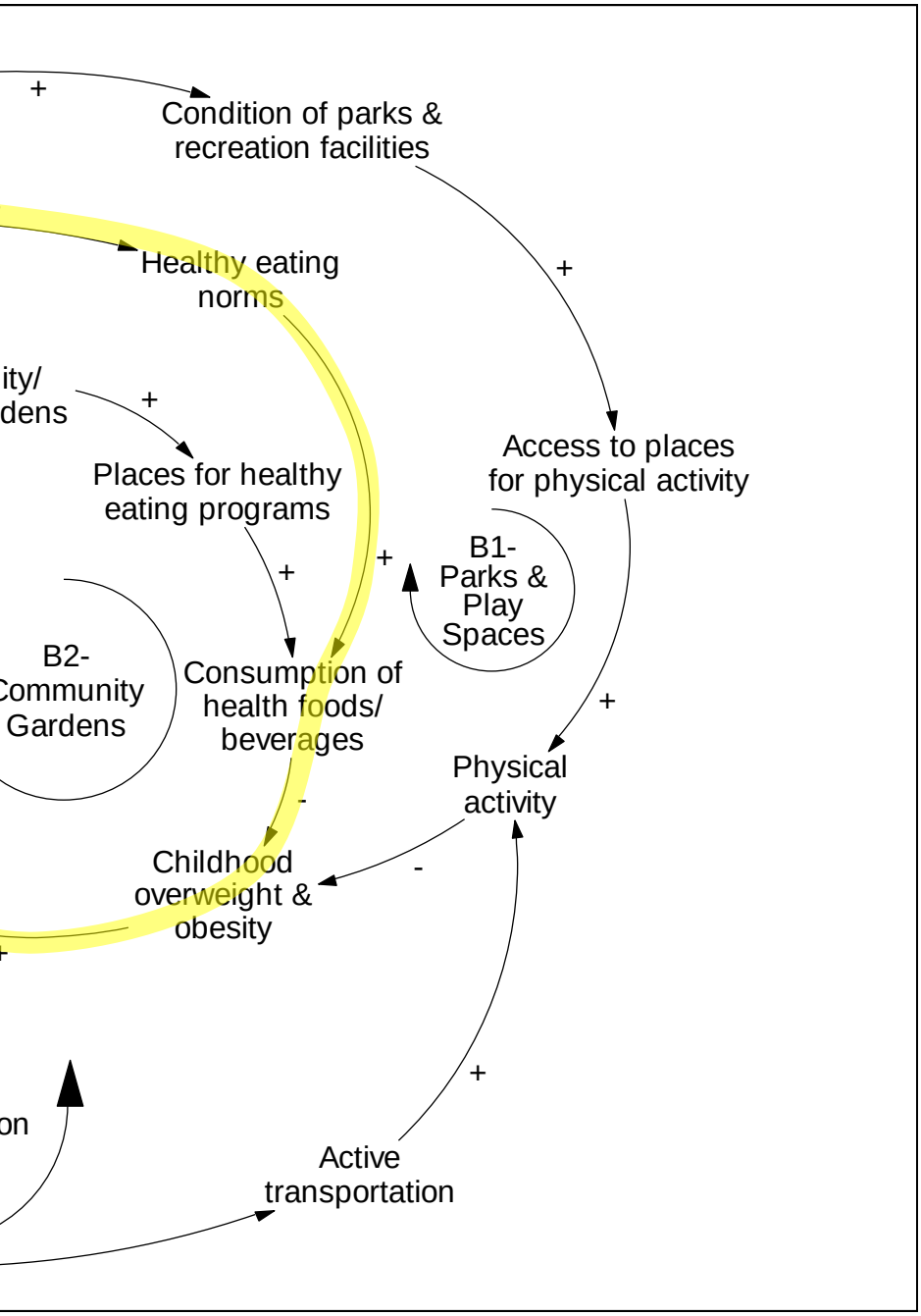
Similar to the previous loops (see Figure 4-6), this is a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., healthy eating and active living funding influence on farmers' markets and farm stands), and, potentially, delayed effects (e.g., consumption of healthy foods and beverages influence on childhood overweight and obesity).

"People used to have access through a lot of local little corner shops that actually had fresh healthy foods that weren't just selling processed food. That's sort of changed again, right? Because there are big supermarkets but they weren't all in our neighborhoods, so it was hard to get to them. Now I see with farmers' markets and farm stands that people are starting to have access [again]." (Participant)

System Insights for *Fun 'n FITchburg*

In the behavior over time graphs exercise, participants described a decrease and a more recent increase in the number of people growing their own food since 1960 to 2013 with the hope that the number of people growing their own food will continue to increase into the future (see behavior over time graph top right). Additionally, participants also described a decrease with a more recent increase in access to fresh fruits and vegetables through the development of farmers' markets and farm stands since 1960 to 2013 with the hope that the access to fresh fruits and vegetables will continue to increase into the future (see behavior over time graph bottom right).



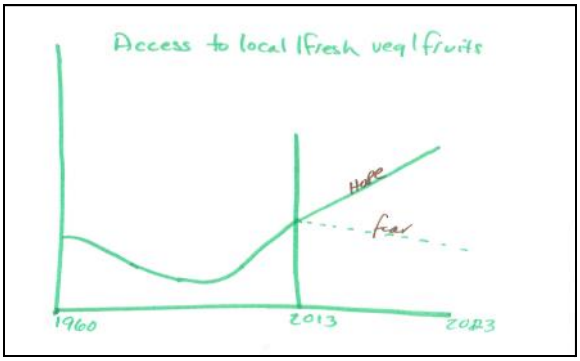


System insights for the partnership's farmers' markets efforts include:

- With the percentage of calories from processed foods steadily increasing over time, farmers' markets provide opportunities to reduce residents' consumption of unhealthy foods and replace these calories with those from healthier foods; this, in turn, supports and potentially increases the vendors at the market.

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

- What is the proportion of unhealthy food and beverage products to healthy food and beverage products sold by local food vendors (e.g., farmers' markets, corner stores, grocery stores)? How do these products differ by cost, product placement within the stores, and marketing or signage in and around the stores?
- What factors lead to an increase in demand for healthy foods and beverages in communities?
- What is the proportion of the population that is food insecure? How many residents are WIC or SNAP recipients? How much produce is required to meet the demands of this population?



Opportunities for Systems Thinking in Fitchburg, Massachusetts

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 *Fun 'n FITchburg* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Fitchburg causal loop diagram as well as six specific feedback loops corresponding to the partnership's primary strategies.

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 Fitchburg, Massachusetts to promote healthy eating and active living as well as preventing childhood overweight and obesity.

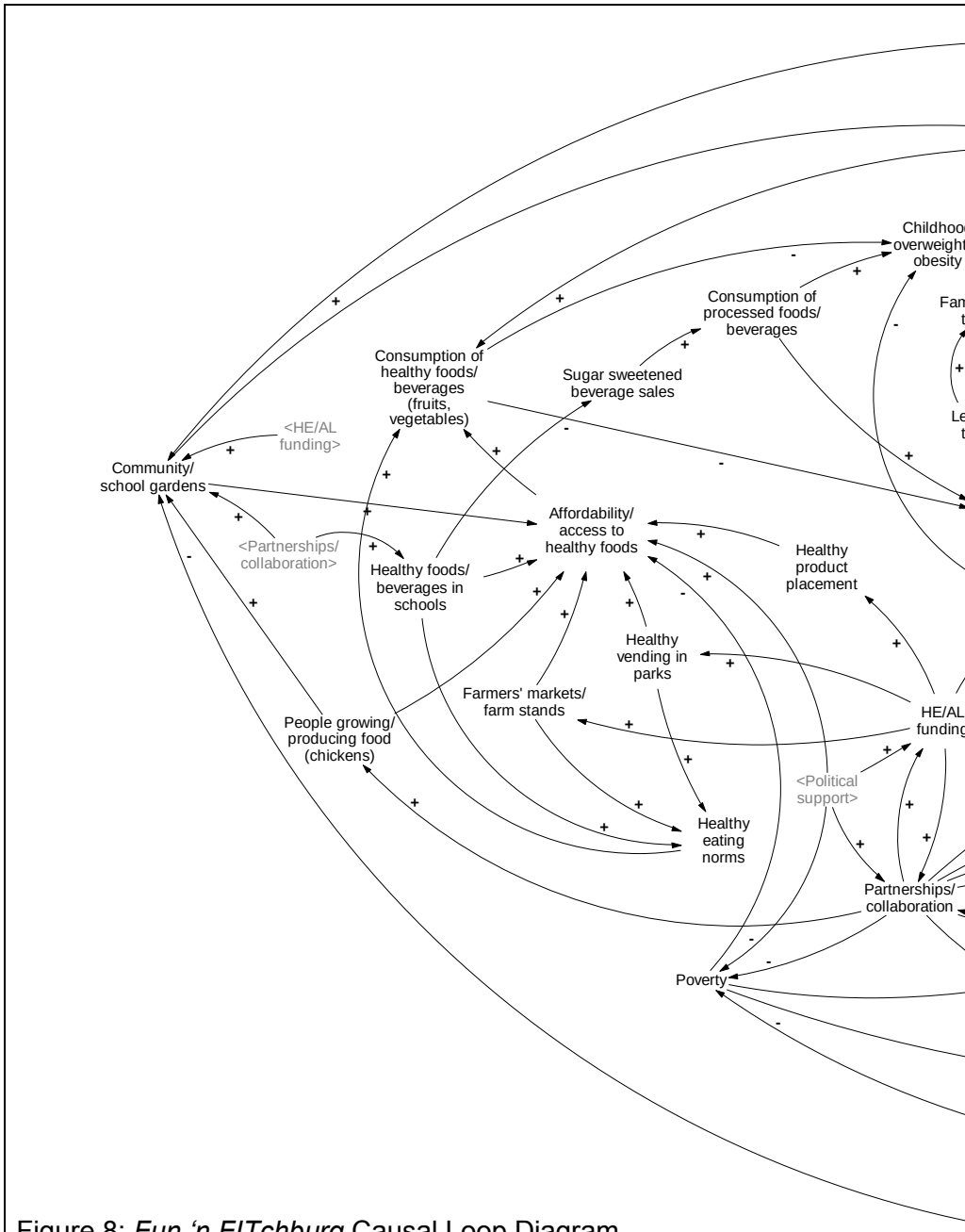


Figure 8: *Fun 'n FITchburg* Causal Loop Diagram

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

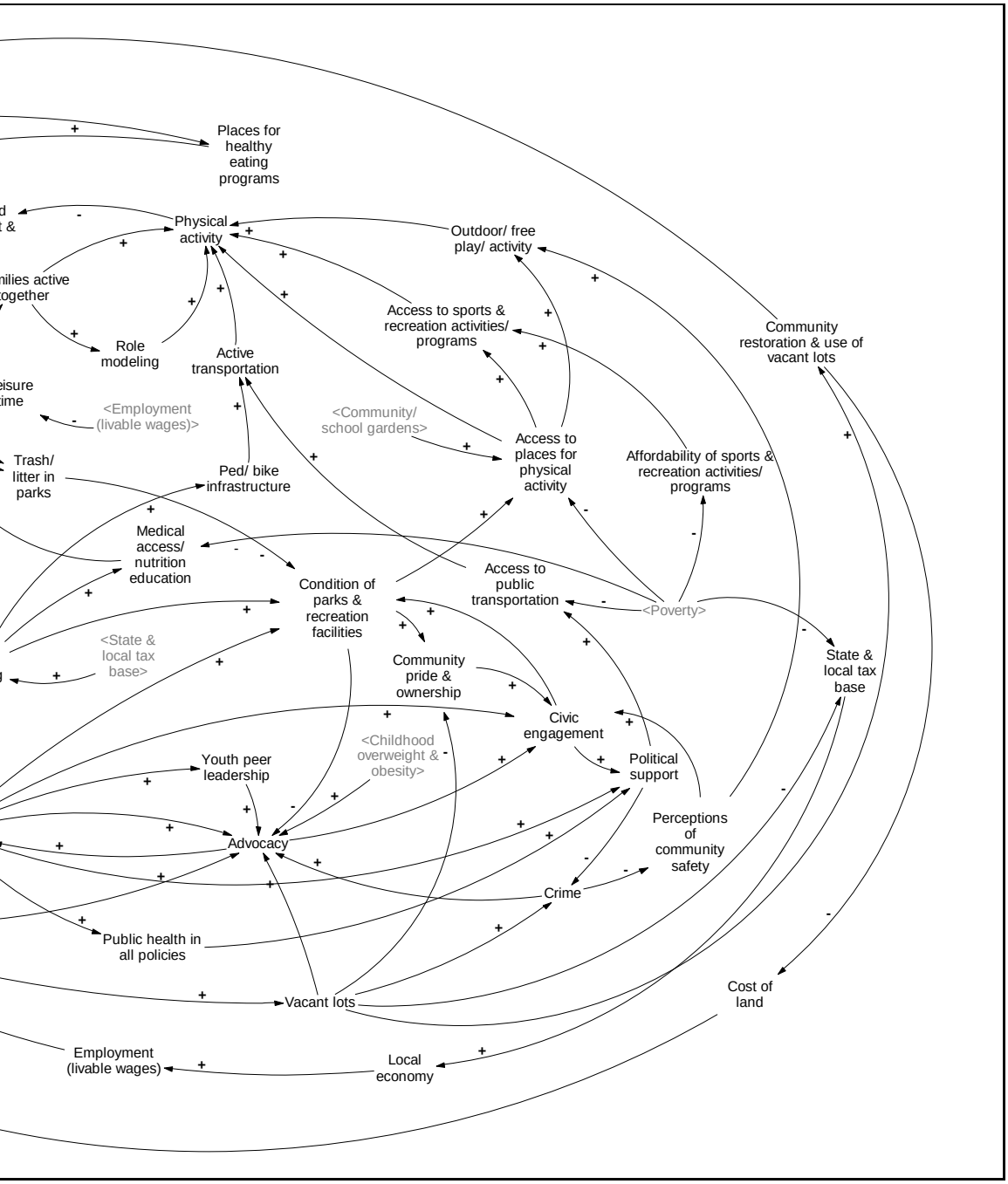
- the participants represent a sample of the *Fun 'n FITchburg* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;
- the behavior over time graphs and the causal loop diagram represent perceptions 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 common community vision for health, screen time, cooking at home, fast food outlets, media advertisements, HE/AL zoning policies, food industry HE/AL regulations, portion sizes, cost of gas, car dependences, recycling, schools in neighborhoods, supermarkets, healthy neighborhood corner stores, grants/external financial support; 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 Fitchburg 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 *Fun 'n FITchburg* 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/

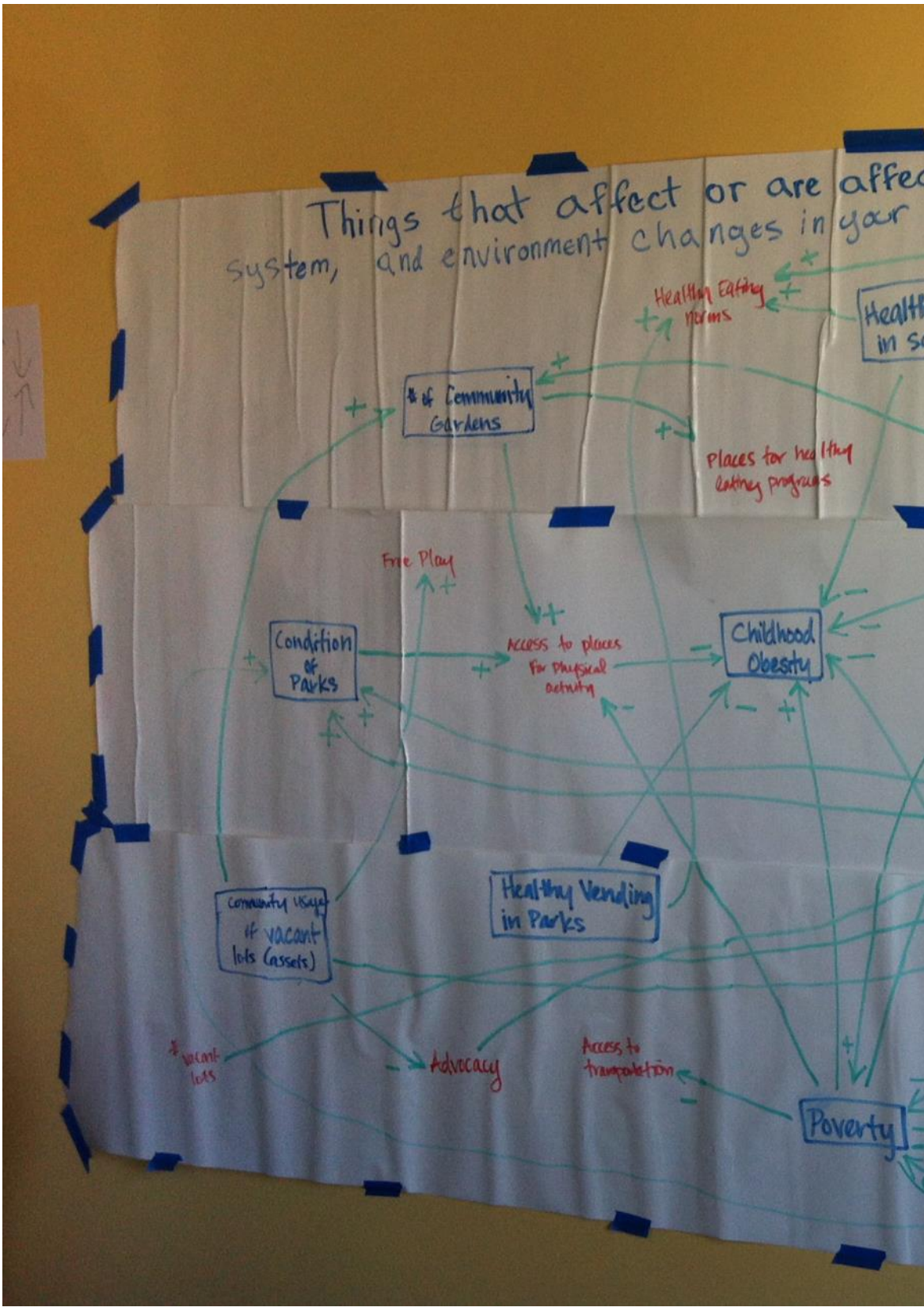
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

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

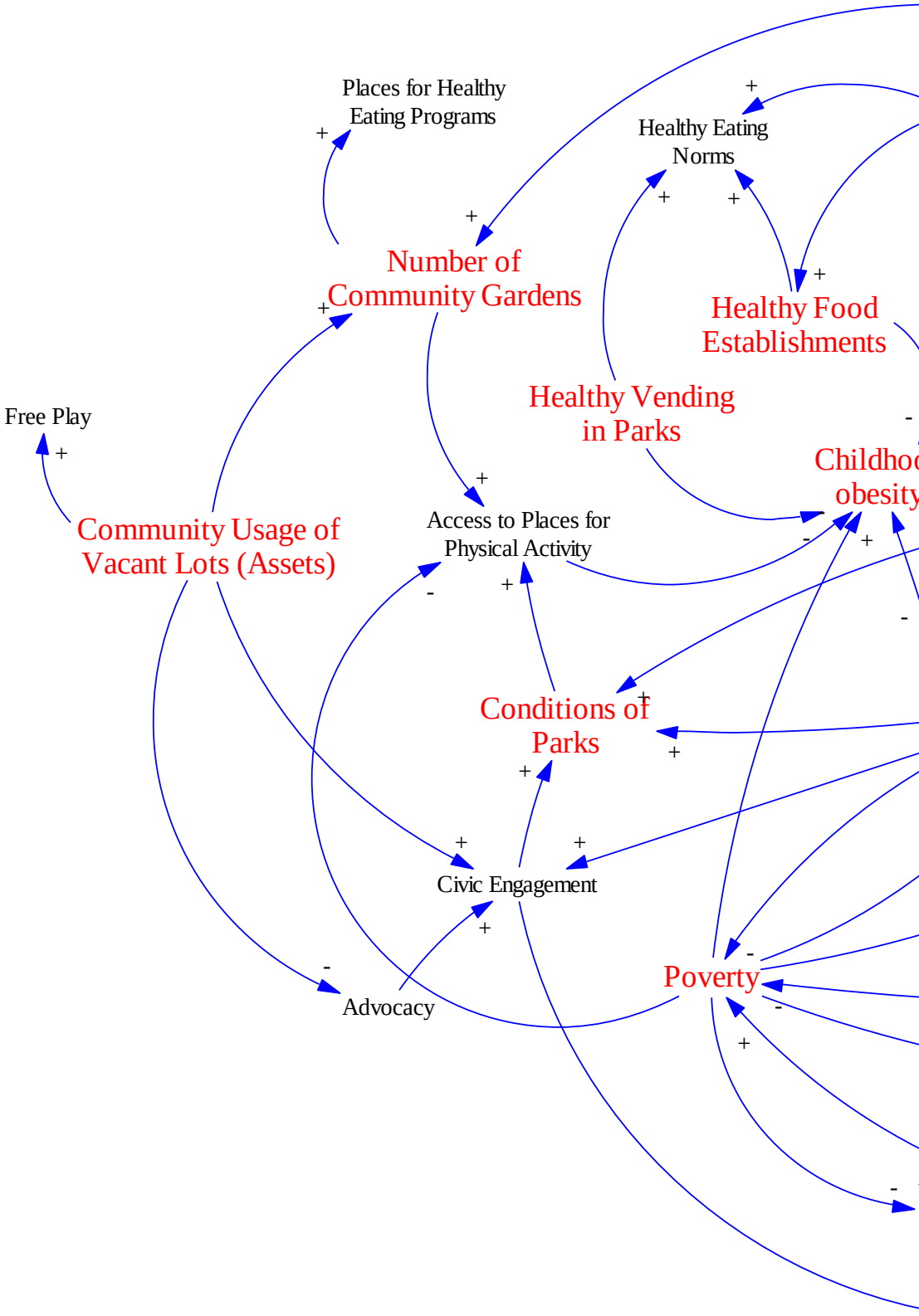
Fitchburg, Massachusetts: *Fun 'n FITchburg*	
Categories	**Number of Graphs**
Active Living Behavior	6
Active Living Environments	3
Funding	2
Healthy Eating Behavior	6
Healthy Eating Environments	7
Marketing and Media Coverage	1
Obesity and Long Term Outcomes	3
Partnership & Community Capacity	2
Policies	1
Programs & Promotions (Education and Awareness)	1
Social Determinants of Health	3
Total Graphs	**35**

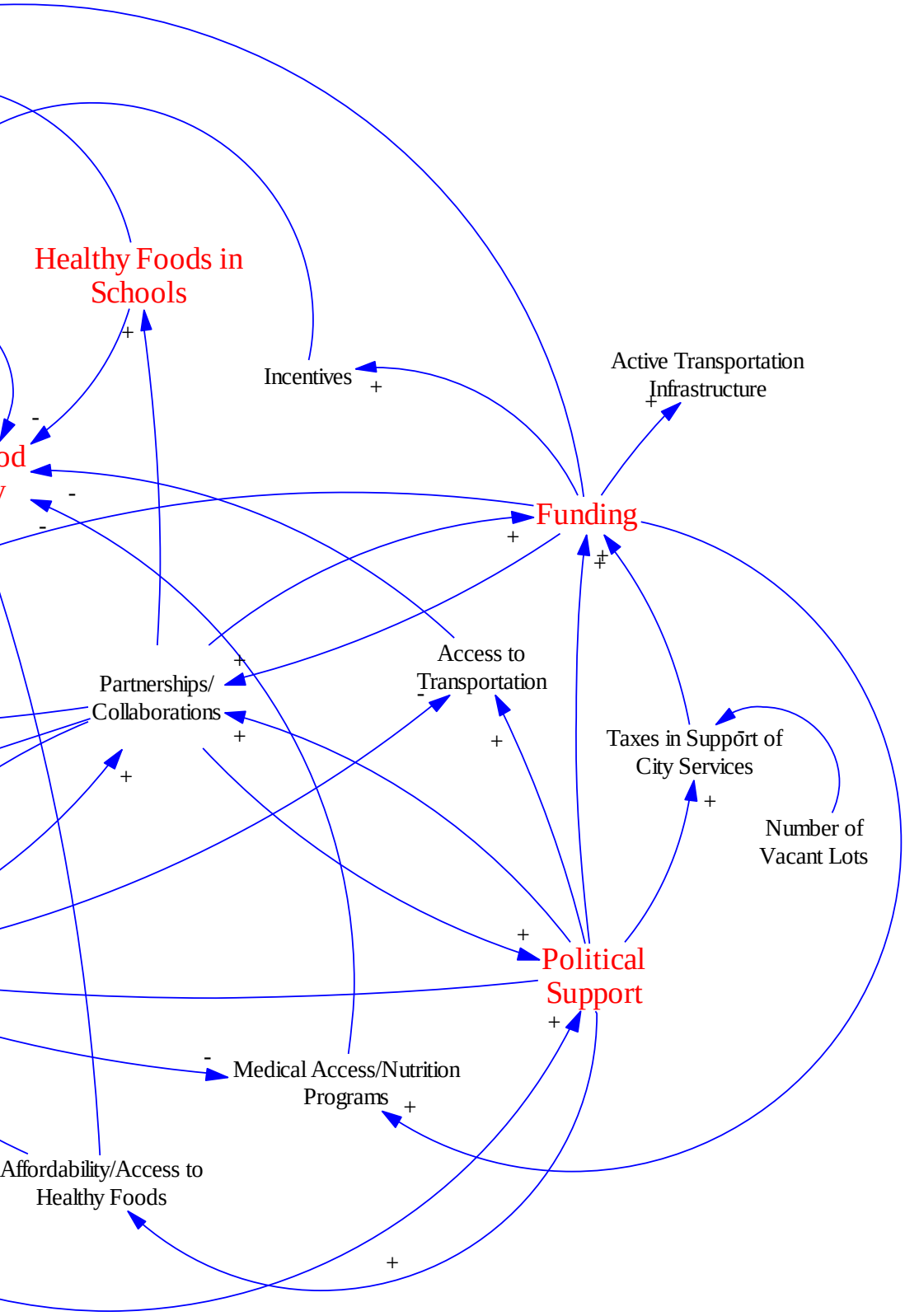
Appendix B: Photograph of the Original Version of the *Fun 'n FITchburg* Causal Loop Diagram



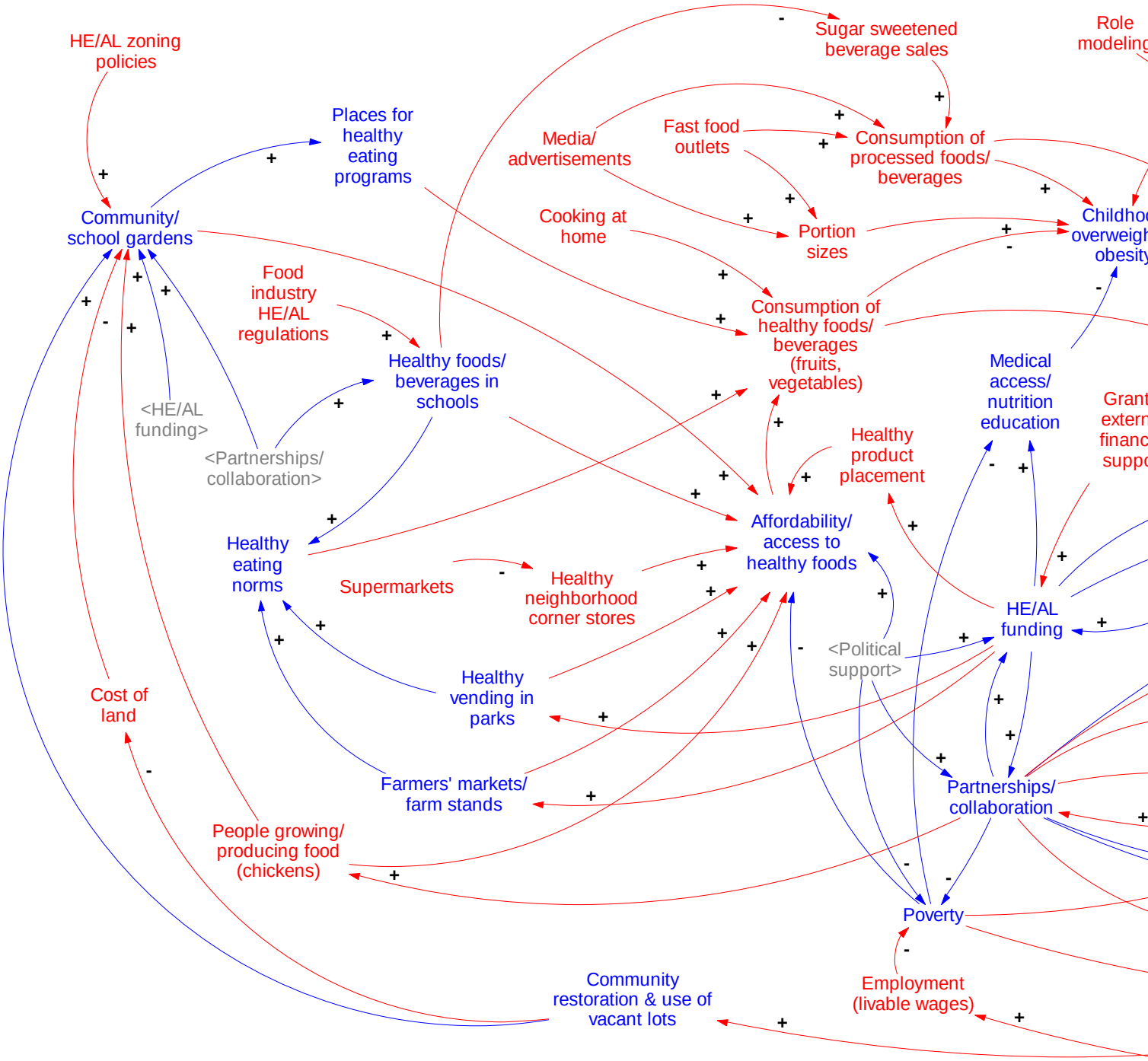

cted by policy)
community (Healthy Eating, Active Living, + Childhood Obesity)
Healthy Foods
Schools
Healthy Food Establishments
Active transportation Infrastructure
Incentives
Affordability/Access of healthy foods
Funding
R
Partnership Collaboration
Civic Engagement
Political Support
Taxes in support of city services
Medical Access
Nutrition Programs

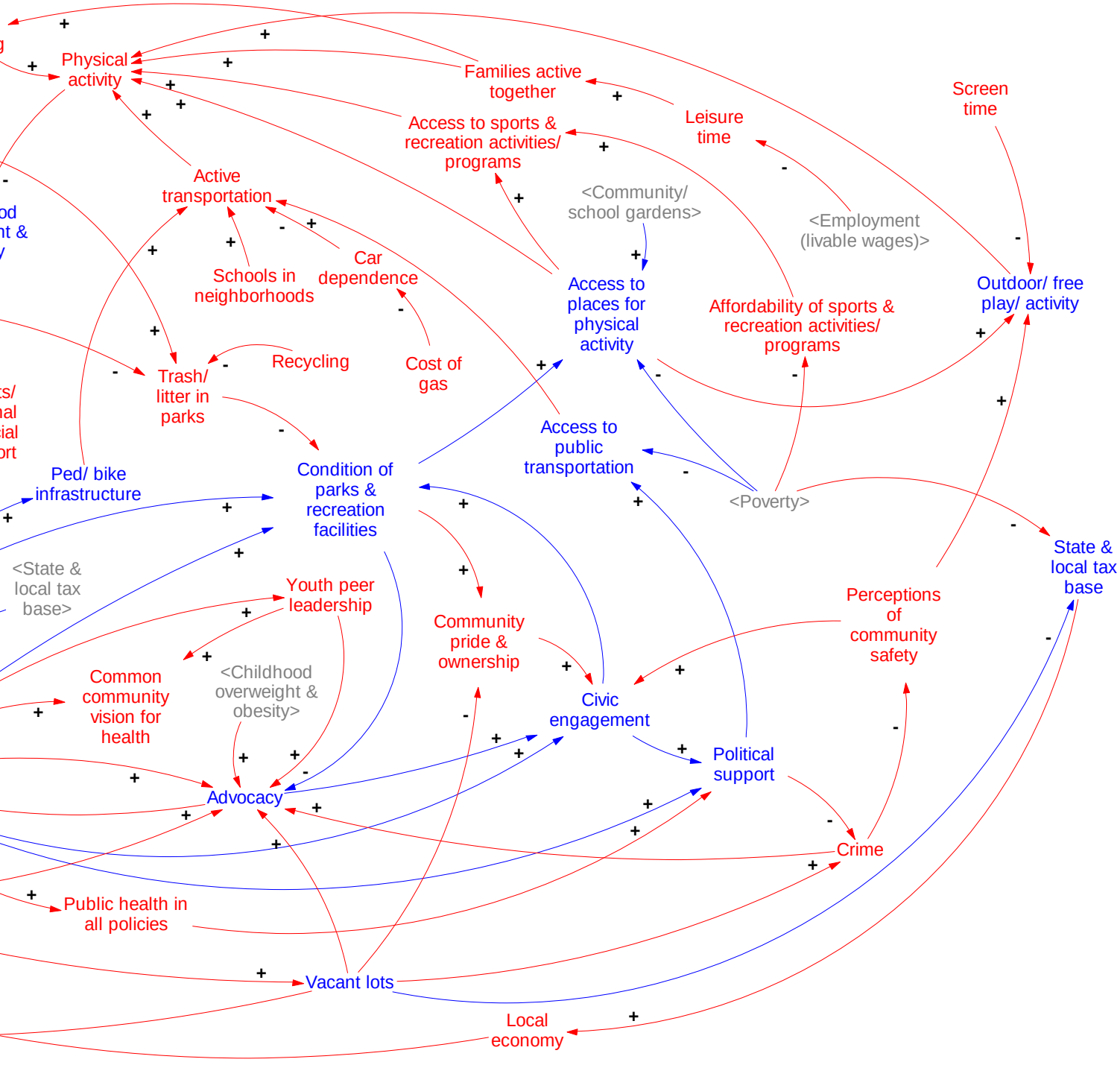
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



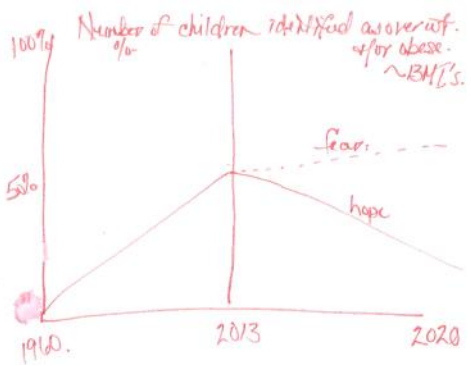

Healthy Foods in Schools
Incentives
Active Transportation Infrastructure
Funding
Partnerships/ Collaborations
Access to Transportation
Taxes in Suppōrt of City Services
Number of Vacant Lots
Political Support
Medical Access/Nutrition Programs
Affordability/Access to Healthy Foods

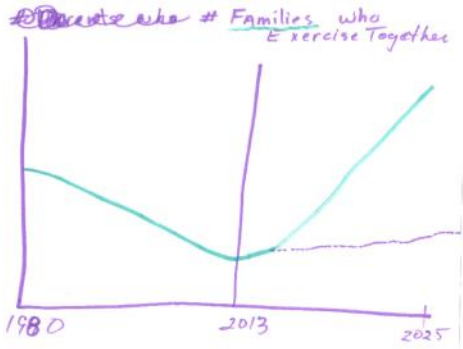
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

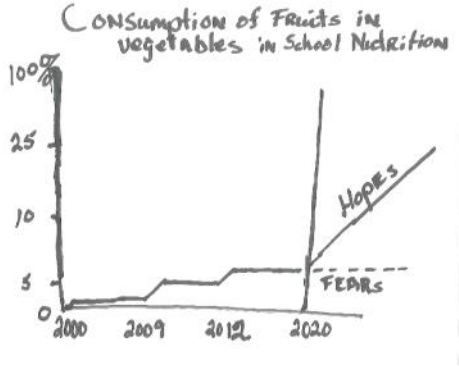


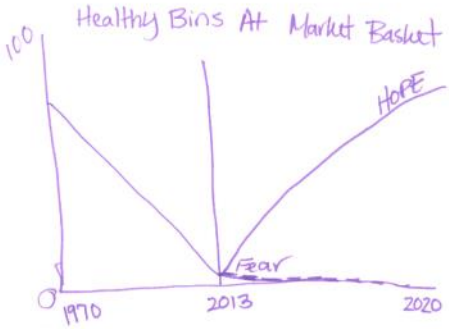

Physical activity
Families active together
Screen time
Leisure time
Access to sports & recreation activities/ programs
Active transportation
<Community/ school gardens>
<Employment (livable wages)>
Schools in neighborhoods
Car dependence
Access to places for physical activity
Affordability of sports & recreation activities/ programs
Outdoor/ free play/ activity
Recycling
Cost of gas
Trash/ litter in parks
Access to public transportation
Ped/ bike infrastructure
Condition of parks & recreation facilities
<Poverty>
State & local tax base
<State & local tax base>
Youth peer leadership
Community pride & ownership
Perceptions of community safety
Common community vision for health
<Childhood overweight & obesity>
Civic engagement
Political support
Advocacy
Crime
Public health in all policies
Vacant lots
Local economy

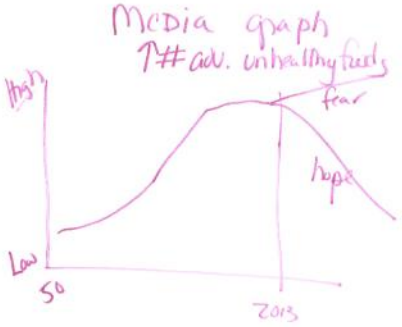
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

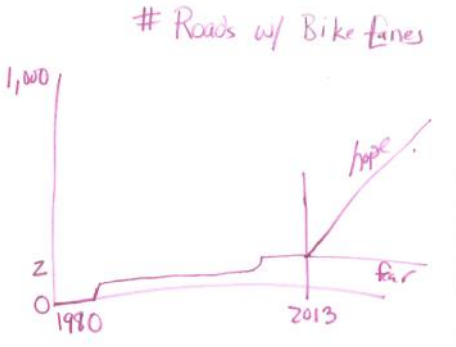


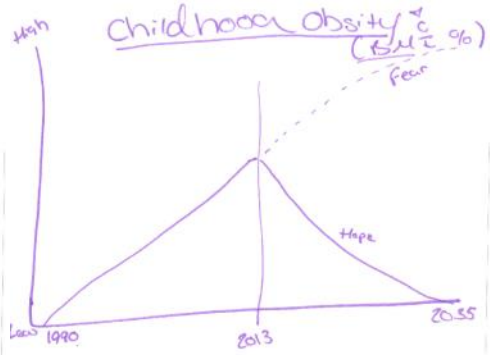


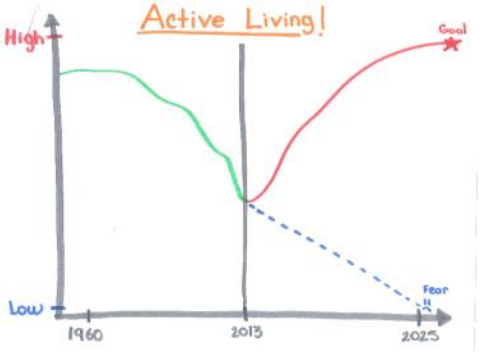


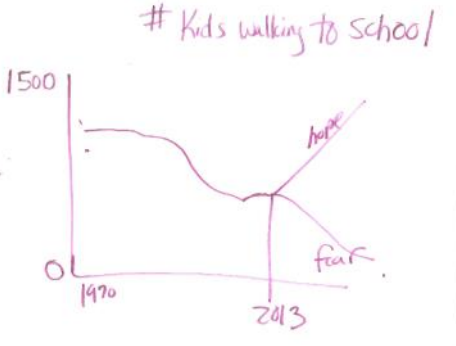


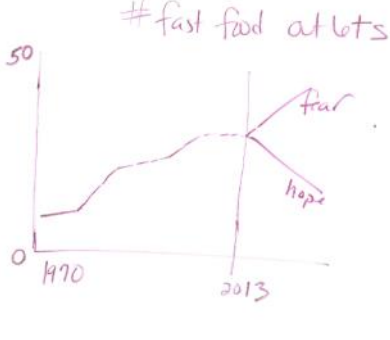


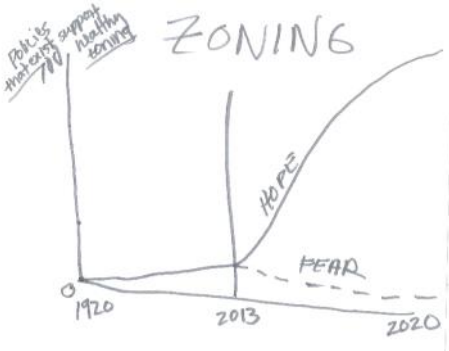


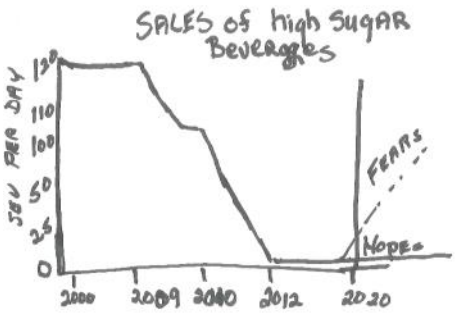


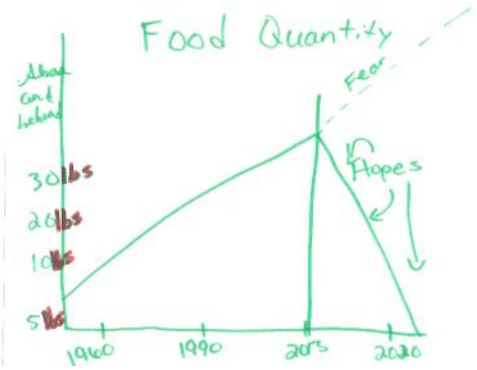


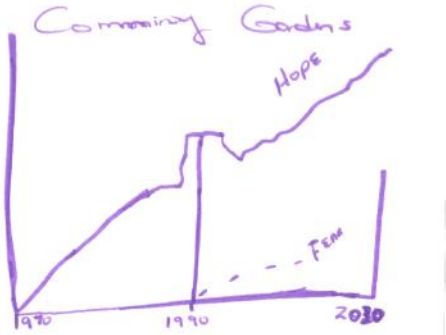


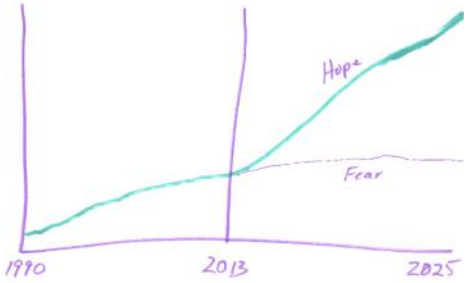


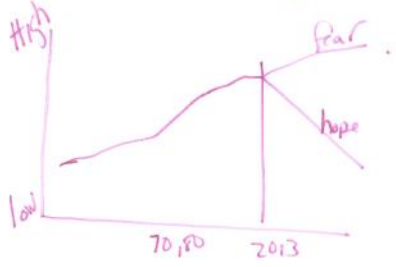


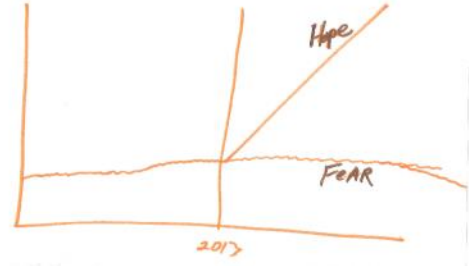

SALES of high SUGAR Beverages
Jars per day
130
110
100
50
25
0
2000
2009
2010
2012
2020
FEARS
HOPE

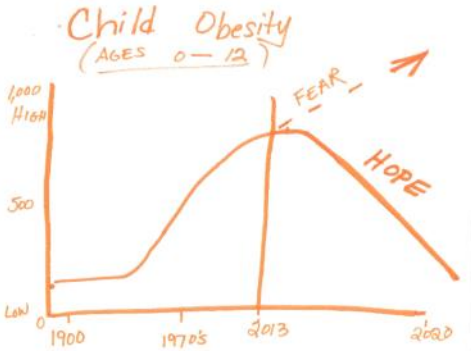

Food Quantity
What we're eating
Fear
Hopes
30lbs
20lbs
10lbs
5lbs
1960
1990
2013
2020

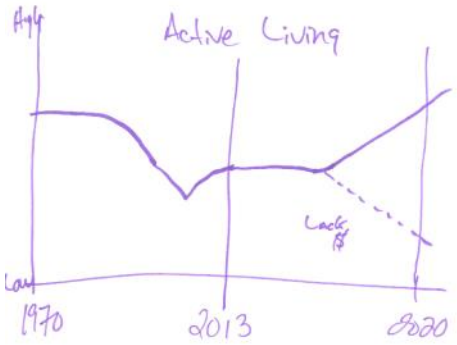

Community Gardens
Hope
Fear
1970
1990
2030

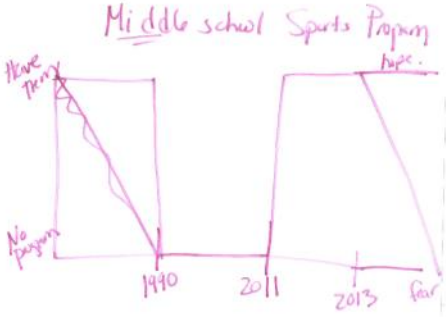

Community Gardeners in Fitchburg
Hope
Fear
1990
2013
2025

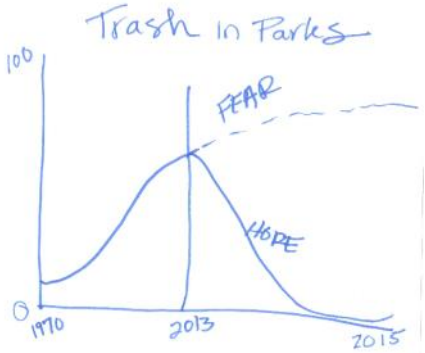

Poverty
High
Low
fear
hope
70,80
2013

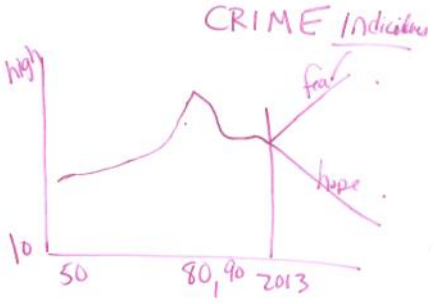

Creative Funding Sources Available
Hope
FEAR
2013

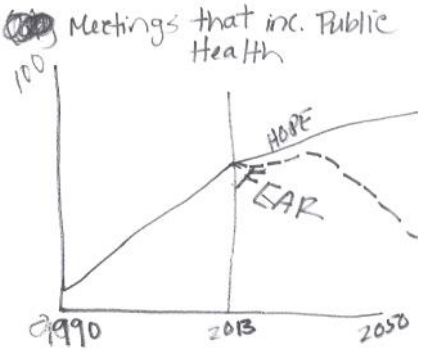

Child Obesity
(AGES 0 — 13)
1000
High
500
Low
0
FEAR
HOPE
1900
1970's
2013
2020


Active Living
High
Low
1970
2013
2020


Middle school Sports Program
Have Many
No Program
1990
2011
2013
Fair


Trash in Parks
100
0
FEAR
HOPE
1970
2013
2015


CRIME Indicators
high
low
fear
hope
50
80,90
2013


Meetings that inc. Public Health
100
HOPE
FEAR
1990
2013
2050

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