Using System Dynamics in Evaluation: A Case Example

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Global Summary of AIDS Epidemic, 2005

- 25 million cumulative deaths worldwide
- 40.3 million people living with HIV/AIDS
- 4.9 million people newly infected
- 3.1 million people died of AIDS

National and Local Epidemic

- 1,039,000 to 1,185,000 persons living with HIV infection in the United States
- 40,000 new infections annually
- 16,200 persons living with HIV infection in Michigan
- 900 new infections annually

Schackman, Gebo, Walensky et al., 2006

"From the time of entering HIV care, per person projected life expectancy is 24.2 years, discounted lifetime cost is $385,200, and undiscounted cost is $618,900 for adults who initiate ART with CD4 cell count <350/[mu]L."

State of HIV Prevention in U.S. Communities

- Community-based organizations (CBOs) are the primary providers of HIV prevention in most U.S. community settings
- CBOs' funding sources have begun to prefer and impose evidence-based prevention programs on CBOs

HIV Prevention Evidence-based Programs

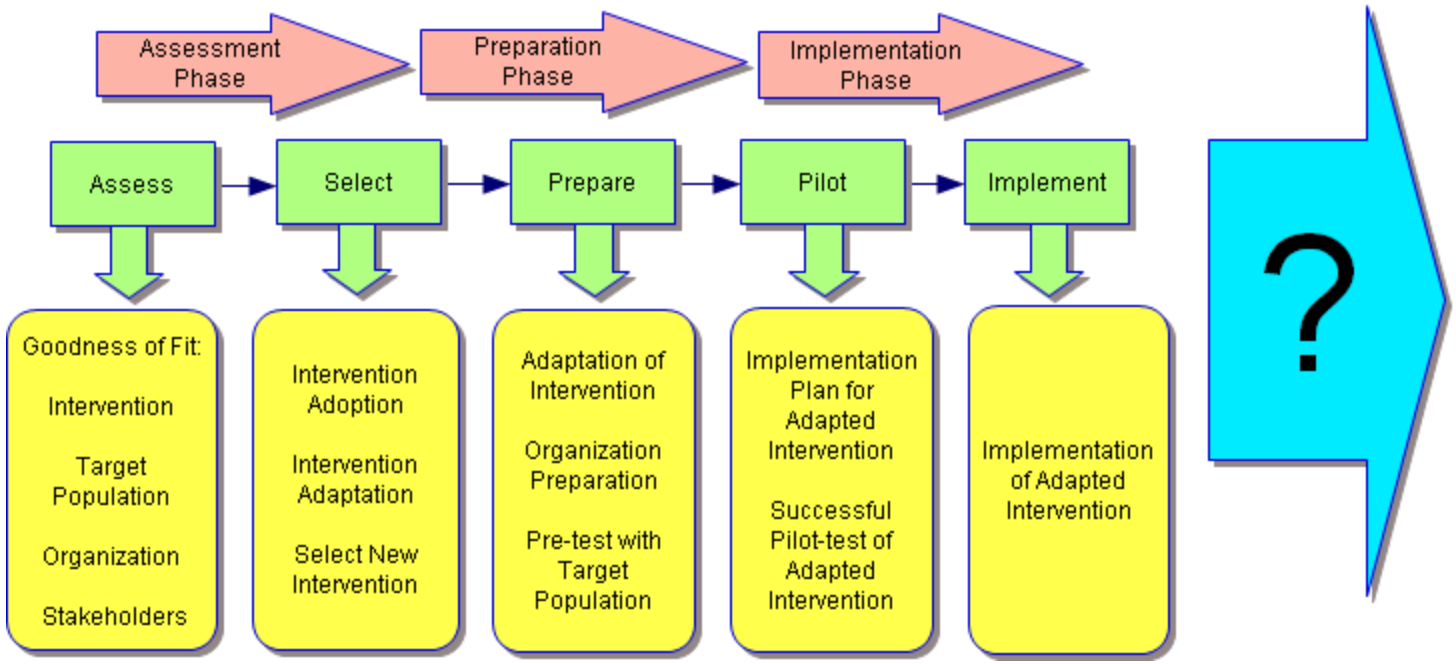
- 12 evidence-based programs have been widely disseminated by CDC since 2002
- Over 2,000 agencies have been trained in these programs
- Programs were selected based on efficacy in controlled trials
- Effectiveness of programs has not been established

Problem

- **Programs are undergoing widespread dissemination prior to thorough investigation of their effectiveness in communities**

Typical Translation Framework

(Adapted from McKelroy et al., 2006)



Purpose of our Model

- To understand the dynamics of implementing evidence-based programs in service delivery settings
- To model common problems reported by providers in delivering these programs

Intervention Typology

LEVEL	TARGET OF CHANGE	DELIVERY	DEBI EXAMPLE
Structural	Economic resources, policy supports, organizational structures & functions	policy changes, physical environment change	None
Community	Community social norms	Peer role modeling; social marketing	Mpowerment; POL; Community PROMISE
Group	Individual behavior	Workshop; Small group discussion	Healthy Relationships; HHRP; 3MV; RAPP; Safety Counts; SISTA; Street Smart; TLC; VOICES/ VOCES
Individual	Individual behavior	1-on-1 counseling	None

Small-group Workshops

- Face-to-face group sessions
- Limited enrollment (~20 people)
- Average of 8 sessions (range 1-24)

Why system dynamics?

- Focuses on problems
- Orients toward policies and actions
- Uses computer simulation to assess what might happen over time
- Uses any form of available data

Data Sources

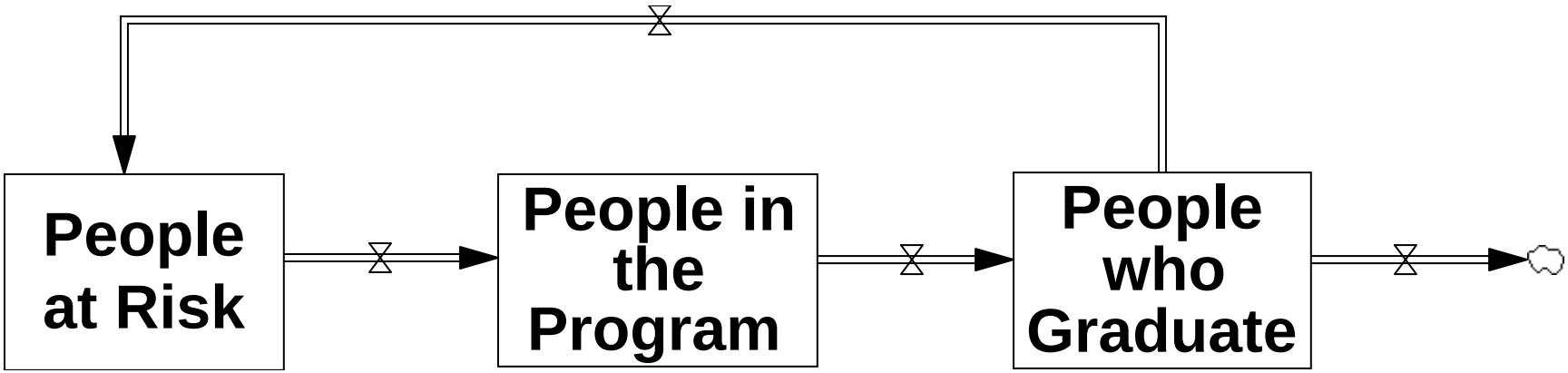
- In-depth interviews with a random sample of providers
- Published evaluations
- Results of published meta-analyses
- Dynamic theories of service delivery

Stock and Flow Representation

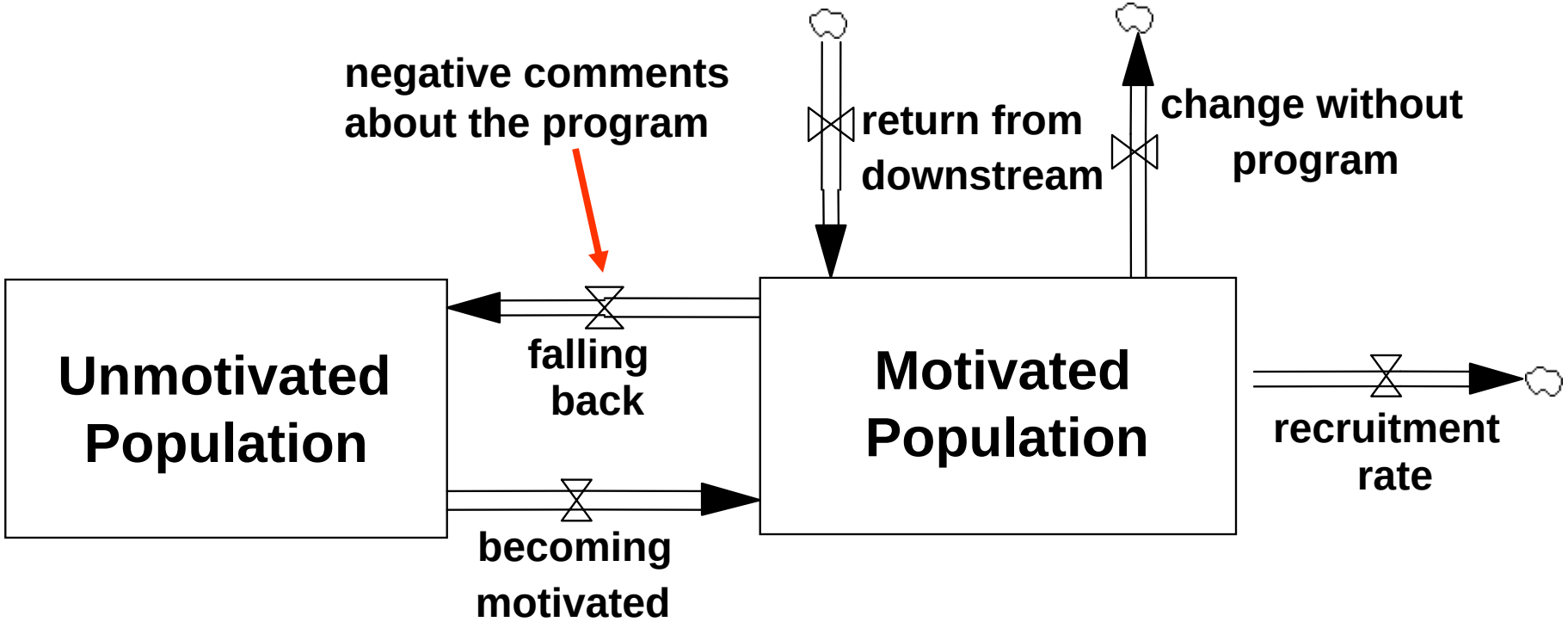
What are stocks and flows?

- Stocks are accumulations
- Flows are the processes and actions that change the values of the stocks

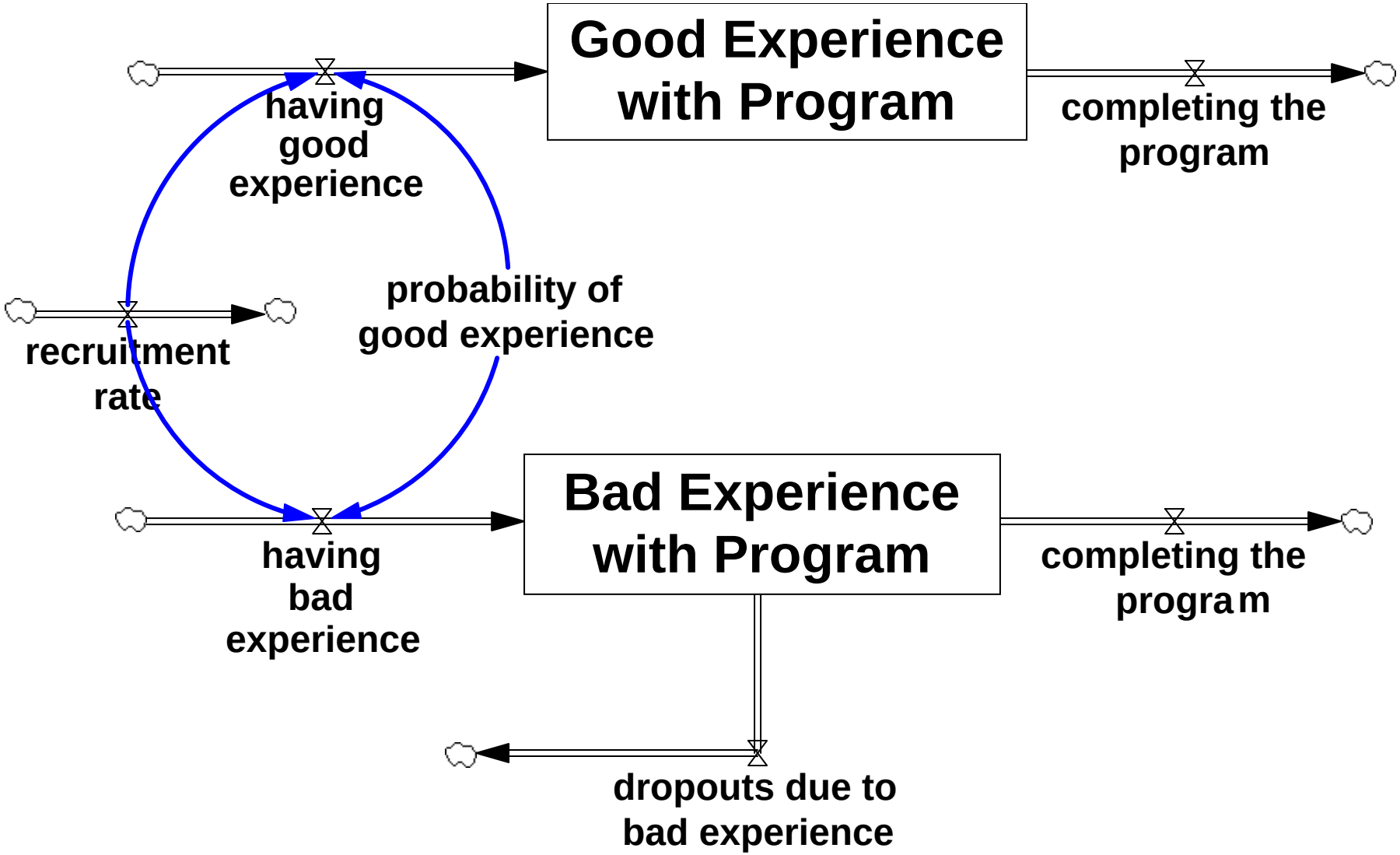
Client Flow



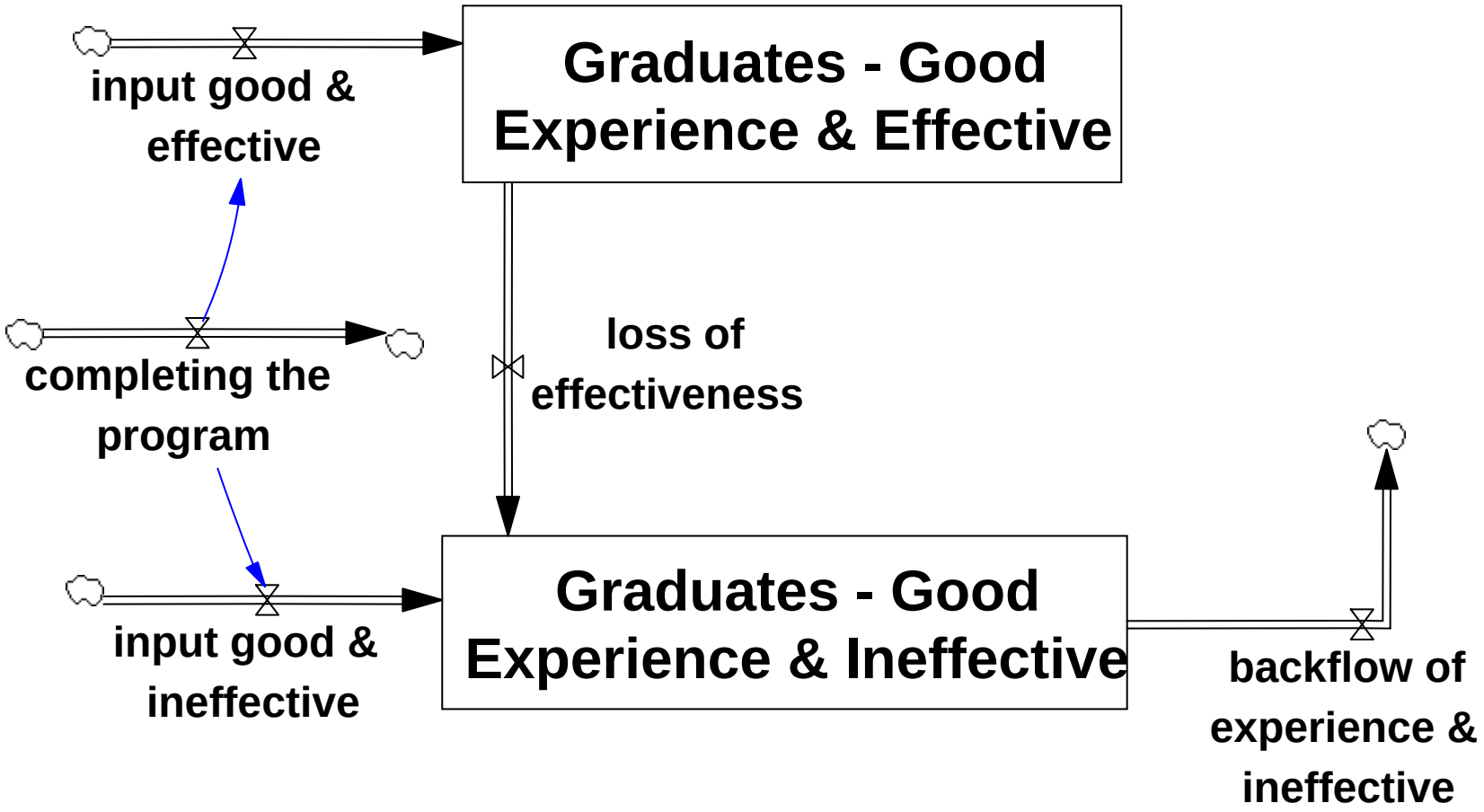
Differences in Motivation



Differences in Quality of Experience



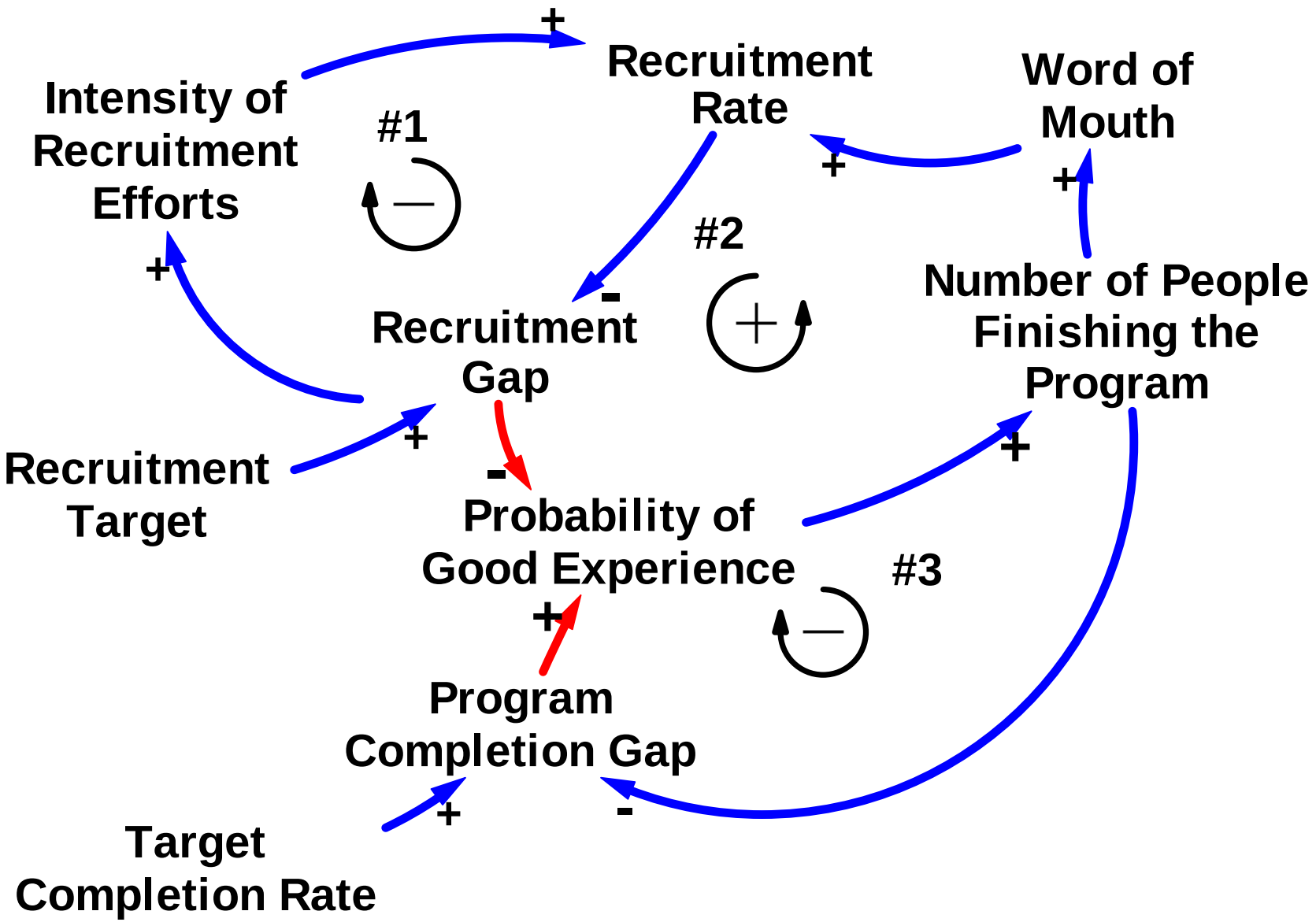
Differences in Program Effectiveness



Main Dynamic Hypotheses

Key Loop Structures

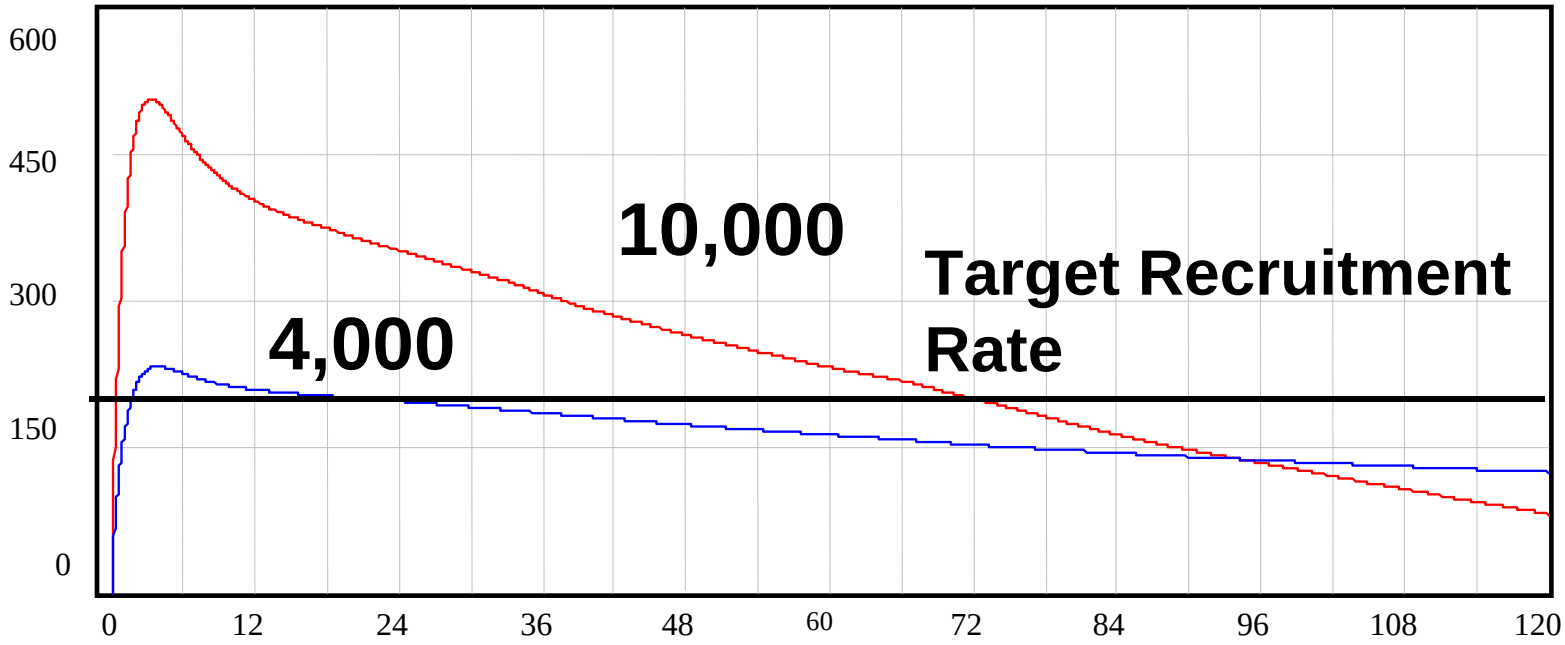
- Word of mouth
- Intensity of recruitment efforts
- Controlling the recruitment rate
- Controlling the graduation rate


Intensity of Recruitment Efforts
Recruitment Rate
Word of Mouth
#1
#2
#3
Recruitment Gap
Number of People Finishing the Program
Recruitment Target
Probability of Good Experience
Program Completion Gap
Target Completion Rate
+
+
+
+
+
+
+
-
-
-

Initial Parameterization

- Time horizon of 120 months
- Percentage of motivated people 20%
- Probability of a good experience .85
- Probability of changing habits .35
- Annual target recruitment rate 200 people

Effect of Target Population Size on Recruitment

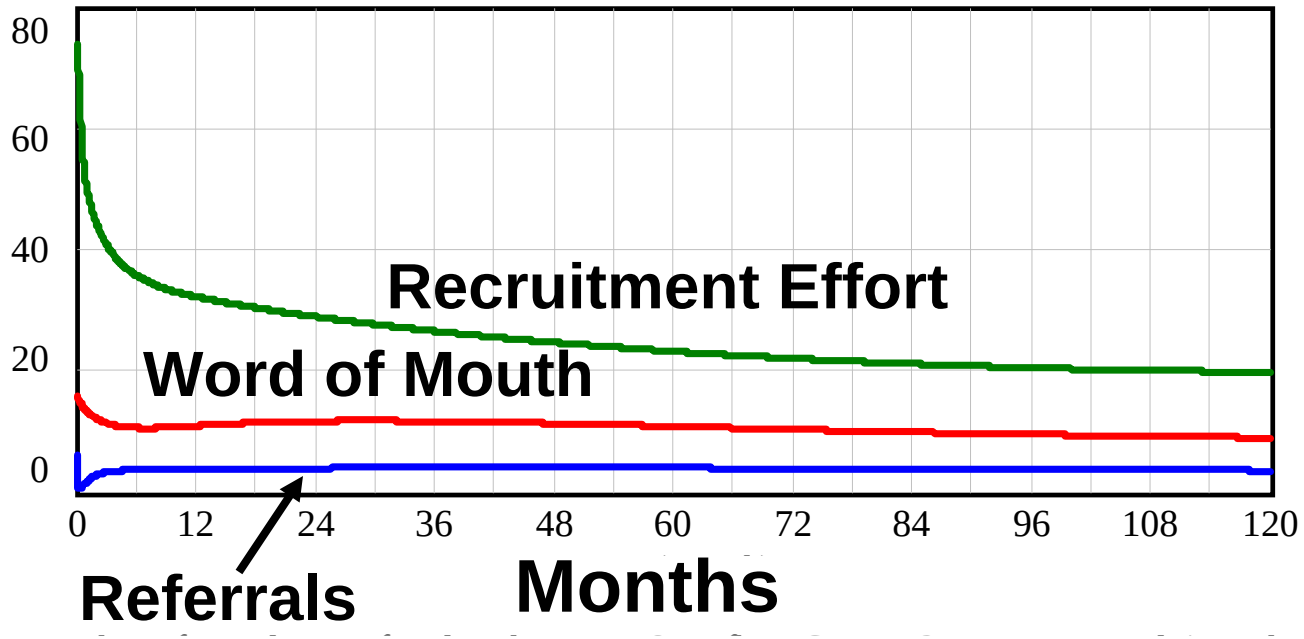


Comparing Internal Recruitment Determinants

Internal Recruitment Determinants

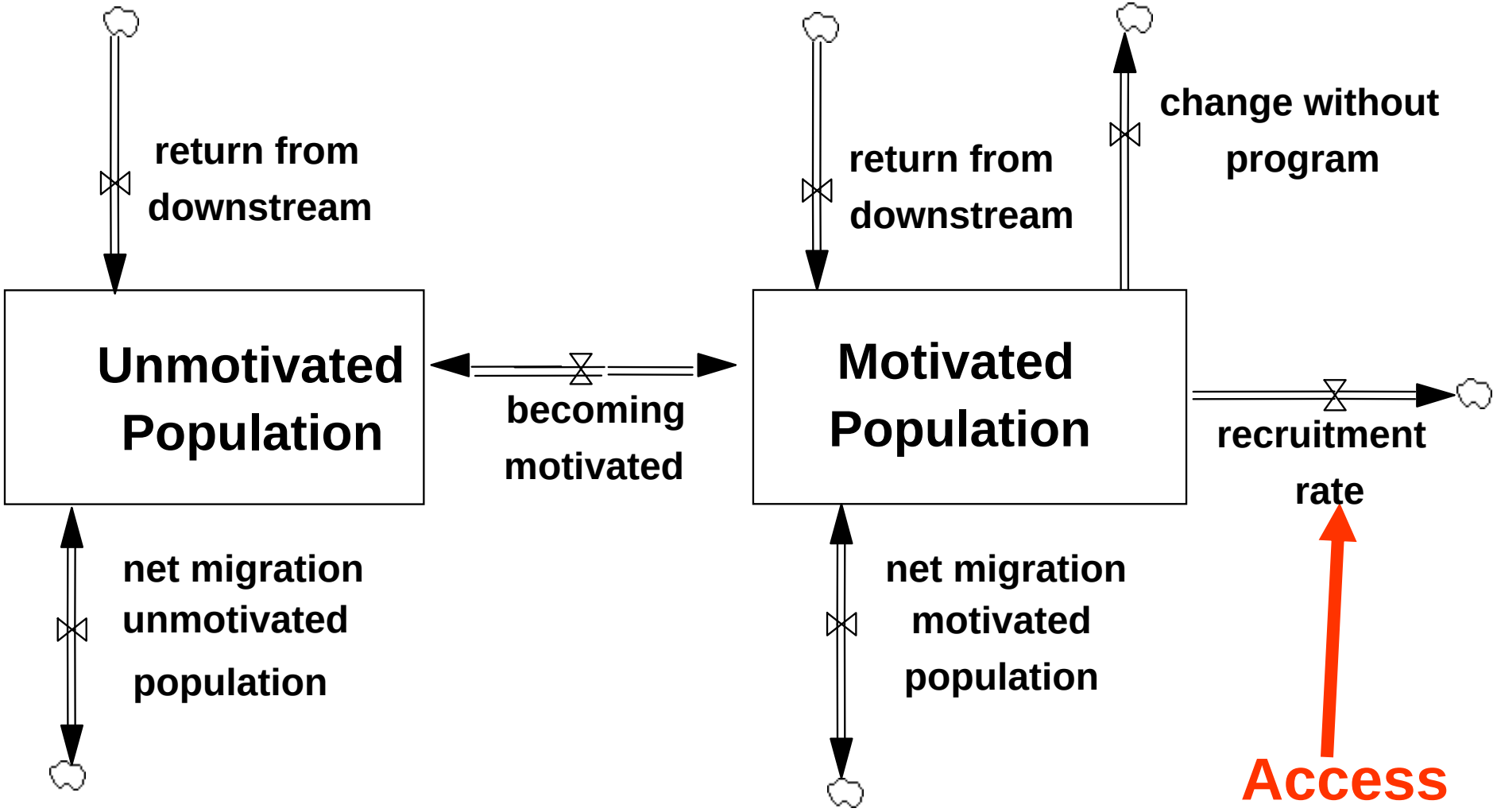
- Word of mouth
- Intensity of recruitment effort
- Referrals from other providers

Internal Recruitment Determinants

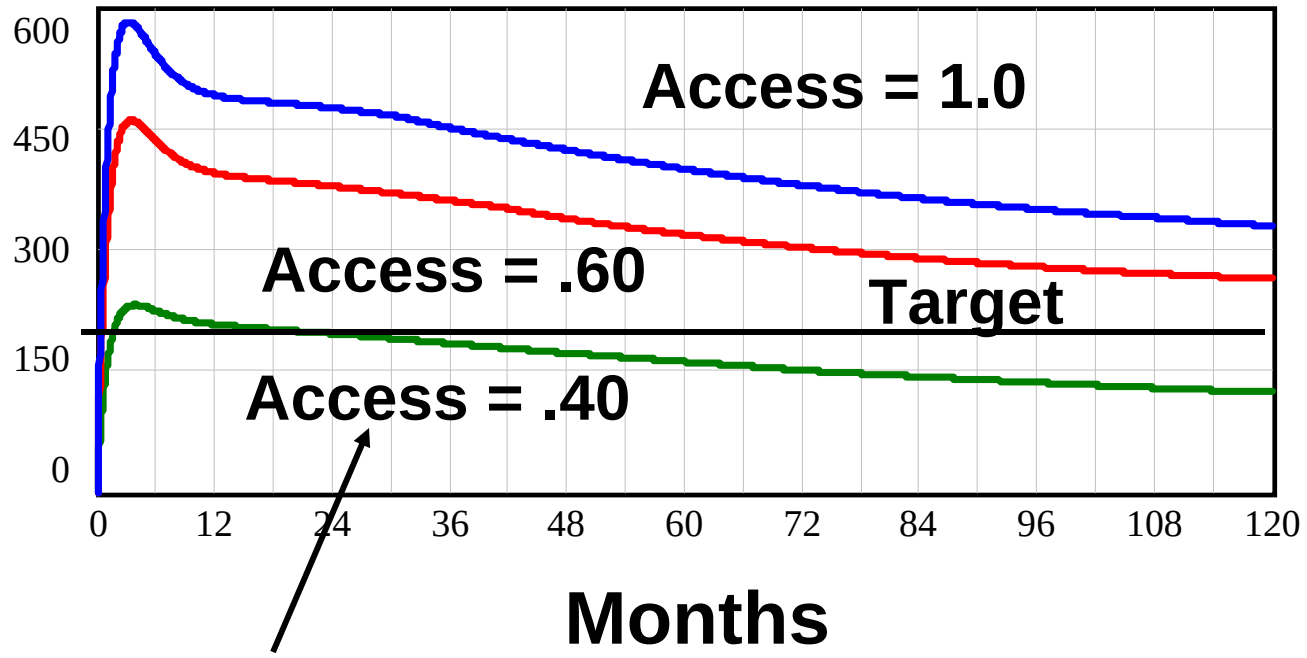


External Recruitment Determinants

Ease of Access to Program



Access and Recruitment Rate

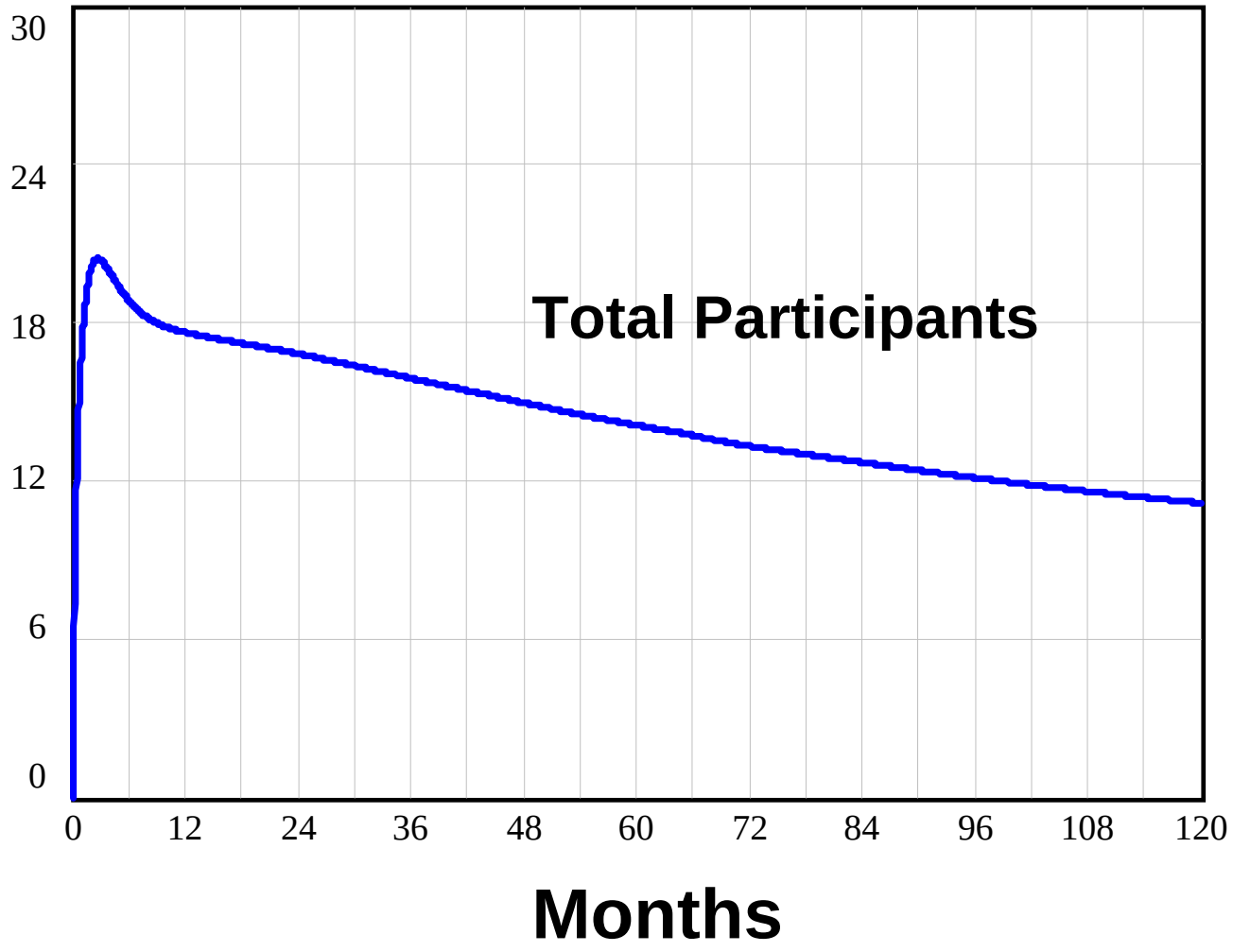


Base Run

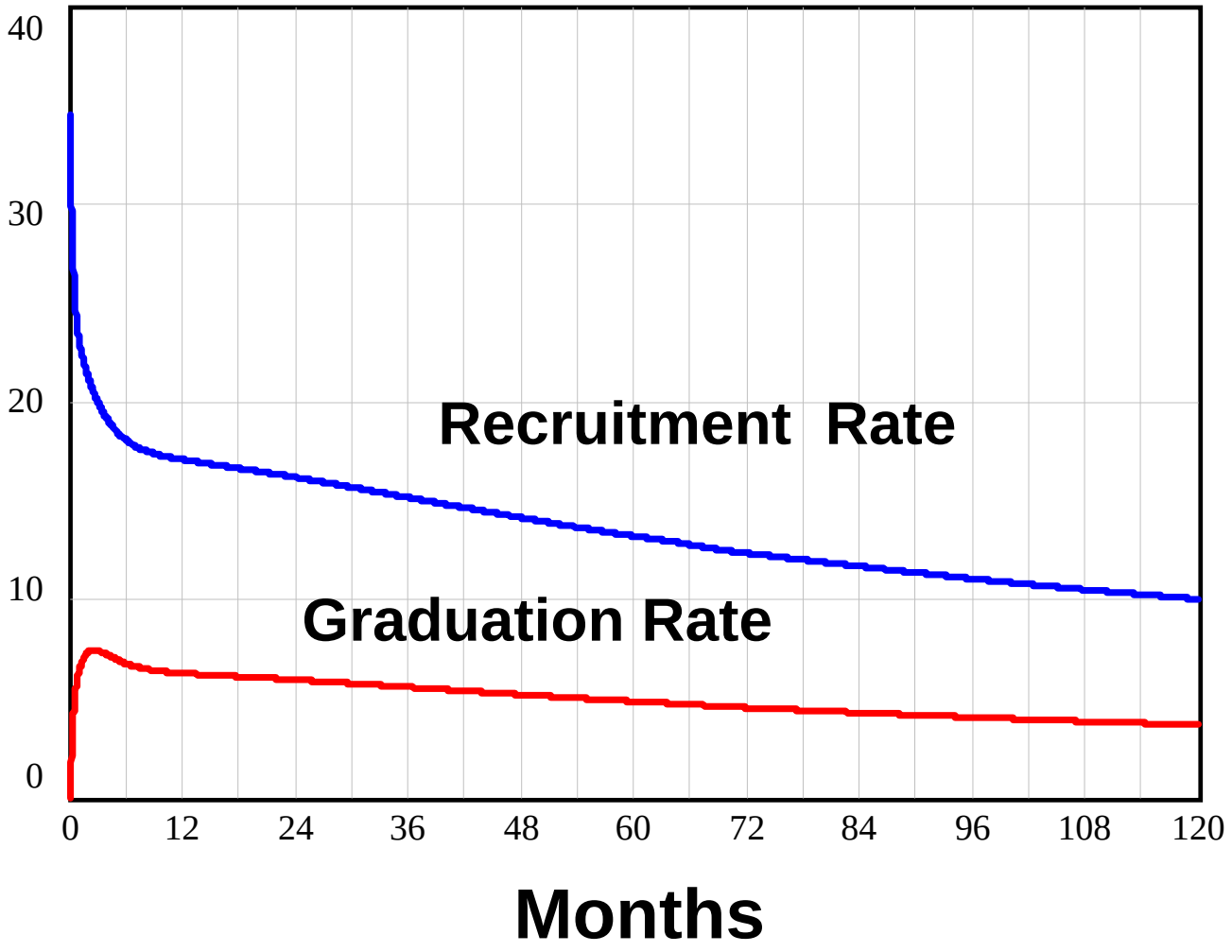
Target Population Size = 4,000

Moving Down the Chain: Participants

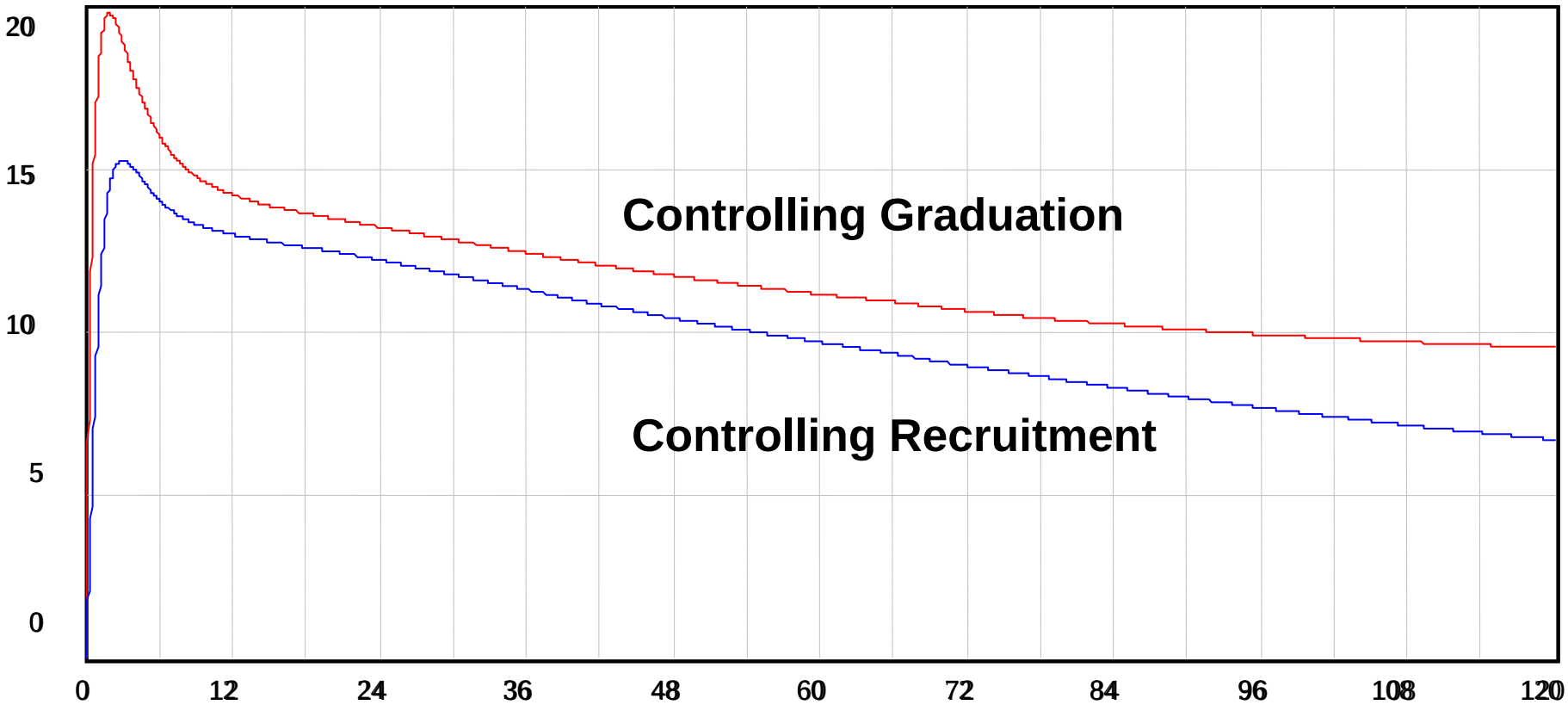
Monthly Total Number of Participants



Participant Input and Output Rates

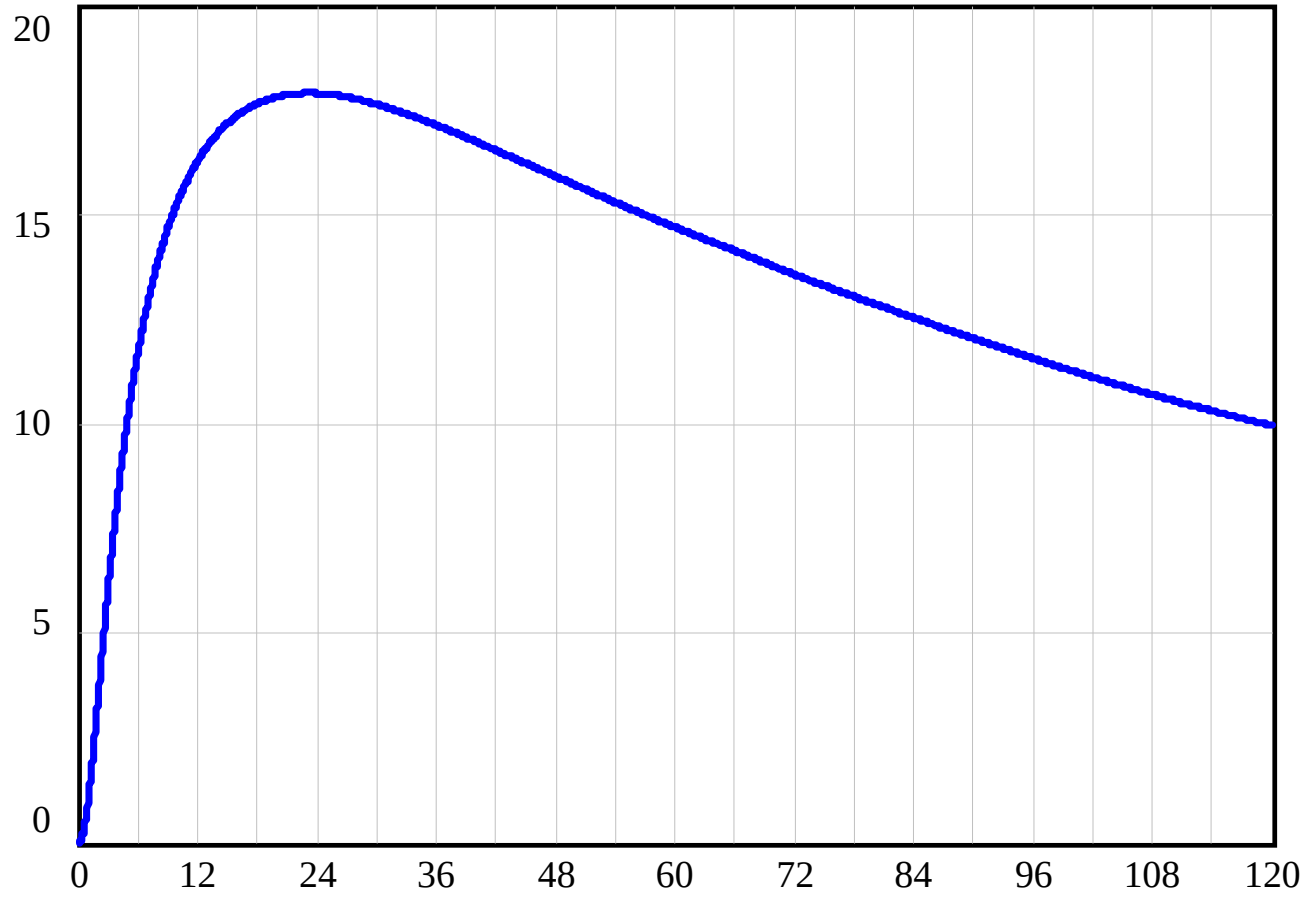


Number of Participants having a Good Experience by Control Policy

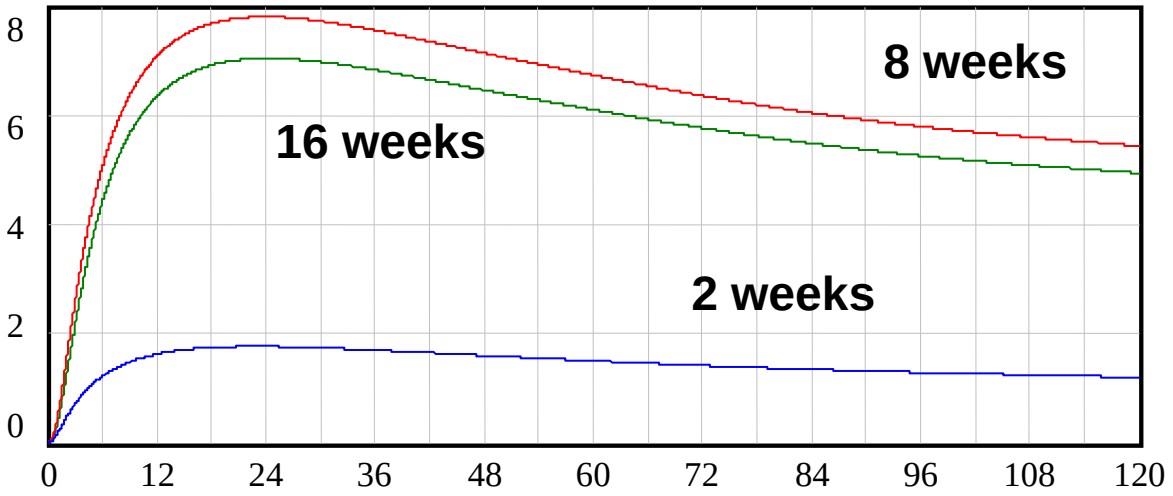


Moving Down the Chain: Graduates

Number of Graduates Having a Good Experience and Practicing Safer Sex



Number of Graduates Having a Good Experience and Practicing Safer Sex by Program Length



Months

Discussion and Implications

Summary of Results

- **Recruitment rates consistently fall below targets**
- **Ultimately, the number of people who graduate and change behavior is small**

Summary of Results

- Access is a major constraining factor in recruitment
- Word of mouth never contributes large numbers of people to recruitment
- There are leaks at every point in the pipeline

Implications

- **Advantages of evidence-based small group workshops may be lost because of recruitment challenges and leaks**
- **Agencies may have to change the program to increase throughput (e.g., shorten it, increase group size)**

But…..

- **Some changes may decrease the program's effectiveness**

Implications for Evaluation

- Using system dynamics as an adjunct tool can provide new insight into the process of program implementation
- Modeling can lead to counterintuitive findings

- **System dynamics provides a theoretical framework for posing new evaluation questions**
- **Allows evaluators to explore changes to the system more efficiently than can often be done in real-time evaluations**