Topanga Source ID Study

Presented to the Santa Monica Bay Restoration Commission

16 April 2015

What we achieved…

1. Identified the sources of bacterial contamination at Topanga Beach

2. Identified BMP's that can reduce exceedances

3. Examined the sources and sinks, as well as trophic level interactions in Topanga Creek and lagoon to understand the Topanga "Magic"

4. Provided outreach to the local community and schools

Thank you to the team!!

Our Funders: Supervisor Zev Yaroslavsky and SIPP

Los Angeles County Departments

State Parks Angeles District

Our TAC and SIPP Collaborators for advice along the way

BioSolutions and Topanga Underground

UCLA Team: Dr. Jenny Jay's Lab Group

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Past Help: Darcy Ebentier, Kaitlyn Hanley, Maria Carvaljo, Sofi Peterson, John Lin, Lynn Rice, Ben Tanimoto, Chris Carandang, Raven LoGiurato

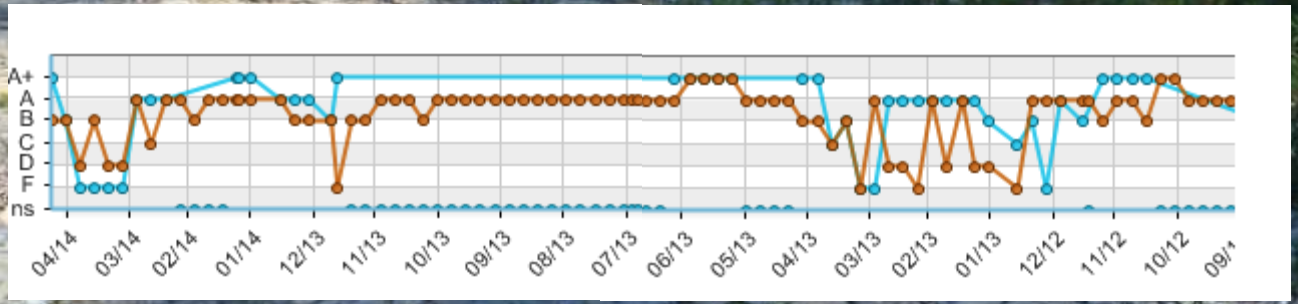
RCDSMM Team: Rosi Dagit, Jenna Krug, Krista Adamak, Steve Williams, Gabriel Sloggy, Ken Wheeland, Steve Harrison

WSP Members Lizzy Montgomery and Crystal Garcia

Heal the Bay- microscope loan

Drought Effects

Topanga Rainfall
Average – 25 inches
2012 - 16.22 inches
2013 - 9.99 inches
2014 - 6.85 inches
2015 – 11.18 inches

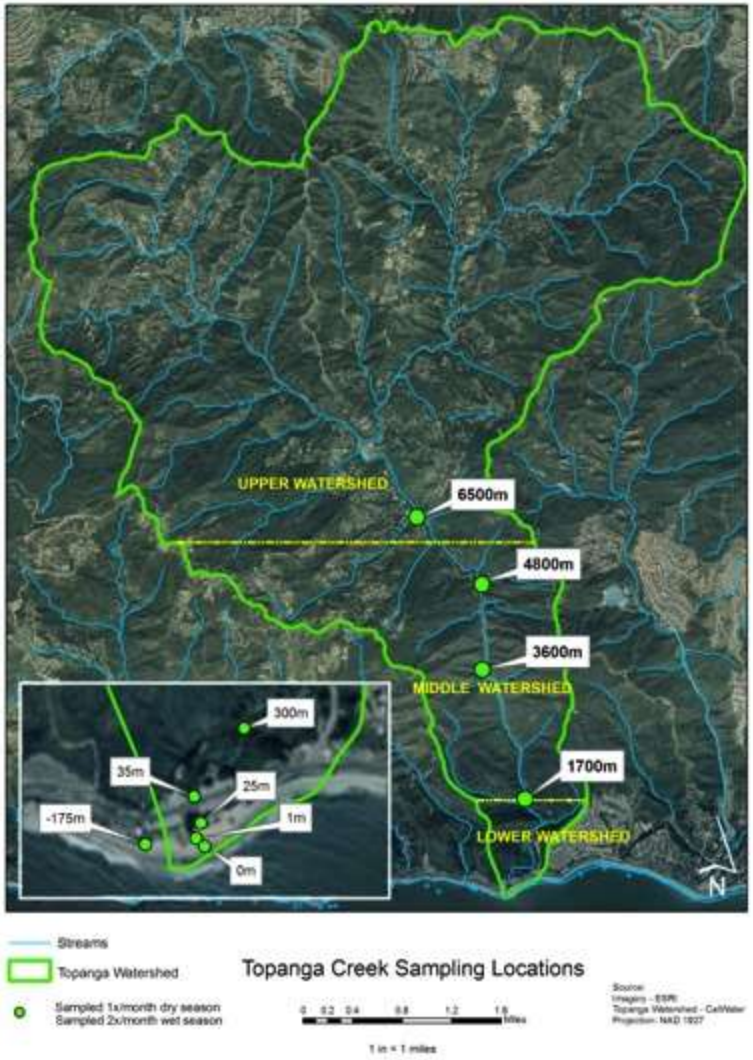


Courtesy of Heal the Bay Beach Report Card

A story with two parts:

Upper watershed and creek

Lower watershed, lagoon and beach



Topanga Creek Source Identification Sampling Sites 2012-2014

Hypotheses tested

- Upper watershed FIB/nutrients not conveyed to the beach
- Concentrations of FIB/nutrients decrease as creek flows downstream
- Benthic macro-invertebrates (BMI) Index of Biotic Integrity increase as creek flows downstream

TOPANGA CREEK RESULTS

Nutrient and In-situ Results

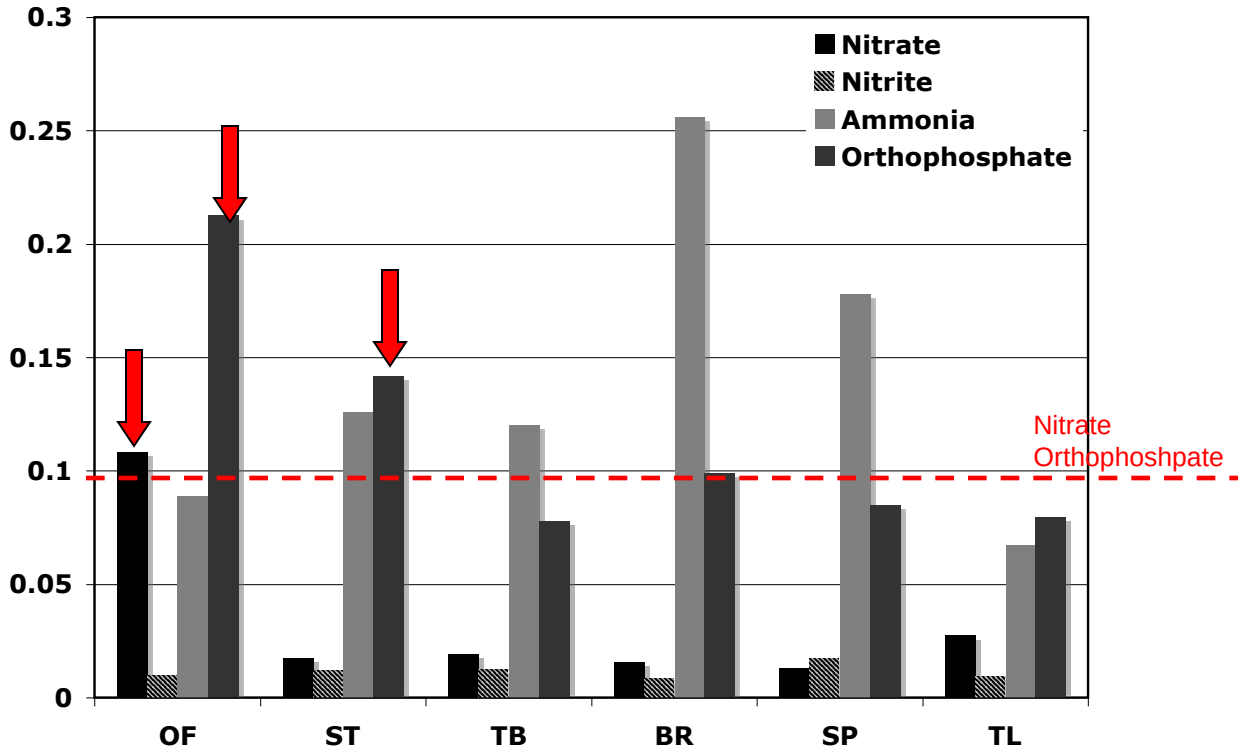
Nutrients, Turbidity & Algae

- Nitrate-N (ppm) >0.1
- Nitrite-N (ppm) >1
- Orthophosphate (ppm) >0.1
- Ammonia (ppm) >0.4
- Turbidity (NTU) >5
- Algae (% cover)

Sites: TL, SP, BR, TB, ST, OF

RCD Stream Team member, Gabe Sloggy, testing for nutrients, February 2013

Average Nutrient Levels, Dec 2012-Aug 2014



Physical Results

pH

(Water Quality Objective: 6.5-9.0)

- Range: 7.1 (OF) – 8.44 (TL)

Highest mean: TL, BR, TB, ST (8.2)

Lowest mean: SP (7.6)

Water Temperature (˚C)

- Range: 6.0˚C (BR) – 22.5˚C (TL)

Highest mean: TL (16.3˚C)

Lowest mean: BR (12.7˚C)

Dissolved Oxygen (mg/L)

(Water Quality Objective: >5 mg/L)

- Range: 1.4 (TL) – 11.8 (TL)

Highest mean: BR (8.2)

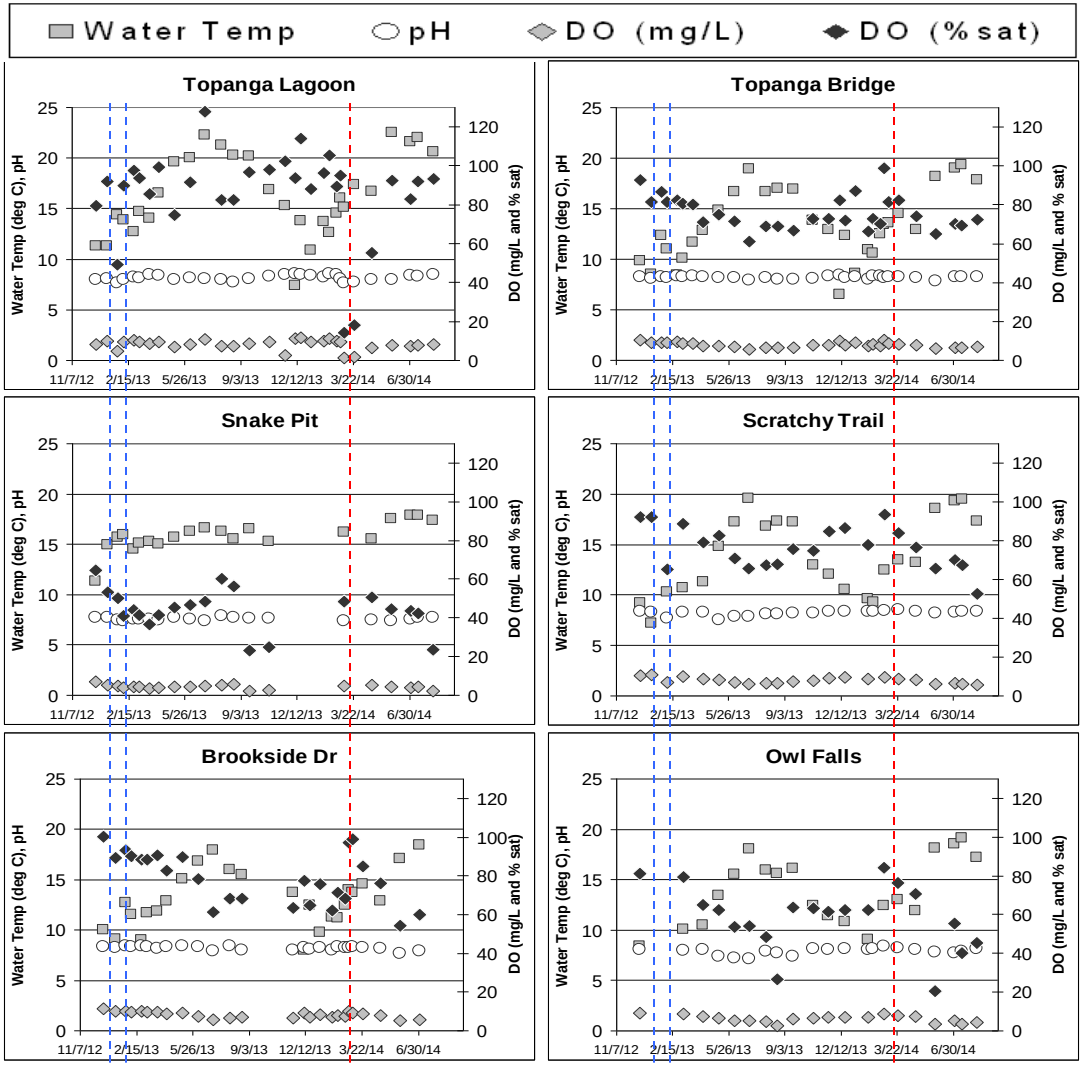
Lowest mean: SP (4.4)

Dissolved Oxygen (%sat)

- Range: 14.2% (TL) – 127.7% (TL)

Highest mean: TL (85.5)

Lowest mean: SP (44.3)



Spatial Correlations

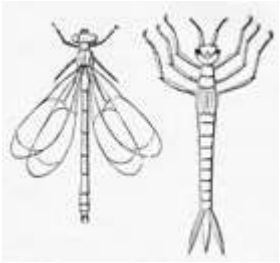
- FIB often highly correlated with orthophosphate, nitrate, turbidity, and flow, especially upstream.
- The number of correlated variables decreased downstream.
- Across all sites, statistically significant correlations were:
  - EC: Ammonia (R^2=0.65, p=0.002)
  - ENT: Ammonia (R^2=0.5, p=0.01)
  - Nitrite: DO (R^2 = 0.60, p=0.07), such that sites with high levels of nitrite had low levels of DO.

Site	*Variable 1*	*Variable 2*	*Correlation Coefficient*
TL (0 m)	turbidity	phosphate	0.74
SP (300 m)	DO mg/L	turbidity	0.87
BR (1700 m)	turbidity	EC	0.96
	flow	EC	0.96
	flow	turbidity	0.99
TB (3600 m)	depth	nitrate	0.76
	depth	turbidity	0.79
ST (4800 m)	turbidity	TC	0.81
	"	EC	0.99
	"	EN	0.99
	flow	EC	0.96
	"	ENT	0.94
	"	turbidity	0.97
OF (6500 m)	nitrate	EC	0.96
	"	ENT	0.96
	turbidity	EC	0.91
	"	ENT	0.9
	"	nitrate	0.95
	flow	EC	0.98
	"	ENT	0.98
	"	nitrate	0.97
	"	phosphate	0.76

Spring stream sampling

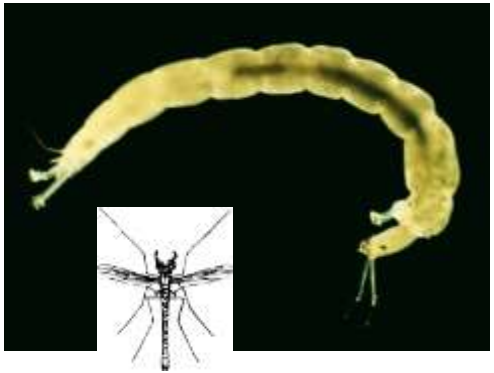
Spatial, Temporal, and Regional Analysis of Benthic Macroinvertebrate Communities in Topanga Creek: 2003-2014

Odonata ‘D-fly’ 6%



Ephemeroptera ‘Mayfly’ 6%

Chironomid ‘Non-biting midge’ 32%

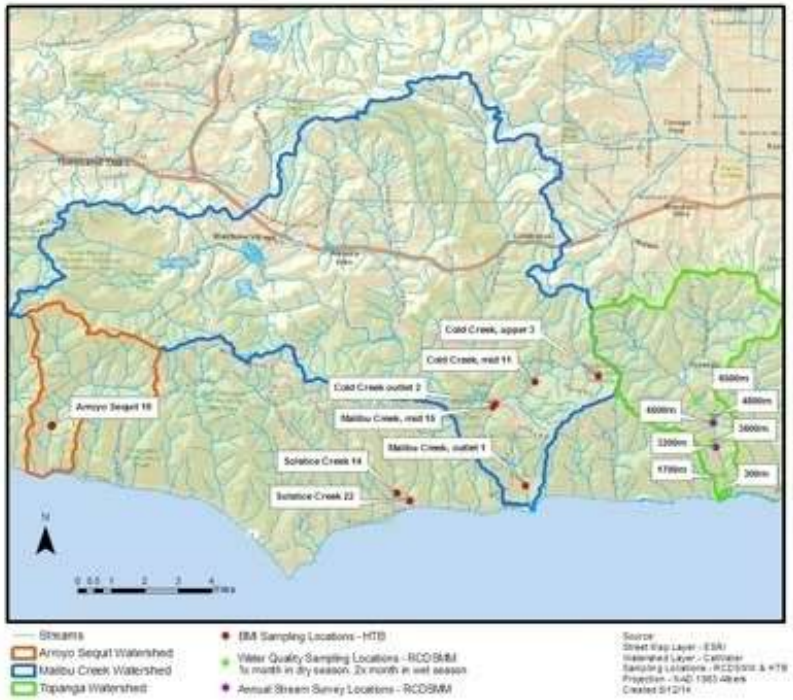


Amphipod ‘Freshwater shrimp’ 19%

Ostracod ‘Seed shrimp’ 10%

Gastropoda ‘Snails’ 7%

BMI sampling locations in SM Bay



SCC-IBI Regional Comparison

SITE	Spr. 2000	Spr. 2001	Spr. 2002	Spr. 2003	Spr. 2006	Spr. 2008	Spr. 2009	Spr. 2010	Spr. 2011	Spr. 2012	Spr. 2013	
Rainfall		27.8	7.24	17.92	21.98	23.08	16.16	24.4	31.44	16.22	9.99	
Malibu Creek												Av.
MC1	16	26	19	26	26	20	27	6				21
MC15	33	24	40	34	17		18	6	16	13	17	22
Cold Creek												
CC2	36	46	53	44	31/42		27	20	19	36		35
CC3	80	92	83	84	73	67	79/80	82	66	76	50	74
CC11	54	56	49	40	47		57	37/43	67	51	45	52
Solstice Creek												
SC14			76	67	60	56	69	49	59	72	60	64
Arroyo Sequit Creek												
AS19			72	72	57	50	70	70	64	56	40	62
Topanga Creek												
LT		66*		31*	40*			34*	30*	24*	27*	37
UT		66*		37	36			41	29*	24*	13*	35

Source ID Key Findings (2013-2014)

**2-fold relationship: BMI activity can release nutrients for microbes to eat, AND many BMI consume bacteria. (Covich 1999)*

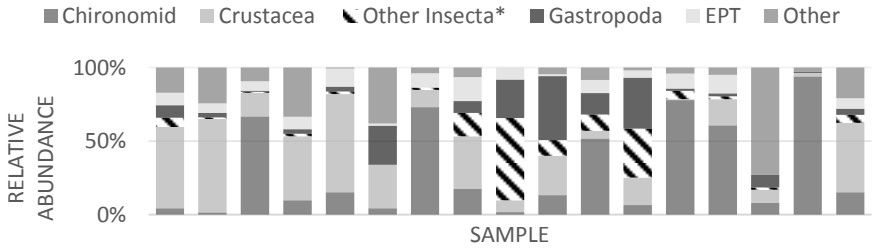
**Van de Bund et al. (1994) found that higher densities of amphipods and chironomids increased the abundance of sediment bacteria.*

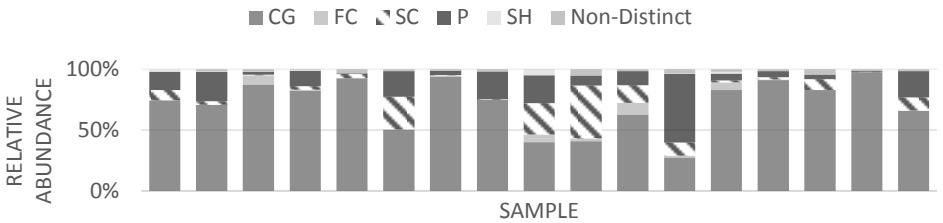
1. SCC-IBI (Southern CA Coastal Index of Biotic Integrity)

- OF consistently scored lowest, ST the highest. *Proximity to development?*
- ↑ *average total coliform* per site in 2014 = ↓total and EPT taxa SCC-IBI scores.
- ↓ dissolved oxygen = ↑ % non-insect taxa

2. Species Composition

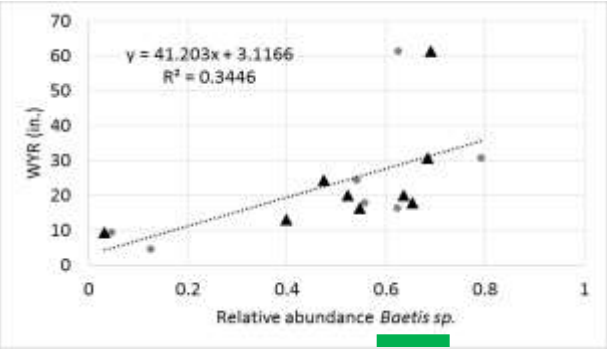
- Collector-gatherers were by far the most abundant
- FFG composition was more stable than taxa composition per site and over time
- High level of seasonal influence

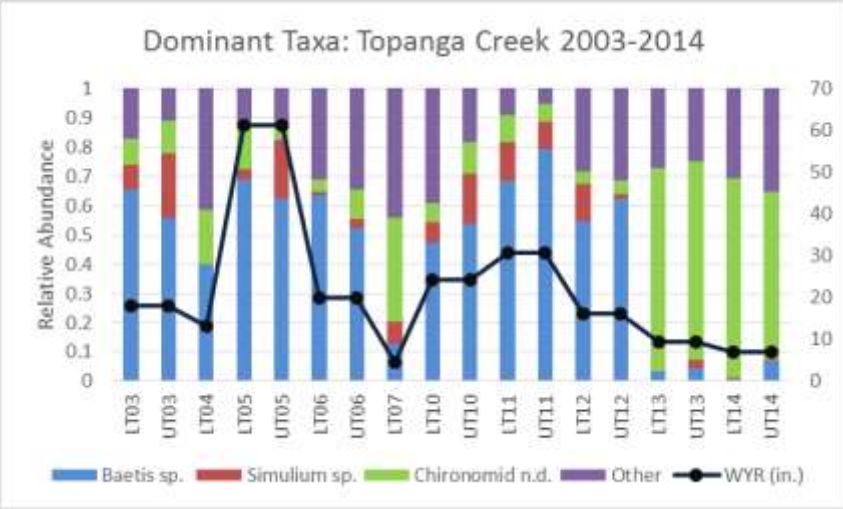




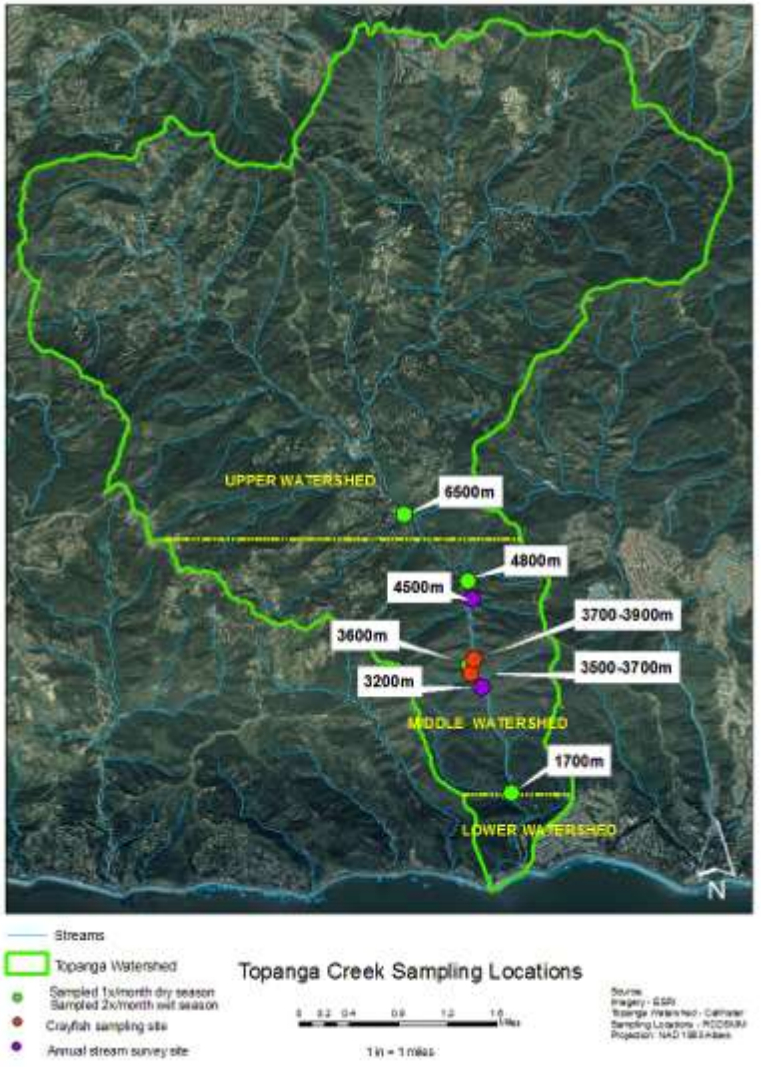
Temporal and Regional Key Findings (2003-2014)

- Biotic integrity has been negatively affected by drought
  - Decreased SCC-IBI
  - Species composition shift
  - % intolerant increases with rainfall, % tolerant decreases ($F<0.05$)
- Both high (>30'') and low(<5'') flow conditions resulted in disturbed BMI communities (Bray-Curtis).
- Regional comparison of Topanga Creek indicated relatively degraded conditions.
  - Still an important reference stream? YES

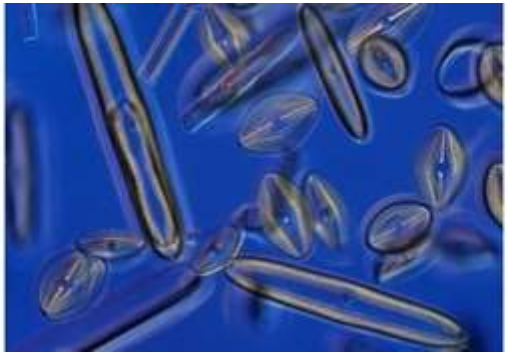




Crayfish Problem



Diatoms – Results



- 61/62 species in upper reach
- 64/66 in lower reach
- Shared 38-40 species
- 23/18 unique to upper, 26/23 unique to lower
- Most very pollution and disturbance tolerant
- Shell shape rapidly responds to changes in water quality

Soft-bodied algae:

includes green, red and cyanobacteria

- Dominant species *Cladaphora and Ulva*
- Lower reach had 3 additional species (13) upper reach had (10)
- *Cladophora* as eutrophication indicator? Maybe not?
- Cyanobactria are nitrogen fixers found mostly in stream with low N levels

Comparison of southern CA Periphyton IBI Indices

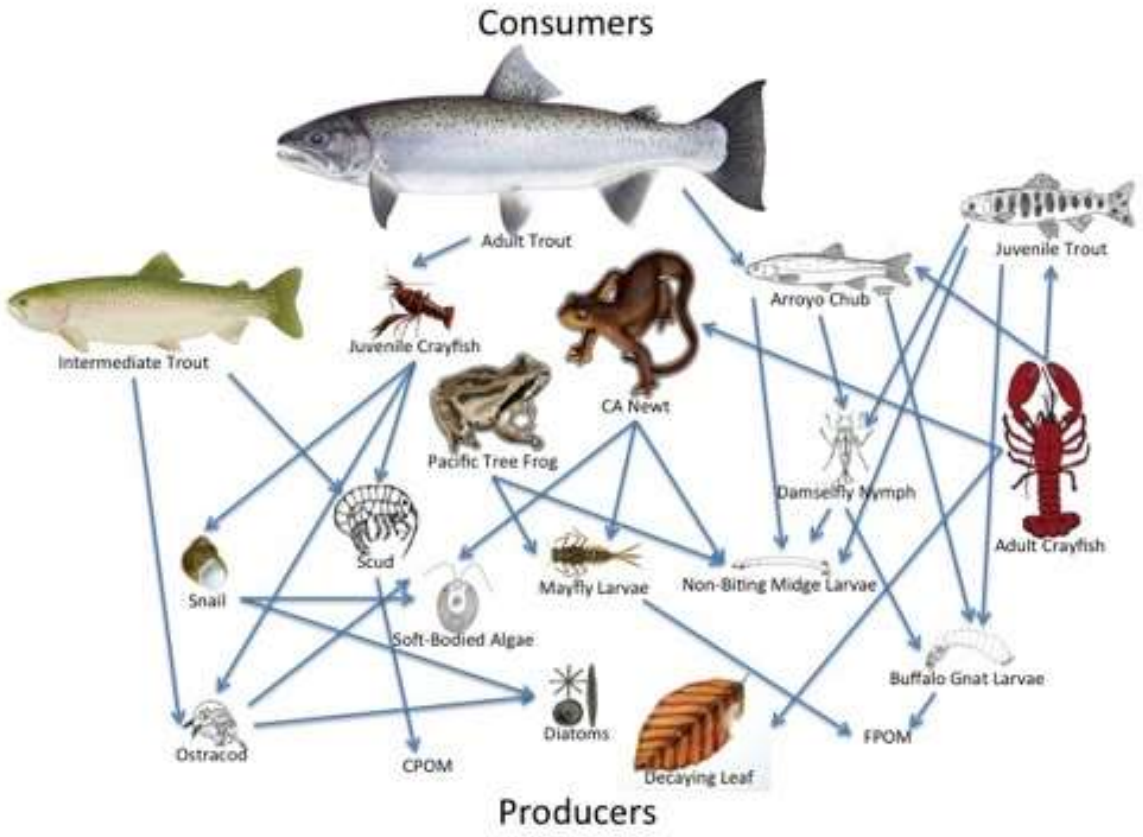
courtesy of SCCWRP online tool

Reference sites >57

Year	Location	S2 Algae	D18 Diatoms	H20 both	Total Diatom Count
2013	TC3200	35	46	45	513
2014	TC3200	NA	46	NA	600
2013	TC4500	42	50	55	506
2014	TC4500	53	58	61	595
2013	Malibu R3	28	58	51	556
2013	Malibu R4	22	46	42	556

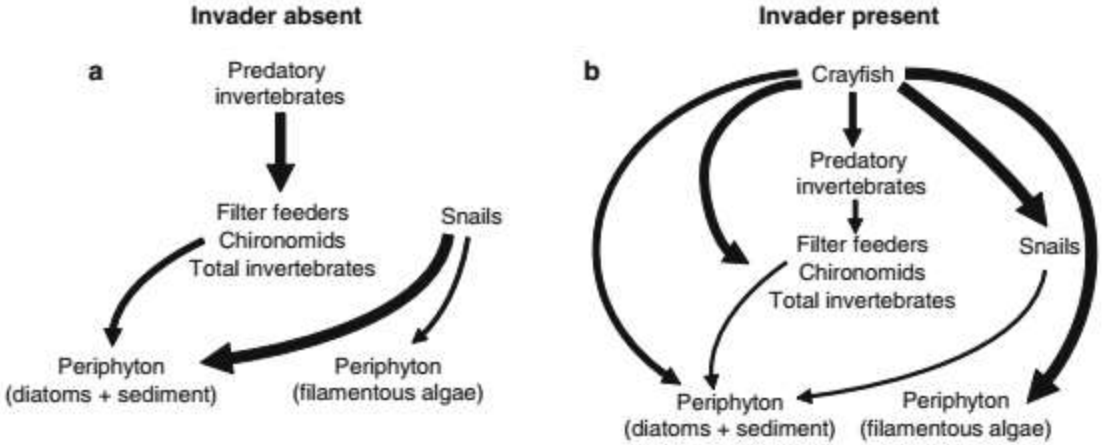
Topanga Creek Food Web

conceptual model



Trophic Level Interactions

- We hypothesize *P. clarkii* presence is leading to a trophic cascade resulting in a reduction in BMI biomass and species richness.



- More research is needed in trophic level interactions.

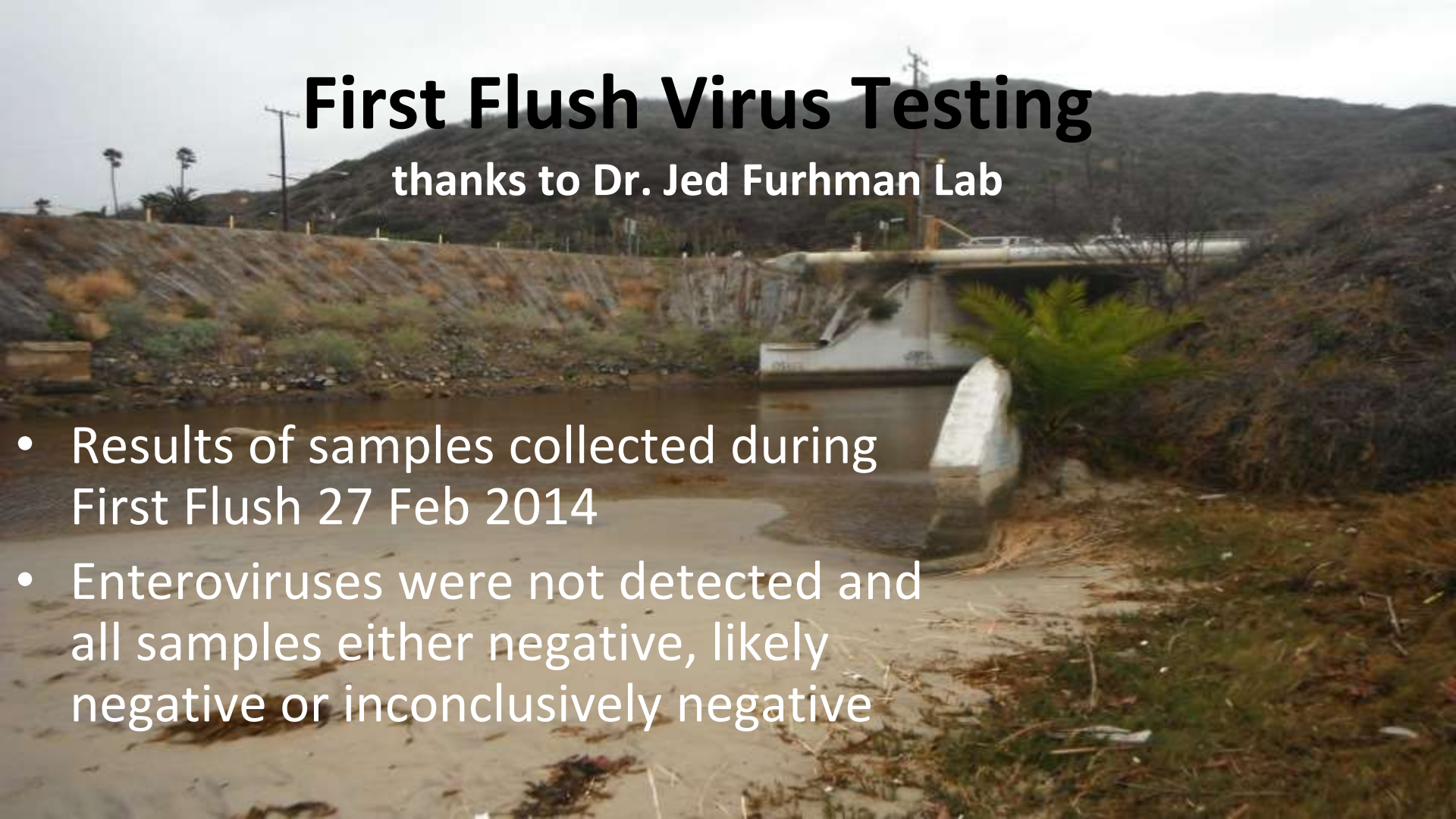
HYPOTHESIS: FIB/pathogens are not leaking from septic systems in the lower watershed, from State Park systems on PCH, or County Lifeguard facility

Septic Testing

- Completed
- No evidence of dye seeping into the creek
- All septic tanks are functional or sealed
  - Except Feed Bin

First Flush Virus Testing

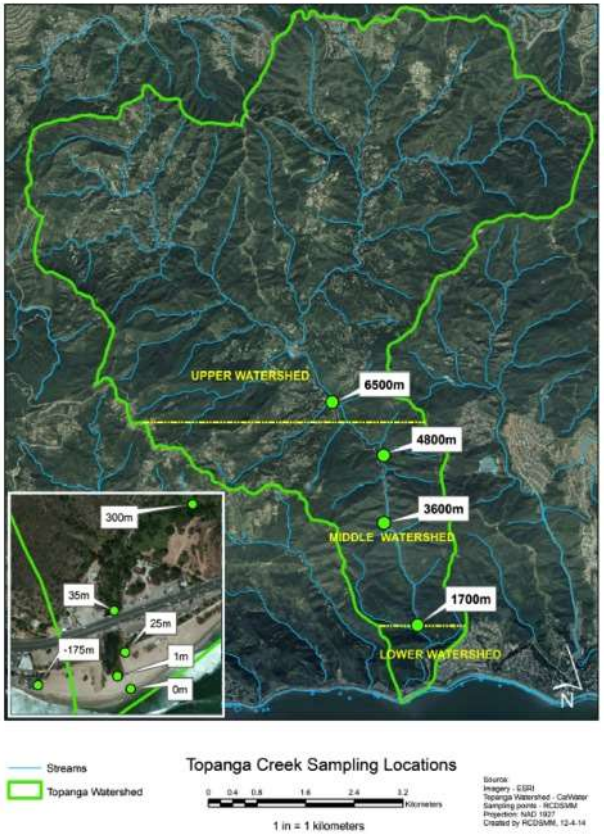
thanks to Dr. Jed Furhman Lab



- Results of samples collected during First Flush 27 Feb 2014
- Enteroviruses were not detected and all samples either negative, likely negative or inconclusively negative

Topanga MST Study

- Two year microbial source tracking (MST) study initiated on the Topanga watershed.
- Need for MST in this watershed due to chronically high FIB levels in surfzone and unknown sources.
- New methods that allow for detection of host-associated fecal contamination applied to Topanga watershed.



Hypotheses and Objectives

1. Lagoon discharge negatively impacts water quality at Topanga Beach (historical data analysis).

2. Upper watershed sources of FIB are not conveyed to lower watershed sites.

3. Spatial and temporal patterns of FIB and host-associated markers exist between sites in the lower watershed.

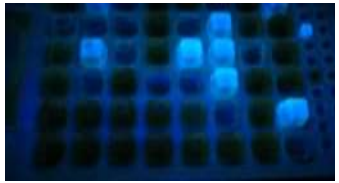
Source ID Methods

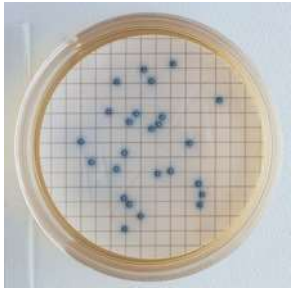
Culture-based methods: quantify fecal indicator bacteria:

- Enterolert (enterococci)- on all samples
- Colilert (Total coliform and *E.coli*)- on all samples

DNA-based markers: target animal and human-sources of fecal contamination:

- Gull marker- all samples
- Dog marker- all samples
- Human marker-HF183 on all samples, Bachum was confirmatory
- Horse marker- selection of upper watershed sites and first flush samples





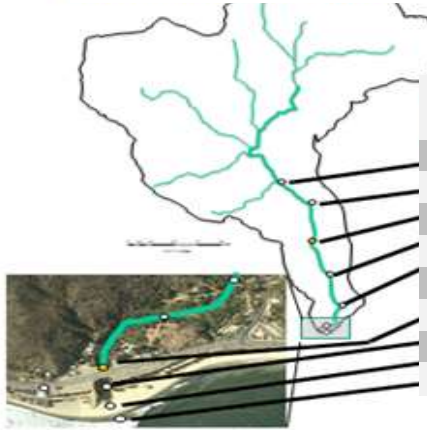
MST FIB Results- All Sites Rain Events

	TC MPN/100ml	EC MPN/100ml	ENT MPN/100ml	HF gene copies/100 ml	BH gene copies/100 ml	Gull gene copies/100 ml	Dog gene copies/100 ml
Raining	**3340.4** **(50)**	**361.5** **(51)**	**278.4** **(59)**	**69.6** **(51)**	**324.2** **(42)**	**1082.0** **(50)**	**4007.1** **(49)**
Not Raining	808.8 (364)	40.6 (364)	61.8 (379)	20.1 (376)	57.1 (242)	910.5 (377)	430.0 (373)

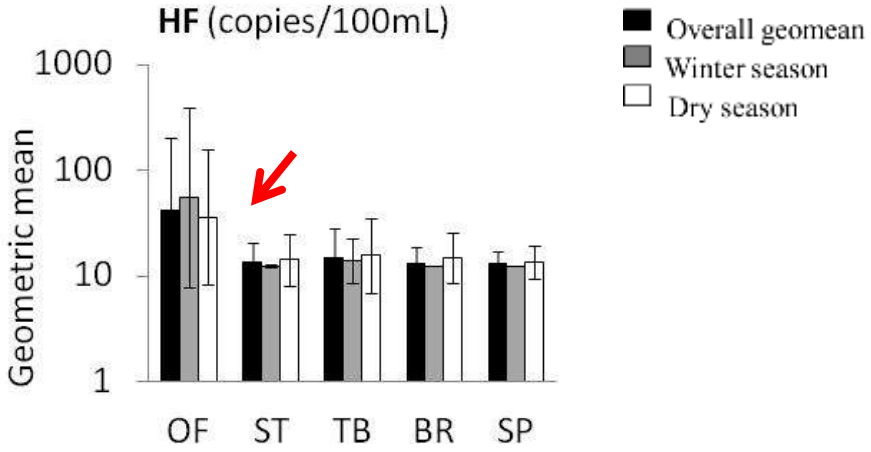
-Geometric means for all markers and FIB were higher in samples collected during active rainfall.
-Active rainfall increases the bacterial levels in the watershed, which is typical of other studies throughout southern California (Noble et al. 2003, Boehm et al. 2002, Surbeck et al. 2006).

MST Results- Creek Sites

ENT Levels in Topanga watershed [MPN/100 mL]



ENT Geomean
94
25
35
32
59
189.2
215
47.2



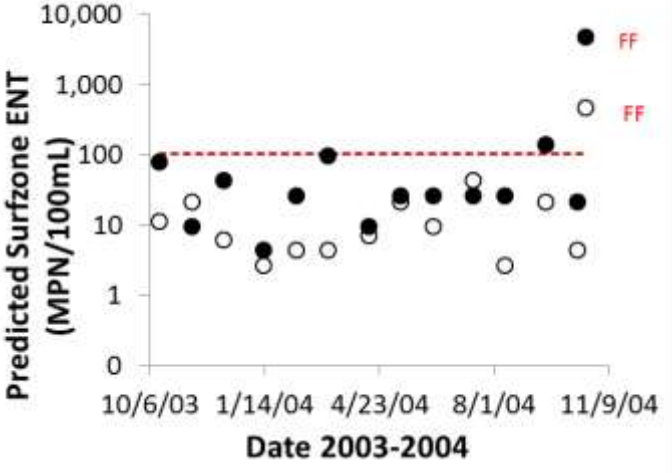
Frequency of marker detection at creek sites.

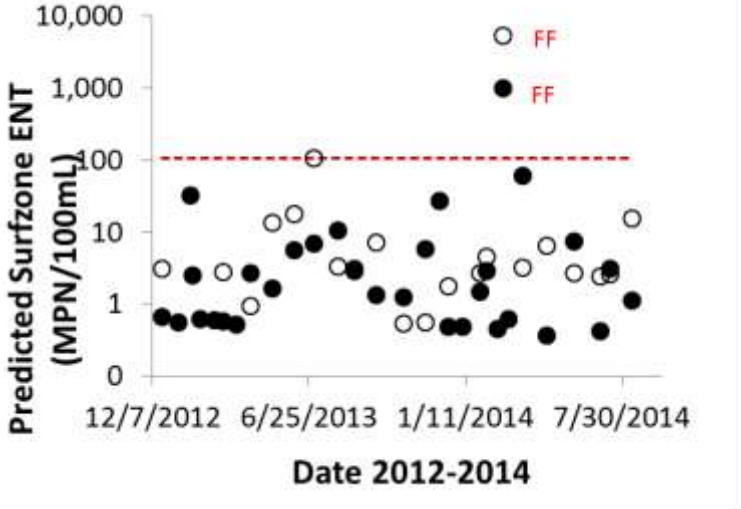
	OF	ST	TB	BR	SP	Creek
HF183	45%	9%	9%	4%	4%	13%
Gull	5%	5%	18%	8%	23%	13%
Dog	14%	5%	12%	13%	22%	13%

MST Results- Creek Sites

Predicted Surfzone FIB:

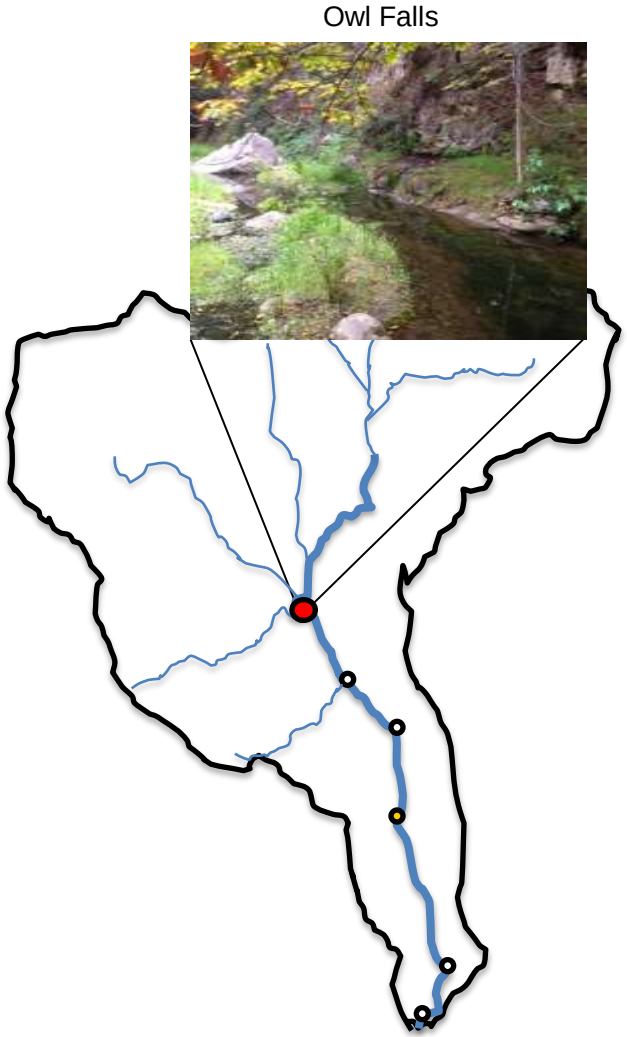
- Predicted surfzone FIB was calculated based on creek flow and creek FIB concentrations from the current study period (2012-2014) and from historical data taken between 2003-2004,
- Upstream creek sources do not appear to be a primary contributor to FIB in the surfzone, except on days when both flow and FIB levels in the upper watershed are elevated.



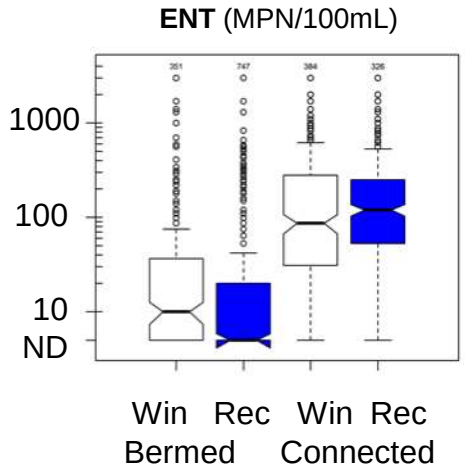


MST Results- Creek

- Human marker detected frequently at OF but markers do not appear to be transported to downstream sites.
- Elevated FIB levels at OF quickly decrease and are not likely to affect lower watershed sites.
- Gull rarely detected in upstream creek sites.
- Dog detected infrequently- on average 13% in creek sites.

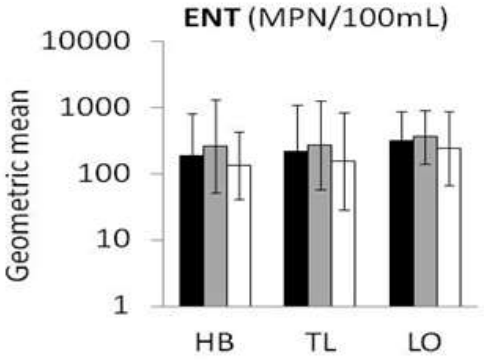


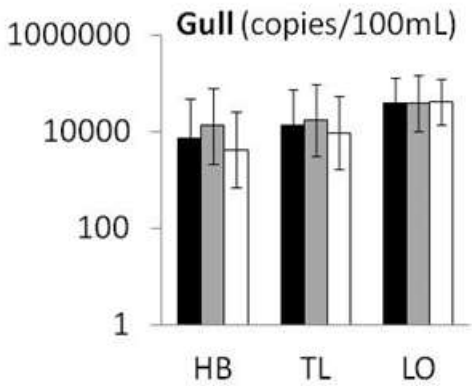
Historical Lagoon and Beach Connection

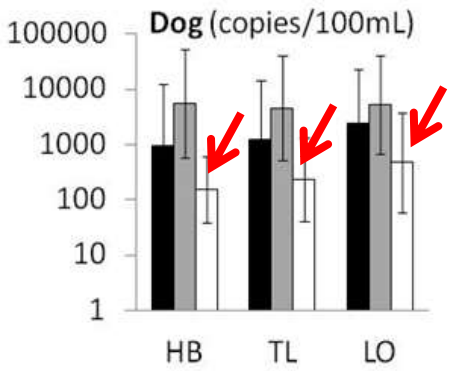


- **Historical analysis of FIB recorded at Topanga Beach:**
  - FIB values recorded by Los Angeles Department of Public Health (LADPH) between January 2005 – November 2011
  - 1809 sampling events, approximately 6 days per week, Monday through Saturday.
  - Any note of flow was scored as “connected” and any note as ponded was scored as “bermed”.

MST Results-Lagoon







Overall geomean
Winter season
Dry season

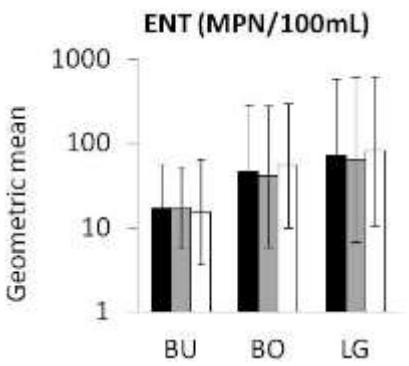
Frequency of marker detection at lagoon sites.

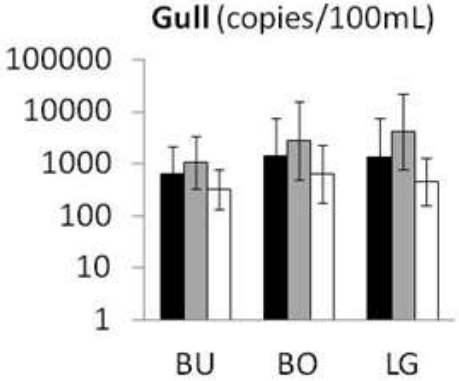
Marker	Site			Total
	HB	TL	LO	Lagoon
HF183	8%	17%	20%	14%
Gull	91%	95%	100%	94%
Dog	58%	64%	80%	64%

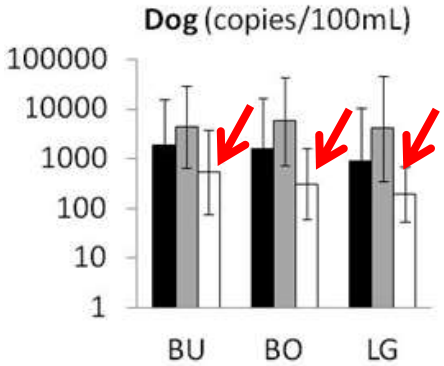
Frequency of exceedance of state single sample limits at TL.

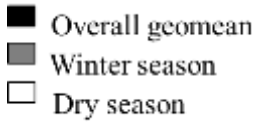
FIB	Site
	TL
TC	33%
EC	48%
ENT	75%

MST Results-Ocean









Frequency of detection of MST markers at each ocean site.

Marker	Site			Total
	BU	BO	LG	Ocean
HF183	12%	16%	8%	13%
Gull	76%	84%	80%	80%
Dog	76%	74%	58%	71%

Frequency of exceedance of state single samples limits at each ocean site.

FIB	Site		
	BU	BO	LG
TC	0%	5%	4%
EC	0%	3%	4%
ENT	15%	26%	28%

Dog Marker Survey

Reference beaches (Malibu and Dockweiler):

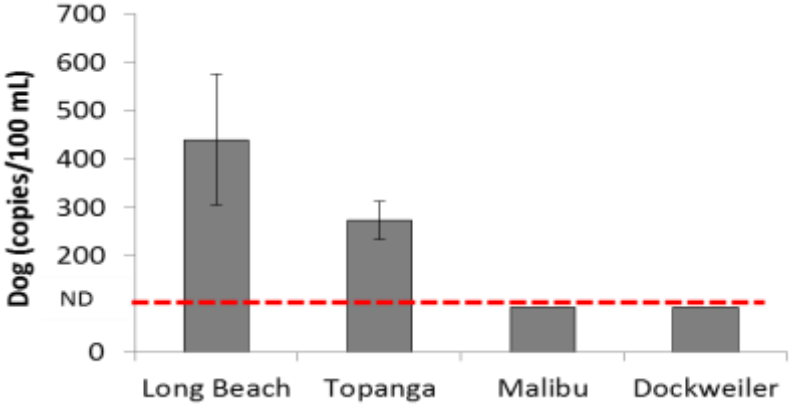
- Negative for Dog marker in samples

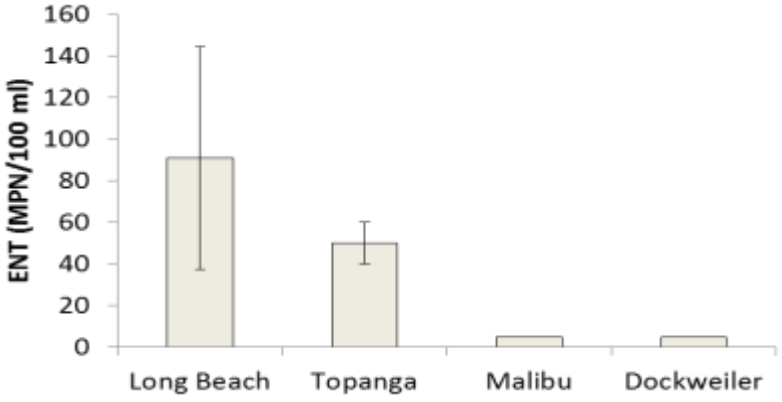
Rosie's Dog Beach (Long Beach, CA):

- Water samples: 219 – 823 copies/100 mL
- Sediment: all negative for dog marker

Topanga Beach

- Water samples: 193 – 334 copies/100 ml
- Sediment samples: BO – 205 copies/g, BU -167 copies/g





MST Results- Lagoon

- Based on historical data, breaching events lead to elevated FIB in the surfzone.
- Consistent dog and gull marker detection throughout the lagoon.
  - Seasonal trend of dog marker
- Little spatial variability between lagoon sites for FIB and marker levels.
- Frequency of human marker detection was 14% for all samples.

MST Results- Ocean

- Consistent dog and gull marker detection at the three ocean sites.
    - Seasonal trend for dog marker.

- Compared to lagoon→ BO had significantly lower levels of all markers and FIB, except for dog marker.

- Little spatial variability between BO and LG ocean sites for FIB.
    - BU had lower levels of ENT than BO and LG.

- Frequency of human marker detection was 14% for all ocean samples collected.

Topanga MST Summary

- Historical analysis confirms importance of lagoon breaching event on elevated FIB in the surfzone.
- FIB in the surfzone do not originate from an upstream creek source.
- Dog and gull were important fecal sources to surfzone.
- Human marker hits were less frequent, but still may be considered a potential source.

WHAT CAN WE DO TO REDUCE EXCEEDANCES?

RESTORE Topanga Lagoon

REDUCE inputs into the upper watershed, along the creek and at Topanga Lagoon

RESTRICT ACCESS to the main stem of the creek and protect from increasing impacts from park visitors, taggers, transients and marijuana farms

MAINTAIN septic systems along the beach

COMMUNITY OUTREACH AND EDUCATION KEY!

Topanga Community Outreach

- Keeping pets off the beach
- Cleaning our creek
- Removing invasives
- And planting oaks

Topanga Elementary and Mountain School

Outreach and Field Trips 2013-2014

- 2 in-school presentations

Content: Topanga Creek Watershed ecology, source ID study, pH activity, field trip prep.

- Field Trip to Topanga Beach

Activities: test WQ, seine lagoon, sediment sampling, bacteria cultures, macroinvertebrates, crayfish

- Water Quality Program @ UCLA

Student scientists collect data

The dog problem…..

Poster Contest Winners 2014

Winning Posters at Topanga Beach

BMP'S

Implement BASIN PLAN RECOMMENDATIONS

Implement North Santa Monica Bay Coastal Watersheds monitoring program at Topanga Bridge

Community outreach needed – what are the best way to reduce inputs in upper watershed

Community meeting update on info gathered – November 2014?

Pet and corralled animal inputs- formal outreach? How? When? Target audience?
Trailhead notification of dog inputs?

Explore the possibility of site specific standards with further testing.

To obtain a copy of the report:
www.rcdsmm.org/topanga-creek-watershed-research-reports

End Goal = Clean Water