Prevalence of Stream Stressors in California: A Comparison Across Regional Water Boards

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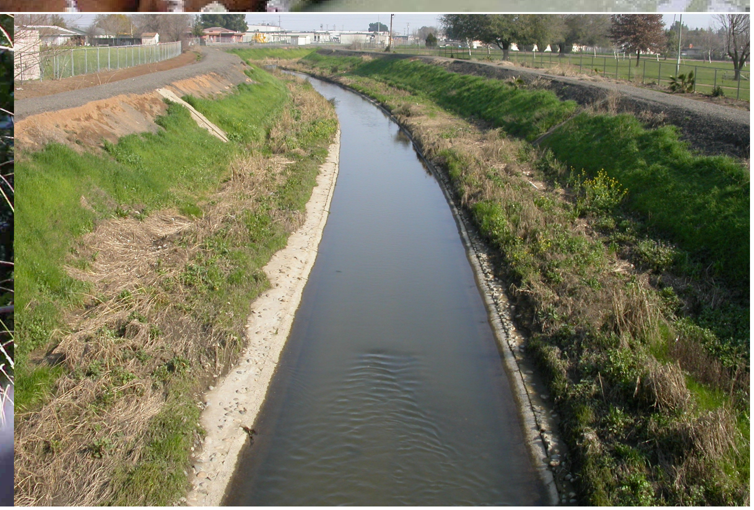
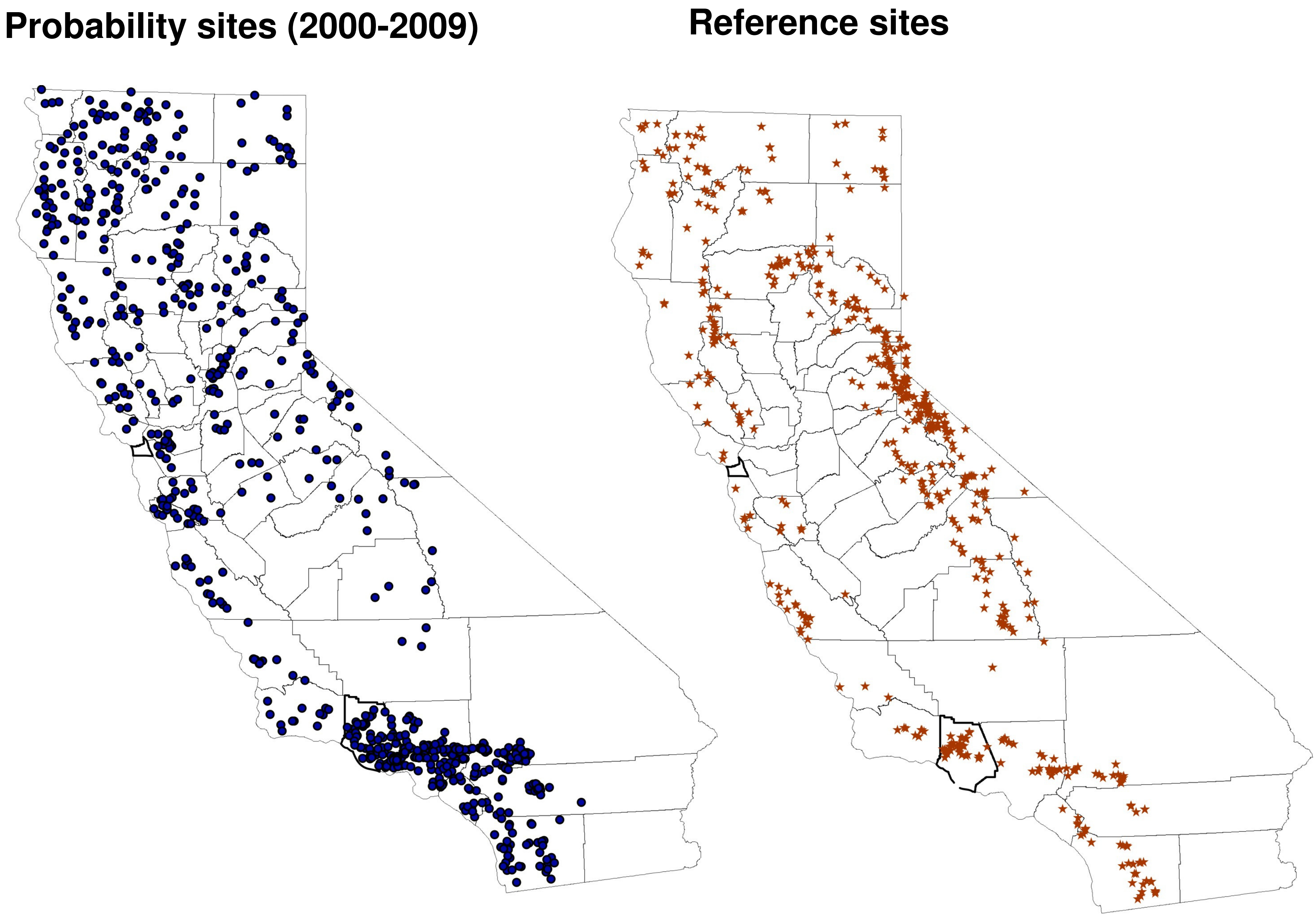


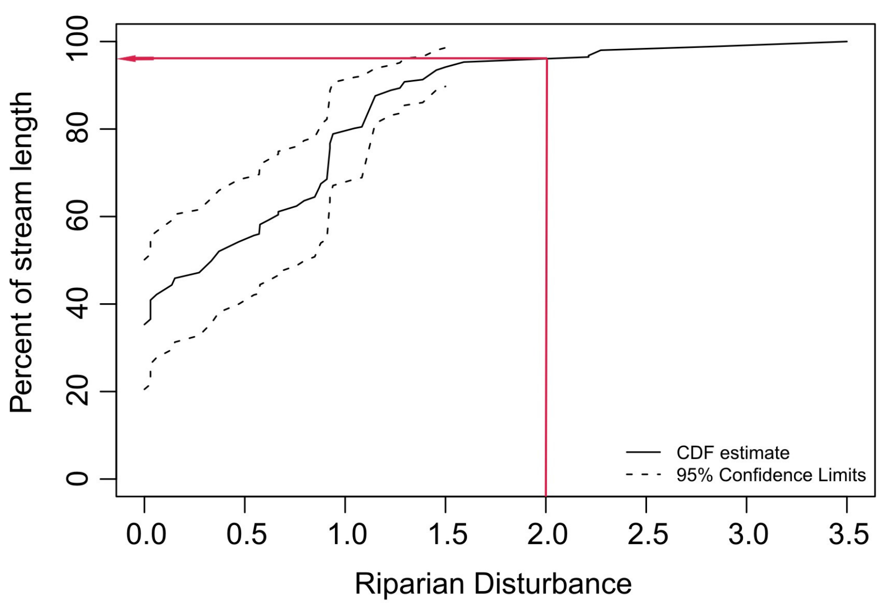

Probability sites (2000-2009)
Reference sites

A better understanding of stressor distributions and pervasiveness can:

1. Put results from site-specific projects into a regional or watershed perspective
2. Help set meaningful and objective restoration targets
3. Help evaluate the success and performance of restoration and protection programs.

Example with real data from the Central Coast:

a



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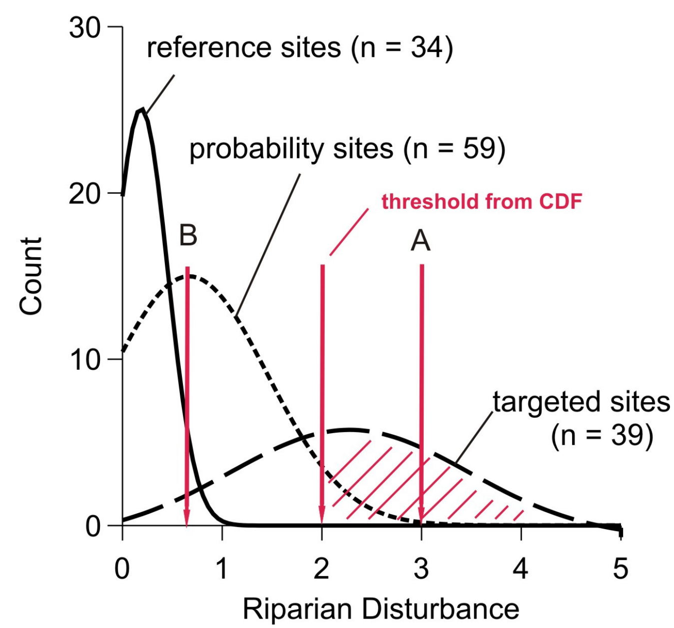


Goals:

1. To use site weights from 10 years of probability data to answer:

What are the most pervasive land use and reach-scale stressors in each Regional Water Board?

How do the most pervasive stressors differ among regions?

What is the relative amount of cumulative stress per stream kilometer in each Regional Water Board, i.e., what regions of California are most and least stressed?

2. To demonstrate how distributions of stressors in reference and probability sites could be used to put results from local projects (e.g., local restoration and protection programs, NPDES monitoring, etc.) into a regional and watershed perspective

Data:

Probability surveys (2000-2009) merged for analyses of statewide and regional stressor prevalence.

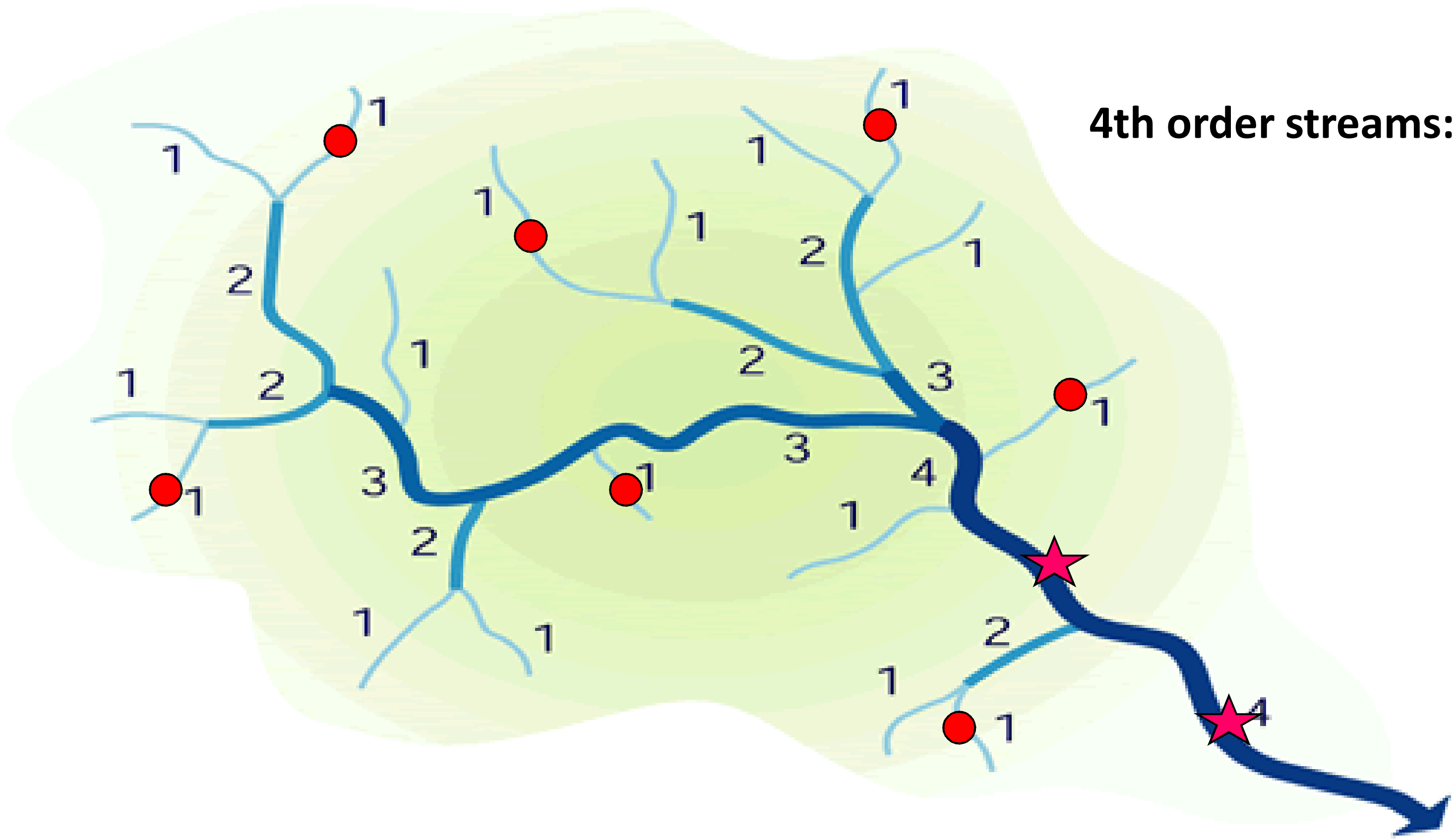
Program	Agency	Geographic scope	# Sites
EMAP	USEPA	Statewide	168
EMAP Central Coast Supplement	USEPA	Central Coast	21
NRSA	USEPA	Statewide	30
CMAP	California SWQRCB	Statewide	179
PSA	SWAMP	Statewide	132
SMC	Stormwater Monitoring Coallition	South Coast	108
San Gabriel Watershed Monitoring Program	Los Angeles - San Gabriel Rivers Watershed Council	Watershed	33
Los Angeles Watershed Monitoring Program	Los Angeles - San Gabriel Rivers Watershed Council	Watershed	60
Santa Ana Regional Monitoring Program	RWQCB 8	Regional	59
		TOTAL	**790**

GRTS selection process is used to generate a list of spatially balanced, yet randomly selected sites

Each sampling site represents a known portion of the total stream length, i.e., each site has a *weight*

1st order streams: 10,000km =1428.5
7 sites

4th order streams: 1,000km = 500
2 sites



Data: Stressor variables used

Metric description	Unit	Scale			
		Local	WS	5k	1k
Population density (2000 census)	people/km^2		x	x	x
Canals or pipes at 100k scale (NHD)	%		X		
Dam distance (nearest upstream)	km		X		
Agriculture (NLCD Codes 81 and 82)	%		X	x	x
Developed open space (NLCD Code 21)	%		x	X	x
Urban (NLCD Codes 22, 23, 24)	%		X	x	x
Sum of Ag + Urban + Code 21	%		x	x	x
Impervious surface area	%		x	x	x
Gravel mines density in riparian zone by stream length	mines/km			X	
Mine count (producer mines only)	count		X	X	
Paved road crossings in riparian zone	count		x	x	x
Road density (paved + dirt + rail)	km/km^2		X	x	x
Riparian disturbance (proximity weighted)	none	X			
Specific conductivity	µS/cm	X			
Total nitrogen	µg/L	x			
Total phosphorous	µg/L	X			
Chloride	µeq/L	x			
Sand and fine sediment	%	X			
Substrate embeddedness	%	x			

METHODS:

Used a simple weighted averaging approach based on site weights and stressor Values for each site to evaluate pervasiveness within and between regions

Within regions: values for each stressor were first relativized by maximum because different variables have very different ranges (e.g., riparian disturbance vs. % sand and fines)

Calculated a weighted average for each *relativized* stressor variable:

= ∑ (site weight X relativized stressor value)/∑ regional site weights

Stressor with highest relativized weighted average was considered to be most prevalent in the region, second highest was second most prevalent, etc…..

This method may not be appropriate for certain chemistry variables (e.g., total nitrogen and total phosphorous) because data ranges are so huge compared to land use and in-channel variables, even after omission of outliers.

METHODS:

Between regions:

Calculated a weighted average for each stressor variable:

= ∑ (site weight X stressor value)/∑ regional site weights

“Cumulative stress” per region was estimated as the sum of weighted averages for 13 least-correlated (Pearson’s $r < 0.7$) land use and local stressor variables

Since stressor values were not relativized for between-region comparisons, weighted average values for any given stressor could be directly compared between regions

RESULTS: Regions with low cumulative stress

Region 5 (Central Valley) represented stream length = 12,586 km
% sand + fines
conductivity
road density (5k)
riparian disturbance
% ag (WS)

Region 1 (North Coast) represented stream length = 8,124 km
road density (WS)
% sand + fines
riparian disturbance
code 21
conductivity

Region 6 (Central Lahontan) represented stream length = 3,412 km
% sand + fines
chloride
conductivity
road density (5k)
total phosphorous

RESULTS: Regions with moderate cumulative stress

Region 3 (Central Coast) represented stream length = 2,401 km
road density (5k)
% sand + fines
code 21 (1k)
conductivity
paved stream crossings (5k)

Region 2 (Bay Area) represented stream length = 2,289 km
code 21 (1k)
road density (1k)
conductivity
population density (WS)
% sand + fines

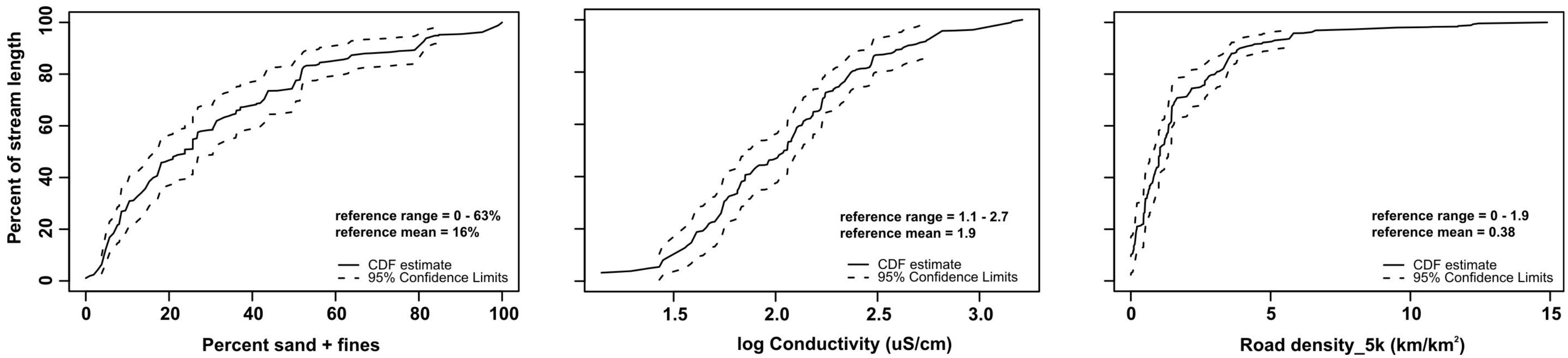
RESULTS: Regions with high cumulative stress

Region 4 (Los Angeles) represented stream length = 1,612 km
% sand + fines
code 21 (WS)
conductivity
road density (WS)
% urban (1k)

Region 8 (Santa Ana) represented stream length = 275 km
% sand + fines
code 21 (1k)
conductivity
road density (1k)
paved stream xings (5k)

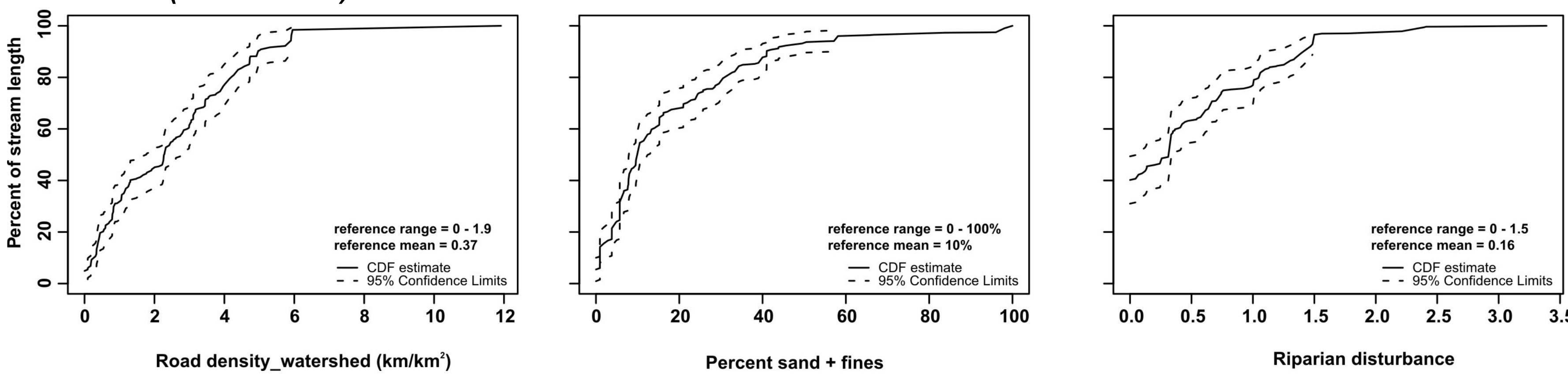
Region 9 (San Diego) represented stream length = 551 km
% sand + fines;
road density (WS)
% urban (5k)
% impervious 1k
riparian disturbance

REGION 5 (Central Valley)



Notes: Represented stream length = 12,586 km (highest in survey). 4th and 5th most important stressors = riparian disturbance and % agriculture in watershed. The majority of stream length (83%) in Region 5 is from the western Sierra and interior chaparral, i.e., regions with relatively low stressor values compared to the Central Valley. *Valley sites alone had moderate "total stress" similar to Regions 2 and 3*.

REGION 1 (North Coast)



Notes: Represented stream length = 8124 km. 4th and 5th most important stressors = code 21 and conductivity. Although road density is the top regional stressor, weighted average road density in Region 9 is over 2.5 times greater.

CAVEATS:

1. Relativization may not be the most appropriate data transformation to "equalize" stressor values for within-region estimates of prevalence

   - probably only matters for water chemistry variables with huge standard deviations

2. Site weights were not adjusted once statewide data was parsed into regional subsets and sites with missing stressor values were omitted

3. Estimates of stressor prevalence within regions and cumulative stress between regions were not meant to be statistical assessments of stress per region, but provided a simple relative scale for ranking and comparing major stressors affecting different regional water boards.

4. Not all types of human activity that potentially affects streams could be measured

FINAL THOUGHTS:

Identification of the most pervasive stressors in different regions of the state will allow for the best prioritization of management strategies to control, and potentially remediate, the most widespread stressors

Accurate characterization of stressor distribution and stressor prevalence, especially for landscape-scale or non-point stressors, is critical information needed by resource managers

The distribution of stressors at probability sites coupled with the reference site distribution provides a framework for evaluating site-specific results within the context of overall statewide or regional conditions and against benchmark reference conditions