Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Buffalo, New York

This community storybook was developed by Transtria LLC.

Support was provided by the Robert Wood Johnson Foundation.

Acknowledgments

Support for this evaluation was provided by a grant from the Robert Wood Johnson Foundation (#67099). Transtria LLC led the evaluation and dissemination activities from April 2009 to March 2014. Representatives from the Healthy Kids, Healthy Communities Buffalo partnership actively participated in the evaluation planning, implementation, and dissemination activities.

We are grateful for the collaboration with and support from the Robert Wood Johnson Foundation (Laura Leviton, PhD and Tina Kauh, PhD), the Washington University Institute for Public Health (Ross Brownson, PhD), the Healthy Kids, Healthy Communities (HKHC) National Program Office (Casey Allred; Rich Bell, MCP; Phil Bors, MPH; Mark Dessauer, MA; Fay Gibson, MSW; Joanne Lee, LDN, RD, MPH; Mary Beth Powell, MPH; Tim Schwantes, MPH, MSW; Sarah Strunk, MHA; and Risa Wilkerson, MA), the HKHC Evaluation Advisory Group (Geni Eng, DrPH, MPH; Leah Ersoylu, PhD; Laura Kettel Khan, PhD; Vikki Lassiter, MS; Barbara Leonard, MPH; Amelie Ramirez, DrPH, MPH; James Sallis, PhD; and Mary Story, PhD), the Social System Design Lab at Washington University in St. Louis (Peter Hovmand, PhD), the University of Memphis (Daniel Gentry, PhD), and Innovative Graphic Services (Joseph Karolczak).

Special thanks to the many individuals who have contributed to these efforts from Transtria LLC, including Evaluation Officers (Tammy Behlmann, MPH; Kate Donaldson, MPH; Cheryl Carnoske, MPH; Carl Filler, MSW; Peter Holtgrave, MPH, MA; Christy Hoehner, PhD, MPH; Allison Kemner, MPH; Jessica Stachecki, MSW, MBA), Project Assistants (James Bernhardt; Rebecca Bradley; Ashley Crain, MPH; Emily Herrington, MPH; Ashley Farell, MPH; Amy Krieg; Brandye Mazdra, MPH; Kathy Mora, PhD; Jason Roche, MPH; Carrie Rogers, MPH; Shaina Sowles, MPH; Muniru Sumbeida, MPH, MSW; Caroline Swift, MPH; Gauri Wadhwa, MPH; Jocelyn Wagman, MPH), additional staff (Michele Bildner, MPH, CHES; Daedra Lohr, MS; Melissa Swank, MPH), Interns (Christine Beam, MPH; Skye Buckner-Petty, MPH; Maggie Fairchild, MPH; Mackenzie Ray, MPH; Lauren Spaeth, MS), Transcriptionists (Sheri Joyce; Chad Lyles; Robert Morales; Vanisa Verma, MPH), and Editors (Joanna Bender and Julie Claus, MPH).

Suggested citation:

Brennan L, Sabounchi N, Hoehner CM, Gouck, J and Ball, M. Systems Thinking in Communities: Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Buffalo, New York. 2013. http://www.transtria.com/hkhc. Accessed <Date Accessed>.

Introduction

Healthy Kids Healthy Communities Buffalo (HKHC Buffalo) 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 *HKHC Buffalo Partnership* project was to introduce systems thinking at the community level by identifying the essential parts of the Buffalo, New York 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, civic and community-based organizations, academic institutions, and municipal planning agencies) 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.

Buffalo, New York: Background and Local Participation

The Buffalo Niagara Medical Campus, Inc. (BNMC) served as the lead agency for the HKHC-Buffalo partnership. As a non-profit organization founded in 2001, the BNMC functions as an organizational structure for a consortium of nine science and healthcare institutions, including: the University at Buffalo, Roswell Park Cancer Institute, Olmsted Center for Sight, Kaleida Health, Hauptman-Woodward Medical Research Institute, Buffalo Medical Group, Buffalo Hearing & Speech Center, Upstate New York Transplant Services, and the Center for Hospice and Palliative Care. Created to be a convening and facilitating organization to work on behalf of the institutions to pursue their joint-development agenda, the BNMC has evolved into a forum by which institutions, local government, and surrounding neighborhoods collaborate and communicate on a range of issues. Representation from these member institutions comprise the board of directors, as well as the mayor of Buffalo, the county executive, and the president of the city's common council to the legislative city body. There is also representation from neighborhoods to the east and west of the Buffalo Niagara Medical Campus. In total, there are under twenty full- and part-time employees at the BNMC.

The HKHC Buffalo partnership had worked closely and successfully together for more than five years prior to the launch of HKHC, as a grantee of the Active Living by Design (ALbD) and Healthy Eating by Design (HEbD) initiatives, among others. In addition to the BNMC as lead agency, the partnership includes: the University at Buffalo, the Wellness Institute of Greater Buffalo and Western New York, the Massachusetts Avenue Project, and Green Options (GO) Buffalo. Overall, there was no formal leadership structure. These organizations formed the Steering Committee and received sub-contracts to carry out specific activities within the partnership, such as youth engagement, active transportation strategies, visioning and communications, and assessment. Other organizations and individuals became members of the larger partnership (listed in Appendix A). In addition, various sub-committees emerged that focused on specific issues, including Visioning and Communications, Safety, and Complete Streets. Throughout the HKHC initiative, BNMC staff assisted on projects and goals specifically related to finances, government relations, transportation-related planning, and community engagement.

Political support is mainly focused through the partnership seats occupied by the Commissioner of Public Works and the Director of the Office of Strategic Planning. Through these two offices, communication about partnership issues is brought to and from the mayor's office. City council members are involved in a non-official process in order to avoid specific political alignment but to still maintain a working relationship to build policy initiatives through the city council. The BNMC board has elected officials and policy makers on the board, giving another route to political support for the community partnership.

Healthy Kids Healthy Communities Buffalo Partnership's Priorities and Strategies

The partnership and capacity building strategies of *Healthy Kids Healthy Communities Buffalo Partnership* included:

- **Food Policy Council (FPC) of Buffalo and Erie County:** In May 2013, the FPC was created as a sub-commission of the Erie County Board of Health. The FPC was created in order to provide local governments (legislative bodies and executive agencies) with an advisory body that would be able to provide expert information on policies that could improve the local food system.
- **Youth Advisors Council (YAC):** In 2011, the Buffalo Common Council adopted a resolution to add two youth seats to the Bicycle/Pedestrian Board. In 2010-2011, the YAC engaged youth and families in the Buffalo Green Code planning process. More recently, in 2013, the YAC secured two voting seats on the Food Policy Council for Buffalo and Erie County. The YAC is currently focused on school wellness, including recruiting and training school leaders, raising awareness about the Buffalo Public School's wellness policy, and supporting school food services.

The healthy eating and active living strategies of *Healthy Kids Healthy Communities Buffalo Partnership* included:

- **Comprehensive Plan/Green Code:** In 2010, the Common Council adopted the Healthy Addendum Recommendations , demonstrating a commitment to amend the city's comprehensive plan to improve the health and quality of life for Buffalo's residents. HKHC Buffalo partners were active in making recommendations to the new zoning code and land use plan to include language promoting a healthy community, including explicitly recognizing and including community gardens and urban agriculture as permitted use. Moreover, partners were instrumental in engaging the public and families during well-attended planning workshops. Indicator and policy briefs were created to educate the public and decision-makers, as well as provide a baseline for future monitoring. The Green Code is currently undergoing legal review.
- **Complete Streets:** GObike Buffalo, Buffalo's lead partner in its Complete Streets initiatives, worked with the Department of Public Works to invest in sharrows, mark new streets as bike routes, and add new bike lanes to connect existing bike routes throughout the city. In 2012, there was a 100% increase in bike lanes/markings in Buffalo, from 14 to 28 miles with even more added in 2013.
- **Safe Routes to School:** Major intersection improvements have been completed around two Buffalo schools. Three major intersections around Hamlin Park School underwent street and sidewalk infrastructure improvements, planting of trees, improvements to vacant lots, and a new pedestrian bridge. Improvements near Bennett Park Montessori included enhanced crosswalks and ramps and countdown timers at one intersection and installation of street beacons.
- **Corner stores:** In 2012, the Common Council passed a resolution promoting the inclusion of fresh, healthy, affordable and culturally appropriate food in the City of Buffalo's food retail landscape. The Buffalo Green Code includes language restricting corner stores based on what is sold, as well as advertising of junk food.
- **Community gardens:** In 2010, the Buffalo Common Council passed a resolution to "recognize, support, and facilitate community gardens and urban agriculture in the City of Buffalo." In 2011, the Common Council approved 34 additional city-owned to Grassroots Gardens of Buffalo's lease for community gardens.
- **School wellness:** In 2012, Buffalo Public Schools Board of Education approved a new wellness policy. It includes: family/community involvement; health promotion for staff; healthy school environment; counseling, psychological and social services, nutrition services, and health services; and physical education and health education. HKHC partners were instrumental in drafting the policy. YAC is currently helping to implement the policy.

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

Systems Thinking in Communities: Buffalo, New York

"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 Buffalo, New York that influence healthy eating, active living, and, ultimately, childhood obesity. This system and the dynamics within the system are complicated with many different elements interacting.

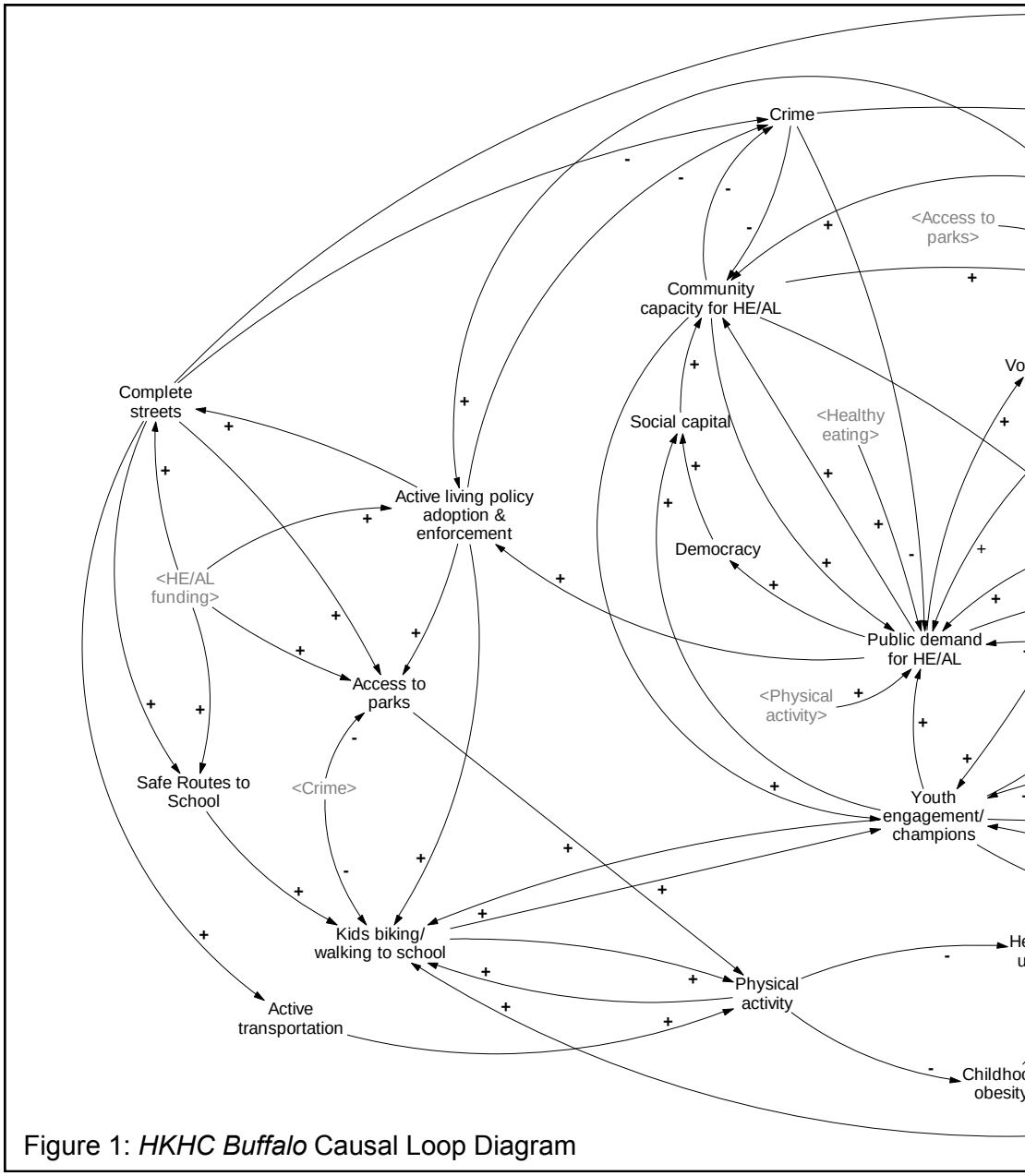


Figure 1: *HKHC Buffalo* Causal Loop Diagram

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

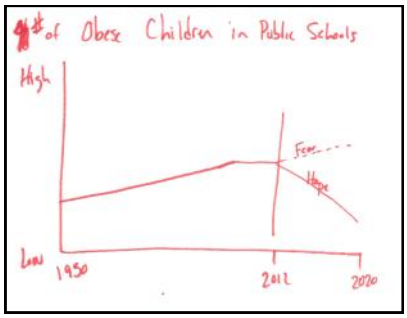
Group Model Building

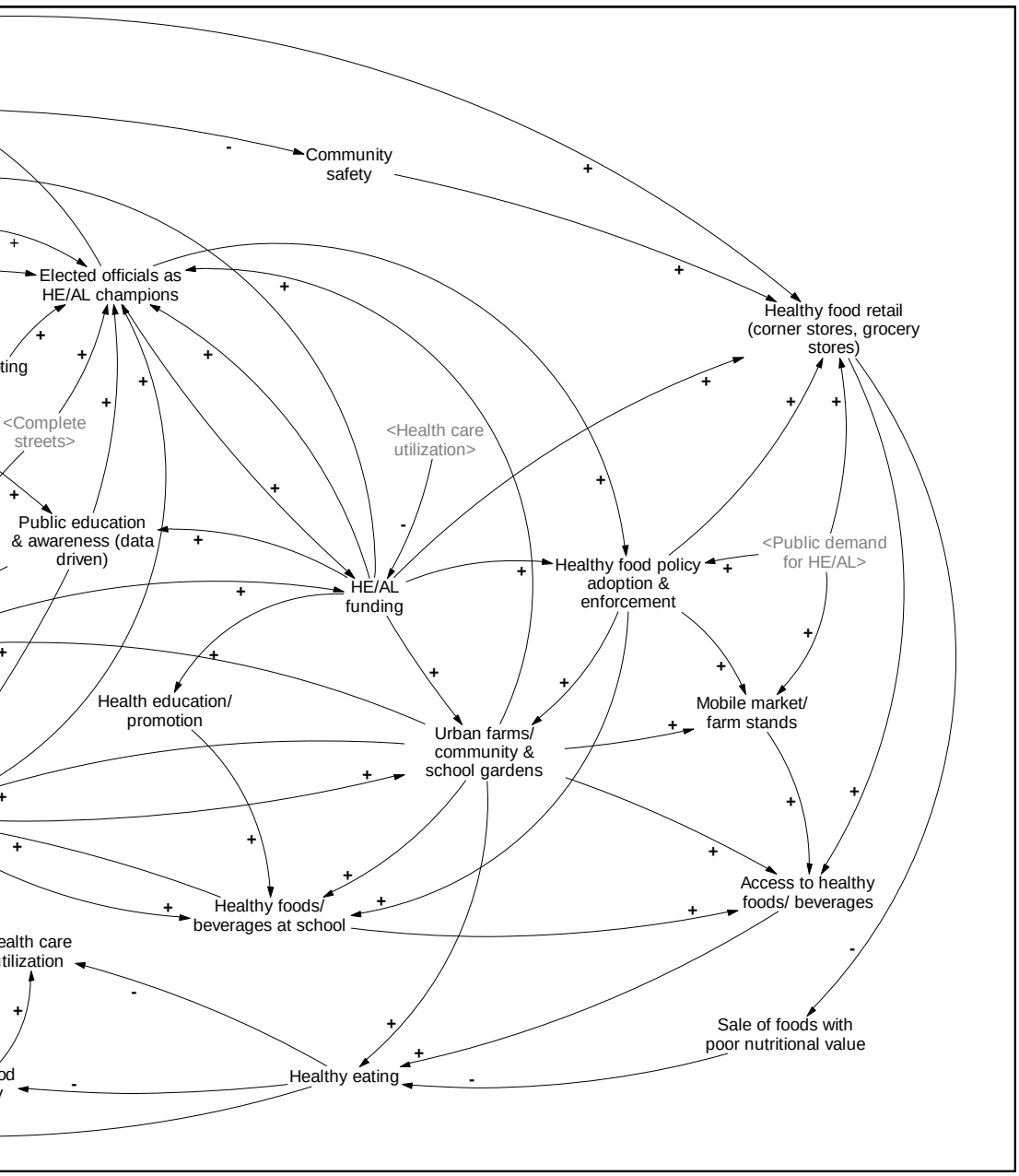
Members of the *Healthy Kids, Healthy Communities Buffalo (HKHC Buffalo)* partnership participated in a group model building session in May, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives from local and state government agencies, academic institutions, municipal planning agencies, community-based and civic organizations, and advocates. The group model building session had two primary activities: 1) a Behavior Over Time Graph exercise; and 2) a Causal Loop Diagram (or structural elicitation) exercise.

Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in Buffalo 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 obese children in public schools, the number has increased since 1950 to 2012 and the participant hopes that this will change and the number of obese children in public schools will

decrease into the future. 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 youth engagement and champions in this causal loop diagram. One feedback loop is: youth engagement and champions → social capital → community capacity for healthy eating and active living. A second feedback loop is: youth engagement and champions → urban farms/ community and school gardens → healthy foods and beverages in schools.

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 youth engagement and champions. Some variables may increase youth engagement and champions while other variables limit youth engagement and champions. 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 *HKHC Buffalo* 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 Buffalo, New York and to stimulate greater conversation related to Buffalo'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 Buffalo, New York. 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.

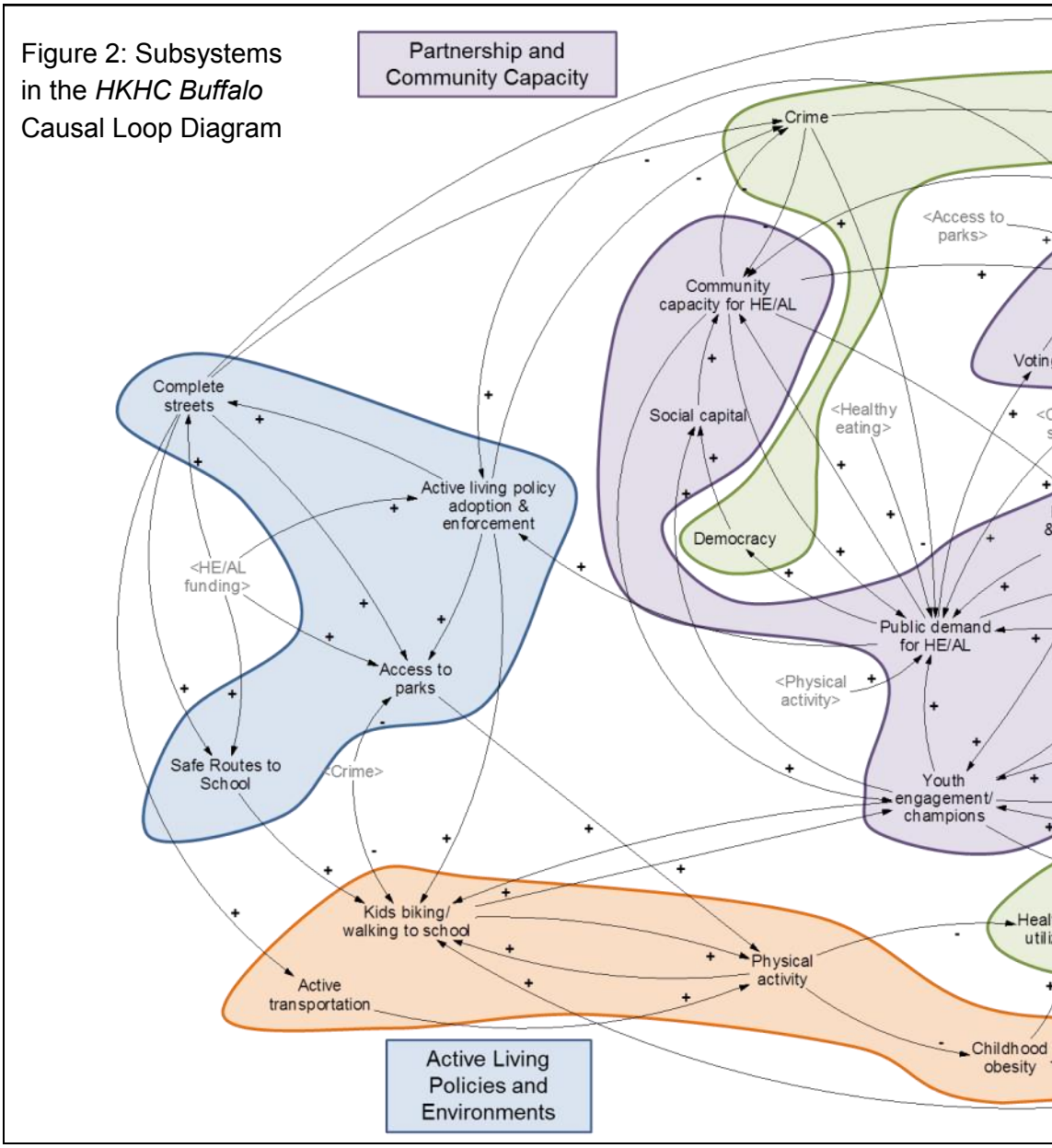


Figure 2: Subsystems in the *HKHC Buffalo* Causal Loop Diagram

Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., urban farms/ community and school gardens), food distribution and procurement (e.g., healthy foods and beverages at schools), and food retail (e.g., healthy eating food retail — corner stores and grocery stores). During the behavior over time graphs exercise, the participants generated eleven graphs related to policy or environmental strategies (e.g., mobile market and farm stands) or contexts (e.g., healthy food policy adoption and enforcement) that affected or were affected by the work of *HKHC Buffalo*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

Active Living Policies and Environments (Blue)

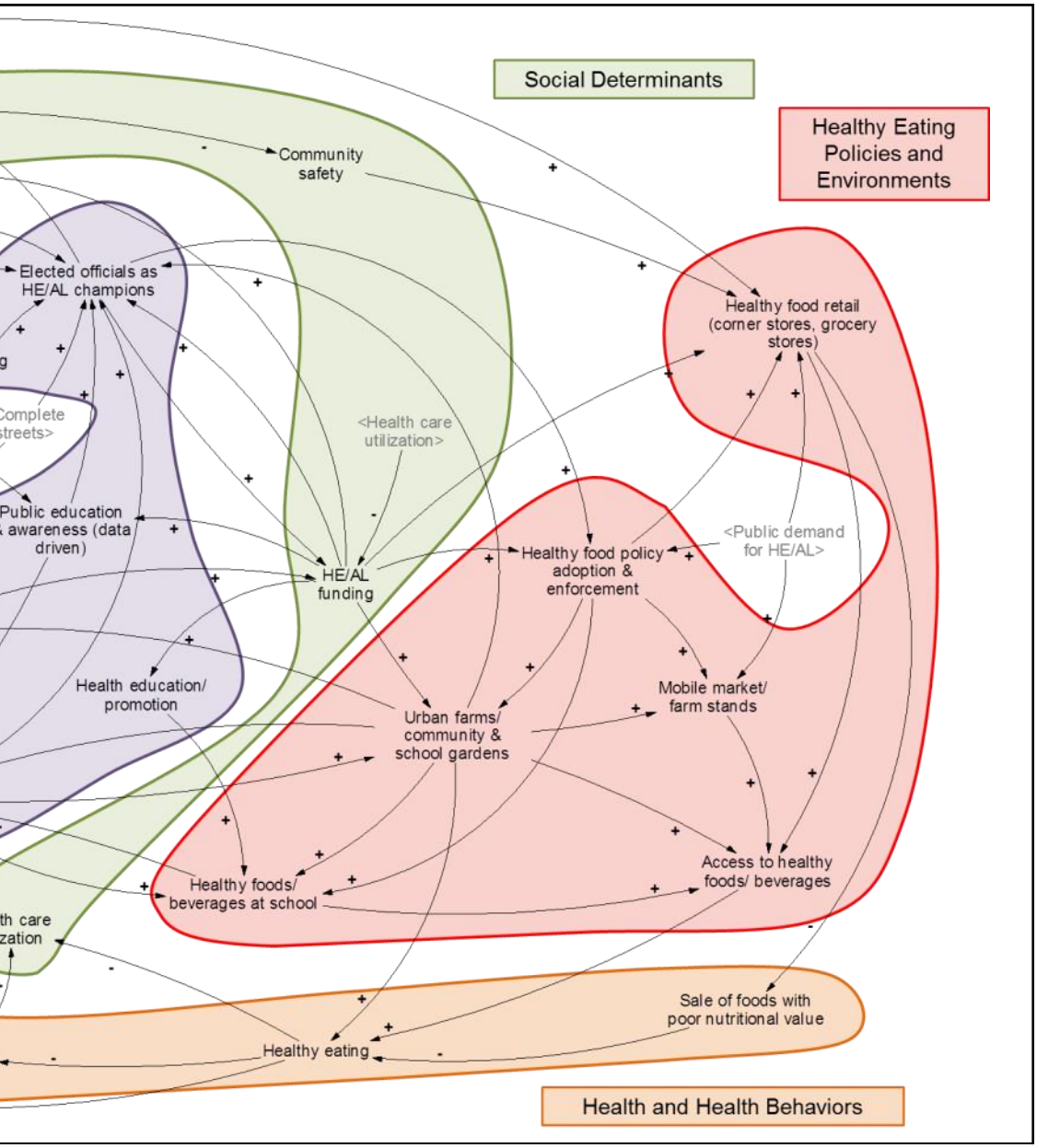
The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed eleven graphs related to policy or environmental strategies (e.g., complete streets, Safe Routes to School) or contexts (e.g., active living policy adoption and enforcement) 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., sale of foods with poor nutritional value).

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, *HKHC Buffalo* has elected officials that serve as healthy eating and active living champions. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as social capital or public demand for healthy eating and active living.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., crime, democracy, health care utilization) and psychosocial influences (e.g., 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 *HKHC Buffalo* partners or by other representatives in Buffalo, New York. 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 community capacity for healthy eating and active living, healthy food retail, and active transportation.

The next sections begin to examine the feedback loops central to the work of *HKHC Buffalo*. 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 Advisors Council Feedback Loop

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

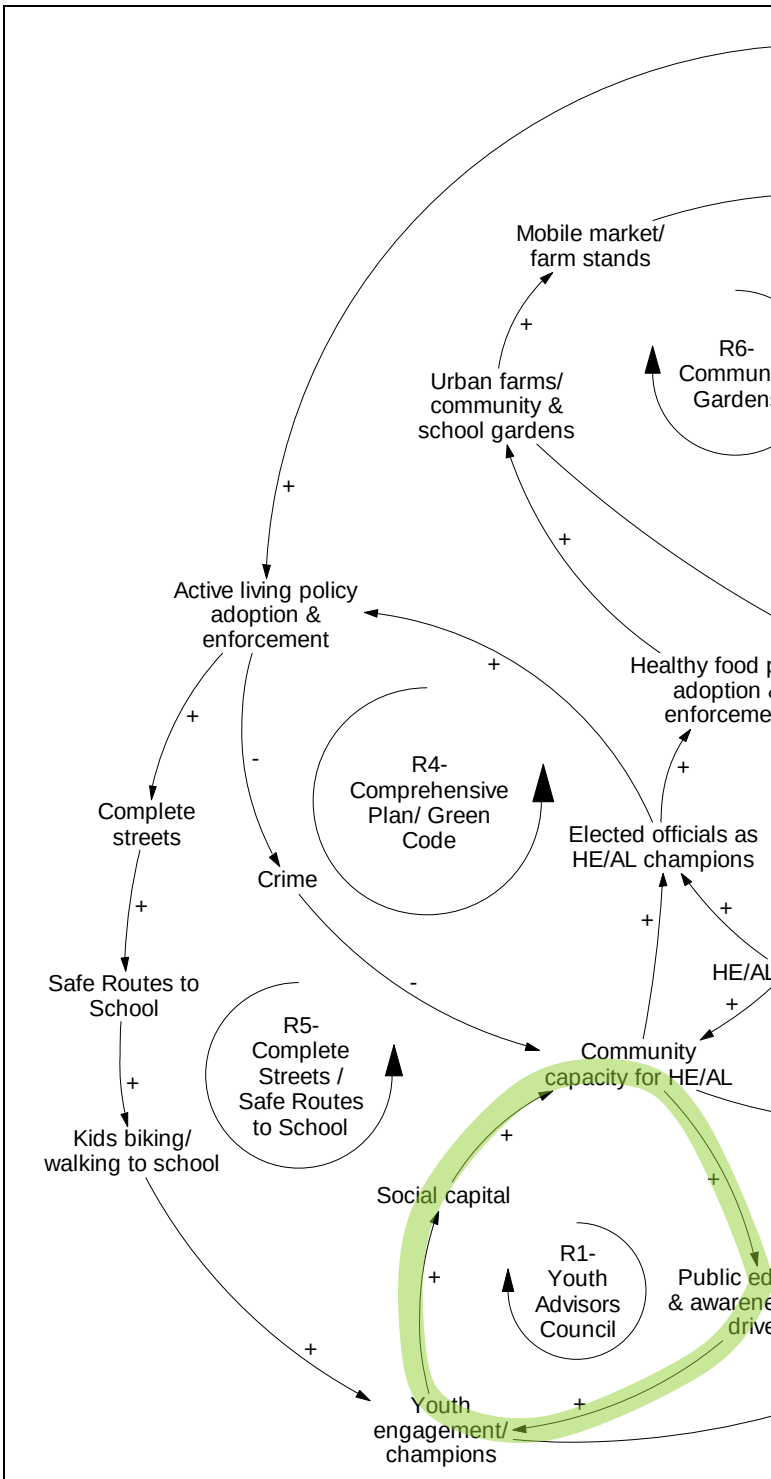


Figure 3: Youth Advisors Council Feedback Loop

Causal Story for Feedback Loop

Story A: In this case , the story is about the Youth Advisors Council (green highlighted loop in Figure 3). Participants described how with more youth engagement and champions, there is an increase in social capital. With more social capital, there is more community capacity for healthy eating and active living. With more capacity for healthy eating and active living, it increases public education and awareness. In turn, with more public education and awareness, there is more youth engagement and champions.

Story B: While the preceding story reflected a positive scenario for Buffalo, New York, the same feedback loop also tells the opposite story. With less youth engagement and champions, there is a decrease in social capital. With more social capital, there is less community capacity for healthy eating and active living. With less capacity for healthy eating and active living, it decreases public education and awareness. In turn, with less public education and awareness, there is less youth engagement and champions.

Reinforcing Loop and Notation

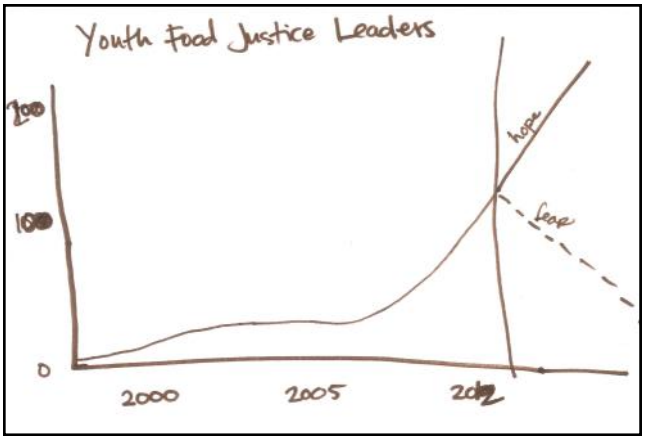
These stories represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing loop (see "R1 — Youth Advisors Council" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above.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

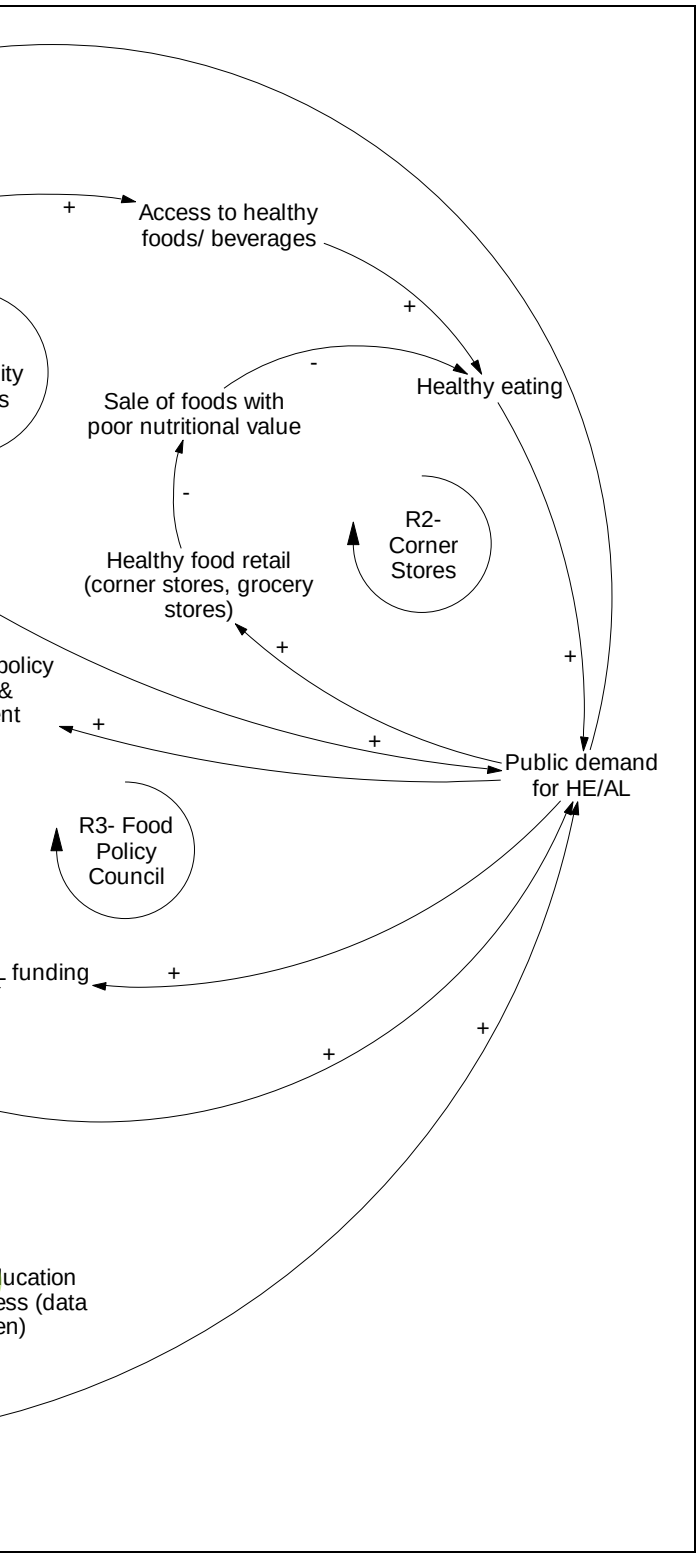
In a reinforcing loop, the effect of an increase or decrease in a variable continues through the cycle and returns an increase or decrease to the same variable, respectively.

Looking specifically at the "+" or "-" notation, a feedback loop that has zero or an even number of "-" signs, or

"When the youth leaders add to community capacity, then they also add to public demand because when young people take it to their peers and also to the families, that's an increase… The increased number of youth leaders increases our social capital." (Participant)

polarities, is considered a reinforcing loop. Balancing loops, with an odd number of "-" signs in the loop, are another type of feedback loop.





In isolation, this reinforcing loop represents a virtuous cycle in Story A as these assets positively support one another, or a vicious cycle in Story B as these challenges perpetuate a downward spiral. Yet, the influence of youth engagement and champions likely levels off at some point when there is saturation with the number of youth involved. To understand what specifically leads to the leveling off of youth engagement and champions, it may be helpful for the partners in Buffalo, New York to consider other variables that influence or are influenced by youth engagement and champions. 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 *HKHC Buffalo*</u>

Participants identified an increase in youth food justice leaders in Buffalo, New York since 2000 to 2012 with the hope that the number of youth food justice leaders will continue to increase into the future (see behavior over time graph top right).

From the systems thinking exercises, several insights can inform future direction and engagement of the youth advisors council, including:

- Strategic partnerships to engage residents and youth in advocacy initiatives stimulate support and funding from city government agencies.
- Non-traditional partners with expertise in community engagement and organizing enhance more traditional advocacy approaches targeting policy– and decision-makers.
- Creating opportunities to increase the cultural competency of agency and organizational staff (e.g., training and technical assistance) and resources to support language justice (e.g., translation and interpretation services) increases engagement of non-traditional partners, including those who do not speak English.

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

- What are some ways to assess empowerment in the community generally and specifically with respect to policy and environmental changes to support healthy eating and active living?

Corner Stores 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 corner stores.

Causal Story for Feedback Loop

Story A: In this case, the story is about corner stores. With more public demand for healthy eating and active living, there is an increase in healthy food retail including corner stores and grocery stores. With more healthy food retail, there is a decrease in the sale of foods with poor nutritional value, which increases healthy eating in the community. In turn, with more healthy eating in the community, the public demand for healthy eating and active living will increase.

Story B: Alternatively, with less public demand for healthy eating and active living, there is a decrease in healthy food retail including corner stores and grocery stores. With less healthy food retail, there is an increase in the sale of foods with poor nutritional value, which decreases healthy eating in the community. In turn, with less healthy eating in the community, the public demand for healthy eating and active living will decrease.

Reinforcing Loop and Notation

Unlike the youth advisors council loop in Figure 3, this loop does have two "-" signs or polarities; because this is an even number, it is still a reinforcing loop (see R2—Corner Stores in Figure 4).

Some of these causal relationships may have more immediate effects (e.g., healthy food retail influence on sale of foods with poor nutritional value) and other relationships may have delayed effects (e.g., the influence of healthy eating on public demand for healthy eating and active living). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

System Insights for *HKHC Buffalo*

In the behavior over time graphs, participants identified ta decrease in the percent of residents with easy access to healthy foods since 1950 with a more recent increase from 2000 to 2012. Participants hope that the percent of residents with easy access to healthy foods will increase into the future (see behavior over time graph on next page top right).

Similarly, participants identified an increase in the number of corner stores that carry healthy options from 2011 to 2012 with the hope that the corner stores offering healthy options will continue to increase into the future (see behavior over time graph next page bottom right).

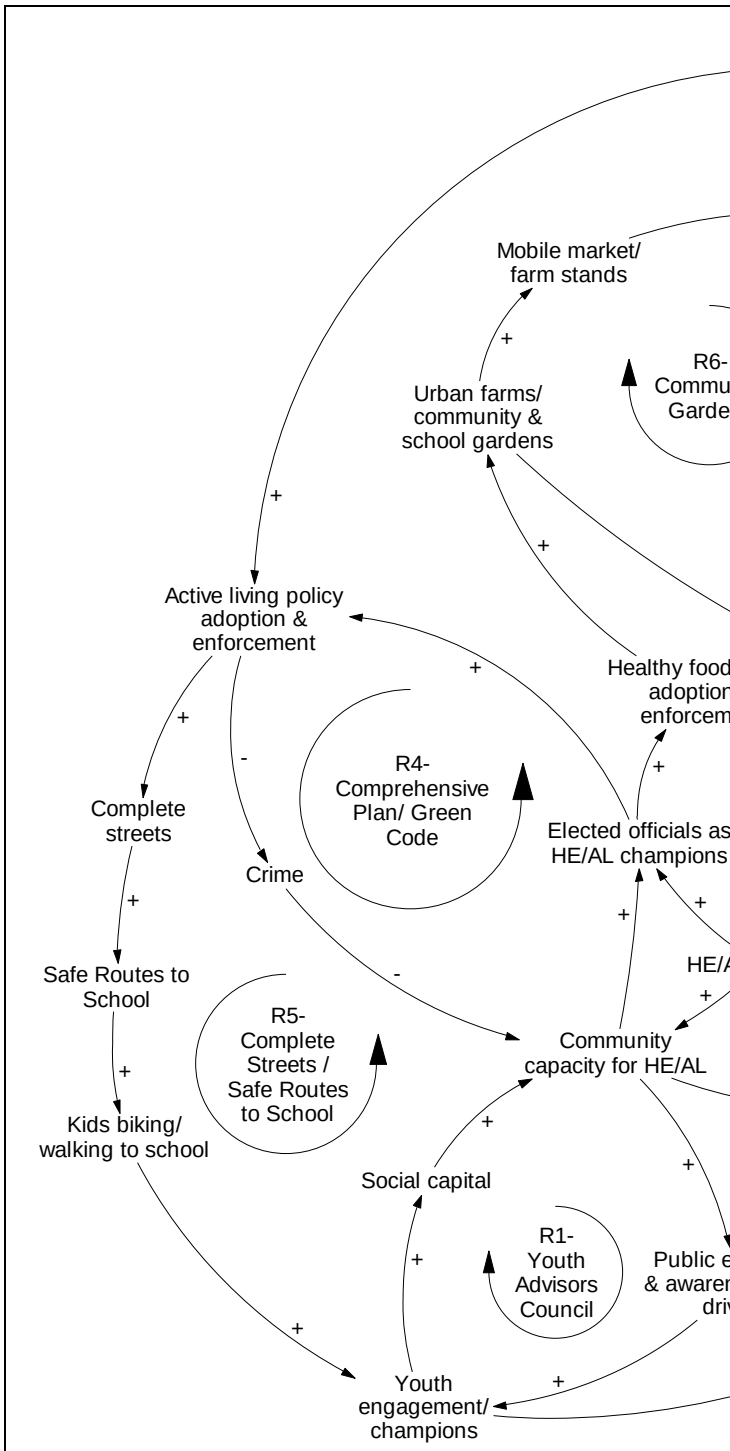
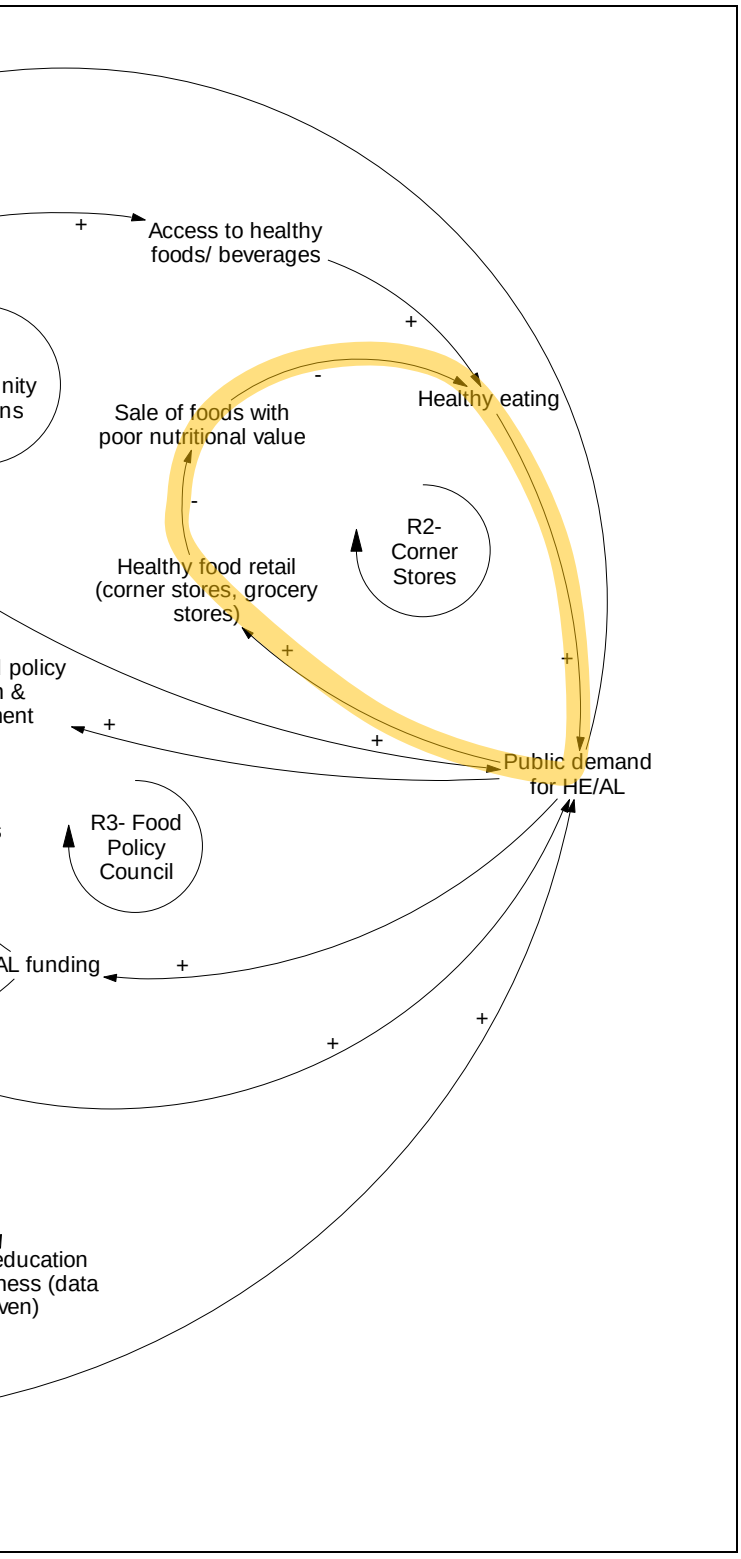
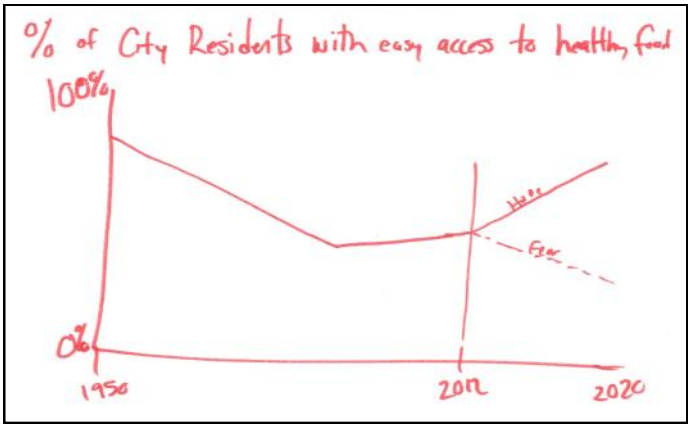


Figure 4: Corner Stores Feedback Loop

"If the corner stores had a reduction in the poor nutritional items that they sold, we might have healthier eating in schools because kids wouldn't buy things on the way to school and then not eat their healthy breakfast that we serve...It's amazing how many kids are in the stores before school—and then recess." (Participants)

System insights can inform the partnership's next steps with corner stores, including:

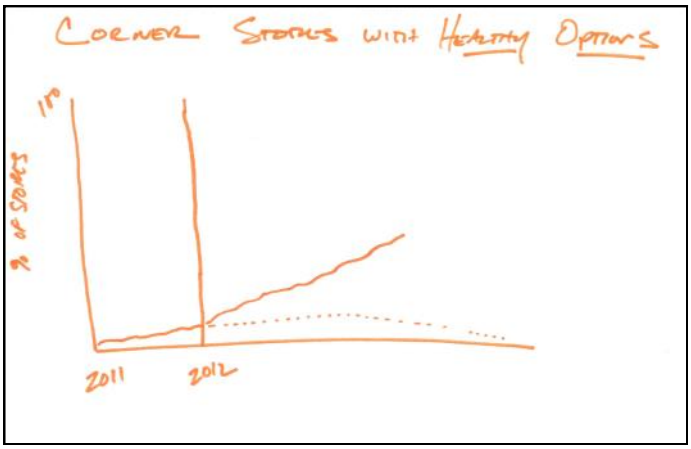




- The slight increase in healthy corner stores may be bolstered by advocacy efforts to increase demand for healthy foods and beverages among residents.
- Greater numbers of healthy corner stores — as well as other healthy food vendors — can lead to a more competitive local market for healthy foods and beverages that may help to drive down costs and increase access.
- Corner stores — similar to fast food restaurants — are perceived to increase access to unhealthy foods and beverages by people in the community; this presents an opportunity to increase the number of healthy corner stores to change residents' perceptions of these food vendors as providers of healthy food and beverage alternatives.

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

- What are the characteristics of a "healthy corner store" (e.g., access to produce, limited access to unhealthy foods and beverages)?
- Does an increase in the number of healthy food vendors increase competition in the local market that drives down the cost of healthy foods and beverages? If so, how?
- 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?



Food Policy Council Feedback Loop

Highlighted in blue in Figure 5, the food policy council feedback loop represents one of the *HKHC Buffalo* strategies to increase healthy eating through Food Policy Councils in Buffalo, New York

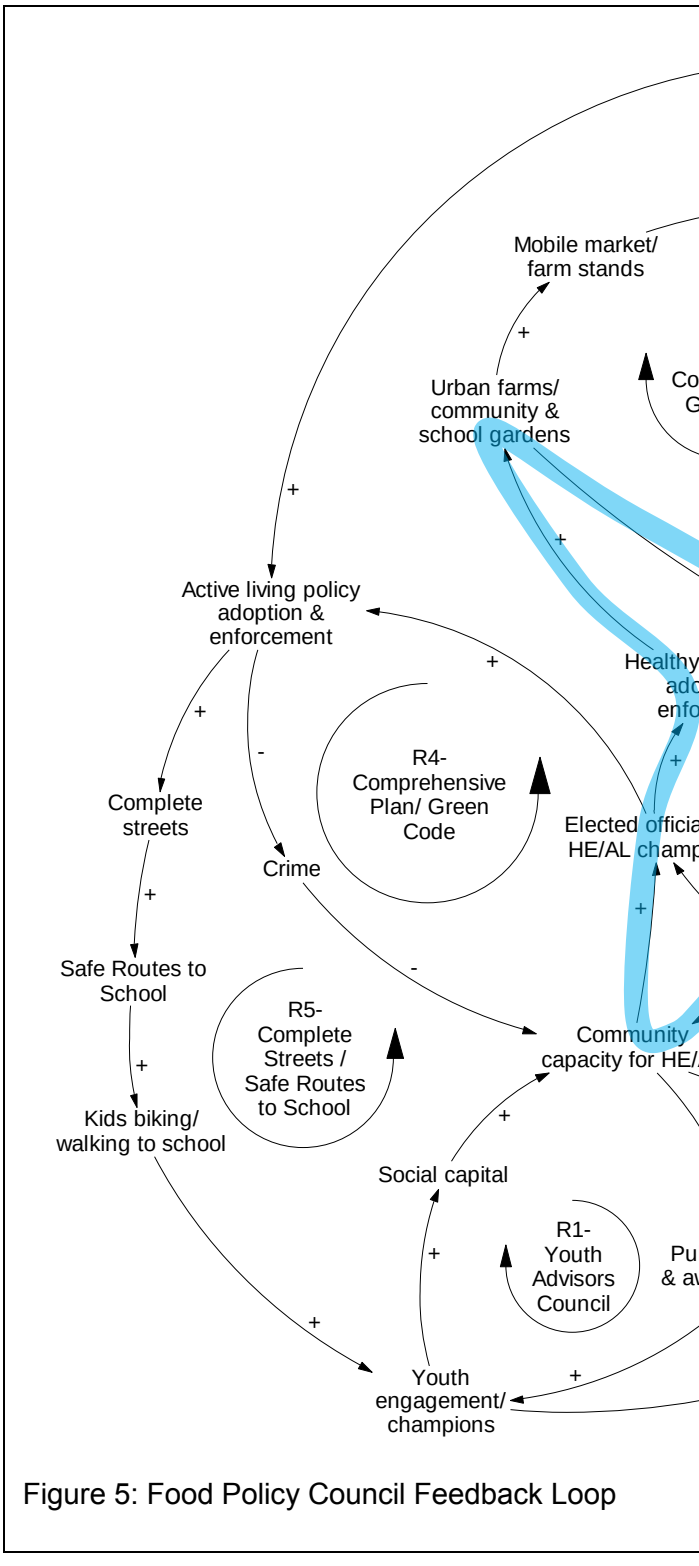


Figure 5: Food Policy Council Feedback Loop

Causal Story for Feedback Loop

Story A: With more public demand for healthy eating and active living, there is an increase in healthy eating and active living funding. As more funding is available, it increases community capacity for healthy eating and active living as funds are available to hold trainings and conferences. With more community capacity for healthy eating and active living (Food Policy Council representatives), it increases elected officials as healthy eating and active living champions. As more elected officials are serving as healthy eating and active living champions (Food Policy Council), there is an increase in healthy food policy adoption and enforcement. With more healthy food policy adoption and enforcement, there is an increase in urban farms/ community and school gardens, and in turn, an increase in the public demand for healthy eating and active living.

Story B: Alternatively, with less public demand for healthy eating and active living, there is a decrease in healthy eating and active living funding. As less funding is available, it decreases community capacity for healthy eating and active living (Food Policy Council representatives). With less community capacity for healthy eating and active living, it decreases elected officials as healthy eating and active living champions (Food Policy Council). As less elected officials are serving as healthy eating and active living champions, there is a decrease in healthy food policy adoption and enforcement. With less healthy food policy adoption and enforcement, there is a decrease in urban farms/ community and school gardens, and in turn, a decrease in the public demand for healthy eating and active living.

Reinforcing Loop and Notation

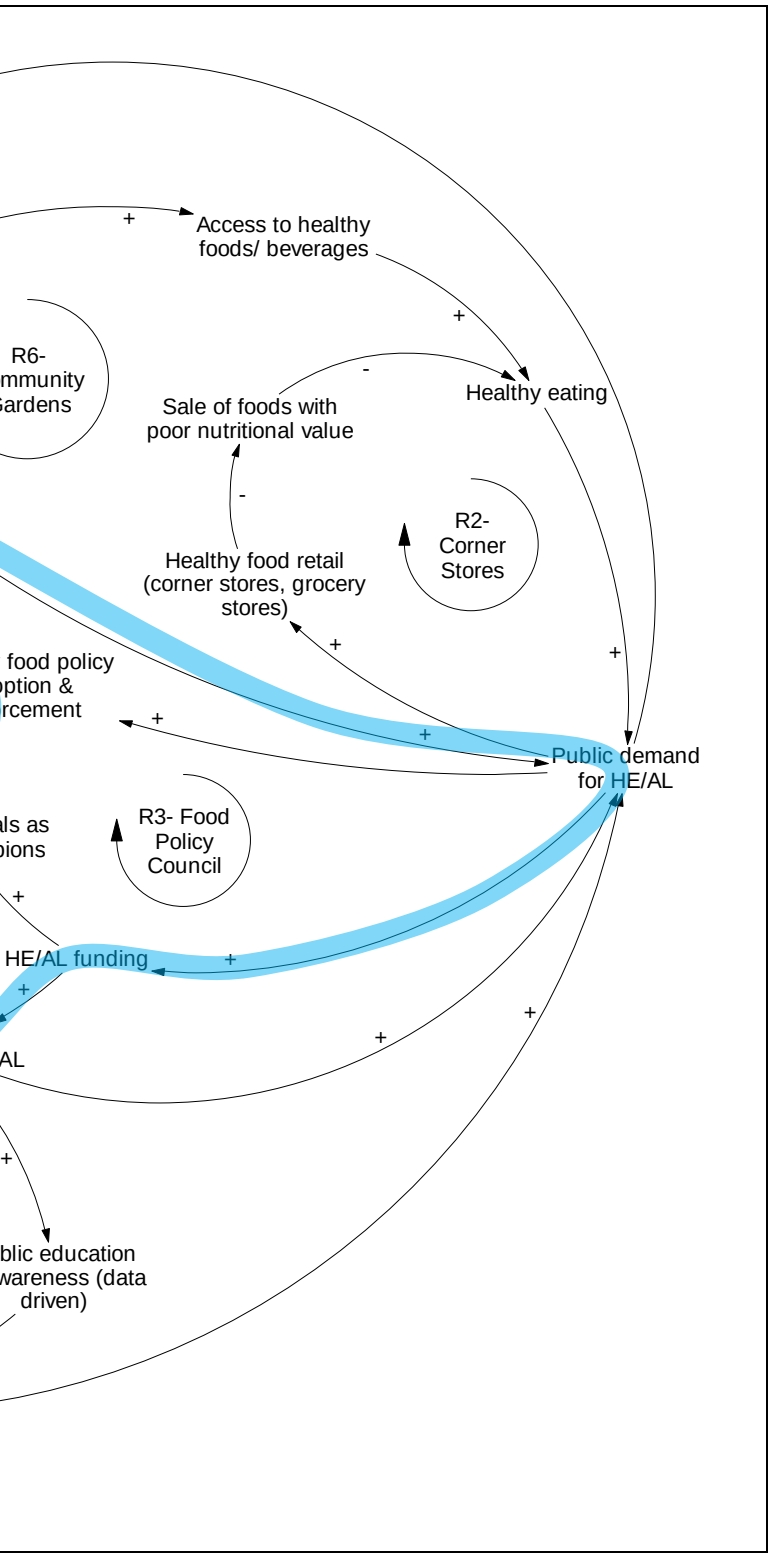
Similar to the previous loops, this one also represents a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., healthy food policy adoption and enforcement), and, potentially, delayed effects (e.g., urban farms/ community and school gardens influence on public demand for healthy eating and active living).

System Insights for *HKHC Buffalo*

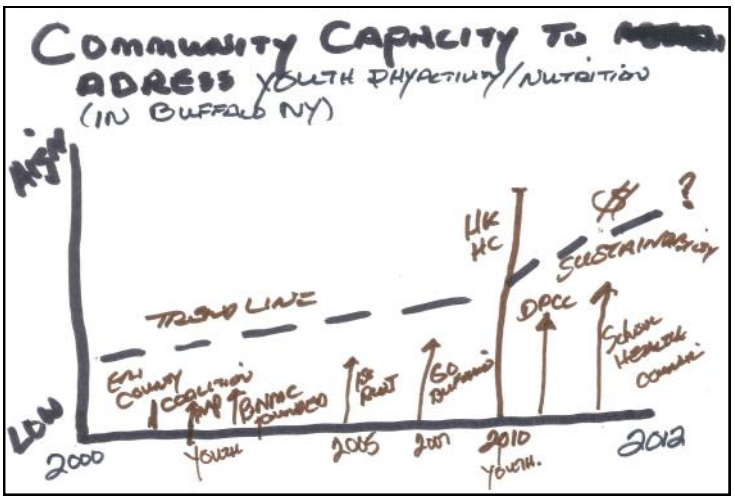
In the behavior over time graphs exercise, participants described an increase in community capacity to address youth

"Thinking specifically around corner stores and access to healthy food within those corner stores, I see a connection between having to increase the number of elected champions because they otherwise could oppose legislation that could change that? Elected champions have actually allowed us to do better now with healthy eating in schools at the state level, local level, but also healthy food retail policies are impacted as well with healthy eating in schools." (Participant)

physical activity and nutrition since 2000 to 2012 with the hope that community capacity will continue to increase into the future (see behavior over time



- What drives community collaboration when funding support is not available?
- What types of partnerships increase resident engagement and participation in advocacy?



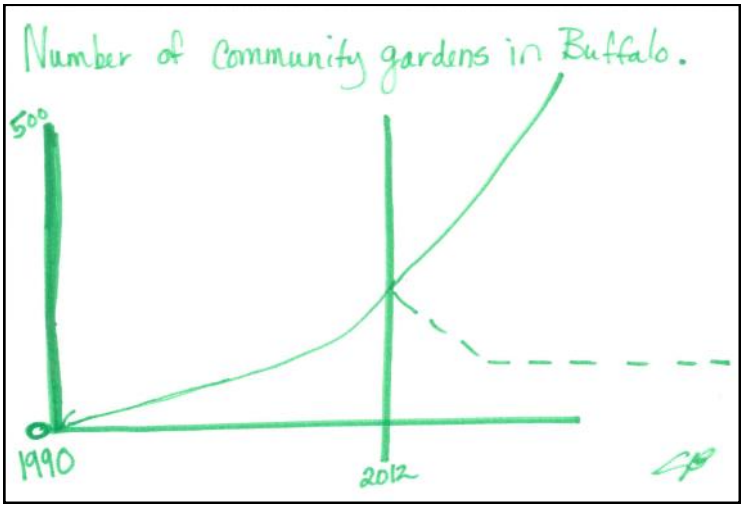
graph at the top right). Participants also identified a an increase in the number of community gardens in Buffalo since 1990 to 2012 with the hope that the number of community gardens will continue to increase into the future (see behavior over time graph bottom right).

System insights for the partnership's access to healthy foods through food policy council efforts include:

- A strategic focus of the food policy council on increasing the number of and/or participation in community and school gardens or small farms has the added benefit of rallying community support for the council.
- 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.

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

- What is the optimal number of school or community gardens or farms for a neighborhood or urban area?



Comprehensive Plan/Green Code Feedback Loop

Highlighted in red in Figure 6, the comprehensive plan/green code feedback loop represents one of the *HKHC Buffalo* strategies to increase active living through comprehensive planning in Buffalo, New York.

Causal Story for Feedback Loop

Story A: With more public demand for healthy eating and active living, there is an increase in healthy eating and active living funding. As more funding is available, it increases elected officials as healthy eating and active living champions. As more elected officials are serving as healthy eating and active living champions, there is an increase in active living policy adoption and enforcement. With more active living policy adoption and enforcement, there is a decrease in crime, which increases community capacity for healthy eating and active living. With more capacity for healthy eating and active living, there is an increase in the public demand for healthy eating and active living.

Story B: Alternatively, with less public demand for healthy eating and active living, there is a decrease in healthy eating and active living funding. As less funding is available, it decreases elected officials as healthy eating and active living champions. As less elected officials are serving as healthy eating and active living champions, there is a decrease in active living policy adoption and enforcement. With less active living policy adoption and enforcement, there is an increase in crime, which decreases community capacity for healthy eating and active living. With less capacity for healthy eating and active living, there is a decrease in the public demand for healthy eating and active living.

Reinforcing Loop and Notation

Similar to the previous loops (see Figure 3-5), this is a reinforcing loop (two "-" signs). In addition, it includes causal relationships representing more immediate effects (e.g., the influence of healthy eating and active living funding on elected officials as healthy eating and active living champions), and, potentially, delayed effects (e.g., crimes influence on community capacity for healthy eating and active living).

System Insights for *HKHC Buffalo*

In the behavior over time graphs exercise, participants described an increase in the available funding for pedestrian and bicycle infrastructure since 1998 to 2012 with the hope that the available funding for pedestrian and bicycle infrastructure will continue to increase into the future (see behavior over time graph on next page top right).

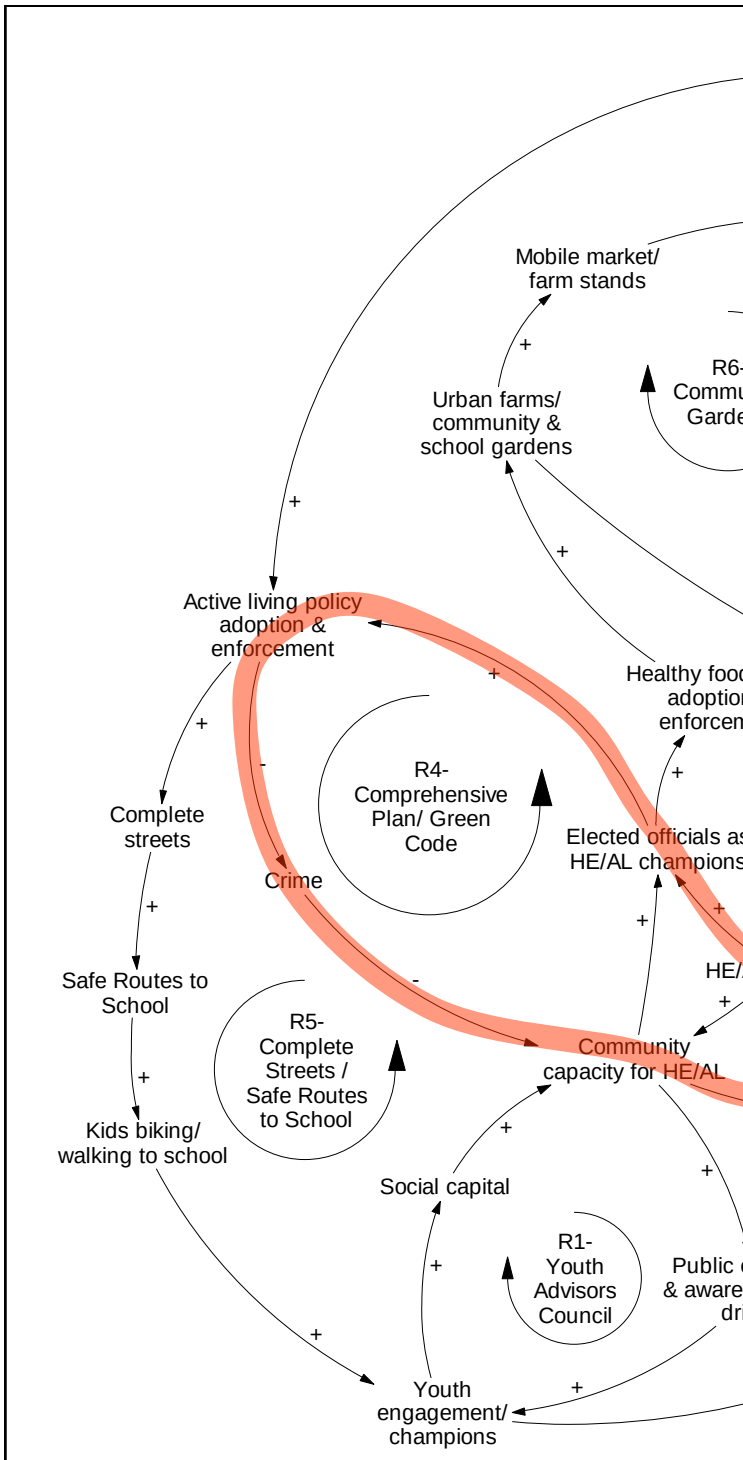
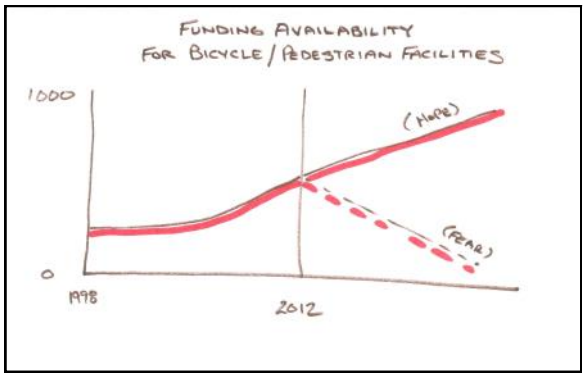


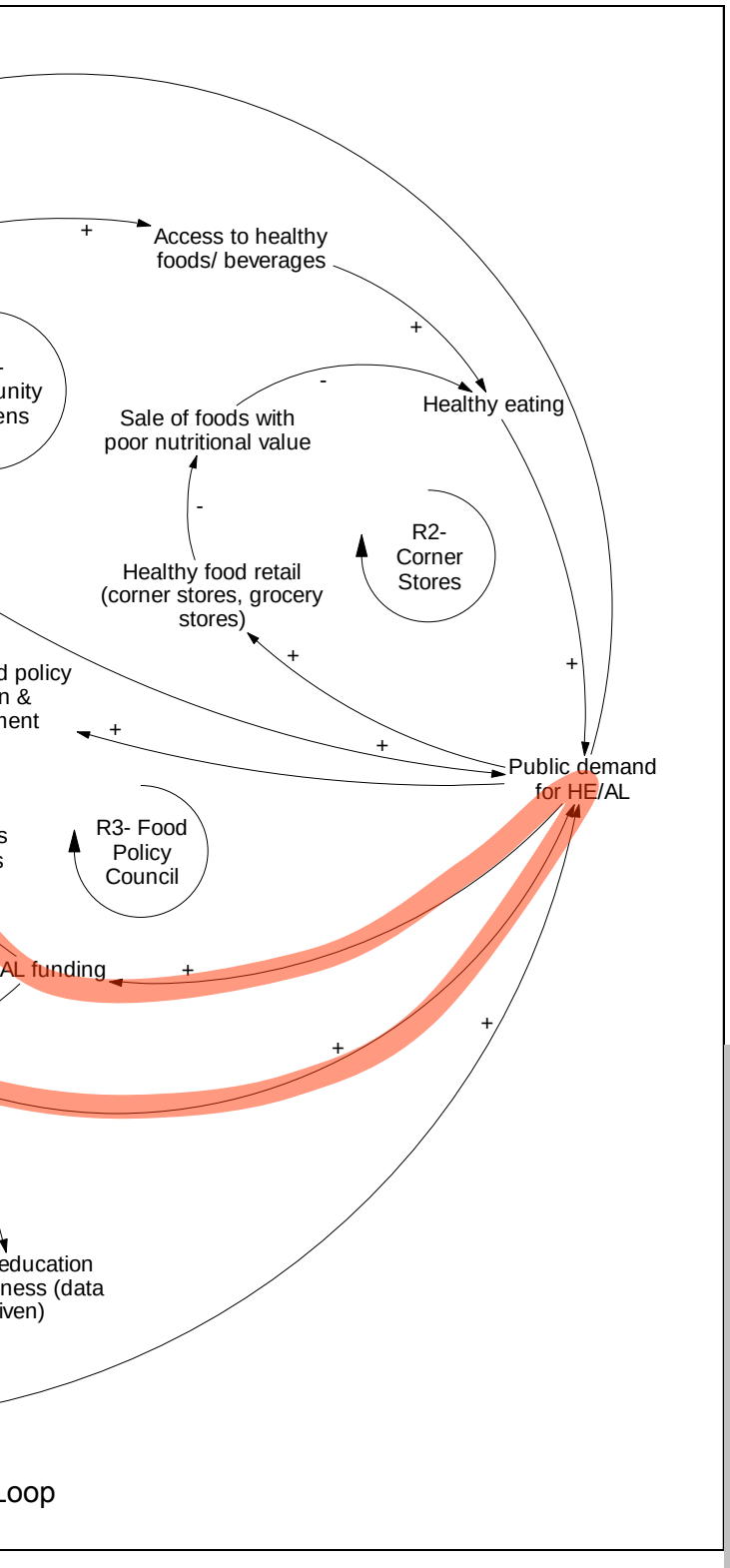
Figure 6: Comprehensive Plan/Green Code Feedback L

System insights for the partnership's comprehensive plan/green code efforts include:

- Increasing perceptions of urban safety plays a major role in maintaining urban density and increasing active transportation.

- Improvements to parks, trails, and recreational facilities increases residents' perceptions of safety in the community, and these perceptions strongly influence parents' decisions to allow their kids to use the facilities for walking and bicycling.





- "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 active living opportunities (pedestrian and bike infrastructure and 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 factors influence neighborhood safety (e.g., rates of crime, violent actions)? Are these the same factors that influence perceptions of neighborhood safety? What are the actual rates of crime and violence as compared to perceptions?
- What is the influence of an increasing number of advocacy initiatives in the community on community knowledge and empowerment?
- What indicators of political will have led to successes in healthy eating, active living, and childhood obesity initiatives in communities?

"When I started, everything was about big parking lots, providing access to them, building intersections bigger, more complicated signal systems—for cars, not for pedestrians—adding [more lanes to the highway]; I can't tell you how many projects I started with looking at a 3-lane highway and determining what we can do to get it to five. Every now and then you'd go to a meeting and there'd be somebody in the back or off to the side that would talk about bikes or pedestrians, and they would kind of get marginalized. Then over the years I've seen them grow in strength and I've seen some of the funding policies starting to be developed to where these people that used to sit in the back have now come forward, and the rest of us that perhaps didn't think they were important [have now] realized the importance." (Participant)

Complete Streets/Safe Routes to School Feedback Loop

Highlighted in yellow in Figure 7, the complete streets/Safe Routes to School feedback loop represents one of the *HKHC Buffalo* strategies to increase active living through complete streets and safe routes to school efforts in Buffalo, New York.

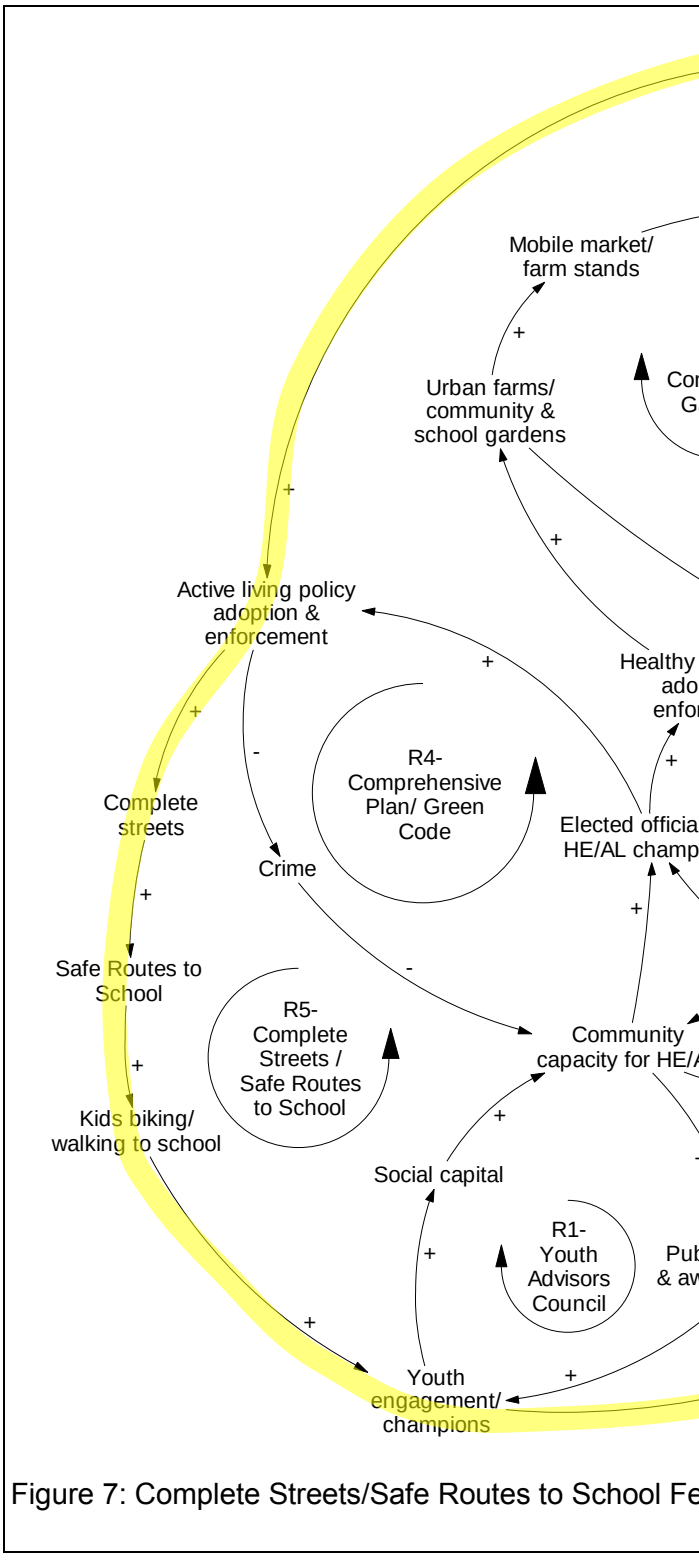


Figure 7: Complete Streets/Safe Routes to School Fe

Causal Story for Feedback Loop

Story A: With more public demand for healthy eating and active living, there is an increase in active living policy adoption and enforcement. With more active living policy and enforcement, there is an increase in complete streets accessible for all modes of transportation. As complete streets increase, there is also an increase in Safe Routes to School, which increases the number of kids biking and walking to school. With more kids biking and walking to school, it increases the youth engaged and champions, and in turn, there is an increase in the public demand for healthy eating and active living.

Story B: Alternatively, with less public demand for healthy eating and active living, there is a decrease in active living policy adoption and enforcement. With less active living policy and enforcement, there is a decrease in complete streets accessible for all modes of transportation. As complete streets decrease, there is also a decrease in Safe Routes to School, which decreases the number of kids biking and walking to school. With less kids biking and walking to school, it decreases the youth engaged and champions, and in turn, there is a decrease in the public demand for healthy eating and active living.

Reinforcing Loop and Notation

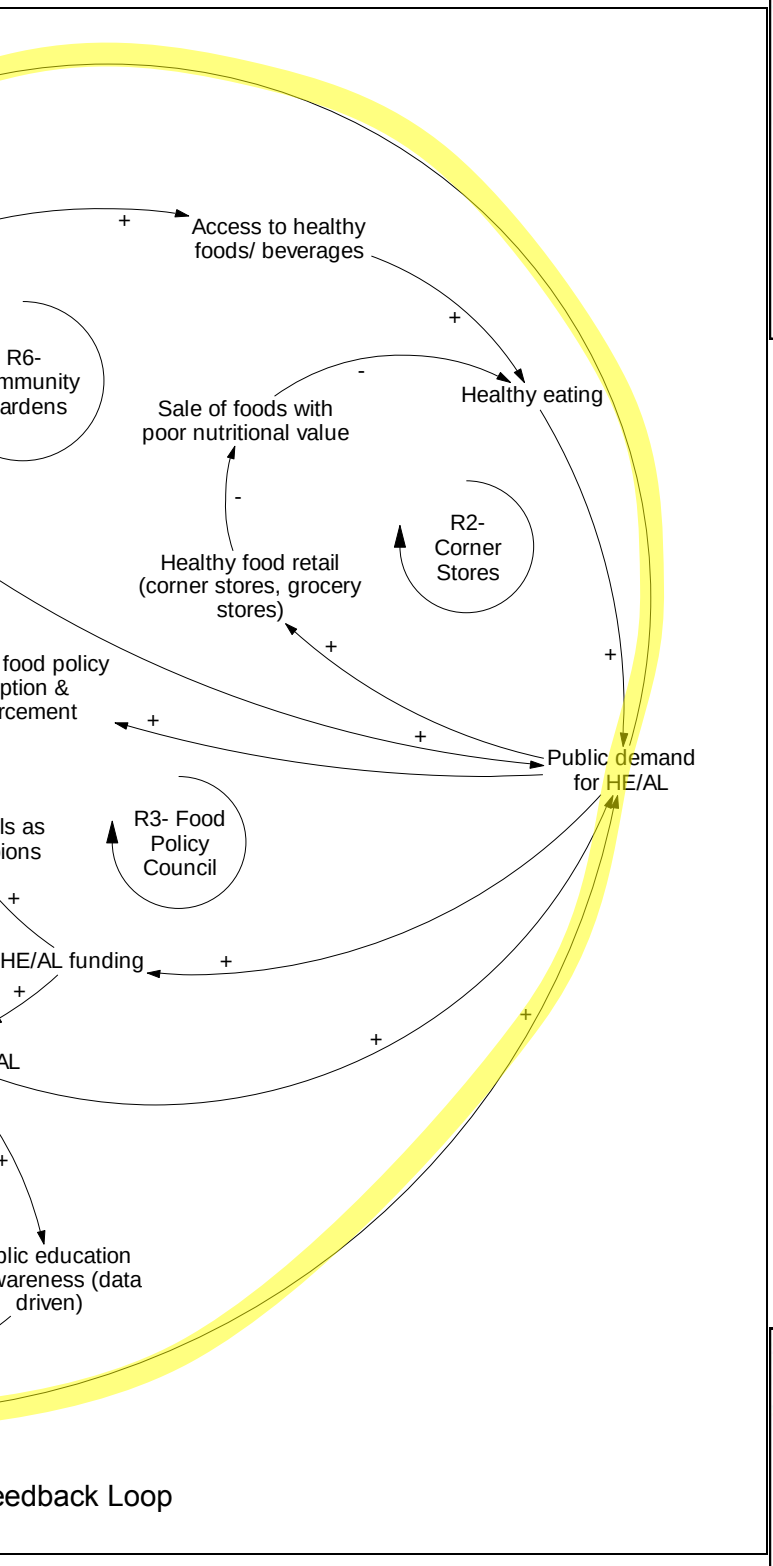
Similar to the previous loops (see Figure 3-6), this is a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., Safe Routes to School's influence on kids biking and walking to school), and, potentially, delayed effects (e.g., the influence of public demand for healthy eating and active living on active living policy adoption and enforcement).

System Insights for *HKHC Buffalo*

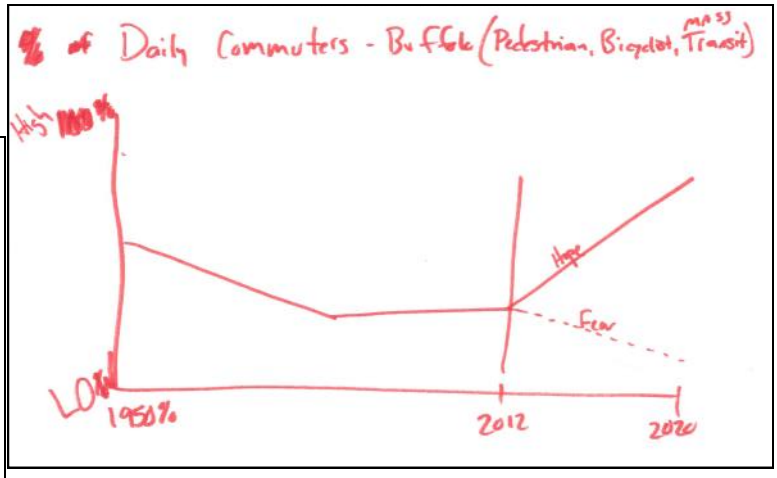
In the behavior over time graphs exercise, participants described a decrease in the number of daily commuters through active transportation methods (bike, walking, transit) from 1950 to 2000 and a more recent increase in the number of daily commuters through active transportation methods from 2000 to 2012. In the future, participants hope this increase will continue and more individuals will commute through active transportation methods (see behavior over time graph on the next page top right). Additionally, participants also described an increase in the number of kids biking to school since 1950 to 2012 with the hope that the number of kids biking to school will continue to increase into the future (see behavior over time graph on next page bottom right).

"If we had better, safer routes to school, then we would have better opportunity for kids biking to school." (Participant)

System insights for the partnership's complete streets/Safe Routes to School efforts include:



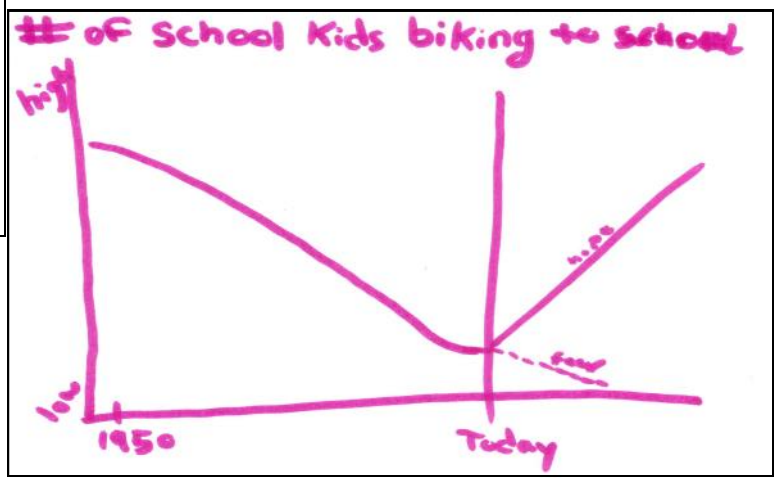
eedback Loop



- 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.
- 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.
- Students gain social benefits from interacting with other students, parents, school staff, or neighbors while walking and biking to school.

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)?



Community Gardens Feedback Loop

Highlighted in purple in Figure 8, the community gardens feedback loop represents one of the *HKHC Buffalo* strategies to increase healthy eating in Buffalo, New York.

Causal Story for Feedback Loop

Story A: With more public demand for healthy eating and active living, there is an increase in healthy food policy adoption and enforcement. With more healthy food policy adoption and enforcement, there is an increase in urban farms/ community and school gardens, which increases mobile markets and farm stands. With more mobile market and farm stands, there is more access to healthy foods and beverages, which increases healthy eating. In turn, with more healthy eating, there is an increase in public demand for healthy eating and active living.

Story B: Alternatively, with less public demand for healthy eating and active living, there is a decrease in healthy food policy adoption and enforcement. With less healthy food policy adoption and enforcement, there is a decrease in urban farms/ community and school gardens, which decreases mobile markets and farm stands. With less mobile market and farm stands, there is less access to healthy foods and beverages, which decreases healthy eating. In turn, with less healthy eating, there is a decrease in public demand for healthy eating and active living.

Reinforcing Loop and Notation

Similar to the previous loops (see Figure 3-7), this is a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., access to healthy foods and beverages influence on healthy eating), and, potentially, delayed effects (e.g., the influence of public demand for healthy eating and active living on healthy food policy adoption and enforcement).

System Insights for *HKHC Buffalo*

In the behavior over time graphs exercise, participants described an increase in customers at mobile markets and farm stands from 2005 to 2012 with the hope that customers at mobile markets and farm stands will continue to increase into the future (see behavior over time graph next page top right). Similarly, participants described an increase in the number of school-based community gardens from 1990 to 2012 with the hope that the number of gardens will continue to increase into the future (see behavior over time graph next page

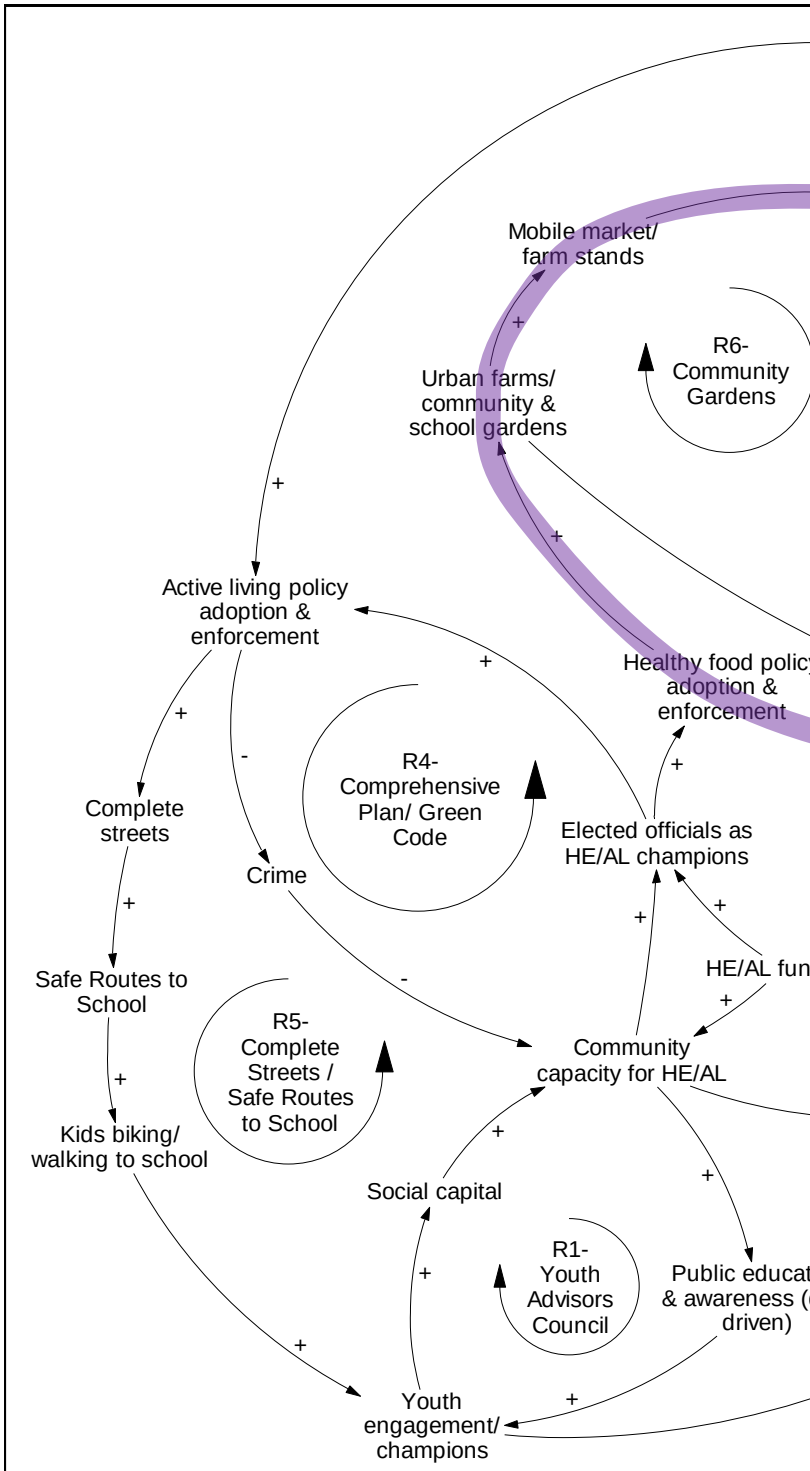
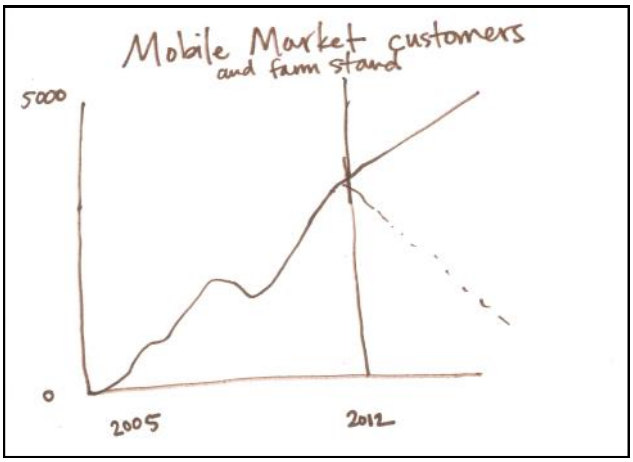


Figure 8: Community Gardens Feedback Loop

"If we had better community gardens/school gardens, we could have healthier eating in schools, because if we get funding, we can support healthy education, health education for nutrition, and also…I hate to say everything is about funding, but it brings me to the kids biking to school to the healthy funding." (Participant)

bottom right).

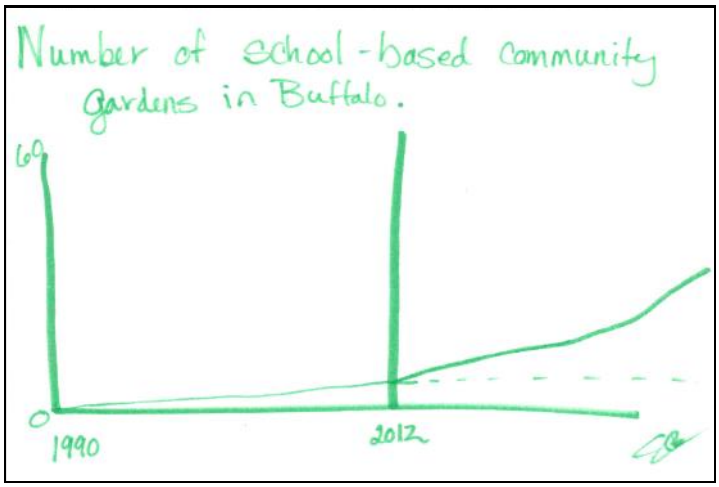
System insights for the partnership's community gardens efforts include:



- Urban gardens and farms increase neighborhood revitalization and food retail opportunities and limit or reverse suburban sprawl as residents feel less vulnerable to crime or violence in urban areas; by drawing residents back into more dense, urban neighborhoods, the gardens and farms minimize geographic isolation in suburban dwellings.
- Farmers' markets have the benefit of increasing a sense of community.
- Teaching youth to prepare meals and snacks with fresh fruits and vegetables and planting fruits and vegetables gives them opportunities to inform and educate their families and friends about the benefits of healthy eating in order to generate greater collaboration and support in the community.

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

- What factors lead to an increase in demand for healthy foods and beverages in communities?
- What is the potential for local food production given the vacant urban lots available for agriculture? What development patterns will sustain the ability to meet these food production requirements into the future?
- Does participation in gardens or farms predict social outcomes (e.g., perceptions of neighborhood safety, civic engagement)?



Opportunities for Systems Thinking in Buffalo, New York

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

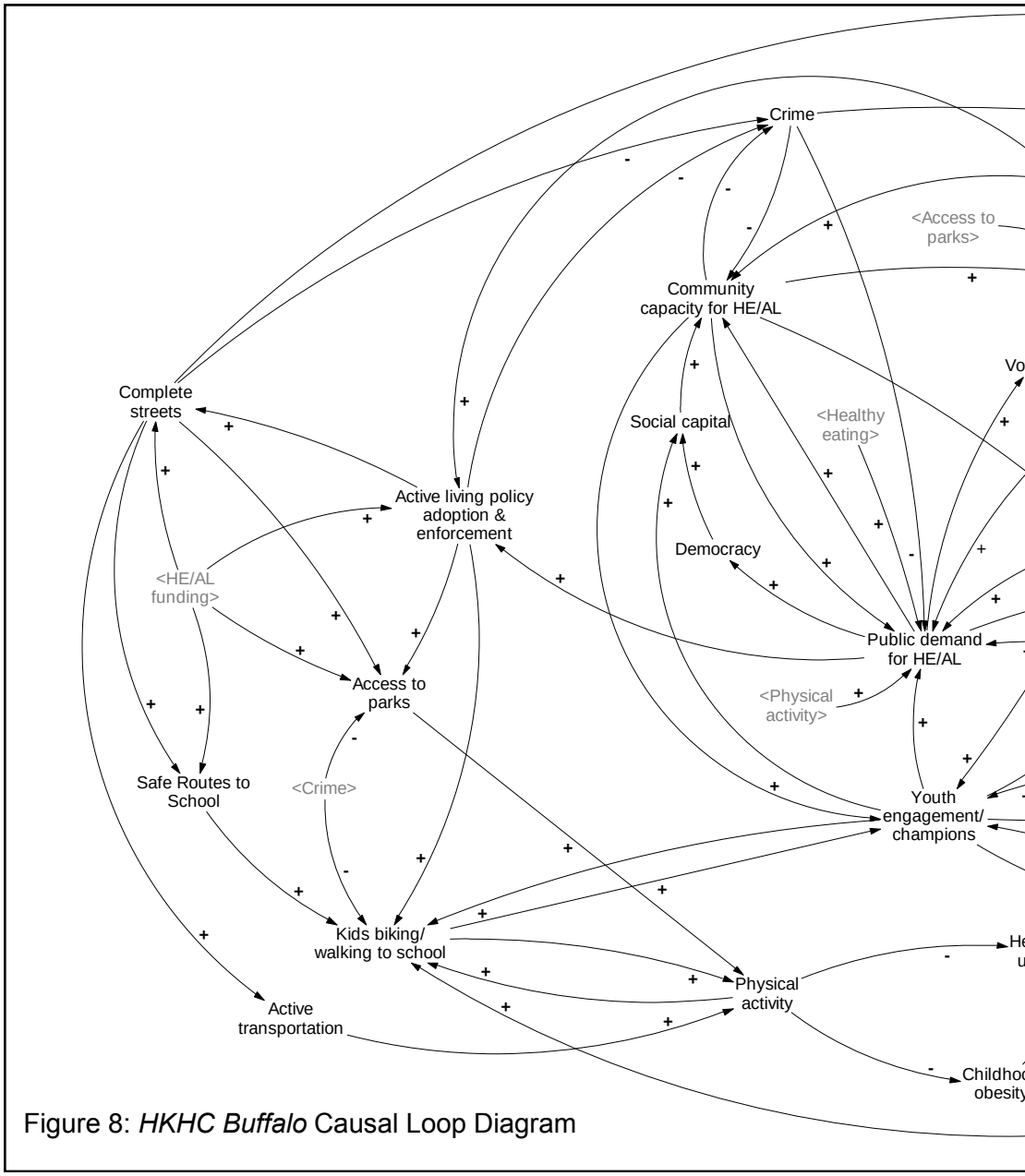


Figure 8: *HKHC Buffalo* Causal Loop Diagram

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

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

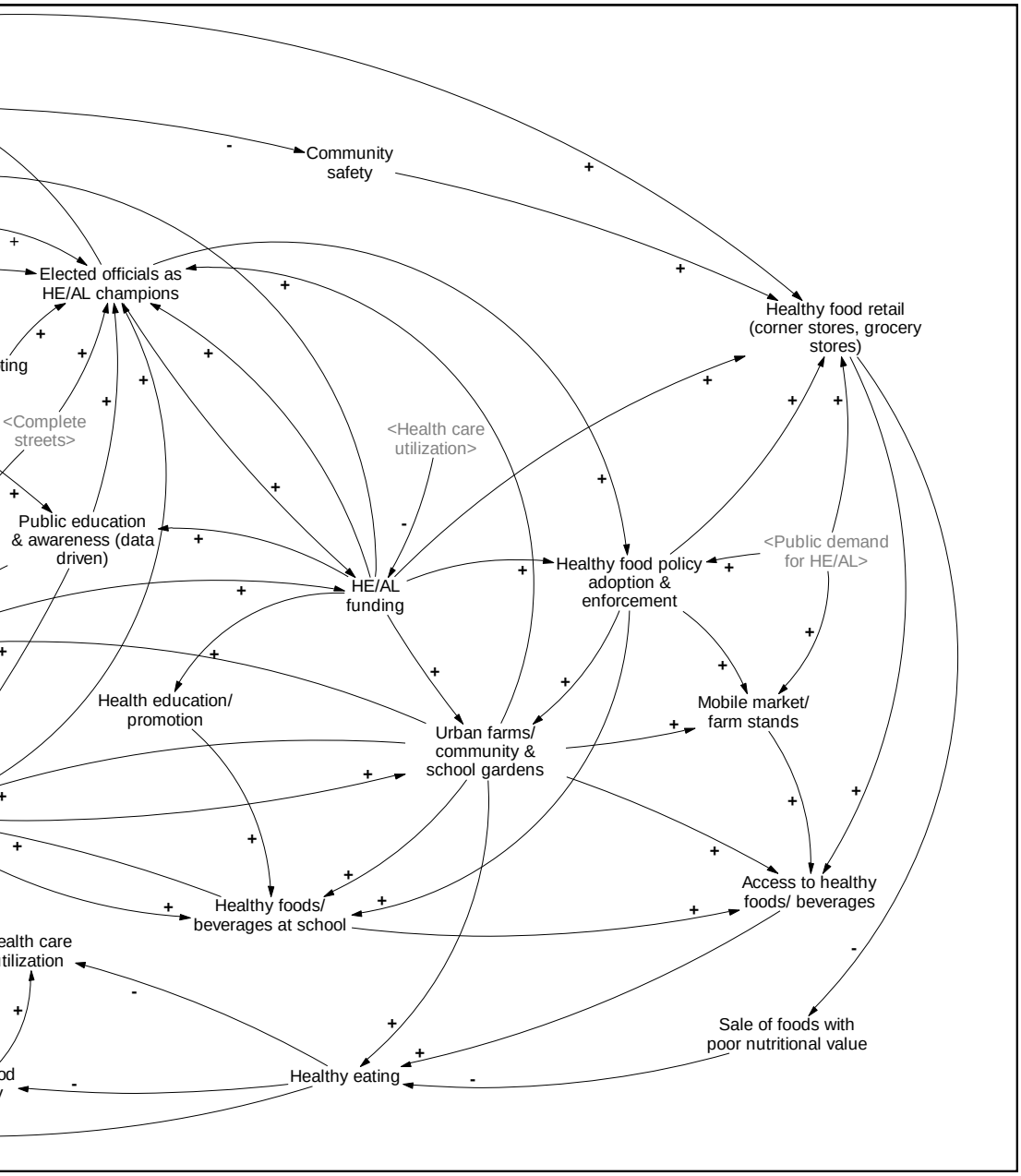
Yet, there are several limitations to this storybook, including:

- the participants represent a sample of the *HKHC Buffalo* 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 busing kids to school, quality of street environment, academic curriculum & testing, technology & social media, economy, auto-oriented design, school PE & recess, employment, abandoned buildings; 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 Buffalo 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 *HKHC Buffalo* 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/

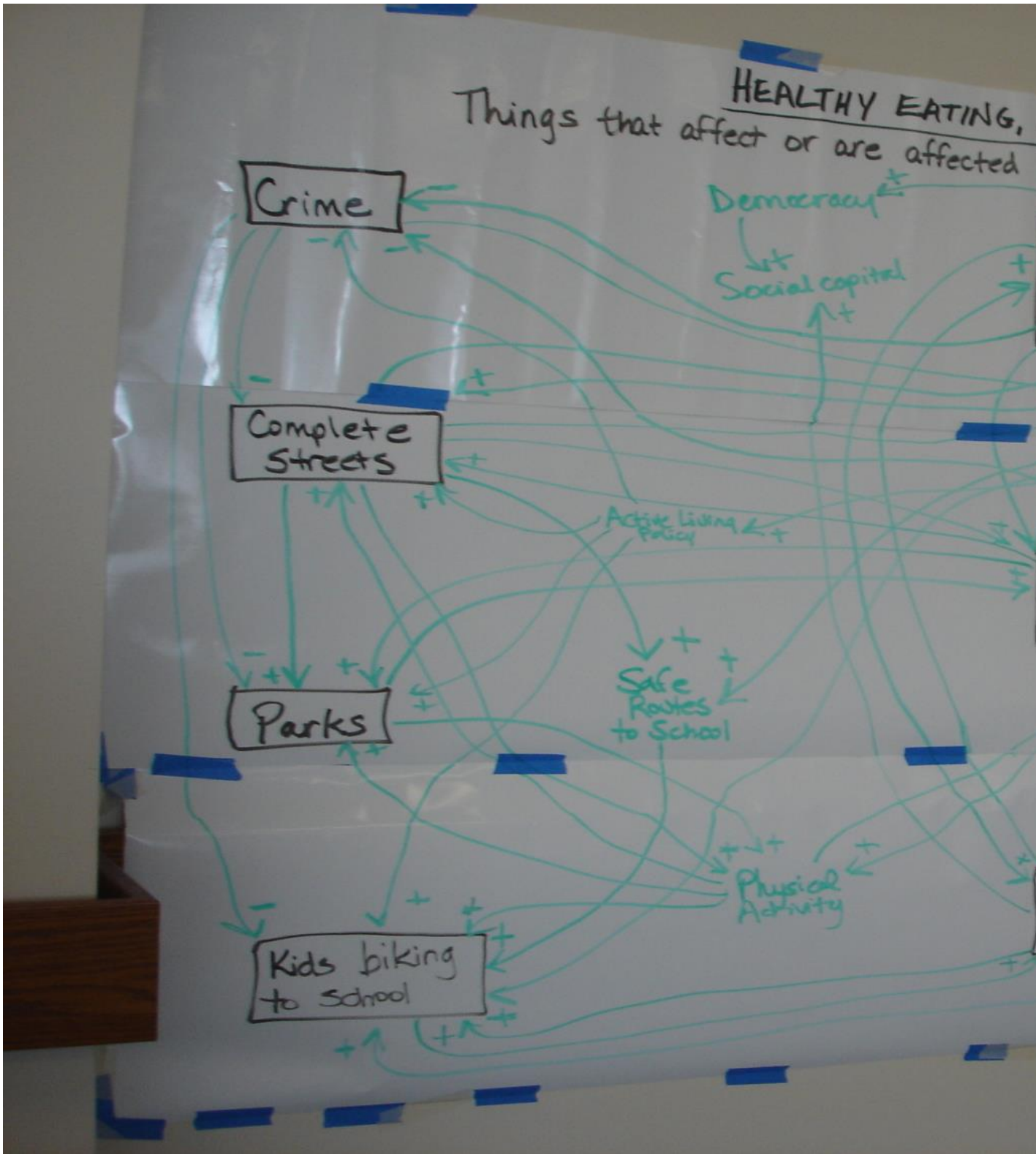
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

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

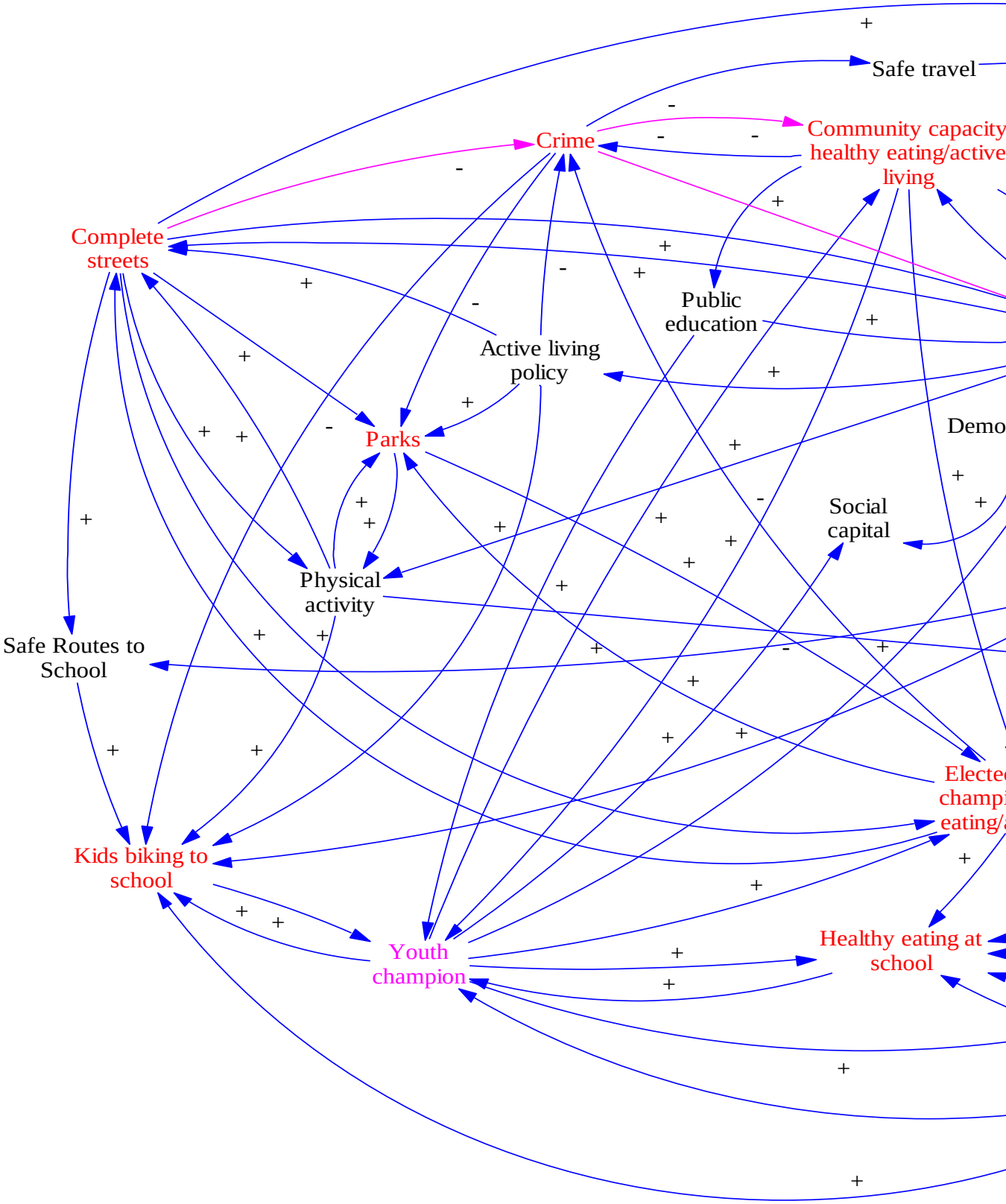
Buffalo, New York: *Healthy Kids, Healthy Communities Buffalo*	
Categories	**Number of Graphs**
Active Living Behavior	3
Active Living Environments	8
Funding	2
Healthy Eating Behavior	0
Healthy Eating Environments	11
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	1
Partnership & Community Capacity	6
Policies	4
Programs & Promotions (Education and Awareness)	2
Social Determinants of Health	2
Total Graphs	**39**

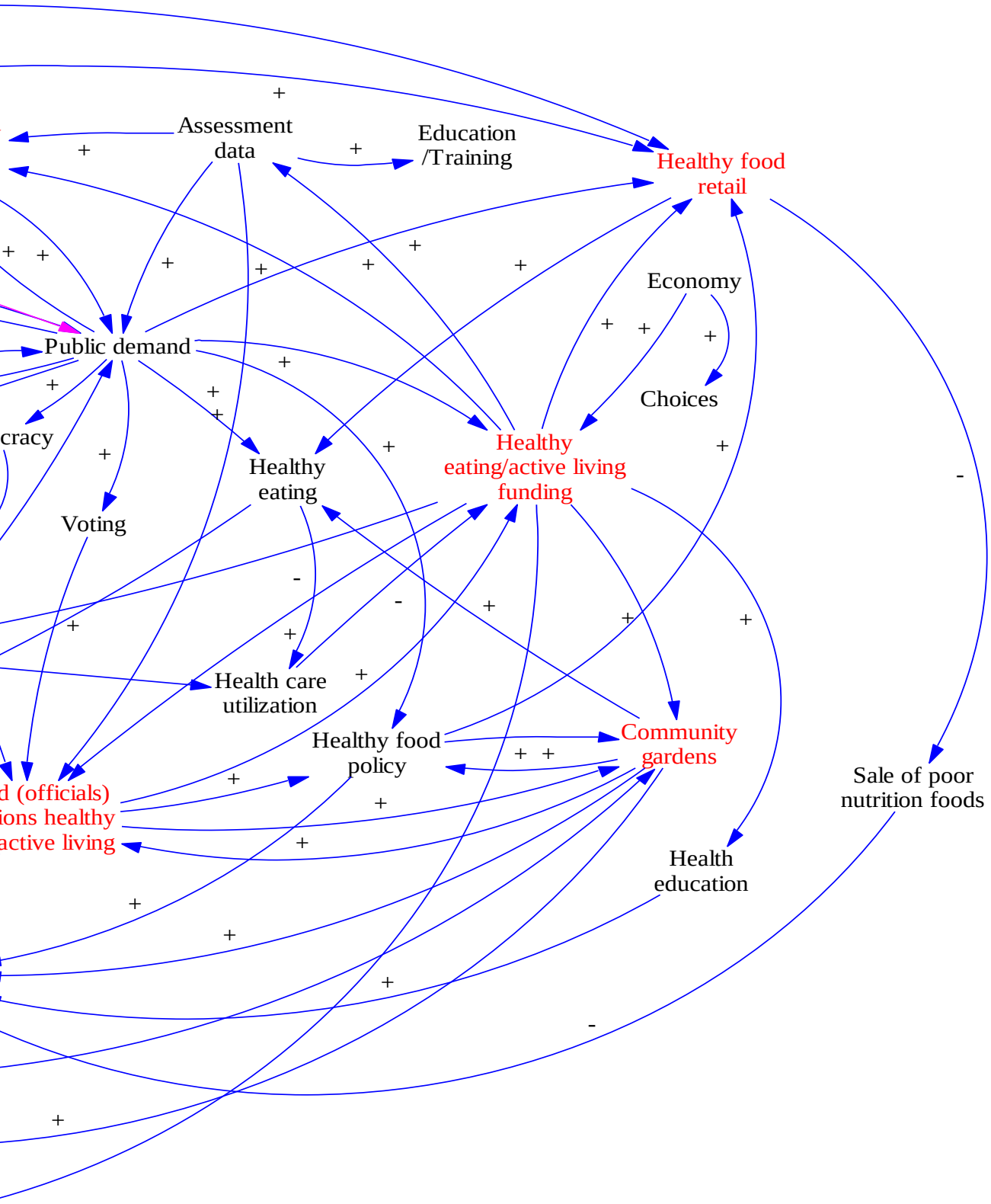
Appendix B: Photograph of the Original Version of the *HKHC Buffalo* Causal Loop Diagram



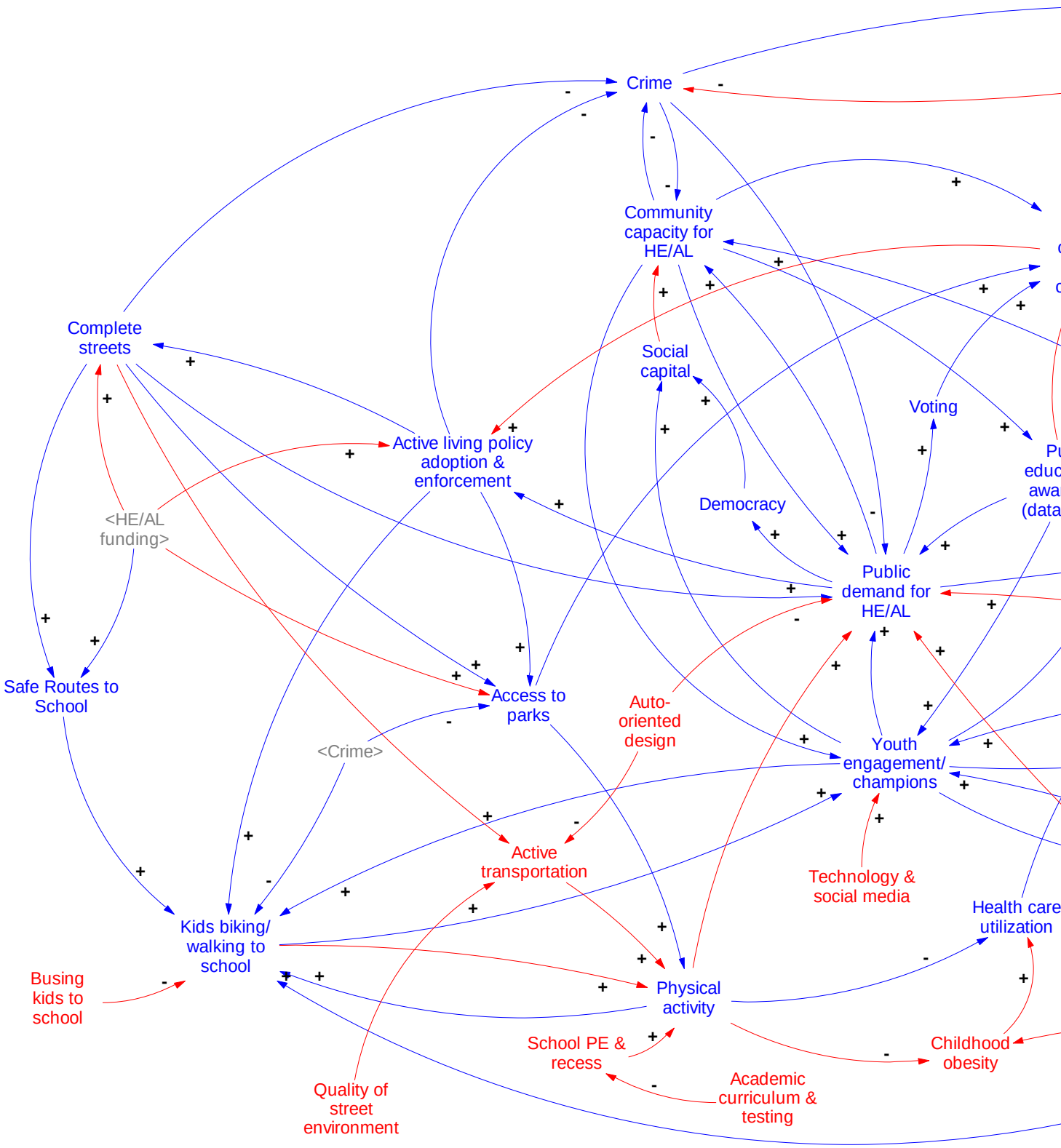

ACTIVE LIVING, & CHILDHOOD OBESITY
by policy, system, and environmental changes in your community...
Community Capacity HE/AL
Public Demand
HE/AL Funding
Public Education
Safe travel
Voting
Education/Training
Healthy Food policy
Elected Champions HE/AL
Community Gardens
Healthy Eating
Youth food justice leaders
Healthy eating at school

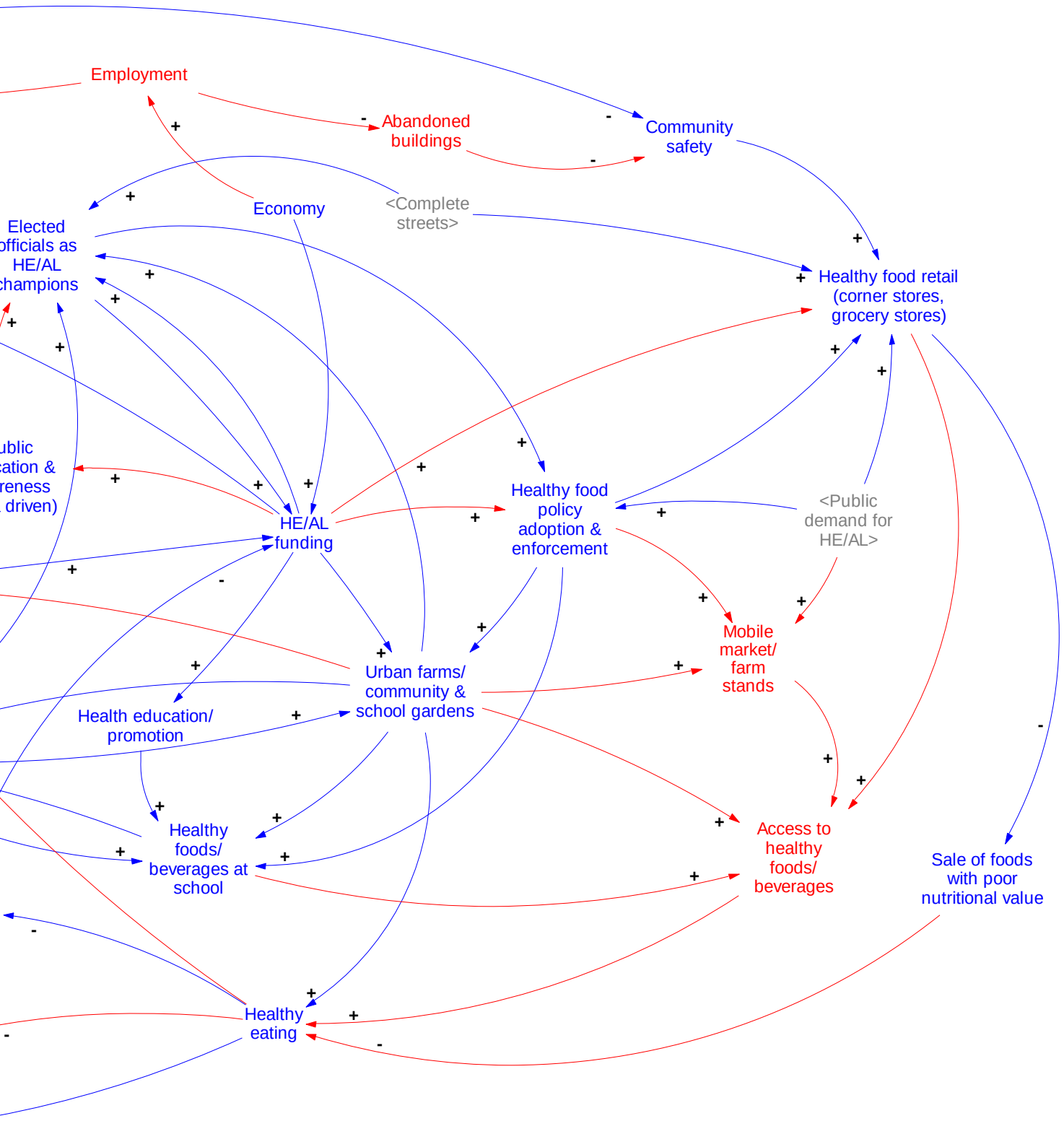
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



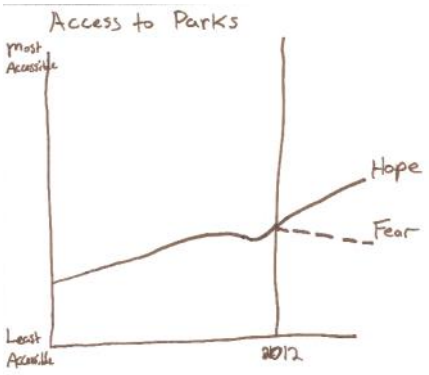

Assessment data
Education /Training
Healthy food retail
Economy
Public demand
Choices
cracy
Healthy eating
Healthy eating/active living funding
Voting
Health care utilization
Healthy food policy
Community gardens
d (officials)
ions healthy
active living
Sale of poor nutrition foods
Health education

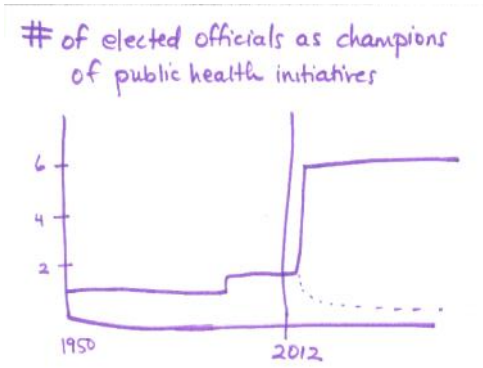
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

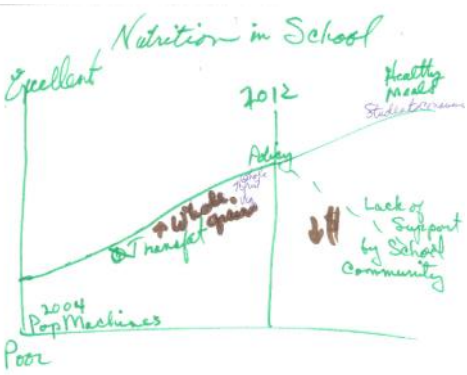


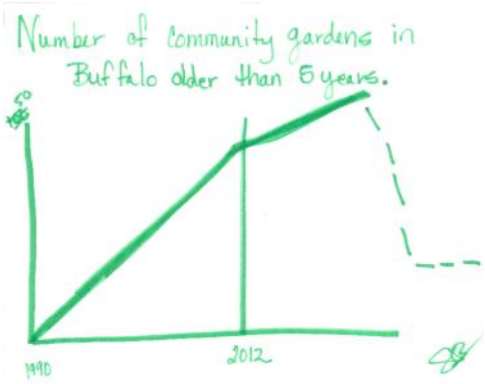

Employment
Abandoned buildings
Community safety
Economy
<Complete streets>
Elected officials as HE/AL champions
Healthy food retail (corner stores, grocery stores)
ublic cation & reness driven)
HE/AL funding
Healthy food policy adoption & enforcement
<Public demand for HE/AL>
Mobile market/ farm stands
Urban farms/ community & school gardens
Health education/ promotion
Healthy foods/ beverages at school
Access to healthy foods/ beverages
Sale of foods with poor nutritional value
Healthy eating

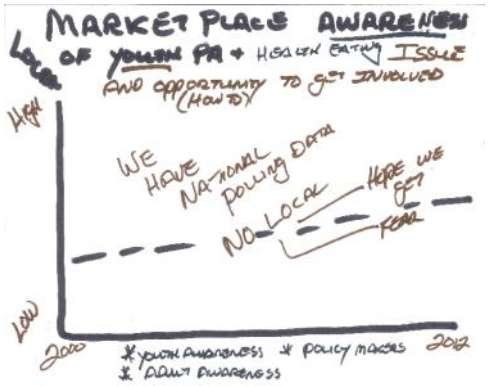
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

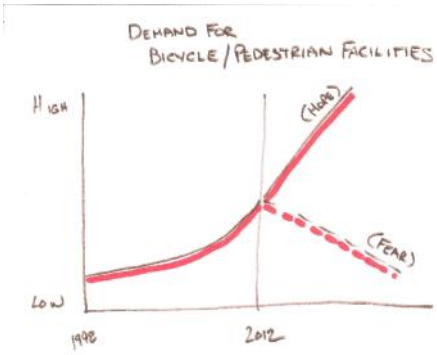


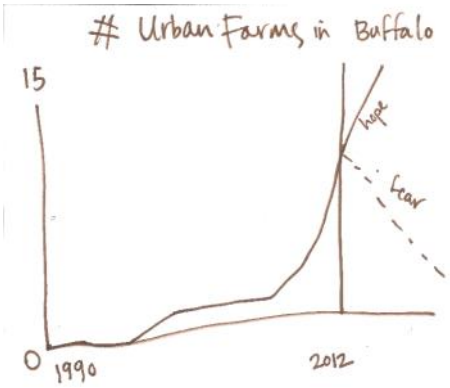


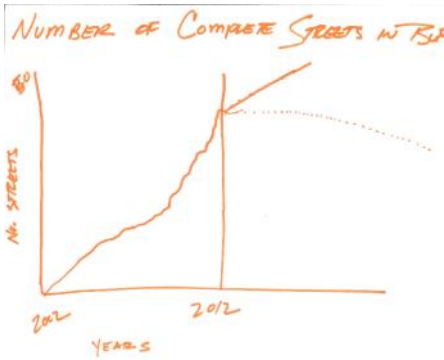


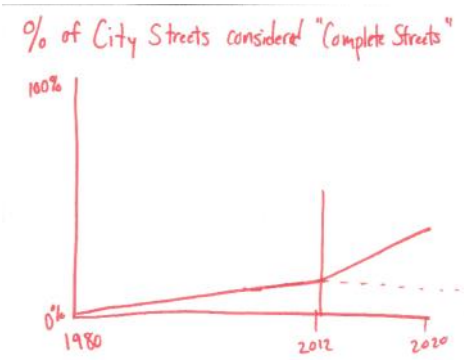


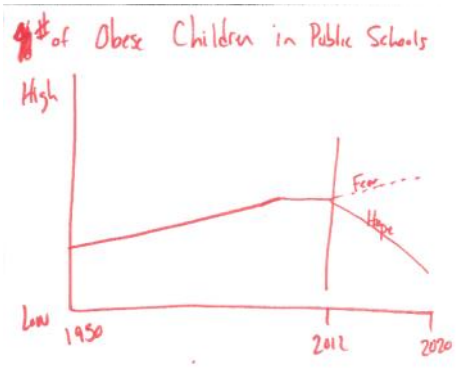


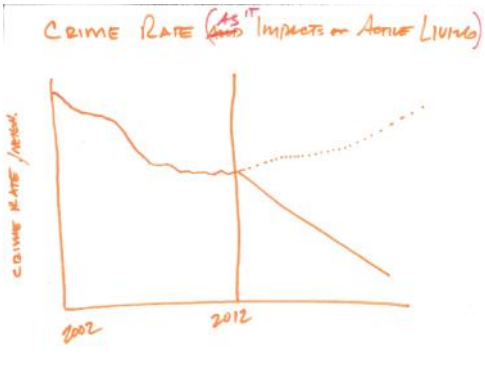


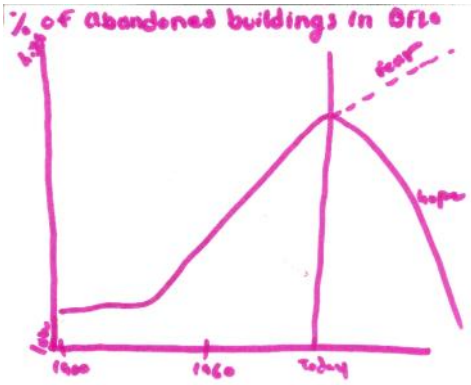


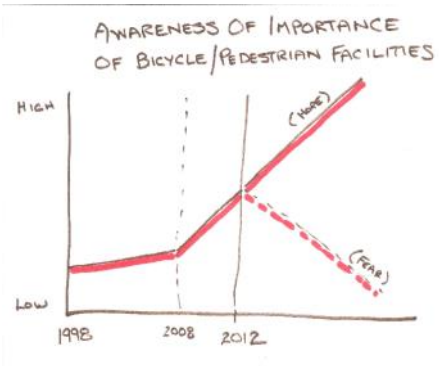


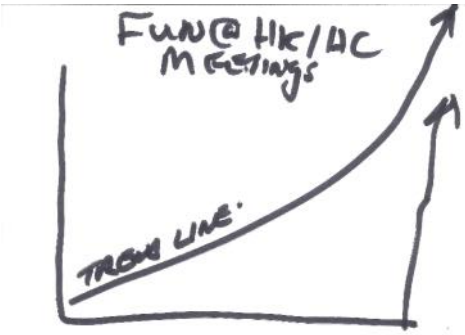


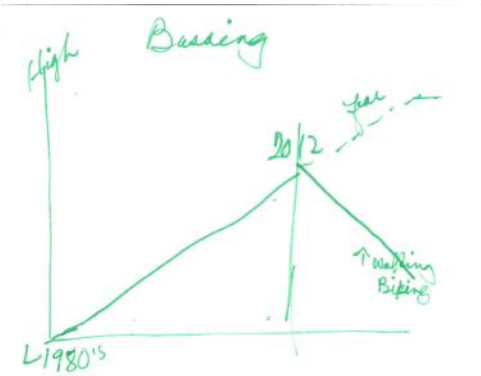


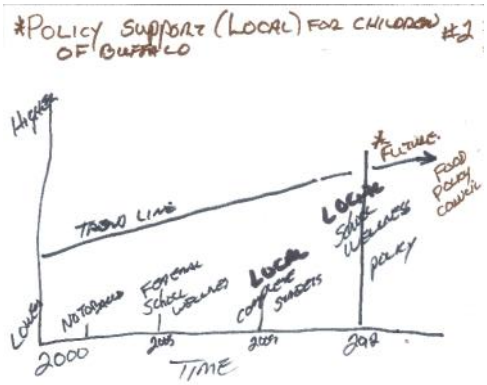


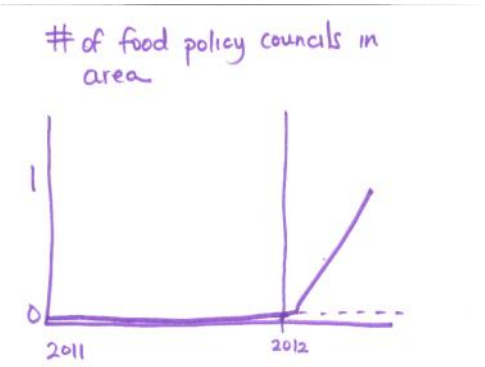


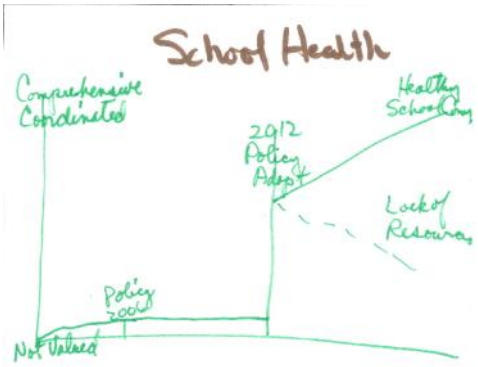

AWARENESS OF IMPORTANCE OF BICYCLE/PEDESTRIAN FACILITIES
HIGH
LOW
(HOPE)
(FEAR)
1998
2008
2012


FUN@ HK/HC MEETINGS
TREND LINE

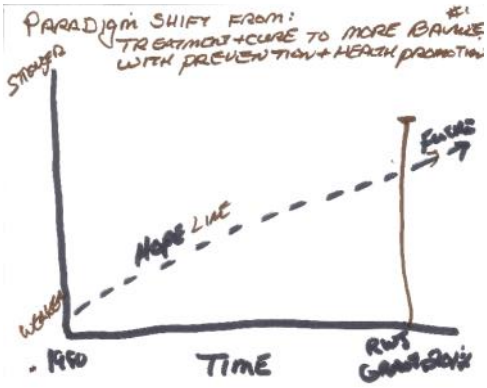

Biking
2012
1980's

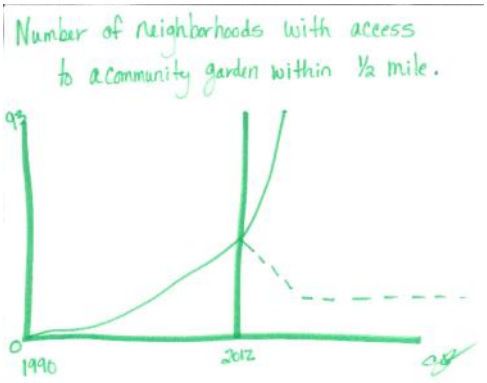

*POLICY SUPPORT (LOCAL) FOR CHILDREN #2 OF BUFFALO
TREND LINE
*FUTURE
FOOD POLICY COUNCIL
NOTHING
2000
TIME

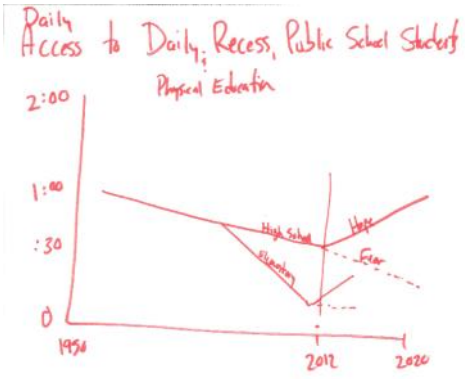

# of food policy councils in area
1
0
2011
2012

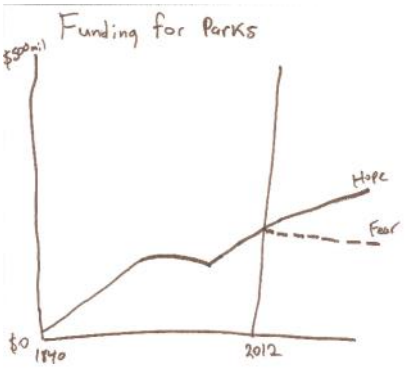

School Health
Comprehensive Coordinated
Healthy School Day
2012 Policy Adopt
Lack of Resources
Policy 2000
Not Valued


Quality of streets in BFLO
Good
Bad
Hope
Fear
2000
Today


PARADIGM SHIFT FROM: TREATMENT+CURE TO MORE BALANCE WITH PREVENTION+HEALTH PROMOTION
#1
STRONG
HOPE LINE
FUTURE
WEAK
TIME


Number of neighborhoods with access to a community garden within ½ mile.
1990
2012


Daily Access to Daily Recess, Public School Students
Physical Education
2:00
1:00
:30
0
1950
2012
2020
High School
Hope
Fear
Elementary


Funding for Parks
$500mil
$0
1940
2012
Hope
Fear


Amount of Fresh Food in city
High
Low
1900
1950
Today