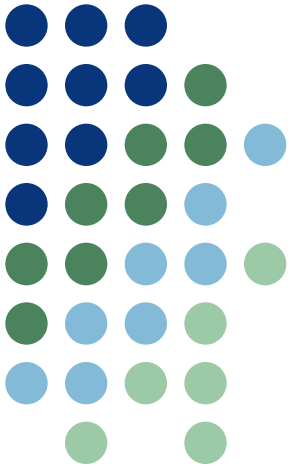
Systems Science & Tobacco Control

Bringing it all together



Center for Public Health Systems Science

GEORGE WARREN BROWN SCHOOL OF SOCIAL WORK

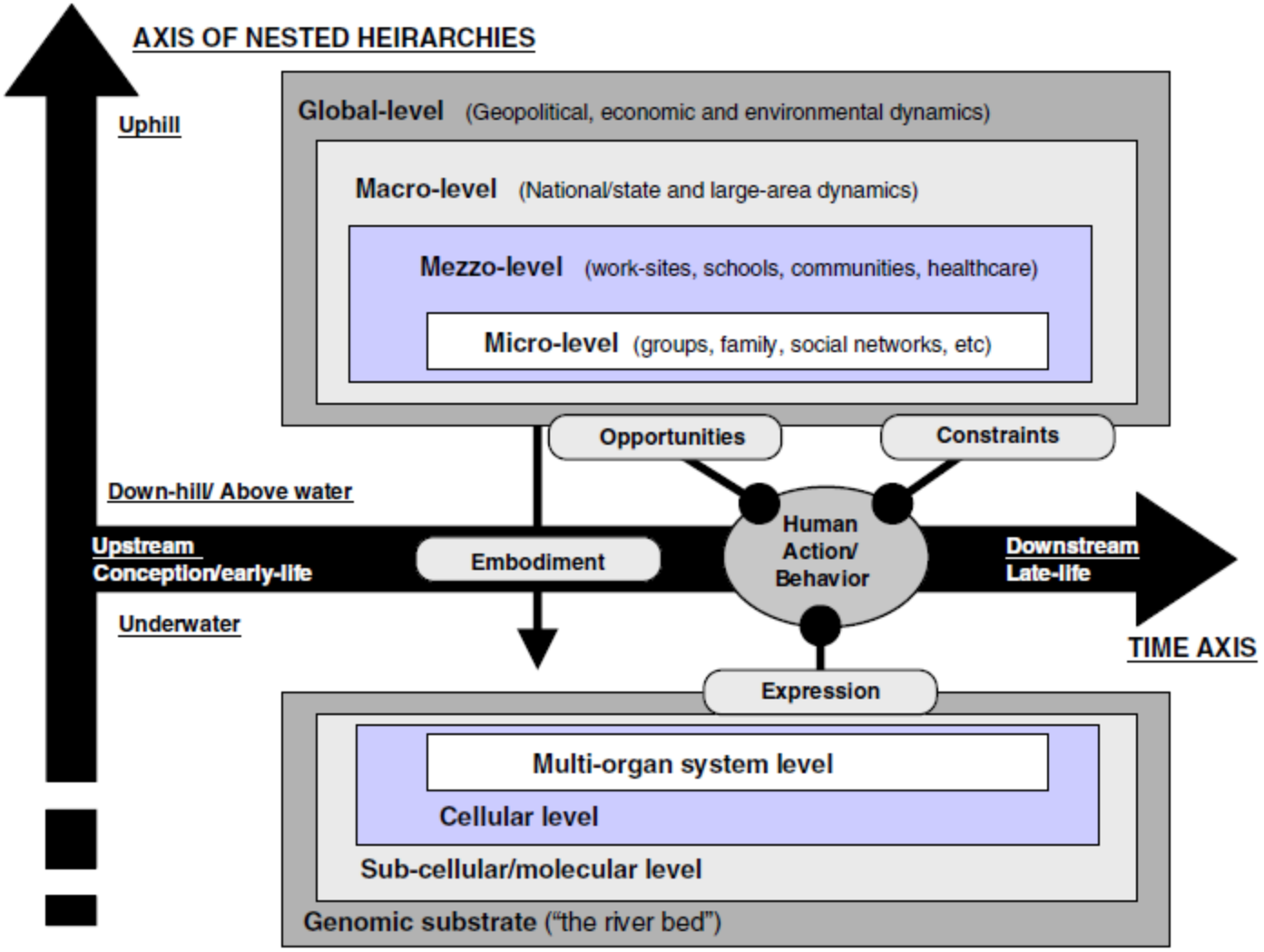
AAHB AMERICAN ACADEMY OF HEALTH BEHAVIOR

A MULTIDISCIPLINARY SOCIETY OF HEALTH BEHAVIOR SCHOLARS AND RESEARCHERS

Goals

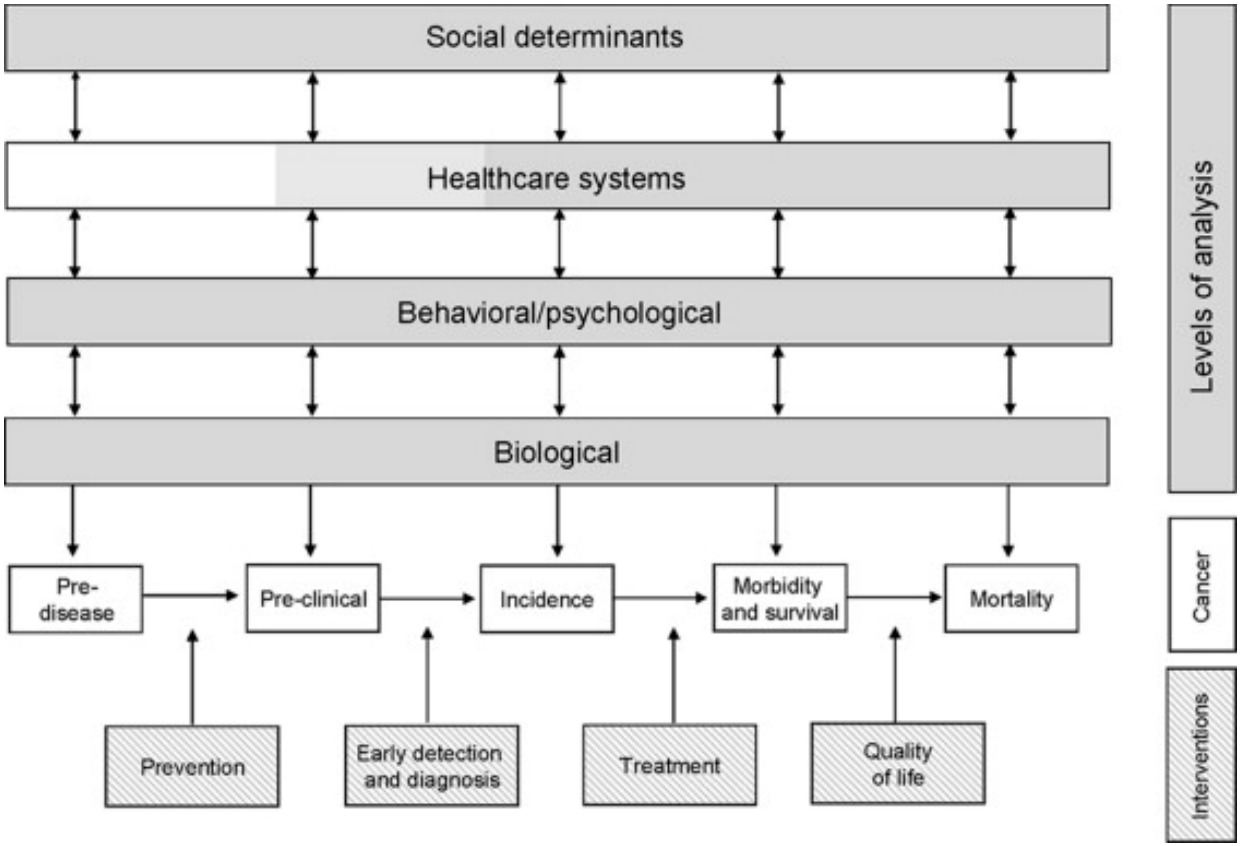
- Present case study of how systems science has been used to address one particular scientific and public health challenge: tobacco control
- Organized by four basic goals of systems modeling:
  - Mapping
  - Predicting
  - Illuminating
  - Explaining

Complex behaviors: Levels of nested systems and time



From Glass & McAtee, 2006, *SSM*

Ecological framework: Social determinants of cancer



From Hiatt & Breen, 2008, *AJPM*

Applicability of systems science methods to tobacco control

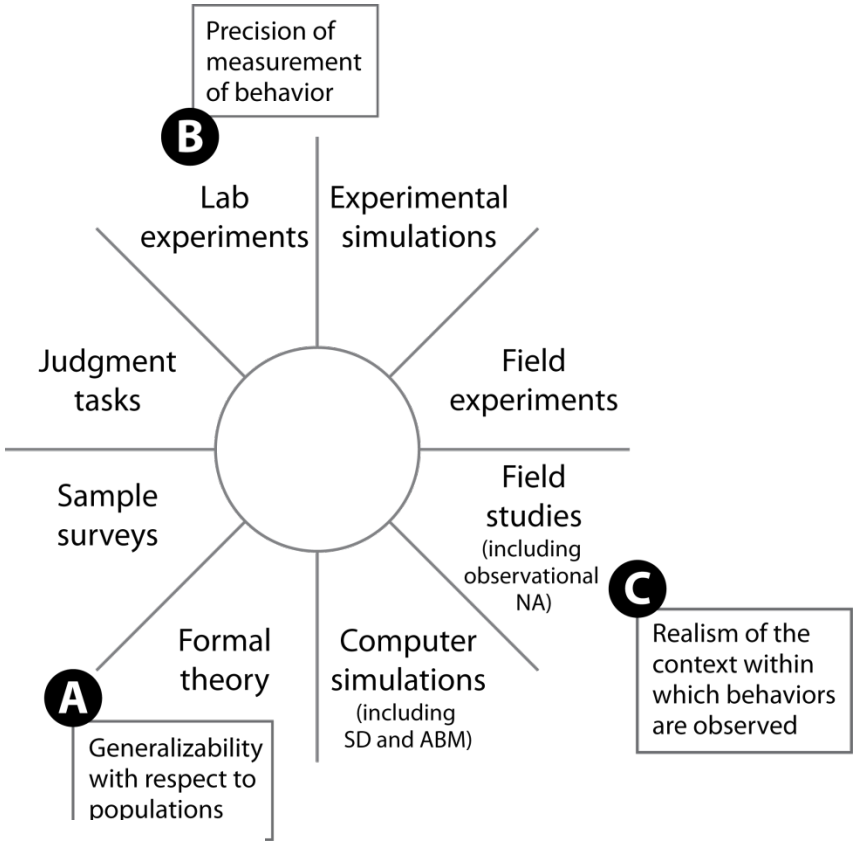
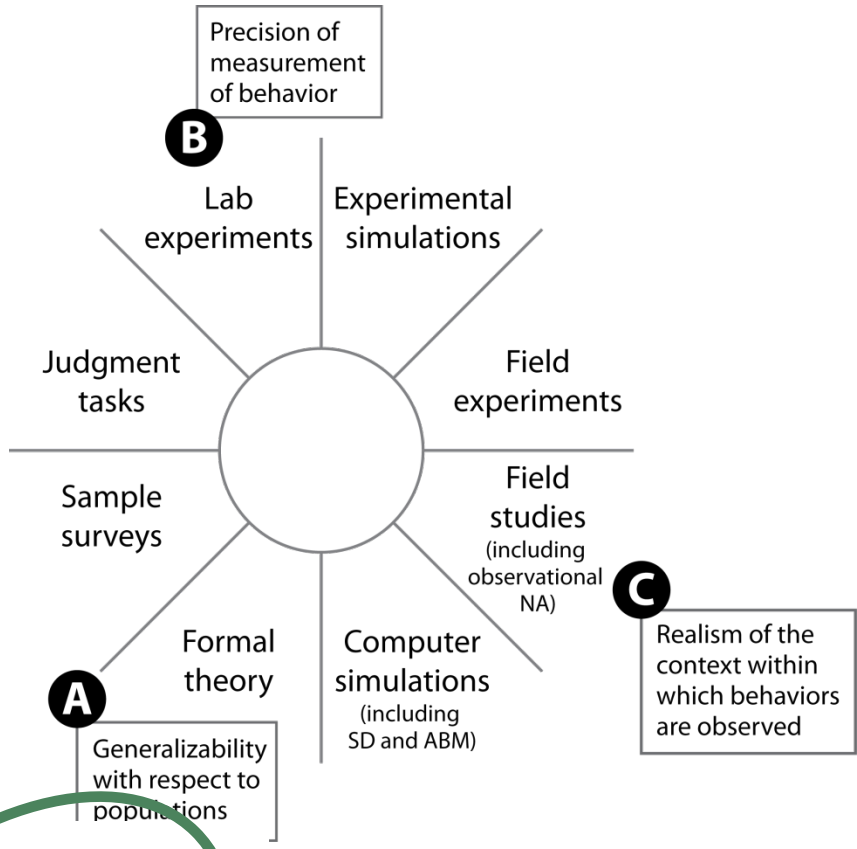


Table 1 Comparison of traditional and complex system analytic assumptions

Domain	Traditional analytic techniques assumptions	Complex systems assumptions
Functional form	Linearity	Nonlinearity
Common distributions	Normality	Nonnormality
Characteristics of actors	Homogeneity	Heterogeneity
Level of analysis	Single level	Multiple levels
Temporality	Static or discretely longitudinal	Dynamic, with feedback
Fundamental relationships	Among variables	Interaction of actors
Perspective	Reductionist	Holistic

From Luke & Stamatakis, 2012, *ARPH*

Applicability of systems science methods to tobacco control



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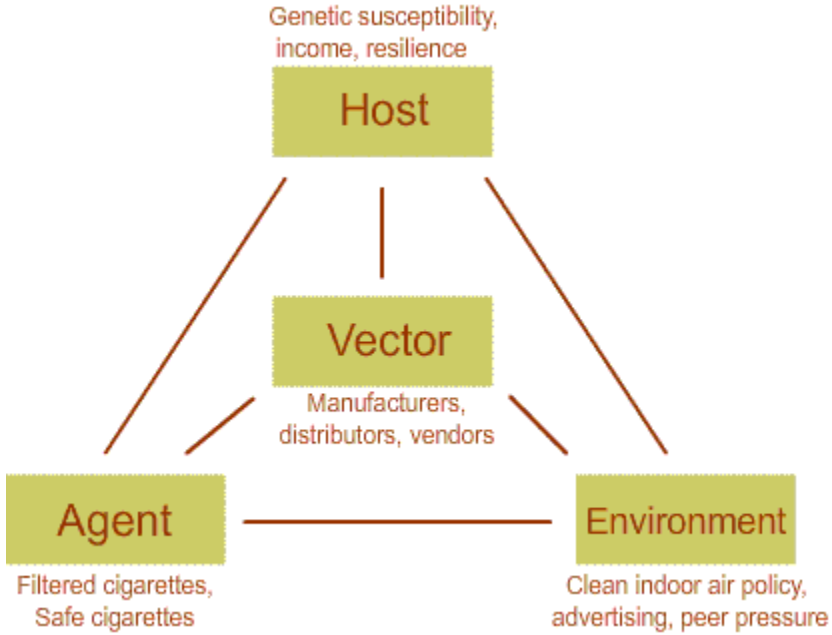
From Luke & Stamatakis, 2012, *ARPH*

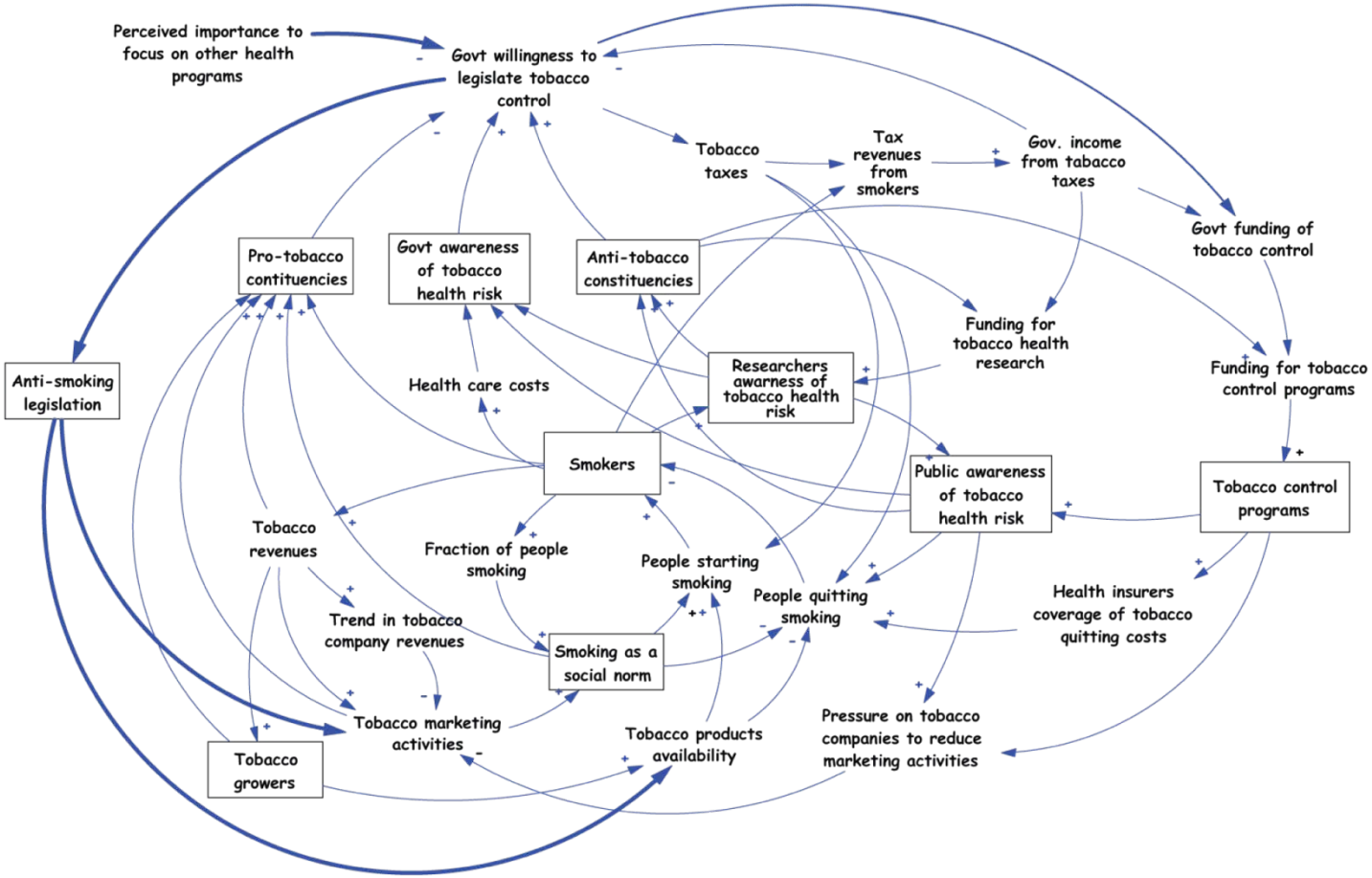
Tobacco control – Multiple levels, heterogeneous actors, interactivity

Level	Research area
Global	International trade
National	Tobacco regulation
Media	Effective messaging
Industry	Economics of tobacco control
Communities	Smokefree policies
Group	Social determinants
Person	Cessation
Product	Reduced harm
Gene, cellular	Nicotine dependence

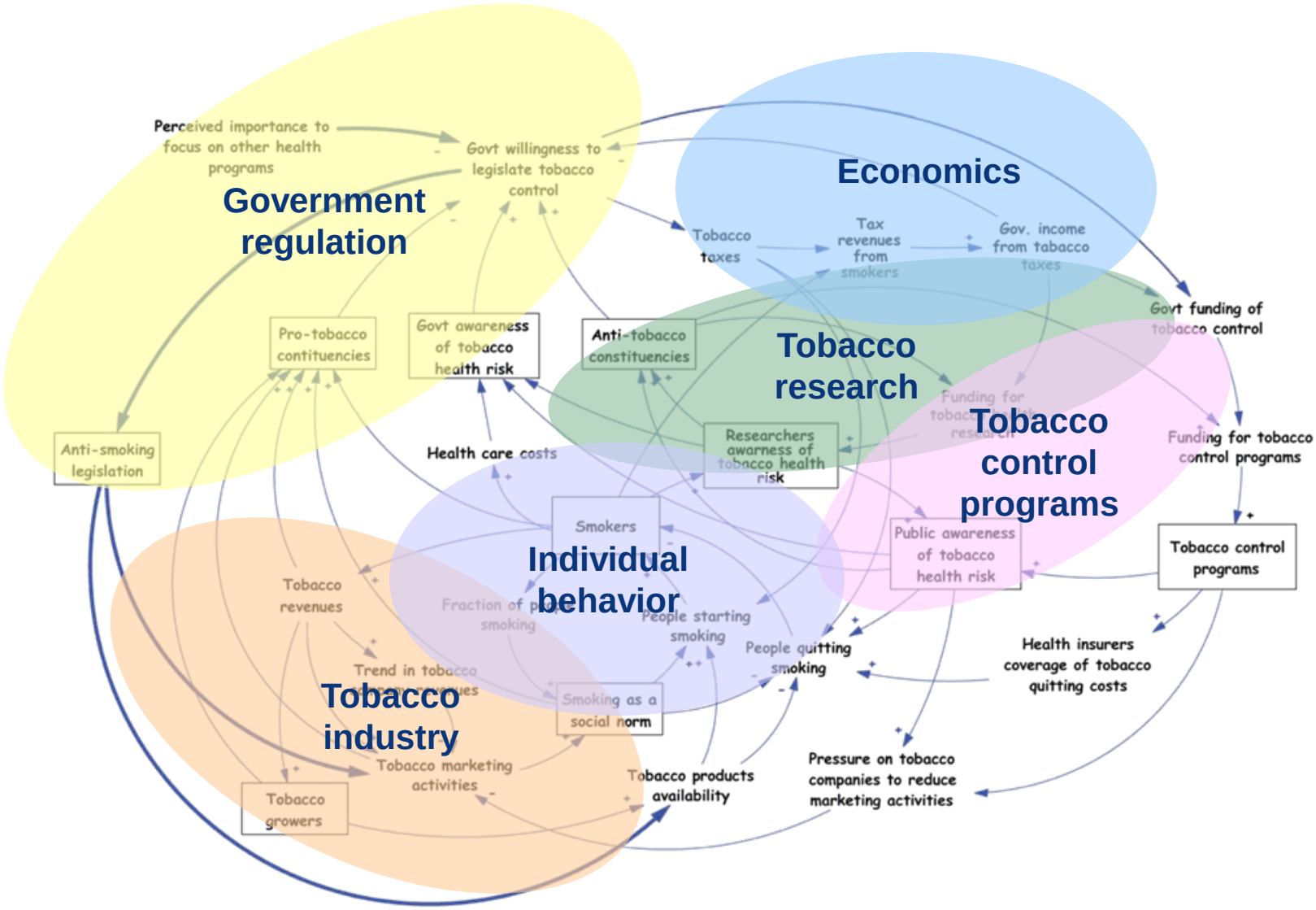


Based on Giovino, 2002, *Oncogene*

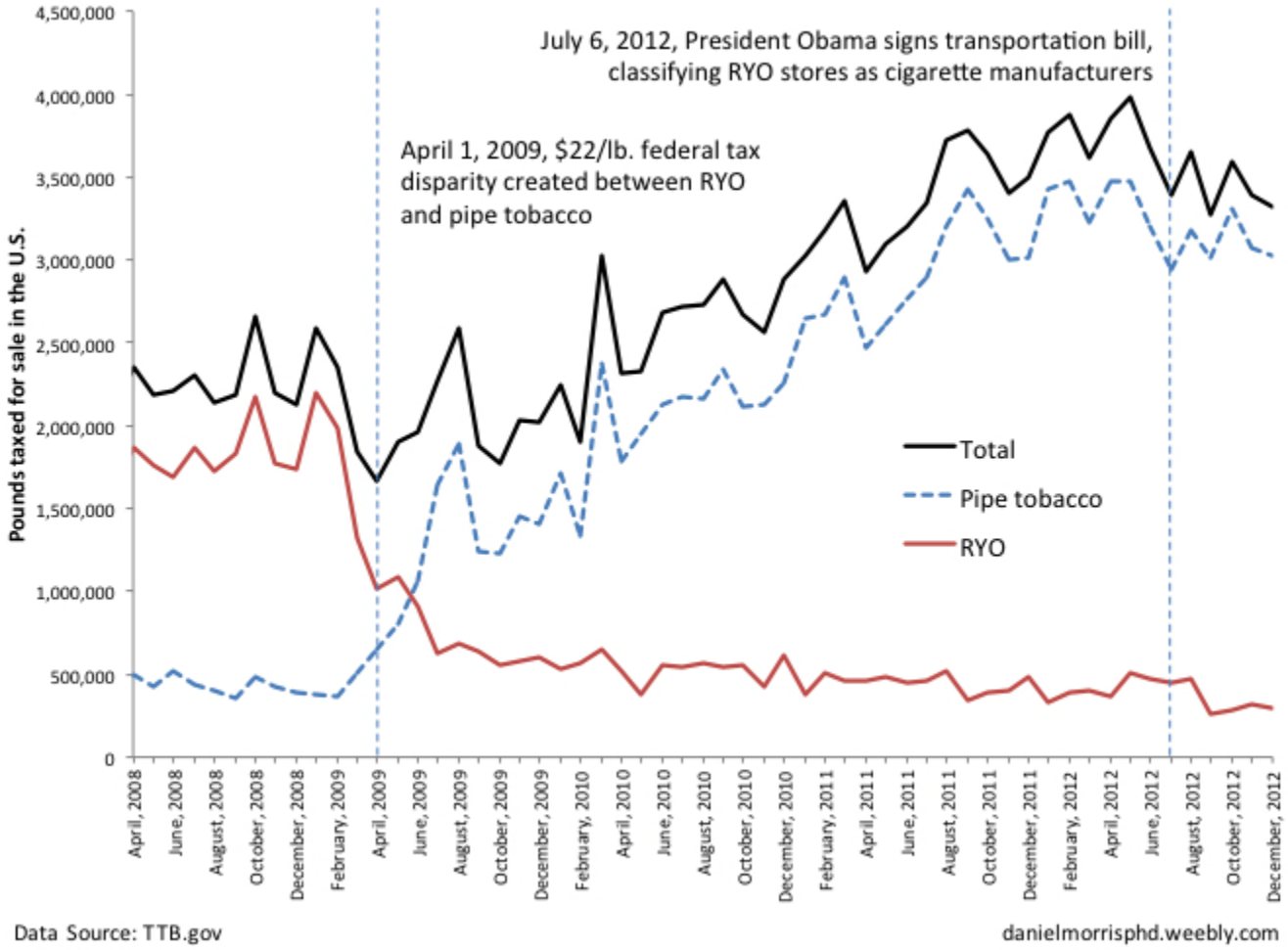
Tobacco control as a complex system



From Best, et al., 2007, *NCI Monograph #18*


Government regulation
Economics
Tobacco research
Tobacco control programs
Individual behavior
Tobacco industry
Perceived importance to focus on other health programs
Govt willingness to legislate tobacco control
Tobacco taxes
Tax revenues from smokers
Gov. income from tabacco taxes
Govt funding of tobacco control
Pro-tobacco contituencies
Govt awareness of tobacco health risk
Anti-tobacco constituencies
Funding for tobacco control programs
Anti-smoking legislation
Health care costs
Researchers awarness of tobacco health risk
Smokers
Public awareness of tobacco health risk
Tobacco control programs
Tobacco revenues
Fraction of people smoking
People starting smoking
People quitting smoking
Health insurers coverage of tobacco quitting costs
Trend in tobacco
Smoking as a social norm
Tobacco marketing activities
Tobacco products availability
Pressure on tobacco companies to reduce marketing activities
Tobacco growers

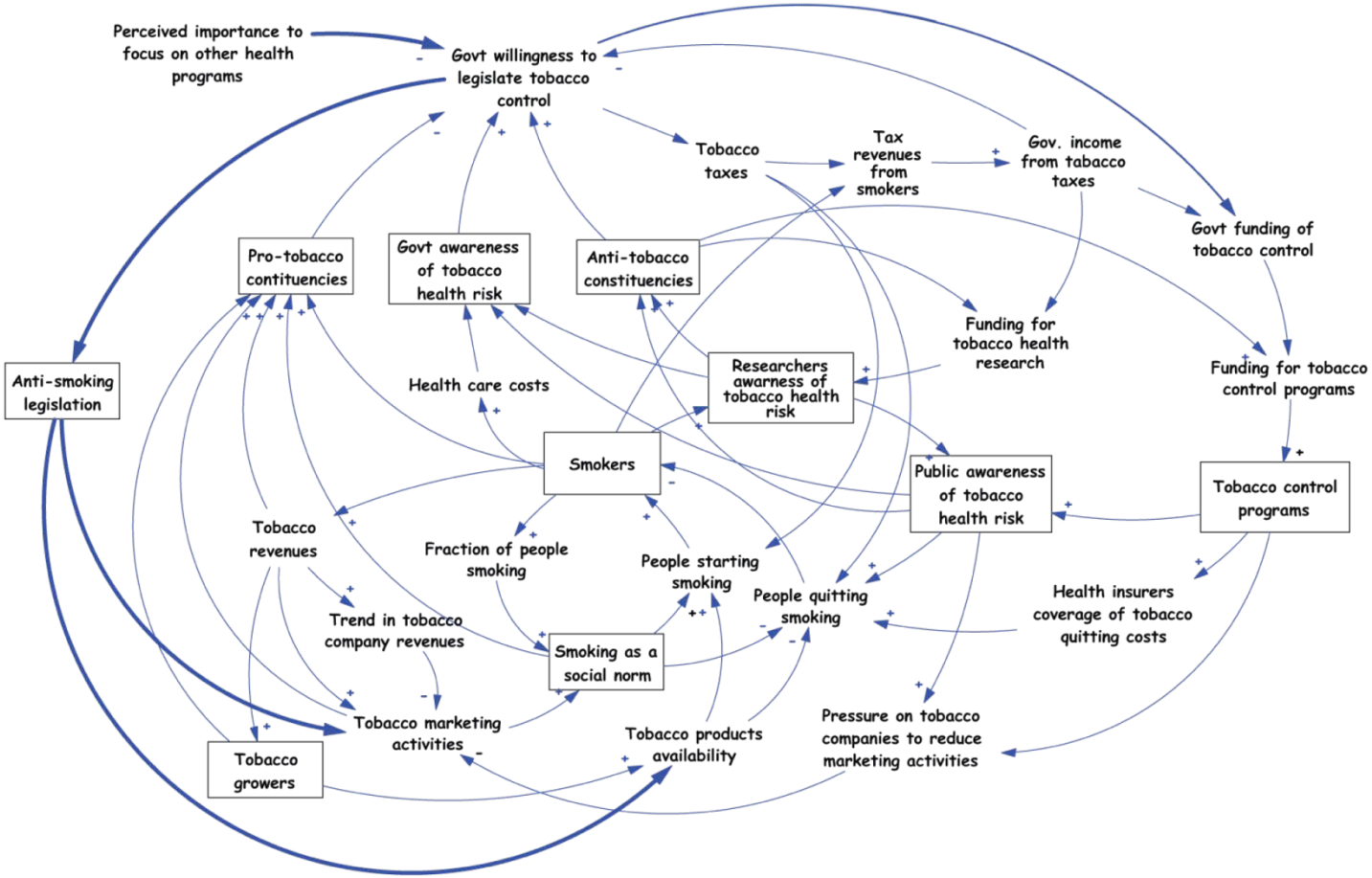
Example – Dynamic nature of tobacco control



Identifying system members and revealing system structure

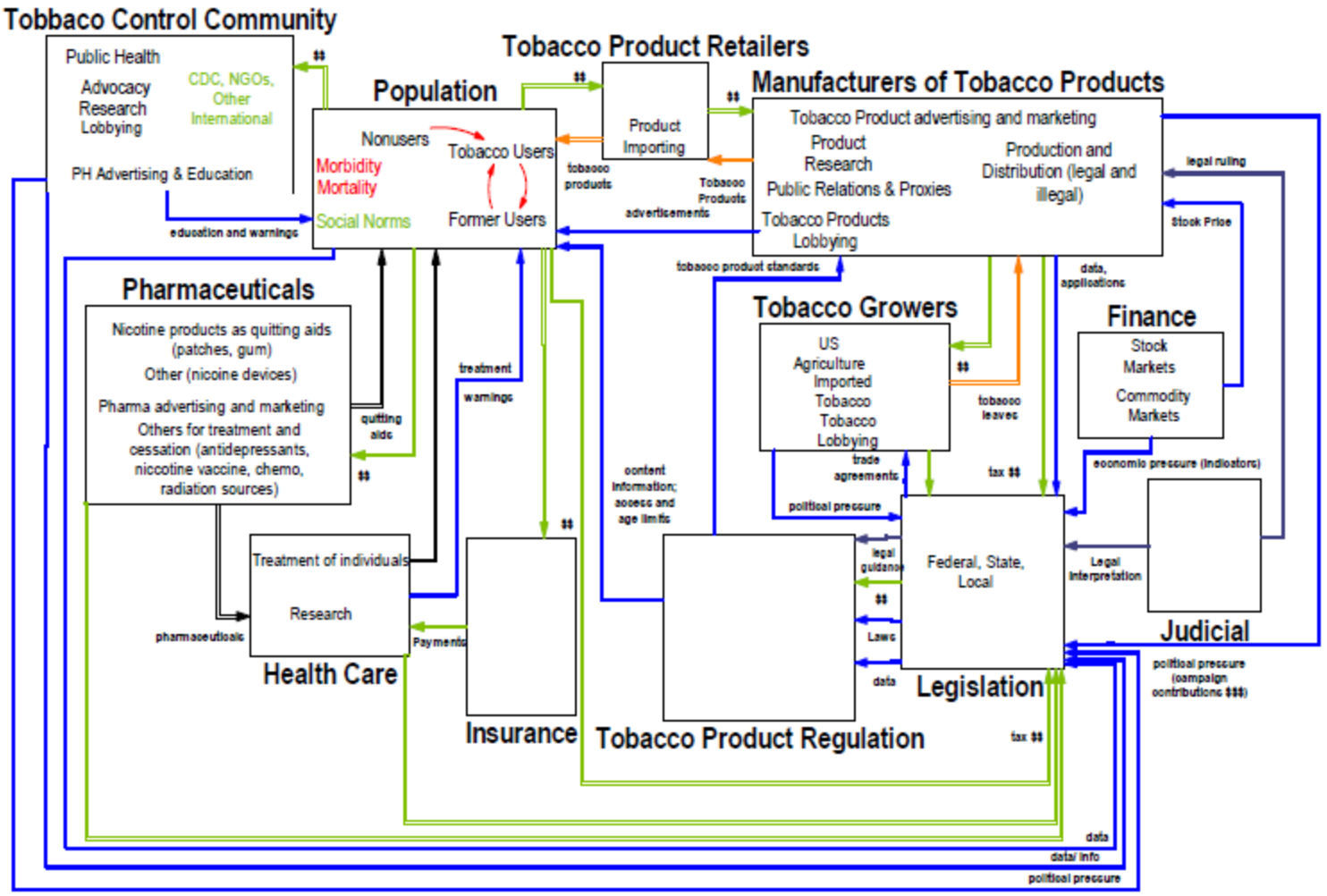
MAPPING

ISIS – TC causal map to direct dynamic systems model



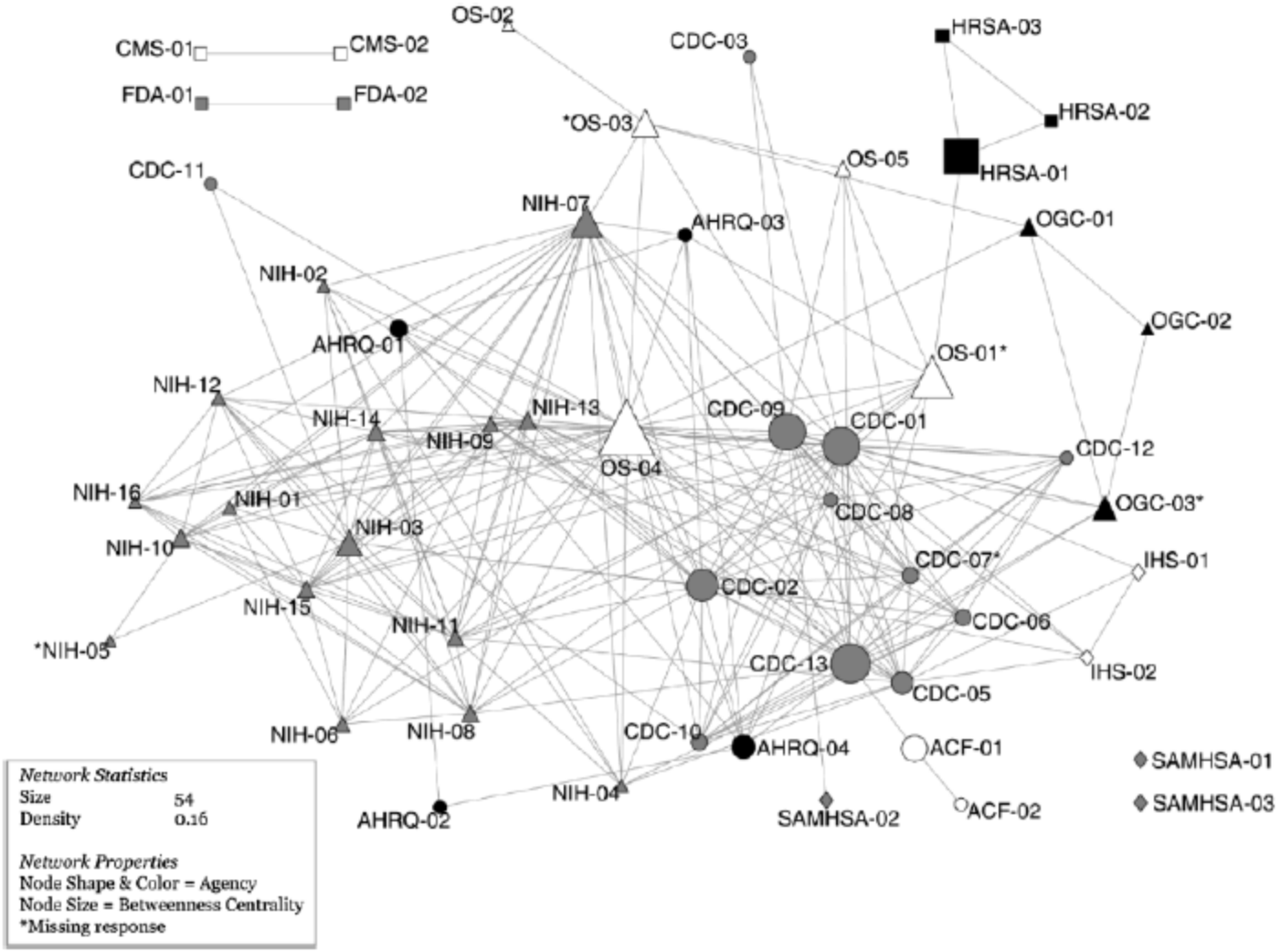
From Best, et al., 2007, *NCI Monograph #18*

Map of tobacco products ‘system of systems’



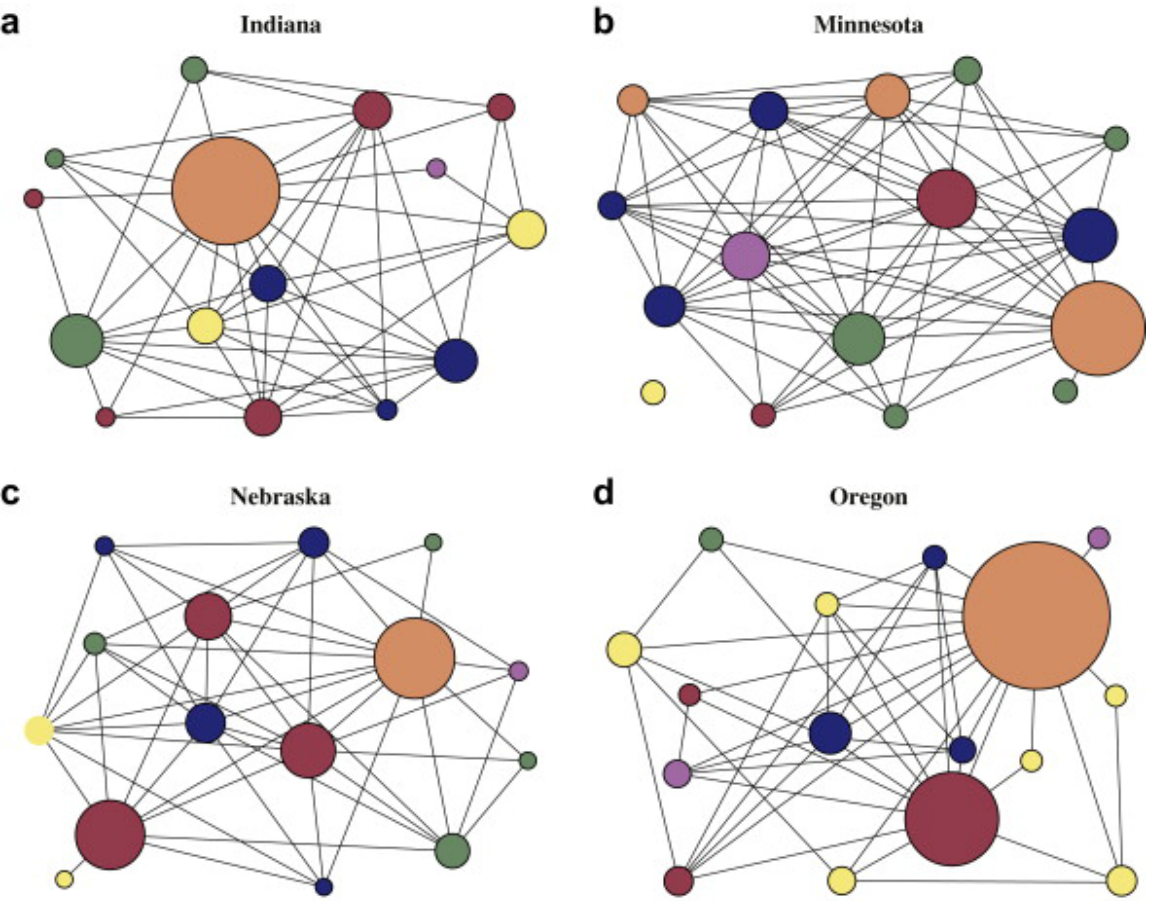
From Brown, et al., 2011, *www.sandia.gov*

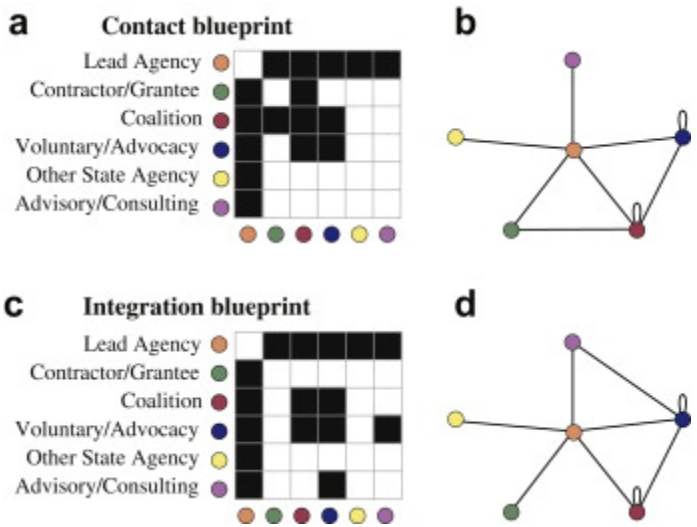
Mapping DHHS Tobacco Control Leadership



From Leischow, et al., 2010, *NTR*

Organizational ‘blueprints’ for state tobacco control programs





From Harris, Luke, Brooke, & Mueller, 2008, *SSM*

Using systems analysis to forecast the behavior of the system

PREDICTING

From Mendez & Warner, 2000, *AJPH*

ABSTRACT

Smoking Prevalence in 2010: Why the Healthy People Goal Is Unattainable

David Mendez, PhD, and Kenneth E. Warner, PhD

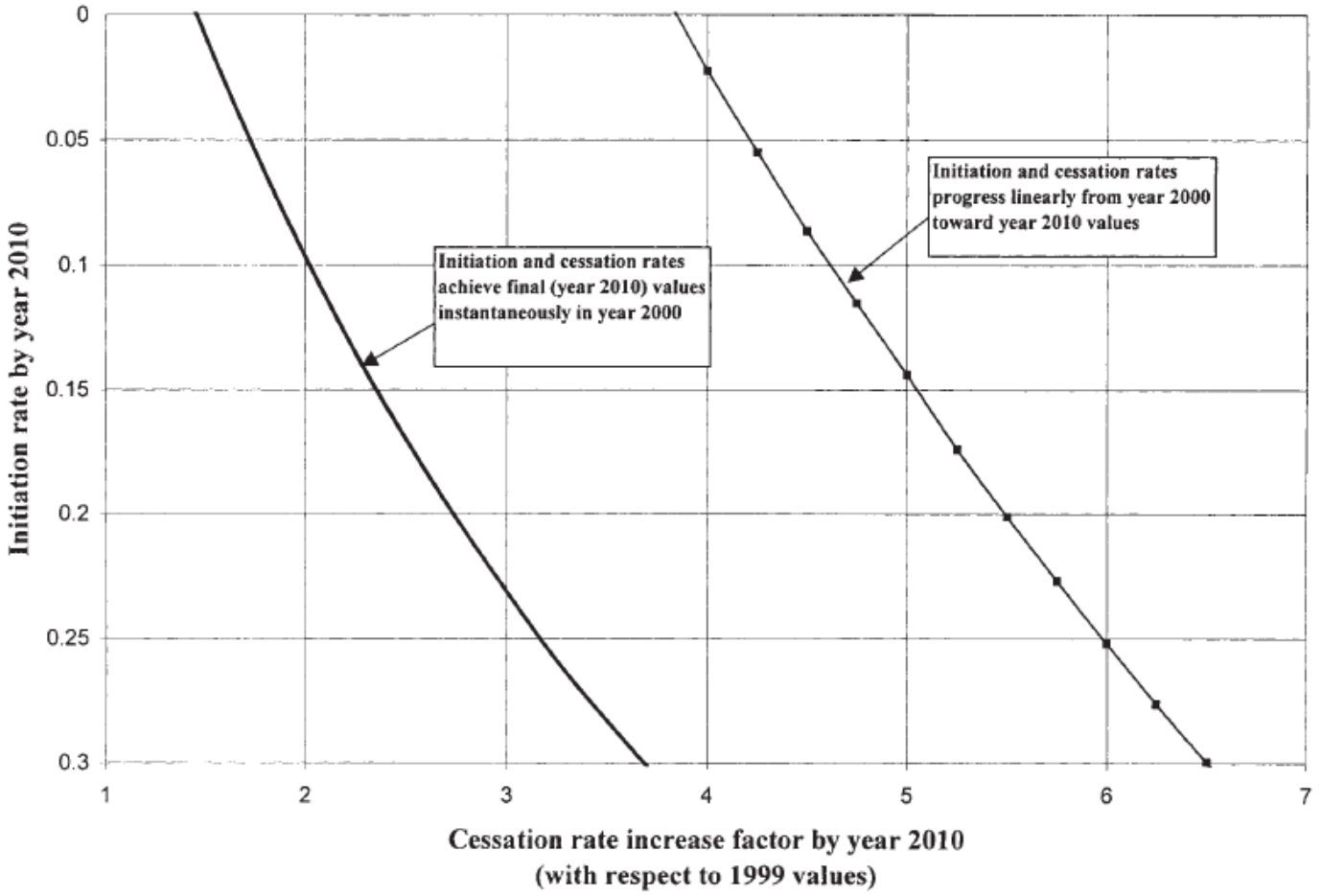
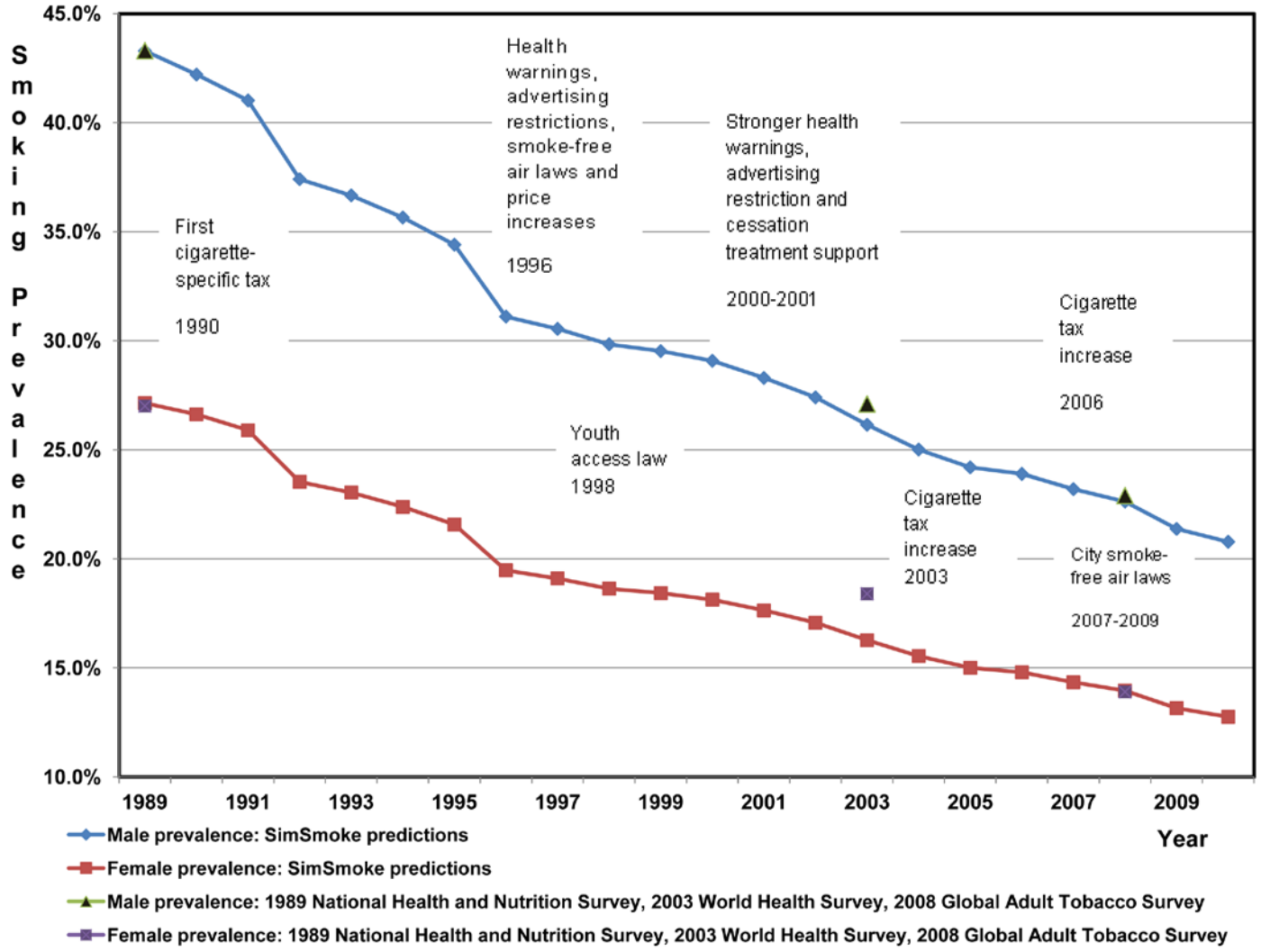


FIGURE 1—Combinations of initiation and cessation rates that would produce a 13% adult smoking prevalence in the year 2010.

SimSmoke – Example from Brazil



From Levy, de Almeida, & Szklo, 2012,
PLOS Medicine

Using systems model to examine counterfactuals

Policy Implementation	Year							
	1989	2000	2010	2010 Lower Bound[a]	2010 Upper Bound[a]	2050	2050 Lower Bound[a]	2050 Upper Bound[a]
Smoking prevalence								
Counterfactual: all policies at 1989 level	35.4%	32.6%	31.0%			24.9%		
All policies implemented	35.4%	23.7%	16.8%	22.2%	10.5%	10.3%	15.7%	5.6%
Percent reduction in smoking prevalence from policy change[a]								
All policies		−27.4%	−45.9%	−27.8%	−66.4%	−59.1%	−35.9%	−77.9%
Price only		−18.4%	−27.1%	−21.2%	−32.5%	−35.7%	−28.1%	−42.5%
Smoke-free air only		−4.7%	−7.6%	−3.9%	−11.3%	−9.6%	−4.9%	−14.2%
Mass media campaign only		0.0%	−3.5%	−1.8%	−5.3%	−4.5%	−2.3%	−6.8%
Marketing restrictions only		−5.3%	−7.7%	−3.9%	−11.4%	−9.8%	−4.9%	−14.5%
Health warnings only		−0.6%	−4.4%	−2.2%	−6.5%	−6.5%	−3.3%	−9.6%
Cessation treatment only		−1.8%	−5.5%	−1.3%	−24.8%	−9.5%	−4.7%	−19.5%
Youth access restrictions only		0.0%	−0.2%	0.0%	−0.1%	−0.5%	0.0%	−0.8%

[a]Represents the percent change in prevalence due to a particular policy or all policies relative to the counterfactual with all policies maintained at their 1989 level.
doi:10.1371/journal.pmed.1001336.t003

Levy D, de Almeida LM, Szklo A (2012) The Brazil SimSmoke Policy Simulation Model: The Effect of Strong Tobacco Control Policies on Smoking Prevalence and Smoking-Attributable Deaths in a Middle Income Nation. PLoS Med 9(11): e1001336. doi:10.1371/journal.pmed.1001336
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CISNET – Smoking history generator

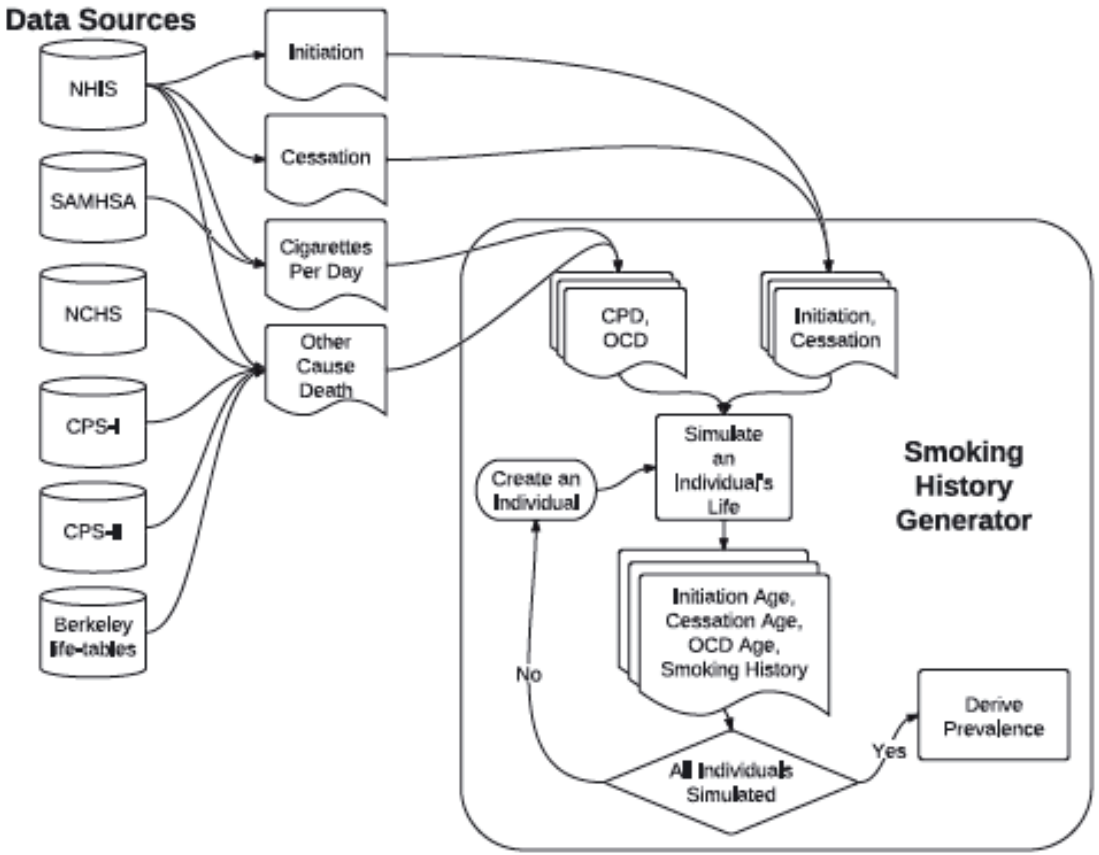


Fig. 1. Flow diagram of the smoking history generator.

From Jeon, et al, 2012, *Risk Analysis*

CISNET – Yale Cancer Model

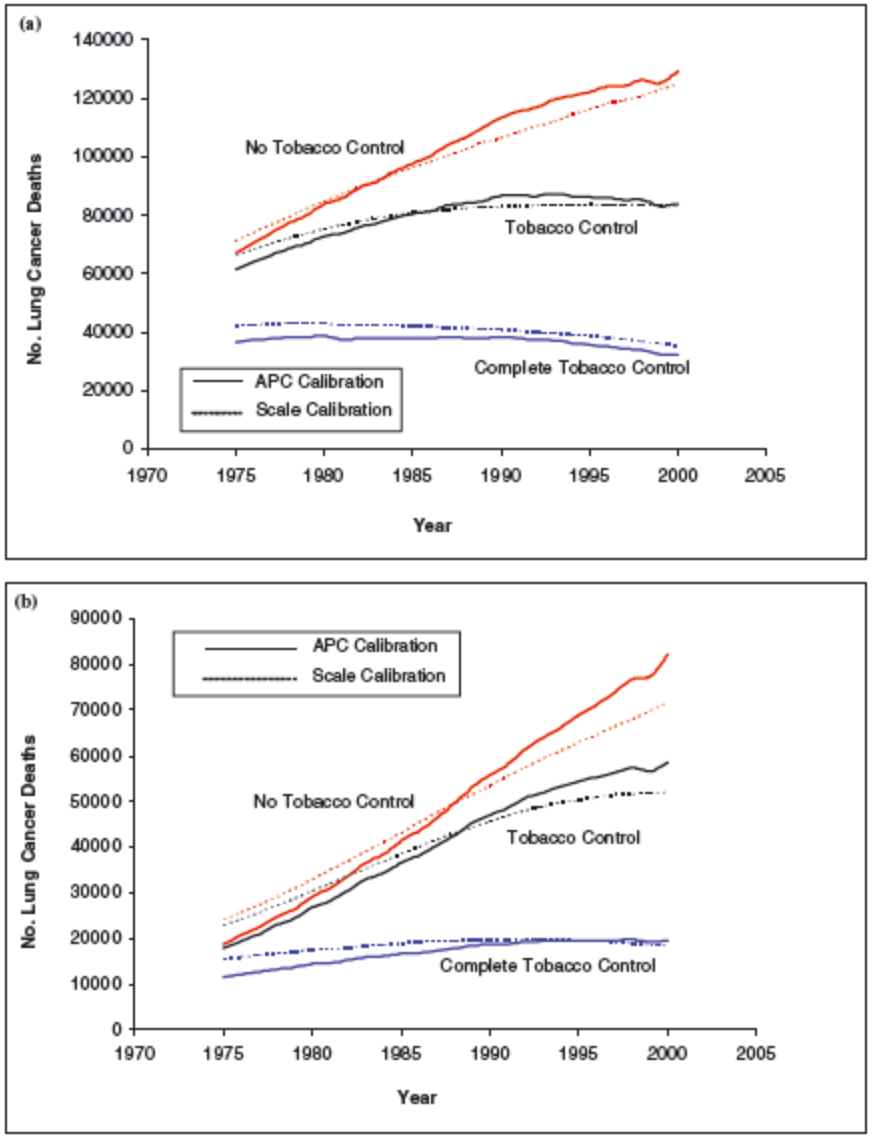


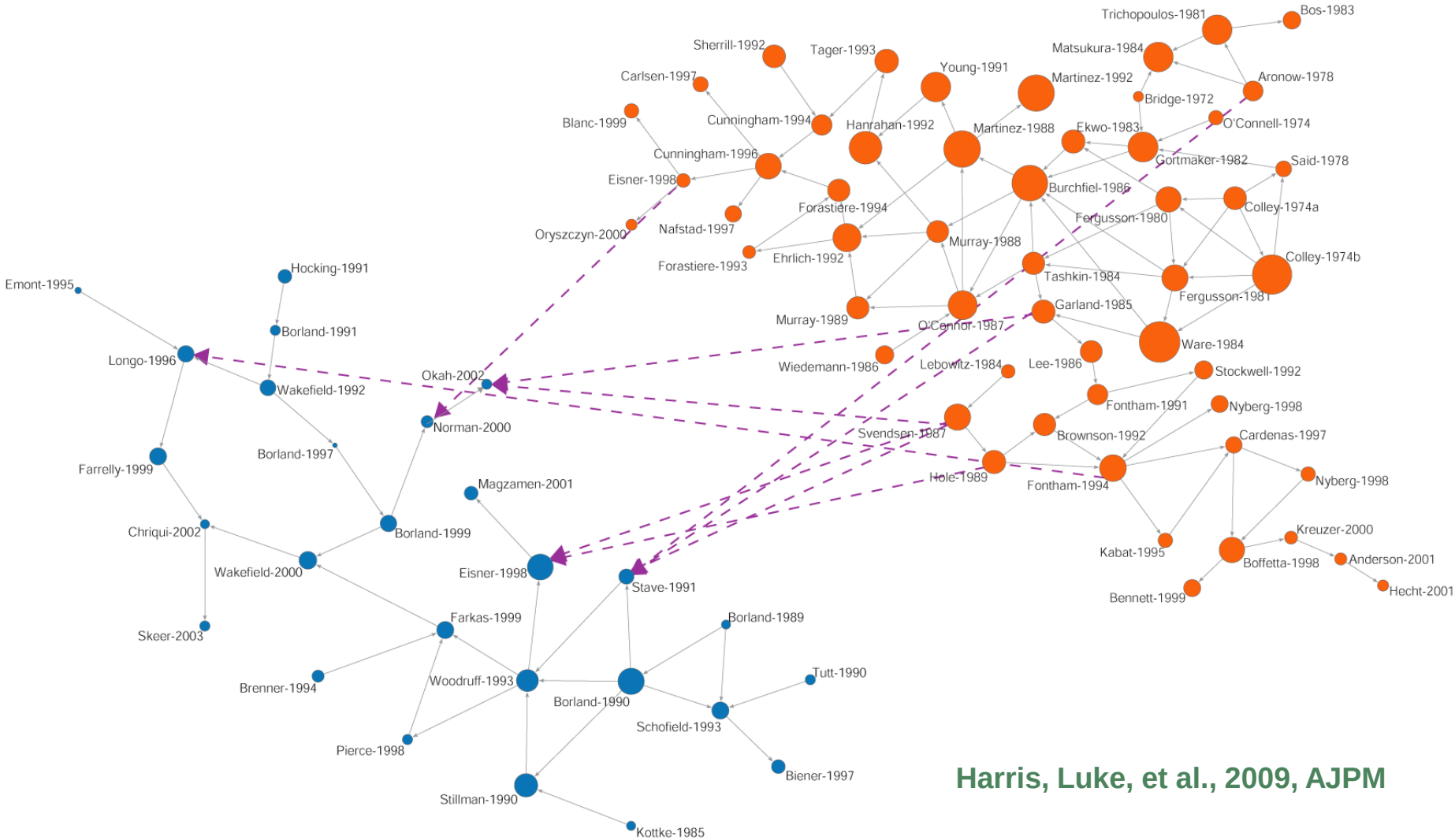
Fig. 5. (a) Estimated number of lung cancer deaths per year among males using APC and scale calibration. (b) Estimated number of lung cancer deaths per year among females using APC and scale calibration.

From Holford, et al, 2012, *Risk Analysis*

Using systems analysis to reveal gaps, new causal mechanisms, new hypotheses

ILLUMINATING

Dissemination of scientific knowledge – Citation networks in secondhand smoke research



Harris, Luke, et al., 2009, AJPM

From discovery…to summary…to delivery

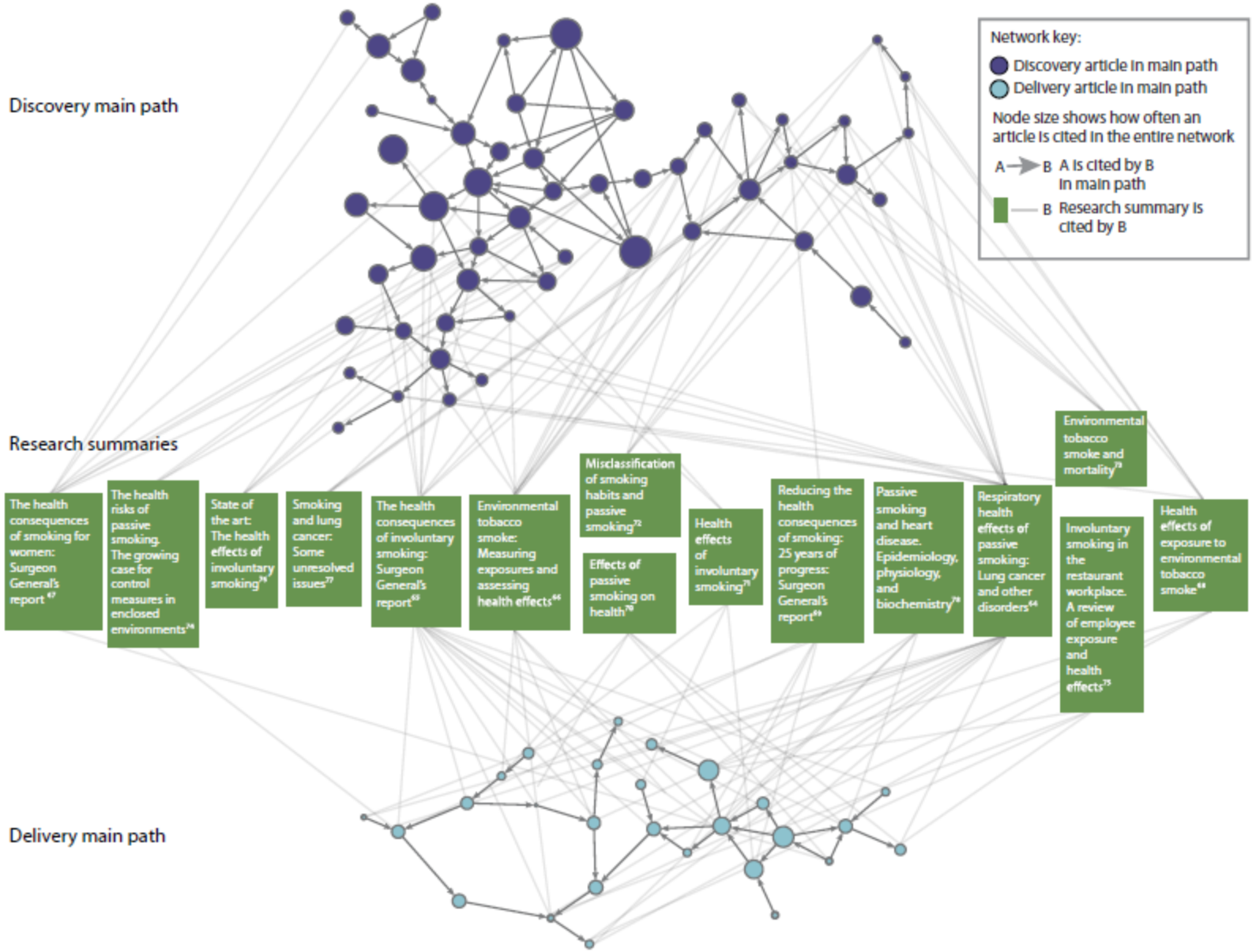
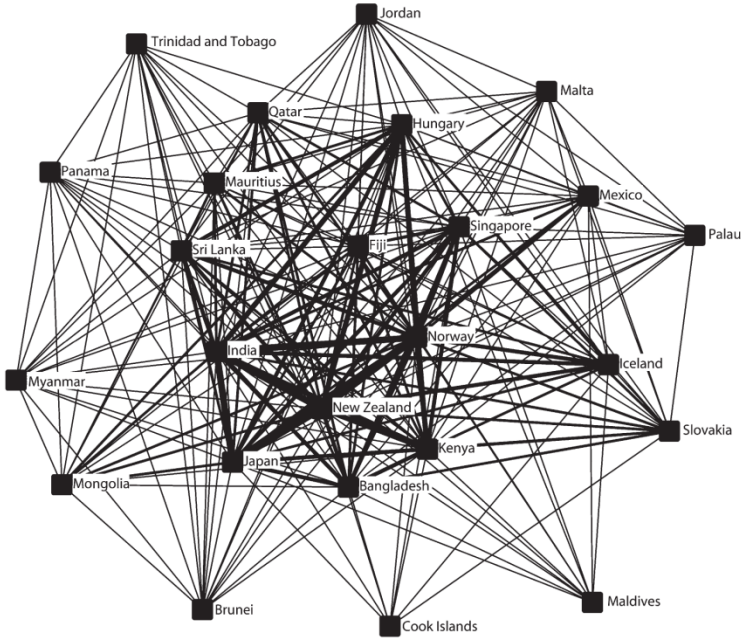


Figure 2. Main citation paths through discovery (top) and delivery (bottom) research articles related to SHS exposure, and the 120 citation links to the 15 research summaries cited most often by main path articles

Network predictors of Framework Convention on Tobacco Control treaty adoption

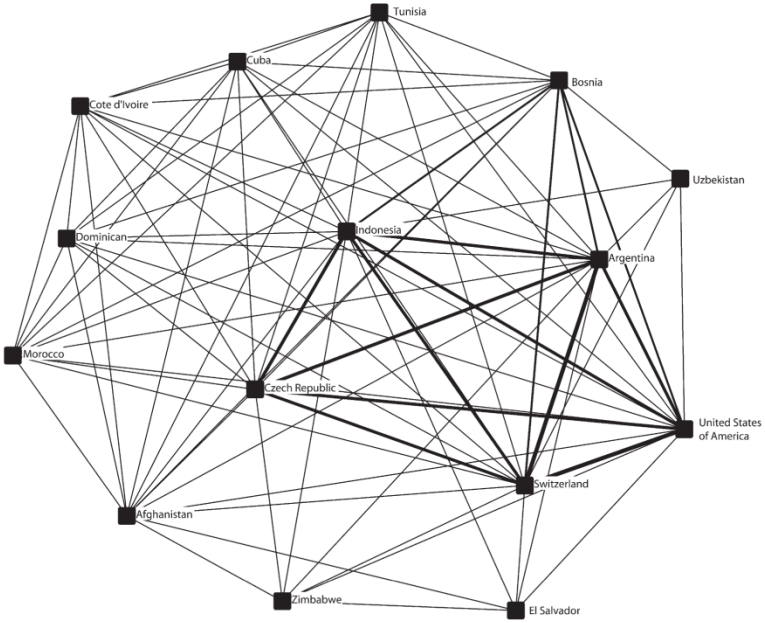
Adopted FCTC



Note. Figure created using Netdraw.[18] For example, Norway and India had at least 1 member (although not necessarily the same individual) who subscribed to GLOBALink for at least 9 years from 1993 to 2005. Conversely, Jordan and Palau only had 1 member during the same period. There were 5 outlying countries. Thicker lines indicate stronger links on GLOBALink.

FIGURE 2—Network of the 30 countries that were the earliest to adopt the Framework Convention on Tobacco Control (first 15.5% of all countries), with links indicating the magnitude of comembership on GLOBALink.

Did not adopt FCTC



Note. Figure created using Netdraw.[18] There were 18 outlying countries. Thicker lines indicate stronger links on GLOBALink.

FIGURE 3—Network of the 33 countries that did not adopt the Framework Convention on Tobacco Control, with links indicating the magnitude of comembership on GLOBALink.

From Wipfli, et al., 2010, *AJPH*

The Cost-Effectiveness of Intensive National School-Based Anti-Tobacco Education: Results from the Tobacco Policy Model[1]

Tammy O. Tengs, Sc.D.,[2] Nathaniel D. Osgood, Ph.D., and Laurie L. Chen, M.S.

Health Priorities Research Group, University of California, Irvine, California 92697-7075

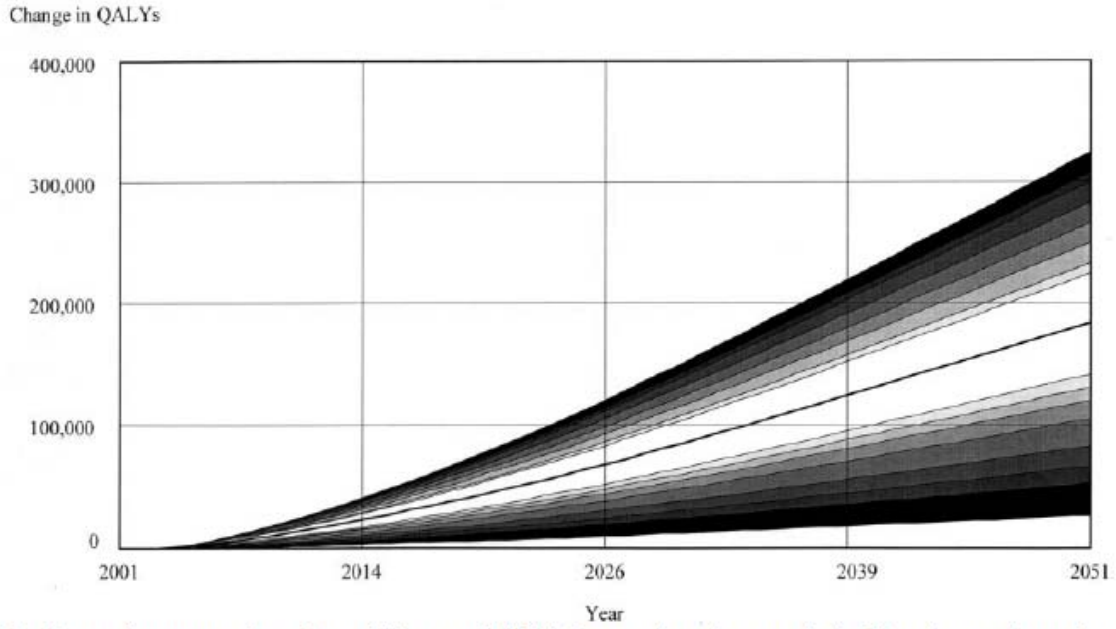


FIG. 2. Expected gain in quality-adjusted life-years (QALYs) due to enhanced national school-based anti-tobacco education.

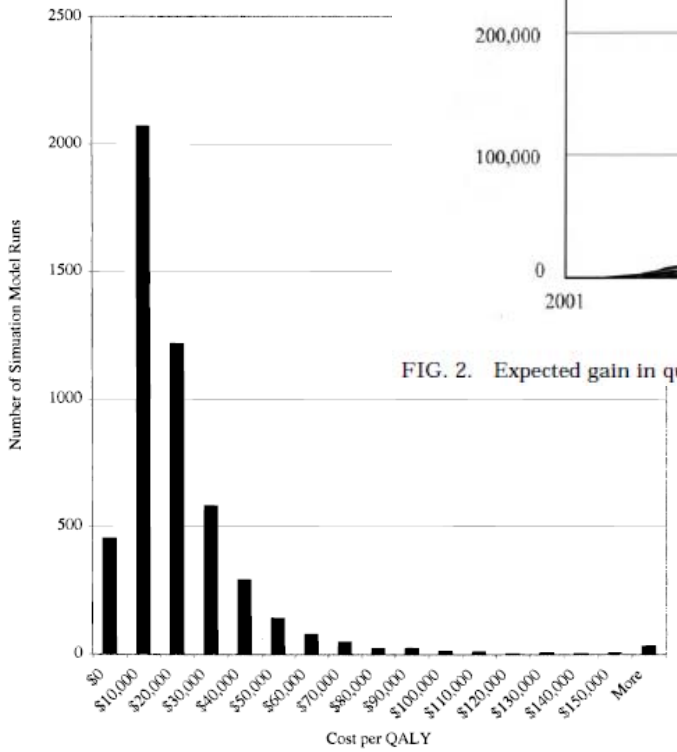


FIG. 3. Uncertainty in cost-effectiveness if an enhanced national school-based anti-tobacco education program is implemented for 50 years: the result of 5,000 simulation runs of the Tobacco Policy Model.

From Tengs, Osgood, & Chen, 2001, *PM*

Interaction of social network characteristics and tobacco control messaging

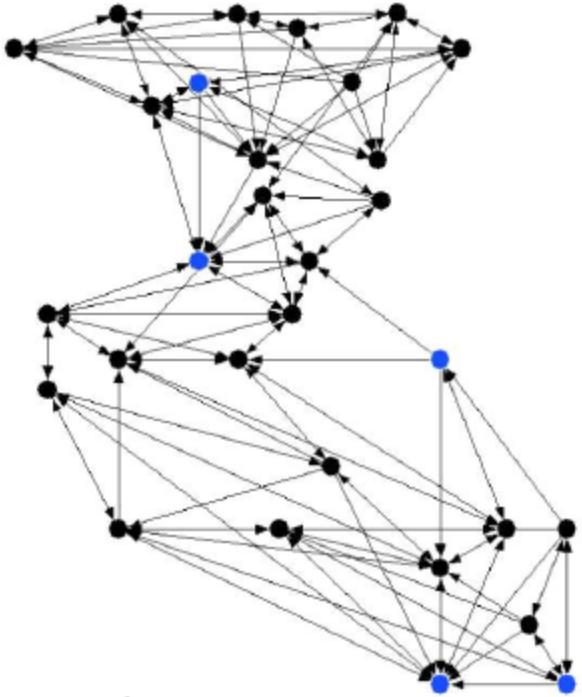


Figure 1. A network with distributed reactance. Dots represent individuals. Arrows represent social influence (more inward facing arrows means greater influence). Blue colored dots represent individuals with high reactance.

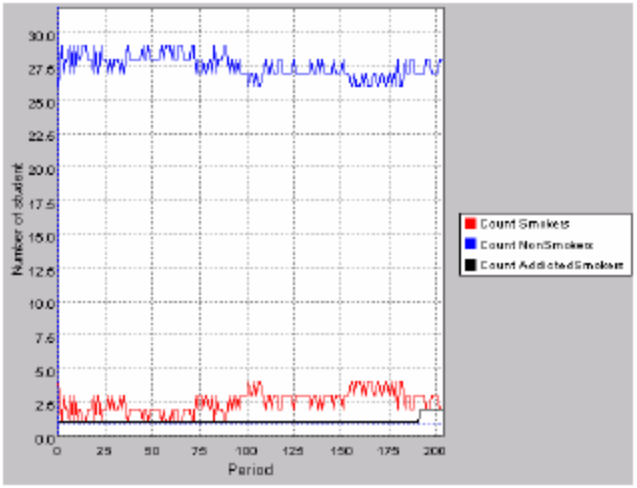


Figure 2. A strong negative message has minimal effect with distributed reactance. The x-axis represents time (each individual makes a decision about smoking in each time period). The y-axis shows the number of individuals (here, "students" in a classroom) who are smokers or non-smokers.

From Hammond, 2006, *Brookings Report*

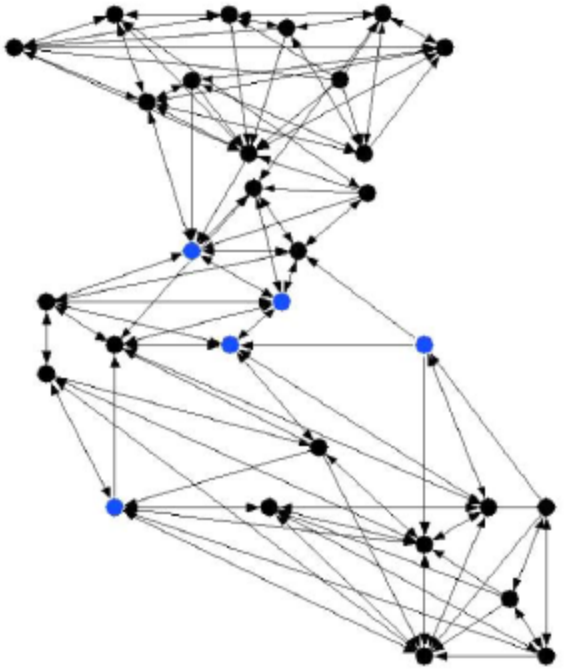


Figure 3. A network with concentrated reactance. As in Figure 1, dots represent individuals (blue color indicates high reactance) and arrows represent social influence (more inward facing arrows means greater influence).

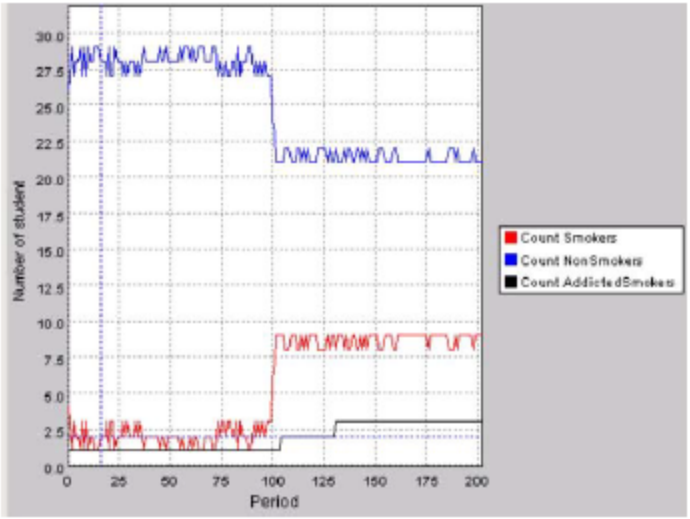


Figure 4. A strong negative message backfires with concentrated reactance. The x-axis represents time (each individual makes a decision about smoking in each time period). The y-axis shows the number of individuals (here, "students" in a classroom) who are smokers or non-smokers.

Using systems analysis to reveal how and why a system works the way it does, or how an intervention/policy will change the system

EXPLAINING

Peer Group Structure and Adolescent Cigarette Smoking: A Social Network Analysis*

SUSAN T. ENNETT
Research Triangle Institute

KARL E. BAUMAN
University of North Carolina, Chapel Hill

Figure 1. Social Network Positions

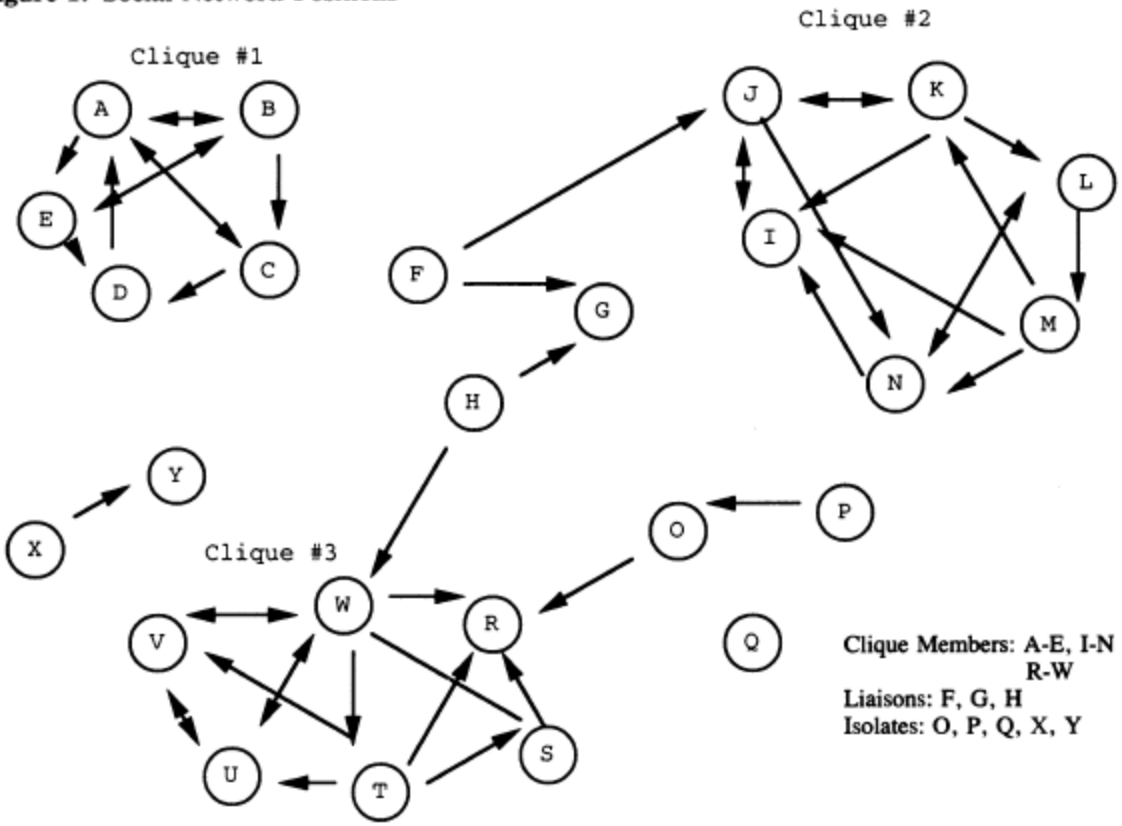


TABLE 3. Results of Logistic Regression Analysis of Current Smoking Status on Social Position, By School

	Adjusted Odds Ratio[a]	95% CI
School A ($N=164$)		
Network Isolate[b]	6.46***	2.08, 20.04
School B ($N=164$)		
Network Isolate	3.66***	1.67, 8.03
School C ($N=257$)		
Network Isolate	2.92***	1.54, 5.54
School E ($N=288$)		
Network Isolate and Male	6.05**	.81, 45.51
Network Isolate and Low Mother's Education	4.84*	1.37, 17.09

[a] Adjusted for gender, race, and mother's education.
[b] Reference is clique member/liaison.
* $p < .05$; ** $p < .01$; *** $p < .001$.

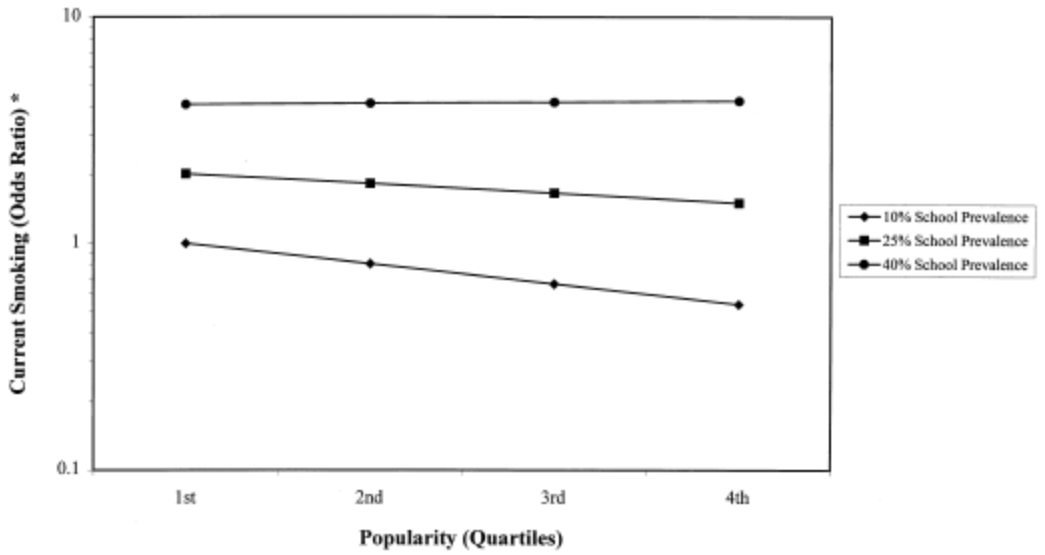
From Ennett & Bauman, 1993, *JHSB*

Peers, Schools, and Adolescent Cigarette Smoking

CHERYL ALEXANDER, Ph.D., MARINA PIAZZA, Sc.D., DEBRA MEKOS, Ph.D., AND THOMAS VALENTE, Ph.D.

Table 2. Logistic Regression Analyses of Peer Variables Associated With Cigarette Smoking Among Adolescents*

Variable	Model 1†			Model 2‡		
	Odds Ratio	Adjusted SE	95% CI	Odds Ratio	Adjusted SE	95% CI
Peer network smoking (<50%)	1.07	0.11	0.88, 1.30	1.03	0.11	0.87, 1.30
Peer network smoking (≧50%)	1.91¶	0.36	1.32, 2.78	1.89¶	0.36	1.30, 2.75
Best friend smoking (one or both)	2.00¶	0.19	1.67, 2.41	2.01¶	0.19	1.66, 2.42
Popularity	1.02	0.07	0.90, 1.16	0.76	0.12	0.56, 1.03
School smoking prevalence§	1.73¶	0.15	1.46, 2.06	1.49¶	0.15	1.22, 1.82
Popularity¶ school smoking prevalence				1.08‖	0.04	1.01, 1.15



From Alexander, et al., 2001, *JAH*

Figure 1. *Interactive effect of popularity and school smoking prevalence on current smoking. (* Logarithmic scale.)*

Peers, Schools, and Adolescent Cigarette Smoking

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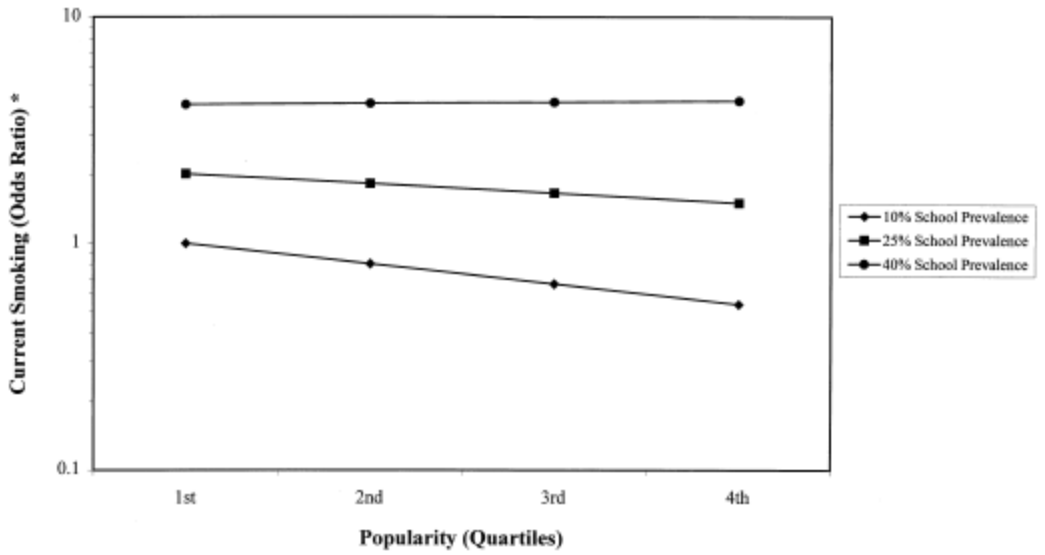
Table 2. Logistic Regression Analyses of Peer Variables Associated With Cigarette Smoking Among Adolescents*

Variable	Model 1†			Model 2‡		
	Odds Ratio	Adjusted SE	95% CI	Odds Ratio	Adjusted SE	95% CI
Peer network smoking (<50%)	1.07	0.11	0.88, 1.30	1.03	0.11	0.87, 1.30
Peer network smoking (≥50%)	1.91¶	0.36	1.32, 2.78	1.89¶	0.36	1.30, 2.75
Best friend smoking (one or both)	2.00¶	0.19	1.67, 2.41	2.01¶	0.19	1.66, 2.42
Popularity	1.02	0.07	0.90, 1.16	0.76	0.12	0.56, 1.03
School smoking prevalence§	1.73¶	0.15	1.46, 2.06	1.49¶	0.15	1.22, 1.82
Popularity¶ school smoking prevalence				1.08‖	0.04	1.01, 1.15



From Alexander, et al., 2001, *JAH*

Figure 1. *Interactive effect of popularity and school smoking prevalence on current smoking. (* Logarithmic scale.)*

Disentangling peer influence and selection

From Hall & Valente, 2007, *AB*

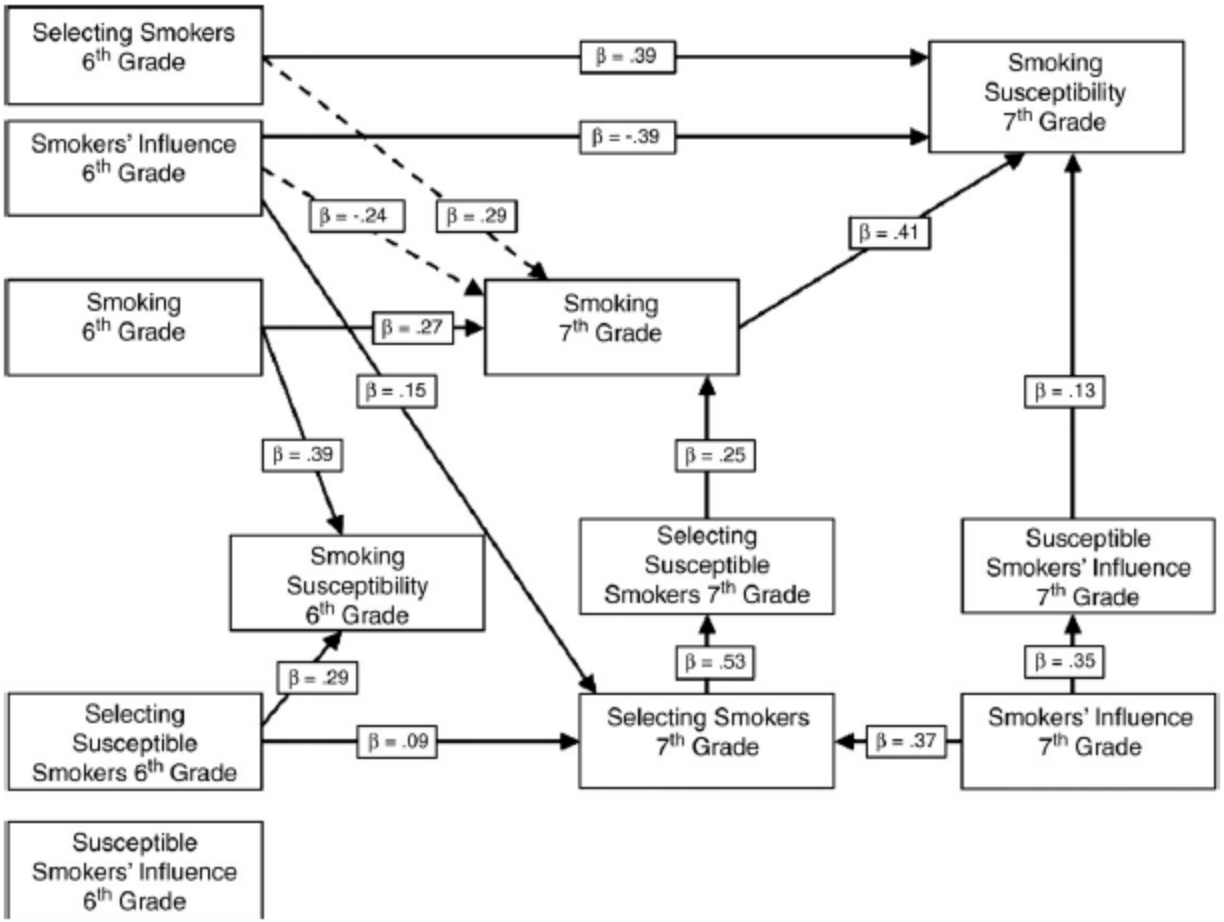


Fig. 2. Final SEM demonstrating direct effects of peer selection on smoking and smoking susceptibility, protective effects of smokers' influence, and indirect effects of selection of susceptible smokers. Marginally significant paths dashed. (GFI=.97, CFI=.94, RMSEA=.055).

Smoking-based selection and influence in gender-segregated friendship networks: a social network analysis of adolescent smoking

Liesbeth Mercken[1,2], Tom A.B. Snijders[3,4], Christian Steglich[4], Erkki Vertiainen[5] & Hein de Vries[1,2]

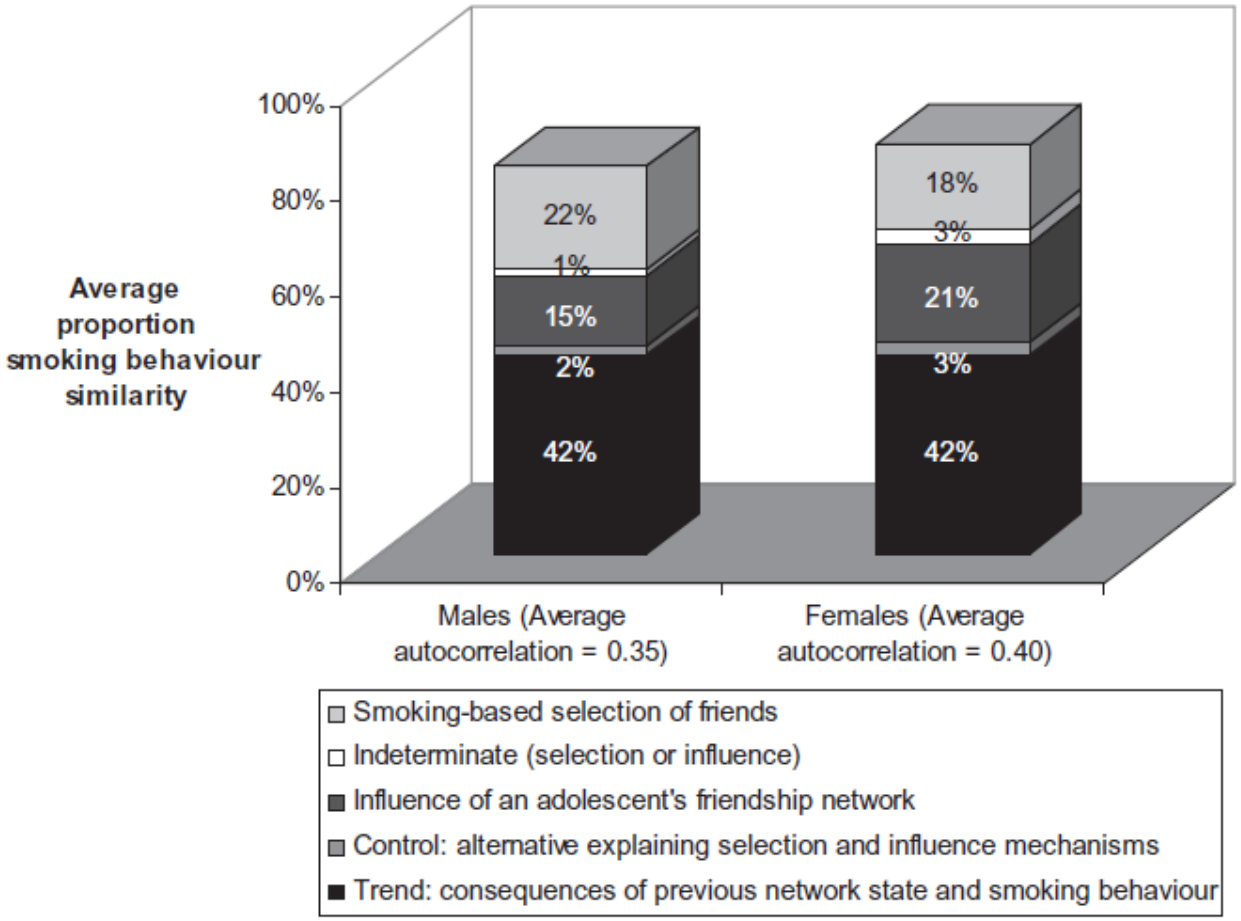


Figure 1 The relative contribution of smoking-based selection and influence on similarities in smoking. Note: the model explained 82% of smoking behaviour similarity among males, 87% among females

From Mercken, et al., 2010, *Addiction*

Modeling dissemination of *Best Practices in Tobacco Control*

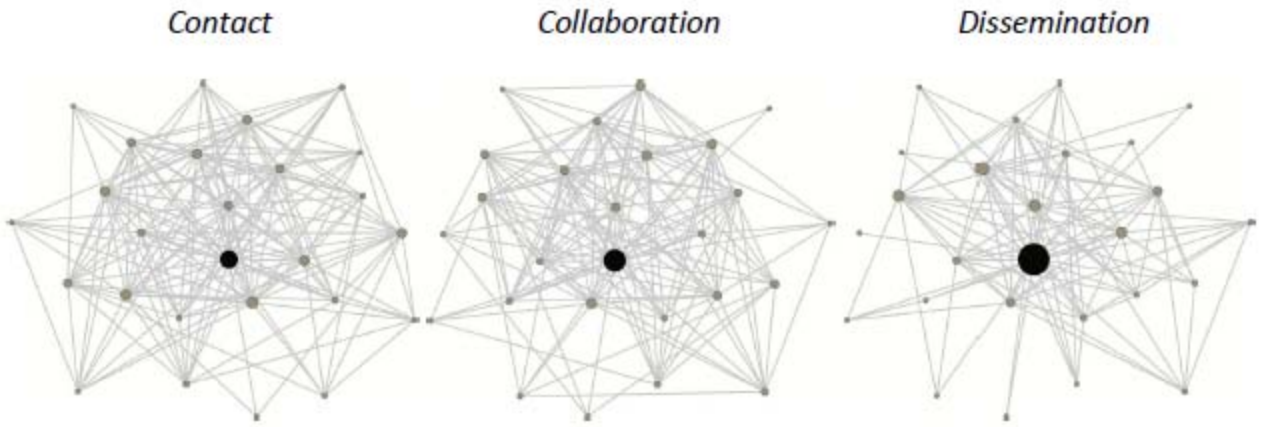


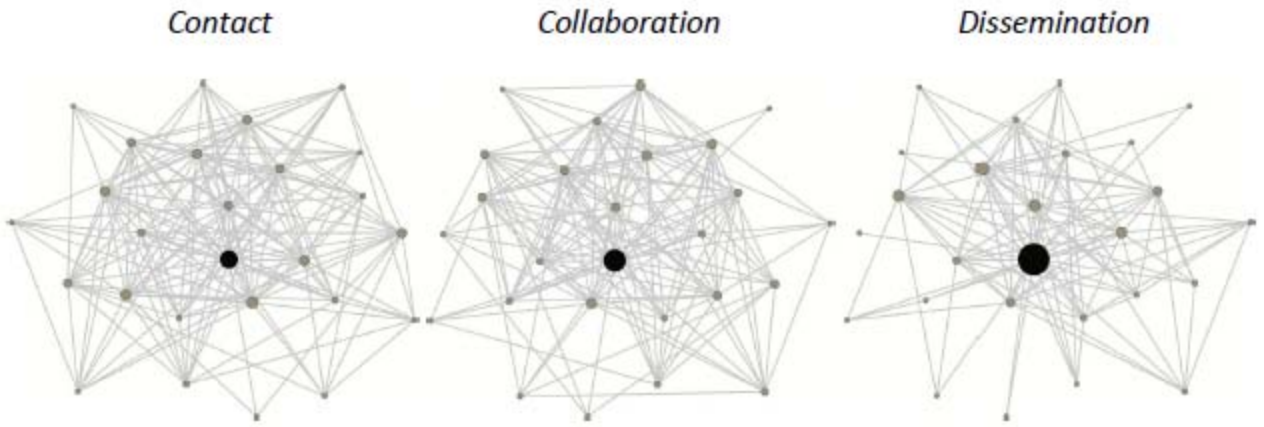
Figure A1. Contact, collaboration, and dissemination networks in Indiana. Nodes sized by betweenness centrality. Betweenness centrality for the lead agency (darker node) was .127 for contact, .207 for collaboration, and .423 for dissemination.

Odds ratios for final model (M3) for all states

	Indiana		Texas		Wyoming		DC	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Edges	0.01	(0.00-0.02)	0.23	(0.09-0.63)	0.07	(0.04-0.15)	0.00	(0.00-0.00)
Degree (GWDegree)	0.06	(0.03-0.11)	0.05	(0.02-0.19)	0.02	(0.01-0.03)	0.12	(0.04-0.35)
TC Experience	1.08	(1.03-1.13)	0.95	(0.88-1.02)	1.08	(1.02-1.15)	1.24	(1.12-1.37)
Geographic Reach (Homophily)	1.72	(1.44-2.04)	5.33	(3.84-7.42)	0.62	(0.50-0.77)	3.95	(3.00-5.20)
Agency Distance	1.00	(0.98-1.02)	0.92	(0.91-0.92)	0.99	(0.98-0.99)	0.99	(0.98-1.01)
Network Contact	2.38	(2.28-2.48)	1.64	(1.43-1.88)	1.64	(1.57-1.71)	1.46	(1.34-1.59)
Network Collaboration	1.78	(1.70-1.86)	2.99	(2.67-3.35)	1.76	(1.68-1.84)	7.29	(6.55-8.12)

From Luke, et al., in press, *HEB*

Modeling dissemination of *Best Practices in Tobacco Control*



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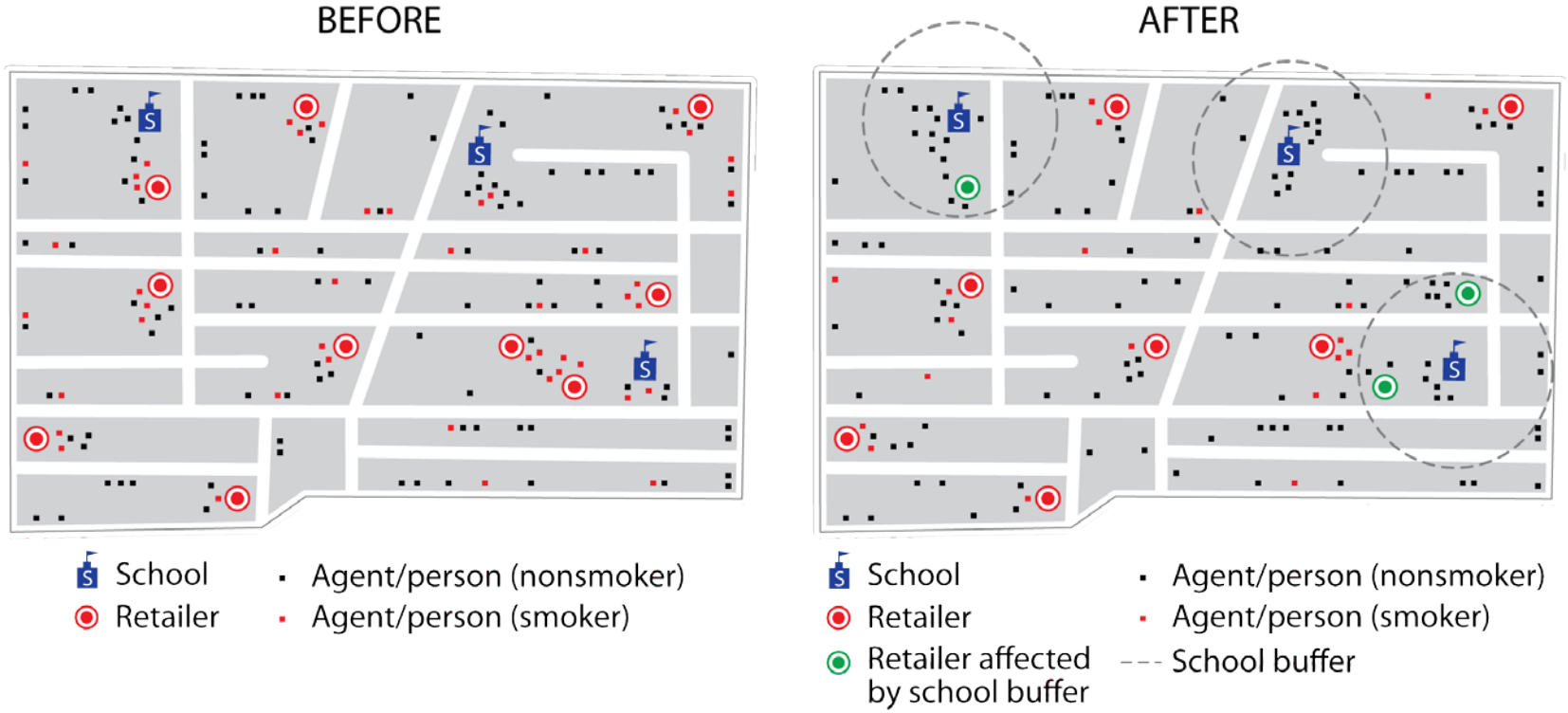
From Luke, et al., in press, *HEB*

Tobacco Town

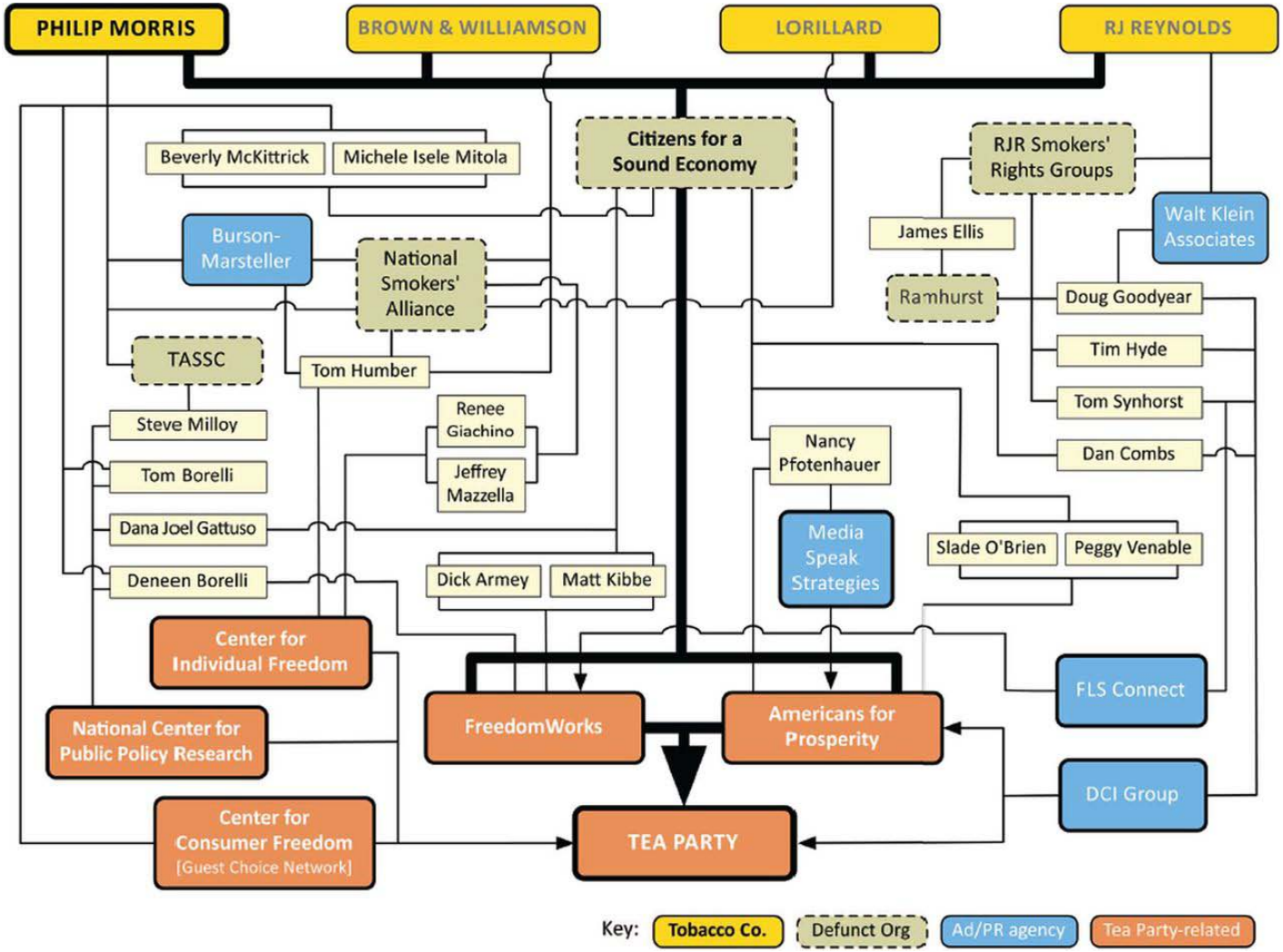
- Use agent-based modeling to study tobacco retailer density and individual tobacco purchasing
- May be used as a retail policy laboratory to explore and compare the potential effects of various policy approaches



Emerging opportunities for systems science in tobacco control

- Understand behavioral dynamics of tobacco use and addiction in the context of new tobacco products and nicotine delivery systems
- Build modeling laboratories to study and test the effects of tobacco control policies
- Use network and systems models to enhance dissemination and implementation of evidence-based practices and policies around the globe
- Greater integration of behavioral data that is contextually and temporally informative (e.g., EMA)

Will the tobacco control system blow up…



From Fallin, Grana, & Glantz, 2013,
Tobacco Control

Will the tobacco control system blow up…

The Scientist » The Nutshell

NIH Funding Spat

A Republican representative objects to a study he said is politically partisan.

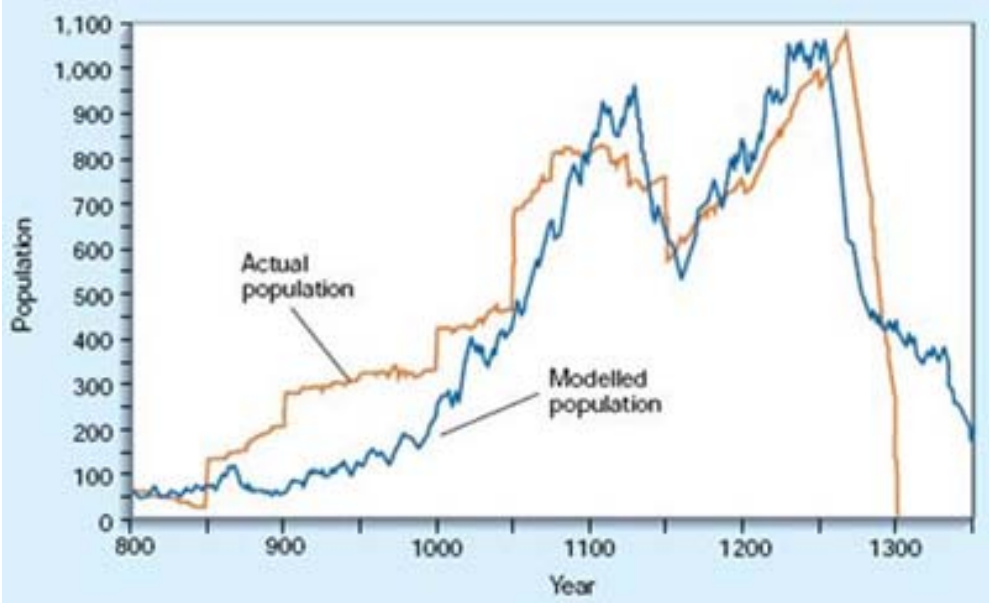
By Kate Yandell | March 7, 2013

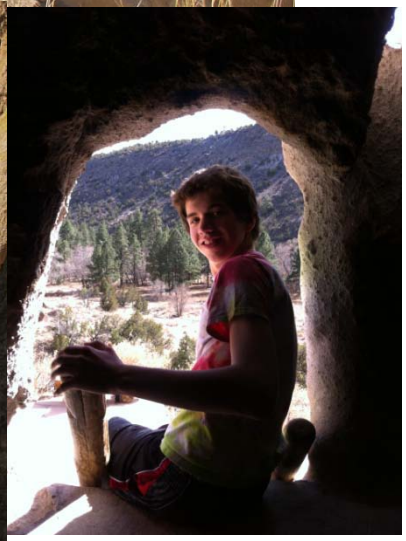
NIH Director Francis Collins
NATIONAL HUMAN GENOME RESEARCH INSTITUTE

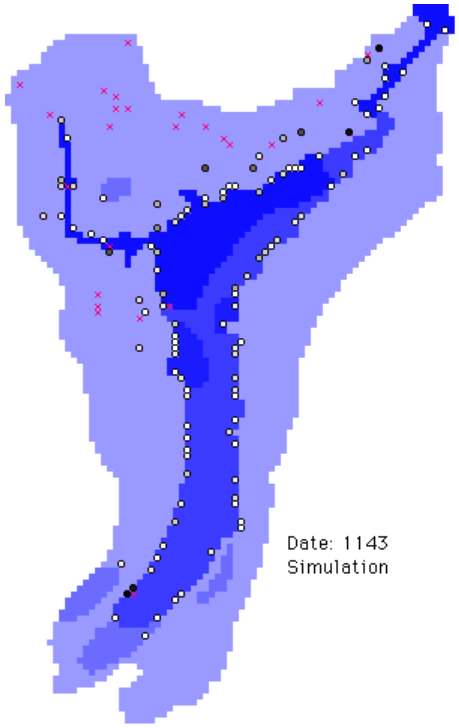
Republican representative Andy Harris of Maryland raised concerns about the National Institutes of Health's oversight of its grantees yesterday (March 5), *Science*Insider reported, after reading about an NIH-funded study connecting the rise of the Tea Party to tobacco funding.

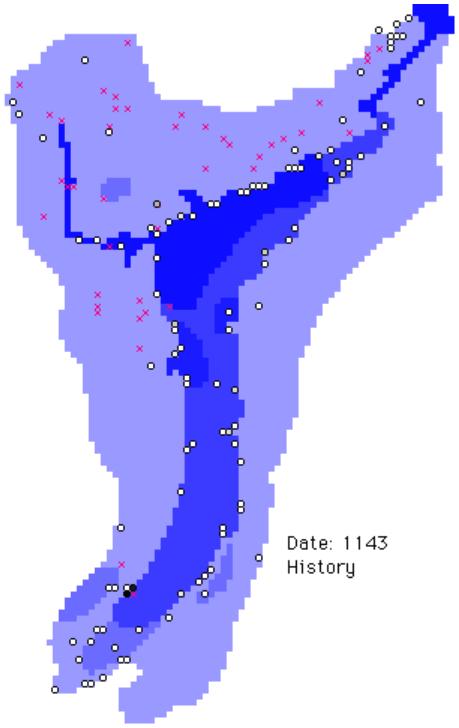
Politicians and other officials, including NIH Director Francis Collins, had gathered at a Committee on Appropriations meeting to discuss how federal agencies were dealing with funding cuts. But as the meeting wound down, Harris addressed Collins to complain about the study, which was published last month (February 8) in *Tobacco Control*.

…Or, will the system return to its resting state?









Source: Brookings "Artificial Anasazi" project, Axtell et al. *PNAS* 2002

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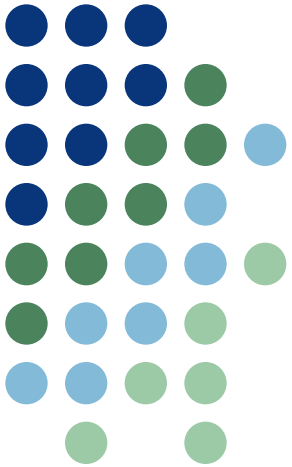

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