Deterministic to Probabilistic

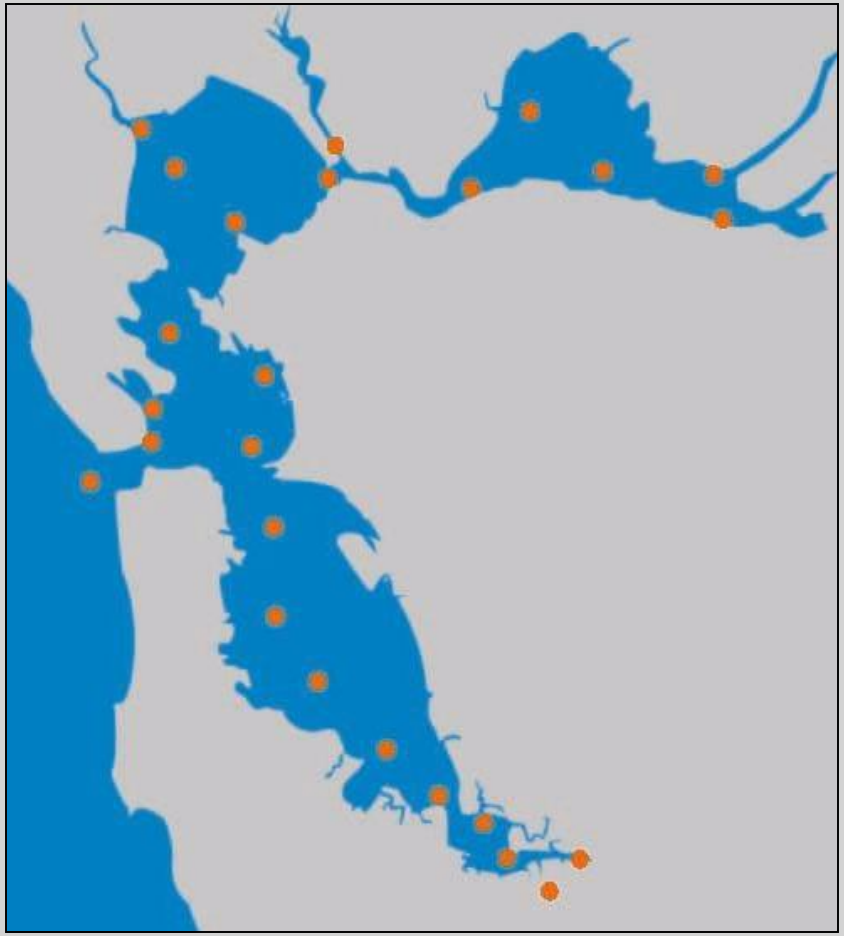
Changing the RMP's Sampling Design

Sarah Lowe & Cristina Grosso

A summary of the efforts of the Design Integration Work Group

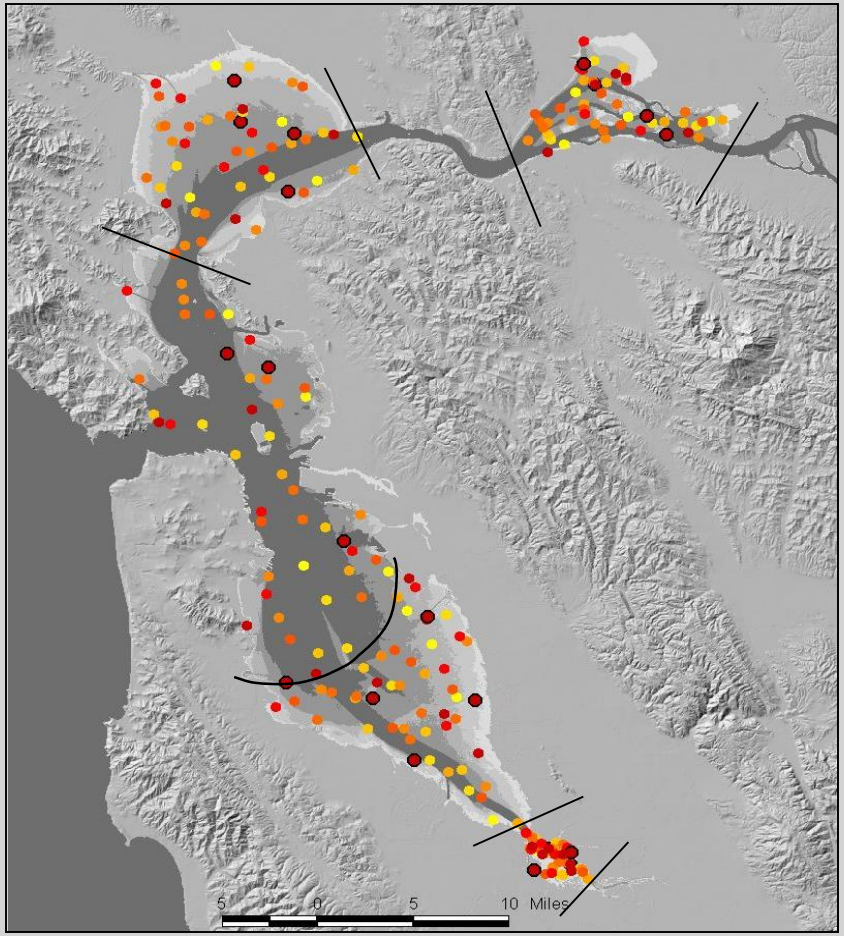
Deterministic

1993 – 2001



Probabilistic

2002 – future



RMP Design Integration Work Group

Applied Marine Sciences		**San Francisco Estuary Institute**	
	Andrew Gunther		Bruce Thompson
	Khalil Abu-Saba		Jay Davis
CA Department of Fish & Game			Jon Leatherbarrow
	Chuck Armor		Rainer Hoenicke
CA Department of Water Resources			Sarah Lowe
	Anke Mueller-Solger	**SFB RWQCB**	
CALFED Bay-Delta Program			Karen Taberski
	Kim Taylor		Tom Mumley
City & County of San Francisco		**University of California Davis - MPSL**	
	Arleen Navarret		Brian Anderson
City of San Jose		**University of California Santa Cruz**	
	David Tucker		Russ Flegal
CLEAN South Bay		**University of Utah, Energy/Geoscience Institute**	
	Trish Mulvey		Wally Jarman
DYNAMAC Corporation		**US Army Corps of Engineers**	
	Don Stevens		Jim Delorey
NOAA		**US Geological Survey**	
	Alan Mearns		Cindy Brown
Port of Oakland			Michelle Hornberger
	Jim McGrath		Tara Schraga
Private consultant			
	Robert Smith		

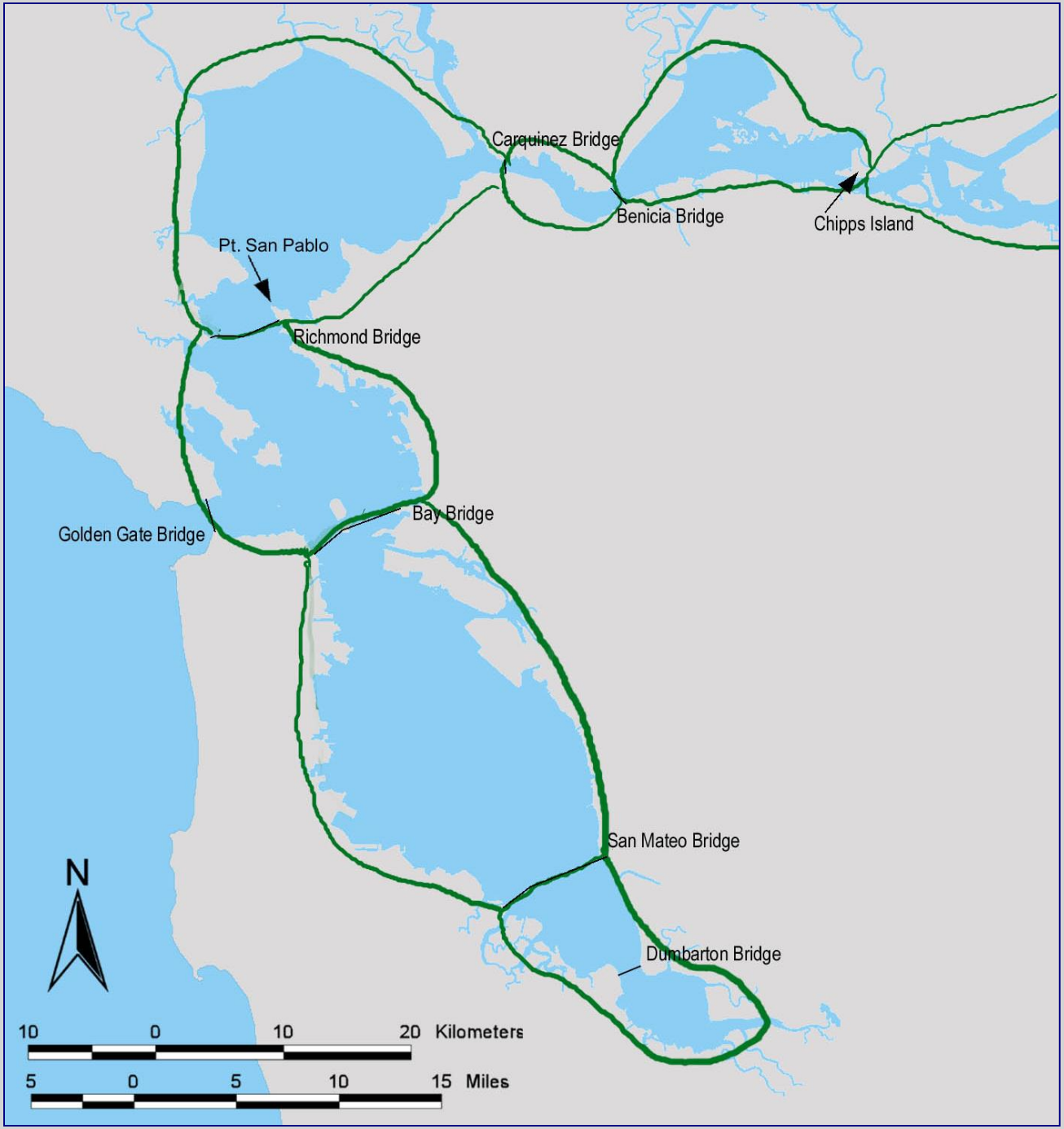
Design Process

- Review and evaluate the hydrographic regions
- Determine the number of samples per hydrographic region
- Develop an optimum sampling design to address the new RMP objectives
- Select the sampling locations

Review and Evaluate the Hydrographic Regions

- Evaluating the existing segmentation scheme
- Soliciting the professional opinions
- Performing our own analyses

Existing Segments



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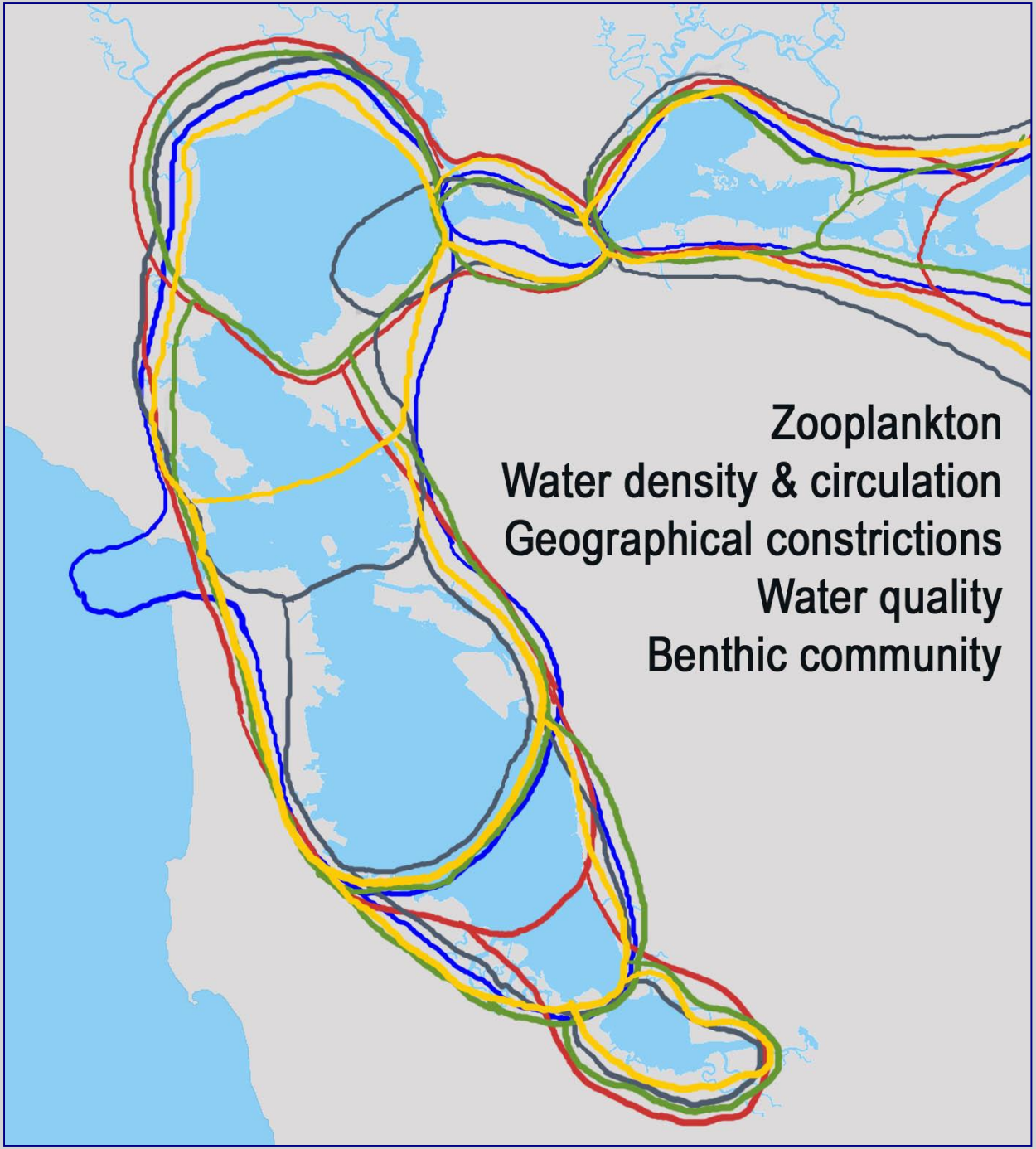
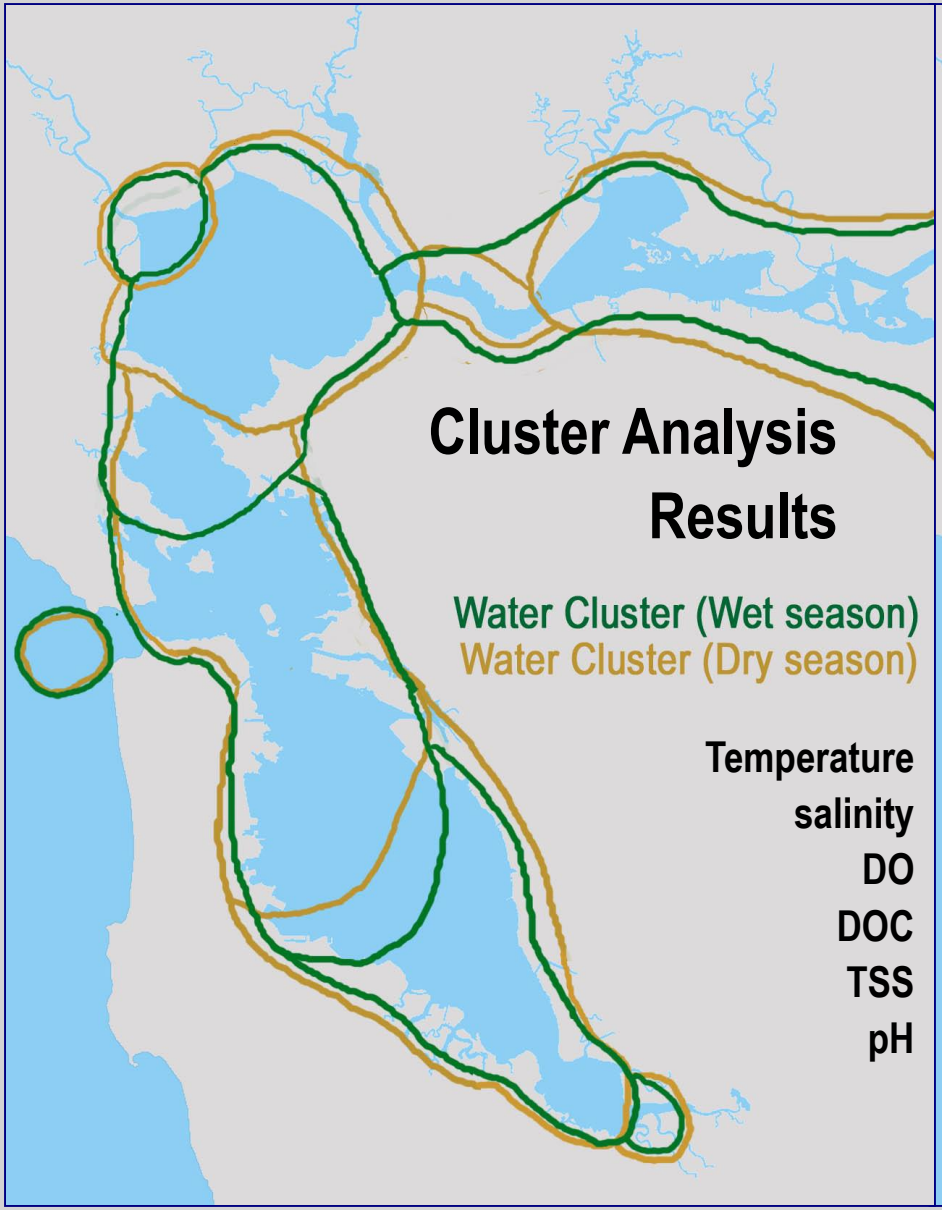
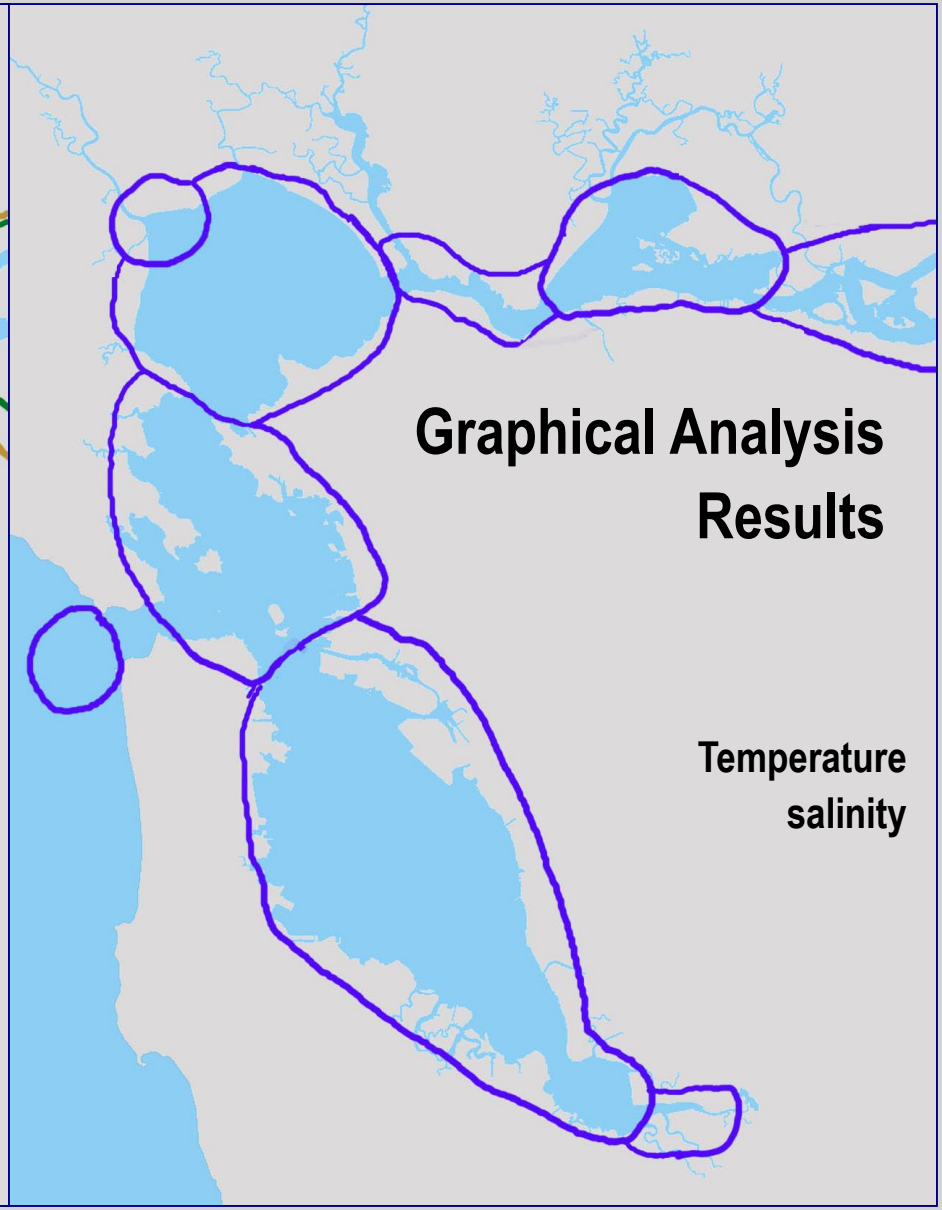
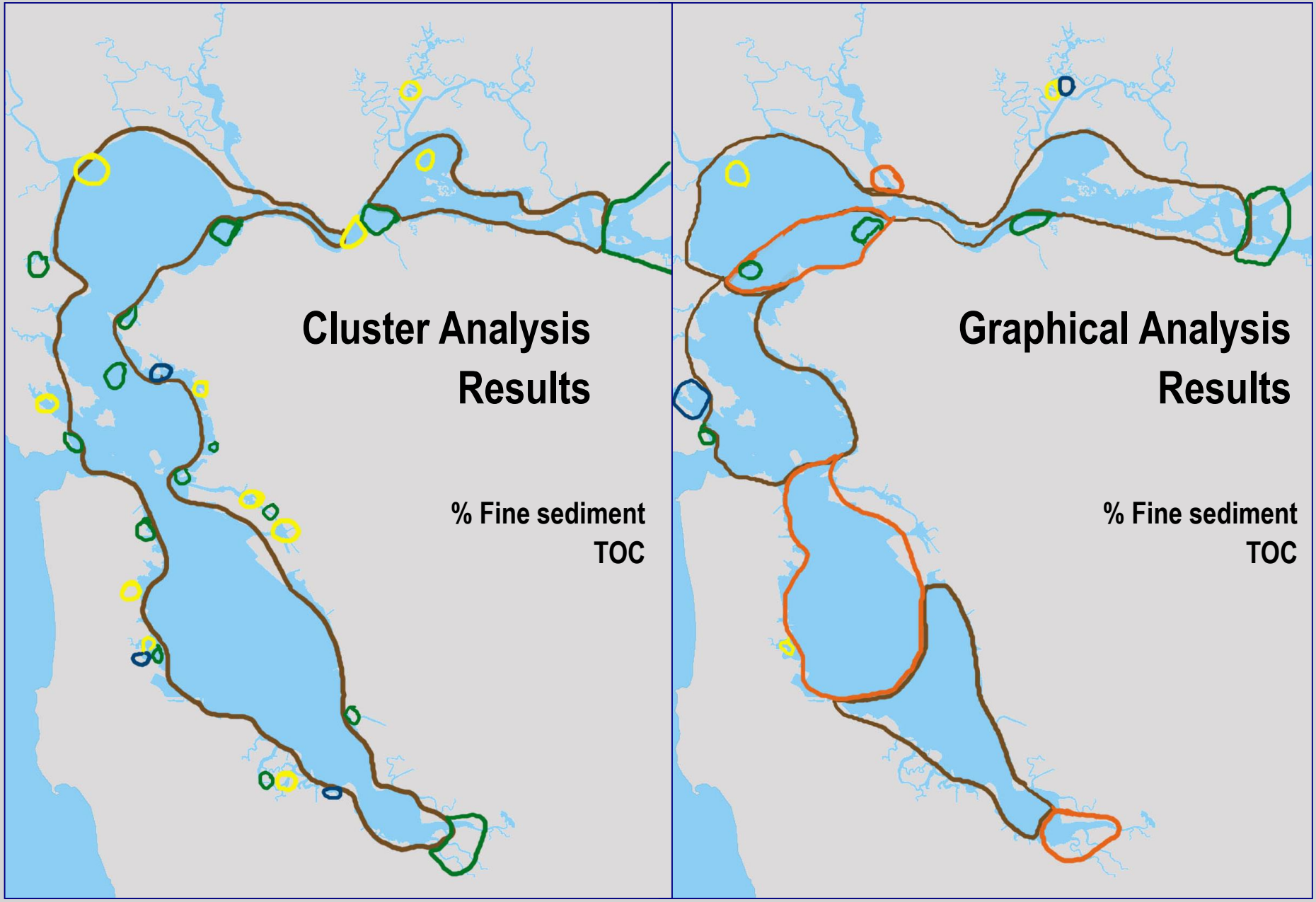


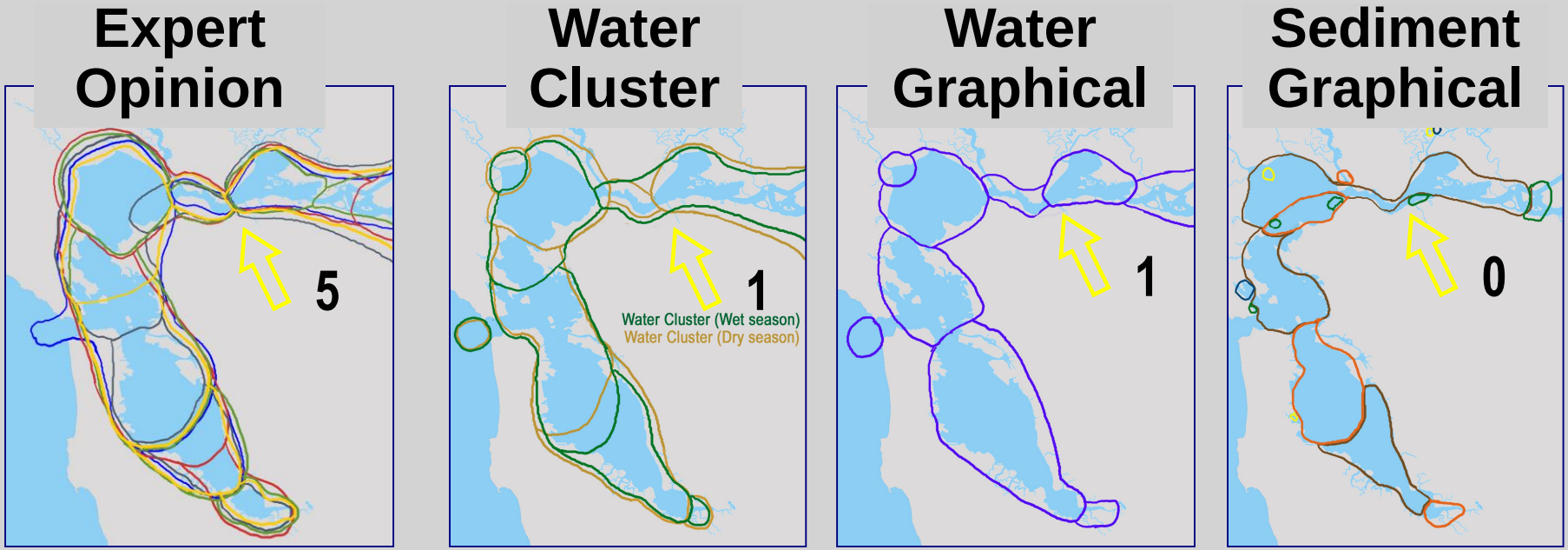




Water Quality data source: RMP and BPTCP (1989-1998)

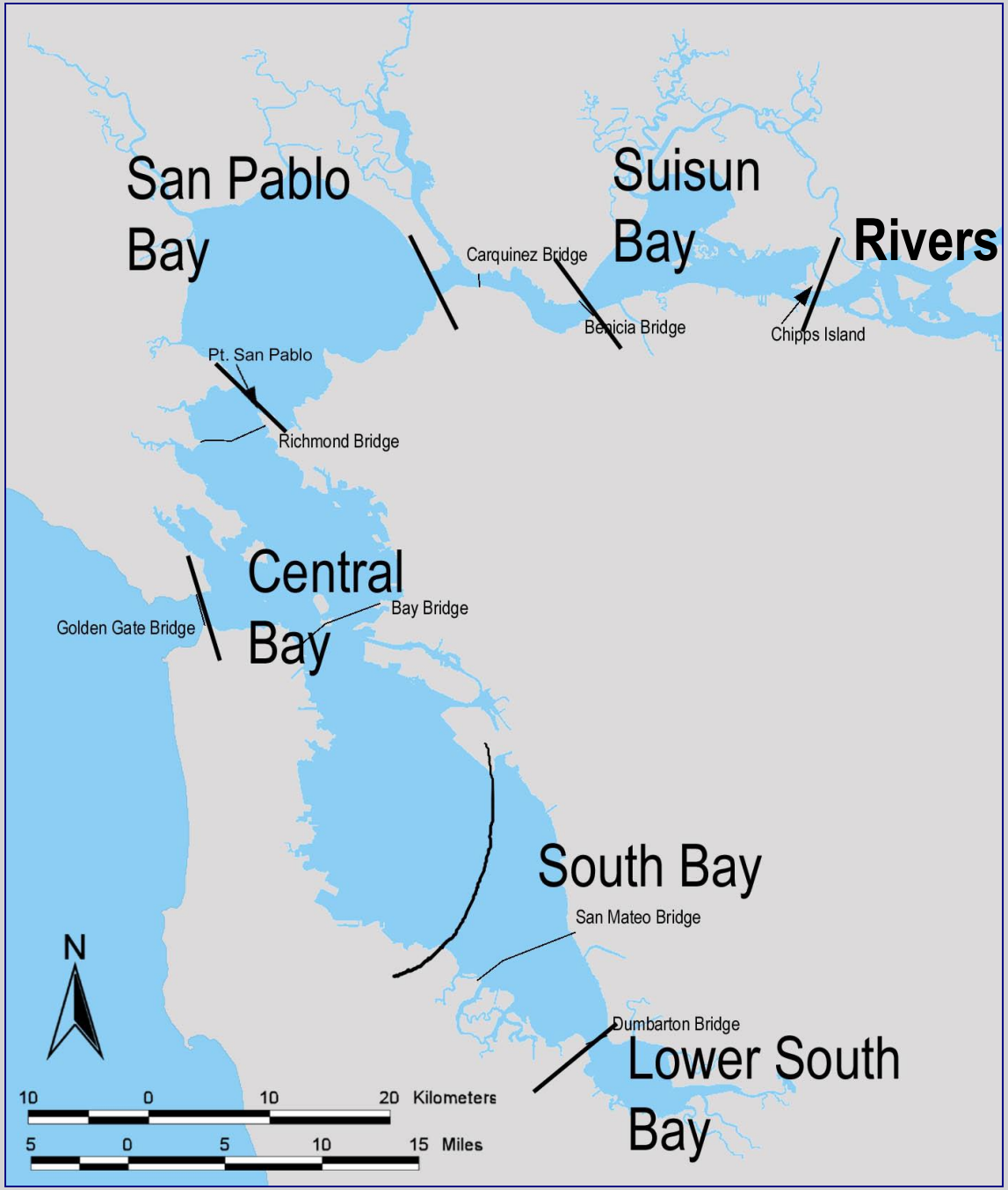


Sediment Quality data source: RMP, BPTCP & DWR (1991-1998)



Region Boundary	Expert Opinion	Water Cluster	Water Graphical	Sediment Graphical	Total	
Number of possible hits	5	2	1	1	9	
Chipps Island *	1	0	1	0	**2**	
Benicia Bridge*	5	1	1	0	**7**	×
Carquinez Bridge*	0	1	0	0	**1**	
Carquinez Straight (west end)	3	1	1	1	**6**	×
Pt. Pinole	1	0	0	0	**1**	
Pt. San Pablo	2	1	1	1	**5**	×
Richmond Bridge*	0	0	0	0	**0**	
Angel Island	1	1	0	0	**2**	
Bay Bridge*	1	0	1	1	**3**	
San Bruno Shoal	4	2	0	1	**7**	×
San Mateo Bridge*	1	0	0	0	**1**	
Dumbarton Bridge	4	0	0	0	**4**	×
Sloughs	0	2	1	1	**4**	×

The New Segmentation Scheme has Six Main Hydrographic Regions



We determined the final number of samples per region based on:

- Statistical power analyses for key contaminants when compared to specific guidelines
- Regional Board priorities
- Funding

Key contaminants were compared to specific guidelines

- **Water:** compared dissolved copper to the CA Toxics Rule – WQC

- **Sediment:** compared copper, mercury and total PAHs to the Effects Range Low guidelines - ERL (Long *et al.* 1995)

Dissolved Copper

	Dry Season		% Power achieved with 2 to 10 samples								
Hydrographic Region	Mean	StDev	2	3	4	5	6	7	8	9	10
Rivers[1]	1.81	0.12	**100**								
Suisun Bay	2.06	0.20	**64**	**99**							
San Pablo Bay	2.02	0.56	**29**	**60**	**81**	**92**	**97**	**99**	**100**		
Central Bay	1.50	0.46	**53**	**96**	**100**						
South Bay	2.88	0.34	**10**	**14**	**19**	**23**	**26**	**30**	**33**	**37**	**40**
Lower South Bay	3.66	0.24	**33**	**69**	**89**	**97**	**99**				

[1] Rivers region was compared to the fresh water criterion.

WQC : saltwater = 3.1, freshwater = 9 (µg/L)

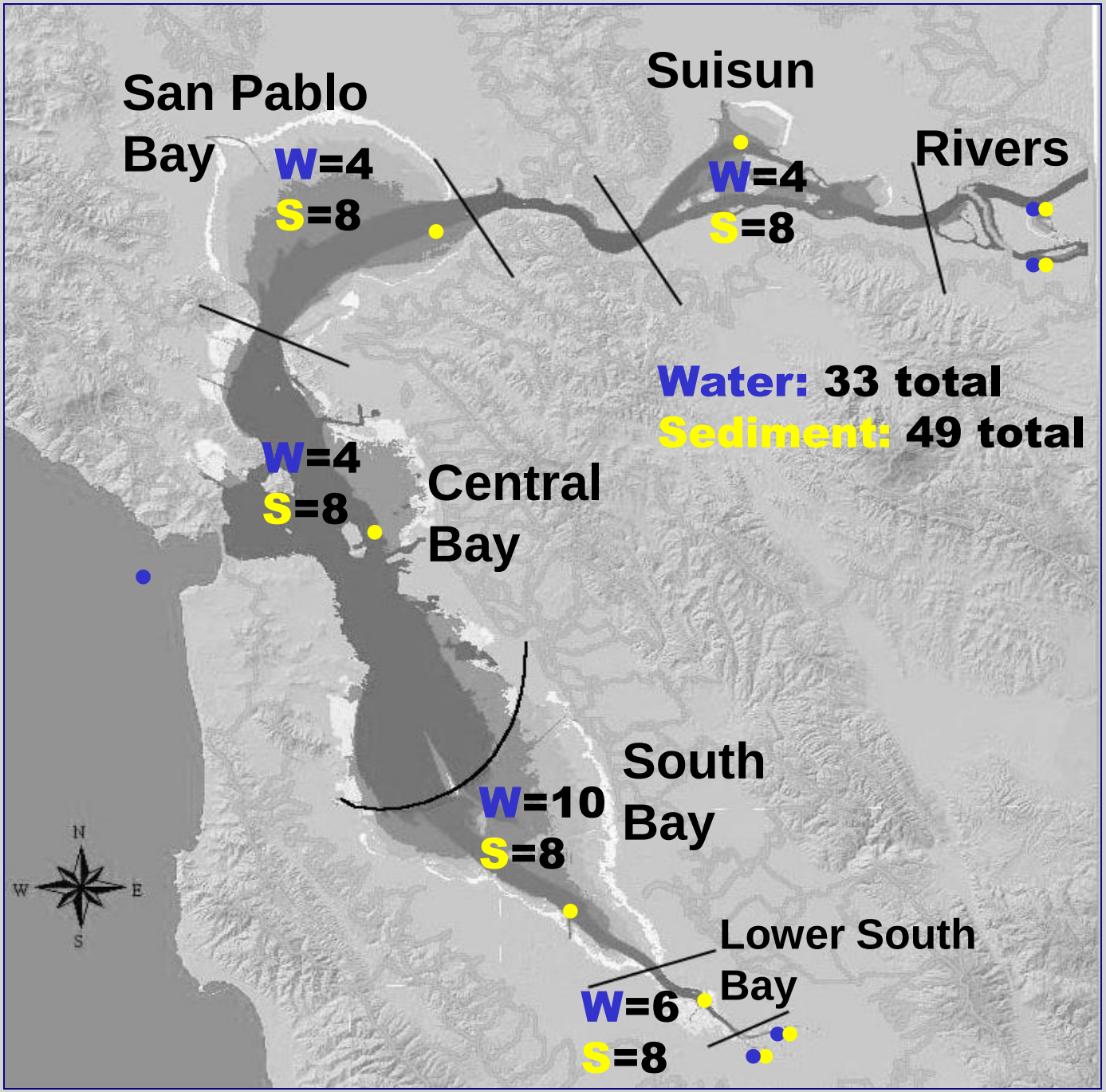
Type I error rate (a) = 0.05. Dry Season: May-Oct.

Sediment samples compared to the ERL guidelines.

Type I error rate (a) = 0.05.

		Dry Season			% Power achieved with 2 to 10 samples								
Hydrographic Region	Parameter	Mean	StDev	ERL	2	3	4	5	6	7	8	9	10
Rivers	CU	28.6	8.1	34	11	16	21	26	30	35	39	43	46
	HG	0.18	0.13	0.15	6	7	8	9	9	10	10	11	12
	TPAH	126	88	4022	100								
Suisun Bay	CU	37.0	19.6	34	6	7	8	9	9	10	10	11	11
	HG	0.19	0.12	0.15	8	9	11	12	14	15	16	17	19
	TPAH	423	232	4022	99								
San Pablo Bay	CU	45.1	22.5	34	9	12	15	17	20	22	25	27	29
	HG	0.28	0.21	0.15	10	13	17	20	23	26	29	32	35
	TPAH	6028	13642	4022	6	6	6	6	7	7	7	7	7
Central Bay	CU	39.2	17.3	34	8	9	11	12	13	15	16	17	18
	HG	0.24	0.13	0.15	12	19	26	32	38	43	49	53	58
	TPAH	2920	2186	4022	10	13	17	20	23	26	29	32	35
South Bay	CU	37.7	3.2	34	17	30	43	55	64	72	78	83	87
	HG	0.30	0.05	0.15	39	80	96	99					
	TPAH	2180	585	4022	42	85	98	100					
Lower South Bay	CU	40.3	4.1	34	19	35	51	64	74	81	87	91	93
	HG	0.34	0.06	0.15	53	96	100						
	TPAH	1962	412	4022	57	98	100						

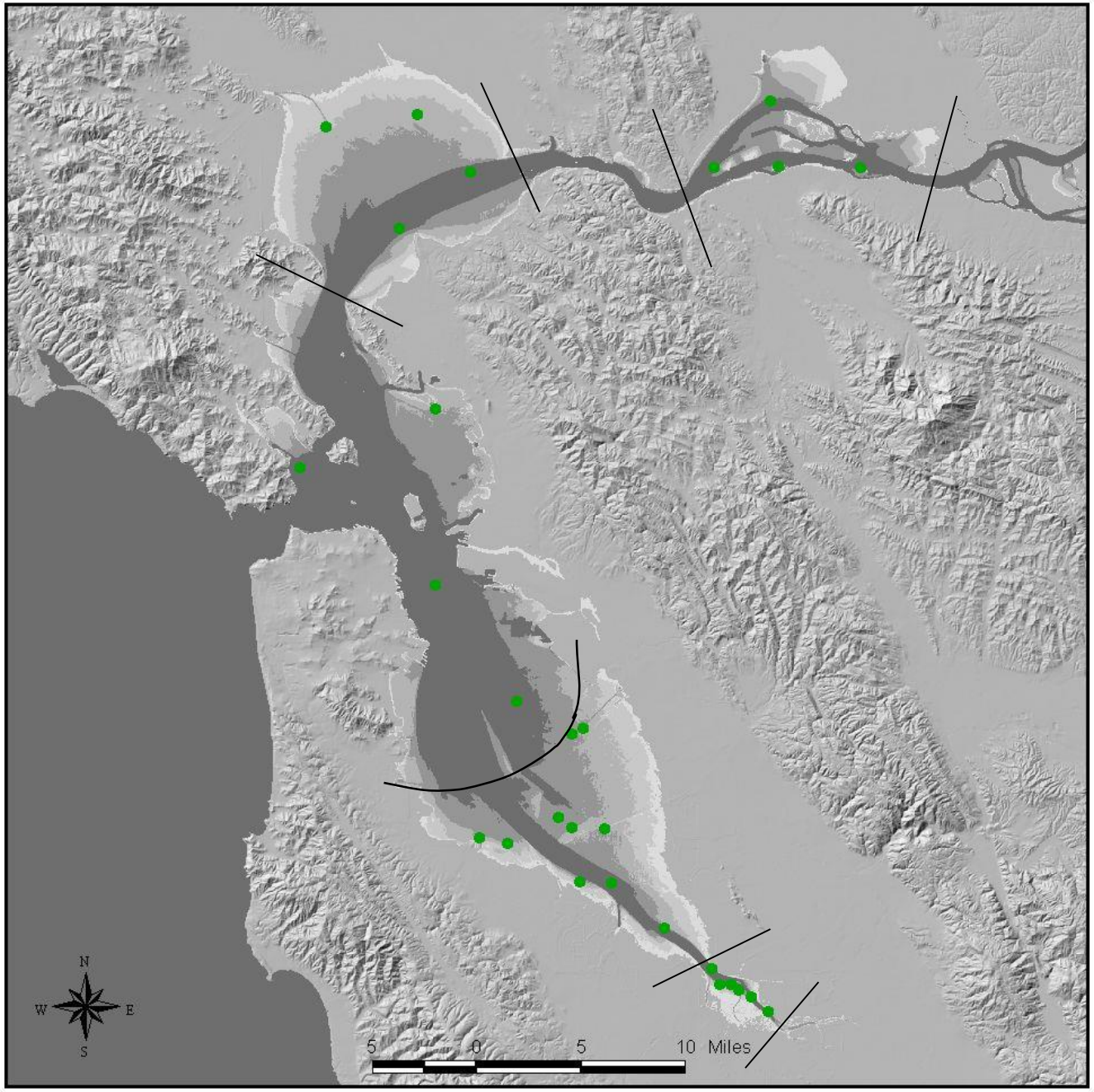
Number of SAMPLES



Sampling Plan

- Annual sampling (during the dry season) measuring
  - priority pollutants & ancillary measures
  - effects (toxicity)
  - bivalve bioaccumulation
- Focused studies
  - sources, pathways, loadings
  - episodic toxicity in major tributaries

WATER



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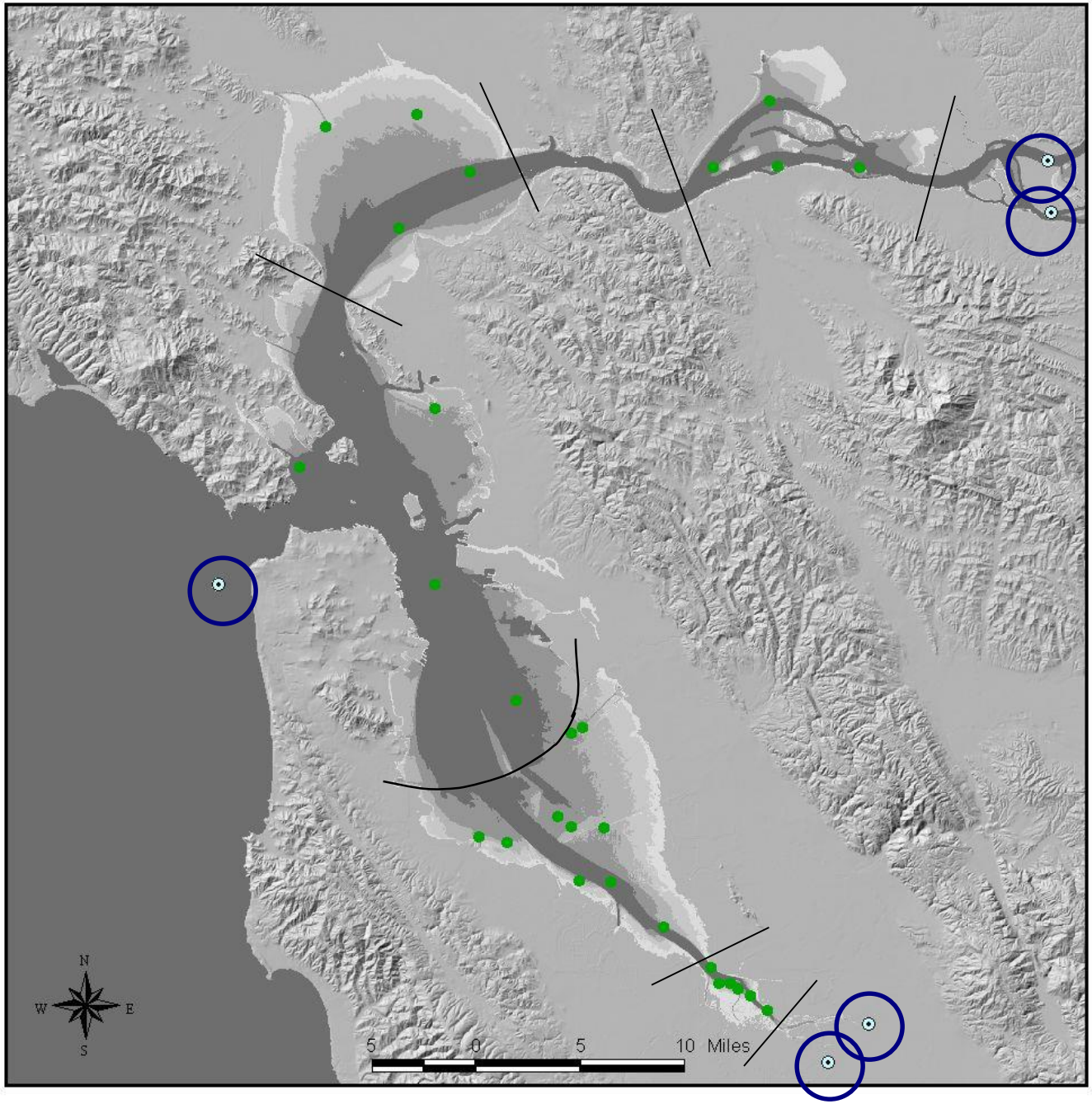

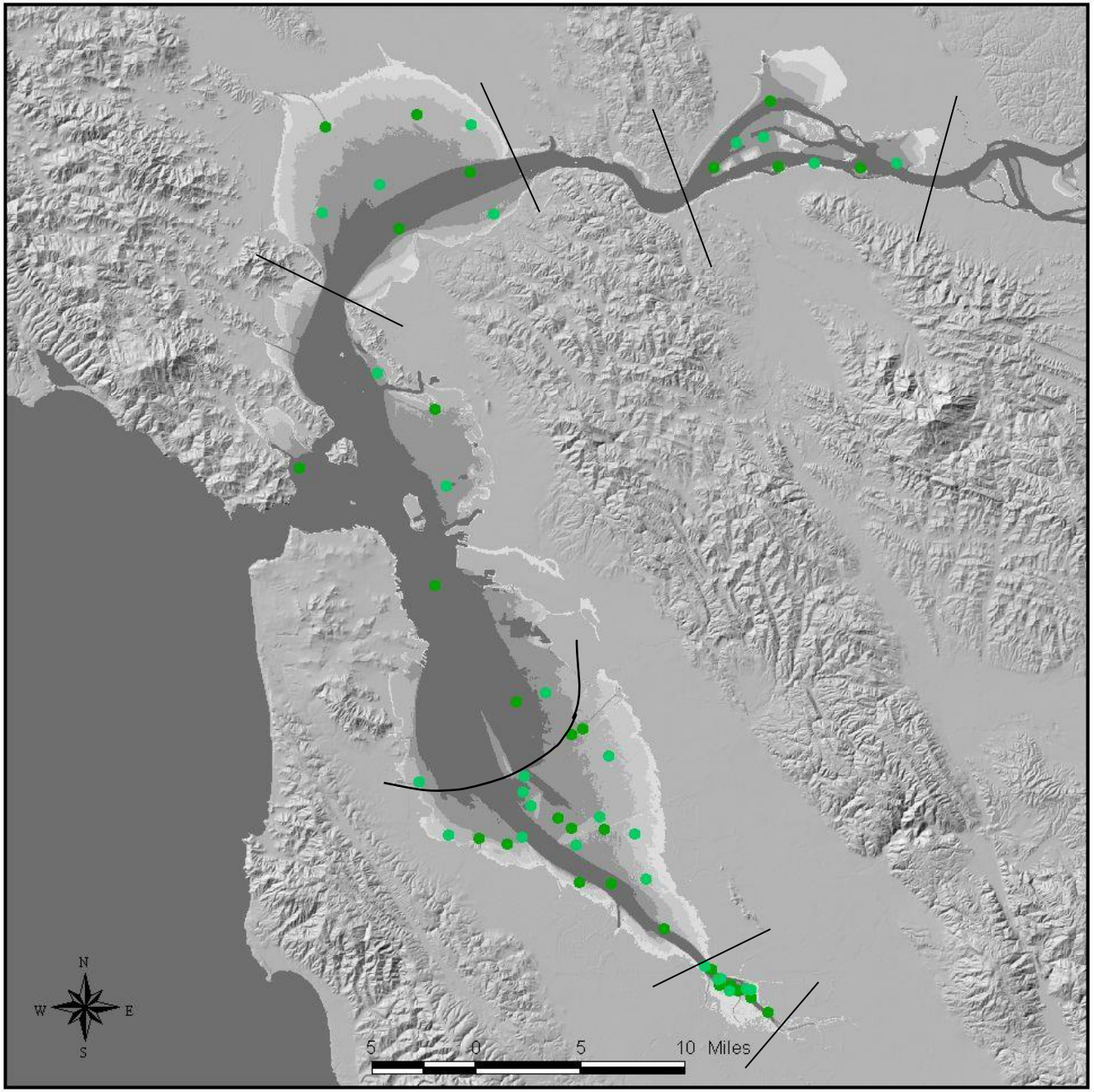
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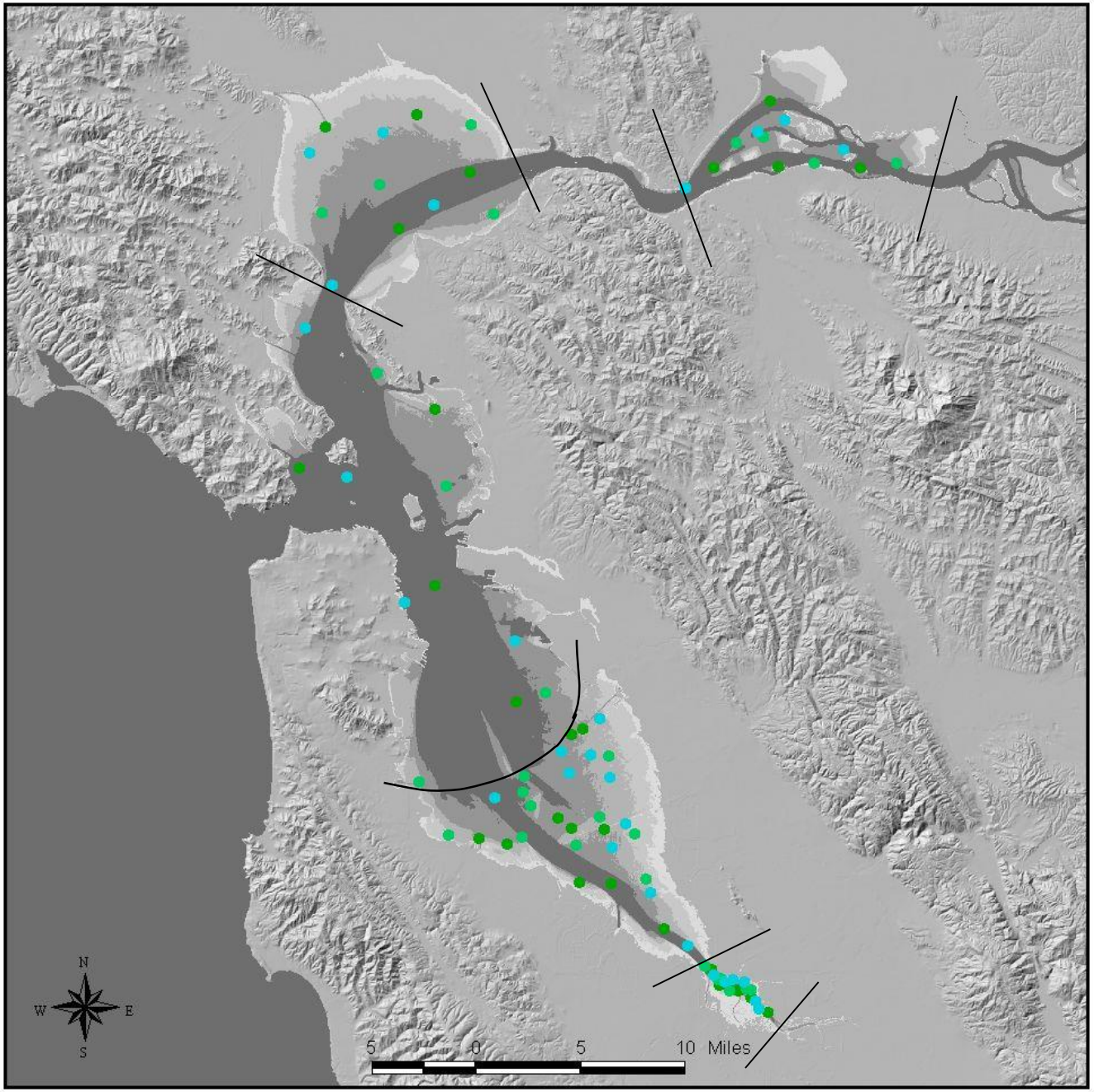
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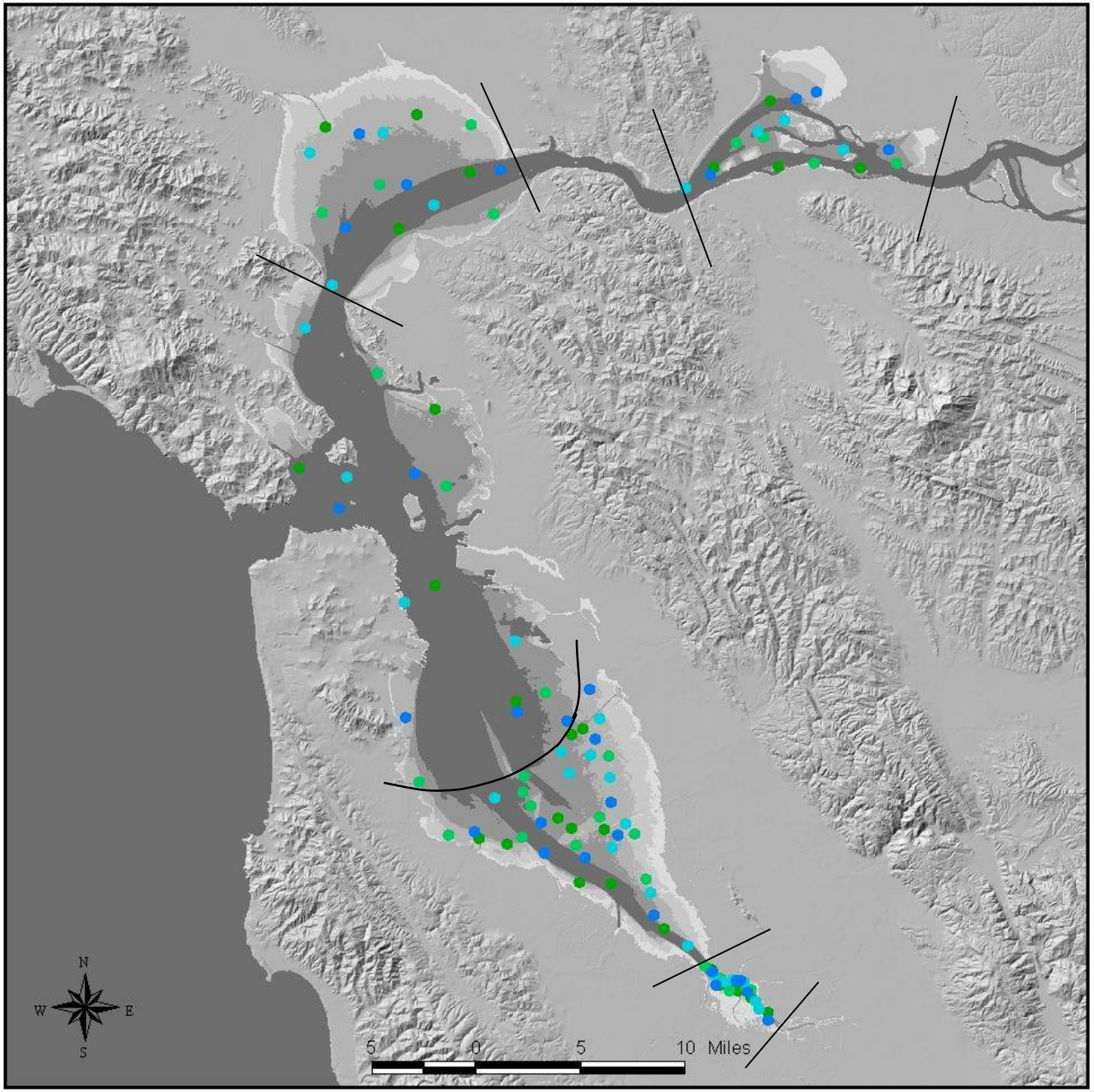
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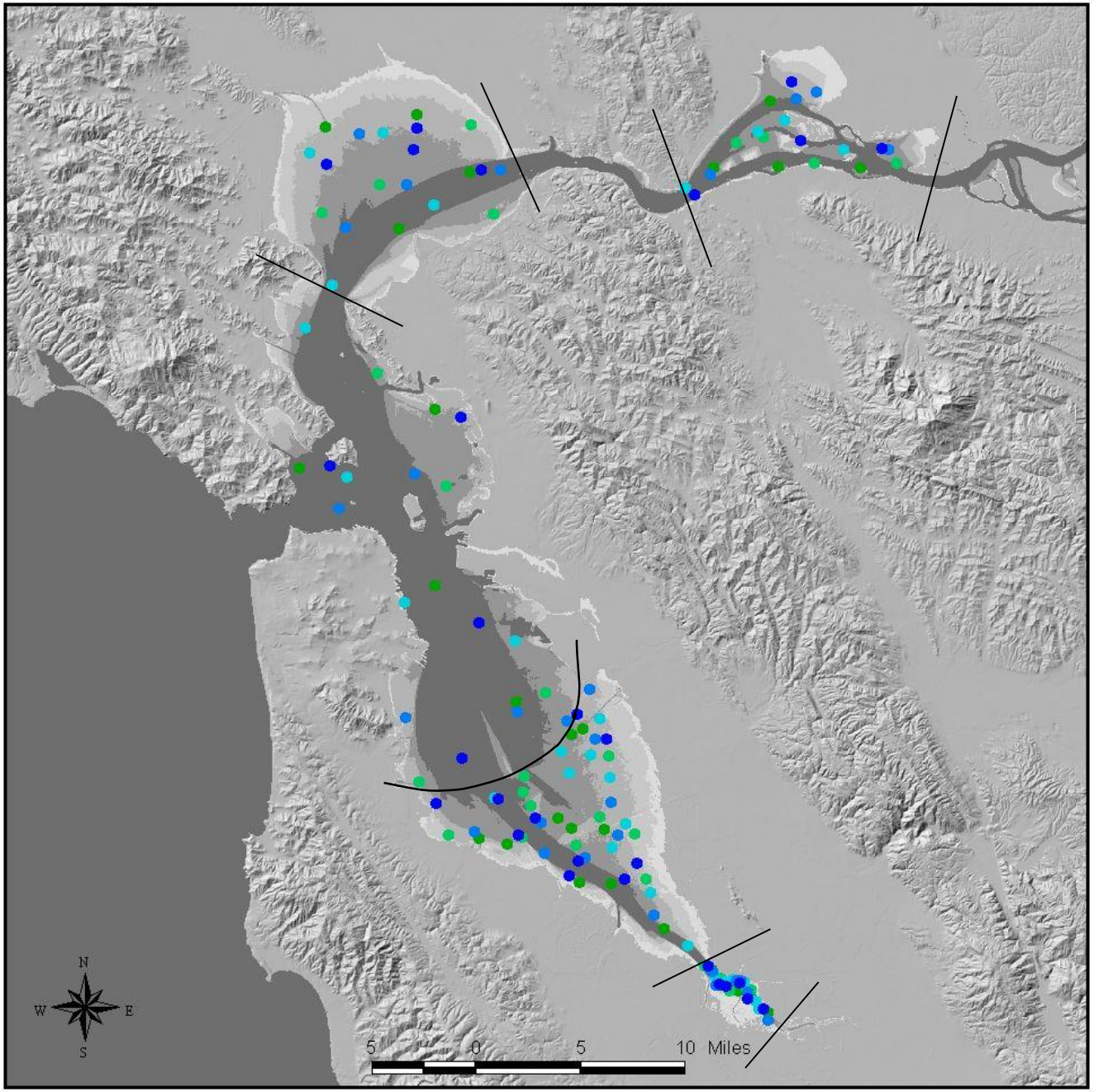
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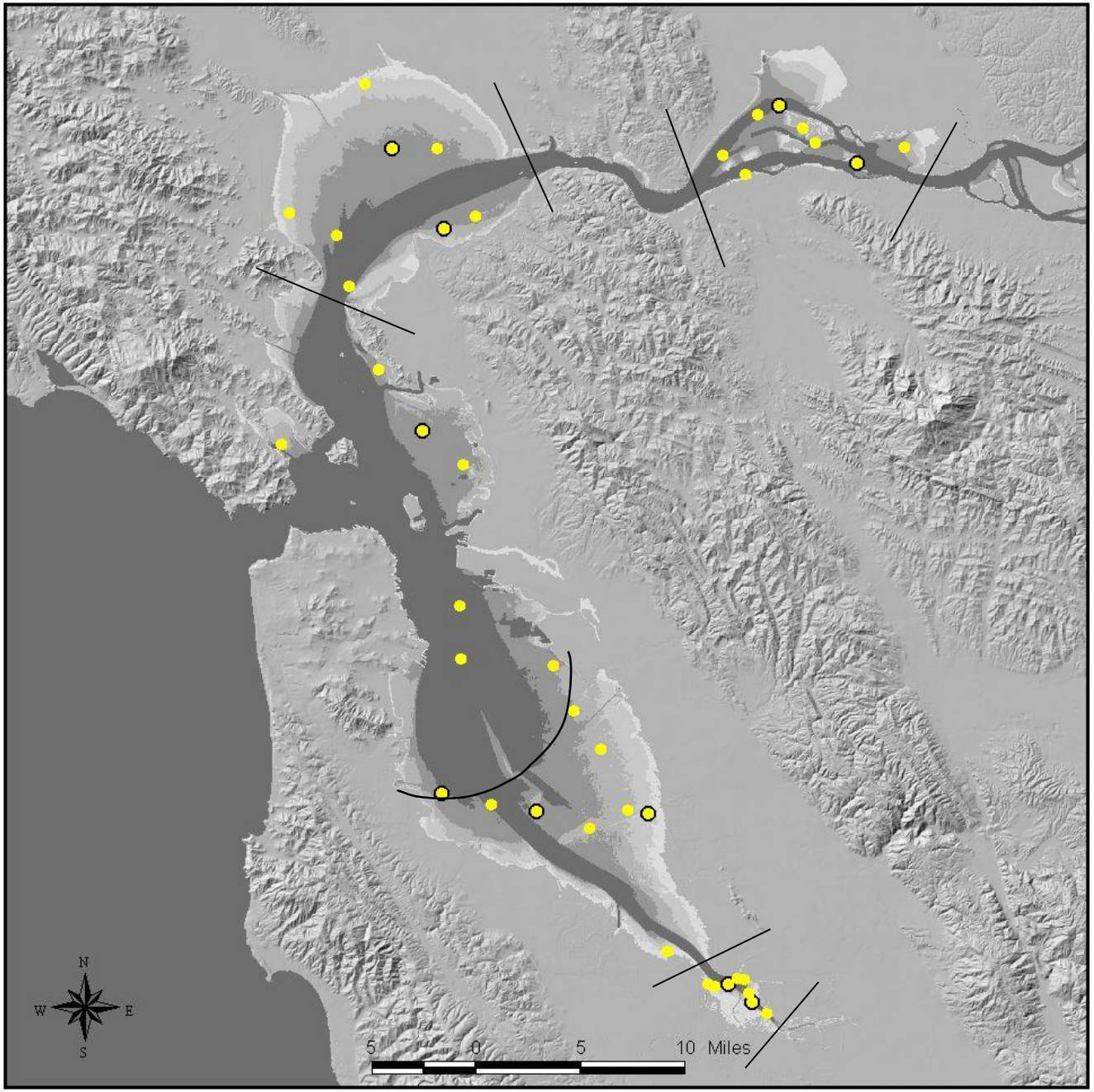

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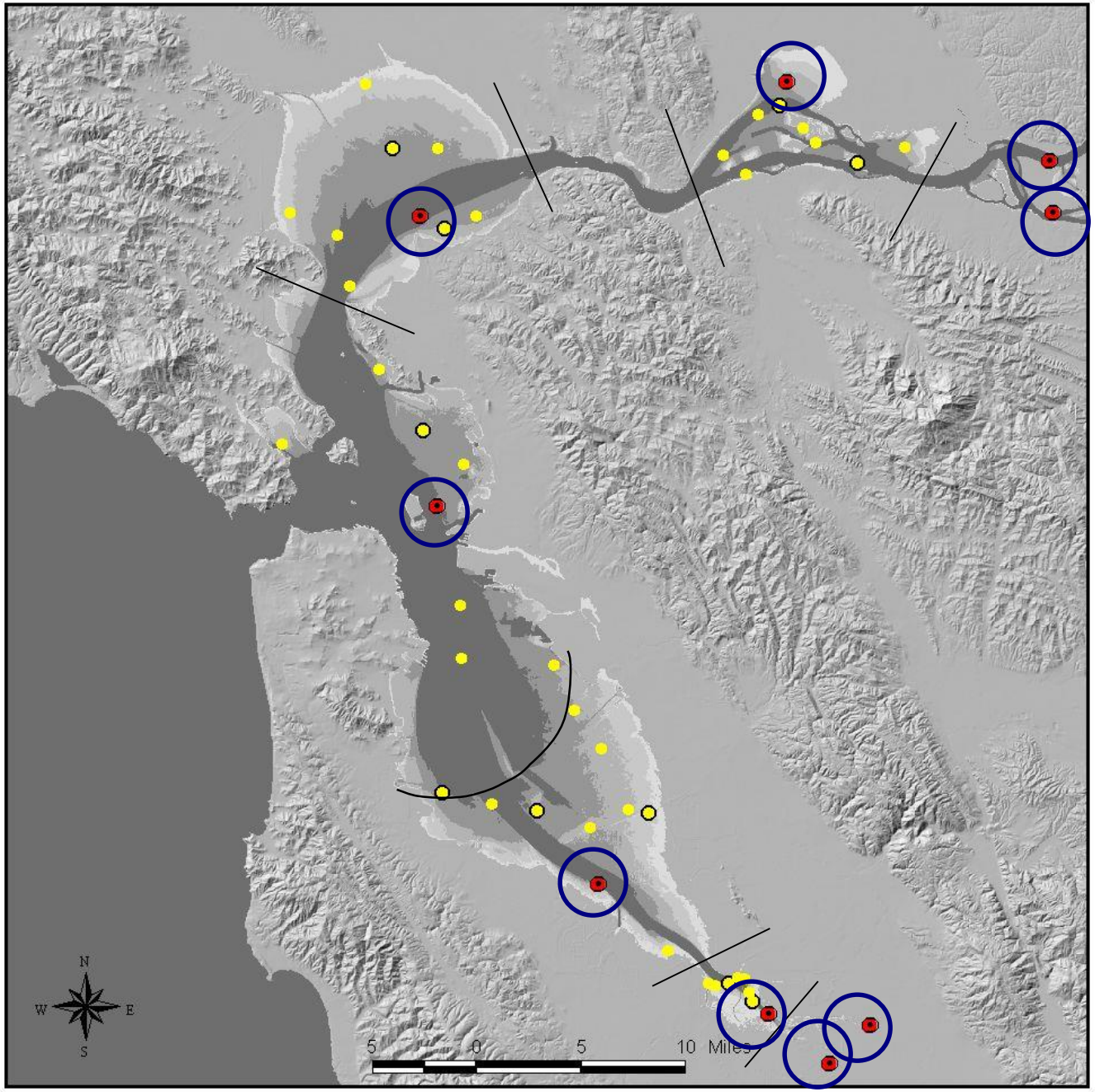

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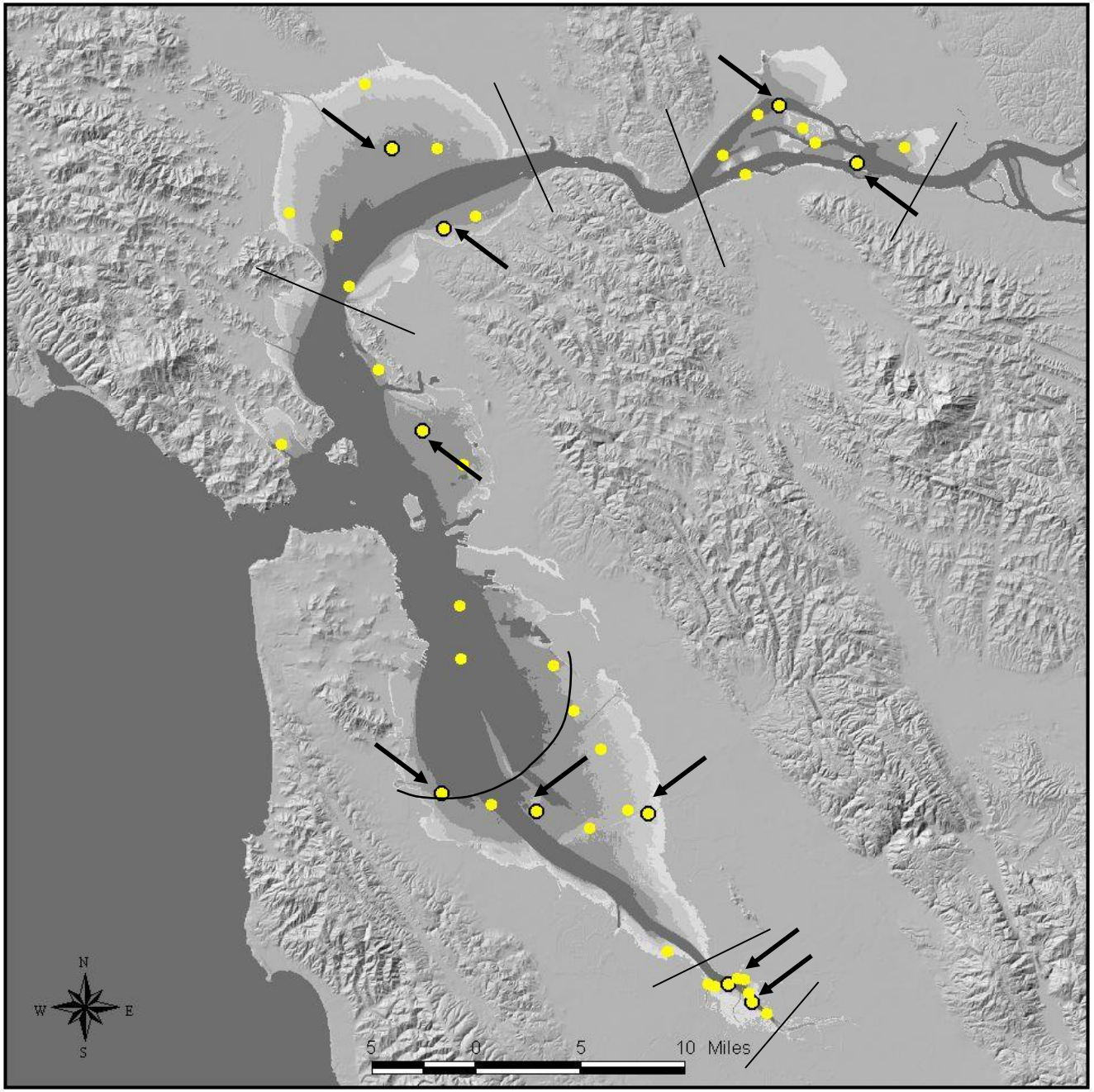

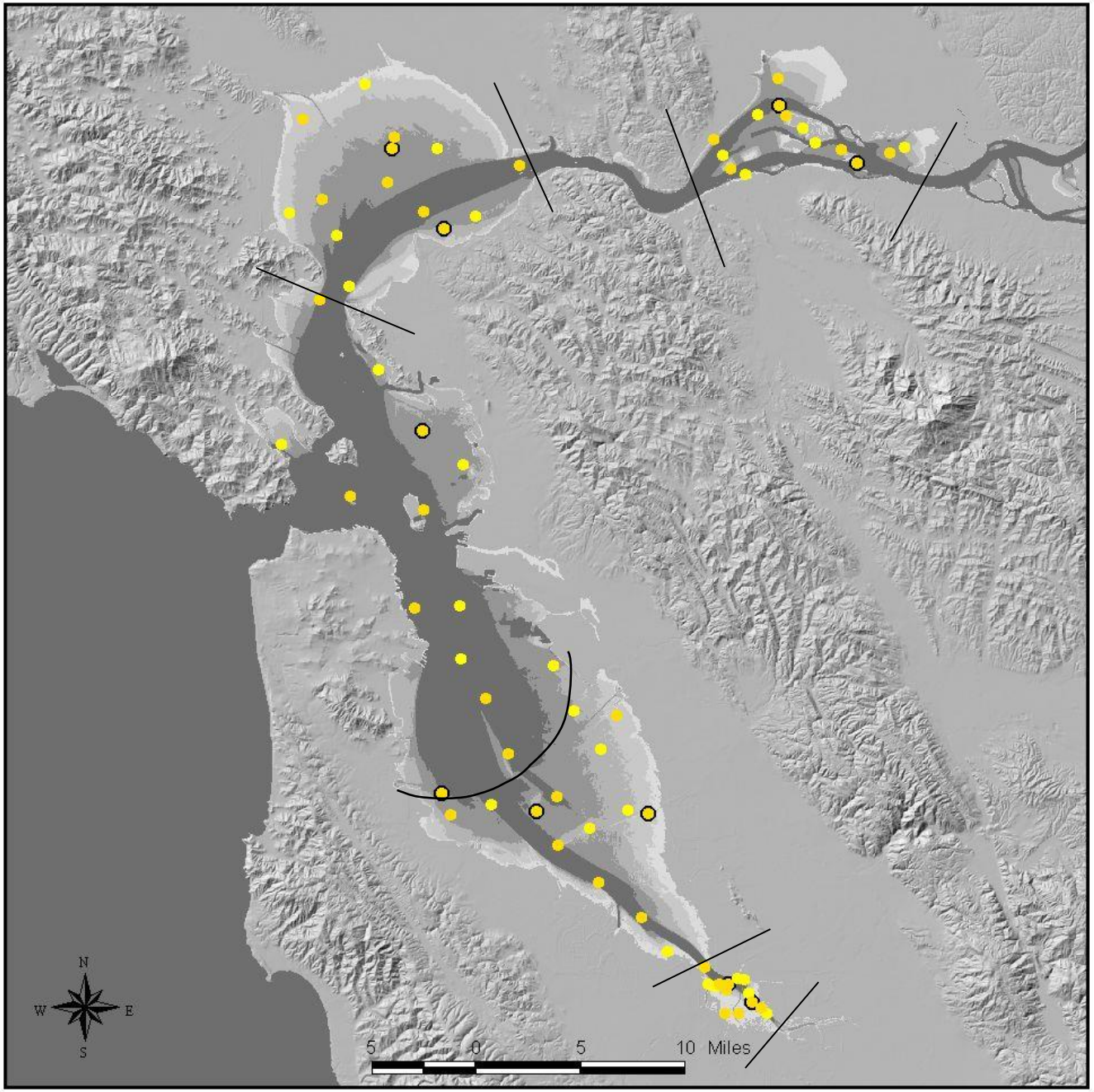
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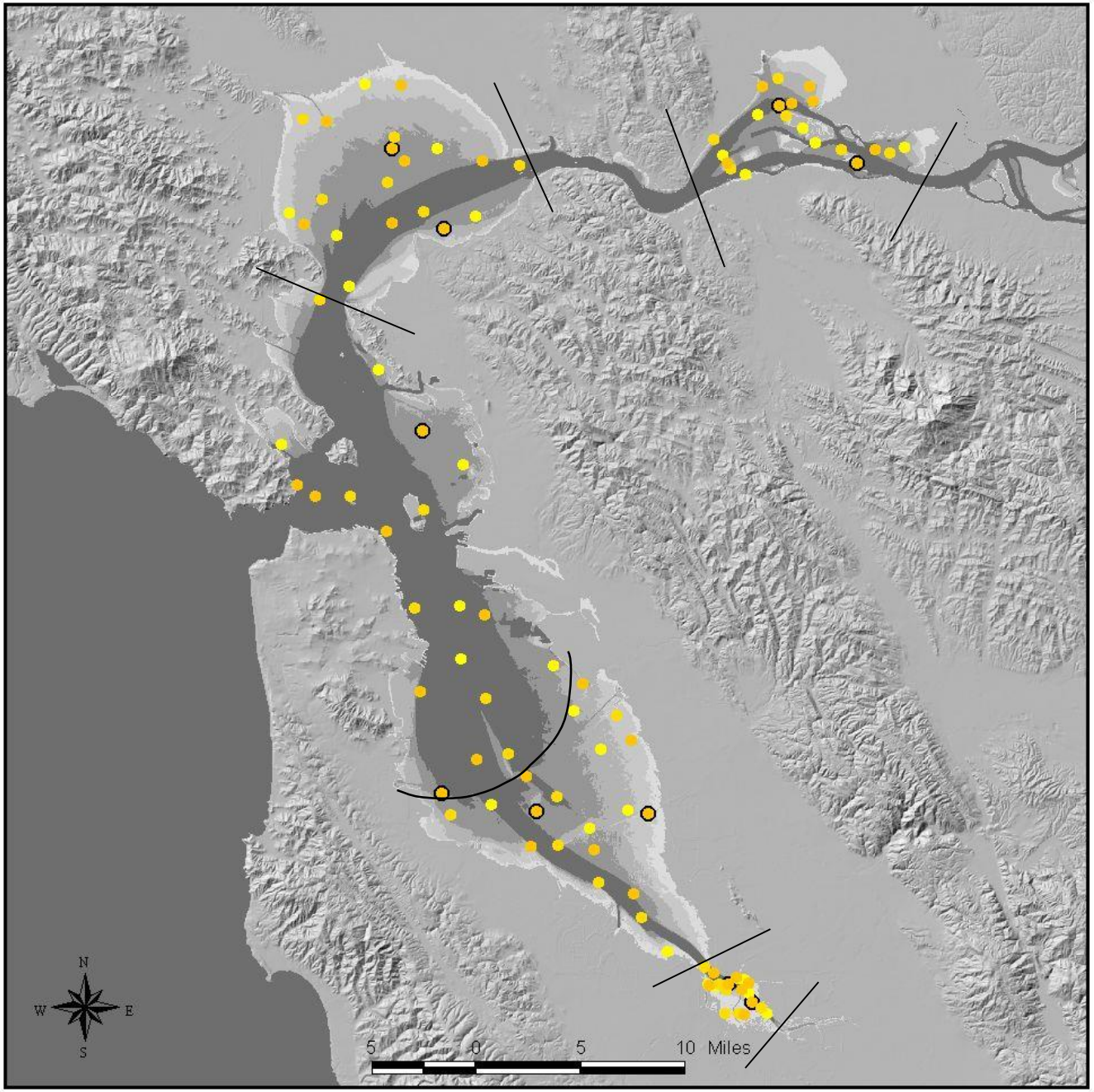
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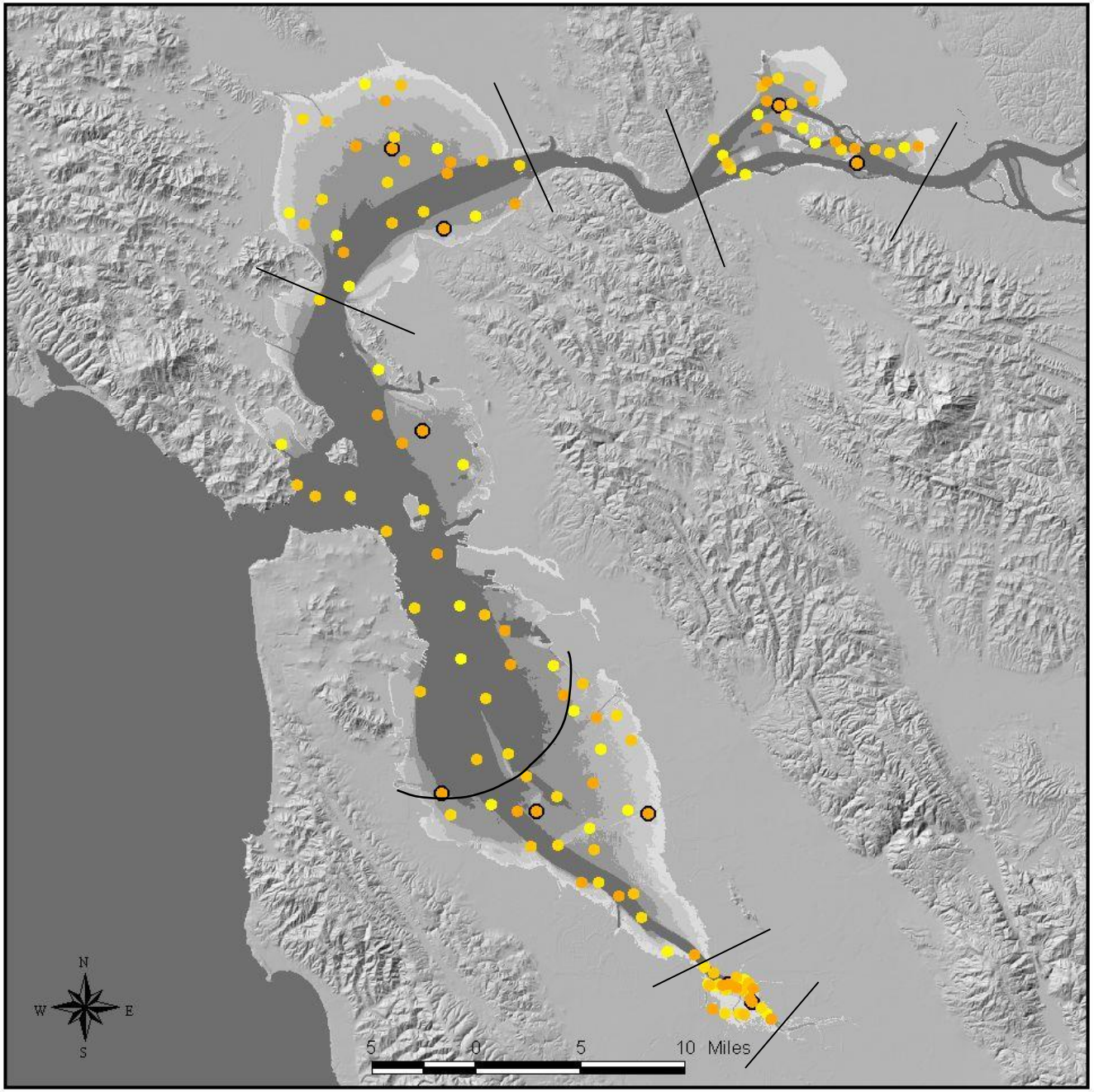
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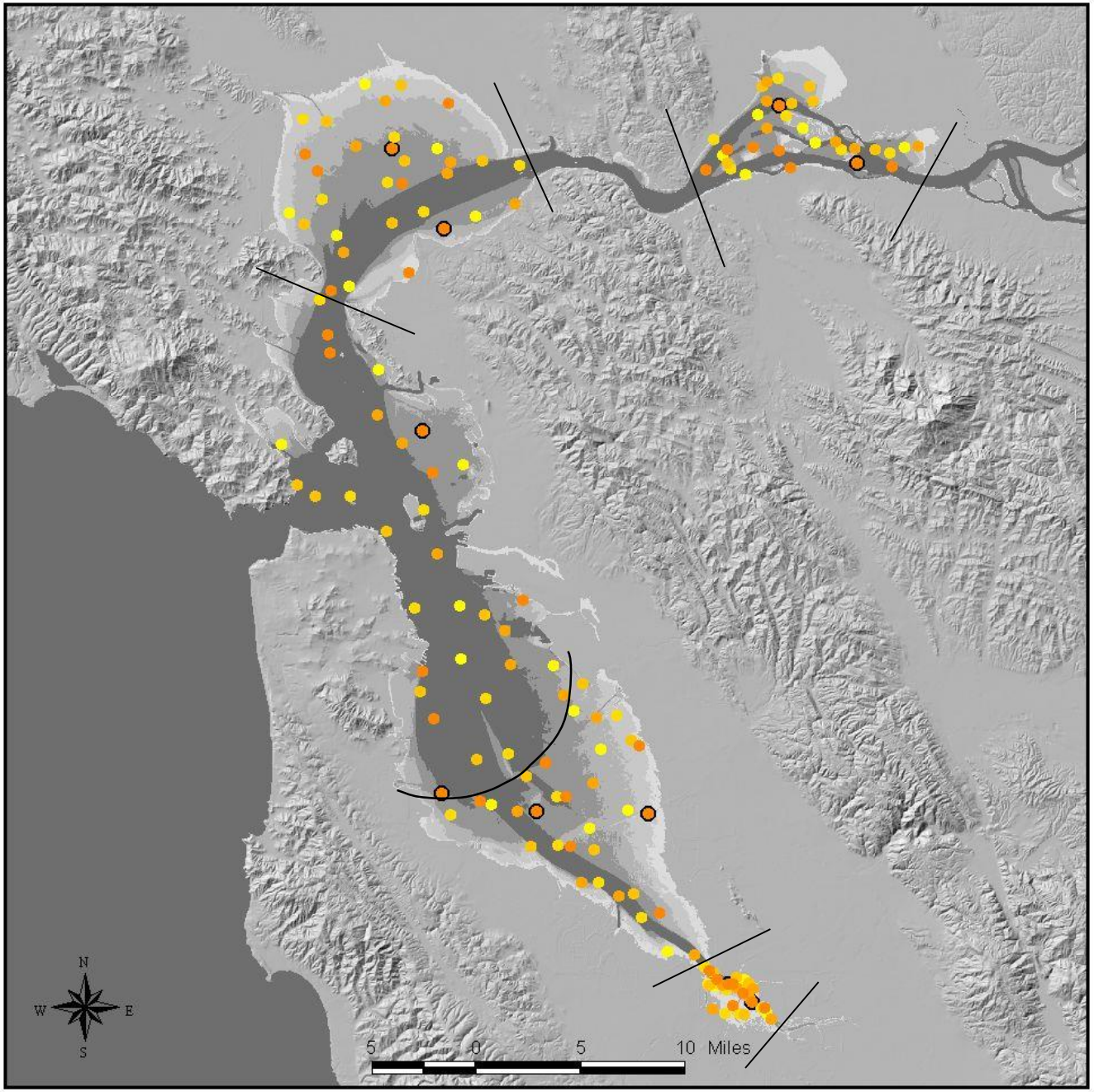
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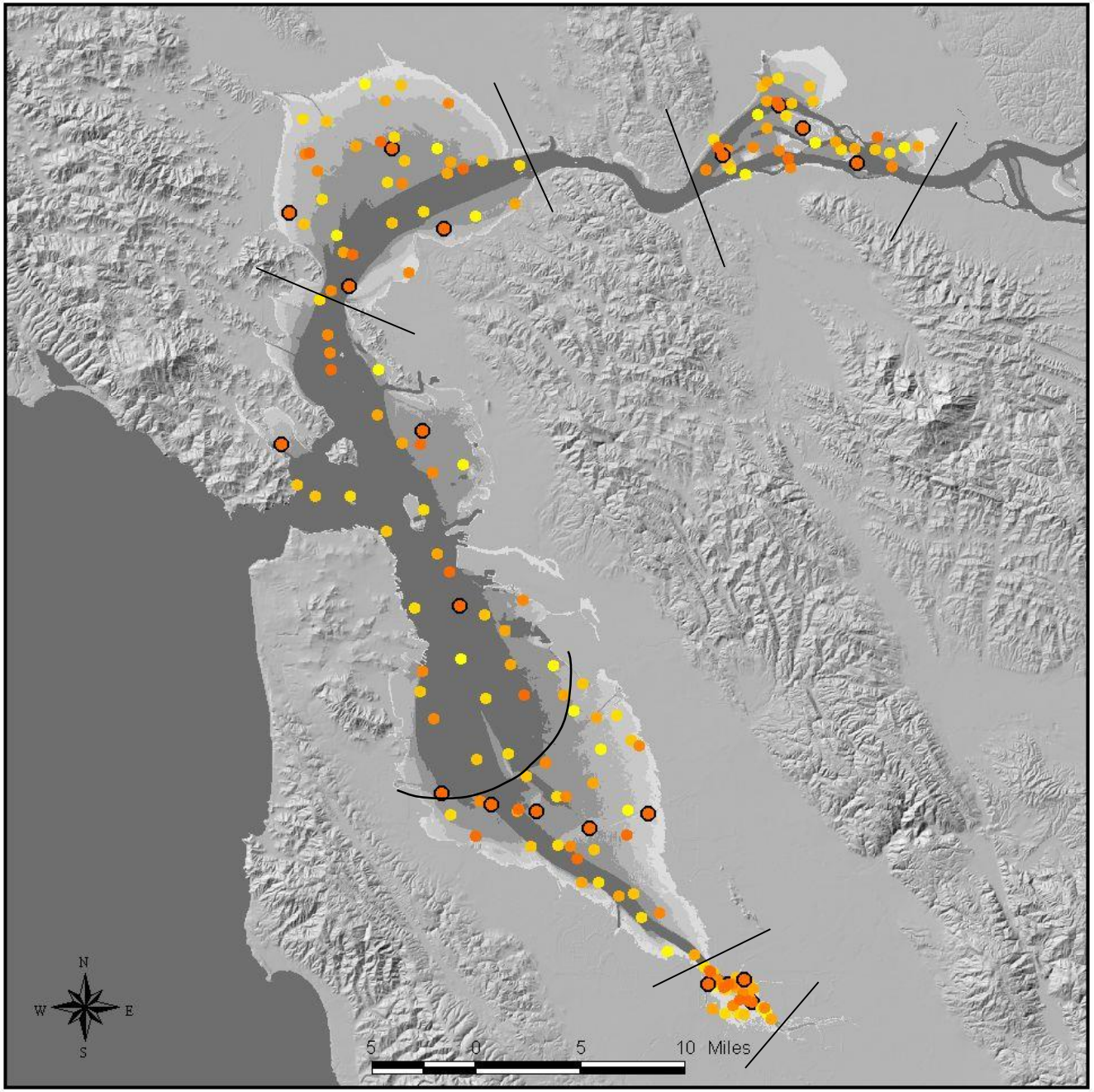

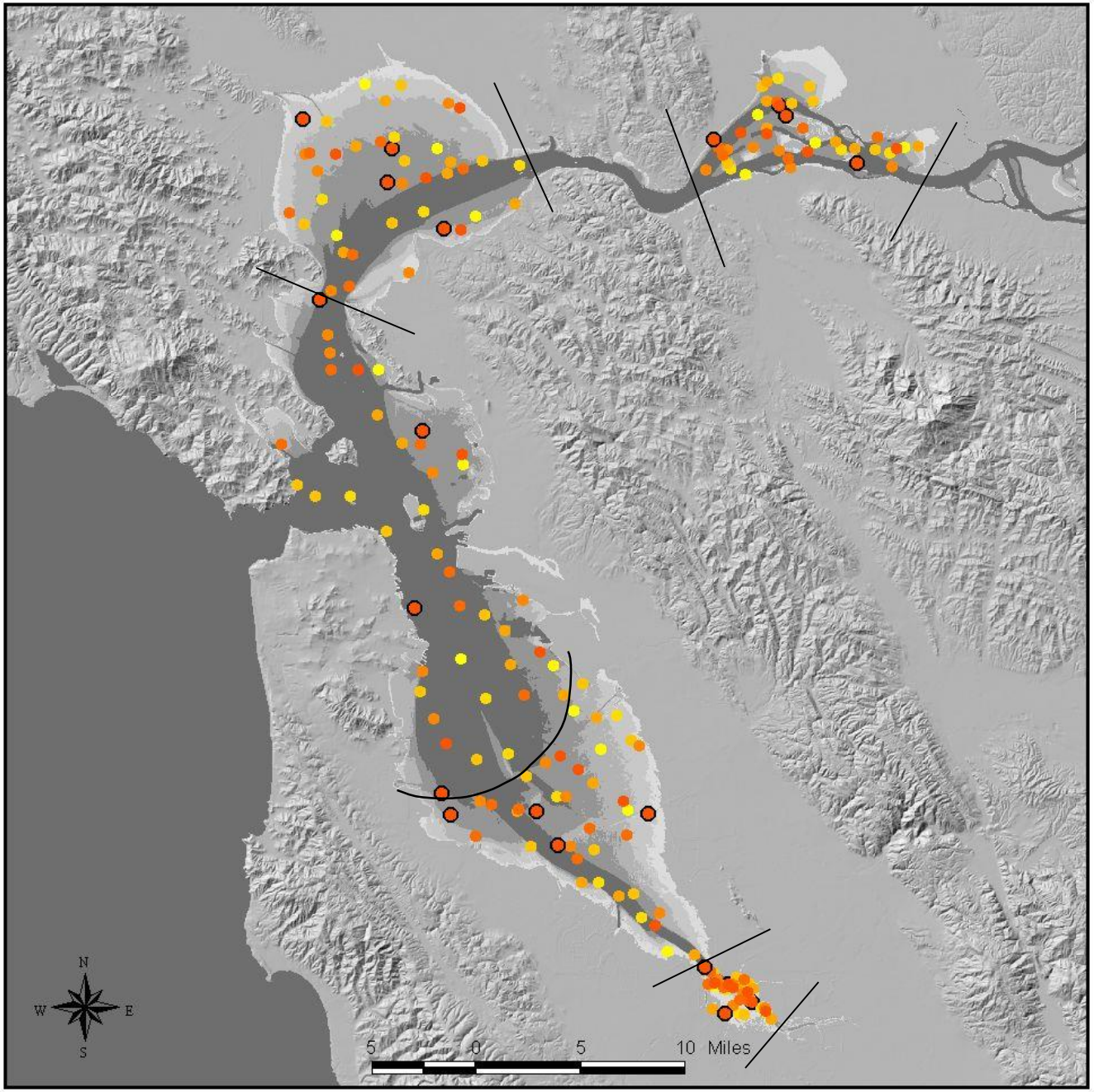
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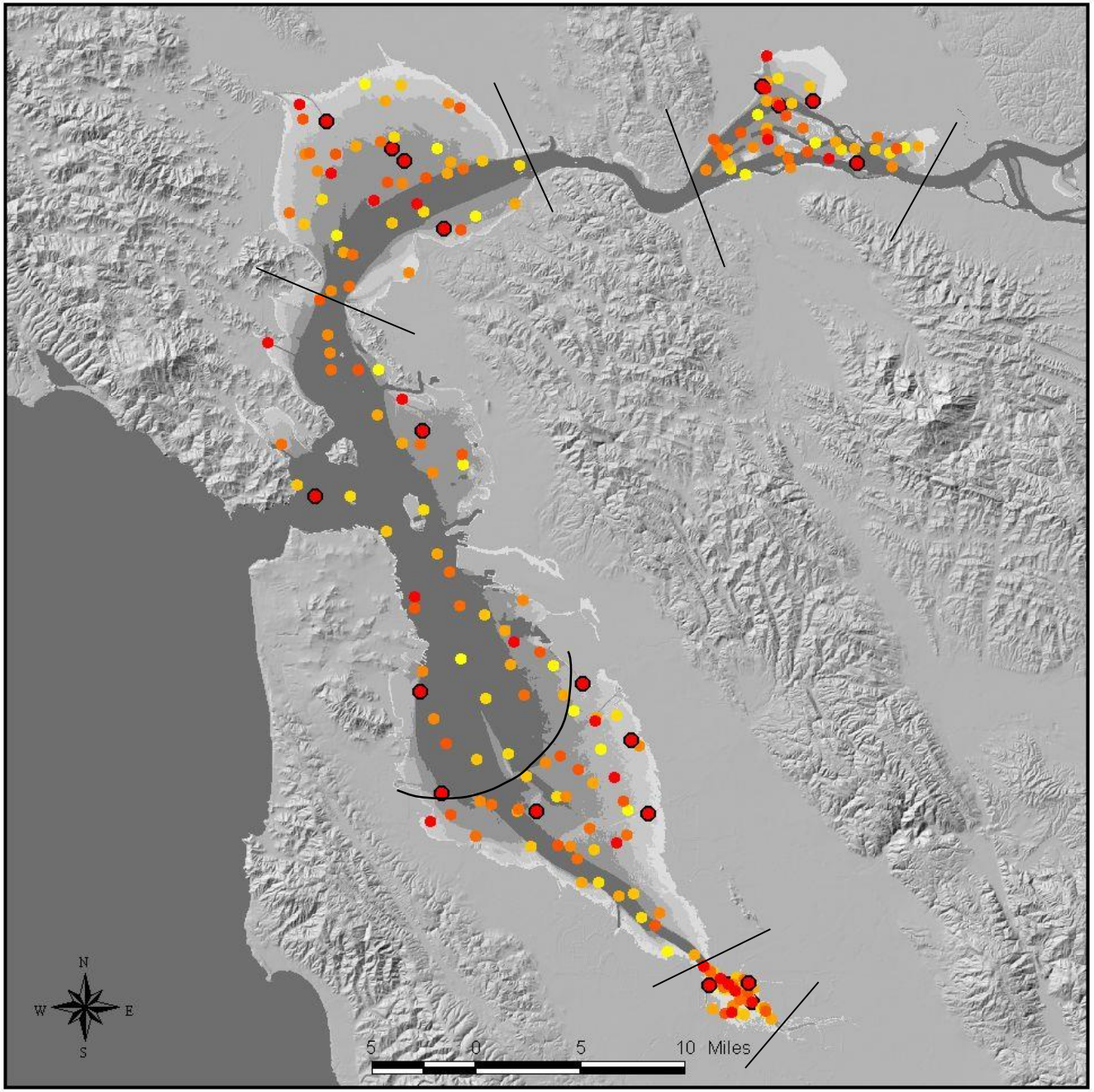
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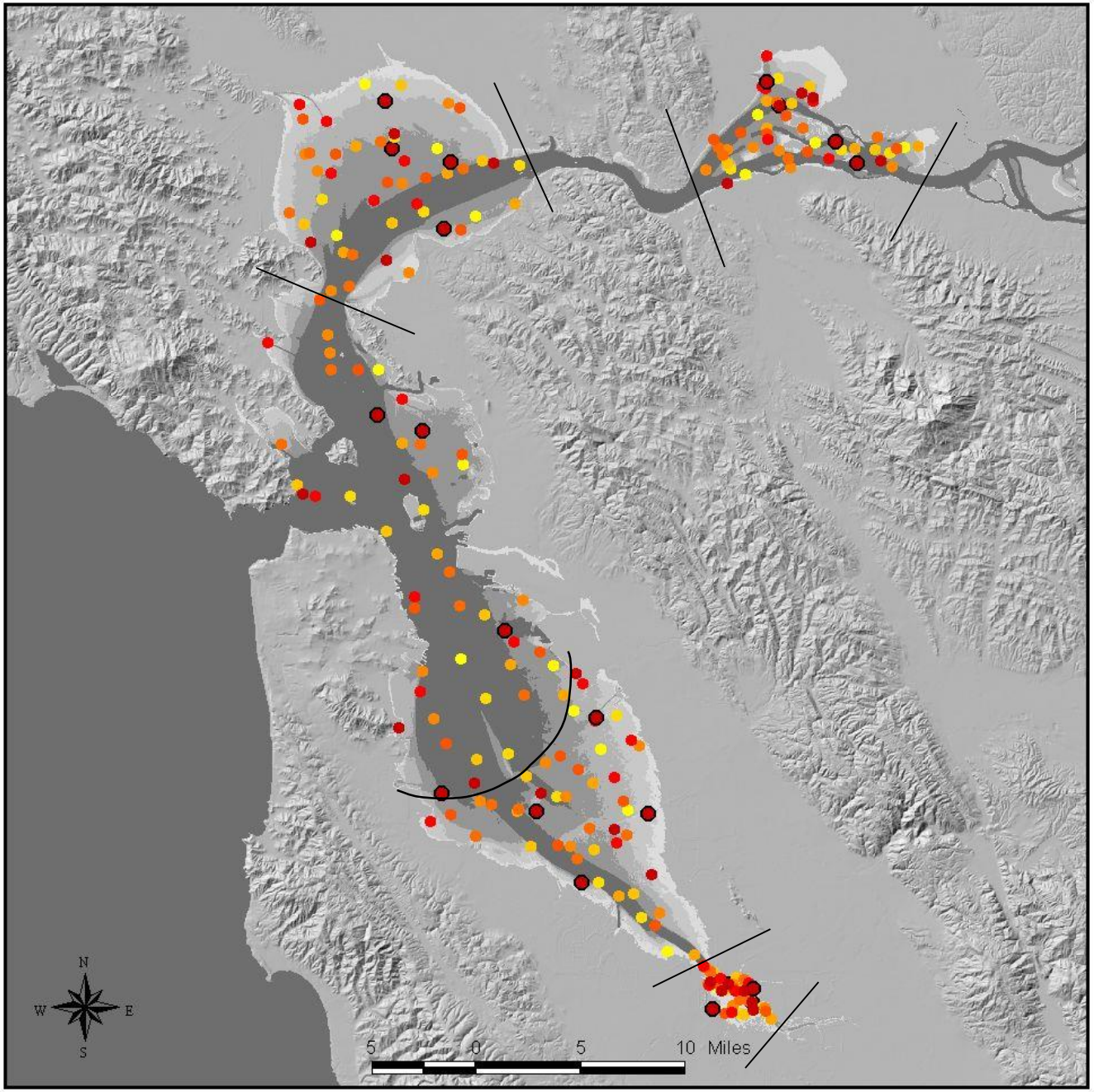
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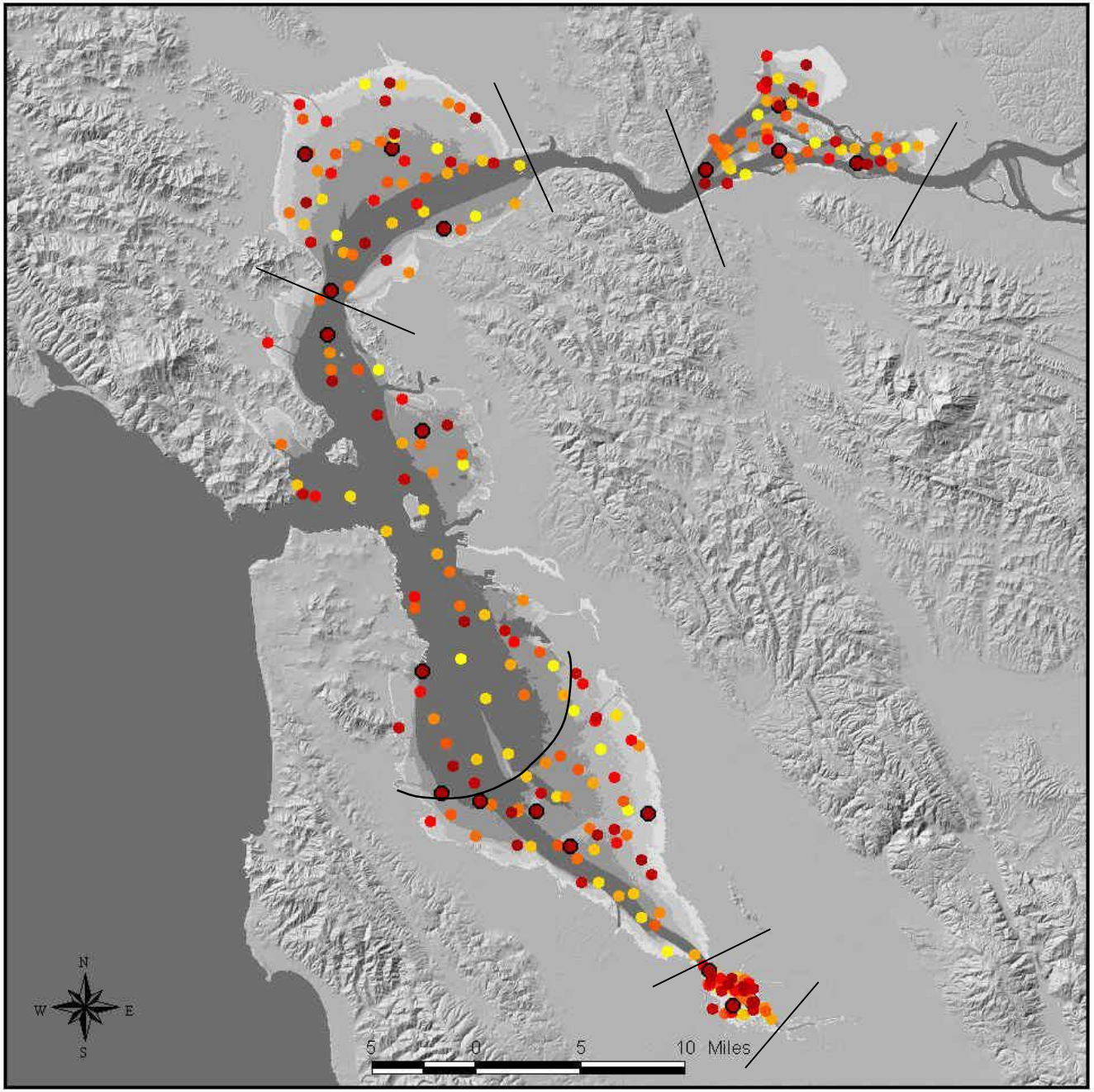
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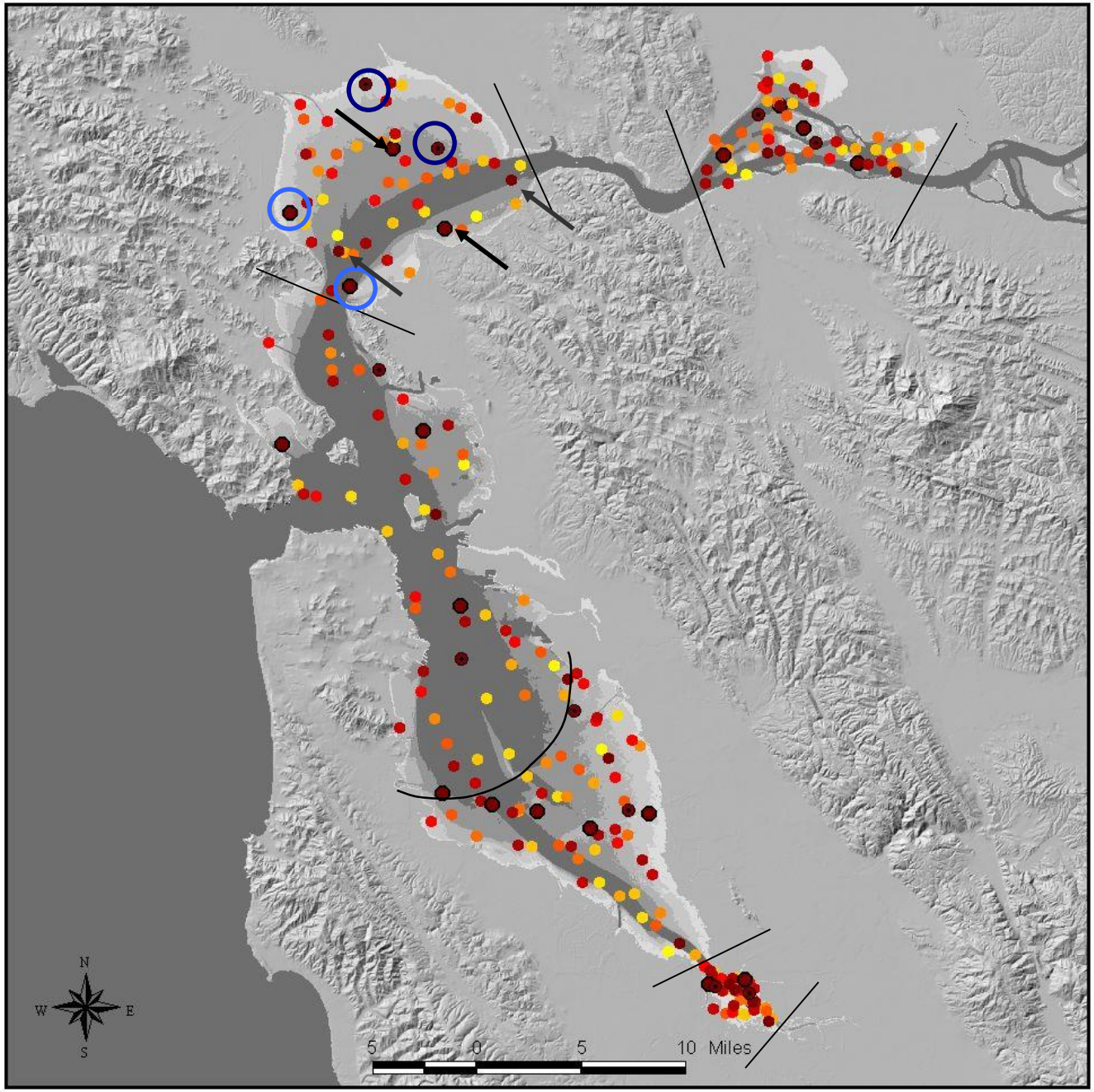

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