

Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Moore and Montgomery Counties, North Carolina



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Introduction

Healthy Kids, Healthy Communities-Moore and Montgomery Counties 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 *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* project was to introduce systems thinking at the community level by identifying the essential parts of the Moore and Montgomery Counties, North Carolina 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, foundations, youth 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.

Moore and Montgomery Counties, North Carolina: Background and Local Participation

The HKHC-Moore and Montgomery Counties partnership focused on five towns within this predominately rural two-county region in North Carolina: Aberdeen, Southern Pines, and Robbins in Moore County and Candor and Mt. Gilead in Montgomery County. These communities were selected because they exhibited high percentages of overweight/obesity in children and the schools had high percentages of children on free and reduced-price lunch. In addition, relationships with potential partners had been established. Percentages of free and reduced-price lunch in elementary schools were nearly 99% in Candor, 87% in Mt. Gilead, 64% in Aberdeen, 57% in Southern Pines, and 91% in Robbins.

The lead agency for the HKHC-Moore and Montgomery Counties partnership was FirstHealth of the Carolinas. FirstHealth is a private, non-governmental, not-for-profit health care network located in Pinehurst, North Carolina. The system serves 15 counties in the mid-Carolinas. It is the largest employer in the region and dedicated to improving the quality of life for residents statewide. FirstHealth is a leader in advancing health policy change—food policy change in particular—and committed to living up to its core purpose, which is simply “to care for people.”

The undertaking of the HKHC work was supported by the organization's long-term, 2020 Vision: “Working Together, First in Quality, First in Health.” As a result of an organizational effort to devise and implement a meaningful long-range vision, FirstHealth initiated the establishment of 2020 Vision Collaborative Groups in 2004. In the process of establishing the collaborative groups, FirstHealth combined local, state and national data with input from community groups, key individuals, and several entity boards of trustees to determine the precise health issues that presented the greatest challenges to those living in the mid-Carolinas. Several priority areas emerged, including Child Health, of which childhood obesity and physical activity/healthy eating were specific indicators.

The HKHC partnership viewed its purpose as providing technical assistance and information regarding environmental systems and policy change to aid in reducing childhood obesity in the five different communities within Moore and Montgomery Counties. The partnership was designed as a learning and sharing network surrounding childhood obesity issues. To this end, it held Quarterly Learning Exchange meetings with its partners. Taskforce meetings with each of the five communities and champion meetings were also held as needed. A quarterly newsletter was developed that provided stories, resources, and updates to the partnership to connect and communicate with the intention of keeping partners engaged.

Healthy Kids, Healthy Communities-Moore and Montgomery Counties' Priorities and Strategies

The partnership and capacity building strategies of *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* included:

- **Community Champions:** The partnership recruited champions in the five communities to spearhead the implementation of community-specific efforts throughout the initiative.
- **Making Moore Connections:** This taskforce was assembled to facilitate policy advocacy, communication and planning efforts between planning, parks and recreation, public health, and policymakers around complete streets policies, creating bicycle, pedestrian, and open space plans.
- **Candor Food Solutions:** This group addressed policies and practices associated with creating a mobile market, healthy corner stores, and increasing farmers' market participation in the Town of Candor and Montgomery County.

The healthy eating and active living strategies of *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* included:

- **Healthy Eating and Physical Activity Policies in Community Settings:** The partnership was instrumental in developing policies for healthy eating through parks and recreation for town-sponsored events, as well as sporting events and camps for children in Mt. Gilead, Candor and Southern Pines. In addition, a physical activity policy was adopted in Mt. Gilead.
- **Corner Stores:** Two corner stores in Candor added 1% and skim milk to their stores as a result of the HKHC partnership's efforts.
- **Farmers' Markets:** The partnership was successful in bringing Supplemental Nutrition Assistance Program (SNAP) and Electronic Benefits Transfer (EBT) benefits to Moore County Farmers' Market and a local buying club, as well as starting a new farmers' market in Mt. Gilead.
- **Pedestrian and Bicycle Connections to Child-Centered Locations:** Efforts by the partnership resulted in bicycle and pedestrian plans and infrastructure improvements in Aberdeen and Southern Pines, as well as trail enhancements in Candor and Mt. Gilead.
- **Coordinated Recreation Plan:** A coordinated plan was developed for recreation for the Northern Moore County region. Significant efforts were dedicated to cleaning up an old mill site in Robbins that had been destroyed by fire, with the goal of transforming the site into a place for recreation. As a result, the Moore County Land Use Plan included a goal explicitly addressing improving the built and natural environments to improve citizen health through the use of open space and recreational opportunities.

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

Systems Thinking in Communities: Moore and Montgomery Counties, North Carolina

“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 Moore and Montgomery Counties, North Carolina 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.

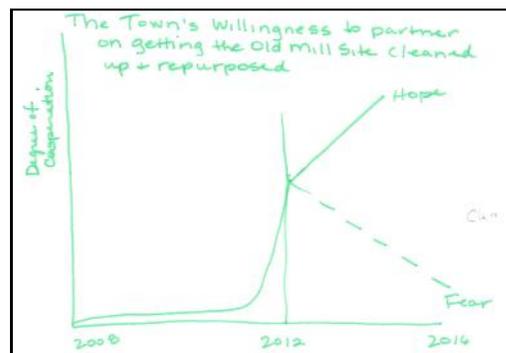
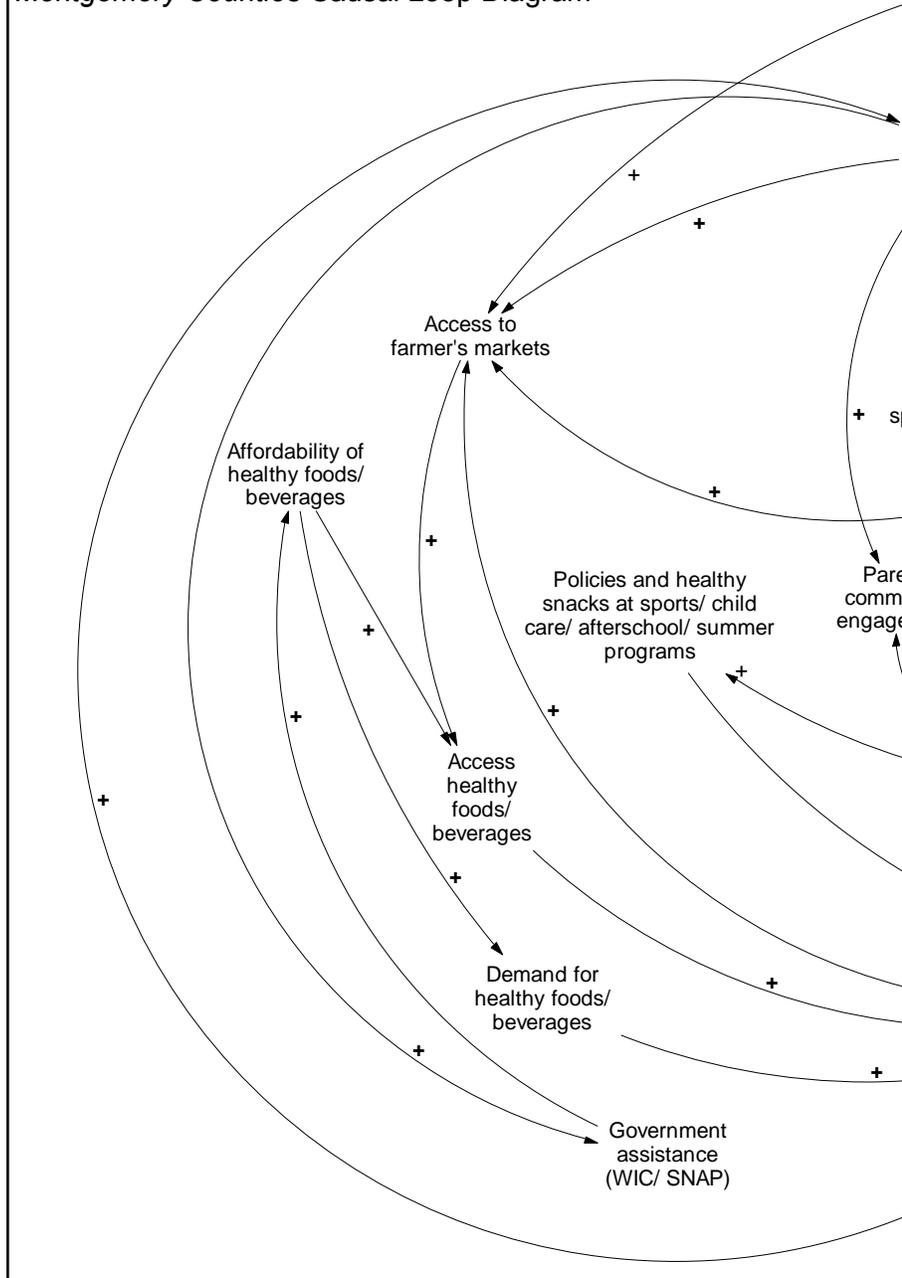
Group Model Building

Members of the *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* partnership participated in a group model building session in September, 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, foundations, youth organizations, universities. 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 Moore and Montgomery Counties 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 towns willingness to partner on getting an old mill site cleaned up and repurposed for some sort of healthy eating and/or active living efforts was stable from 2008 to 2011 with an increase

Figure 1: *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* Causal Loop Diagram



from 2011 to 2012. The hope is that the community will continue to see the value in repurposing the old mill and support will increase into the future (see behavior over time graph previous page 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

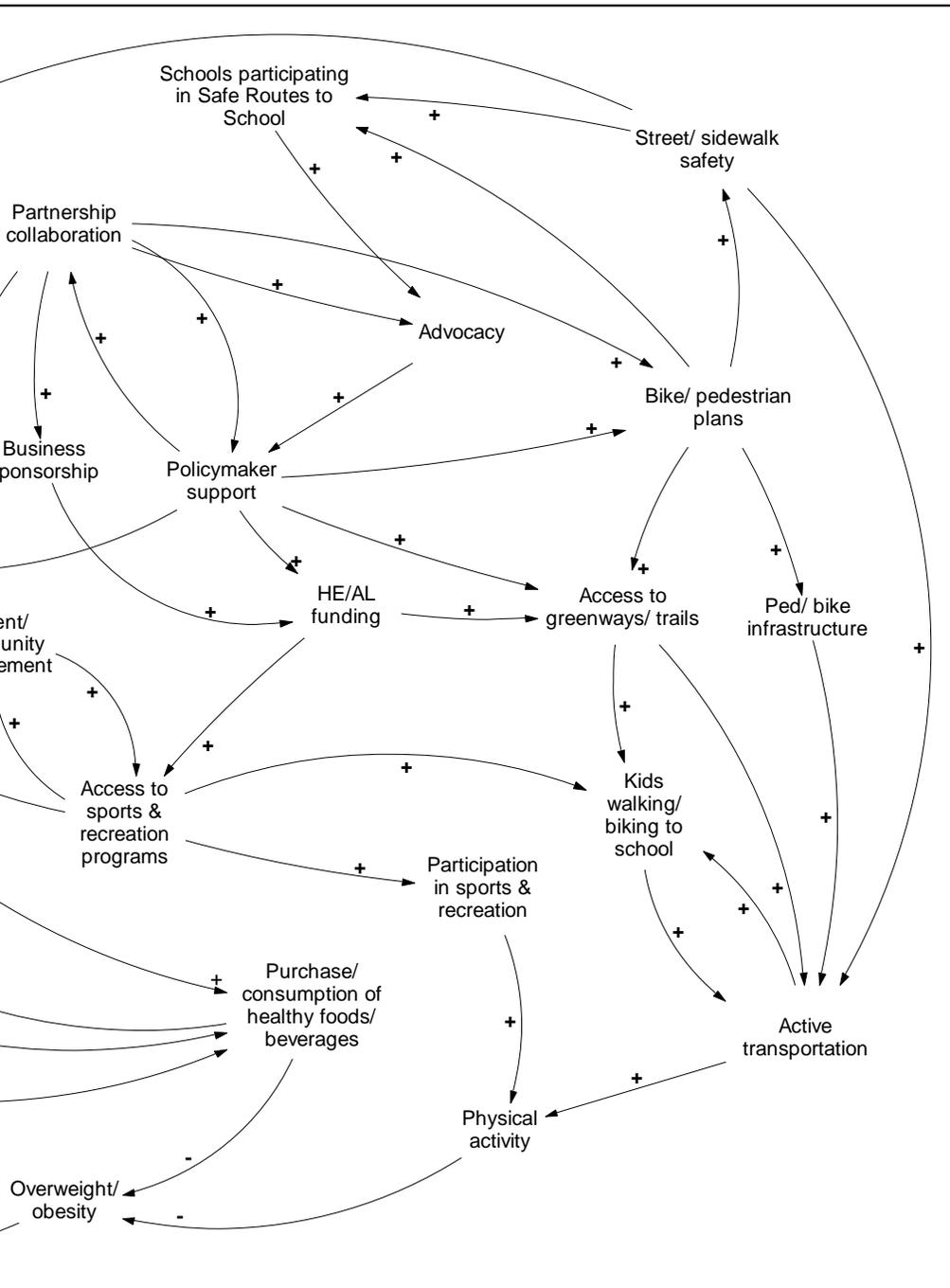
To examine the relationships among the variables from the behavior over time graphs, participants worked together and with facilitators to develop a causal loop diagram. In Figure 1, the words represent variables of quantities that can increase and decrease over time (i.e., the behavior over time graphs). 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 policymaker support in this causal loop diagram. One feedback loop is: policymaker support → partnership collaboration → advocacy → policymaker support. A second feedback loop is: policymaker support → bike and pedestrian plans → schools participating in safe routes to school → advocacy → policymaker support.

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 policymaker support. Some variables may increase <variable> while other variables limit <variable>. 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 *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* 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 Moore and Montgomery Counties, North Carolina and to stimulate greater conversation related to Moore and Montgomery Counties' 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 Moore and Montgomery Counties, North Carolina. 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.

Healthy Eating Policies and Environments (Red)

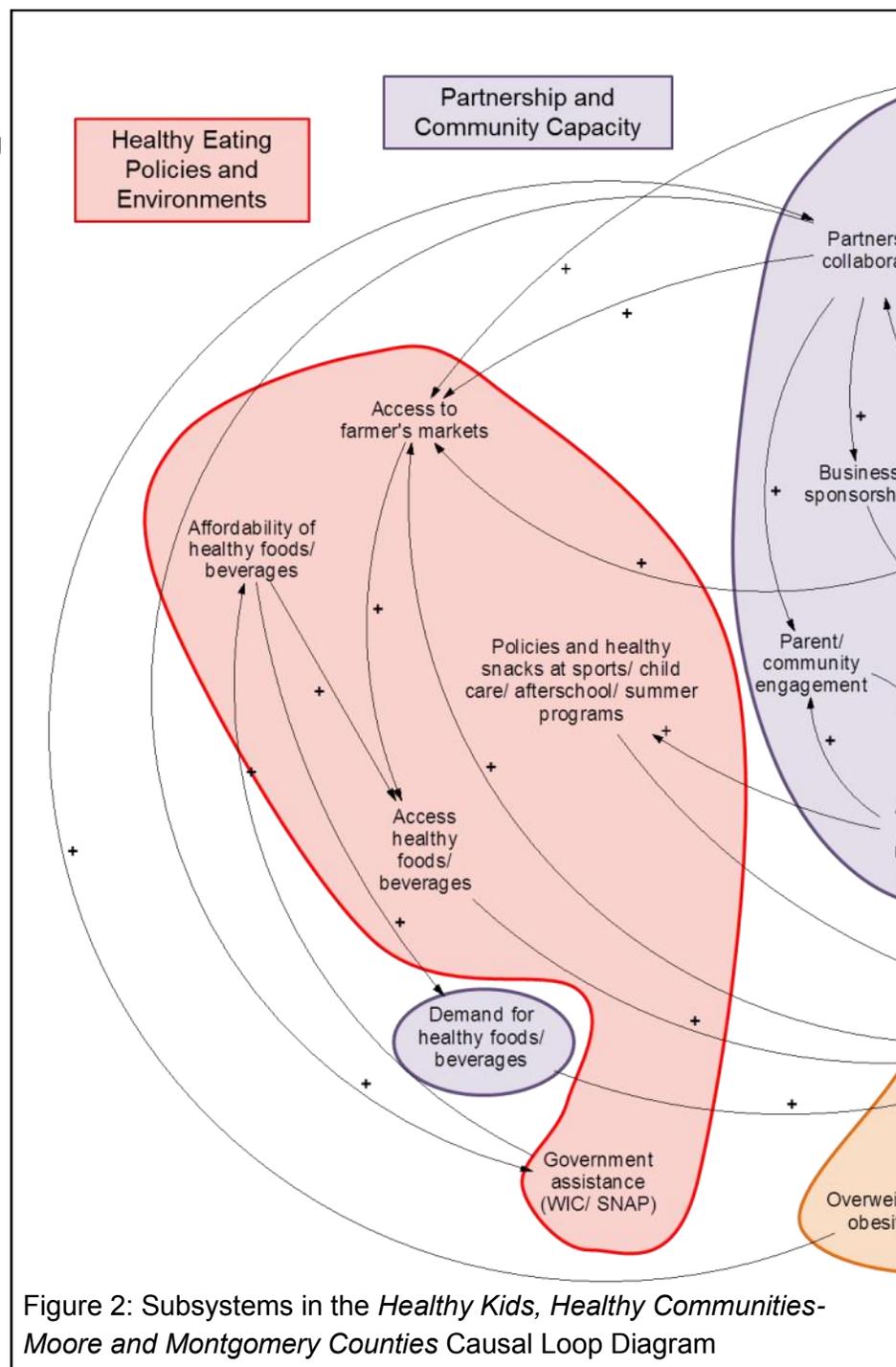
The healthy eating policy and environmental subsystem includes food production (e.g., gardens), food distribution and procurement (e.g., government assistance), and food retail (e.g., access to farmers' markets). During the behavior over time graphs exercise, the participants generated six graphs related to policy or environmental strategies (e.g., policies and healthy snacks at sports, child care, after school, and summer programs) or contexts (e.g., access to healthy foods and beverages) that affected or were affected by the work of *Healthy Kids, Healthy Communities-Moore and Montgomery Counties*. 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 seven graphs related to policy or environmental strategies (e.g., pedestrian and bike infrastructure) or contexts (e.g., access to greenways and trails) that affected or were affected by the partnership's work.

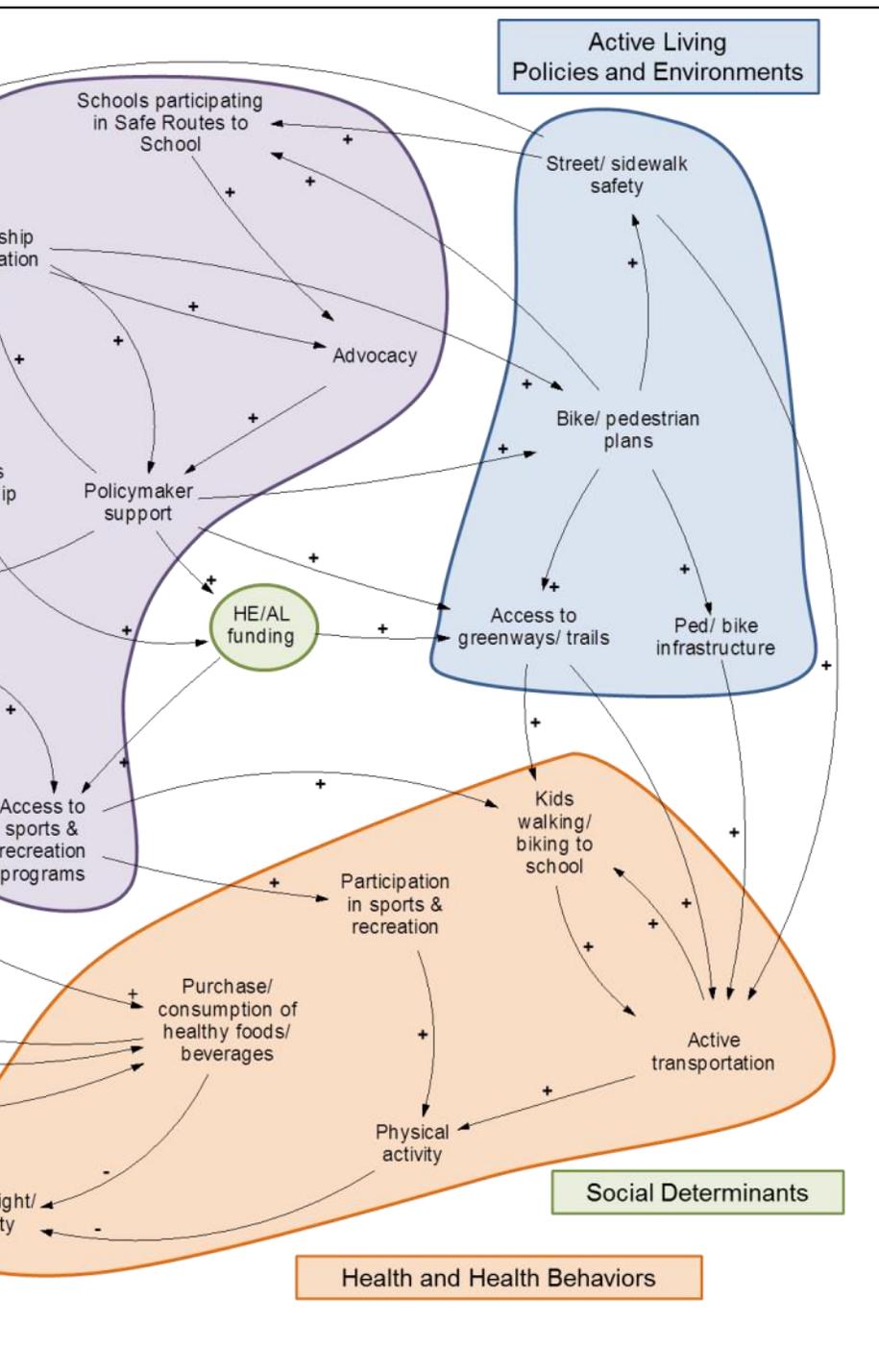
Health and Health Behaviors (Orange)

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., purchase and consumption of healthy foods and beverages, participation in sports and recreation).



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, *Healthy Kids, Healthy Communities*



-Moore and Montgomery Counties partnership recruited champions in the five communities to spearhead the implementation of community-specific efforts throughout the initiative. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as policymaker support or business sponsorship.

Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., healthy eating and active living funding) and psychosocial influences (e.g., perceptions of 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 *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* partners or by other representatives in Moore and Montgomery Counties, North Carolina. 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 partnership collaboration, access to farmers' markets, and pedestrian and bike infrastructure.

The next sections begin to examine the feedback loops central to the work of *Healthy Kids, Healthy Communities-Moore and Montgomery Counties*. 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.

Community Decision-Making Bodies Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the Healthy Kids, Healthy Communities-Moore and Montgomery Counties 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 Moore and Montgomery Counties, North Carolina, each feedback loop tells a story about a more specific change process.

Causal Story for Feedback Loop

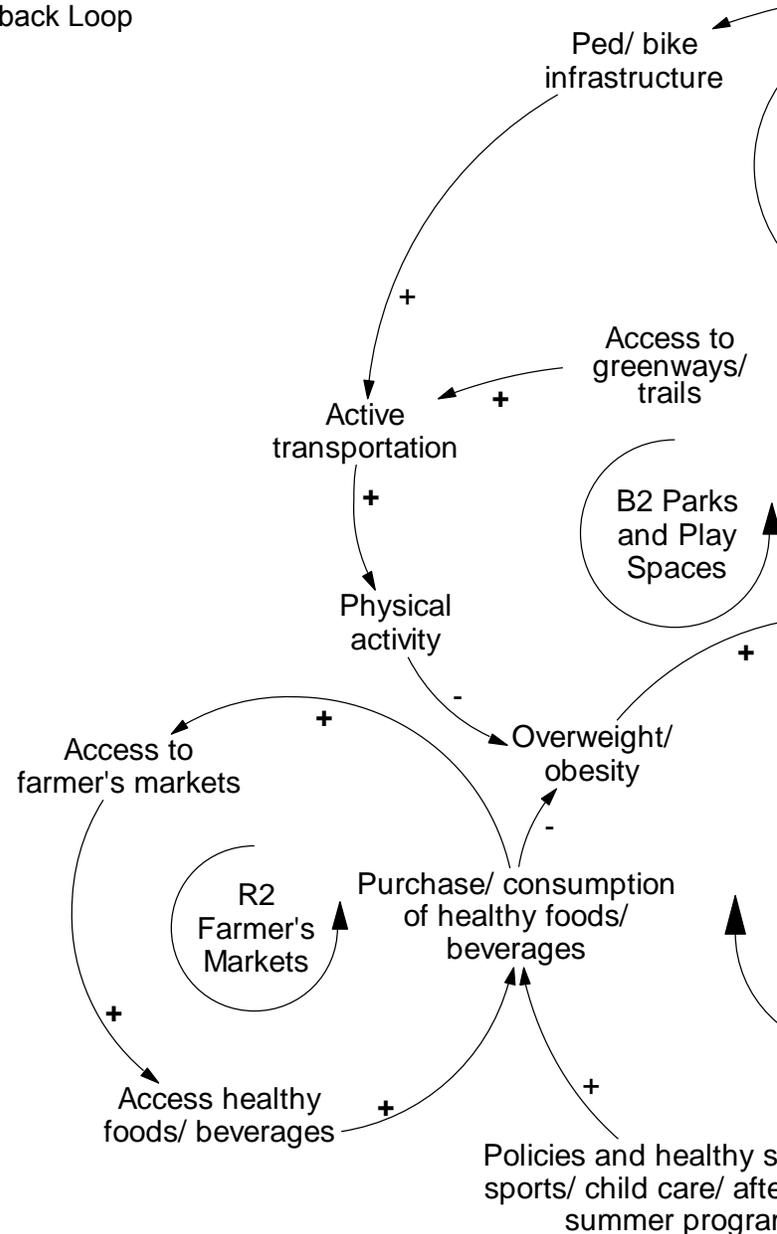
Story A: In this case, the story is about the Community Decision-making Bodies (green highlighted loop in Figure 3). Participants described how greater policymaker support, there is an increase in partnership collaboration. As more partners are engaged and collaborating, there is an increase in advocacy efforts toward healthy eating and active living. In turn, with greater advocacy efforts, there is an increase in the policymaker support.

Story B: While the preceding story reflected a positive scenario for Moore and Montgomery Counties, North Carolina, the same feedback loop also tells the opposite story. With less policymaker support, there is a decrease in partnership collaboration. As less partners are engaged and collaborating, there is a decrease in advocacy efforts toward healthy eating and active living. In turn, with less advocacy efforts, there is a decrease in the policymaker support.

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—Community Decision-making Bodies” 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/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

Figure 3: Community Decision-Making Bodies Feedback Loop

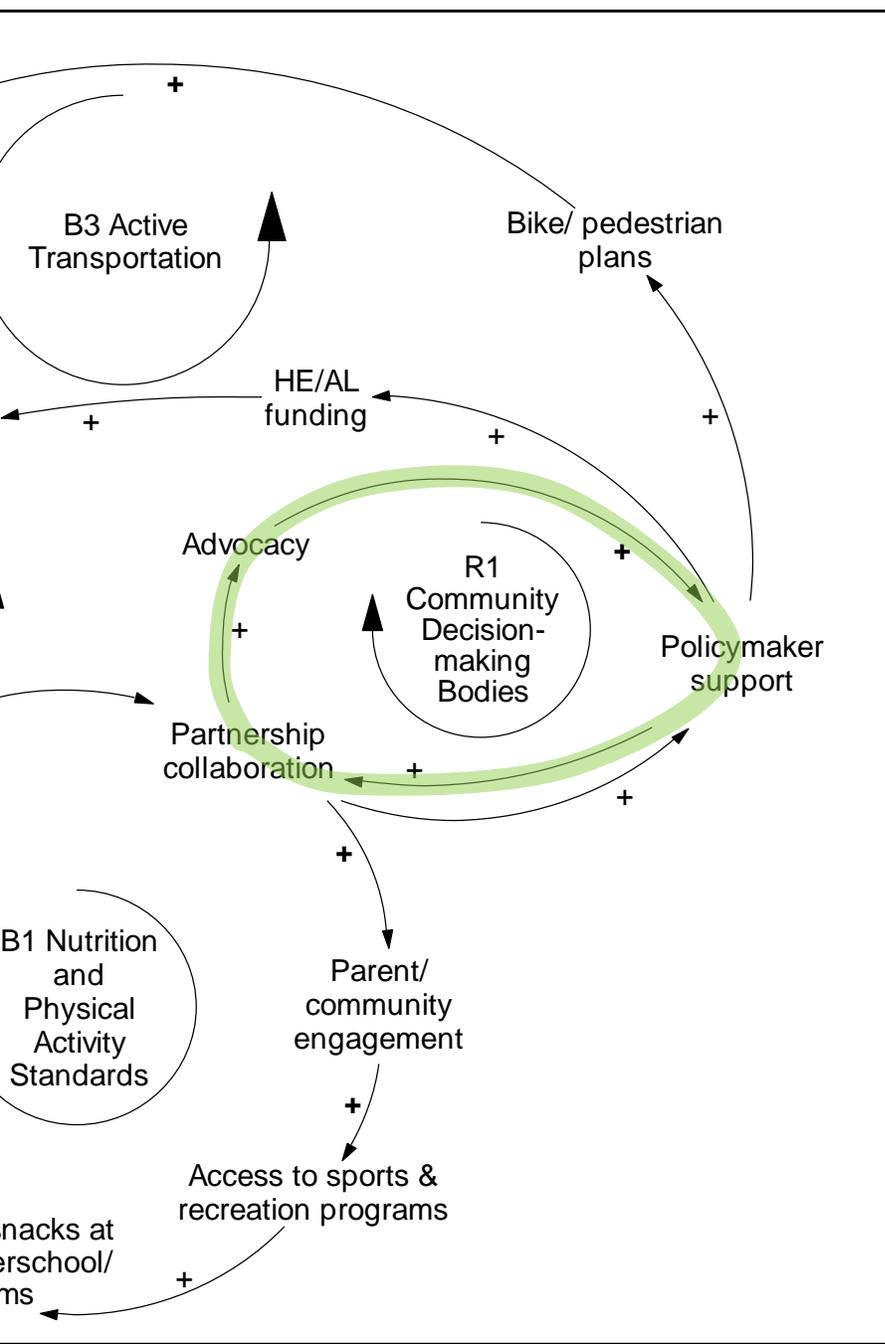


by the arrows indicate whether or not the influence of one variable on another variable (1) increases/adds to (plus or “+” sign), or (2) decreases/removes from the other variable (minus or “-” sign). These signs are referred to as polarities. In a reinforcing loop, the effect of an increase or

“My perception of the organizational partnerships particularly within Montgomery County wanting to help is that they are pretty low. The awareness [among organizations] that because they are involved in one particular organization or institution, the idea that you can connect with other seemingly unrelated partnerships or organizations and get together to form ideas on how to better serve the communities within and surrounding.” (Participant)

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 partnership collaboration likely levels off at some point. To understand what specifically leads to the leveling off of partnership collaboration, it may be helpful for the partners in Moore and Montgomery Counties, North Carolina to consider other variables that influence or are influenced by partnership collaboration. 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.

System Insights for Healthy Kids, Healthy Communities-Moore and Montgomery Counties

Participants identified an increase in the number of healthy eating policies adopted by municipalities since 2010 to 2012 with the hope that healthy eating policies will continue to increase and be adopted (see behavior over time graph on the bottom right).

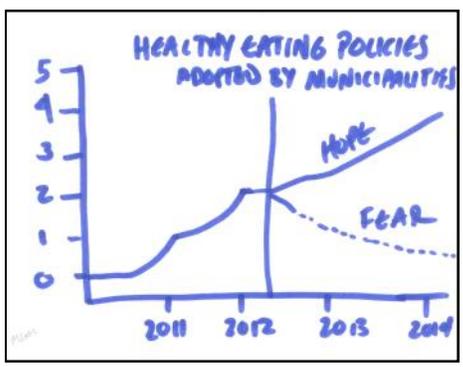
From the systems thinking exercises, several insights can inform the community decision-making bodies strategy, including:

- Strategic partnerships to engage residents in advocacy initiatives stimulate support and funding from city government agencies.
- New collaborations forged with city agency

representatives or community organization leaders generates more political will in various sectors of the community for those whose voices are not well represented.

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 drives community collaboration when funding support is not available?



Farmers' Markets 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 farmers' markets.

Causal Story for Feedback Loop

Story A: Participants described when there is an increase in access to farmers' markets, there is an increase in access to healthy foods and beverages through the markets. With more access to healthy foods and beverages, there is an increase in the purchase and consumption of healthy foods and beverages, which increases demand and access to farmers' markets.

Story B: Alternatively, with a decrease in access to farmers' markets, there is a decrease in access to healthy foods and beverages. With less access to healthy foods and beverages, there is a decrease in the purchase and consumption of healthy foods and beverages, which decreases demand and access to farmers' markets.

Reinforcing Loop and Notation

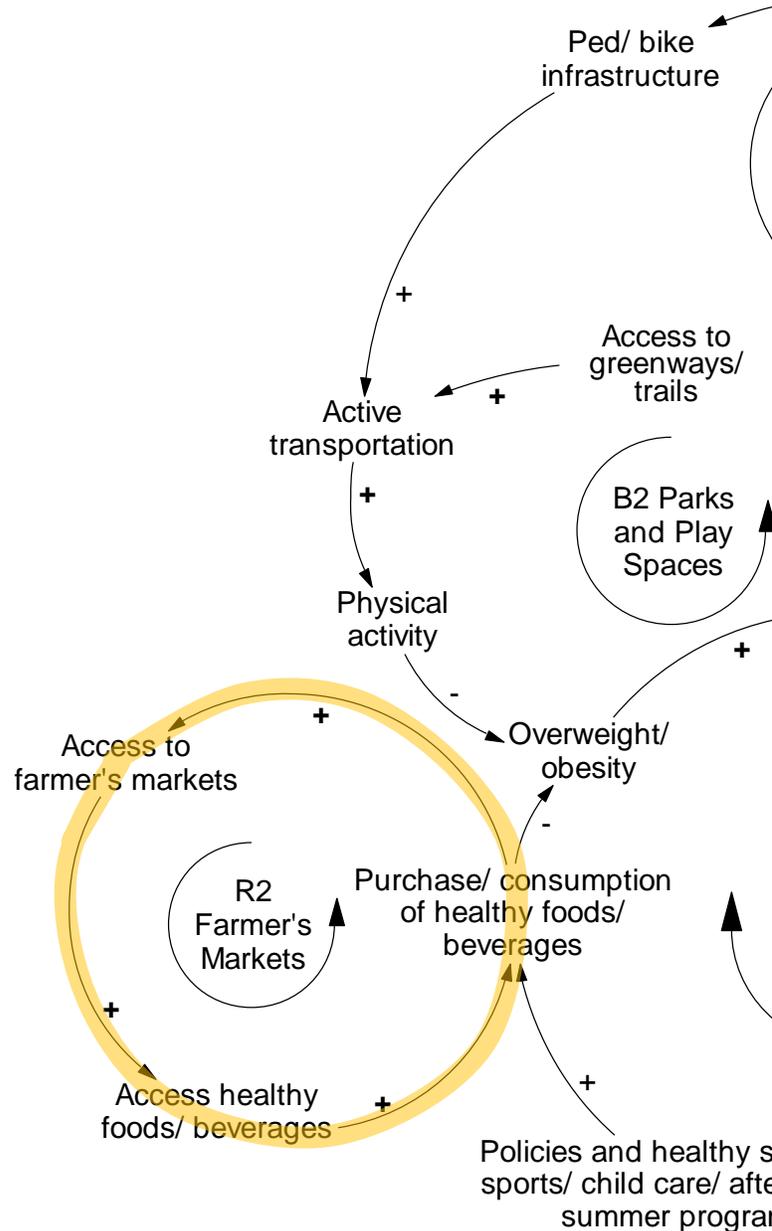
Similar to the previous loop (see Figure 3) this is a reinforcing loop with all "+" signs or polarities (see R2—Farmers' Markets in Figure 4).

Some of these causal relationships may have more immediate effects (e.g., access to farmers' markets influence on access to healthy foods and beverages) and other relationships may have delayed effects (e.g., purchase and consumption of healthy foods influence on access to farmers' markets). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

System Insights for *Healthy Kids, Healthy Communities-Moore and Montgomery Counties*

In the behavior over time graphs, participants identified no change in the success of the farmers' market since 2011 to 2012 with the hope that the success of the farmers' market will increase into the future (see behavior over time graph on next page top right).

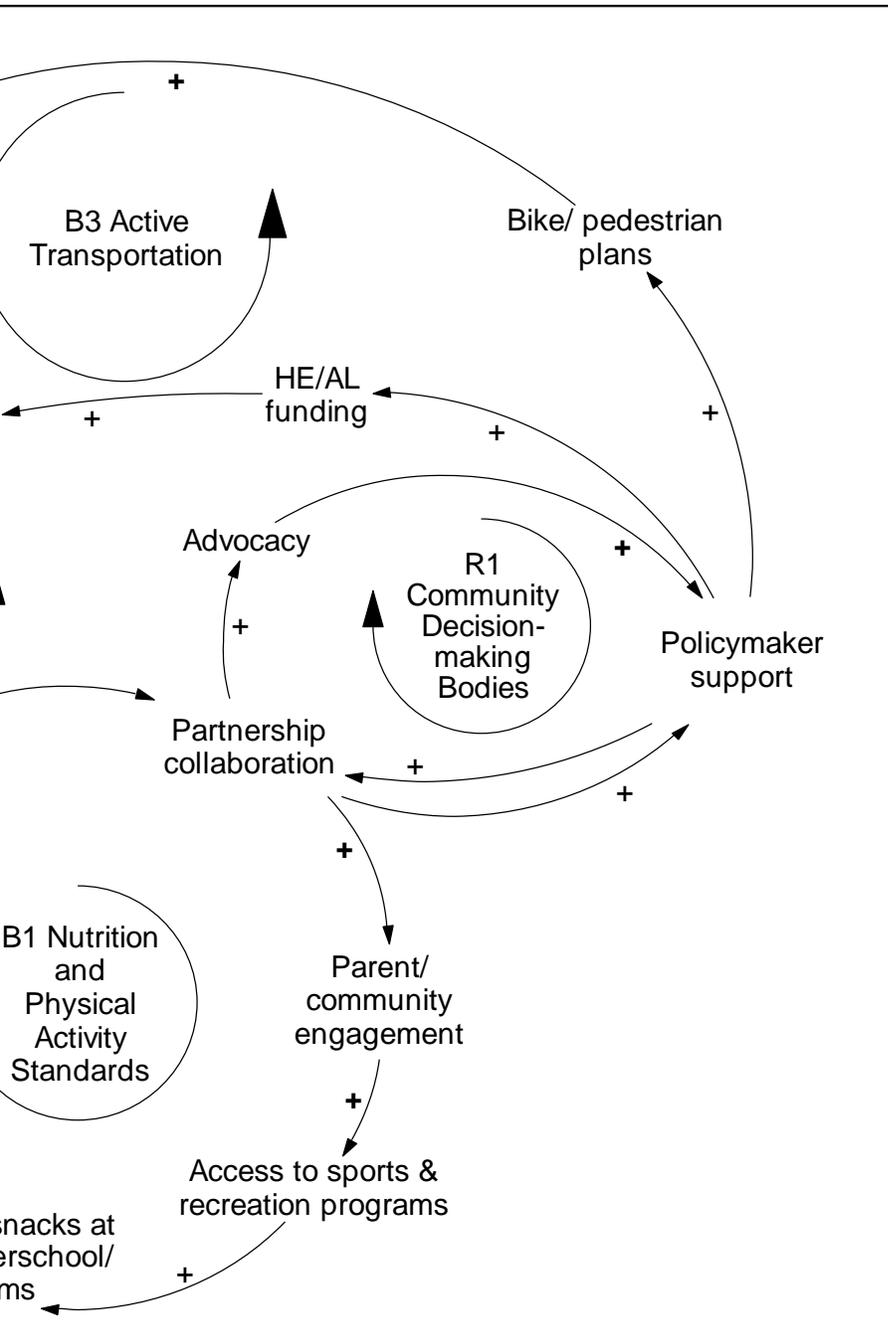
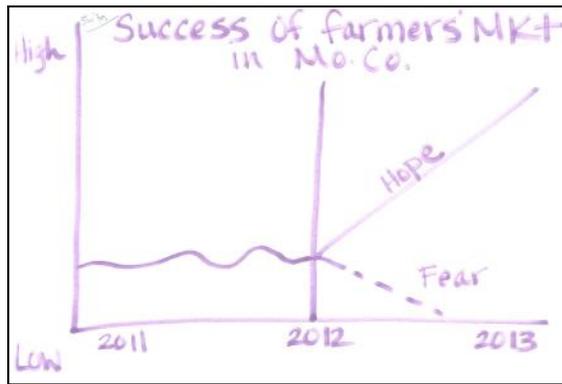
Figure 4: Farmers' Markets Feedback Loop



“Many areas of Montgomery County are food deserts. The availability of highly processed foods and fast food far outnumbers access to fresh whole food for low income families. My hope is that within the realm of the farmers’ market we are able to move forward with the official organization and then our first line of remedying the lack of access is to provide SNAP/EBT benefits, WIC, and then pursue the senior farmers market nutrition programs.” (Participant)

Participants also described a slight increase in the usage of the Supplemental Nutrition Assistance Program (SNAP) and Electronic Benefit Transfer (EBT) at the farmers' market since July 2012 to September 2012 with the hope that usage of SNAP and EBT will continue to increase into the future (see behavior over time graph bottom right).

System insights can inform the partnership's next steps with

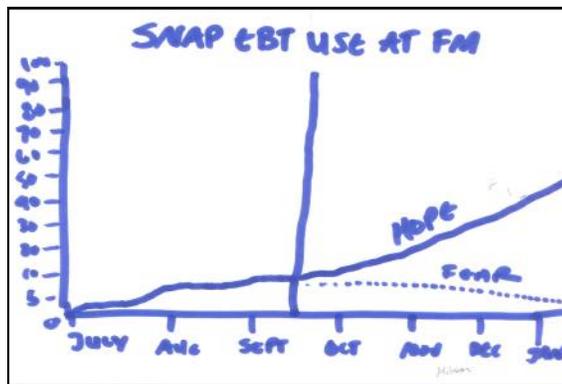


farmers' markets, including:

- The slight increase in healthy farmers' markets may be bolstered by advocacy efforts to increase demand for healthy foods and beverages among residents.
- With the low numbers of food vendors accepting SNAP benefits, strategies to engage residents in advocacy initiatives to demonstrate demand for these services in the community may push this agenda forward; at the same time, residents need to be made aware of the food vendors accepting WIC or SNAP benefits so that vendors view these services as a good investment of their time and effort.

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?
- Do sales of healthy foods and beverages increase with greater access to these products in the markets?
- How many food vendors at the farmers' markets have EBT machines and accept SNAP



benefits? Accept WIC vouchers? What is the average distance residents have to travel in order to purchase foods and beverages using SNAP benefits or WIC vouchers?

- What healthy foods and beverages are most likely to be purchased and consumed in communities? Does this vary by subpopulation?

Child Care Nutrition and Physical Activity Standards Feedback Loop

Highlighted in blue in Figure 5, the child care nutrition and physical activity standards feedback loop represents one of the *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* strategies to increase active living and healthy eating in Moore and Montgomery Counties, North Carolina.

Causal Story for Feedback Loop

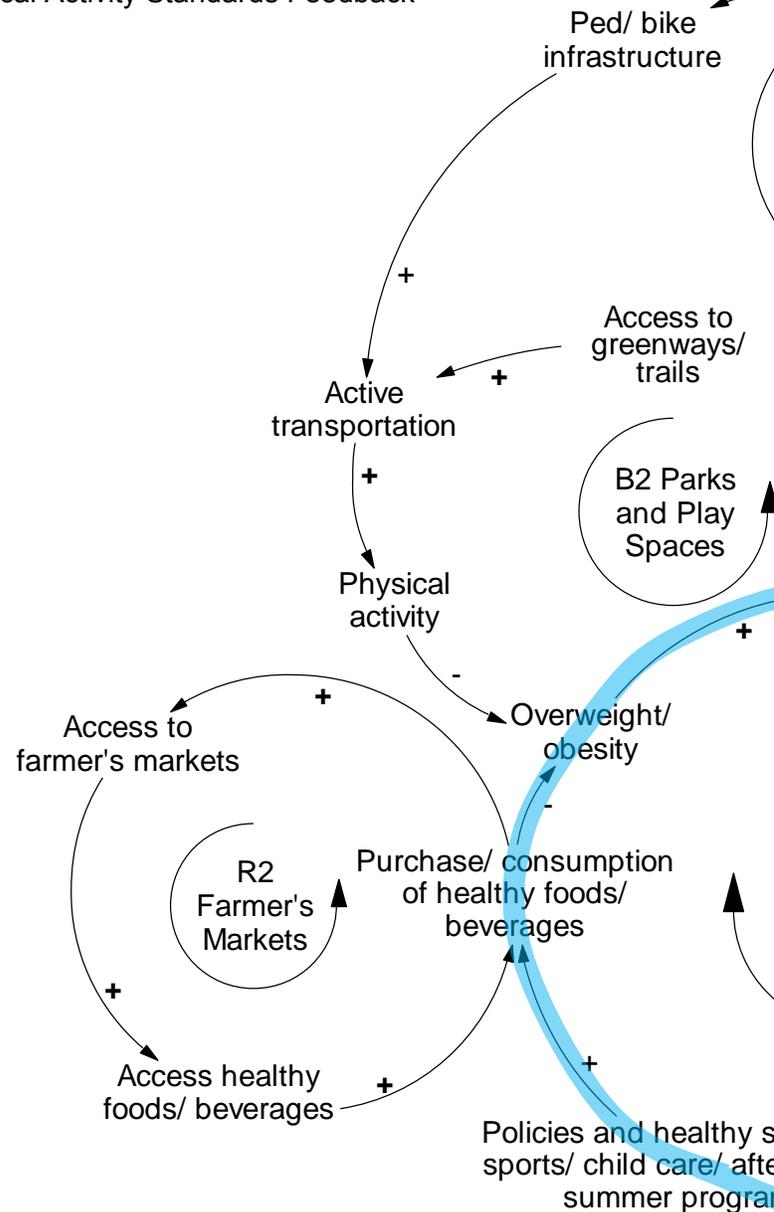
Story A: With more policies and healthy snacks at sporting events, child care facilities, and after school and summer programs, there is an increase in the purchase and consumption of healthy foods and beverages. As more healthy foods and beverages are purchased and consumed, there is a decrease in overweight and obesity, which decreases partnership collaboration since obesity is less of an issue. With less partnership collaboration, there is less parent and community engagement. In turn, less parent and community engagement decreases access to sports and recreation programs, which decreases policies and healthy snacks and sporting events, child care facilities, and after school and summer programs.

Story B: Alternatively, with fewer policies and healthy snacks at sporting events, child care facilities, and after school and summer programs, there is a decrease in the purchase and consumption of healthy foods and beverages. As less healthy foods and beverages are purchased and consumed, there is an increase in overweight and obesity, which increases partnership collaboration since obesity is more of an issue. With more partnership collaboration, there is more parent and community engagement. In turn, more parent and community engagement increases access to sports and recreation programs, which increases policies and healthy snacks and sporting events, child care facilities, and after school and summer programs.

Balancing Loop and Notation

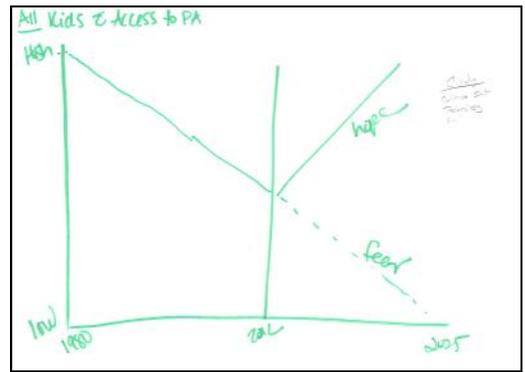
Unlike the previous loops, this one represents a balancing loop (one “-” sign). In a balancing loop, the effect of the variables tend to create more of a stable trend over time, as opposed to one that is continually increasing or decreasing. This effect continues through the cycle and returns a stabilizing influence to the original variable, respectively.

Figure 5: Child Care Nutrition and Physical Activity Standards Feedback Loop



“If your kids are in one of my day camps they are going to be active. But what I see from parents and their feedback, “oh it is too hot for the kids to be playing outside today”, even though we’ve just done a water game to cool them down; or, “you are not taking after school kids outside today, are you? It’s too cold to be outside”. And that comes from parents, that’s not the kids. ” (Participant)

Some of these causal relationships may have more immediate effects (e.g., partnership collaboration influence on parent and community engagement) and other relationships may have delayed effects (e.g., purchase and consumption of healthy foods and beverages influence on overweight and obesity). Again, delayed effects are noted using two hash marks through the middle of the arrow line (not included here).



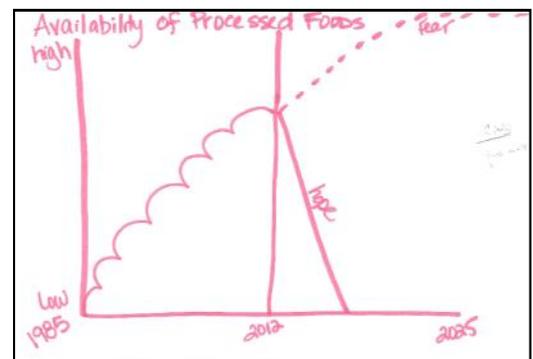
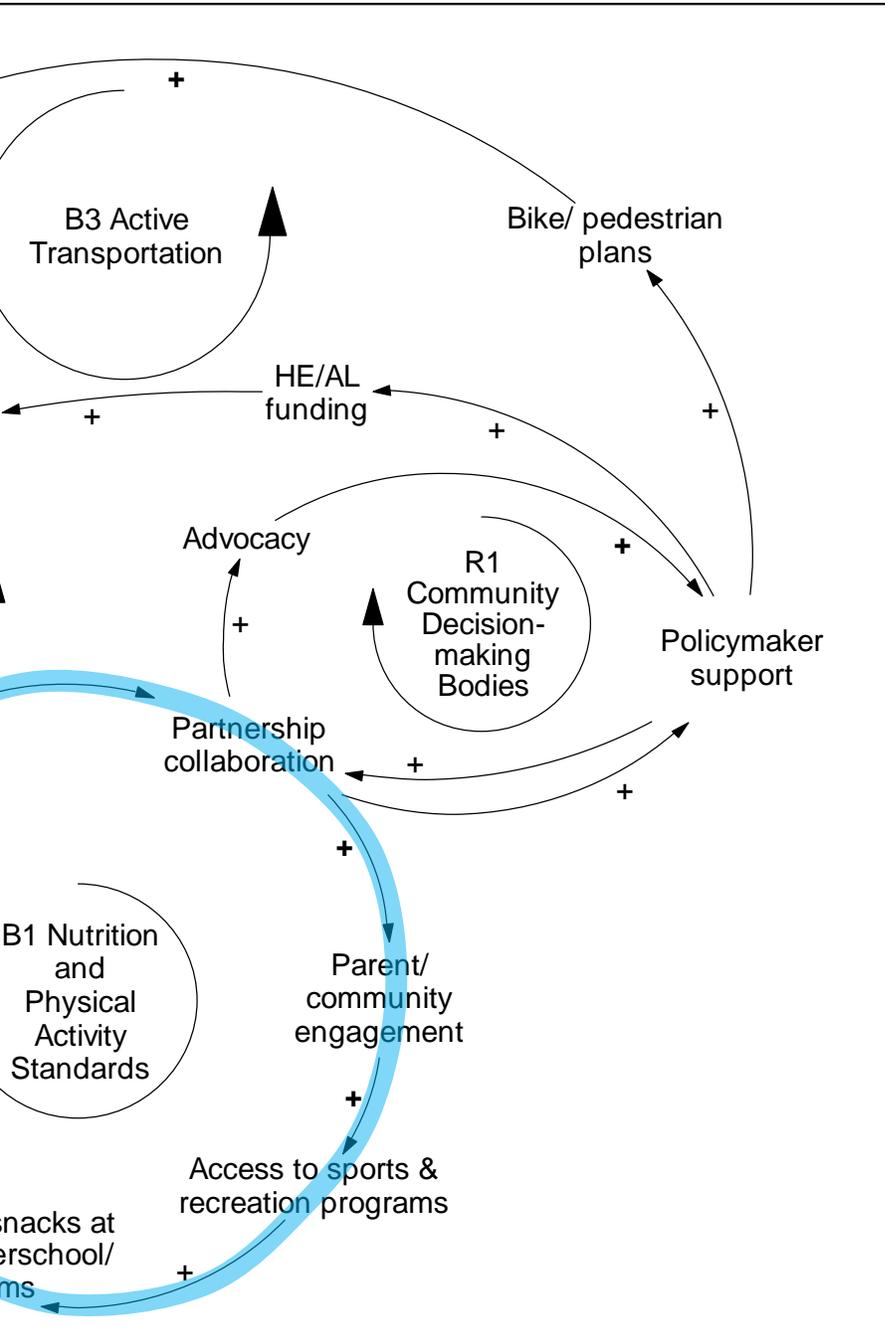
System Insights for Healthy Kids, Healthy Communities-Moore and Montgomery Counties

In the behavior over time graphs exercise, participants described a decrease in the number of kids with access to physical activity since 1980 to 2012 with the hope that more kids will have access to physical activity into the future (see behavior over time graph at the top right). Participants also identified an increase in the availability of processed foods since 1985 to 2012 with the hope that processed foods will become less available into the future (see behavior over time graph bottom right).

System insights for the partnership's child care nutrition and physical activity standards efforts include:

- With the percentage of calories from processed foods steadily increasing over time, child care nutrition policies provide opportunities to reduce youth consumption of unhealthy foods and replace these calories with those from healthier foods.

Parent knowledge and awareness is key to their engagement in efforts to increase healthy eating and active living and reduce childhood obesity; this knowledge and awareness increases their skills to interact with their children through cooking meals at home or engaging in physical activity.



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

- What is the quantity and quality of food vendors within a one-mile radius of child care center and after school programs (e.g., access to fruits and vegetables, access to junk foods)?

Parks and Play Spaces Feedback Loop

Highlighted in red in Figure 6, the <strategy> feedback loop represents one of the *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* strategies to increase active living in Moore and Montgomery Counties, North Carolina.

Causal Story for Feedback Loop

Story A: With more access to greenways and trails, there is an increase in active transportation, which increases physical activity. With more residents participating in physical activity, there is a reduction in the overweight and obesity rates. With less obesity, there is a decrease in the need for partnership collaboration around obesity issues. With less partnership collaboration, there is a decrease in the policymaker support. In turn, with less policymaker support, there is a decrease in the healthy eating and active living funding that is available, which decreases access to greenways and trails.

Story B: Alternatively, with less access to greenways and trails, there is a decrease in active transportation, which decreases physical activity. With less residents participating in physical activity, there is an increase in the overweight and obesity rates. With more obesity, there is an increase in the need for partnership collaboration around obesity issues. With more partnership collaboration, there is an increase in the policymaker support. In turn, with more policymaker support, there is an increase in the healthy eating and active living funding that is available, which increases access to greenways and trails.

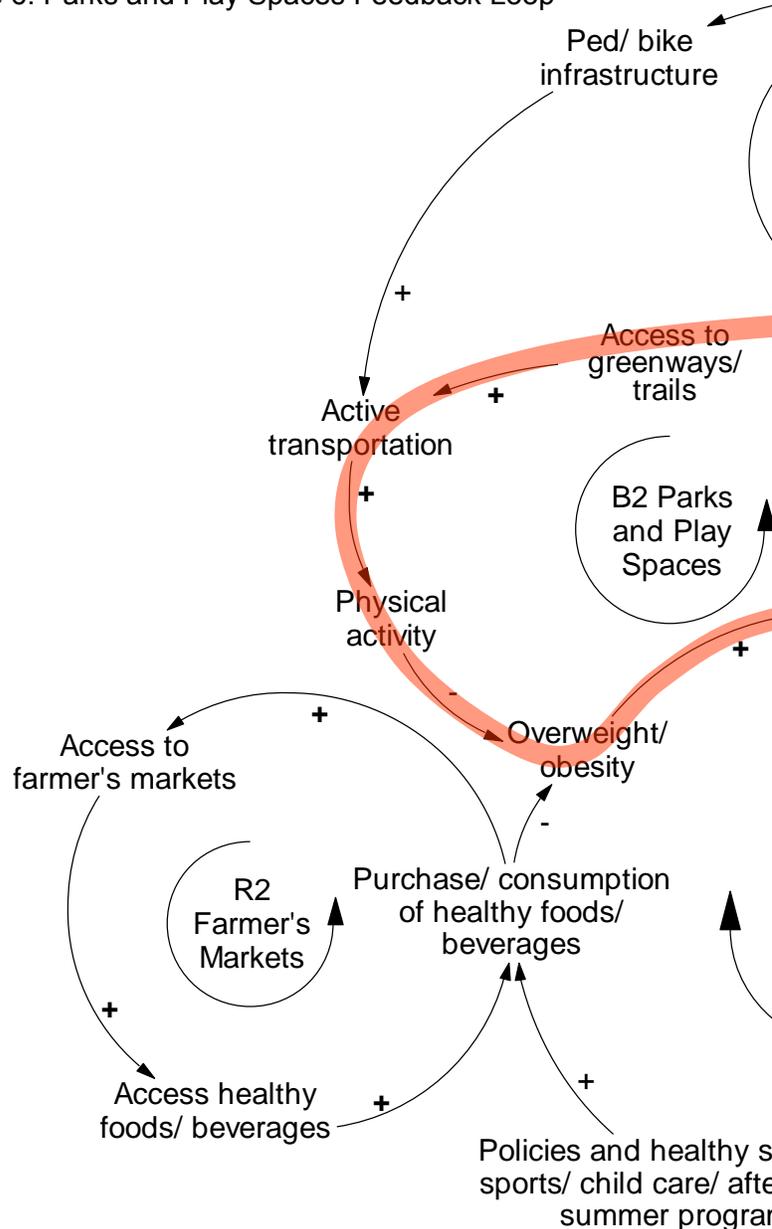
Balancing Loop and Notation

Similar to the previous loop (see Figure 5), this is a balancing loop (one “-” sign). In addition, it includes causal relationships representing more immediate effects (e.g., access to greenways and trails influence on active transportation), and, potentially, delayed effects (e.g., physical activity influence on overweight and obesity).

System Insights for *Healthy Kids, Healthy Communities-Moore and Montgomery Counties*

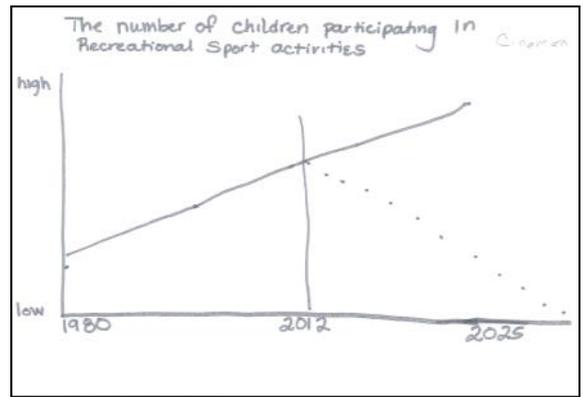
In the behavior over time graphs exercise, participants described an increase in the number of children participating in recreational sport activities since 1980 to 2012 with the

Figure 6: Parks and Play Spaces Feedback Loop



“The lack of participation in programs available to community members in the area where I live is frustrating...I think parents want their kids to participate but it’s so far down on the list of things that they are able to prioritize. What I see as a huge challenge is this gigantic gap between the wealth and poverty levels in Montgomery County. You have people with extremely low incomes who physically, and literally—logistically—cannot participate; they either can’t afford to put the gas in the car to get there or let alone pay the workshop fee.” (Participant)

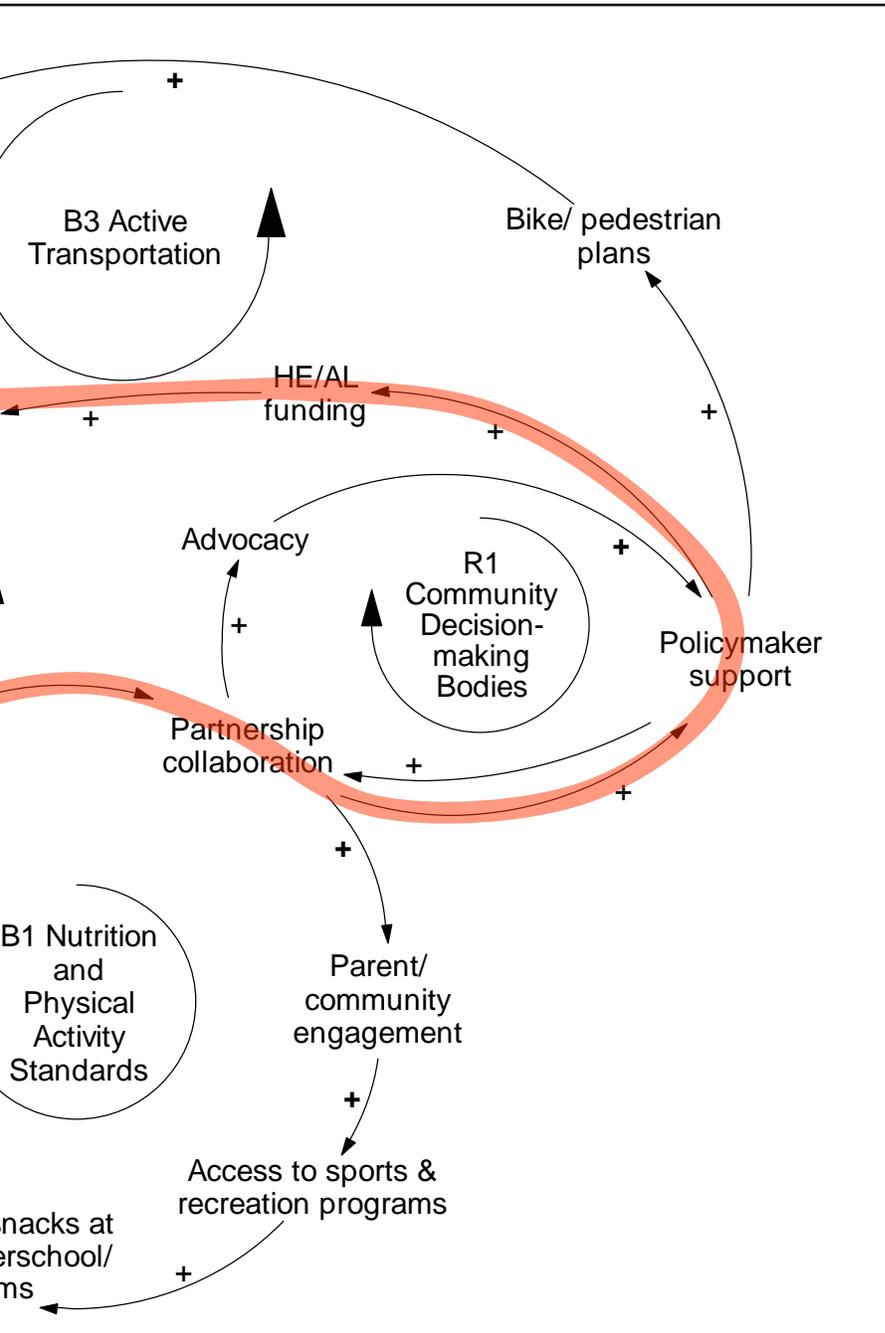
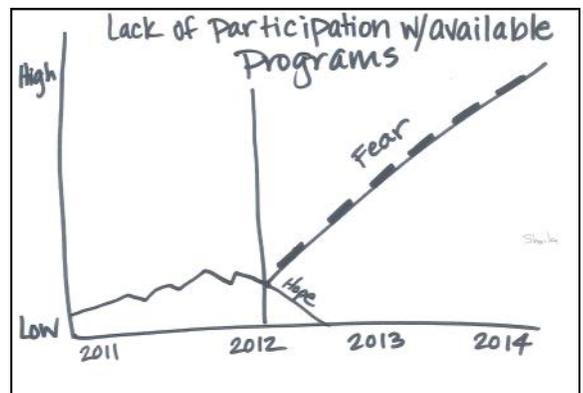
hope that participation in sports activities will continue to increase into the future (see behavior over time graph at the top right). However, participants also described a slight increase in the lack of participation in recreational programs that are available since 2011 to 2012 with the hope that the lack of participation with available recreational programs will decrease into the future and more youth will utilize the existing programs (see behavior over time graph at the bottom right).



System insights for the partnership's parks and play spaces 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.
- Parks, trails, and greenways 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.
- Higher rates of childhood obesity increase resident engagement and attention to this issue; as rates of obesity decline, it may be difficult to maintain these advocacy efforts in order to sustain improvements that have been made.
- "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?
- 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?

Active Transportation Feedback Loop

Highlighted in yellow in Figure 7, the active transportation feedback loop represents one of the *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* strategies to increase active living in Moore and Montgomery Counties, North Carolina. <Figure 8 is purple; 9 is grey>

Causal Story for Feedback Loop

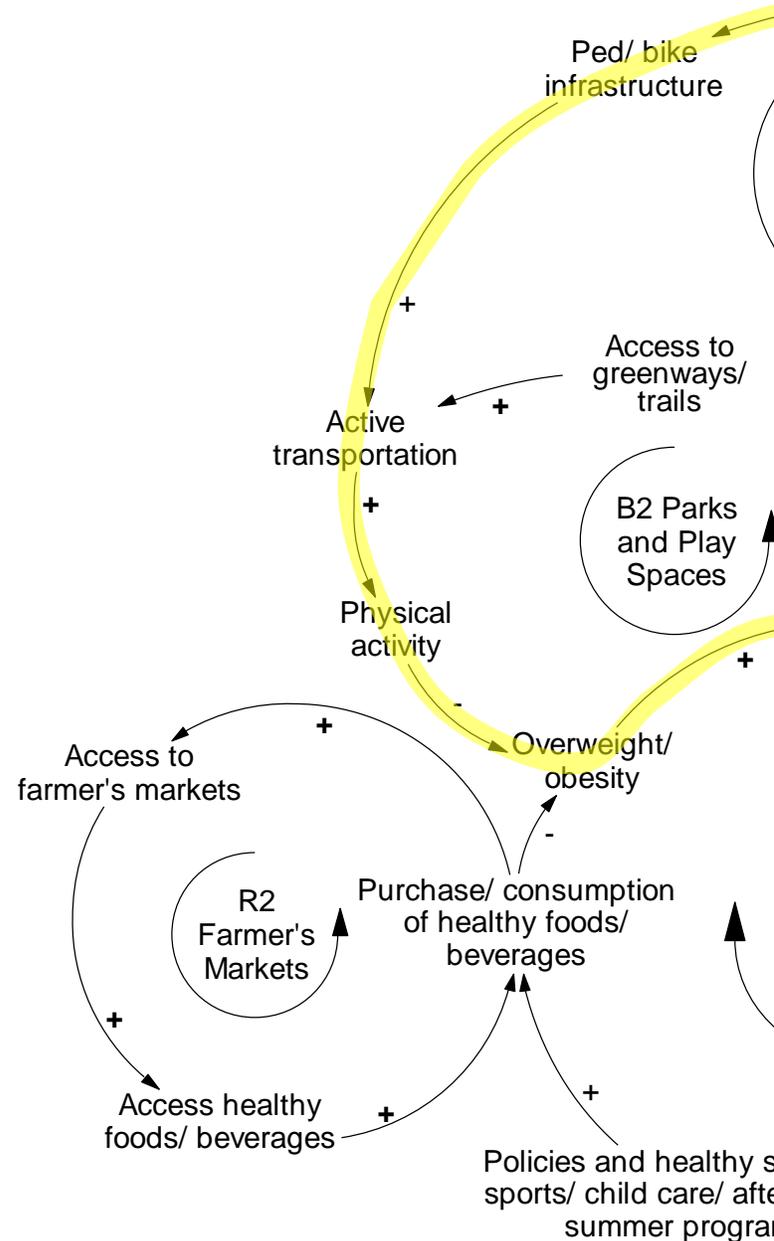
Story A: With more bike and pedestrian plans, there is more pedestrian and bike infrastructure being built and maintained in the community. With more pedestrian and bike infrastructure, there is an increase in active transportation, which increases physical activity. With more residents participating in physical activity, there is a reduction in the overweight and obesity rates. With less obesity, there is a decrease in the need for partnership collaboration around obesity issues. With less partnership collaboration, there is a decrease in the policymaker support. In turn, with less policymaker support, there is a decrease in the need for bike and pedestrian plans.

Story B: Alternatively, with less bike and pedestrian plans, there is less pedestrian and bike infrastructure being built and maintained in the community. With less pedestrian and bike infrastructure, there is a decrease in active transportation, which decreases physical activity. With less residents participating in physical activity, there is an increase in the overweight and obesity rates. With more obesity, there is an increase in the need for partnership collaboration around obesity issues. With more partnership collaboration, there is an increase in the policymaker support. In turn, with more policymaker support, there is an increase in the need for bike and pedestrian plans.

Balancing Loop and Notation

Similar to the previous loops (see Figure 5 & 6), 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 overweight and obesity).

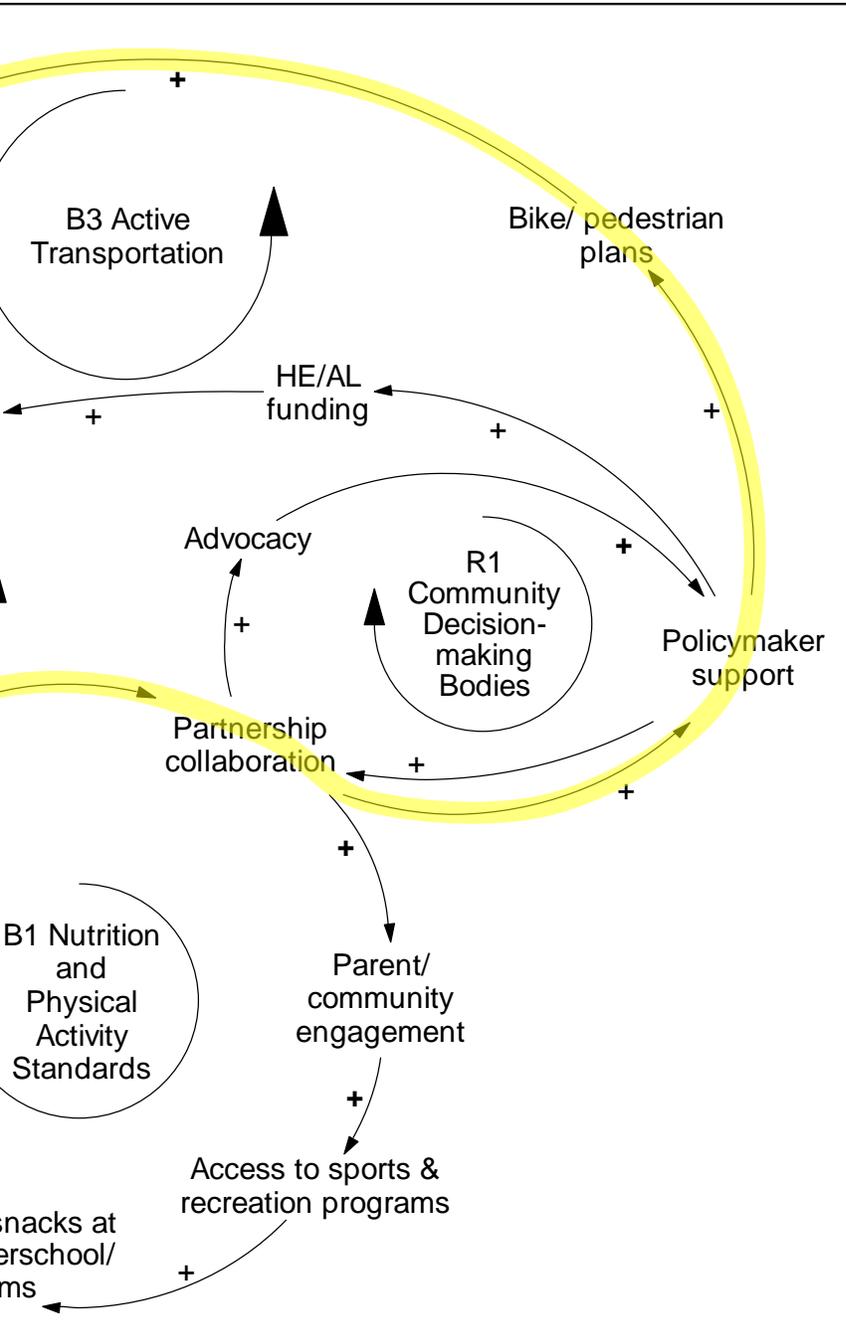
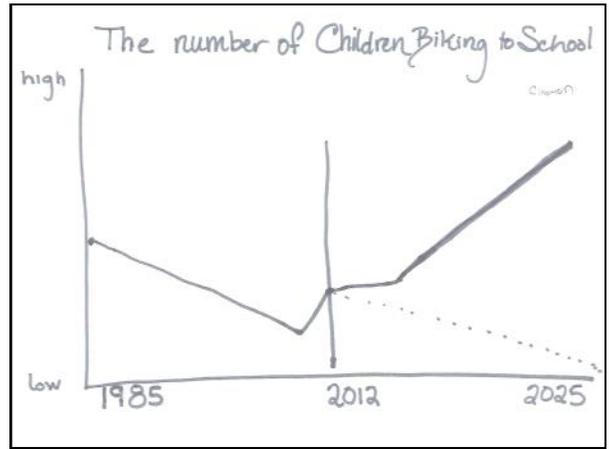
Figure 7: Active Transportation Feedback Loop



“It was safer to walk here in the early 80s but it’s been decreasing, probably because of more traffic, more people in the communities. It was already not that great maybe because we didn’t have many sidewalks. Slowly, we are making a change. We have been putting in more sidewalks, specifically in the Southern Pines area to accommodate, but without those safe ways to walk I have seen less kids walking to school, less parents walking to school, less seniors too, and a lot of seniors are taking care of their grandkids so it is really important that people are able to get from one place to another in a safe way and walking there.” (Participant)

System Insights for Healthy Kids, Healthy Communities-Moore and Montgomery Counties

In the behavior over time graphs exercise, participants described a decrease in the number of children biking to school since 1985 to 2012 with the hope that the number of children biking to school will change and increase into the future (see behavior over time graph at the top right). However,



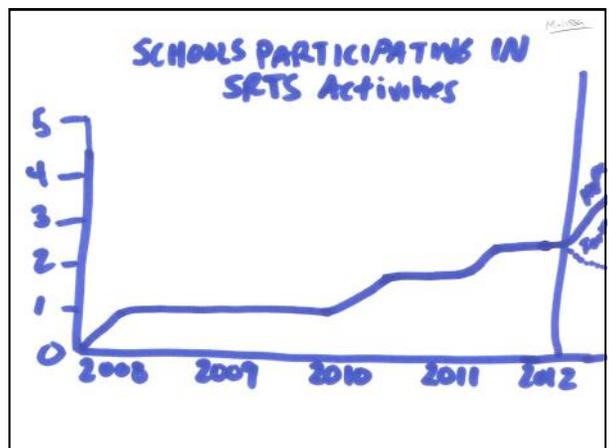
participants also described an increase in the number of schools participating in safe routes to school activities since 2008 to 2012 with the hope that the number of school participating in safe routes to school activities will continue to increase into the future (see behavior over time graph at the 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 choose active rather than sedentary transportation modes.
- Efforts to build political will — particularly support from policy-makers — for improvements to transit and bike infrastructure benefit from economic data forecasting how short-term expenditures have substantive long-term

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 car, bike, and foot in communities? Who is using the current active transportation infrastructure and who is not (e.g., adults, children)?

Opportunities for Systems Thinking in Moore and Montgomery Counties, North Carolina

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 *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Moore and Montgomery Counties 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.

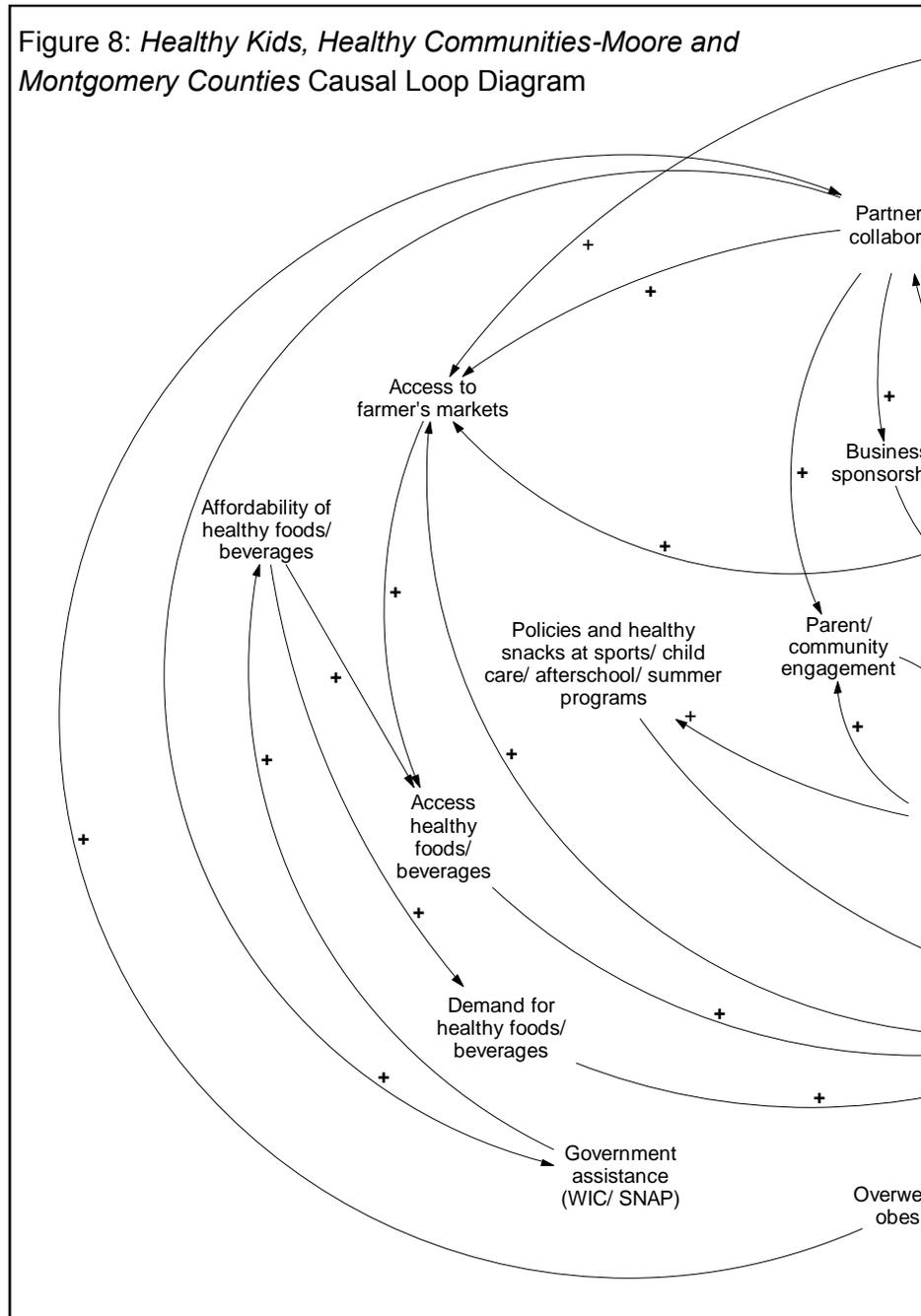
This represented a first attempt to collectively examine the range of things that affect or are affected by policy, system, and environmental changes in Moore and Montgomery Counties, North Carolina to promote healthy eating and active living as well as preventing childhood overweight and obesity.

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

- the participants represent a sample of the *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* 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

Figure 8: *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* Causal Loop Diagram



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/>

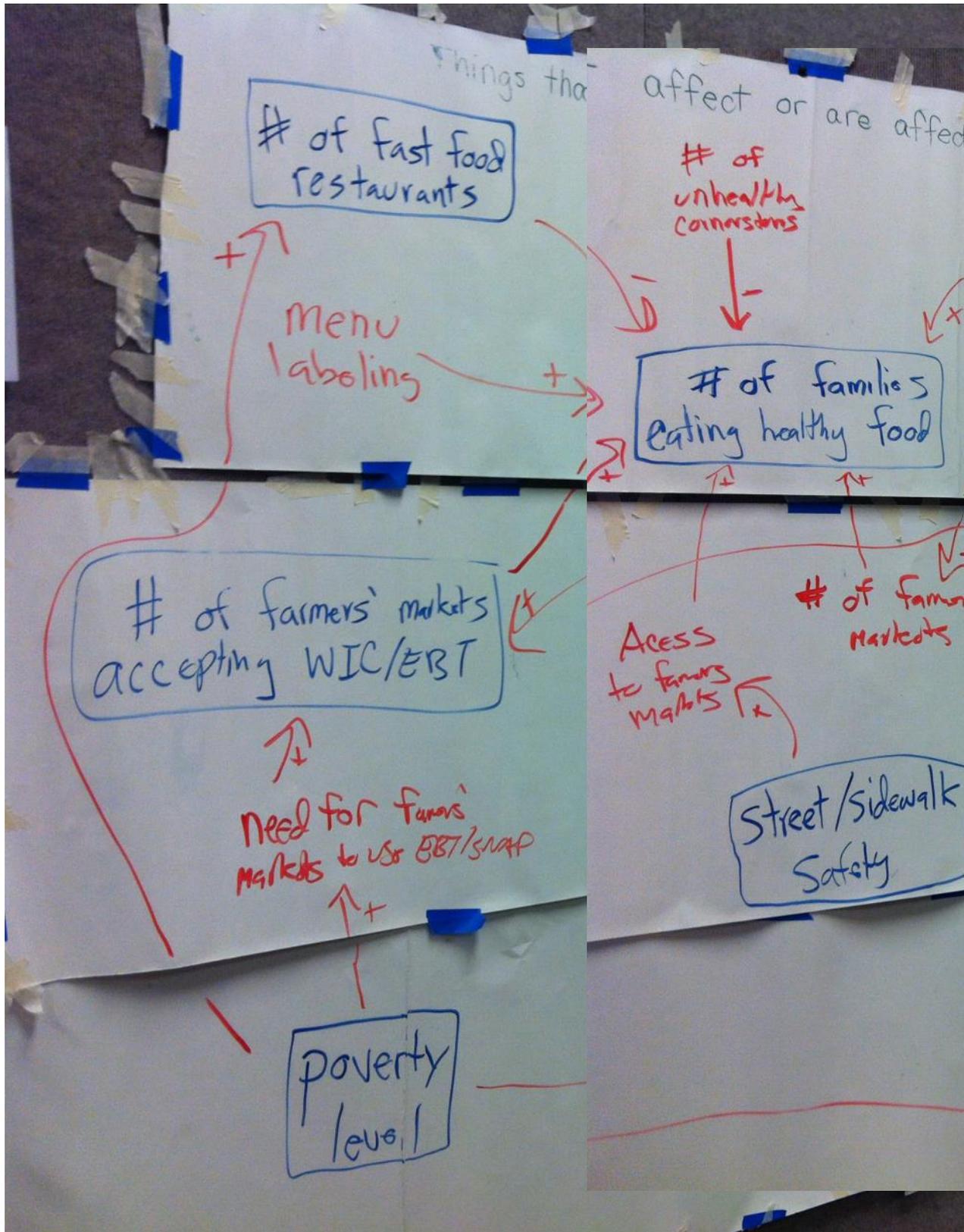
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

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

Moore and Montgomery Counties, North Carolina: <i>Healthy Kids, Healthy Communities-Moore and Montgomery Counties</i>	
Categories	Number of Graphs
Active Living Behavior	4
Active Living Environments	3
Funding	0
Healthy Eating Behavior	4
Healthy Eating Environments	2
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	0
Partnership & Community Capacity	2
Policies	1
Programs & Promotions (Education and Awareness)	4
Social Determinants of Health	1
Total Graphs	21

Appendix B: Photograph of the Original Version of the *Healthy Kids, Healthy Communities-Moore and Montgomery Counties* Causal Loop Diagram



ed by policy, systems, and environmental change in your community (active living, healthy eating, Childhood obesity)

HE Policies @ sports facilities

Policy maker support

of affordable sports leagues

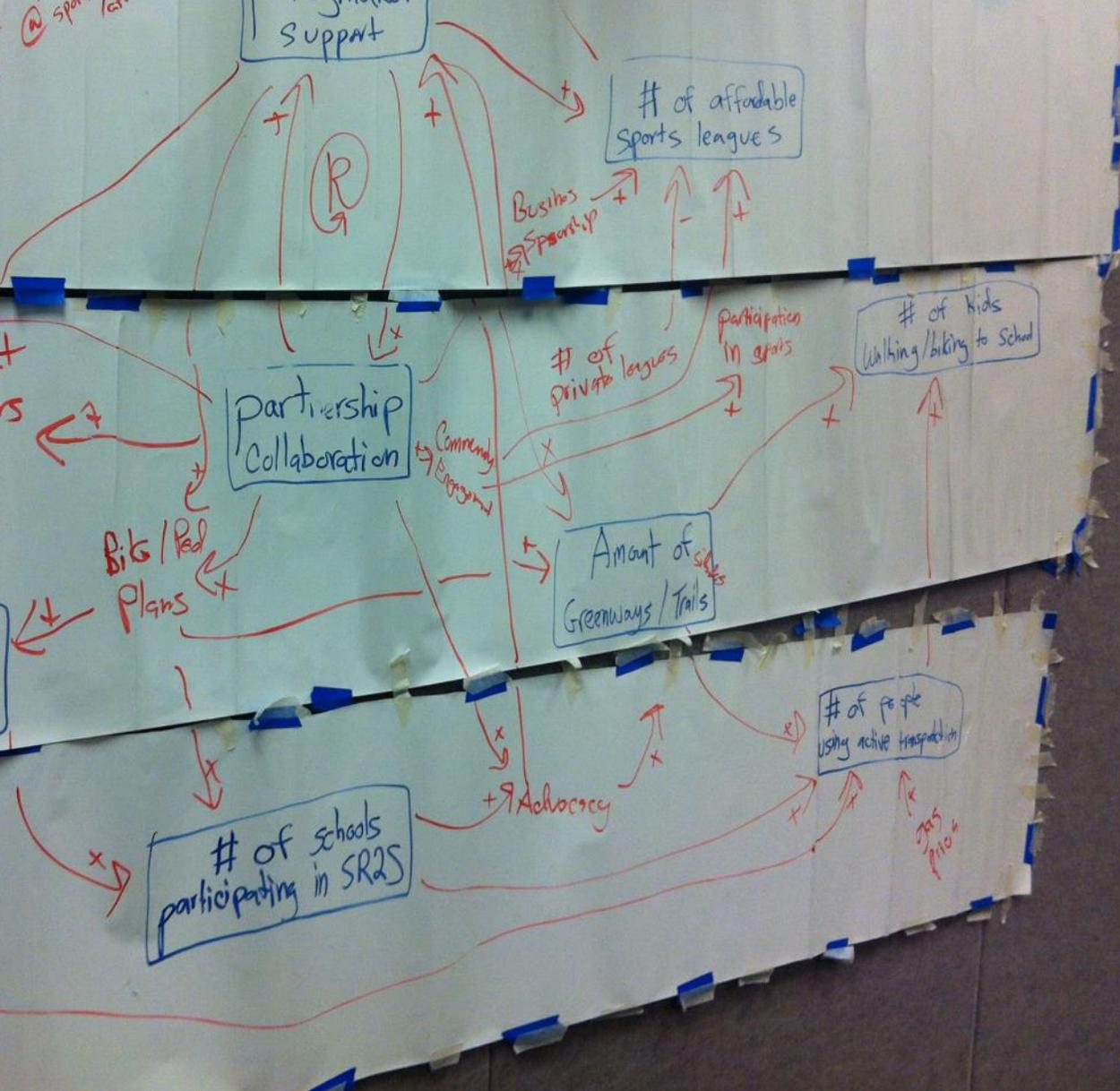
Partnership Collaboration

Amount of Greenways/Trails

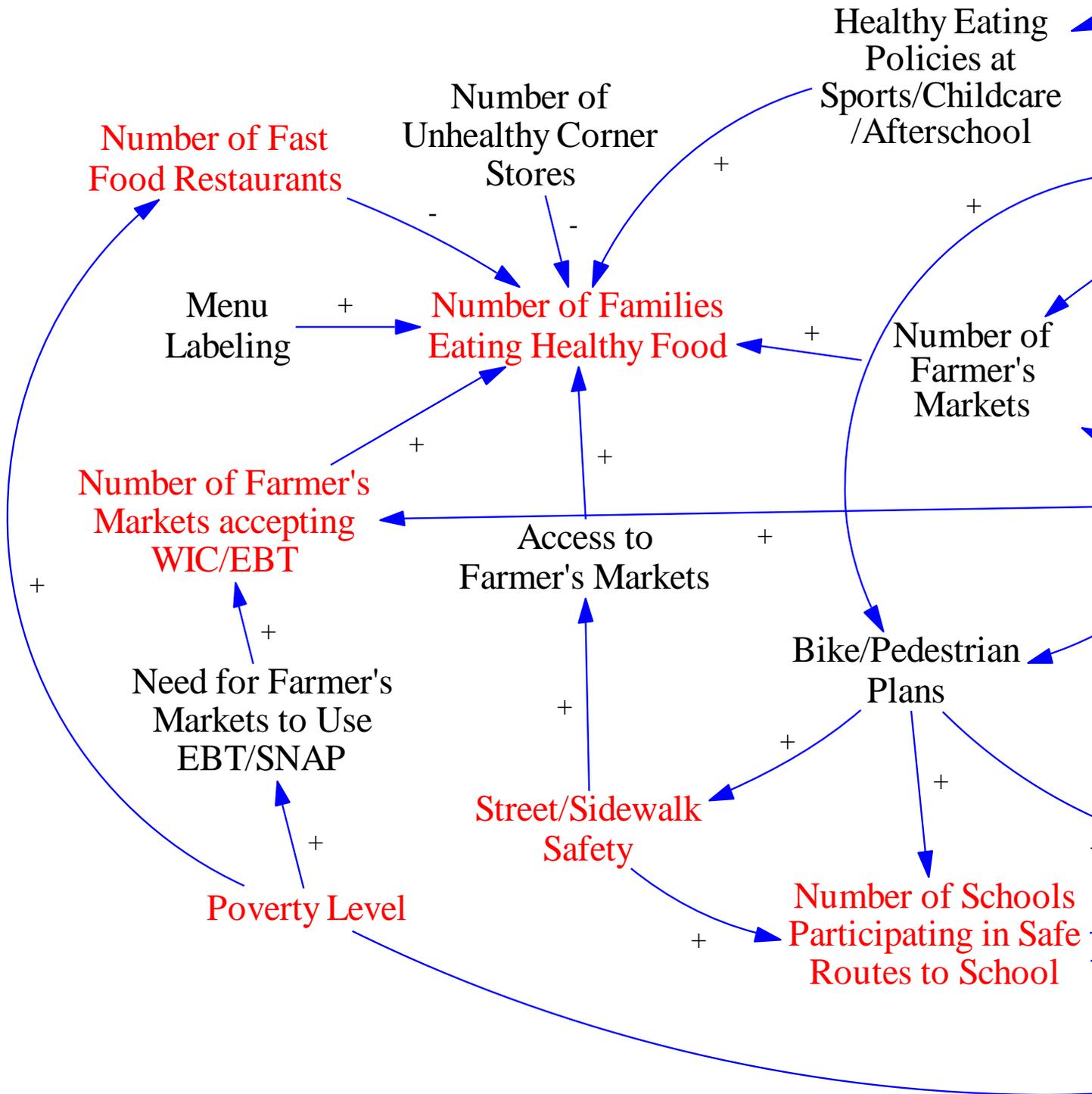
of kids walking/biking to school

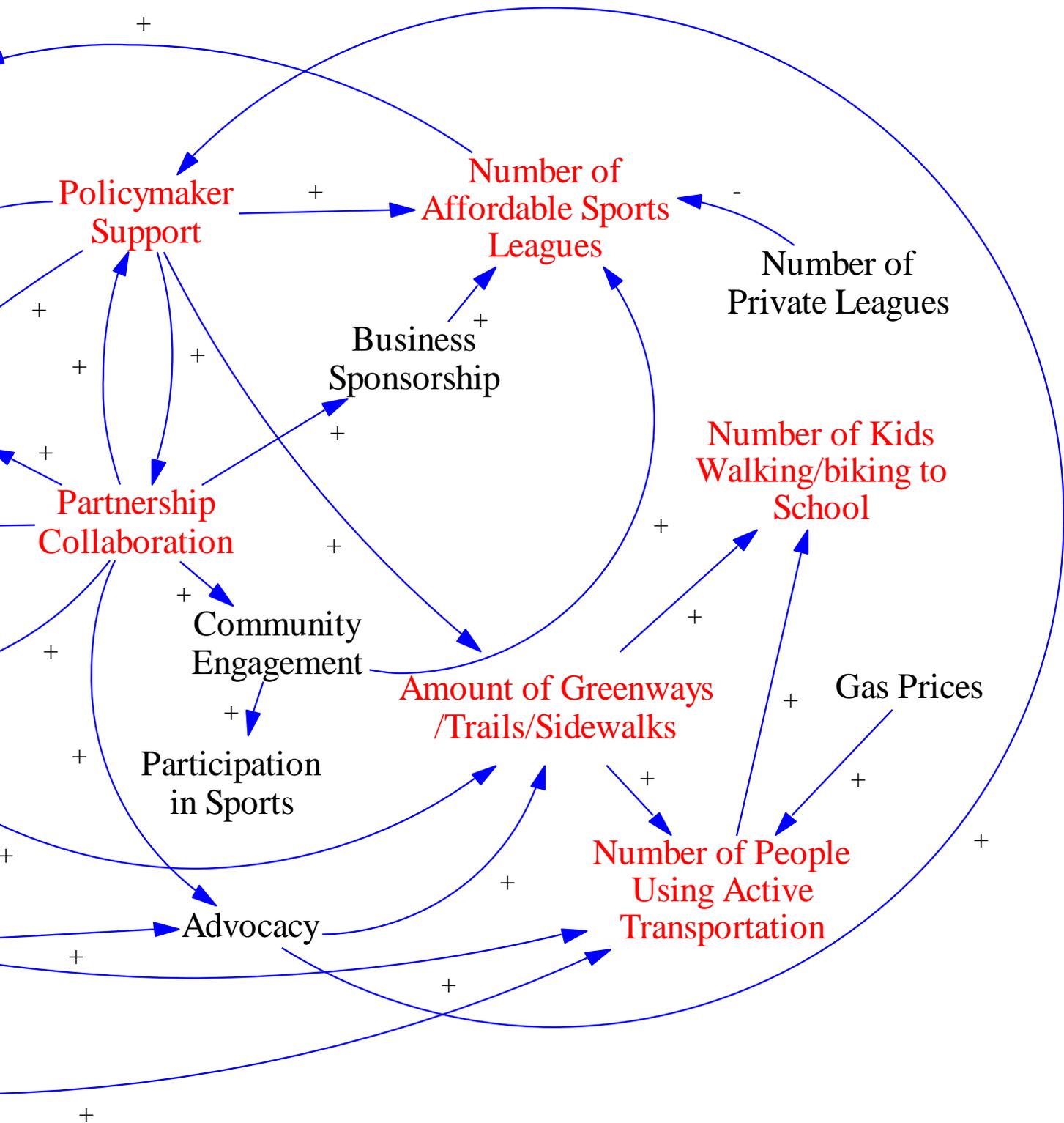
of schools participating in SR2S

of people using active transportation

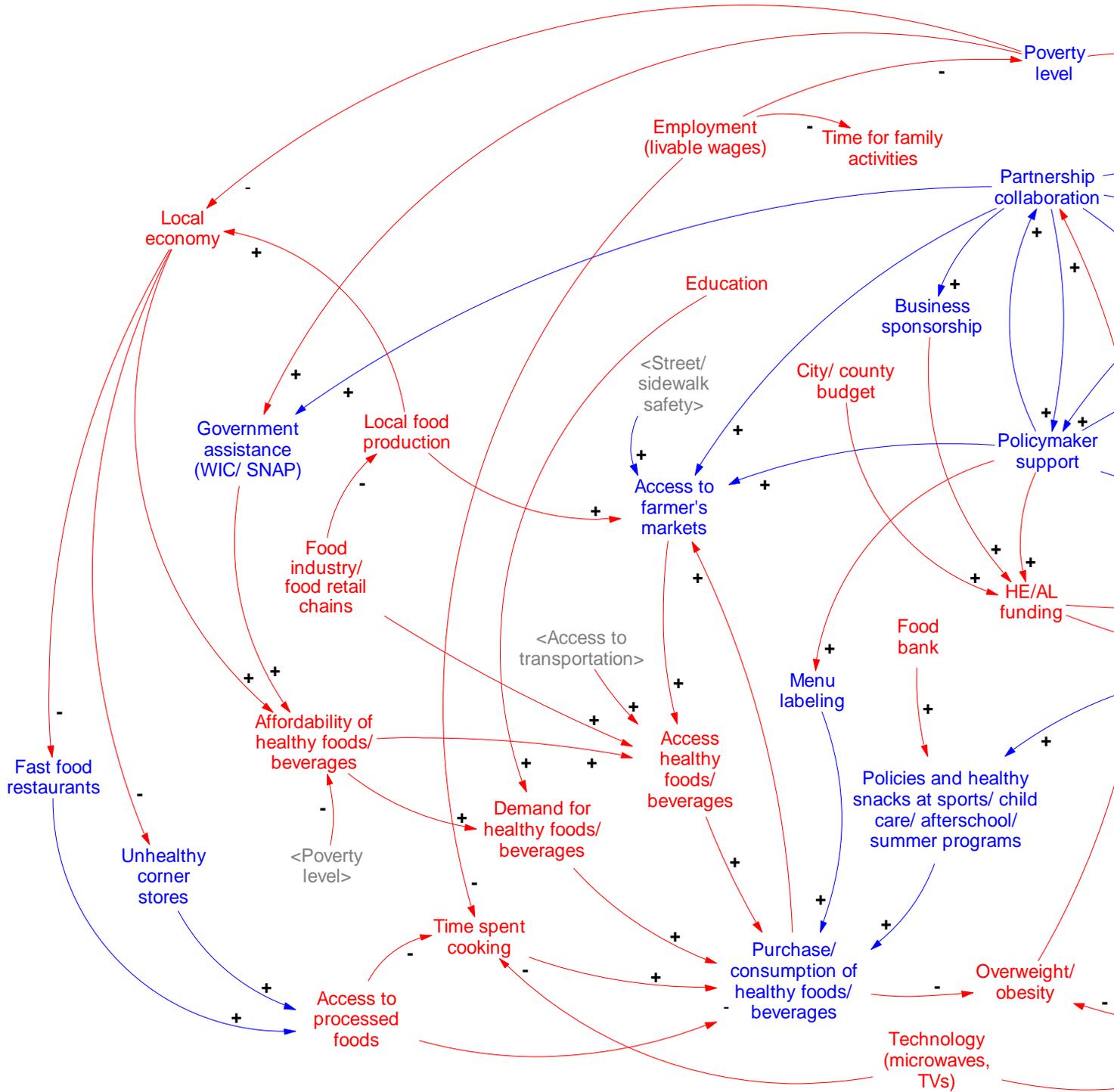


Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE

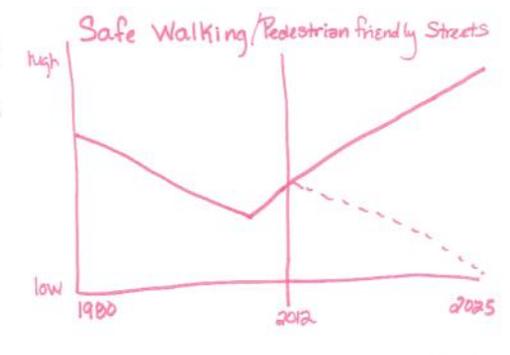
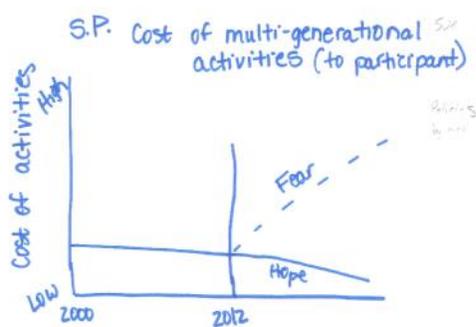
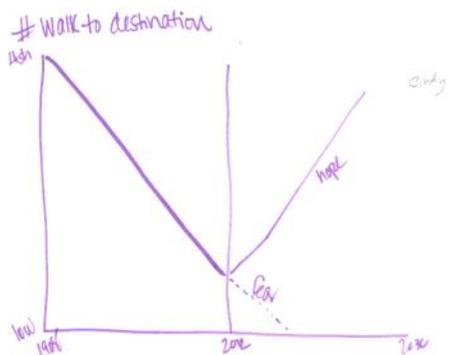
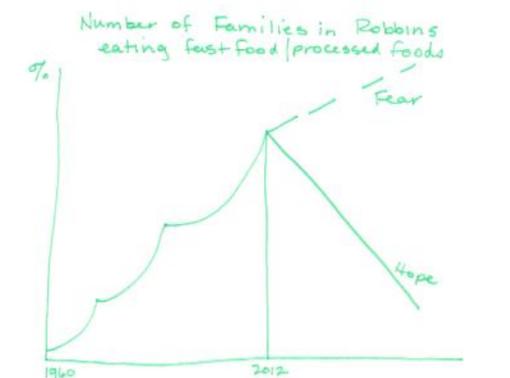
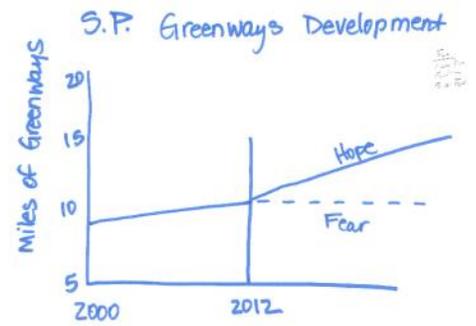
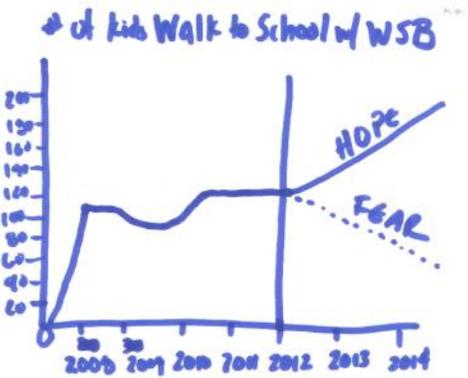
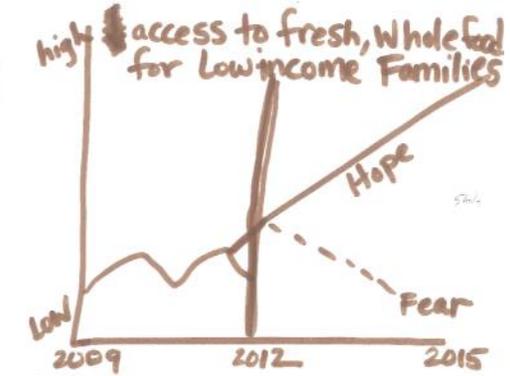
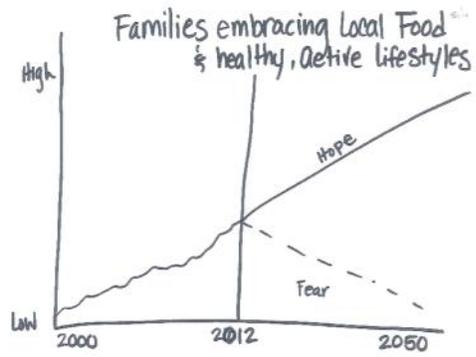
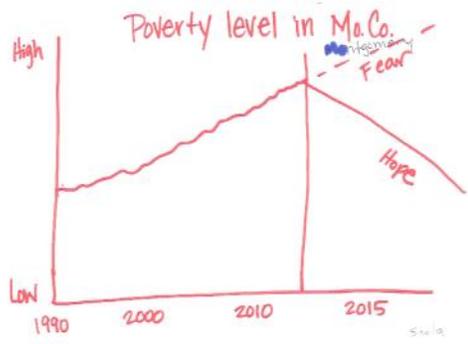
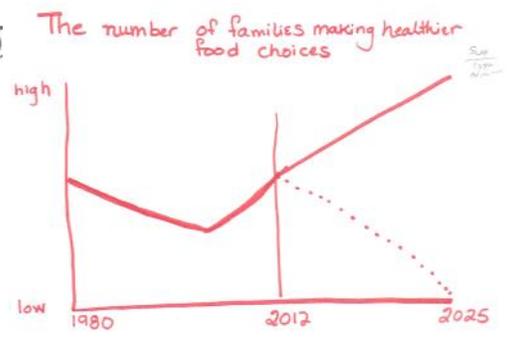
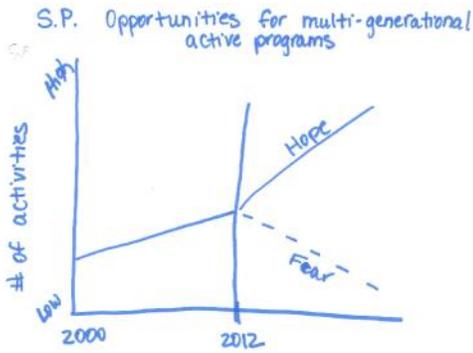




Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE



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



10. Access to Soccer for Children in Robbins

