Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Milledgeville, Georgia

Acknowledgments

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Introduction

Live Healthy Baldwin 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 *Live Healthy Baldwin* project was to introduce systems thinking at the community level by identifying the essential parts of the Live Healthy Baldwin 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., residents, government agencies, community-based organizations, businesses, academic institutions, policy/advocacy organizations) 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.

Milledgeville, Georgia : Background and Local Participation

Baldwin County, with a population of 45,720, is located in the center of Georgia. The rural county's population is mainly white (54.9%) and black (41.5%). Approximately 27.2% of the population is below the federal poverty level and the per capita income is $17,953 (see Table 1 for demographic information). The project predominantly focuses on the City of Milledgeville, which is located in Baldwin County (see Figure 2). The city, bordered by the Oconee River, is comprised of mainly white (53.4%) and black (42.2%) residents. The federal poverty level is much higher in the city (43.3%) than Baldwin County and the state of Georgia (16.5%). Milledgeville's per capita income is $12,487. The City of Milledgeville has a downtown area that includes Georgia College and State University, a major asset in the community. Another asset, the Oconee River, flows east of the downtown area and provides numerous recreational opportunities for residents and tourists.

The Center of Health and Social Issues in the College of Health Sciences at Georgia College and State University was the lead agency for Live Healthy Baldwin. Georgia College and State University is a public liberal arts university located in Milledgeville. Founded in 1889, there are about 6,700 students (85% undergraduate) attending the university. The mission of the Center of Health and Social Issues is "to improve the health and residents of Central Georgia through collaborative campus/community partnerships to provide research and education concerning contemporary health problems and social issues."

Live Healthy Baldwin was formed as a result of HKHC. The partnership, which was originally comprised of 15 organizations, agencies, and businesses in Baldwin County, focused on reversing the childhood obesity epidemic. The partnership was divided into five leadership teams to focus on: developing gardens in schools and in the community; implementing policies to accept Supplemental Nutrition Assistance Program (SNAP) vouchers at the local farmers' market; providing healthy snacks in summer and after-school programs; seeking Safe Routes to School funding and constructing the Fishing Creek Community Trail; and pursuing the Bicycle Friendly Community designation. In the last two years of the grant, the focus shifted slightly to include increasing capacity of the Southside Community Garden and school gardens; establishing a Central Georgia Food Policy Council; increasing access to locally grown foods for those receiving SNAP benefits; establishing a community garden and edible walking trail at the Collins P. Lee Recreation Center in the Harrisburg neighborhood; creating Farm to School/Garden to School programs; seeking funding for SRTS infrastructure changes; constructing Phase I of Fishing Creek Trail; passing a Complete Streets policy; obtaining Bicycle Friendly Community designation; and garnering support for a 33-mile rail-trail that would connect Milledgeville and Macon.

The partnership held regular meetings and included some of the following core partners: Community Healthy Works, Oconee River Greenway Foundation, The Bicycling Club of Milledgeville, Milledgeville Community Garden Association, First Presbyterian Church, The City of Milledgeville, Baldwin County Parks and Recreation Department, Georgia Military College, The New Beginning Worship Center, Oconee Regional Medical Center, Baldwin County Health Department, and the YES program. New partners were added throughout the HKHC initiative.

***Live Healthy Baldwin's* Priorities and Strategies**

The partnership and capacity building strategies of *Live Healthy Baldwin* included:

- **Student Involvement:** Live Healthy Baldwin actively engaged students attending Baldwin County Schools and the local colleges and universities in many of the HKHC initiatives, including Safe Routes to School and community gardens.
- **Leadership Teams:** The partnership was divided into leadership teams to focus on each of the HKHC initiatives (e.g., gardens, Safe Routes to School).

The healthy eating and active living strategies of *Live Healthy Baldwin* included:

- **Active Transportation:** The partnership worked to increase active transportation in the community through developing a Complete Streets policy, pursuing Bicycle Friendly Community designation, and implementing a Safe Routes to School program and infrastructure changes.
- **Trails and Greenways:** Live Healthy Baldwin worked to develop a pedestrian and bicycle path along Fishing Creek and to garner support to construct a rail-trail from Milledgeville to Macon.
- **Community and School Gardens:** To increase healthy eating in the community, the partnership collaborated with the Milledgeville Community Garden Association, Baldwin County Schools, New Beginnings Worship Center, and youth to establish community gardens on city- and county-owned land.
- **Nutrition Assistance:** Live Healthy Baldwin worked to increase access to healthy foods by accepting Supplemental Nutrition Assistance Program (SNAP) through Electronic Benefit Transfer (EBT) at the Fall Line Farmers' Market.
- **Other Healthy Eating Strategies:** To improve healthy eating in after-school and summer feeding programs, the partnership worked to implement nutrition standards and a farm-to-school program. In addition, the partnership started the initial plan for establishing a Central Georgia Food Policy Council.

For more information on the partnership, please refer to the Milledgeville case report (www.transtria.com/hkhc).

Systems Thinking in Communities: Milledgeville, Georgia

"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 Milledgeville, Georgia 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.
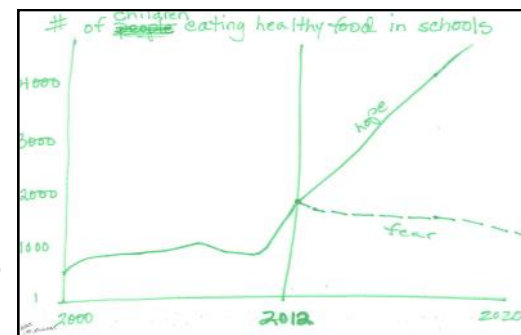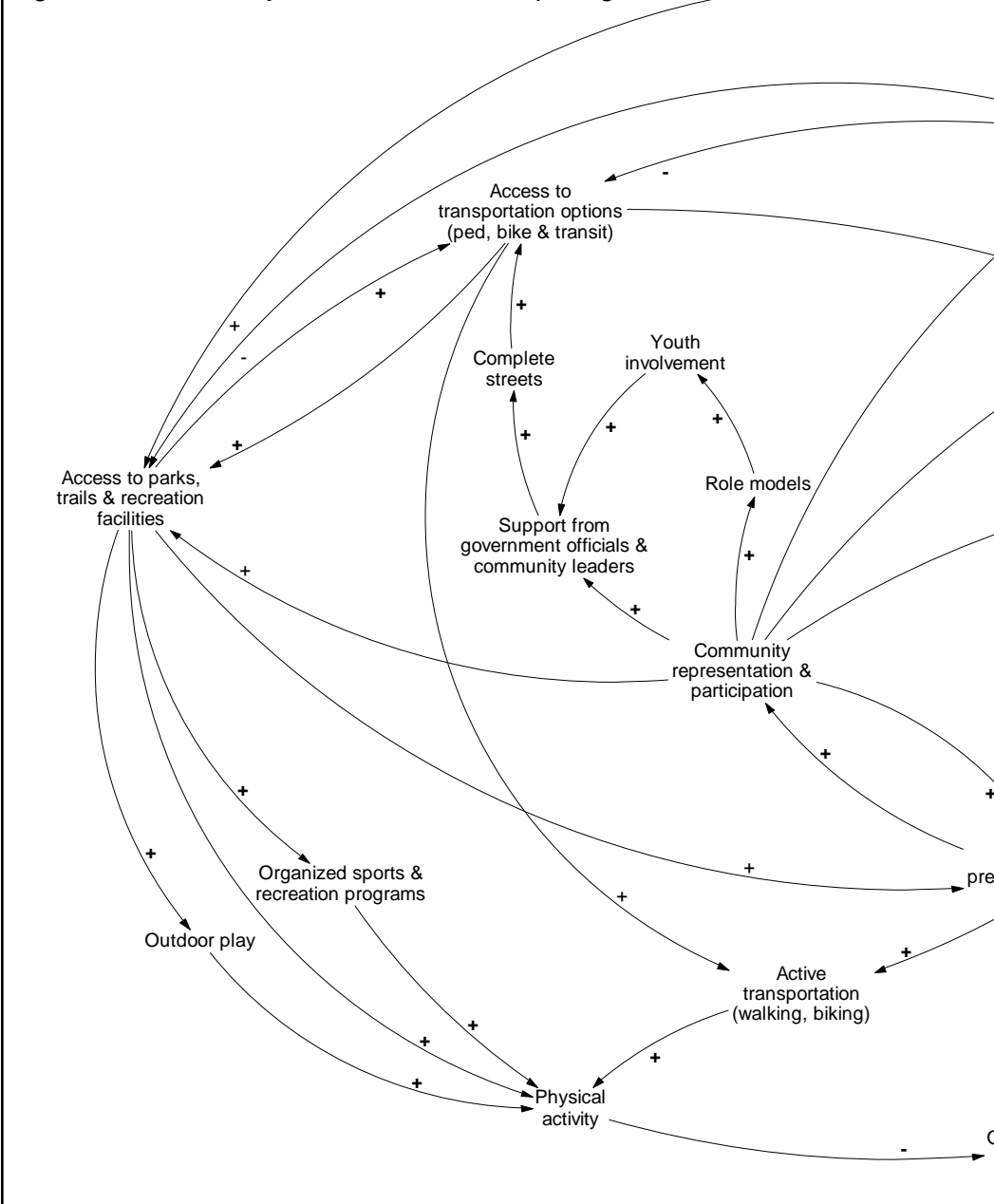
Group Model Building

Members of the *Live Healthy Baldwin* partnership participated in a group model building session in March, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included residents and representatives from government agencies, community-based organizations, businesses, academic institutions, 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.

Figure 1: *Live Healthy Baldwin* Causal Loop Diagram

Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in Milledgeville 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 children eating healthy food in schools, the number of children eating healthy food has remained fairly low

since 2000, with a more recent increasing trend, and the participant hopes that this trend will continue 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.
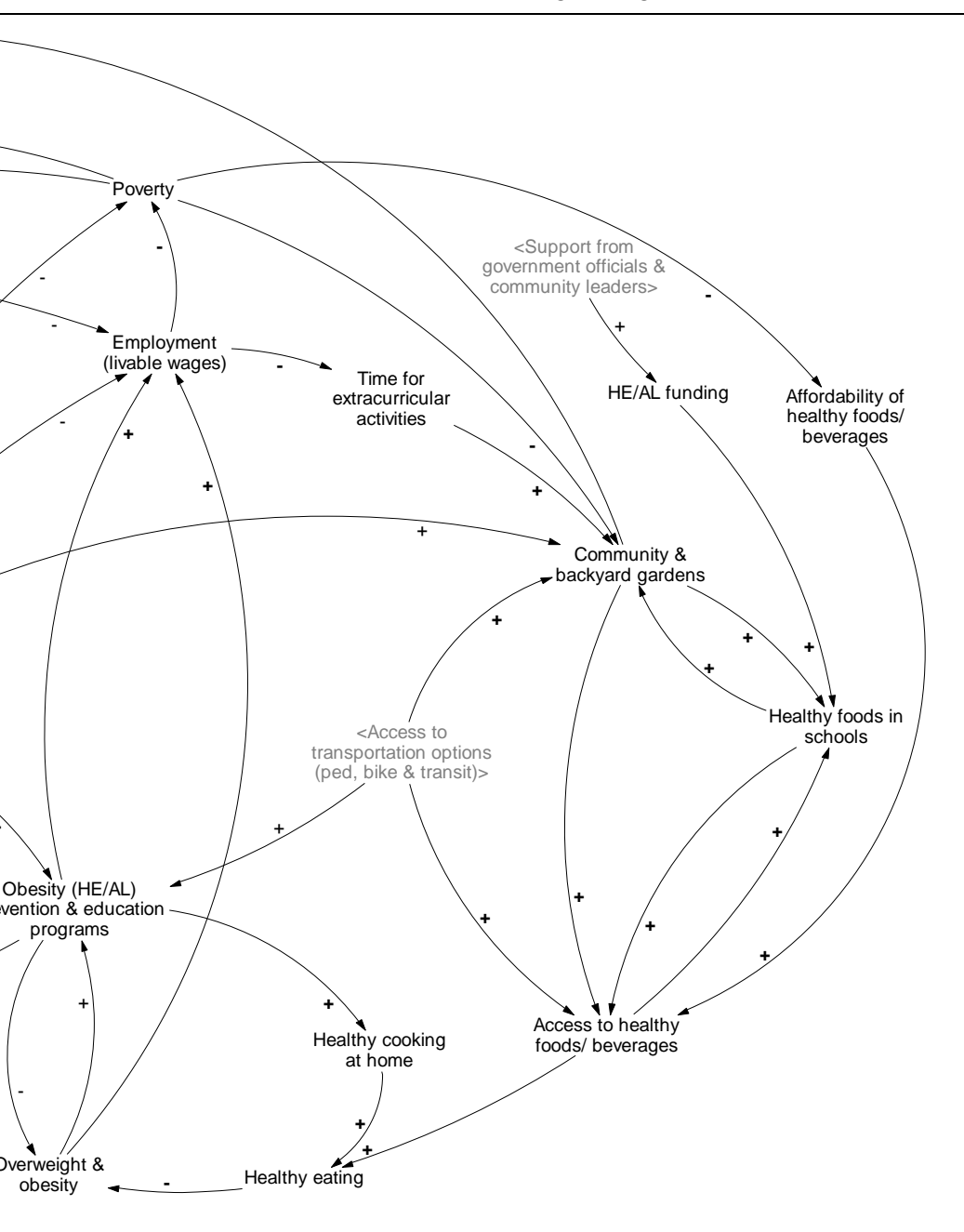
Causal Loop Diagram

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.

One feedback loop is: poverty → access to transportation options → employment → poverty.

What is important to notice is that there are other feedback loops interacting simultaneously to influence or to be influenced by poverty. Some variables may increase poverty while other variables limit it. 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 *Live Healthy Baldwin* 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 Milledgeville, Georgia and to stimulate greater conversation related to Milledgeville'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.

Poverty

Employment (livable wages)

Time for extracurricular activities

\<Support from government officials & community leaders\>

HE/AL funding

Affordability of healthy foods/ beverages

Community & backyard gardens

Healthy foods in schools

\<Access to transportation options (ped, bike & transit)\>

Obesity (HE/AL) prevention & education programs

Access to healthy foods/ beverages

Healthy cooking at home

Overweight & obesity

Healthy eating

Causal Loop Diagram for the Childhood Obesity System

The causal loop diagram (CLD) represents a holistic system and several subsystems interacting in Milledgeville, Georgia. 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, food distribution and procurement, and food retail. During the behavior over time graphs exercise, the participants generated nine graphs related to policy or environmental strategies (e.g., community gardens) or contexts (e.g., affordability of healthy foods and beverages) that affected or were affected by the work of *Live Healthy Baldwin*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

Figure 2: Subsystems in the *Live Healthy Baldwin* Causal Loop Diagram

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 six graphs related to policy or environmental strategies (e.g., Complete Streets) or contexts (e.g., access to transportation options) that affected or were affected by the partnership's work.

Health and Health Behaviors (Orange)

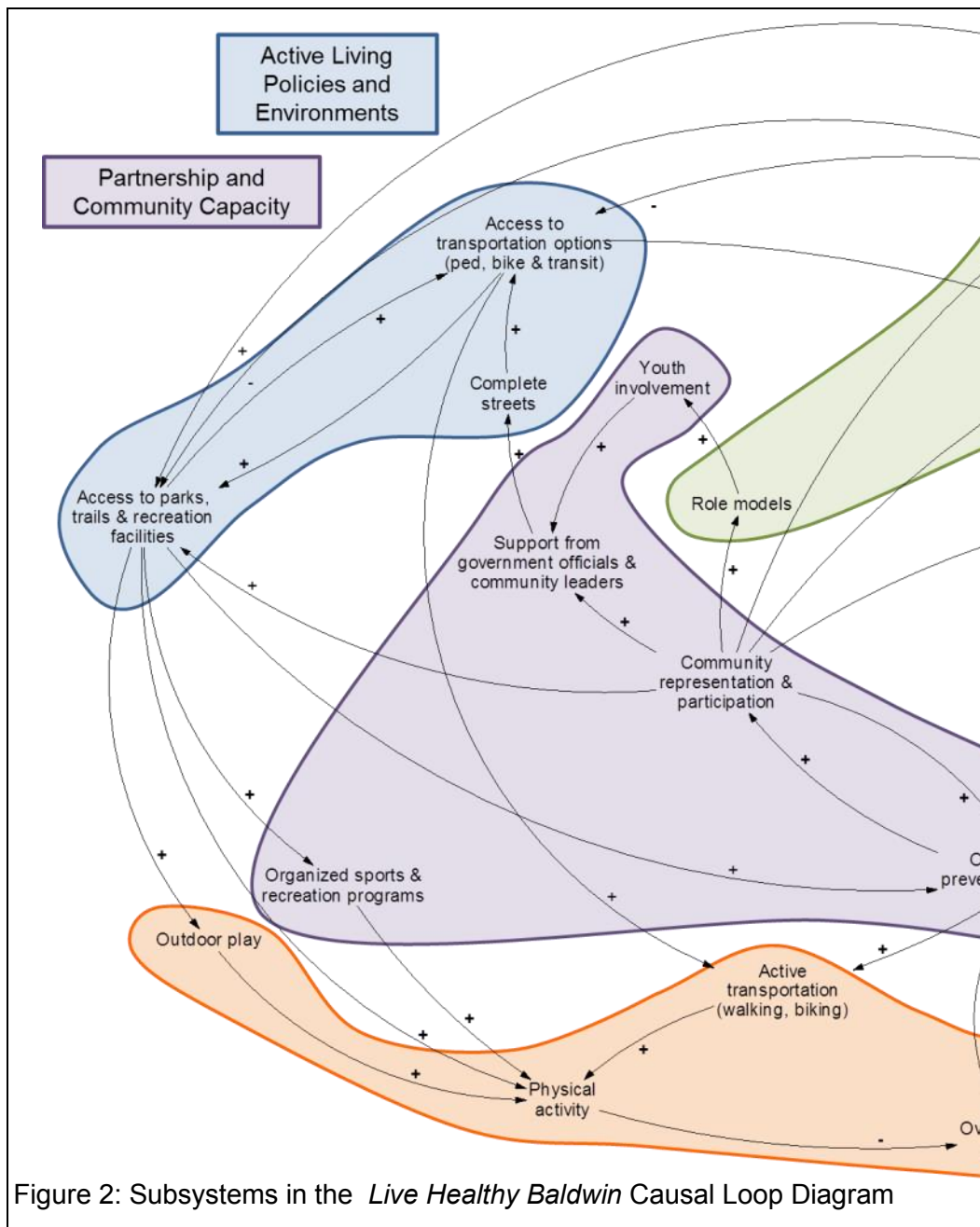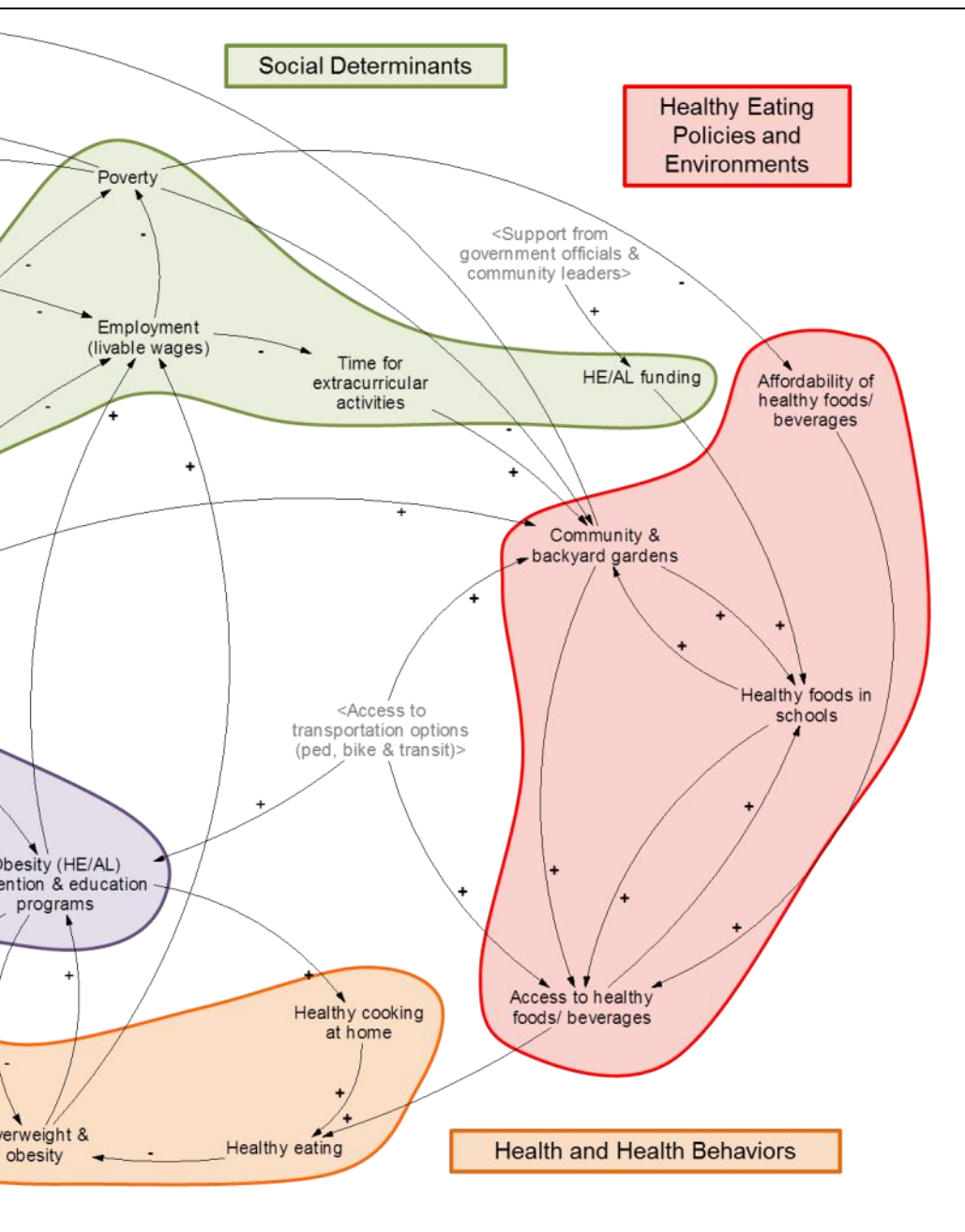The subsystem for health and health behaviors includes health outcomes (e.g., obesity), health behaviors

(e.g., healthy eating, physical activity), and behavioral proxies or context-specific behaviors (e.g., healthy cooking at home, outdoor play, active transportation).

Social Determinants

Healthy Eating Policies and Environments

Poverty

<Support from government officials & community leaders>

Employment (livable wages)

Time for extracurricular activities

HE/AL funding

Affordability of healthy foods/ beverages

Community & backyard gardens

Healthy foods in schools

<Access to transportation options (ped, bike & transit)>

Obesity (HE/AL) ...ention & education programs

Access to healthy foods/ beverages

Healthy cooking at home

...verweight & obesity

Healthy eating

Health and Health Behaviors

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, *Live Healthy Baldwin* involved youth in their partnership's activities. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as support from government officials and community leaders.

Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., poverty) and psychosocial influences (e.g., role models) 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 *Live Healthy Baldwin* partners or by other representatives in Milledgeville, Georgia . Using this CLD as a starting place, community conversations about different theories of change within subsystems may continue to take place.

The next sections begin to examine the feedback loops central to the work of *Live Healthy Baldwin*. 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.
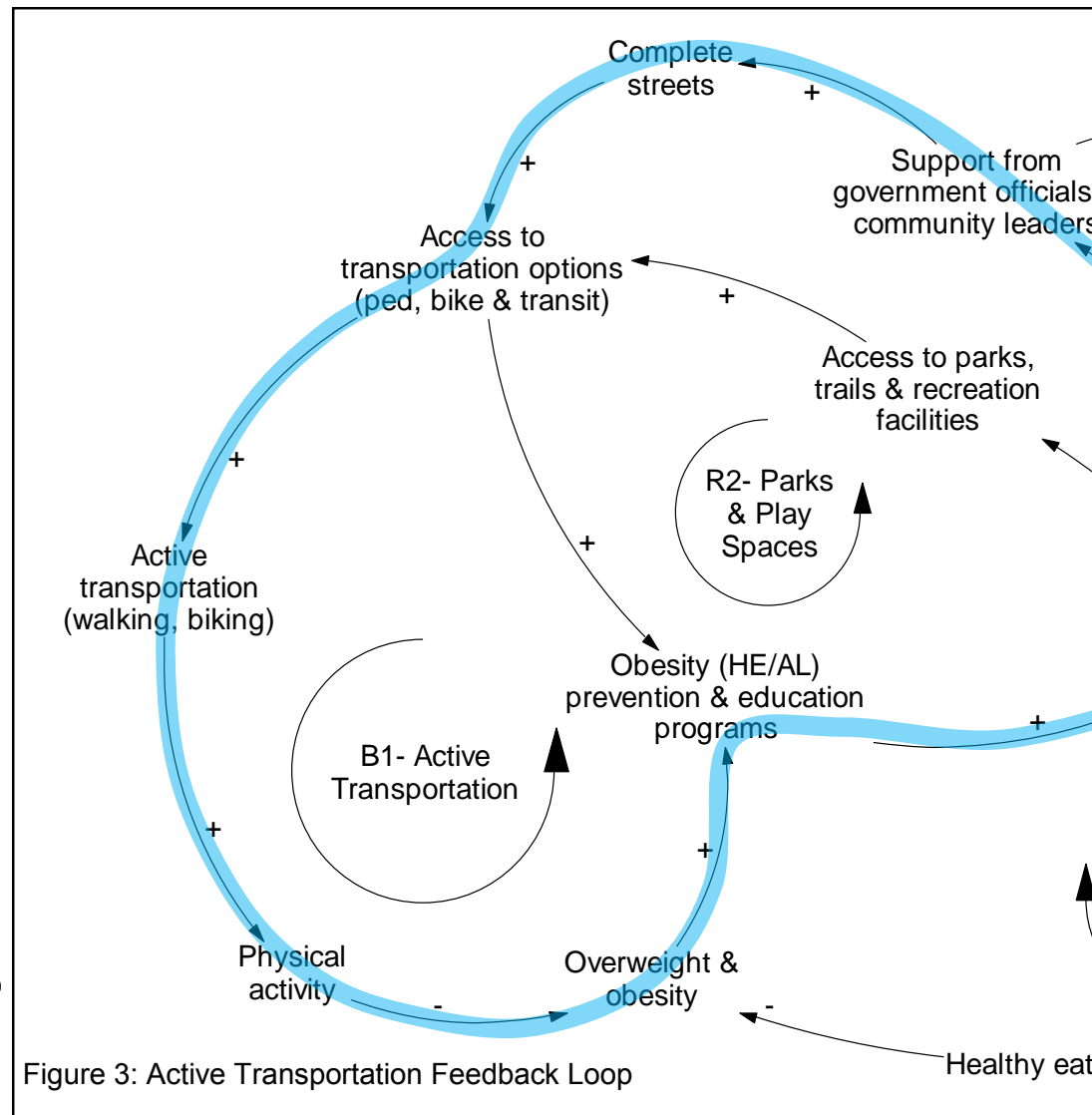
Active Transportation Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *Live Healthy Baldwin* CLD (see Figures 1 and 2) are shown in Figure 3. While the CLD provides a theory of change for the childhood obesity prevention movement in Milledgeville, Georgia , 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 active transportation (blue highlighted loop in Figure 3). Milledgeville, Georgia partners developed a Complete Streets policy, designated Bicycle Friendly Communities, and implemented Safe Routes to School infrastructure changes. Participants described how Complete Streets policies improve access to transportation options for pedestrians, bicyclists, and transit users, increasing active transportation and physical activity. These health behaviors help to prevent or reduce overweight and obesity. In turn, less obesity burden requires fewer prevention and education programs and less community and political support (as necessary policies and environments are in place).

Story B: While the preceding story reflected a positive scenario for Milledgeville, Georgia, the same feedback loop also tells the opposite story. A lack of Complete Streets policies leads to less development and maintenance of environments supporting active transportation, thus decreasing physical activity and increasing overweight and obesity. With greater obesity burden, more prevention and education programs are needed and, consequently, community and political support to initiate these policies.

Figure 3 content:

Complete streets → + → Access to transportation options (ped, bike & transit) → + → Active transportation (walking, biking) → + → Physical activity → - → Overweight & obesity → + → Obesity (HE/AL) prevention & education programs

Support from government officials & community leaders → + → Complete streets

Access to parks, trails & recreation facilities → + → Access to transportation options

R2- Parks & Play Spaces

B1- Active Transportation

Obesity (HE/AL) prevention & education programs → +

Healthy eat... → - → Overweight & obesity
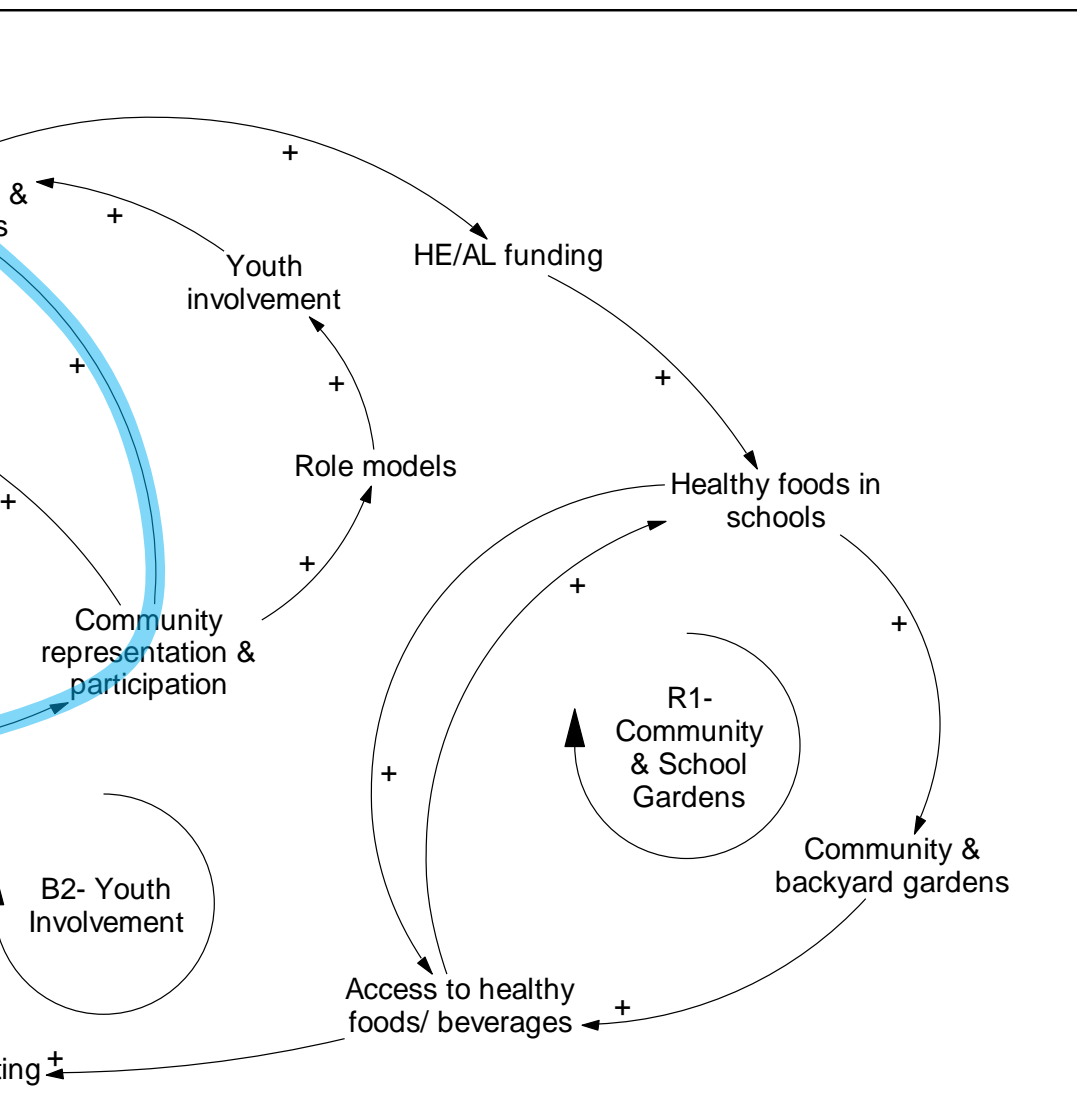
Figure 3: Active Transportation Feedback Loop

Balancing Loop and Notation

These stories represent a balancing loop, and the notation in the feedback loop identifies it as a balancing loop (see "B1 — Active Transportation" and blue 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.

"With some folks we've been talking to on the south side of town, they're telling us that just getting out [of the neighborhood] is difficult. They want access to trails for walking, but it's too expensive for them to drive to the trails and they can't walk in their neighborhoods because there aren't sidewalks and there's too much traffic." (Participant)

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.

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

In isolation, this balancing loop represents the influence of Complete Streets policies on physical activity and overweight and obesity. To understand other influences on these variables, 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 *Live Healthy Baldwin*

Participants also identified a sharp increase in bicycling since 2005 in Milledgeville, Georgia (see behavior over time graph).

From the systems thinking exercises, several insights can inform the active transportation strategy. For instance, engaging the growing bicycling community in efforts to gain support from local elected and appointed officials as well as community leaders can improve the implementation and maintenance of complete streets.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including assessing facilitators and barriers of gaining support from elected and appointed officials as well as community leaders for complete streets as well as evaluating the impact of changes to the built environment on active transportation mode choices, and, ultimately, physical activity, overweight, and obesity.

Diagram labels: HE/AL funding · Youth involvement · Role models · Community representation & participation · Healthy foods in schools · R1- Community & School Gardens · Community & backyard gardens · B2- Youth Involvement · Access to healthy foods/ beverages

Bicycling Club Membership graph labels: Member Numbers · hype · Fear · 2005 · 2010 · 2020
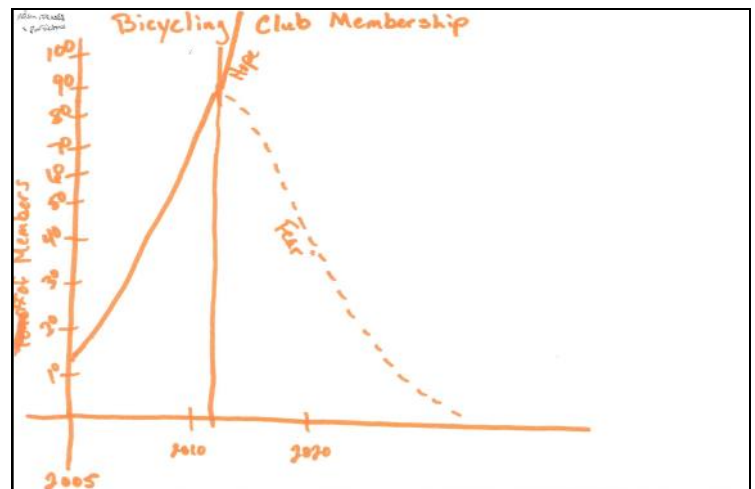
Opportunities for Systems Thinking in Milledgeville, Georgia

This storybook provided an introduction to some basic concepts and methods for systems thinking at the community level, including: causal loop diagrams, variables, causal relationships and polarities, reinforcing feedback loops, and balancing feedback loops, among others. For the *Live Healthy Baldwin* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Milledgeville causal loop diagram as well as an example feedback loop 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 Milledgeville, Georgia 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 *Live Healthy Baldwin* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;

Figure 7: *Live Healthy Baldwin* Causal Loop Diagram

- 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;
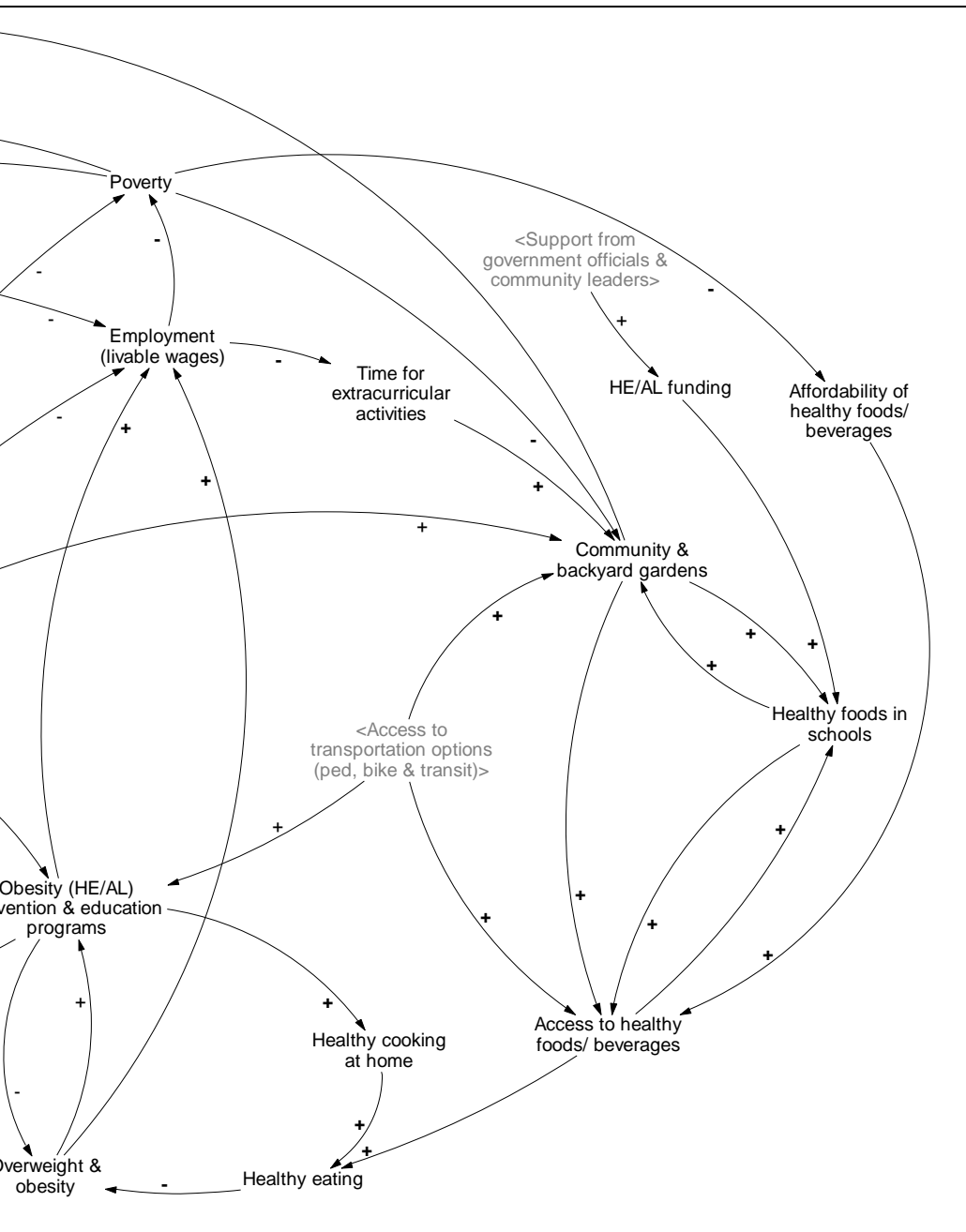
- revisiting variables removed because they were not part of feedback loops, including quality of life, collaborative decision-making, gas prices, car ownership/ use, fast food restaurants, education, illiteracy, affordability of recreation programs, school PE, community gathering spaces, school in neighborhoods, local economy, local businesses for youth activities; 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 Milledgeville 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 *Live Healthy Baldwin* Causal Loop Diagram
- Appendix C: Original translation of the causal loop diagram into Vensim PLE
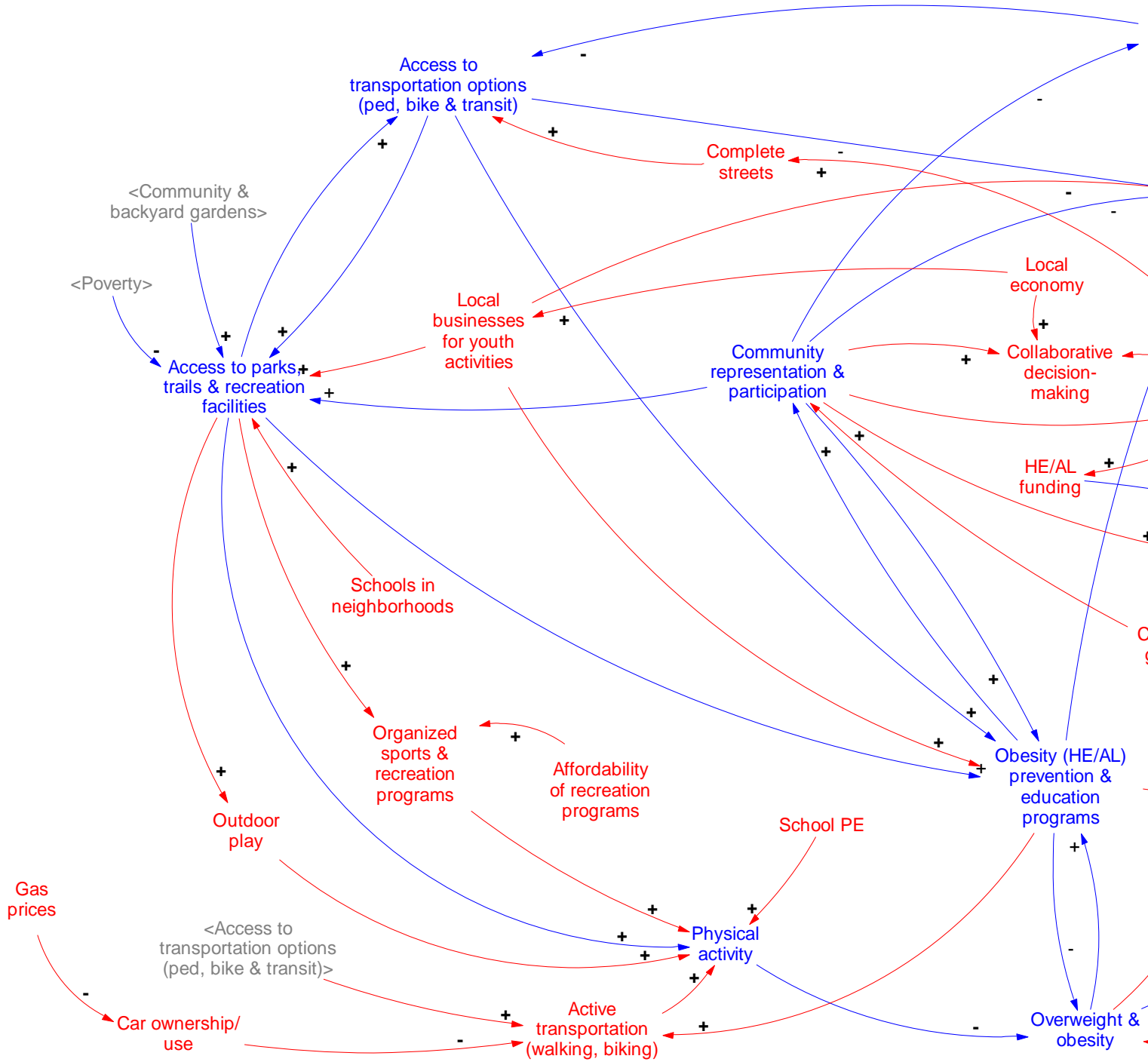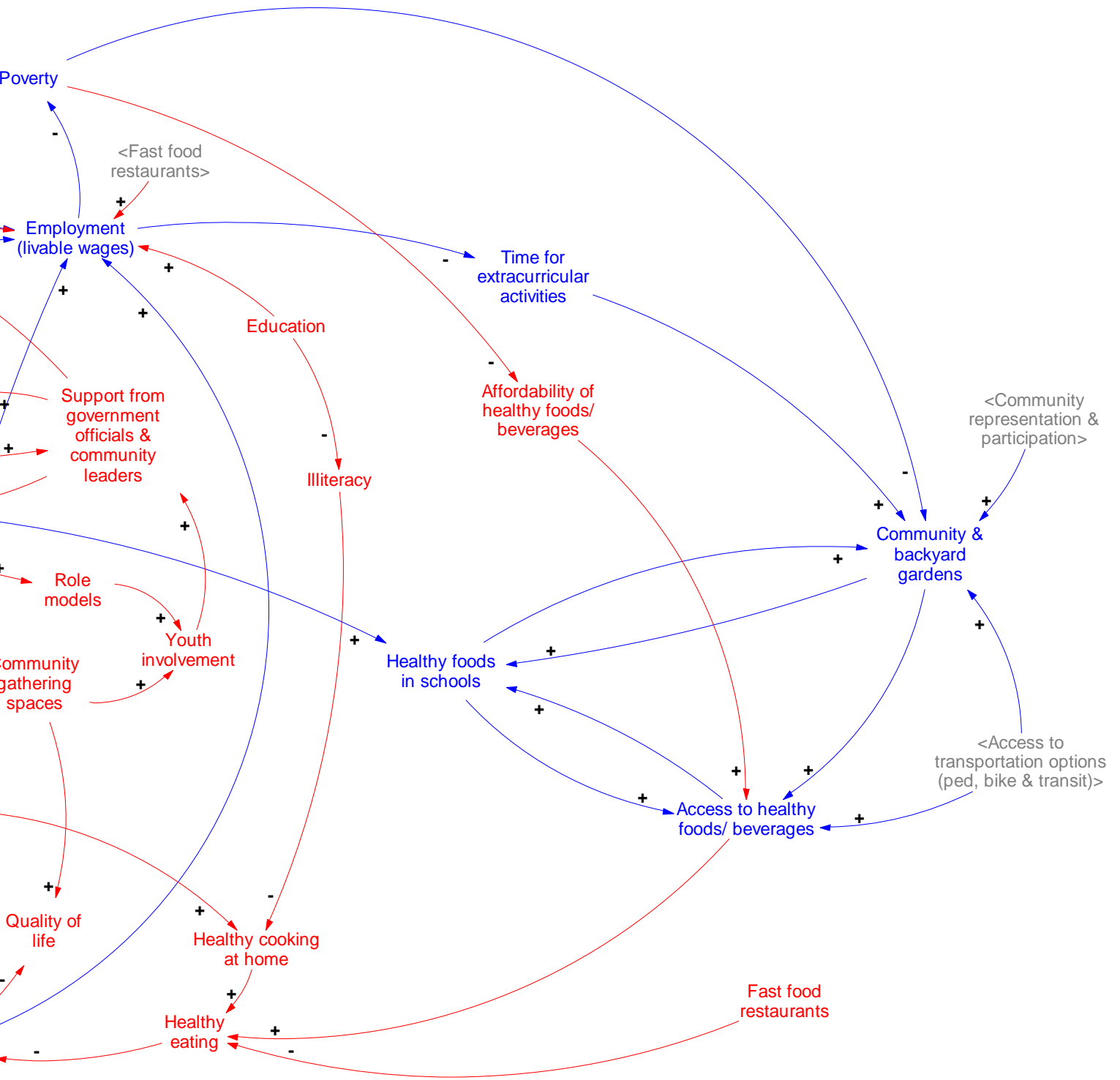- Appendix D: Transcript translation of the causal loop diagram into Vensim PLE
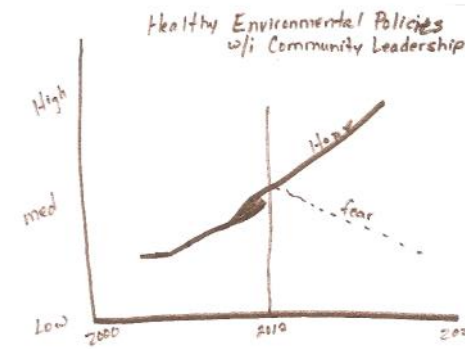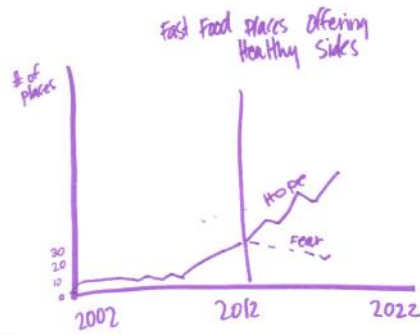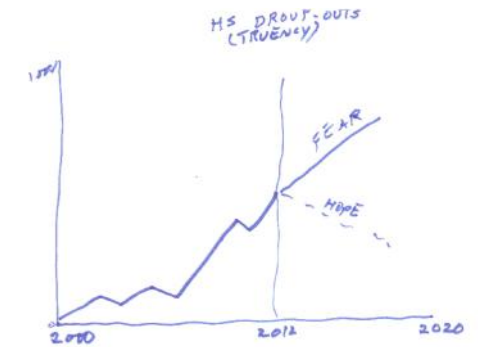- Appendix E: Behavior over time graphs not represented in the storybook

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.

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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.

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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

Milledgeville, Georgia: *Live Healthy Baldwin*	
Categories	**Number of Graphs**
Active Living Behavior	1
Active Living Environments	5
Funding	0
Healthy Eating Behavior	2
Healthy Eating Environments	7
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	2
Partnership & Community Capacity	2
Policies	2
Programs & Promotions (Education and Awareness)	4
Social Determinants of Health	4
Total Graphs	**29**

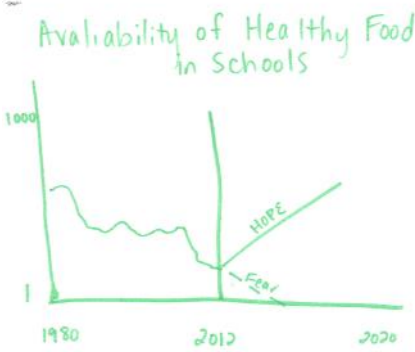**Appendix B: Photograph of the Original Version of the *Live Healthy Baldwin* Causal Loop Diagram**
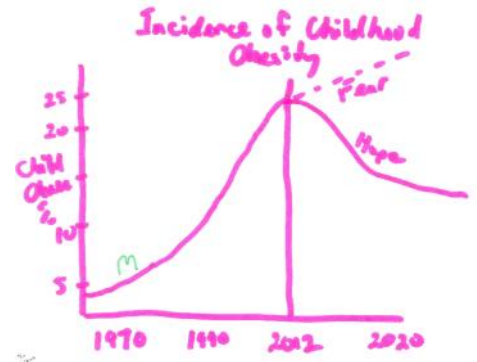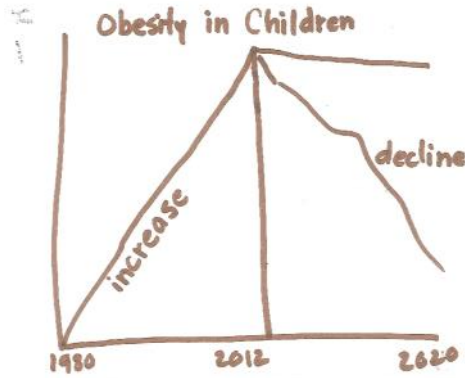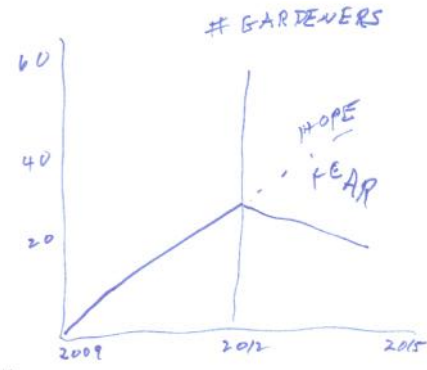
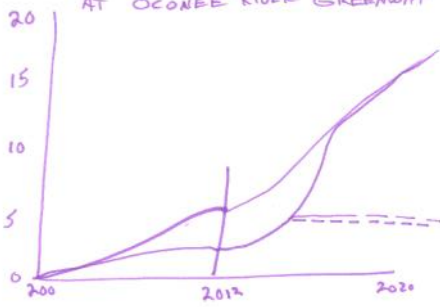# Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

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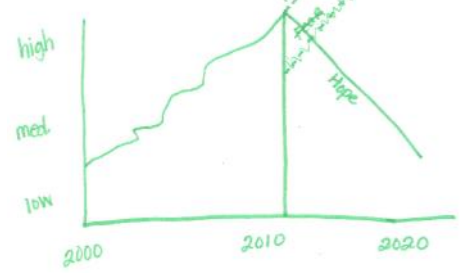

GARDENERS
HOPE
FEAR
60 40 20
2009 2012 2015

Obesity in Children
increase
decline
1980 2012 2020

Incidence of Childhood Obesity
Fear
Hope
Child Obesity %
25 20 5
m
1970 1990 2012 2020

Availability of Healthy Food in Schools
HOPE
Fear
1000 1
1980 2012 2020

% UNMARRIED MOTHERS (PREGNANCY)
FAMILY LOSS
FEAR
HOPE
50 25 0
2000 2012 2020

Funding Opportunities to Combat Healthy Living (poor community) (Federal)
High
Hope
Low
1992 2012 2024

# of Fast Food Restaurants
fear
Hope
1990 2012 2020

Healthy Cooking for Less
Future
Fears
1980 2012 2020

HS DROP-OUTS (TRUENCY)
FEAR
HOPE
2000 2012 2020

Fast Food Places Offering Healthy Sides
# of places
HOPE
FEAR
30 20 10
2002 2012 2022

Healthy Environmental Policies w/i Community Leadership
High
med
Low
Hope
fear
2000 2010 2020

accessing cooking classes for healthy eating
hope
fear
2000 NOW 2020
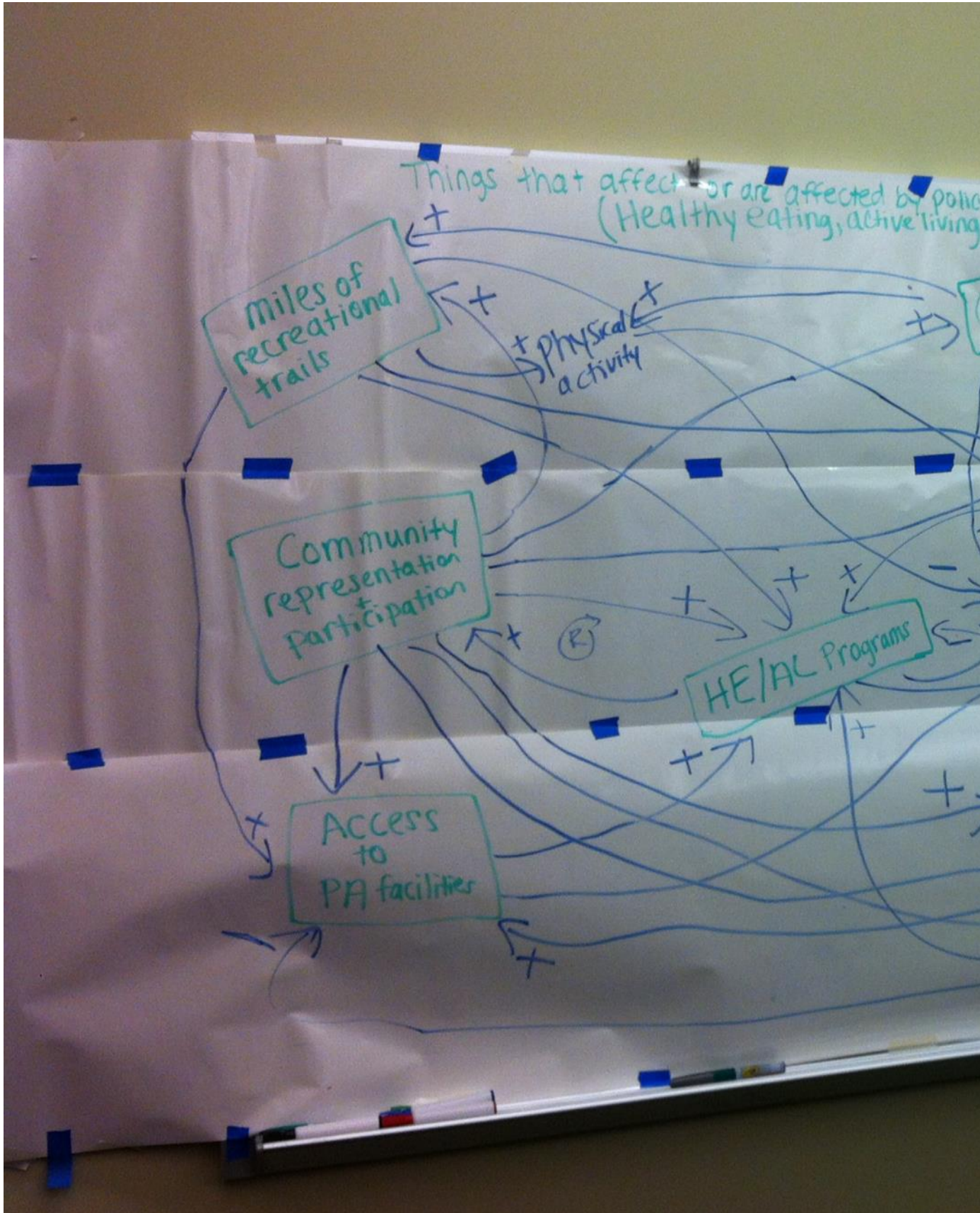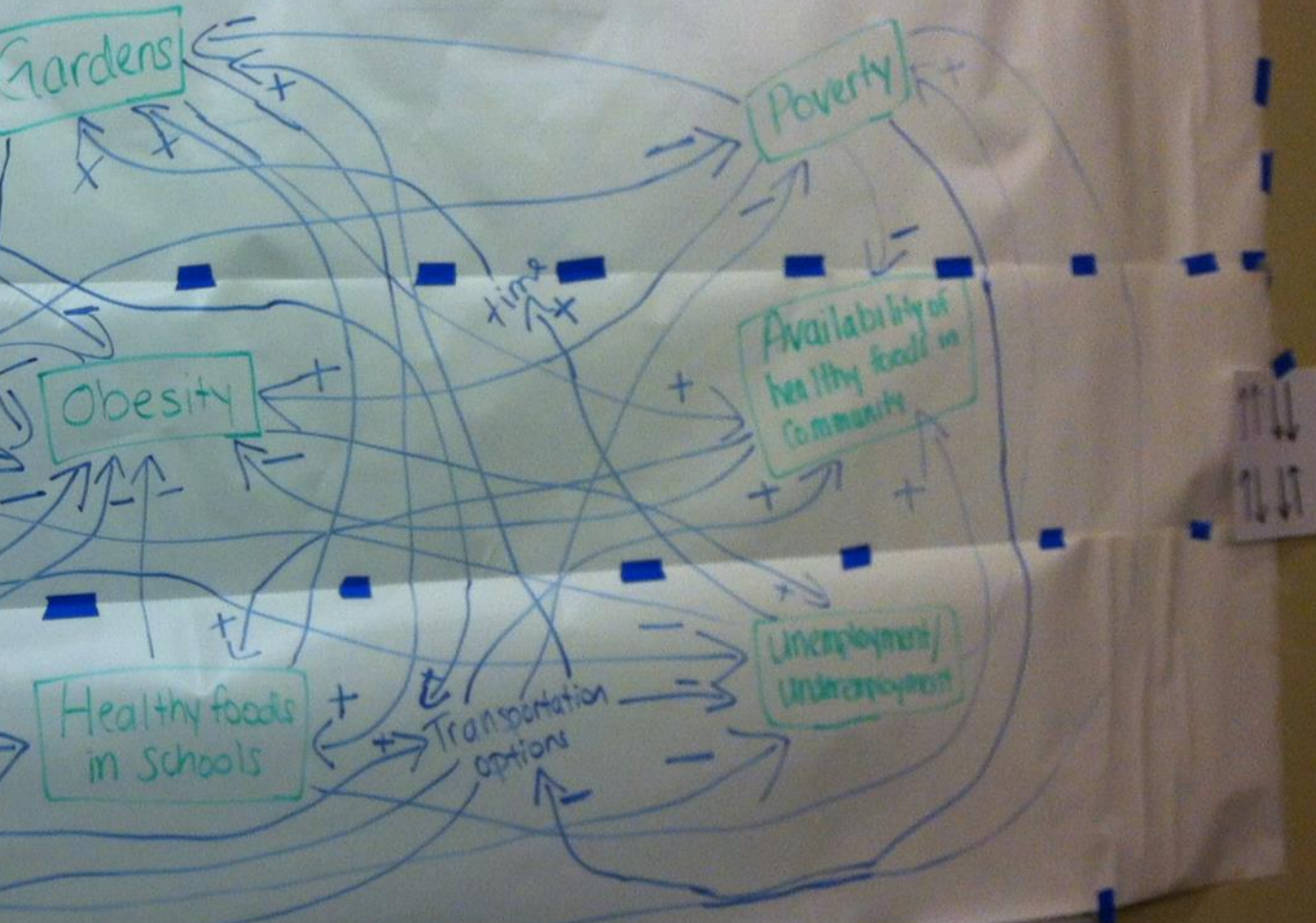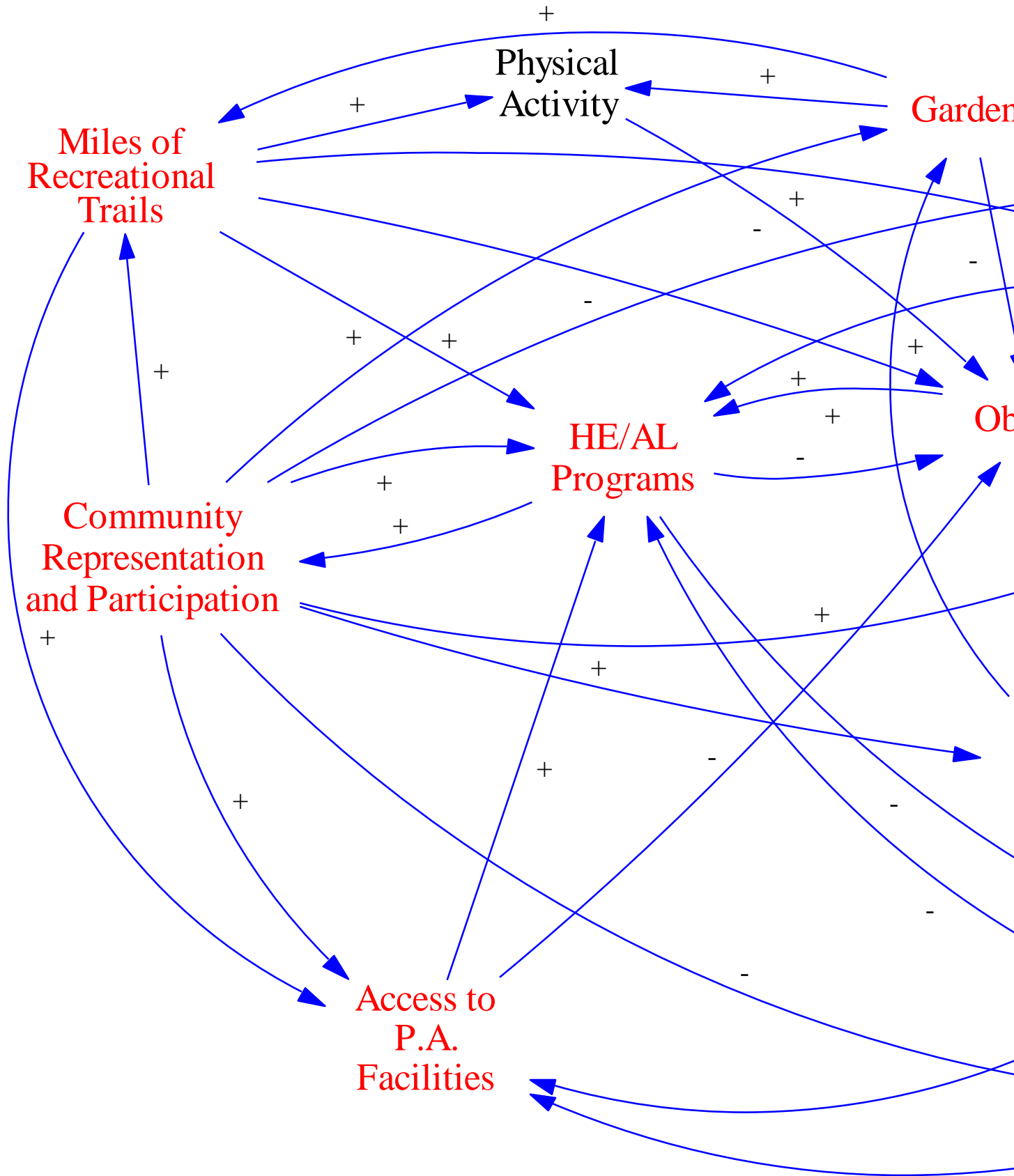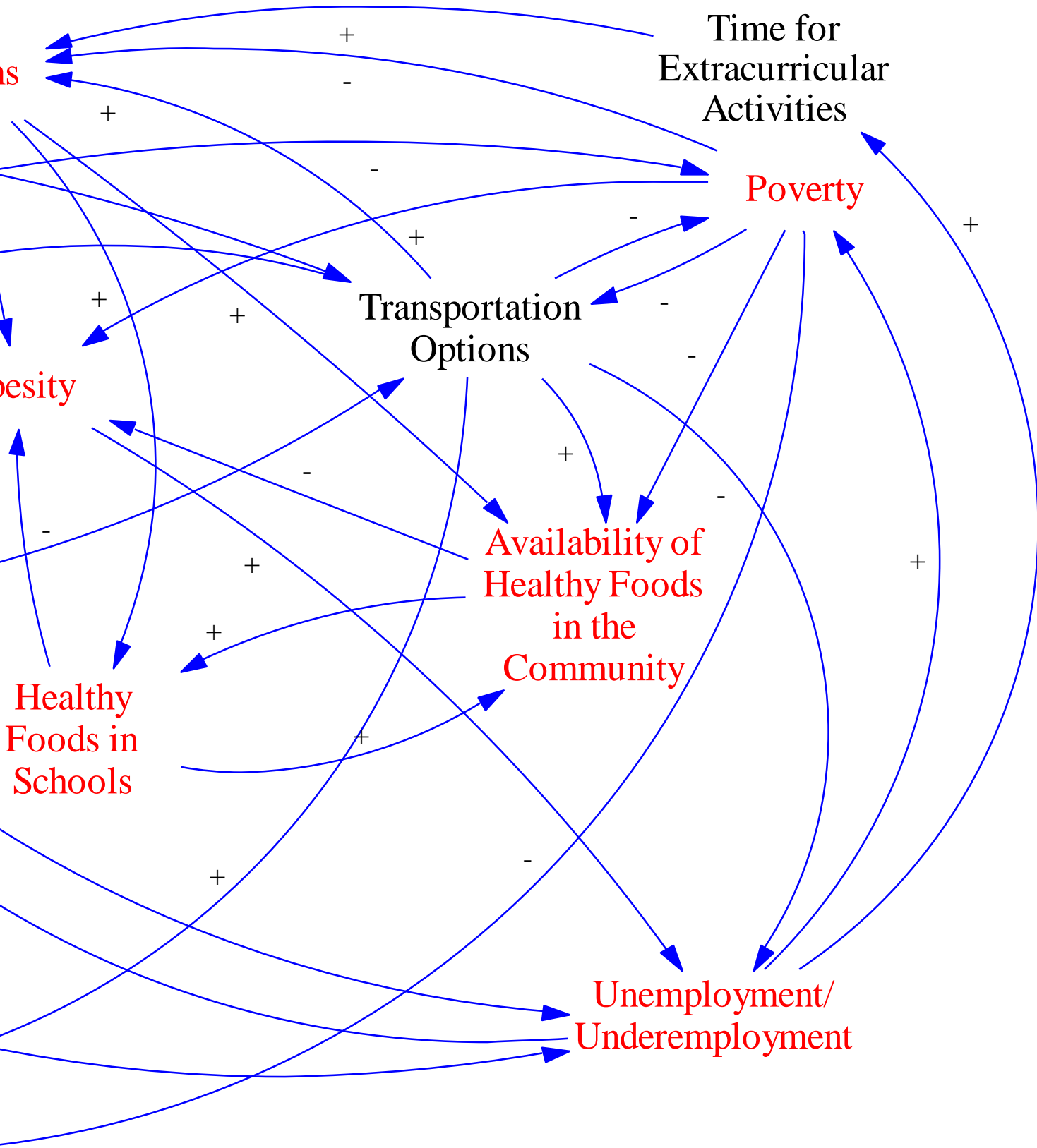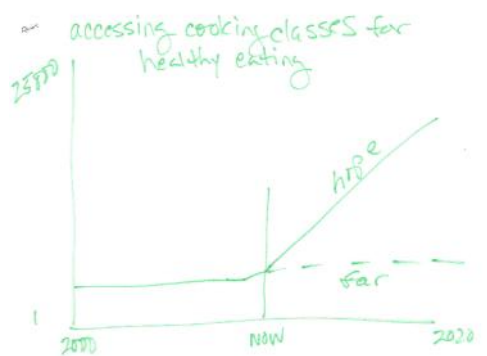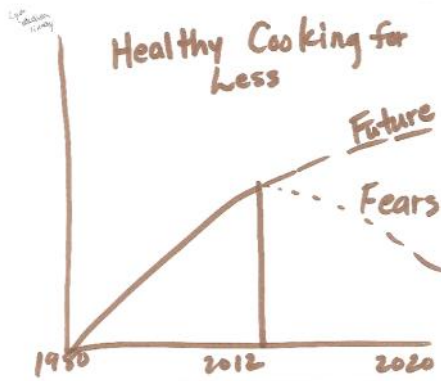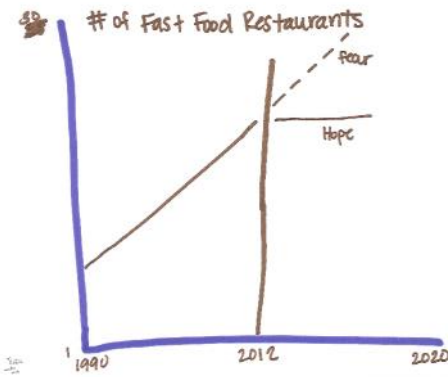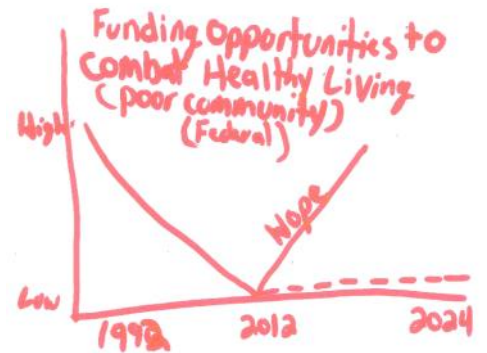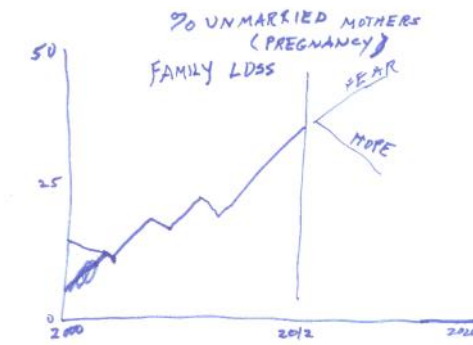
Annual Cultural Performances at Oconee River Greenway

20
15
10
5
0

200   2012   2020

Adult Access to FREE Fitness
Parks & Recreation Classes
Fitness Staff

100
75
50
25

2000   2012   2020

Cost of Foods (Healthy)

high
med.
low

2000   2010   2020

FEAR

Hope
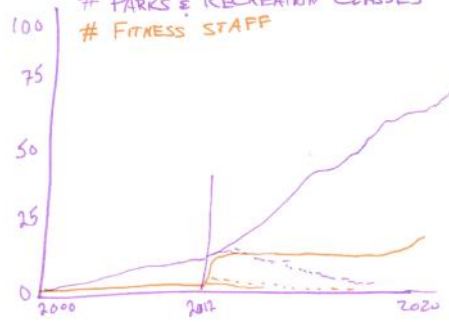
Quality of Life Issues Addressed by Local Politicians

High
Low

HOPE

2000   2012   2024
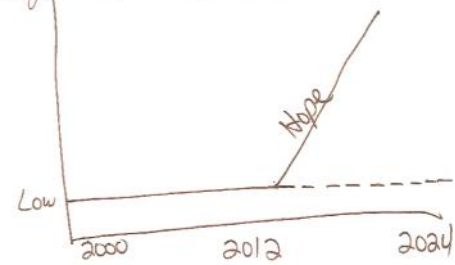
Availability of Childhood Obesity Prevention\Education

1000
1

HOPE
FEAR

1980   2012   2020
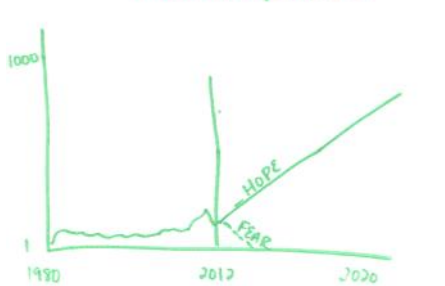
Accessibility of Fresh + Healthy Foods to Low-income Families

High
Low

Hopes
Fears

1995   2012   2025
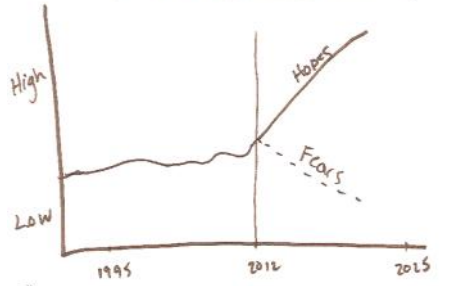
Exercise Opportunities
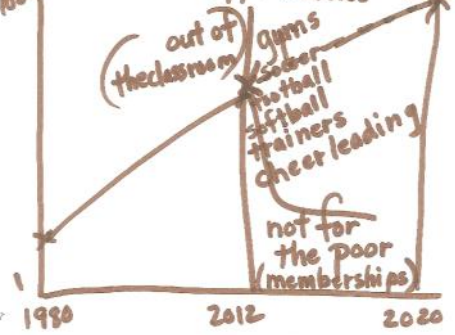
out of (the classroom) gyms
soccer
football
softball
trainers
cheerleading
not for the poor (memberships)

1980   2012   2020

Access to Trails

High
med
low

Hope
Fear

Heather Langston

2000   2012   2020

Availability Healthy Food Options

High
med
low

Hope
fear

2000   2012   2020

Access to Facilities

high
med.
low

FEAR

2000   2012   2020
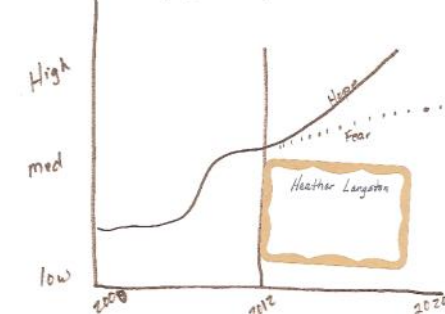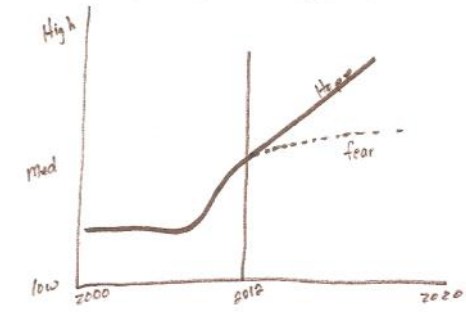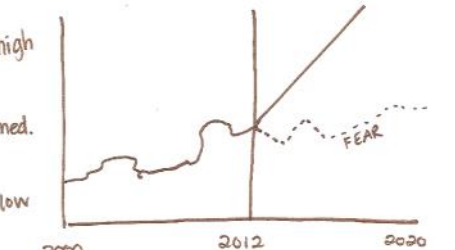
Unemployment/Underemployment in Baldwin Co.

High
Low

Fear
Hope

2005   2010 2013   2020