Preliminary Findings:
Doheny State Beach Epidemiology Study

SCCWRP Symposium

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January 25, 2011

BACKGROUND

- **qPCR measures a different endpoint than traditional methods**
  - Presence of genetic material vs. evidence of metabolic activity

- **Good relationship between the two, but not perfect**

- **Epidemiology studies provide the basis for determining how health risk relationships differ between these endpoints**
  - Also the basis for establishing a threshold specific to qPCR

Doheny State Beach

Predominately non-human fecal sources

STUDY DESIGN OVERVIEW

- **Prospective cohort design**
  - Screened and interviewed on day of beach visit
  - Participant health surveys by phone 10-14 days later

- **Collect water quality data the same days as recruitment**

- **Correlate exposure (water contact and indicator level) with a suite of health outcomes**

- **Tight design parallel with EPA's epidemiology studies**
  - Similar study instruments
  - EPA's QPCR method processed by EPA

NUMBER OF PARTICIPANTS

Swimmers	Non-swimmers	Total
5940	3585	9525

SYMPTOMS MEASURED

GASTROINTESTINAL

Nausea

Vomiting

Diarrhea

Cramps

Highly Credible Gastrointestinal Illness 1 (HCGI-1)

HCGI-2

HCGI-3

DERMATOLOGICAL

Skin rash

Infected scrapes or wounds

RESPIRATORY

Cough

Cough with phlegm

Nasal congestion

Sore throat

Significant respiratory disease (SRD)

NON-SPECIFIC

Fever

Chills

Earache

Ear discharge

Eye irritation

	Method	Investigator
Traditional Indicator Bacteria		
Enterococcus	Idexx	SCCWRP
Enterococcus	MF	SCCWRP
Fecal Coliform	Idexx	SCCWRP
Fecal Coliform	MF	SCCWRP
Total Coliform	Idexx	SCCWRP
Total Coliform	MF	SCCWRP
Rapid Methods		
Enterococcus	QPCR	EPA
Enterococcus	QPCR	Noble
Enterococcus	TMA	Moore
Enterococcus	IMS	Jay
E. coli	QPCR	Shanks
E. coli	QPCR	Noble
E. coli	IMS	Bushon
E. coli	IMS	Jay
Enterococcus	IMS	Bushon
Enterococcus	Raptor	Harwood
Enterococcus	QPCR Narrow	Noble
Virus		
Adenovirus	QPCR	Sobsey
Enterovirus	QPCR	Stewart
Norovirus	QPCR	Stewart
Norovirus	QPCR	Sobsey
Polyomavirus	QPCR	Harwood
Polyomavirus	PCR	Harwood
HAV	QPCR	Fuhrman

	Method	Investigator
Phage		
Phage +/-	Culture	Stewart
Phage +/-	Culture	Sobsey
Rapid phage	Antibody	Sobsey
Marker Genes		
Bacteroides	QPCR	EPA
Bacteroides theta	QPCR	Noble
Bacteroides theta	QPCR	EPA
Human Bacteroides (HF183)	QPCR	Field
Human Bacteroides (Kildare)	QPCR	Wuertz
Human Bacteroides (HF183, HF134, HumM19)	QPCR	Shanks
B. dorei	PCR/QPCR	Shanks
B. stericoris	PCR	Shanks
B. uniformis	QPCR	Shanks
C. perfringens	QPCR	Shanks
Enterococcus ESP gene	QPCR	Scott
E. coli virulence gene	QPCR	Sadowsky
Phylochip		Anderson
Other Bacteria		
Methanogens	QPCR	Ufnar
Legionella	QPCR	Gast
Staphylococcus aureus	Culture	Goodwin
Staphylococcus aureus	QPCR	Goodwin
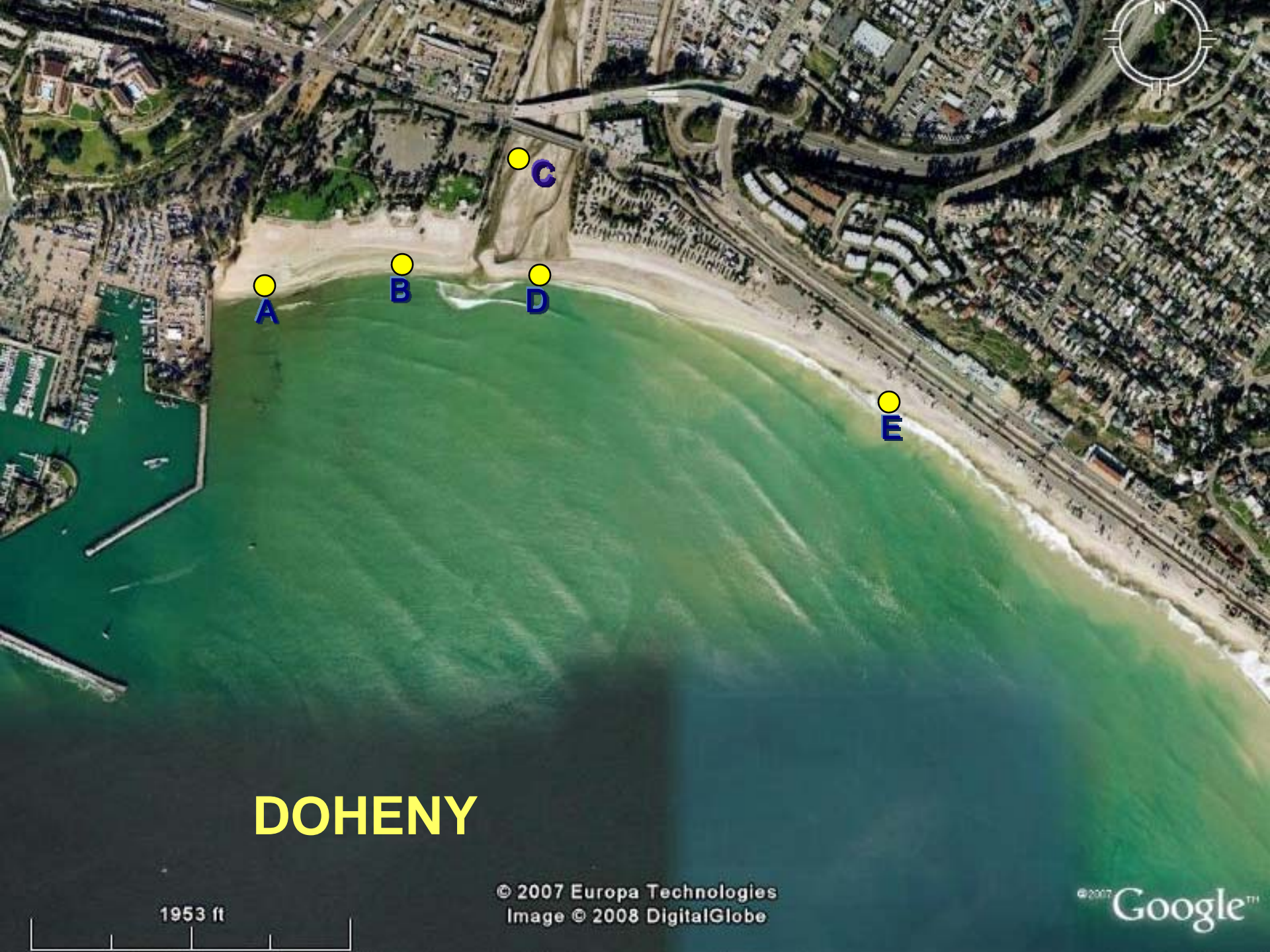
DOHENY

PERCENT ILLNESS - DOHENY

	Non-swimmers	Body Contact	Head Under	Swallow Water
Gastrointestinal:				
Diarrhea	3.49	**4.58**	**4.59**	**6.13**
HCGI-3	5.37	6.82	6.92	8.07
Nausea	2.36	2.34	2.64	2.69
Cramps	4.60	5.67	5.77	6.22
Vomiting	1.51	1.63	1.61	1.60
Fever	1.95	2.61	2.71	2.95
Skin Rash	2.23	3.48	**3.45**	4.15
Eye Infection	0.31	**0.72**	**0.76**	0.58
Earache	1.21	**2.08**	**2.25**	**2.40**
Respiratory:				
Cough	1.82	2.39	2.30	2.66
Throat	4.23	4.34	4.70	4.34

DAYS FOLLOWING EXPOSURE - DOHENY
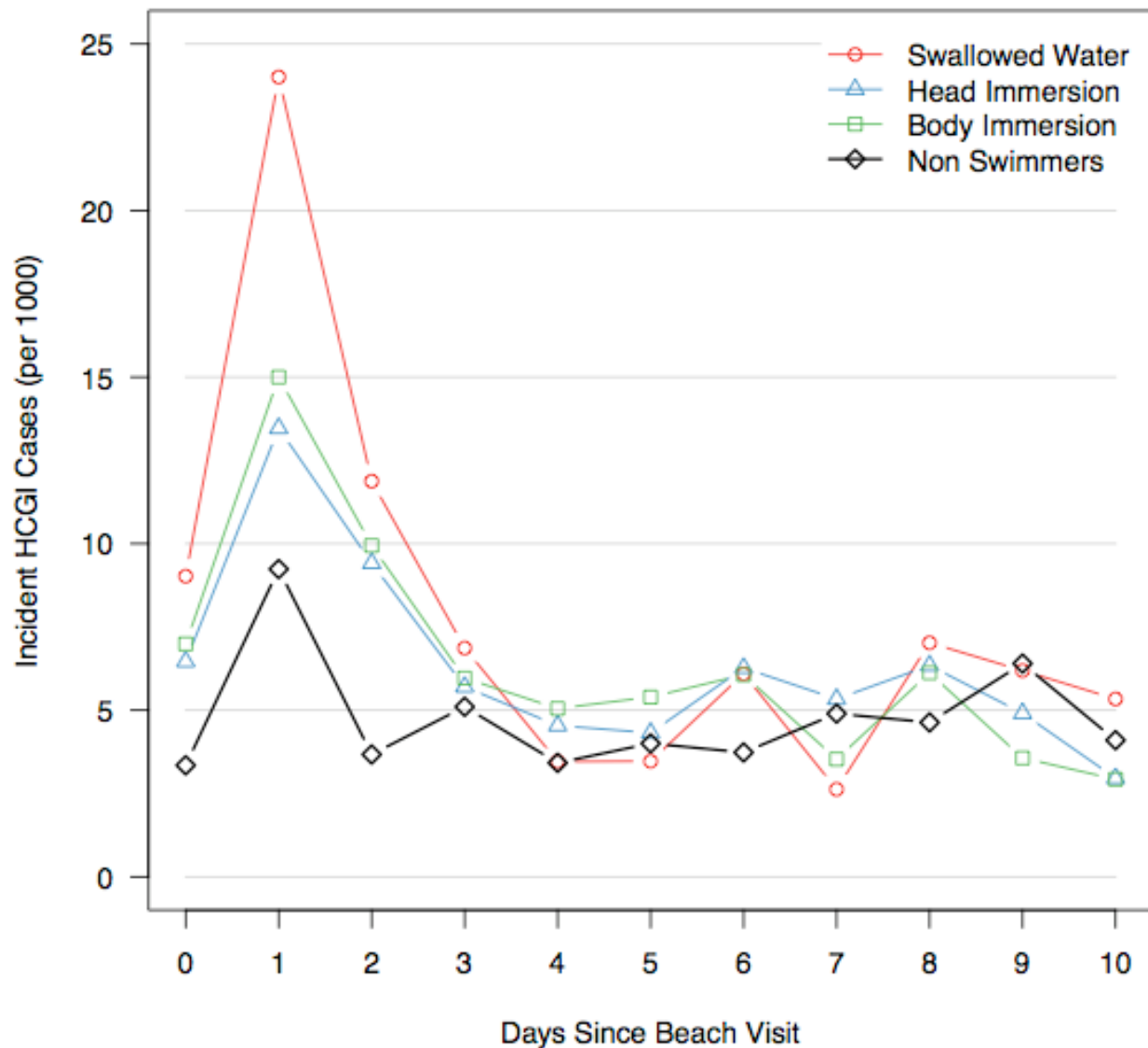
HCGI-3 ODDS RATIO FOR DOHENY

	Head Under	Swallow Water
EPA 1600	1.16	**1.52**
Enterolert	1.16	1.32
EPA qPCR	0.94	1.21
EPA qPCR 2	0.96	1.27
Noble qPCR	1.11	1.28
Noble qPCR 2	1.00	**1.35**

DOHENY *ENTEROCOCCUS* INDICATORS
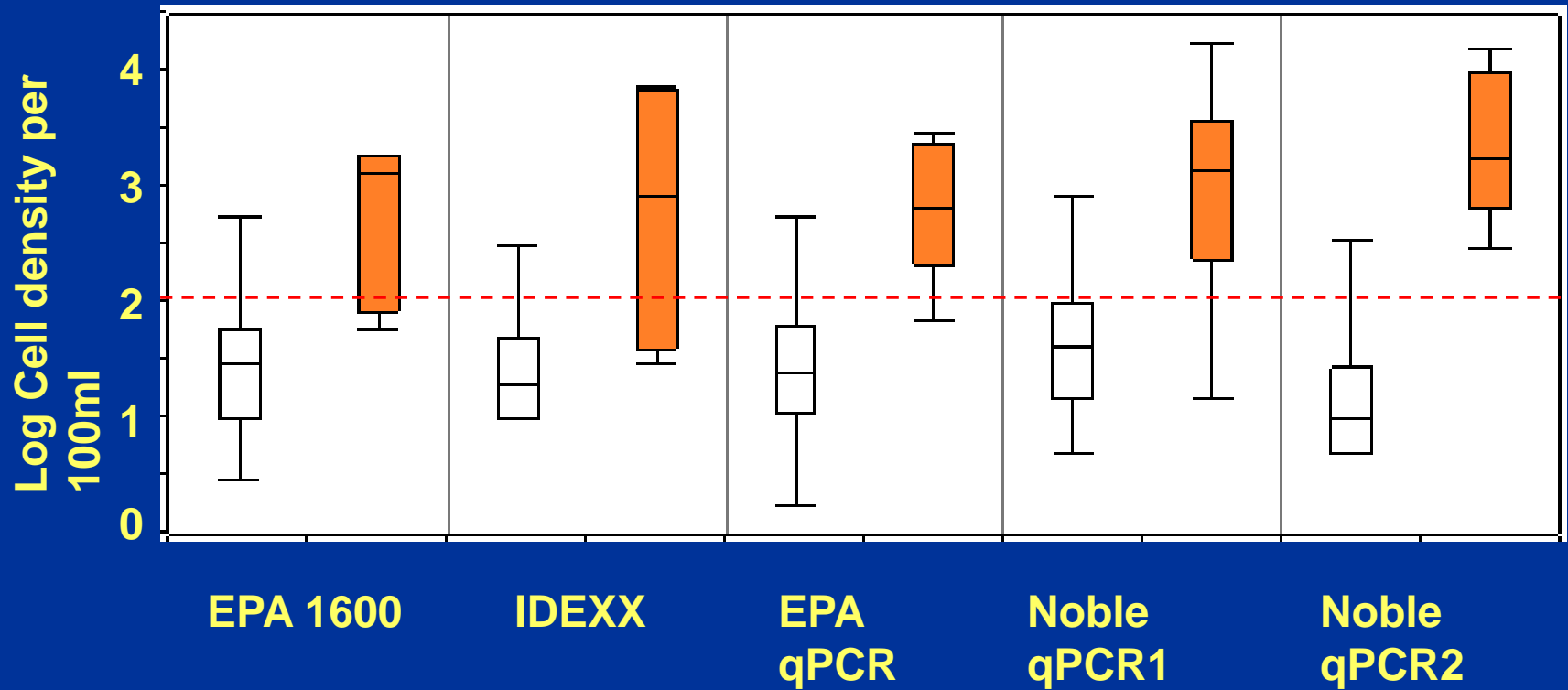
HCGI-3 ODDS RATIO FOR DOHENY

	Berm Open		Berm Closed	
	Head Under	**Swallow Water**	**Head Under**	**Swallow Water**
EPA 1600	**1.55**	**2.37**	1.00	1.22
Enterolert	1.20	**1.87**	1.05	0.91
EPA qPCR	1.35	2.51	0.82	0.94
EPA qPCR 2	1.23	**1.92**	0.83	0.94
Noble qPCR	1.22	1.46	1.03	1.17
Noble qPCR 2	1.13	**1.90**	0.93	1.20

CONSIDER THE PROCESSING TIME

- **The previous table compared health risk relationship among indicators for samples collected at the time of swimmer exposure**

- **That is reasonable for qPCR, but not for culture methods**
  - With sample processing delay, today's sample are used to predict tomorrow's health risk

- **We repeated the epidemiology analyses lagging culture-based exposure measures by one day**

DOHENY HCGI-3 ODDS RATIO
Lagged Comparison

	Head Under	Swallow Water
EPA 1600	**1.55**	**2.37**
Enterolert	1.20	**1.87**
EPA qPCR	1.35	2.51
EPA qPCR 2	1.23	**1.92**
Noble qPCR	1.22	1.46
Noble qPCR 2	1.13	**1.90**
EPA 1600 (Lagged 1 day)	1.06	0.95
Enterolert (Lagged 1 day)	1.13	1.15

HCGI-3 - DOHENY

	Berm Open		Berm Combined	
	Head Under	Swallow Water	Head Under	Swallow Water
EPA 1600 Continuous	**1.55**	**2.37**	1.18	**1.52**
EPA 1600 104 Cutoff	2.15	**7.42**	1.17	2.68

DIARRHEA - DOHENY

	Berm Open		Berm Combined	
	Head Under	Swallow Water	Head Under	Swallow Water
EPA 1600 Continuous	**1.89**	**3.26**	**1.33**	**1.74**
EPA 1600 104 Cutoff	**4.04**	**17.90**	1.85	**3.94**

SUMMARY

- **Enterococcus was an effective indicator, but mostly when the runoff source was continuous**
  - Different health relationships at a beach, depending on source, presents an interesting management challenge

- **Traditional methods and qPCR yielded equivalent relationships to health outcomes**

- **When the processing lag was considered, qPCR provided a superior relationship**

QUESTIONS?