COASTAL OCEAN VALUES CENTER

THE OCEAN FOUNDATION

The Public Policy of Bacterial Beach Contamination

Linwood Pendleton

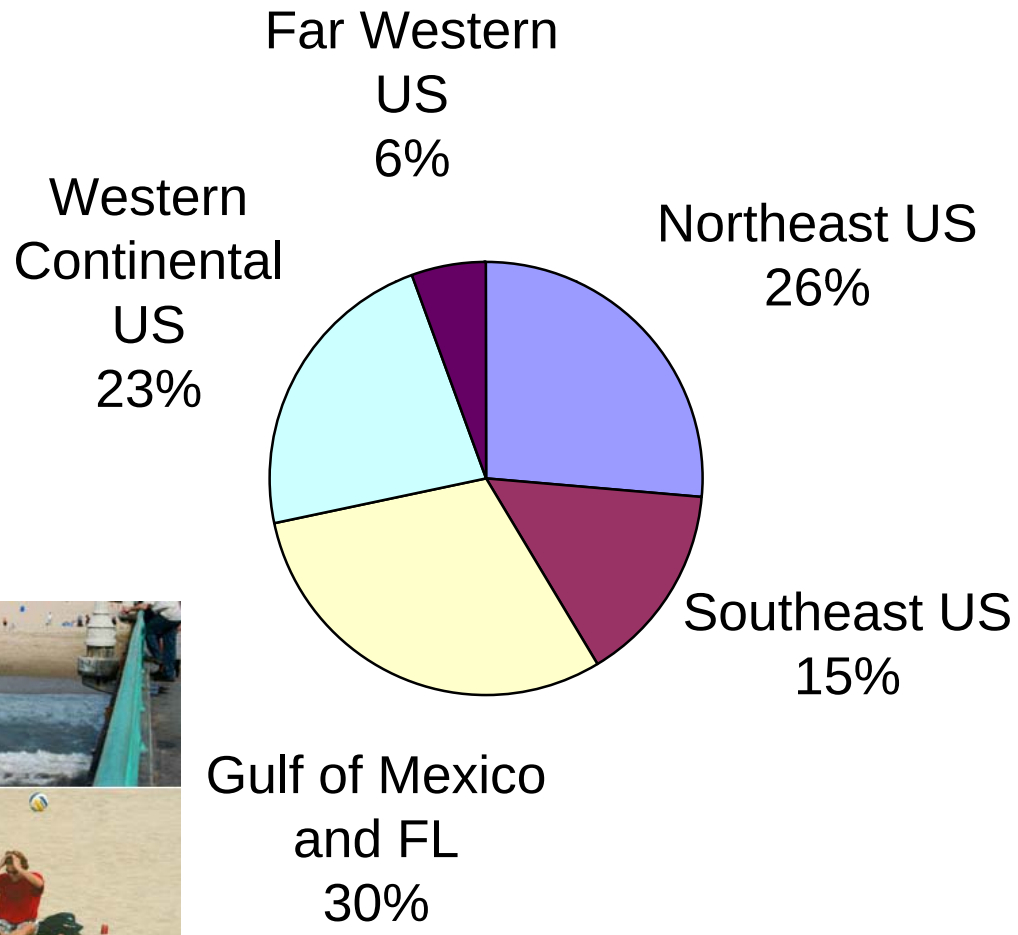
Senior Fellow and Director of Economic Research, The Ocean Foundation

Director, Coastal Ocean Values Center,

Associate Professor, UCLA (adjunct)

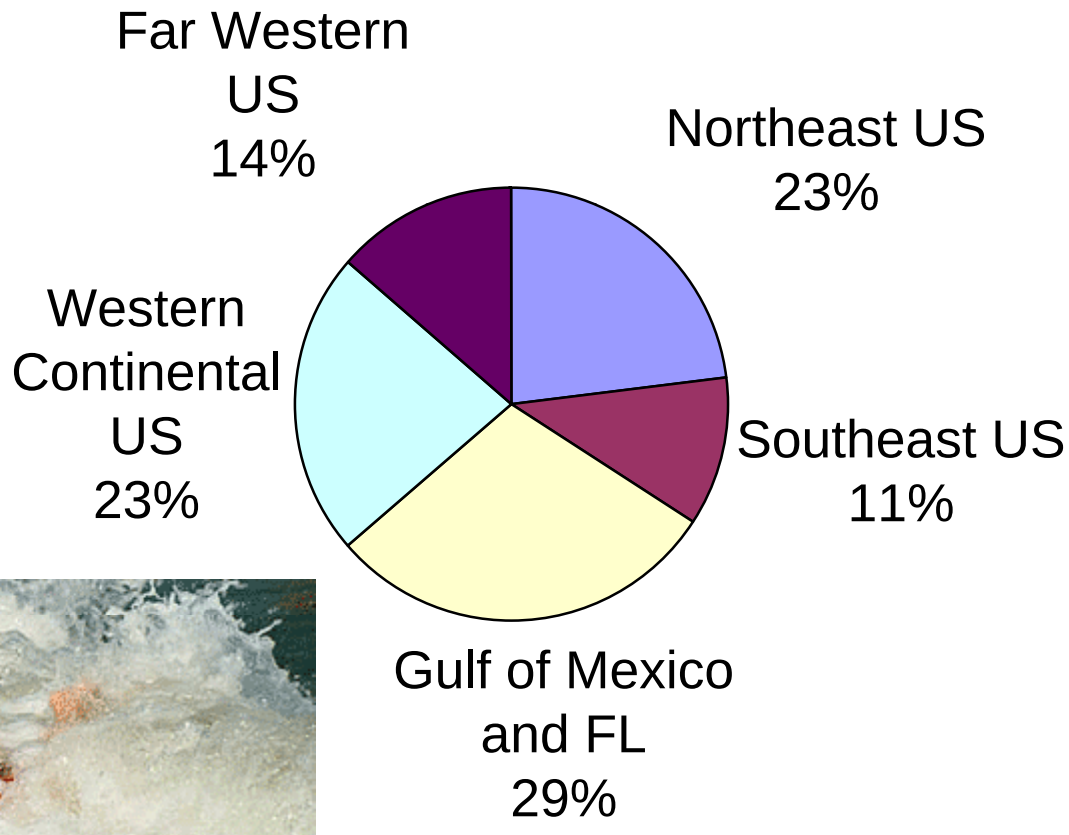
noep NATIONAL OCEAN ECONOMICS PROGRAM

62 million Americans Swim in Oceans and Estuaries[1]



Leeworthy and Wiley 2001, NSRE

Americans Spend 800+ million days at the beach[1]



[1]Leeworthy and Wiley 2001

Los Angeles Times latimes.com

http://www.latimes.com/news/local/la-me-sewage25jan25,1,807124.story?coll=la-headlines-california

STUDY FINDS UNREPORTED CONTAMINATION

More than 90% of raw sewage spills in L.A. County since 2002 were neither officially recorded nor cleaned up, report says.

By Tony Barboza
Times Staff Writer

January 25, 2007

Los Angeles County public health officials failed to document more than 90% of raw sewage spills that have occurred since 2002, largely because city, county and state agencies did not report them, according to a study released Wednesday.

Most of the 208 potentially health-threatening sewage spills between January 2002 and July 2006 were neither officially recorded nor cleaned up, according to the 24-page report by the Los Angeles County auditor-controller.

Regional Public Health Cost Estimates of Contaminated Coastal Waters: A Case Study of Gastroenteritis at Southern California Beaches

With Suzie Given (Orange County Department of Public Works)
and Ali Boehm (Stanford University)

Environmental Science and Technology. Environ. Sci. Technol., 40 (16), 4851 -4858

GOALS:

- Determine how many people are getting sick from contaminated beach water.

- Determine the cost of illness from swimming in contaminated marine water.

Estimating Public Health Burden: The Approach

1. Characterize and estimate illness risks (P(FIB)) – gastrointestinal

2. Assess exposure based on beach attendance

3. Estimate number of illness (risk*#exposed)

4. Estimate costs of illness (number of illnesses*cost GI/case)

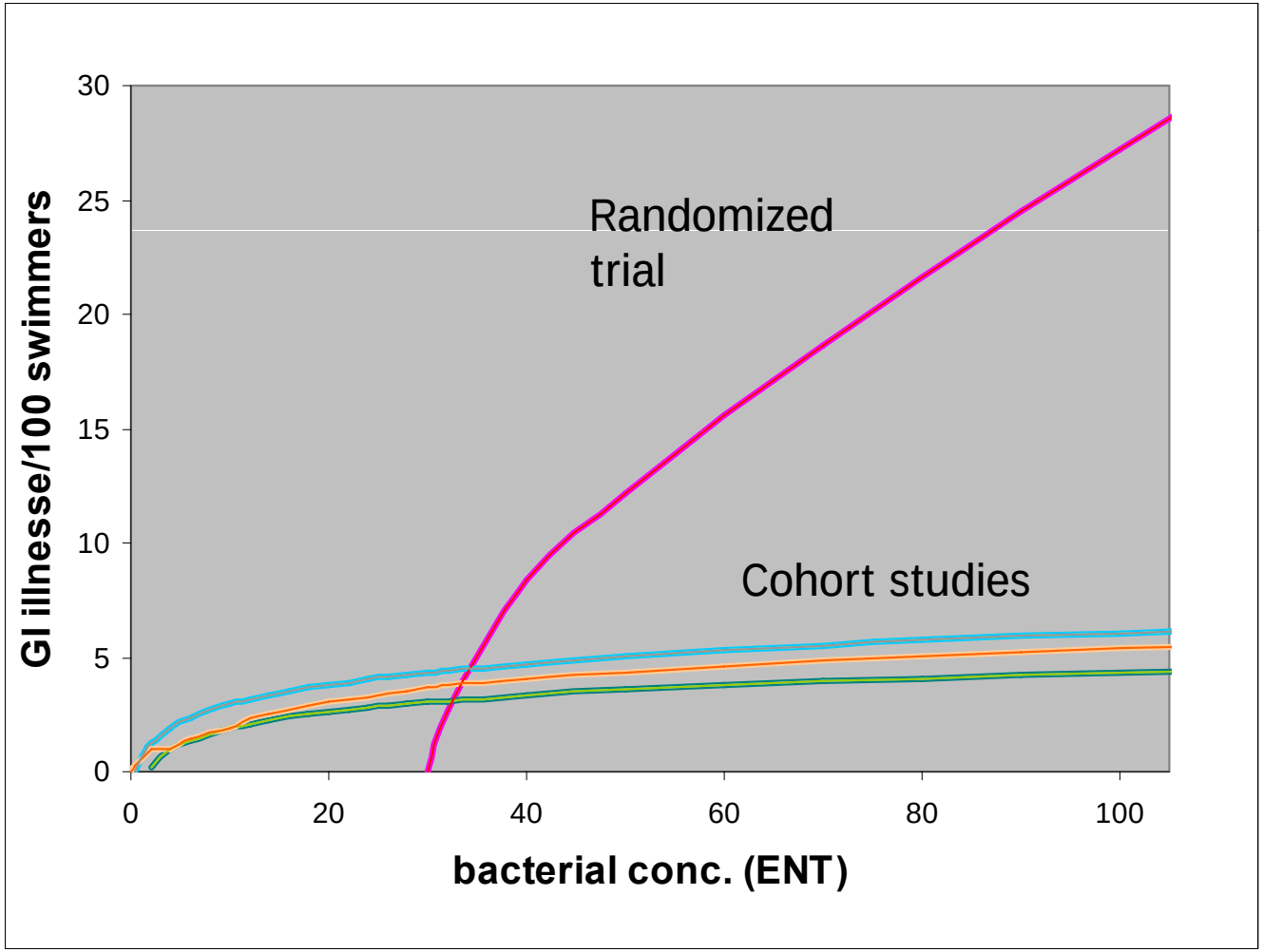
Estimating Risk of Illness

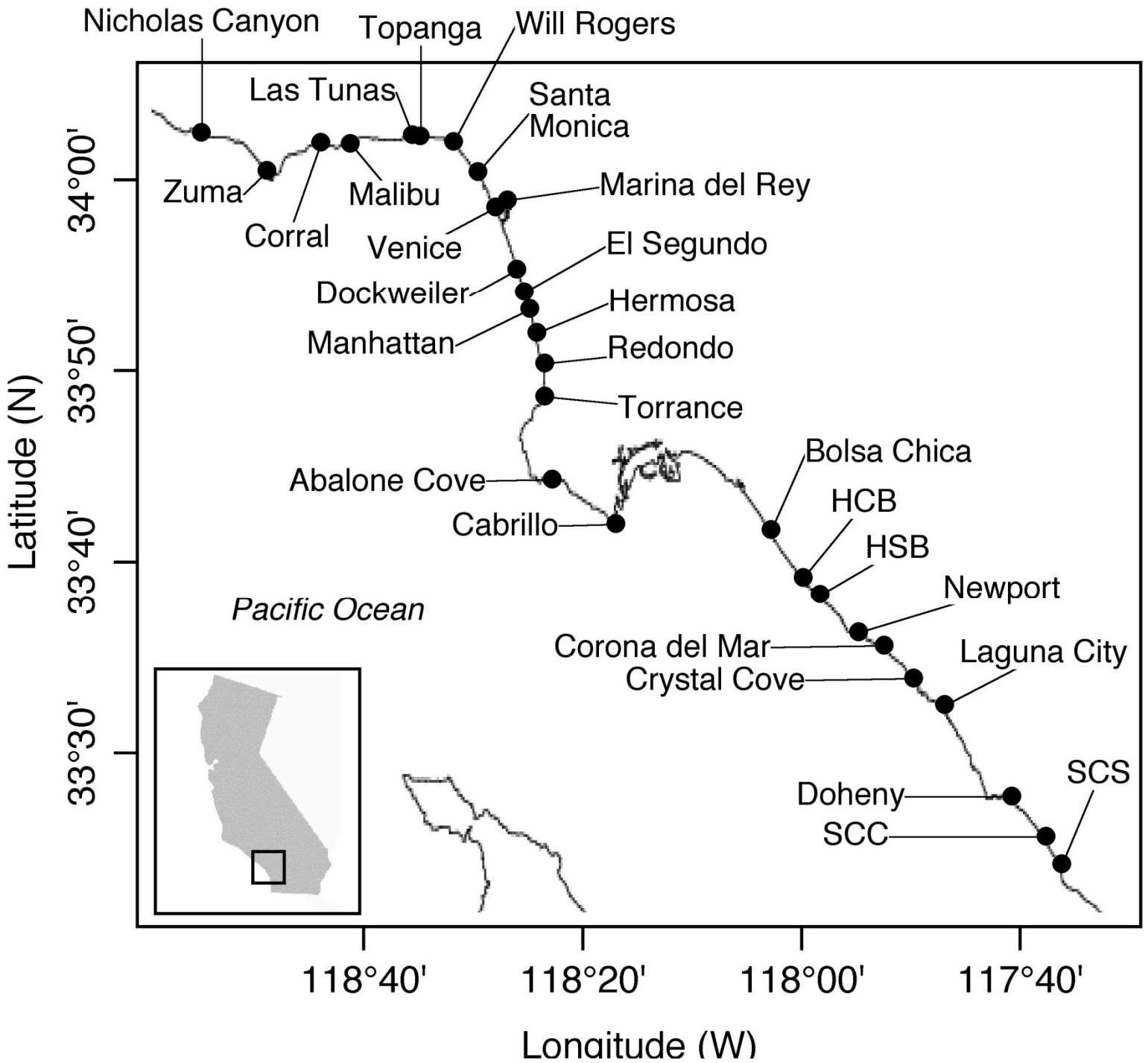
Two type of studies:

1) COHORT STUDIES
   - Cabelli et al. 1982 – widely used, self-reported illness, many locations
   - Wymer and Dufour 2002 – Cabelli data, different analysis, same basic results
   - Wade et al. 2003 – Meta-analysis (using Cabelli data and others)

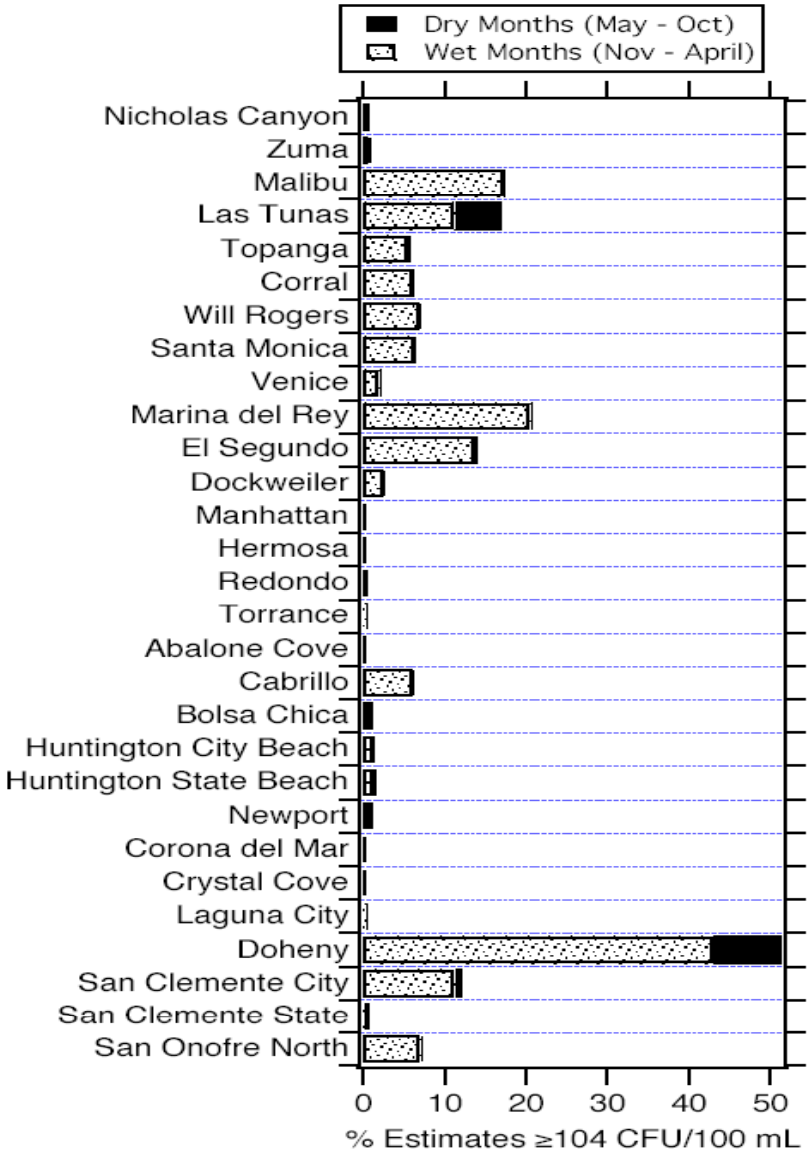
2) RANDOMIZED FIELD TRIAL
   - Kay et al. (1994) – only randomized clinical trial

Dose Response Estimates



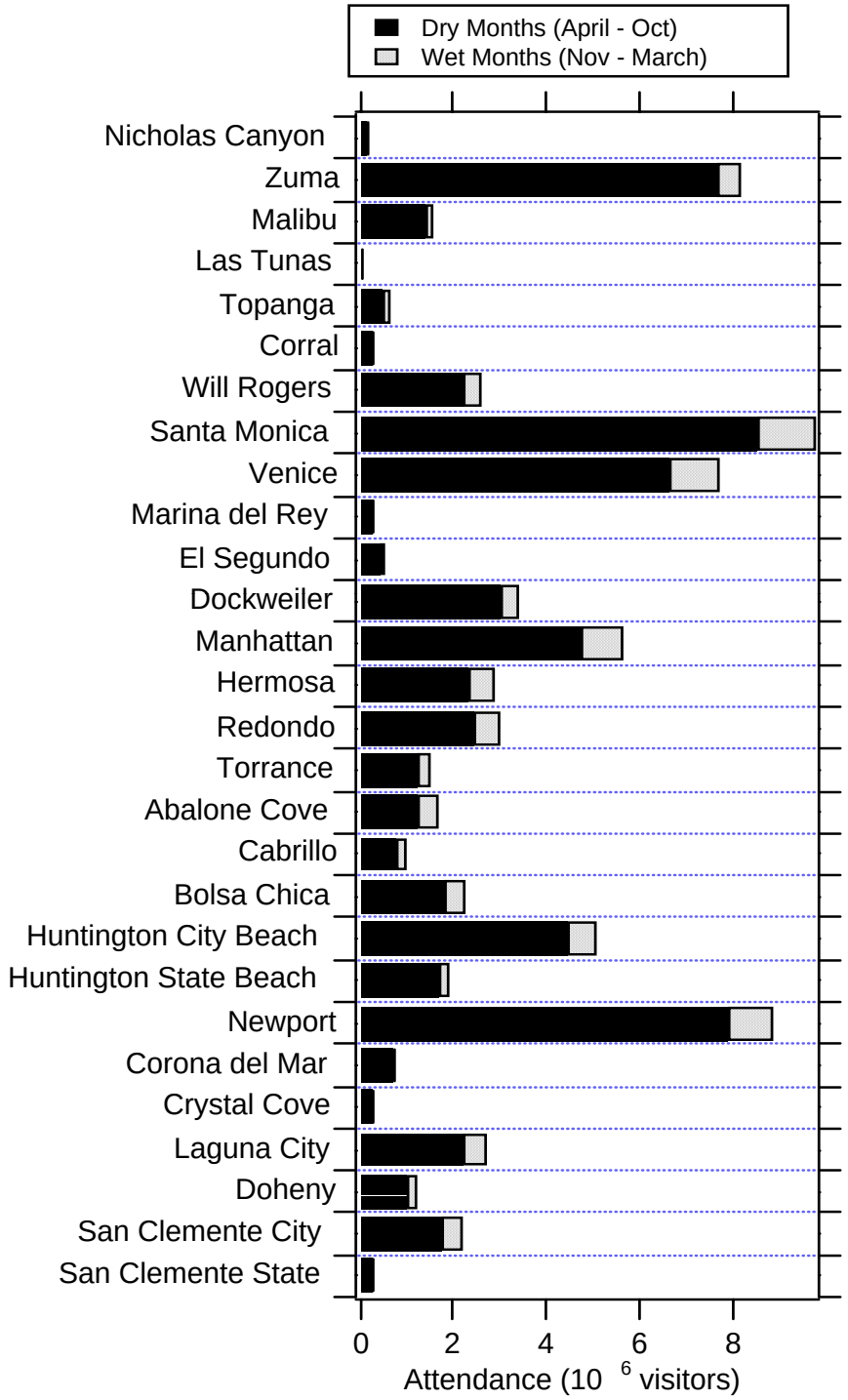

Nicholas Canyon
Topanga
Will Rogers
Las Tunas
Santa Monica
Zuma
Malibu
Marina del Rey
Corral
Venice
El Segundo
Dockweiler
Hermosa
Manhattan
Redondo
Torrance
Bolsa Chica
Abalone Cove
HCB
Cabrillo
HSB
Newport
Pacific Ocean
Corona del Mar
Laguna City
Crystal Cove
SCS
Doheny
SCC
34°00'
33°50'
33°40'
33°30'
Latitude (N)
118°40'
118°20'
118°00'
117°40'
Longitude (W)

Beach Water Quality 2000



Beach Attendance

% swimmers varies across seasons, average ~ 28%



Number of Excess Illnesses

$$GI_{i,j} = A_{i,j}\, f_i (P_{i,j} - P_o)$$

$A_{i,j}$ is the number of beach visitors, and
f_i is the fraction of swimmers on day *i*
Pi,j-P0 is the excess risk of GI on day *i* at beach *j*

	Cohort Models	Random Trials
Dry Season	579,000	1,224,000
Wet Season	48,800	255,200
Total	***627,800***	***1,497,200***

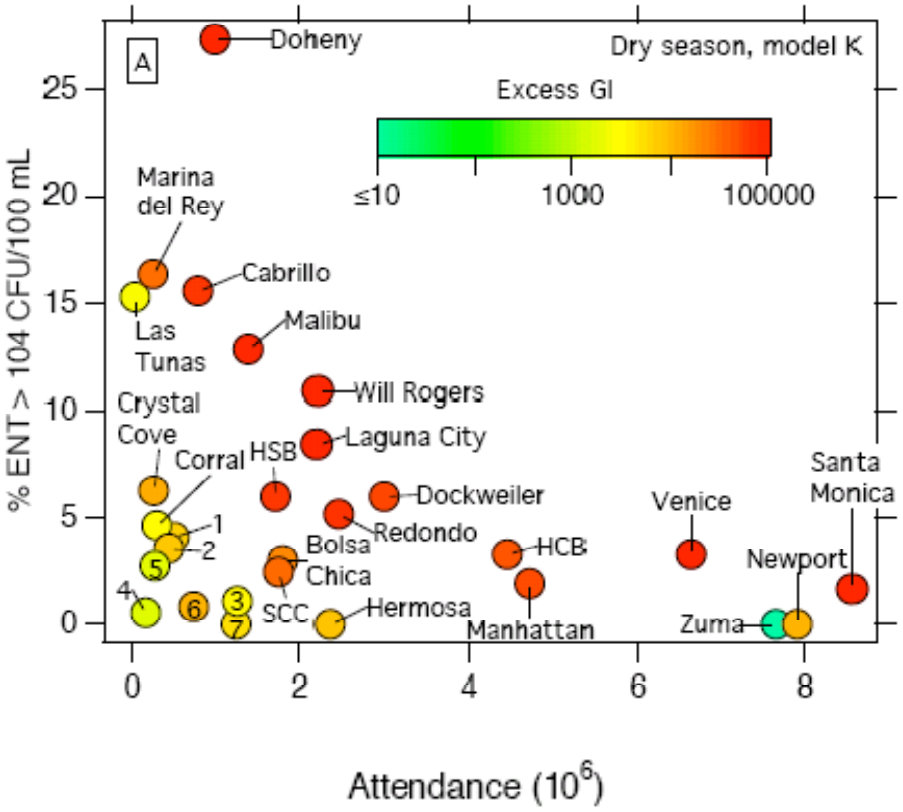
Costs of Illness

$33.35 per illness (Dwight et al. 2005)
$280 per illness (Rabinovici et al. 2004)

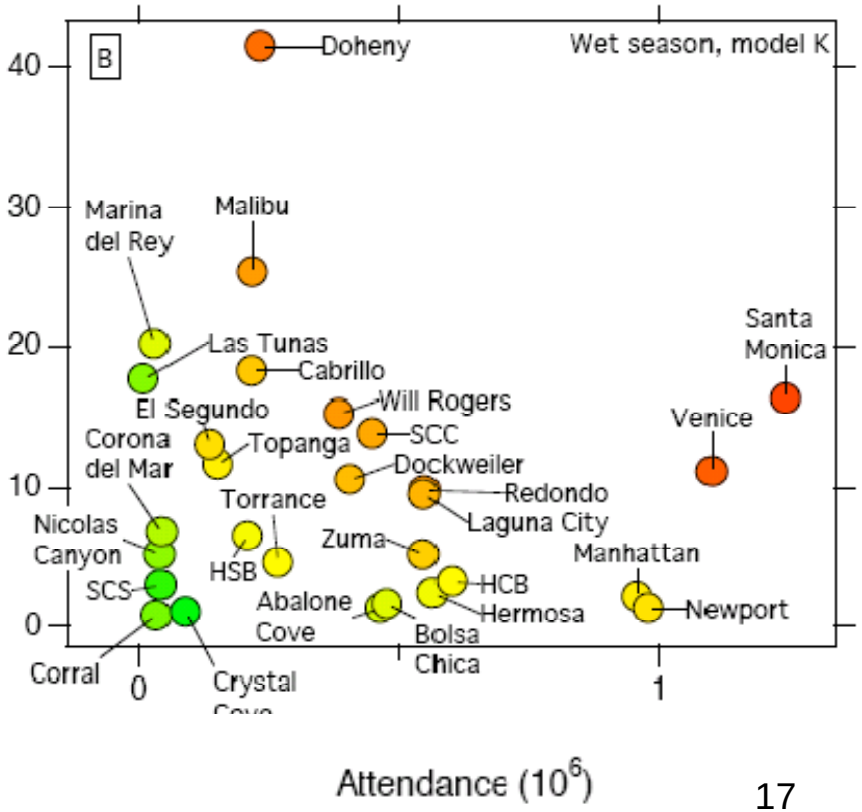
	Cohort Models	Random Trials
Dry Season	$19,280,000	$40,800,000
Wet Season	$1,630,000	$8,520,000
Total	***$20,910,000***	***$49,320,000***

Which Beaches Bear Burden? (Estimates using Kay et al.)

DRY SEASON



WET SEASON



Further Research Issues

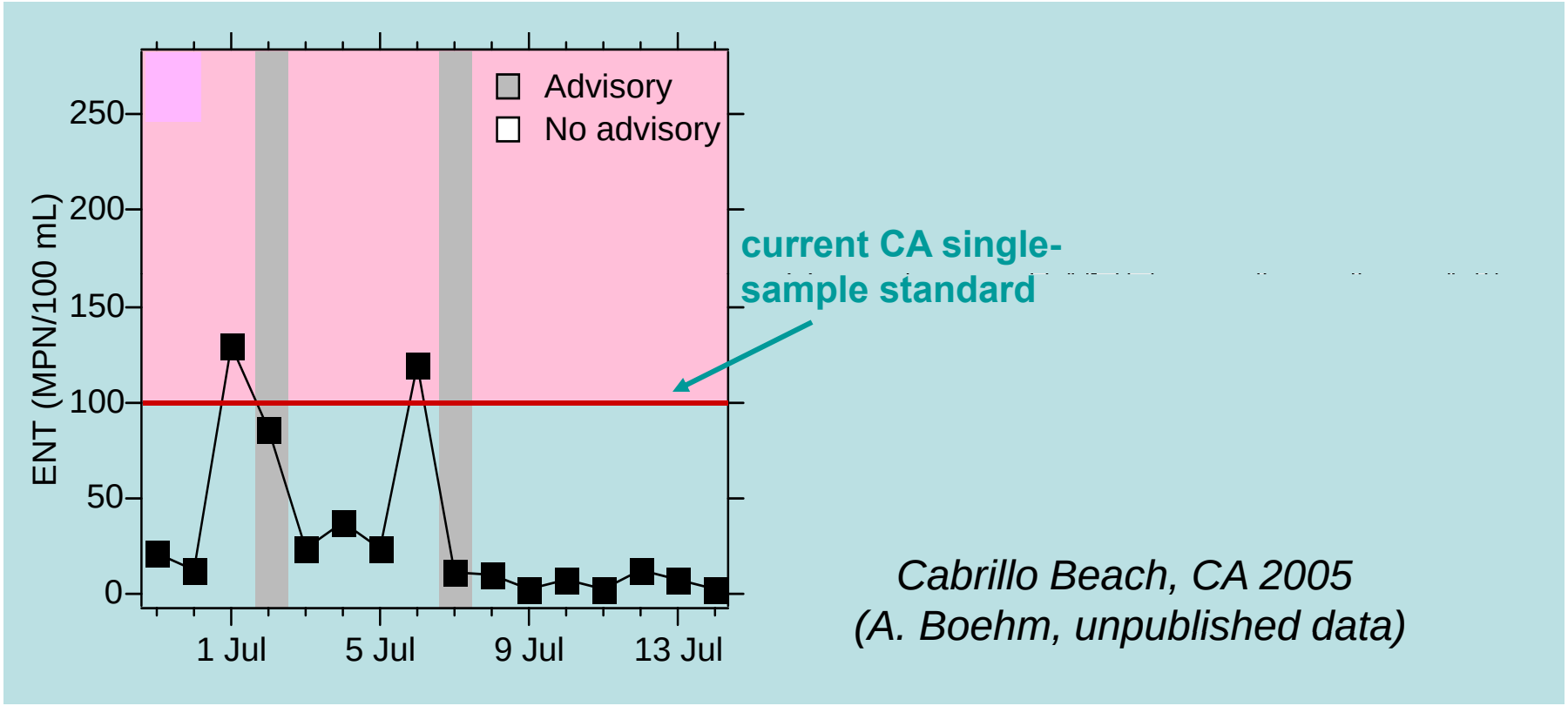
- Dose-Response Models Needed for SoCal and other Regions
- FIB samples need to be monitored when swimmers are most at risk – midday
- Bacterial Source Important – Mission Bay
- Viruses are better measure, but no monitoring data
- Other illnesses

What Can We Do To Protect Swimmers

What Can We Do To Protect Swimmers

- Monitoring Water Quality
  - ➔ Beach Advisories
  - ➔ Beach Closures
- Is this effective?
- Work with Sharyl Rabinovici (UCBerkeley), Justin Warren (Stanford), and Ali Boehm (Stanford)

Time Lags Between Monitoring and Advisory.



commonly used culture-based methods take 24 hours - advisories are posted/lifted at least one day too late

Research Questions:

- Does the standard practice protect the public?
- Does the standard practice make economic sense?
- Would rapid detection of contamination improve our ability to protect the public?
- Would rapid detection improve the net economic benefits of monitoring and advisories?
- What if we just did nothing?

CASE STUDY:
Advisories in Orange County, CA

- Focus on Huntington State Beach, summer 2000

- Same approach as before

The Economics of Swimming

Need to assess tradeoffs between recreational value and public health value.

What's the tradeoff?

The Economic Value of Swimming (in contaminated water).

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Net Benefits of Swimming =  **= $ -** 

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Rec Value of Swimming – Expected Cost of Illness

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Rec Value of Swimming – Expected Cost of Illness

Net Benefits of Swimming $= V_{rec} - E(V_{health})$

Comparing Advisory Policies

- Three Scenarios
  - Rapid Detection (RD), Rapid Detection/Notification
  - Standard Practice (SP), 1day delay
  - No Intervention (NI), no notification to public

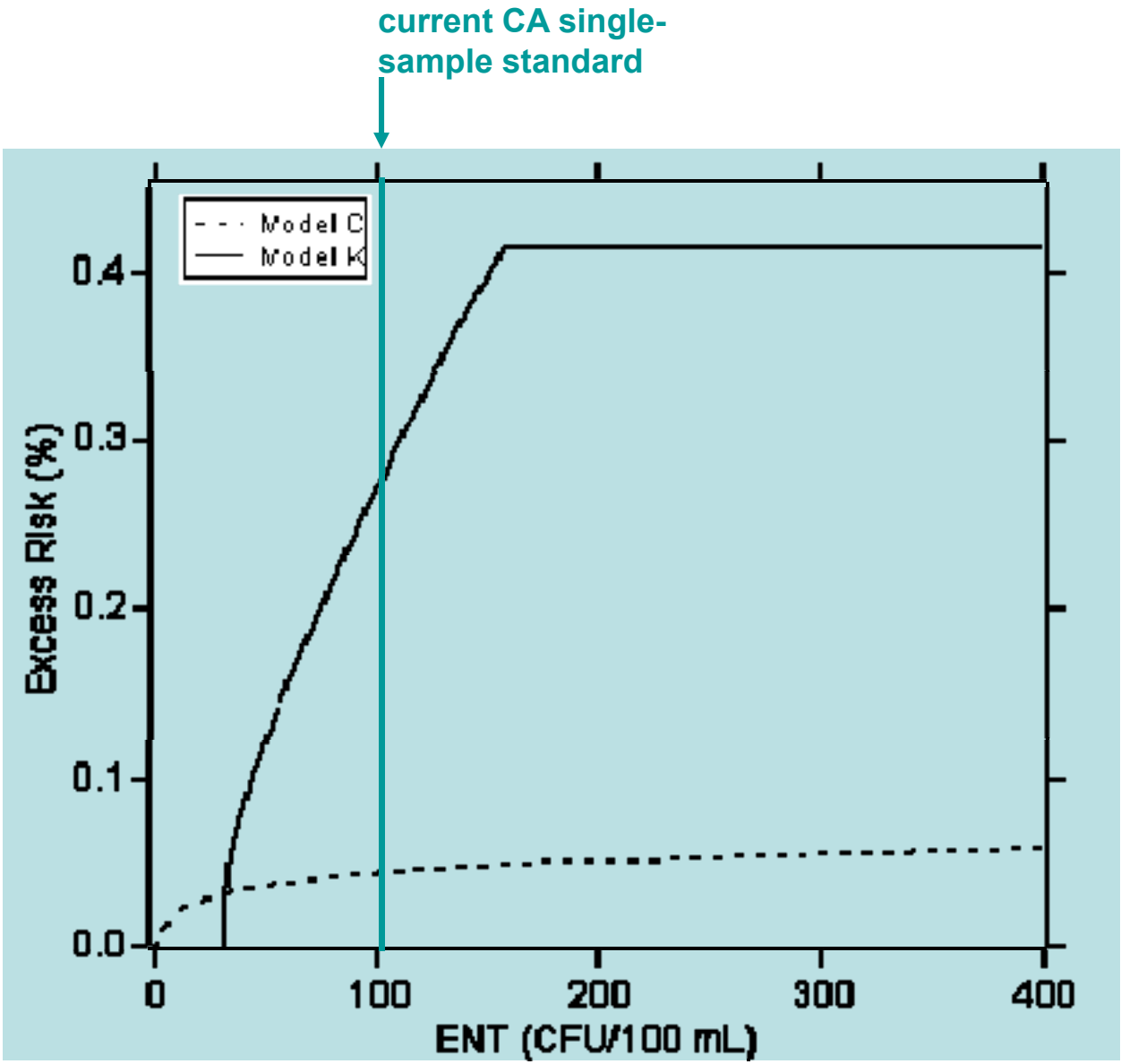
DATA

water quality and attendace for 71 summer days

43% of visitors intend to swim

cost of illness and value of recreation estimates from the local, recent economic studies (Dwight et al. 2005)

We used two different epidemiologic models for GI: Cabelli et al. (1986) and Kay et al. (1994)



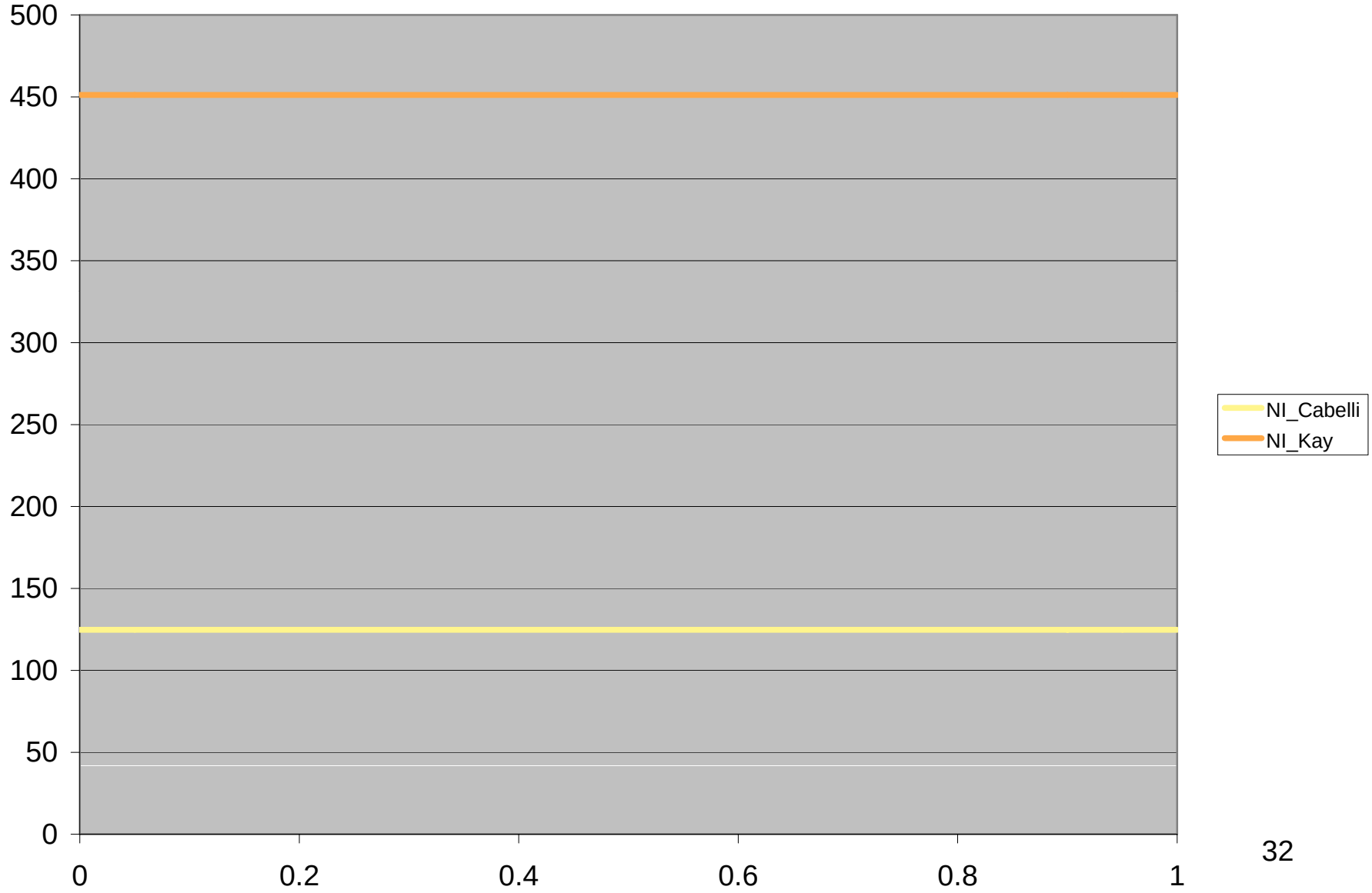
(Forced) COMPLIANCE

ADVISORY HAS NO EFFECT ON SWIM BEHAVIOR

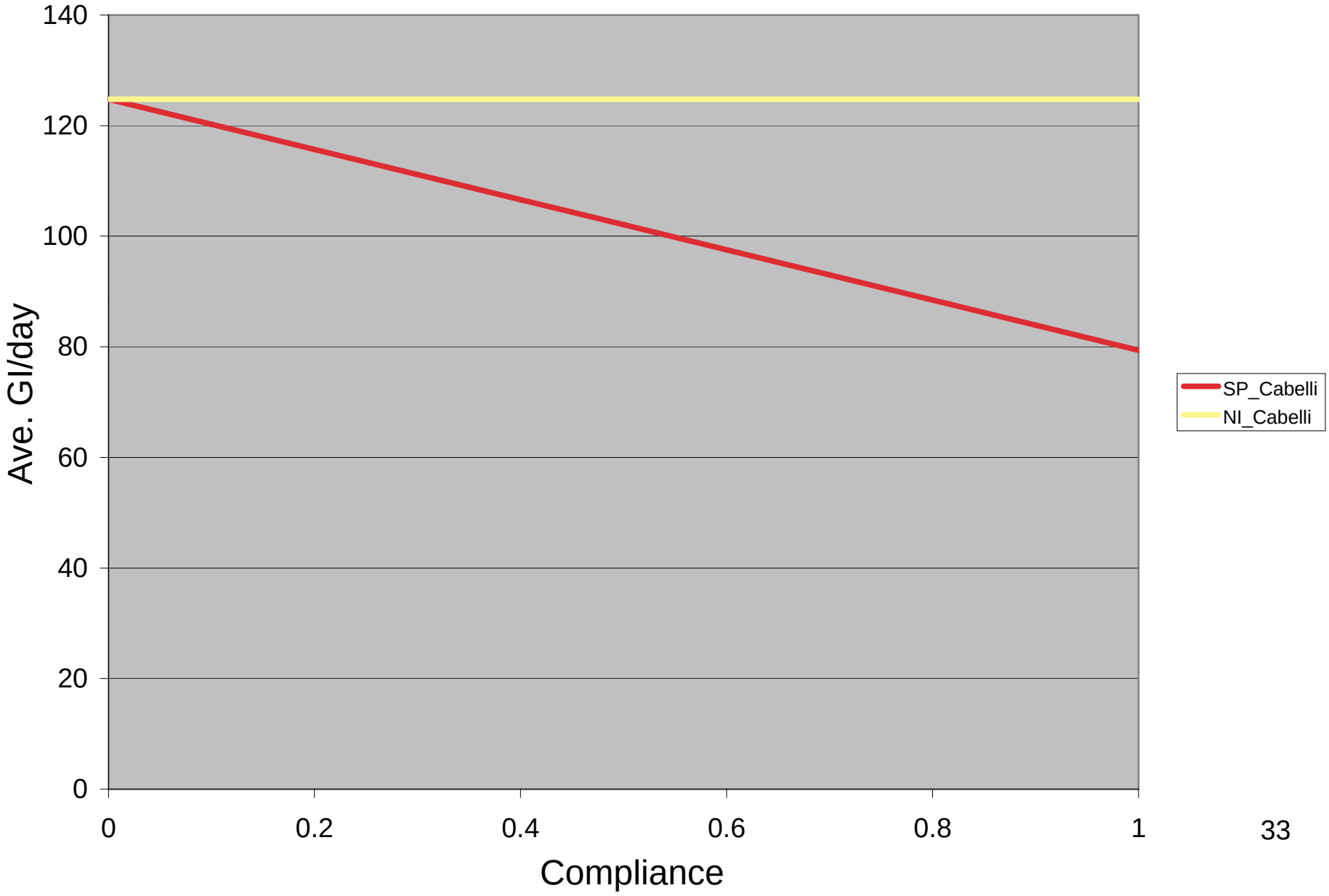
ADVISORY = "CLOSURE"

fraction of swimmers that comply with advisory

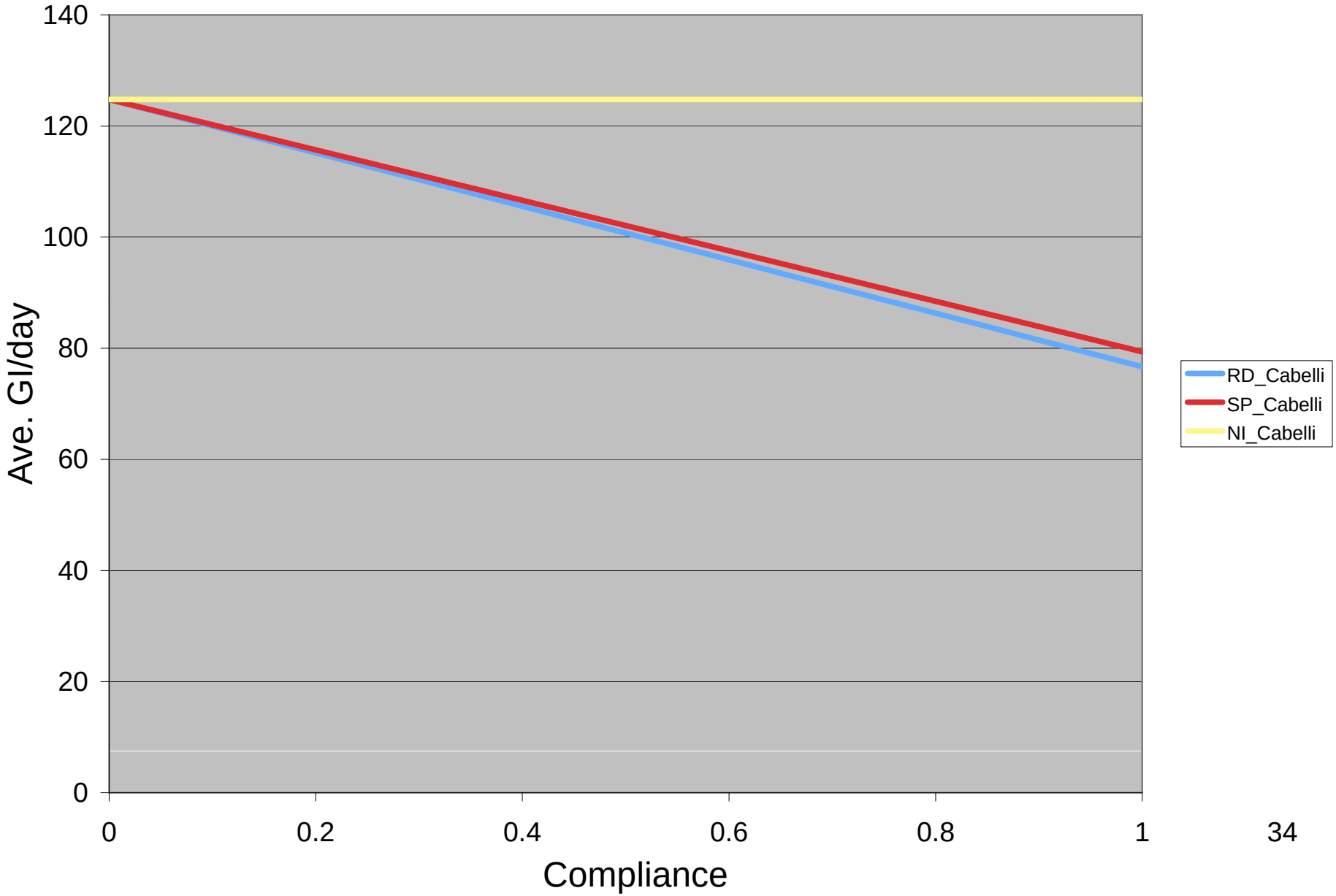
Average GI/day Under Cabelli et al and Kay et al. (NO INTERVENTION)



Average GI/day Under Cabelli et al (Standard Practice - SP)



RD does not result in fewer illnesses than SP under Cabelli et al. Epi Model



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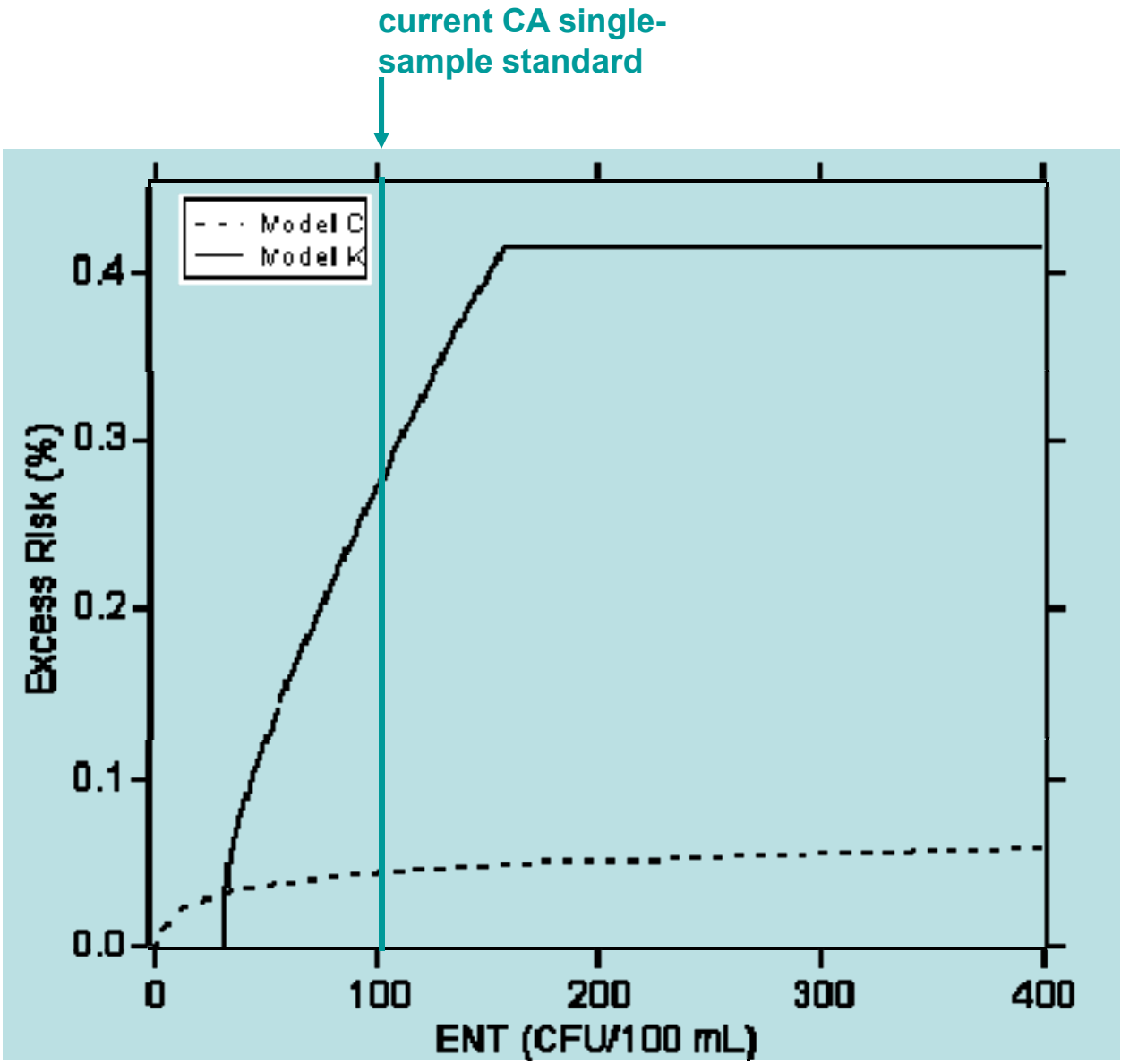

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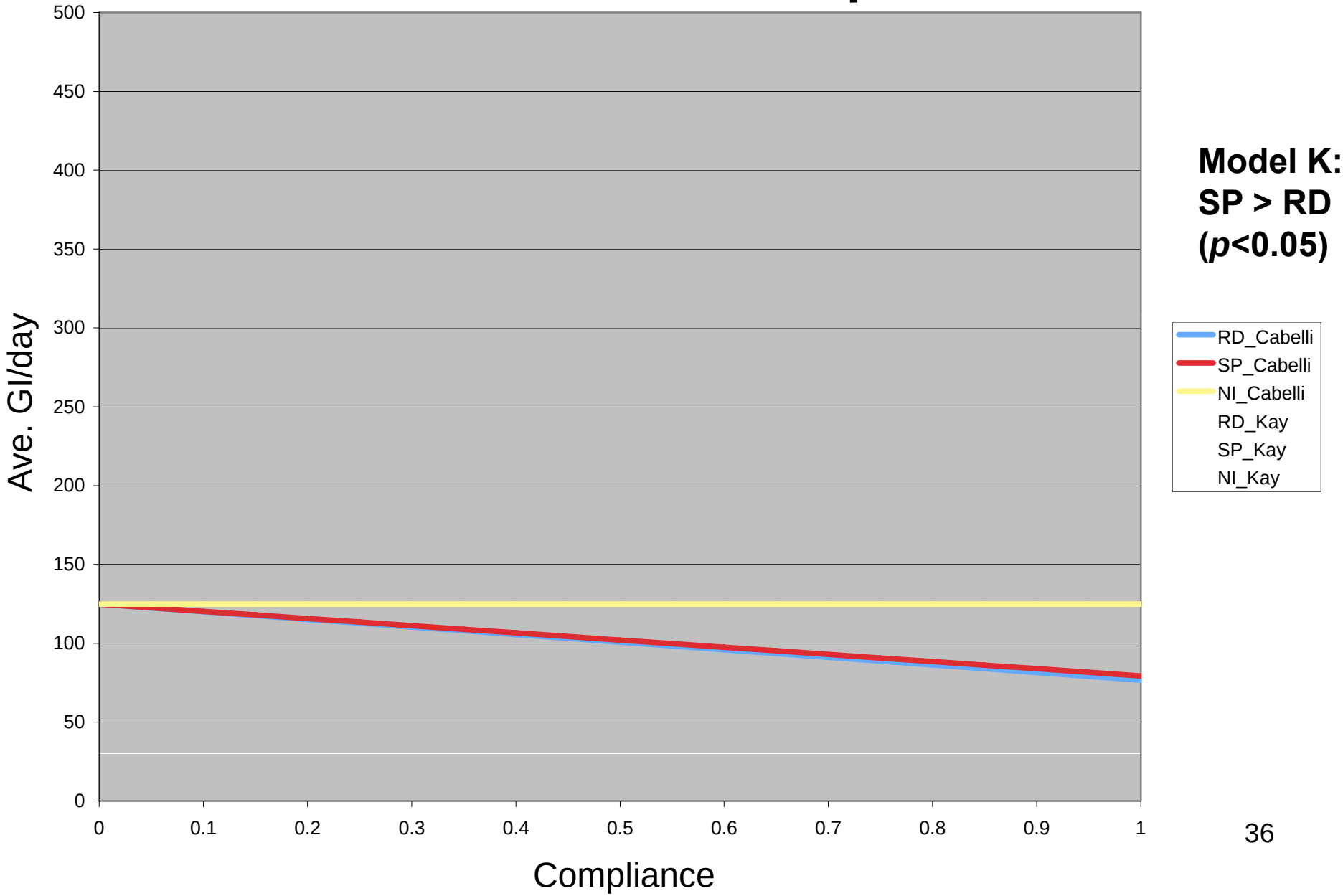
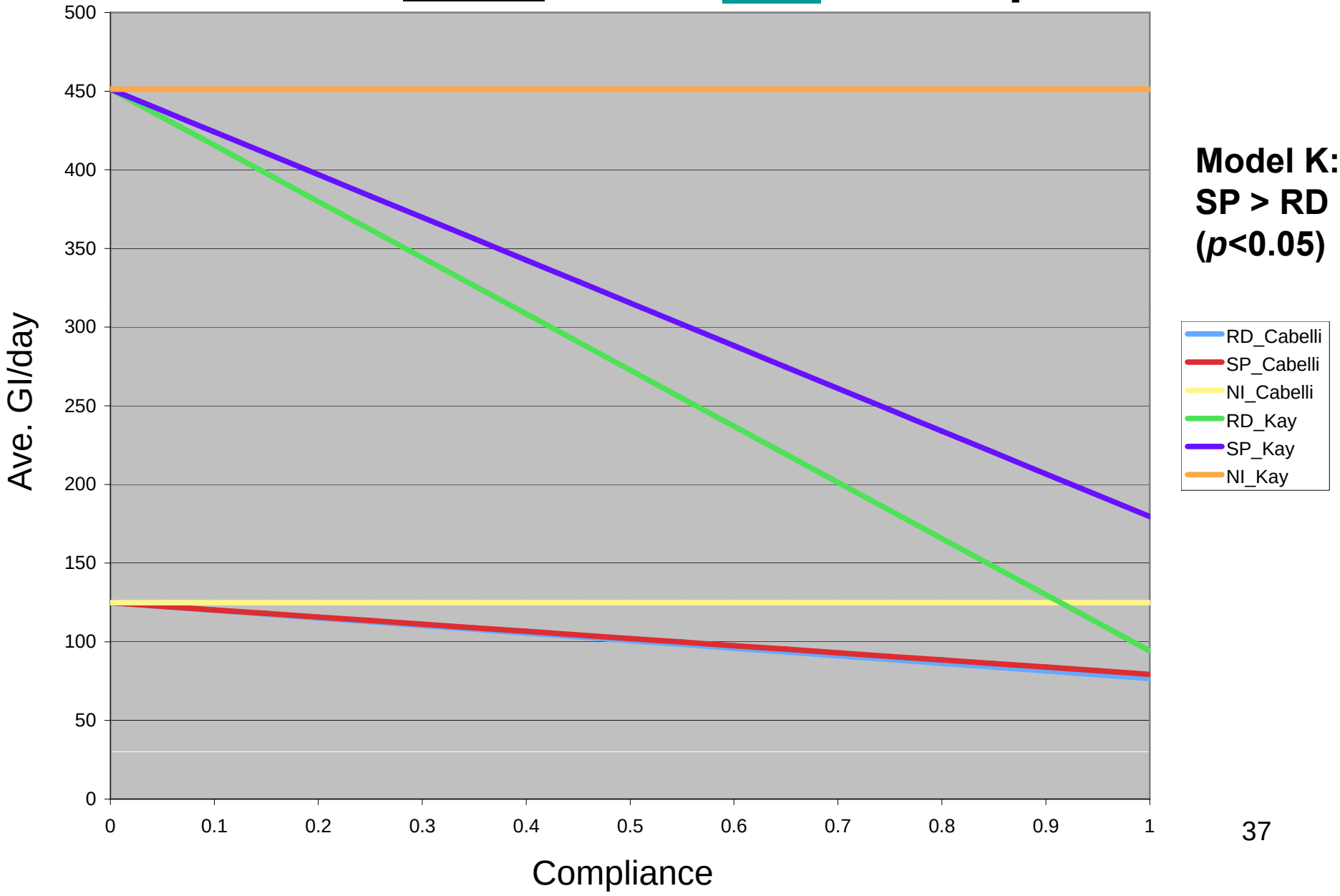


Model K: SP > RD ($p<0.05$)

RD results in significantly fewer illnesses than SP under ONLY under Kay et al. Epi Model



Model K: SP > RD ($p<0.05$)

Estimating the Net Benefits of Swimming

$$\text{Swimmers Exposed} = \sum_{k} S_k (1 - c \mid P_k)$$

 # swimmers **compliance**

P_k=1 if advisory

Estimating the Net Benefits of Swimming

$$NB = \sum_{k} S_k (1 - c \mid P_k)\left[V_{rec} - R_k V_{health}\right] - M$$

 # swimmers **compliance** **P_k=1 if advisory** **R_k = excess illness rate** **Mgt costs**

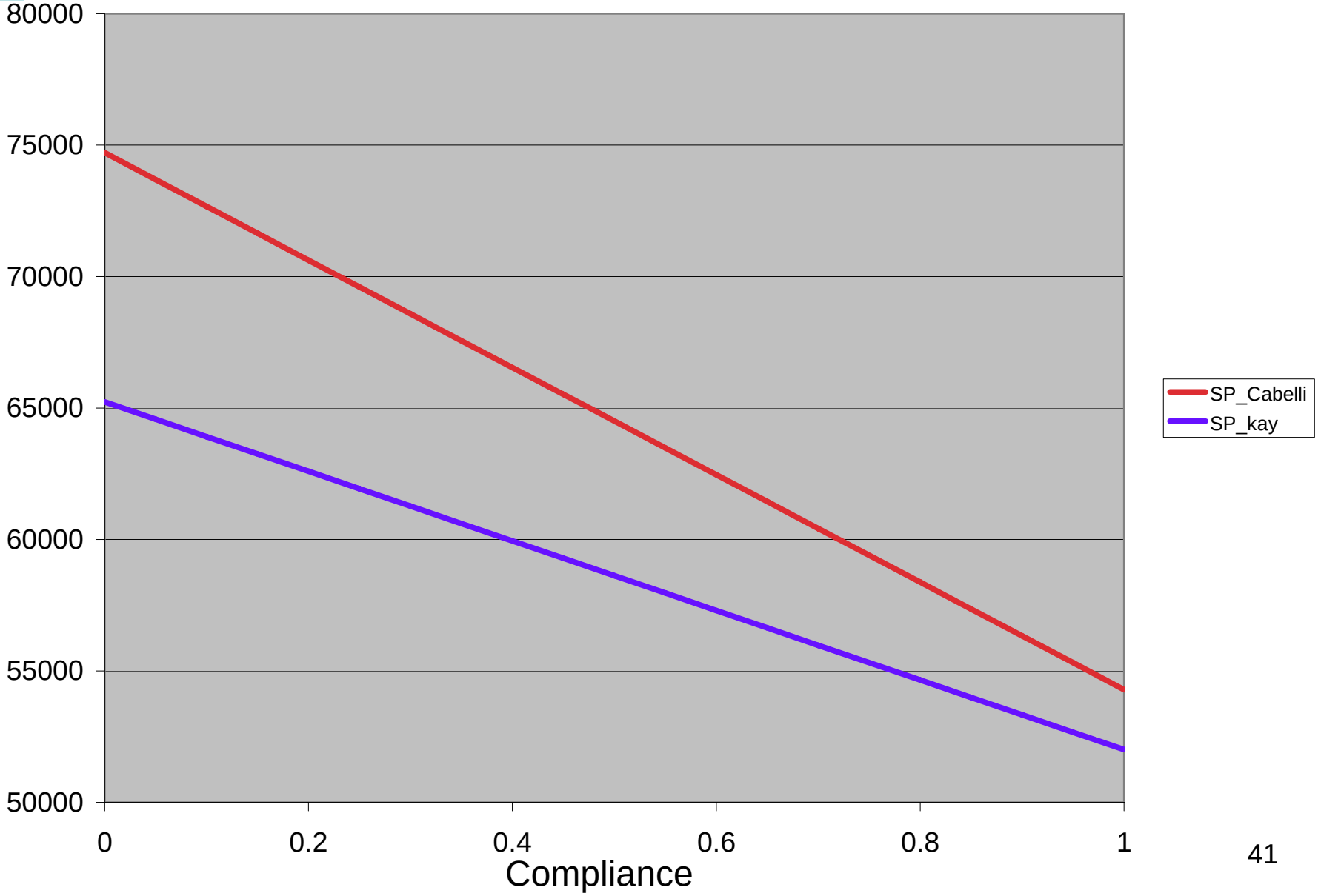
Estimating the Net Benefits of Swimming

$$NB = \sum_k S_k (1 - c \mid P_k)\left[V_{rec} - R_k V_{health}\right] - M$$

 # swimmers **compliance** **P_k=1 if advisory** **R_k = excess illness rate** **Mgt costs**

Value swim recreation visit (in 2000 U.S. dollars) from Hanemann (1997)	**V_{rec} = $ 16.15**
Cost of illness per GI (in 2000 U.S. dollars) from Dwight et al. (2005)	**V_{health} = $ 35.57**
Costs of sampling and posting ($/day)	**M = $120 for SP $370 for RD $0 for NI**

Average Net Benefits/Day of Monitoring and Posting (Standard Practice)



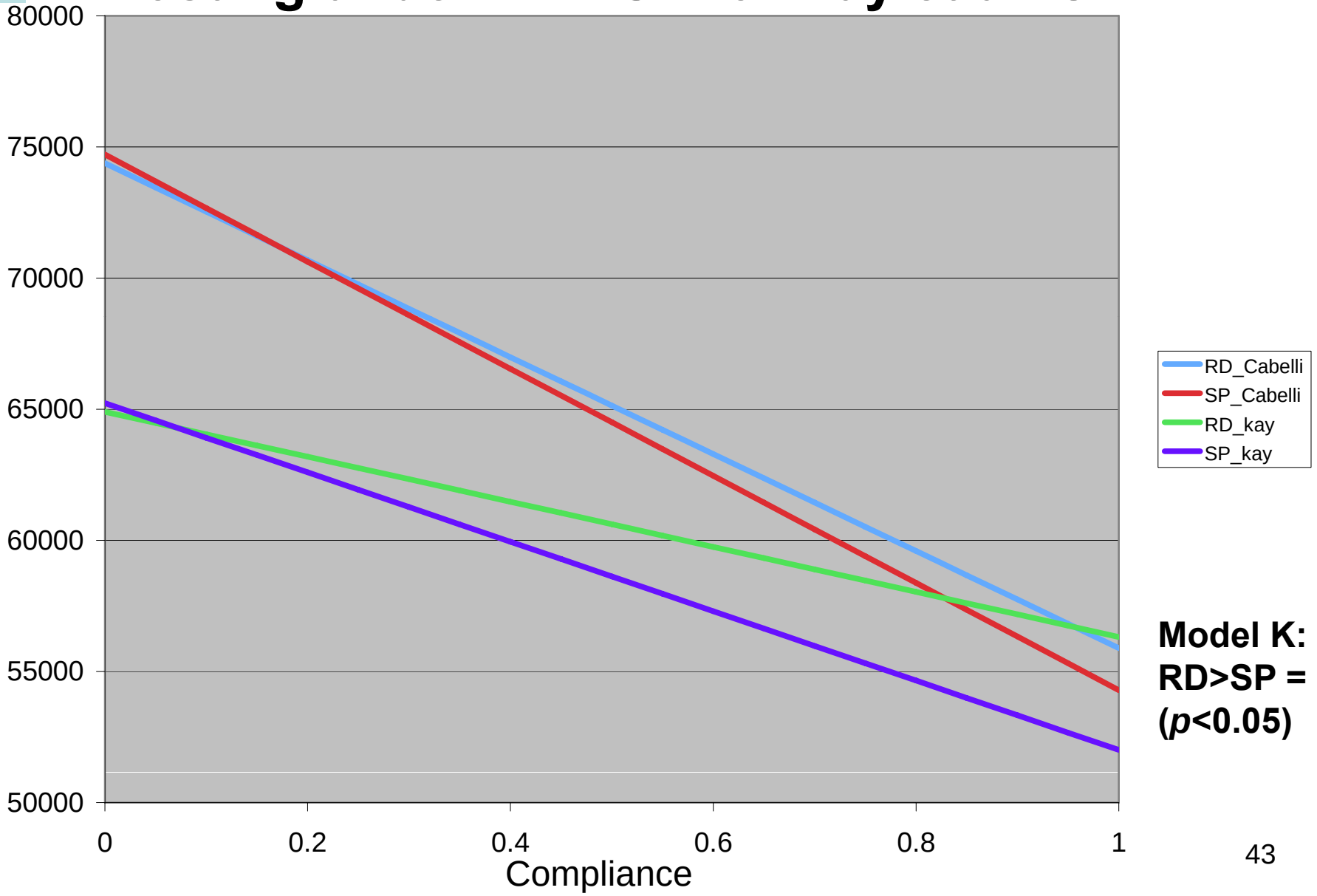
When Does Non-Compliance Make Sense?

Value of Swimming >> Expected Cost of Getting Sick

- V_{rec}, Probability of Getting Sick, V_{health}
  - All vary by user

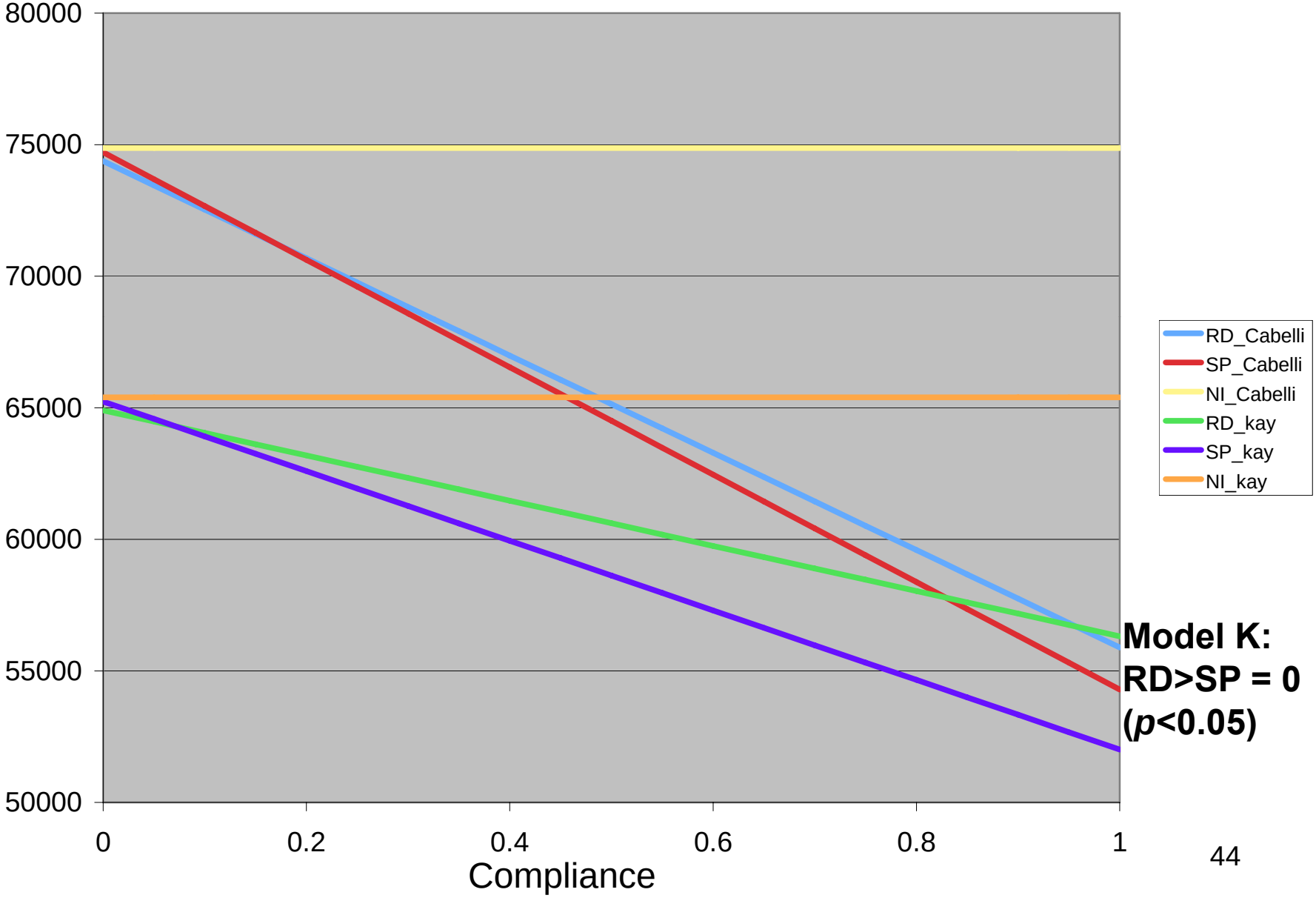
- Surfers have high V_{rec}
- Children and old people have higher Probability of Getting Sick (and possibly higher V_{health})

$ Average Net Benefits/Day of Monitoring and Posting under RD >SP for Kay et al. ONLY



Model K: RD>SP = 0 ($p<0.05$)

Non-Intervention (NI) Has the Highest Net Benefits

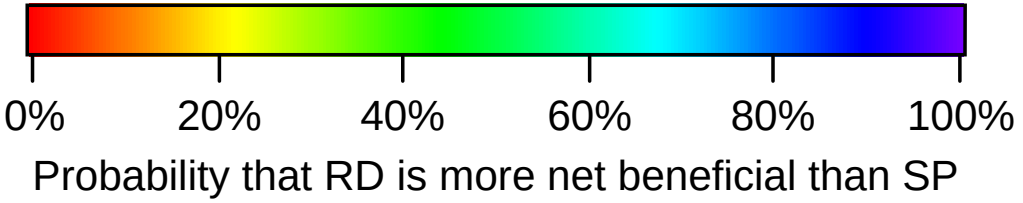


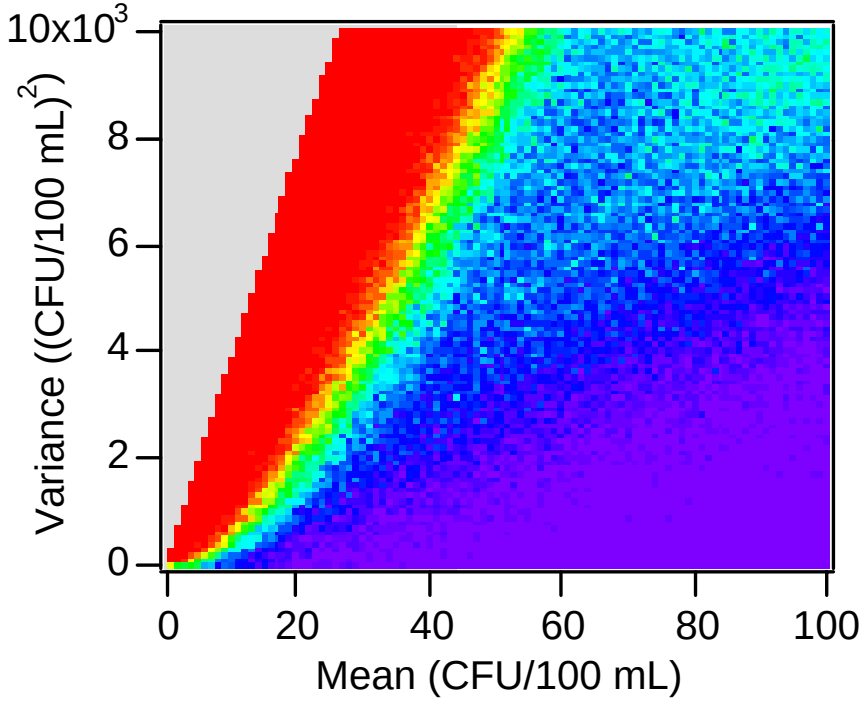
Model K: RD>SP = 0 ($p<0.05$)

What Does This Mean?

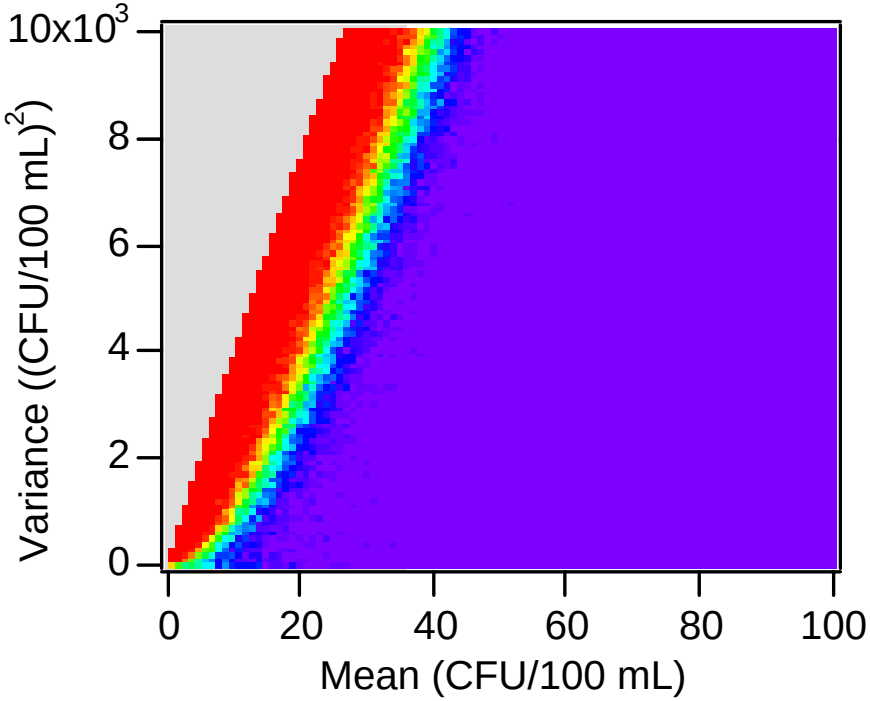
1) Rapid Detection is only valuable if we believe chances of getting sick are high (and/or highly variable)

High Variation and Water Quality affects the likelihood that RD has higher NB than SP





MODEL C



MODEL K

What Does This Mean?

1) Rapid Detection is only valuable if we believe chances of getting sick are high (and/or highly variable)

2) If people don't comply, rapid detection doesn't matter anyhow

3) Non-compliance makes sense for some people

Conclusions

1) Conclusions depend on the epidemiological model
   - – Models preferred by US Agencies do not indicate RD better than SP

2) Water quality regime matters

3) Compliance matters

4) One Size Does Not Fit All Swimmers
   - variability in health susceptibility, recreation values, and behavioral responses

5) Monitoring costs not decisive

WHAT'S THE SOLUTION?

Mitigation, Reduce Surface Water Runoff, Prevent Spills!

1) Lowers public health cost

2) Raises recreation value (per day)

3) Increases number of recreation days

4) Decreases other impacts, not yet accounted for

5) Upstream bio-mitigation has ancillary benefits