

**Assessment of microbial contaminants pertinent to swimming-related illnesses  
at Doheny Beach, Orange County, CA**

**A Final Report Submitted to**

**The NOAA/UNH Cooperative Institute for Coastal and Estuarine  
Environmental Technology (CICEET)**

**Submitted by**

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Project Title: Assessment of microbial contaminants pertinent to swimming-related illnesses at Doheny Beach, Orange County, CA

Principal Investigator(s): Rachel T. Noble

Additional Investigator(s): Jed Fuhrman, Troy Scott, Jill Stewart (separate budget)

Project Start Date: May 1, 2007

Project End Date: March 31, 2009 (extension granted through this period)

### **Introduction:**

Historically, most epidemiological studies conducted in the recreational waters of the United State have focused on point source fecal contamination, i.e. studies have been conducted on beaches that have a known human sewage source contributing to their water quality degradation. However, the US EPA currently estimates that 60-80% of the impaired waters in the USA are impaired due to non-point source inputs. The current indicator system for monitoring beach water quality is no longer adequate for public health protection, and the US EPA is facing law suits to update regulations. The research supported by this grant has enabled application of novel pathogen detection technology in the 2007 epidemiological studies coordinated by the Southern California Coastal Water Research Project (SCCWRP) in consultation with the US EPA. These studies are focused on bathing beaches impacted by nonpoint sources of pollution. In 2007, SCCWRP organized a preliminary methods evaluation study designed to test methods prior to the epidemiological studies. Blind challenge samples were prepared by SCCWRP and sent to investigators. This preliminary study was followed by epidemiological trials at both Doheny State Beach in Orange County, CA then Avalon Beach on Catalina Island, CA. Beach water for microbial analysis was collected concurrent with health surveys targeting bathers and nonbathers visiting these beaches. The ultimate goal of this research is to assess new fecal pollution indicators for predicting swimmer health risk.

1. Project Objectives for Past Reports were accomplished as listed below.

Objectives: The objectives are to analyze samples from the Doheny Beach Epidemiological Study, which was abandoned in July, 2007, and also conduct the same analyses for the City of Avalon (Catalina Island) Epidemiological Study. The analyses funded by this grant are specific to the PI.

PI Noble: QPCR *E. coli* analysis, QPCR *Bacteroides thetaiotamicron* analysis

Co-PI Scott: ESP Gene analyses, quantitative and qualitative

Co-PI Fuhrman: Hepatitis A Virus analysis

Co-PI Stewart: Real time polymerase chain reaction (PCR) assays for (1) enteroviruses, and (2) *Methanobrevibacter smithii*, an archean associated with human-source fecal contamination.

2. As of spring 2008, discussions with SCCWRP scientists resulted in their desire for quantification of three specific Enterococcus species (referred to as Enterococcus speciation) for samples from the Doheny and Avalon Epidemiology Studies.

3. Tasks to meet objectives:

- a) conduct Enterococcus speciation
- b) conduct data analysis

a) Progress on Tasks:

As of 1 March 2009 these assays have been completed and the data reported to SCCWRP. Additional data analysis and manuscript writing is taking place.

- b) Have the results/data gathered during this reporting period changed the project objectives when compared to your original proposal? Please explain.

Yes, we did not originally expect to use CICEET resources to conduct the Enterococcus speciation, but given our success with the approach and the interest of SCCWRP scientists in the method we decided to move forward with the analyses.

- c) Dissemination activities during this reporting period (please include the number of participants where applicable): This period has largely been used to conduct sample analysis, and conduct data analysis.

A manuscript is in preparation for the special issue of Journal of Water Research, with lead author Reagan Converse, the Ph. D. student who conducted these analyses and who has been supported by this project.

- d) Difficulties: None

- e) Data Generated to date: Attached tables provide QPCR data for Enterococcus speciation.

2. Project Objectives for Next Reporting Period:

- a) Objectives: Our contract with CICEET has been extended to March 31 2009, in the time period between September 1 2008 and March 1 2009 we have conducted additional analyses on the epidemiological study samples collected from Doheny and Avalon 2008 and are finalizing data analysis and writing manuscripts.

- b) Work Plan to Meet Objectives: Continue with analyses as described in proposal. PI meetings will occur for data discussions.

- c) Dissemination Objectives for next reporting period: Multiple publications are expected, including one detailing results from the preliminary study, others detailing the microbiological analysis, and a final one including health outcomes from the epidemiological study.

- d) Overall Project Timeline Update: Work appears to be on schedule and the project is being finalized.

3. Expenditures:

Please state whether or not expenditures are in the range anticipated for the work accomplished to date.

All expected billing has taken place from the subcontractors, Furhman and Scott, on this project.

The expenditures are in range. A minor budget modification request was submitted from my Office of Sponsored Research to finalize this project. We expect this project to be finalized and completed on the required date.

Enterococcus Speciation Data reported as cell equivalents per 100 ml for each of three species. Enterococcus faecalis, E. faecium, E. casseliflavus. ND= none detected

Date	Sample ID	Faecium dCt	Faecium ddCt	Faecalis dCT	Faecalis ddCT	Cass dCT	Cass ddCT
7/26/2007	B8-2	ND	ND	95.31	291.51	42.35	28.64
7/26/2007	C8-3	ND	ND	188.70	57.72	1.61	1.09
7/27/2007	C8-15	33.02	20.35	149.21	45.64	28.03	18.95
7/27/2007	B12-17	ND	ND	421.65	128.96	3.04	2.06
7/28/2007	C8-27	140.96	86.89	871.22	266.47	49.53	33.49
7/29/2007	C12-42	ND	ND	42.96	13.14	6.66	4.50
8/2/2007	B8-50	ND	ND	503.73	15.05	19.23	13.00
8/2/2007	C8-51	198.34	122.26	455.74	139.46	25.02	16.91
8/2/2007	B12-53	7.84	4.84	427.69	130.81	56.30	38.07
8/2/2007	BD12-56	86.20	53.18	314.96	96.33	2292.82	1550.32
8/2/2007	A3-58	122.58	755.67	41.16	12.59	82.08	55.50
8/2/2007	B3-59	228.60	140.96	293.33	89.72	46.46	31.41
8/2/2007	C3-60	ND	ND	19.78	6.05	77.54	52.43
8/3/2007	C8-63	537.04	331.05	788.62	241.20	11.77	7.96
8/3/2007	B12-65	204.06	125.79	149.21	45.64	53.56	36.22
8/3/2007	C12-66	ND	ND	38.07	11.64	4051.07	2739.18
8/3/2007	AD12-67	ND	ND	33.73	10.32	5.08	3.44
8/3/2007	B3-71	ND	ND	14.57	4.46	384.40	259.91
8/3/2007	C3-72	ND	ND	0.22	0.07	1.59	1.08
8/4/2007	A8-73	ND	ND	69.69	21.32	5.74	3.88
8/4/2007	A12-76	ND	ND	22.64	6.26	9.64	6.52
8/4/2007	C12-78	ND	ND	19.92	6.09	9.17	6.20
8/4/2007	B3-83	7.90	4.87	69.62	21.32	108.33	73.25
8/4/2007	C3-84	ND	ND	196.93	60.23	71.20	48.14
8/5/2007	C8-87	440.04	271.25	96.68	29.57	42.66	28.84
8/5/2007	B12-89	2.62	1.62	5.27	1.61	7.68	5.19
8/5/2007	C12-90	16.28	1.00	22.48	6.88	14.26	9.64
8/5/2007	AD12-91	ND	ND	ND	ND	1.80	1.22

8/5/2007	B12-92	ND	ND	12.11	3.70	5.16	3.49
8/5/2007	<u>A3-94</u>	ND	ND	368.33	112.66	25.56	17.28
8/9/2007	A8-97	ND	ND	74.30	22.73	1070.88	724.09
8/11/2007	C8-123	ND	ND	60.88	18.62	3.54	2.39
8/12/2007	C8-134	119.67	73.77	324.06	99.11	1048.26	708.79
8/12/2007	C8-135	641.59	395.49	178.26	54.52	6.85	4.63
8/16/2007	A3-145	ND	ND	10.45	2.61	0.53	0.27
8/16/2007	B8-146	ND	ND	45.71	11.89	0.42	0.21
8/16/2007	B3-155	ND	ND	7.23	1.78	0.26	0.13
8/16/2007	C3-156	ND	ND	79.78	24.40	7.20	4.87
8/17/2007	B3-167	ND	ND	100.89	30.86	5.30	3.59
8/18/2007	B8-170	27.42	14.16	5.33	1.30	0.82	0.42
8/18/2007	C8-171	922.25	568.50	195.54	59.81	27.64	18.69
	C12-						
8/18/2007	174	ND	ND	331.05	101.25	67.74	45.80
8/18/2007	A3-178	ND	ND	1174.65	359.27	19.36	13.09
8/18/2007	B3-179	823.01	507.33	119.68	36.60	125.79	85.06
8/19/2007	A8-181	ND	ND	4.78	1.16	0.66	0.34
8/19/2007	B8-182	ND	ND	8.71	2.16	0.19	0.10
8/19/2007	C8-183	ND	ND	12.91	3.25	1.77	0.92
	B12-						
8/19/2007	185	ND	ND	42.66	1.1.76817489813	0.15	0.07
8/19/2007	A3-190	ND	ND	39.26	10.17	0.27	0.13
8/19/2007	B3-191	ND	ND	13.74	3.45	0.65	0.33
8/23/2007	A8-193	ND	ND	ND	ND	0.40	0.20
8/23/2007	B8-194	2.82	1.36	11.80	2.95	0.74	0.38
	B12-						
8/23/2007	197	154.62	95.31	82.08	25.11	#####	#####
8/23/2007	C3-204	0.91	0.56	148.16	45.31	345.49	233.60
	A12-						
8/25/2007	220	ND	ND	163.67	50.06	114.68	77.54
8/25/2007	C3-228*						
8/26/2007	C8-231	391.74	219.11	1741.81	505.53	475.34	293.33
	B12-						
8/26/2007	236	ND	ND	360.58	99.82	39.81	22.81
8/30/2007	B8-242	ND	ND	428.55	119.25	201.84	121.39
8/30/2007	C3-243	ND	ND	1127.20	322.91	33.04	18.82
	B12-						
8/30/2007	245	ND	ND	527.30	147.60	21.98	12.37
	BD12-						
8/30/2007	248	ND	ND	755.09	213.72	25.94	14.67
8/30/2007	A3-250	ND	ND	1548.82	447.94	19.82	11.12
8/31/2007	C8-255	ND	ND	5223.96	#####	17.02	9.51
9/2/2007	C8-279	ND	ND	1636.82	474.17	99.77	58.75
9/2/2007	B3-287	ND	ND	1506.61	435.37	46.03	26.48
9/3/2007	A8-289	ND	ND	#####	#####	10.64	5.86
9/3/2007	B8-290	ND	ND	1367.73	394.09	62.37	36.22
9/3/2007	C8-291	ND	ND	3749.73	#####	132.43	78.65

8/2/2007	A8-49	ND	ND	40.09	12.69	0.77	0.52
8/2/2007	A12-52	ND	ND	13.55	4.29	1.17	0.80
8/2/2007	C12-54	ND	ND	15.67	4.96	0.84	0.58
8/2/2007	BD12-56	ND	ND	38.46	12.18	1.00	0.69
8/2/2007	CD12-57	ND	ND	19.41	6.14	0.80	0.55
8/11/2007	A8-121	ND	ND	7.96	2.52	0.70	0.48
8/11/2007	B8-122	ND	ND	12.13	3.84	0.77	0.52
8/11/2007	A12-124	ND	ND	5.33	1.69	0.82	0.56
8/11/2007	B12-125	ND	ND	0.57	0.18	1.43	0.97
8/11/2007	C12-126	ND	ND	3.11	0.99	0.80	0.55
8/11/2007	AD12-127	ND	ND	4.88	1.54	0.75	0.51
8/11/2007	BD12-128	ND	ND	6.75	2.14	0.53	0.37
8/11/2007	CD12-129	ND	ND	2.17	0.69	0.90	0.61
8/11/2007	B3-131	ND	ND	11.80	3.74	0.81	0.55
8/11/2007	C3-132	ND	ND	1.73	0.55	0.72	0.50
8/16/2007	C8-147	ND	ND	60.26	19.08	0.72	0.50
8/16/2007	A12-148	ND	ND	14.03	4.44	0.89	0.61
8/16/2007	B12-149	ND	ND	7.85	2.49	0.62	0.43
8/16/2007	C12-150	ND	ND	0.38	0.12	0.80	0.55
8/16/2007	AD12-151	ND	ND	11.40	3.61	0.95	0.65
8/16/2007	BD12-152	ND	ND	11.25	3.56	1.10	0.75
8/16/2007	CD12-153	ND	ND	0.16	0.05	0.74	0.51
8/17/2007	A8-157	ND	ND	64.12	20.30	1.03	0.70
8/17/2007	B8-158	ND	ND	9.27	2.93	0.68	0.46
8/17/2007	A12-160	ND	ND	7.23	2.29	0.76	0.52
8/17/2007	B12-161	ND	ND	26.30	8.33	0.94	0.64
8/17/2007	C12-162	ND	ND	13.00	4.12	0.76	0.52
8/17/2007	A3-166	ND	ND	7.59	2.40	0.95	0.65
8/17/2007	C3-168	ND	ND	4.58	1.45	0.70	0.48
8/19/2007	A12-184	ND	ND	21.98	6.96	0.76	0.52

8/19/2007	C12- 186	sample inhibited	sample inhibited	sample inhibited	sample inhibited	7961.59	5445.03
8/19/2007	AD12- 187	ND	ND	40.36	12.78	0.98	0.67