Mercury Studies in the Cache Creek Setting Basin, Yolo County

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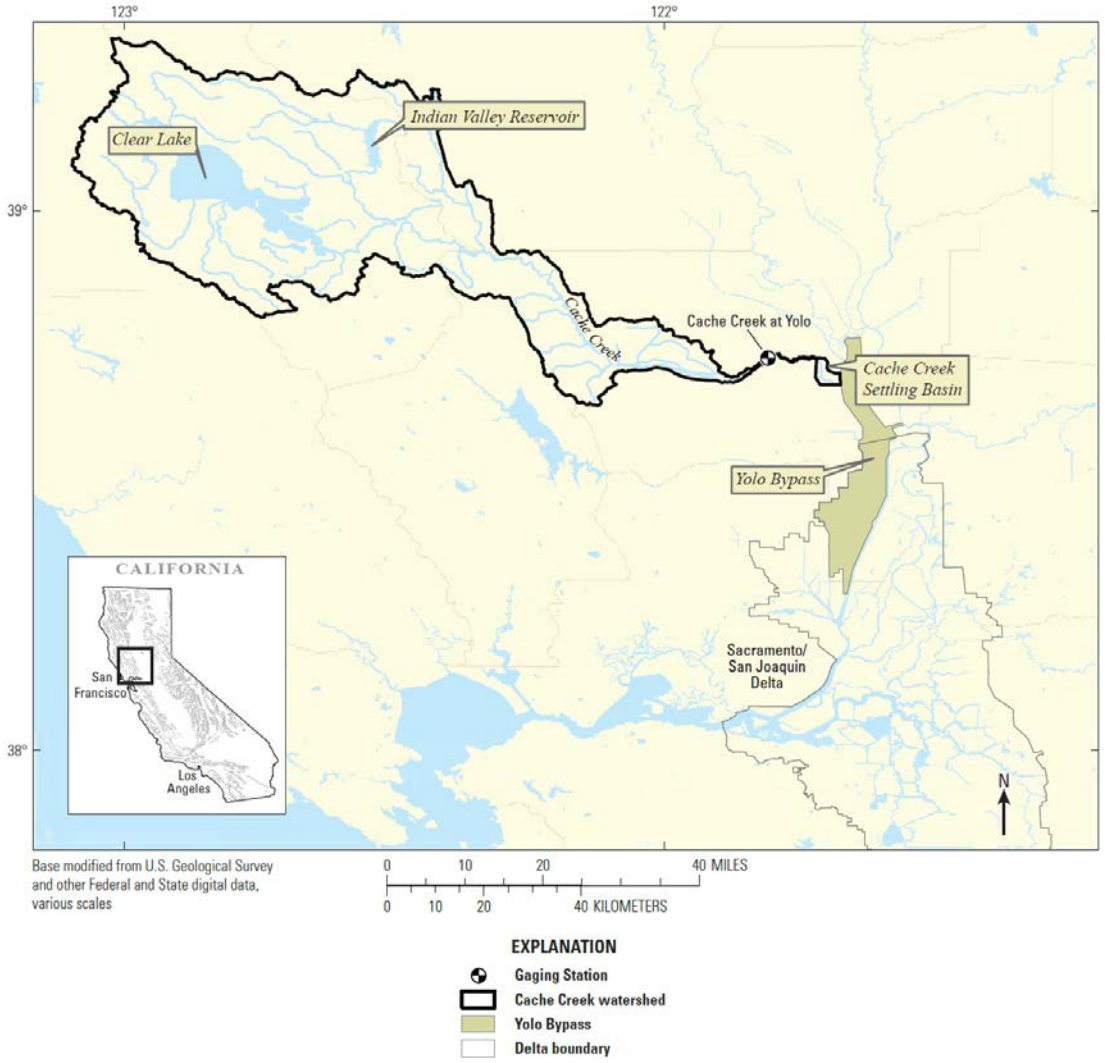
Outline of Presentation

- Background
- Project Goals and Objectives
  - Approach and Study Design
- Preliminary Results
  - Water
    - Hg and MeHg Loads
    - Sediment and Hg trap efficiency
  - Sediment
  - Biota
- Conclusions

Cache Creek Watershed



Mercury Sources:

- Historical Hg and Au mines
- Transport of mine wastes
- Erosion and transport of natural high-Hg soils
- Natural hot springs
- Natural cold springs

Arias et al. (in review)

Inflow

January 22, 2010

Discharge: ~3,000 ft^3/s
~85,000 L/s

Outflow - gate

Outflow - weir

Role of CCSB in Trapping Sediment & Hg

- CCSB constructed by USACE in 1937 to trap sediment
  - Basin expanded, levees & weir raised in 1993
- CCSB outflow is a major source of THg and MeHg to Yolo Bypass and Delta (RWQCB, Wood et al., 2010)
  - THg load ~118 kg/yr (1984–2003)
    - 11% to 30% of overall THg load to Delta
    - Only 1.1% to 1.6% of water volume
    - ~60% of THg load to Yolo Bypass
  - MeHg load ~0.14 kg/yr (2000–2003)
    - ~3% of overall MeHg load to Delta
- Cache Creek Hg TMDL (Cooke and Morris, 2005)
  - Unfiltered THg in Cache Creek above CTR criterion (50 ng/L)
  - Mercury Control Plan
    - Cleanup of Abbott/Turkey Run mines, 2006–07
- Delta MeHg TMDL (Wood et al., 2010)
  - Goal: increase THg trap efficiency of CCSB from ~50% to 75%

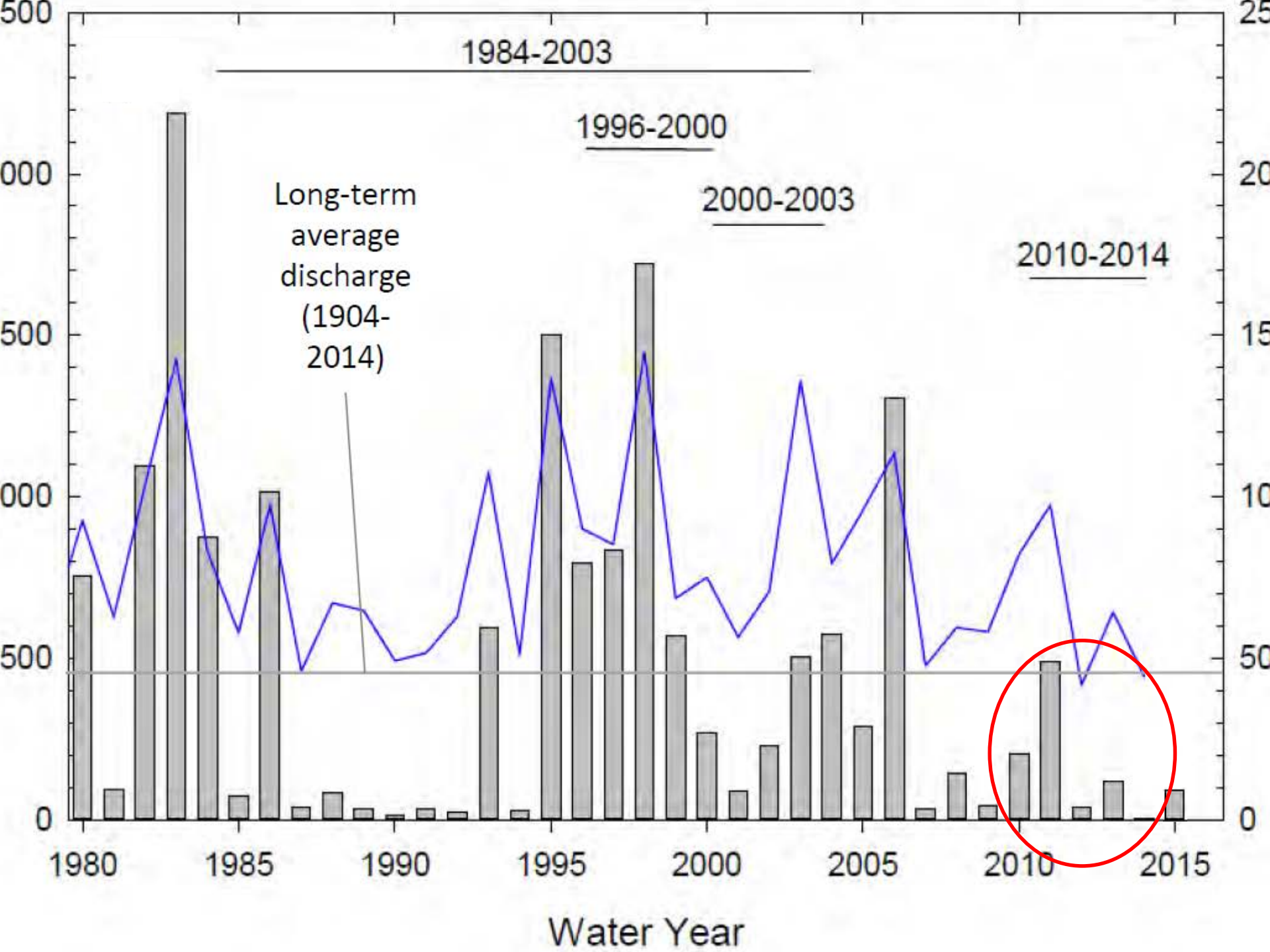
Goals

- Provide stakeholders (DWR +) with information on Hg and MeHg needed for management of the CCSB
  - Specific data requirements
    - TMDLs (Cache Creek and Delta) (RWQCB, 2005, 2010)
    - “MeHg Control Study” due to RWQCB in Fall 2017
  - Anticipated future data needs
    - Operation and Maintenance Manual (USACE, 2007)
    - Lower Cache Creek Feasibility Study (USACE, City of Woodland, on hiatus)
- Transfer value to other parts of Bay-Delta system
  - Dominant habitat types (ag, floodplain, stream channels, riparian)

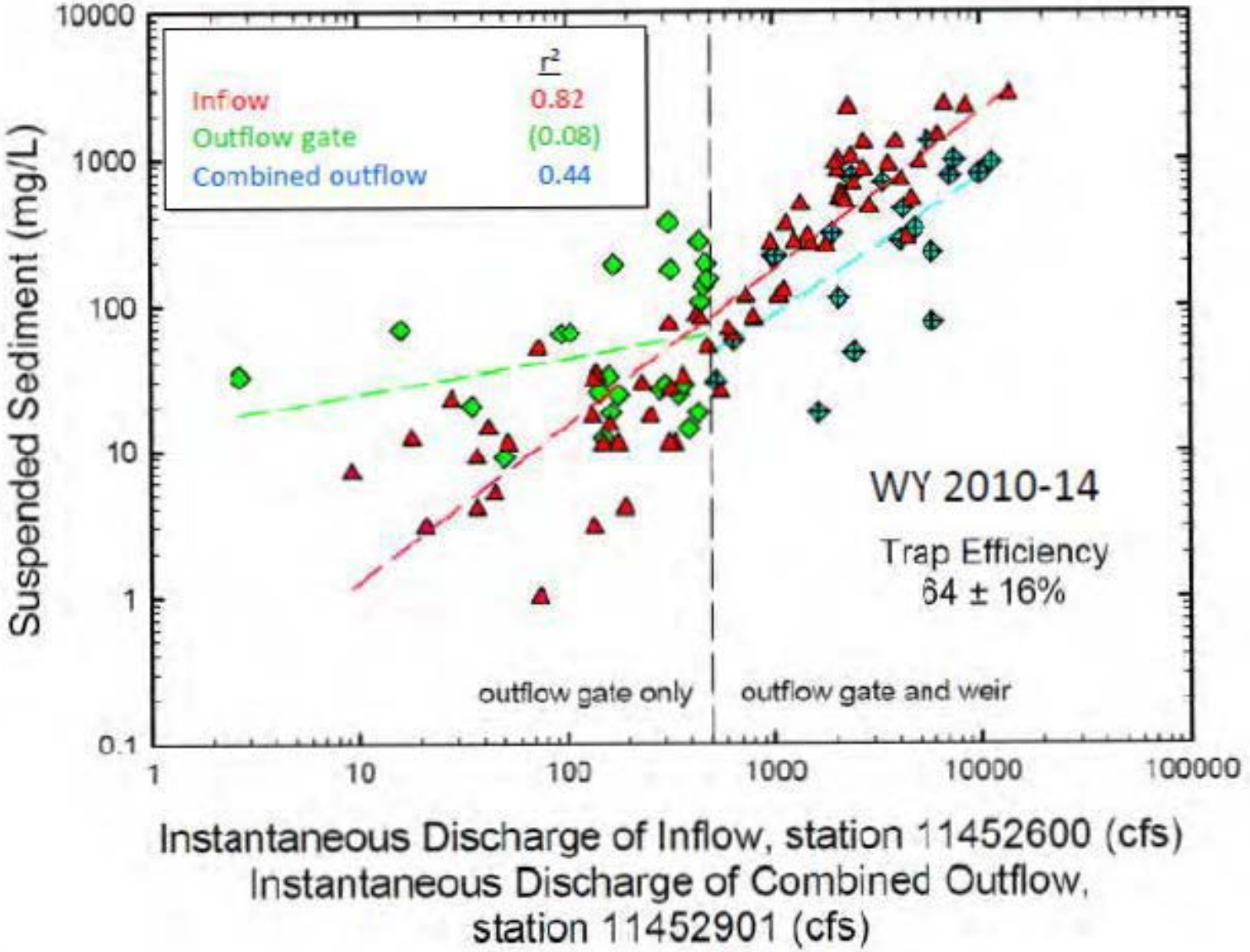
Overall Study Objectives

- In *vs.* out
  - Determine [THg] & [MeHg] in water at CCSB inlet/outlet
    - storm and non-storm flow conditions
  - Compute THg & MeHg loads (and SS loads) in & out of CCSB
    - Trap efficiency

- In-basin processes
  - Assess spatial/temporal variability of [THg] & [MeHg] in water, bed sediment & selected biota within the CCSB
  - Assess vertical variability in sediment [THg] in deep cores


1984-2003
1996-2000
2000-2003
2010-2014
Long-term average discharge (1904-2014)
500
000
500
000
500
0
25
20
15
10
50
0
1980
1985
1990
1995
2000
2005
2010
2015
Water Year

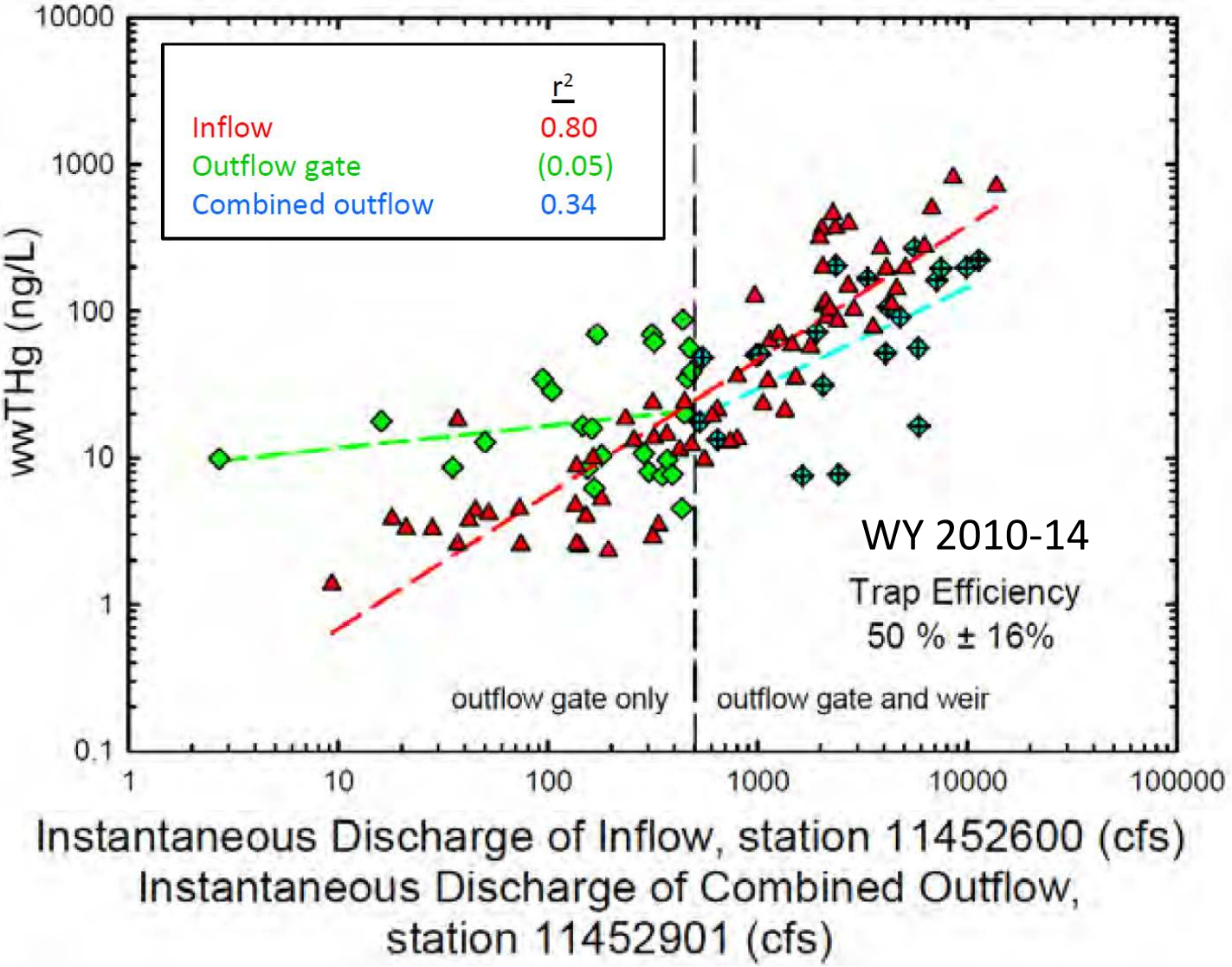
Suspended Sediment – CCSB Inflow and Outflows



TE = (In-Out)/In
= (100-36)/100 = 64%

5-yr avg. annual SS loads: In: 162 x 10^6 kg
Out: 58 x 10^6 kg

Whole Water Total Mercury – CCSB Inflow and Outflows



TE = (In-Out)/In
= (100-50)/100 = 50%

5-yr avg. annual wwTHg loads: In: 30 kg
Out: 15 kg

LOADEST - models for load calculations

1	$a_0 + a_1 \ln Q$
2	$a_0 + a_1 \ln Q + a_2 \ln Q^2$
3	$a_0 + a_1 \ln Q + a_2 dtime$
4	$a_0 + a_1 \ln Q + a_2 \sin(2\pi dtime) + a_3 \cos(2\pi dtime)$
5	$a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 dtime$
6	$a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi dtime) + a_4 \cos(2\pi dtime)$
7	$a_0 + a_1 \ln Q + a_2 \sin(2\pi dtime) + a_3 \cos(2\pi dtime) + a_4 dtime$
8	$a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi dtime) + a_4 \cos(2\pi dtime) + a_5 dtime$
9	$a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi dtime) + a_4 \cos(2\pi dtime) + a_5 dtime + a_6 dtime^2$

- Variables: $a_0, a_1, a_2 \ldots a_6$, constants; Q, flow; *dtime*, decimal time
- All 9 linear models computed for each constituent at each gaging station
- Model chosen with best statistics
  - lowest bias, highest Nash- Sutcliffe Efficiency (NSE)
- Program computes standard error (1 sigma = 68 % confidence)

Runkel et al. (2004) USGS Techniques and Methods, Book 4, Chapter A5

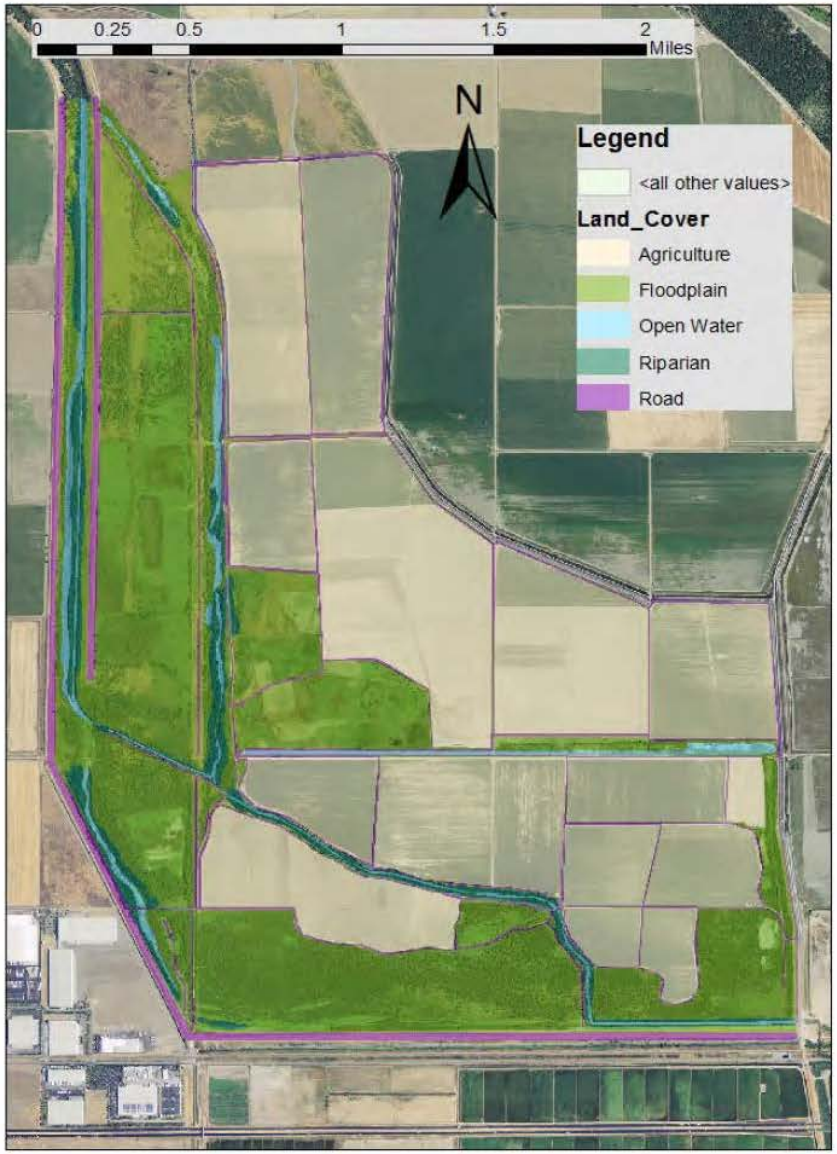
Hg and MeHg trap efficiency in CCSB

WY's 2010-14

	THg	MeHg
Particulate	56 ± 19 %	51 ± 16 %
Filtered	10 ± 23 %	–34 ± 16 %
Whole water	50 ± 19 %	37 ± 15 %

- Trap efficiency of suspended sediment: 64 ± 16% to 75 ± 16%
- No apparent change in filtered-THg loads (water loss ~10%)
- Apparent production of MeHg within basin
  - Net export of f-MeHg (most bioavailable form)
  - Increase in %f-MeHg of loads from 2% to 3% from In to Out

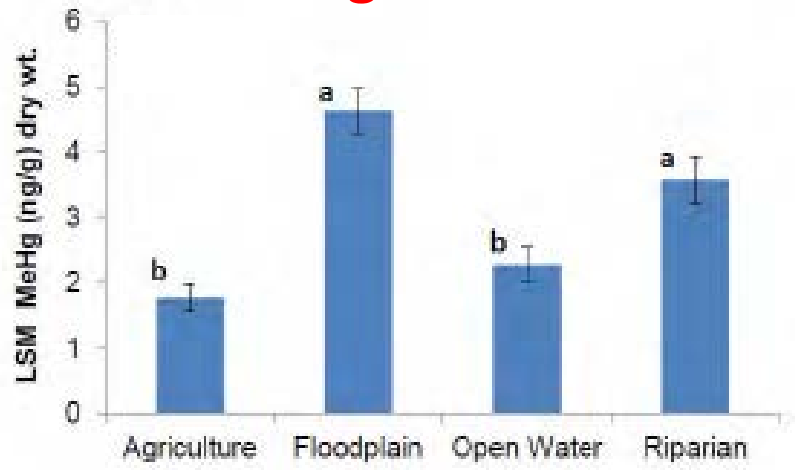
Cache Creek Settling Basin_ Level 1 Habitat Map



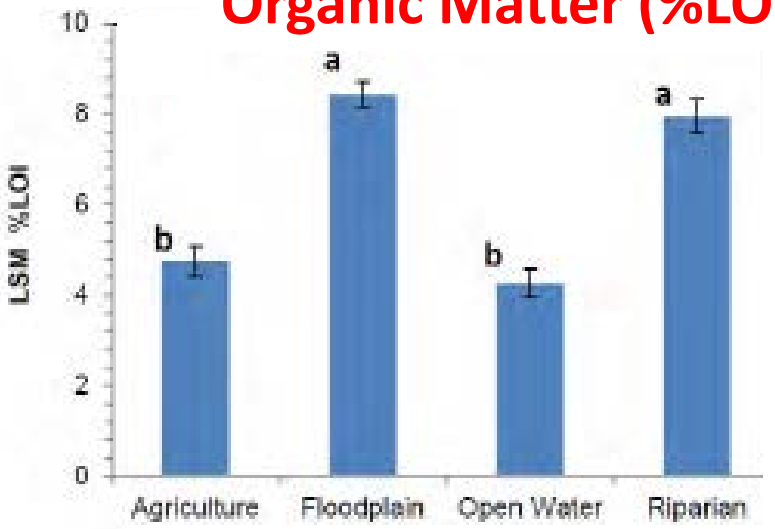
Alpers et al. (in review) USGS SIR

Cache Creek Settling Basin – Shallow Sediment (0-2 cm), 2010-2013

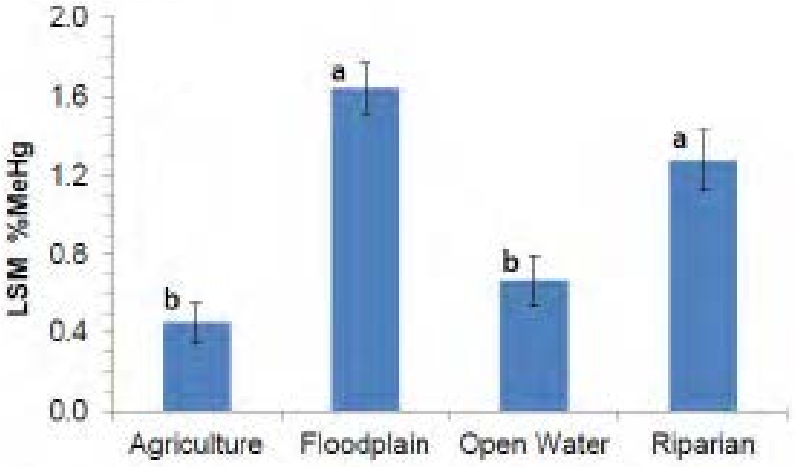
MeHg concentration



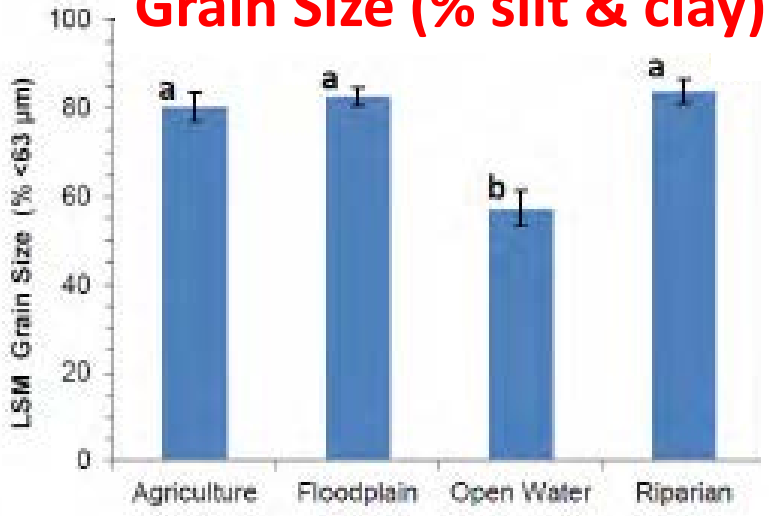
Organic Matter (%LOI)



% MeHg (MeHg/THg)



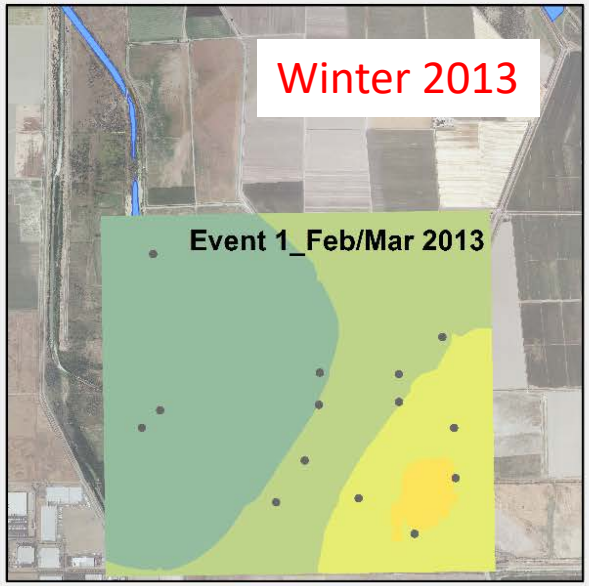
Grain Size (% silt & clay)

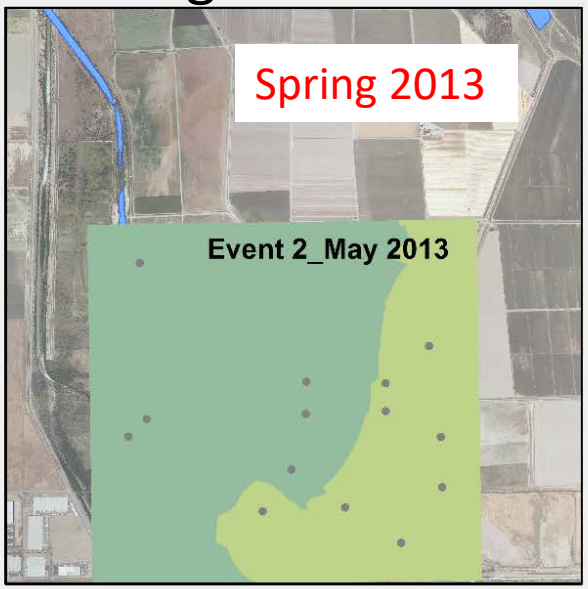


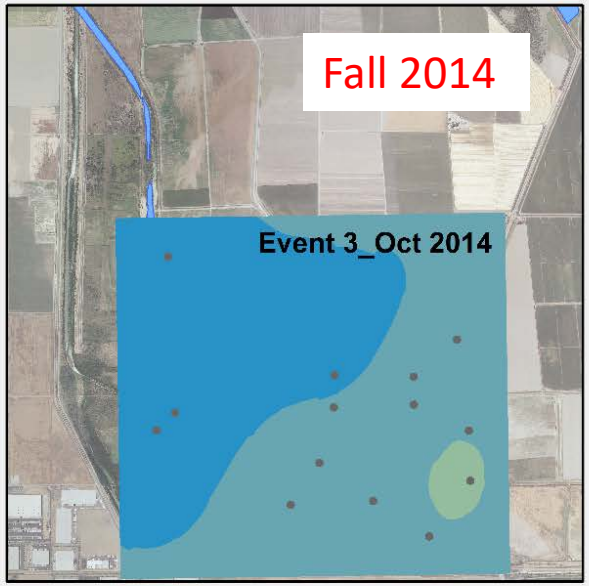
N = 251

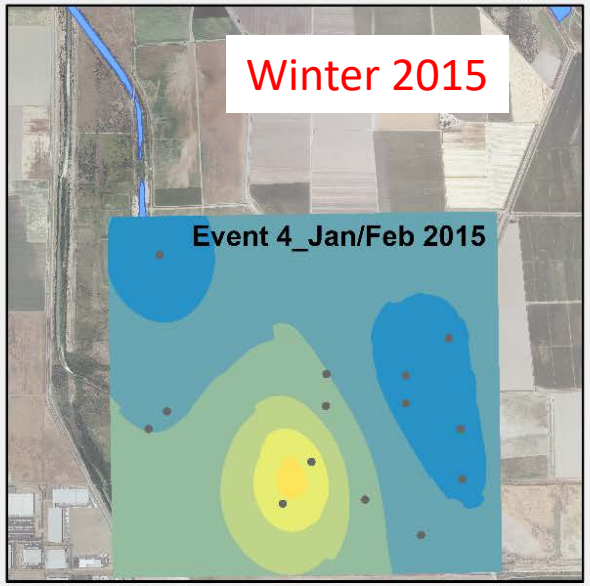
Alpers et al. (in review)

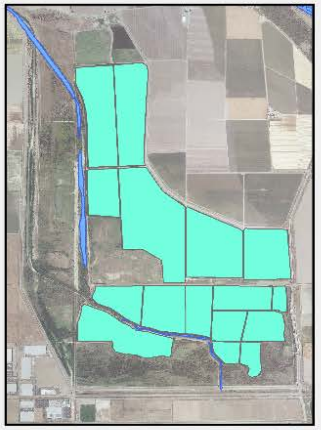
%MeHg (MeHg/THg) — Agricultural Land Use











Agricultural Land Use

Explanation

Kriged Contour Intervals

MeHg %

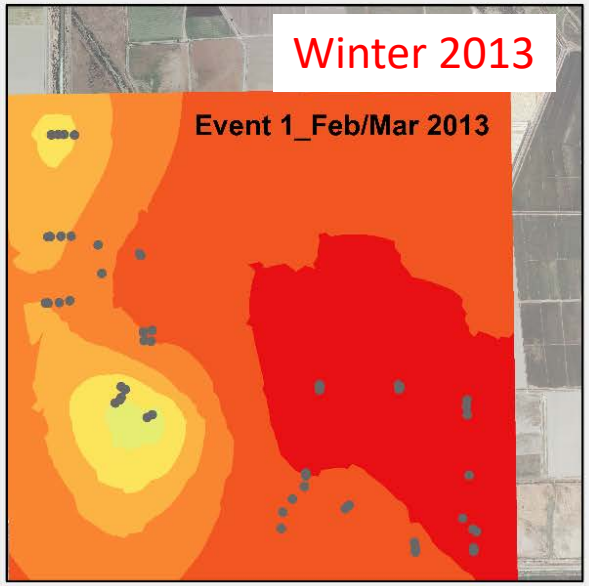
- 0 – 0.19
- 0.19 – 0.27
- 0.27 – 0.41
- 0.41 – 0.55
- 0.55 – 0.66
- 0.66 – 0.86
- 0.86 – 1.09
- 1.09 – 1.52
- 1.52 – 2.2
- 2.2 – 6.45

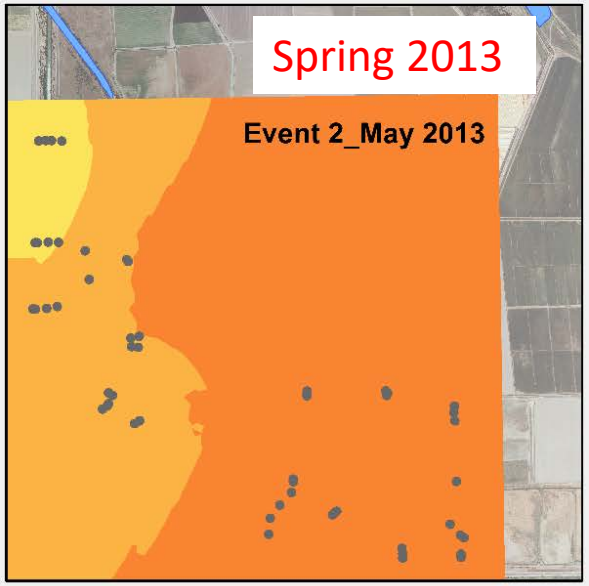
N = 14

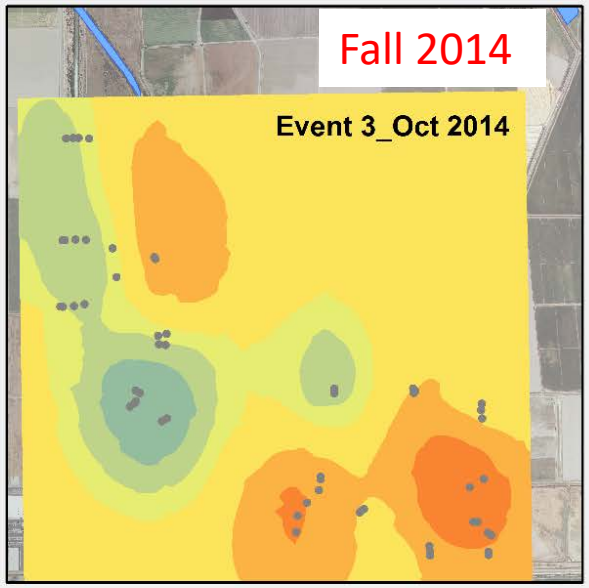
0 0.475 0.95 1.9 Miles

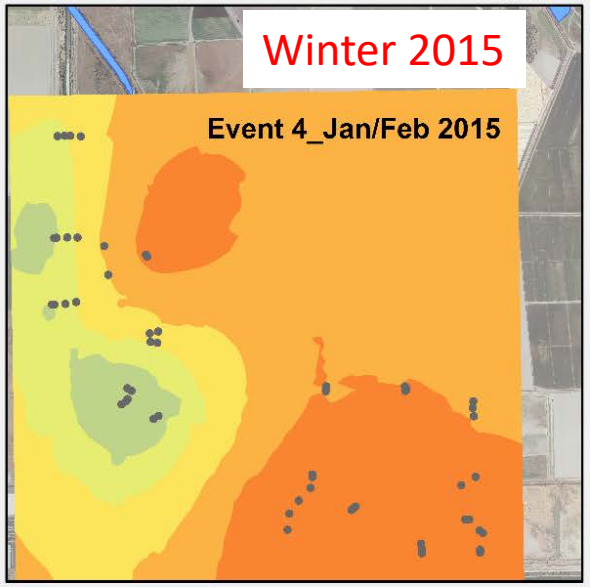
0 0.5 1 2 Kilometers

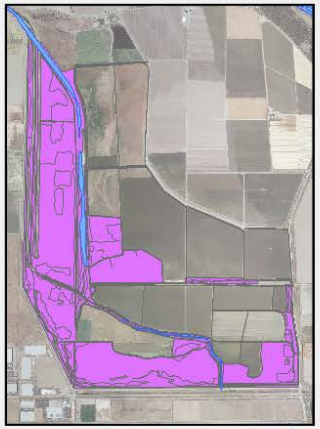
%MeHg (MeHg/THg) — Floodplain & Riparian Land Use











Floodplain and Riparian Land Use

Explanation

Kriged Contour Intervals

MeHg %

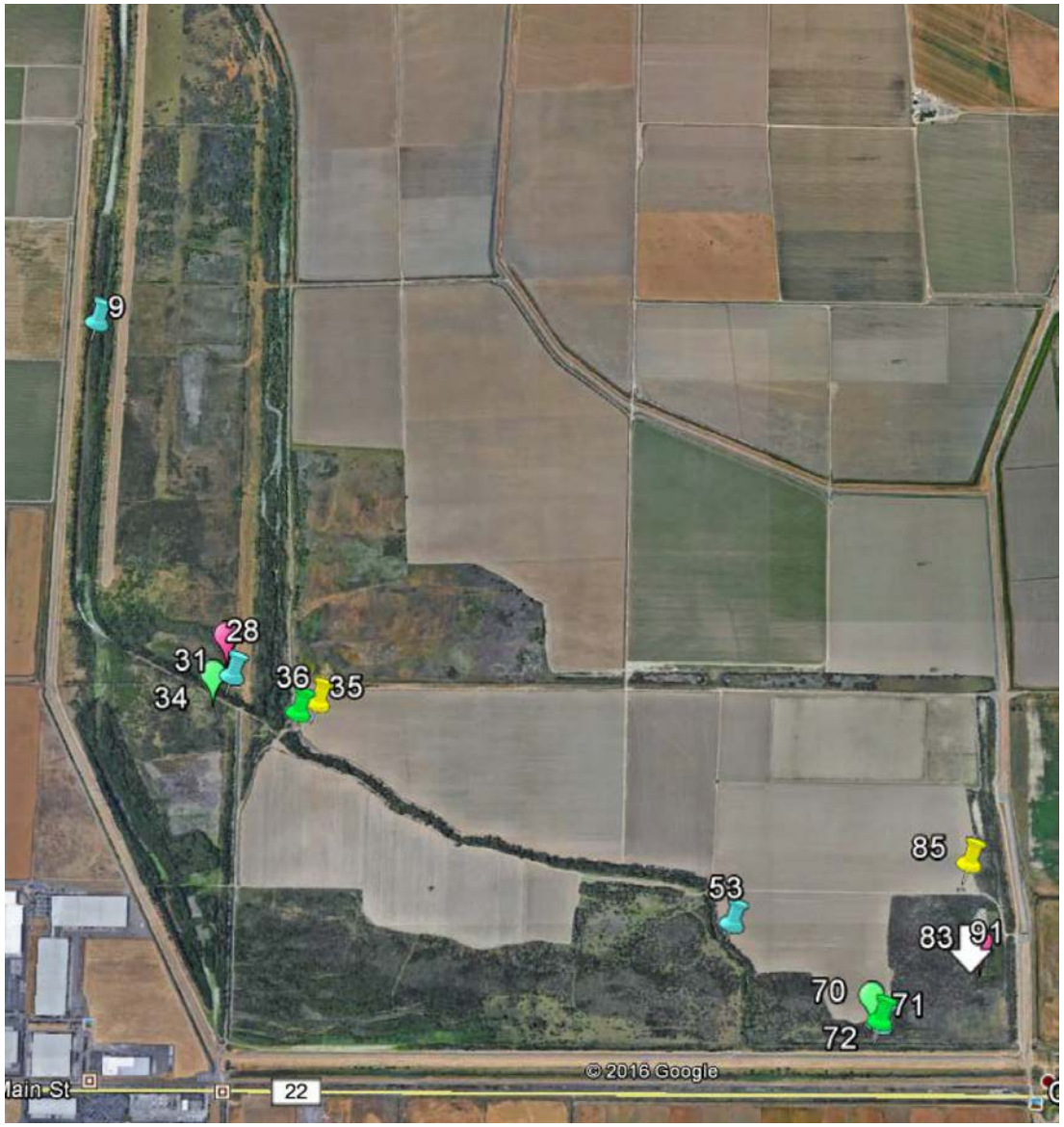
- 0 – 0.19
- 0.19 – 0.27
- 0.27 – 0.41
- 0.41 – 0.55
- 0.55 – 0.66
- 0.66 – 0.86
- 0.86 – 1.09
- 1.09 – 1.52
- 1.52 – 2.2
- 2.2 – 6.45

N = 64

0 0.475 0.95 1.9 Miles

0 0.5 1 2 Kilometers

CCSB - Shallow Sediment Time Series
2010 - 2016



	Level 1 (land use)	Level 2 (sub-habitat)
2	Agriculture	corn
4	Open-Water	creek
2	Riparian	mixed woody
2	Floodplain	mixed woody
2	Floodplain	mixed non-woody
1	Floodplain	changed from mixed woody to mixed non-woody in summer 2014

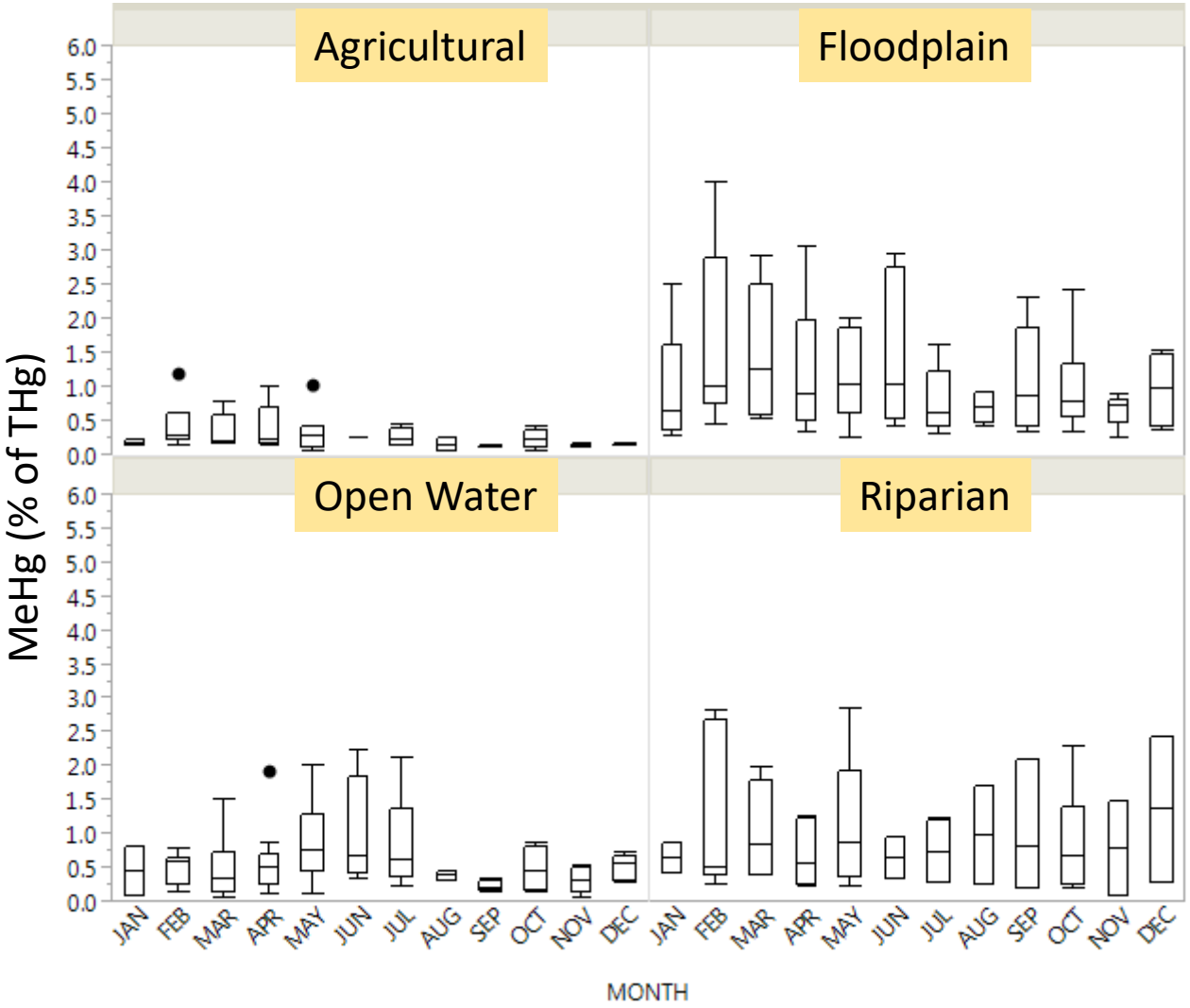
13 sites

20-27 sampling events during 2010-16
- Seasonal (n = 10), 2010-14
- Monthly (n = 17), 2015-16

288 samples (including replicates)

Percent Methylmercury By MONTH & HABITAT (2010-2016 Data)

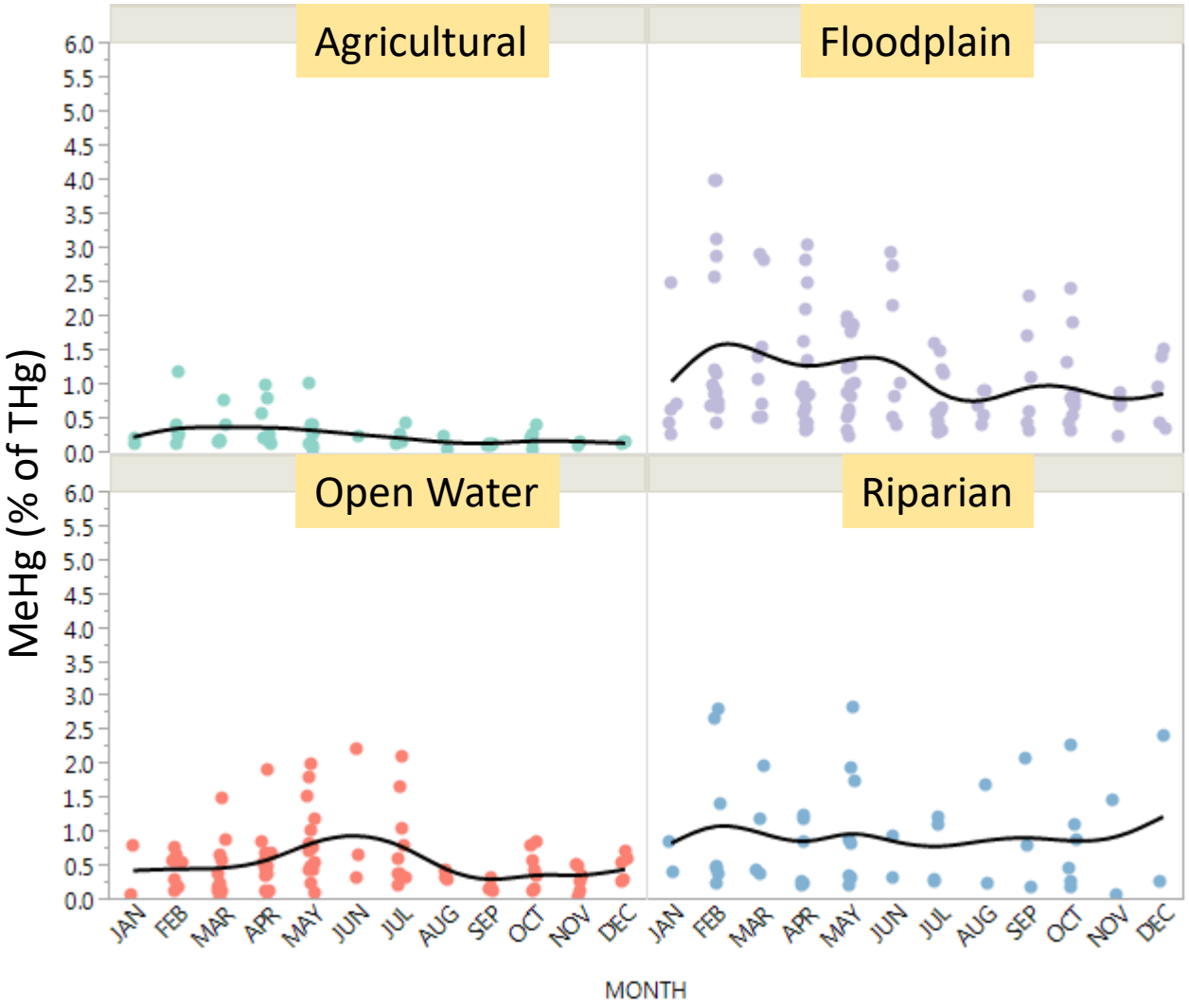
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Percent Methylmercury By MONTH & HABITAT (2010-2016 Data)

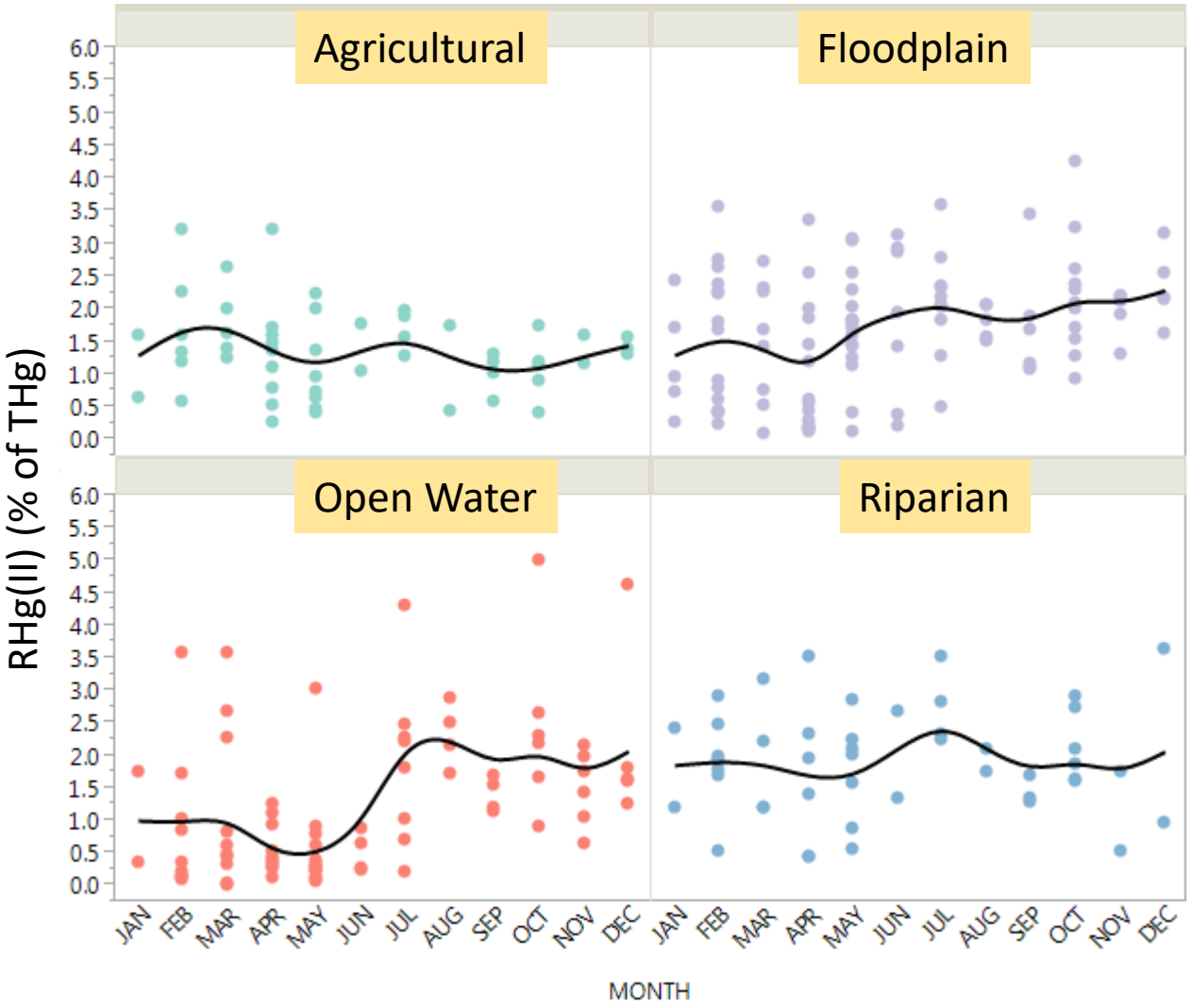
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Percent Reactive Mercury By MONTH & HABITAT (2010-2016 Data)

Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23

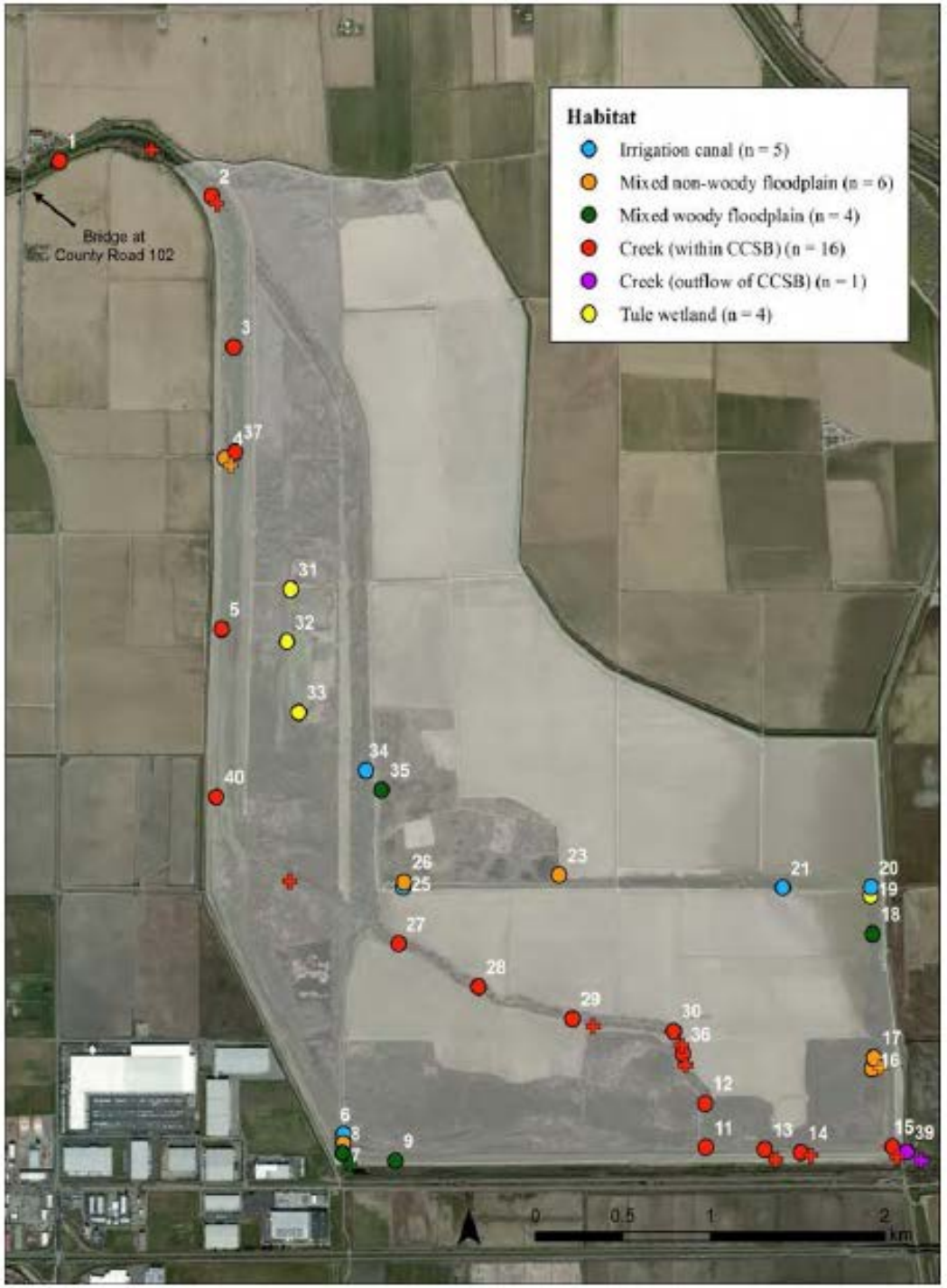


All data with Smoothing Line

Alpers et al. (in review

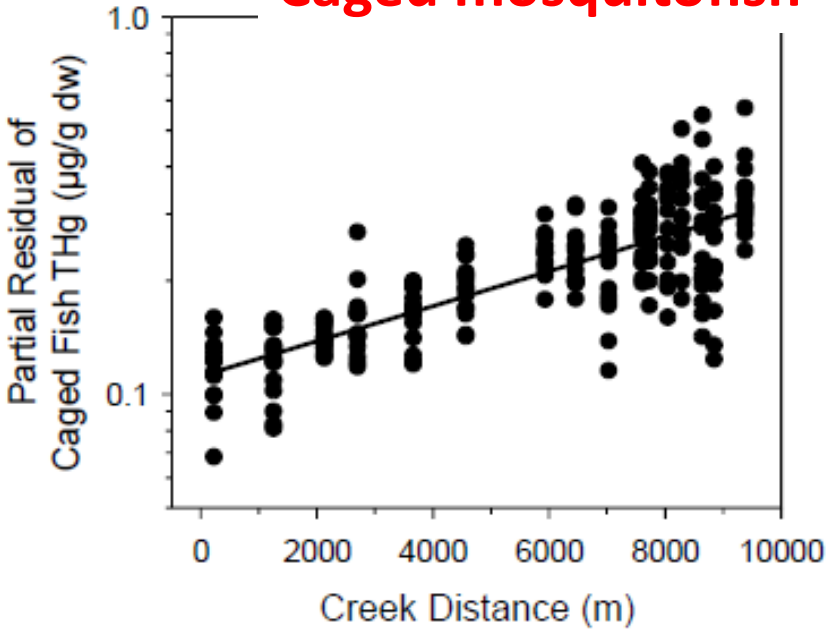
Caged and wild mosquitofish

March-April 2013

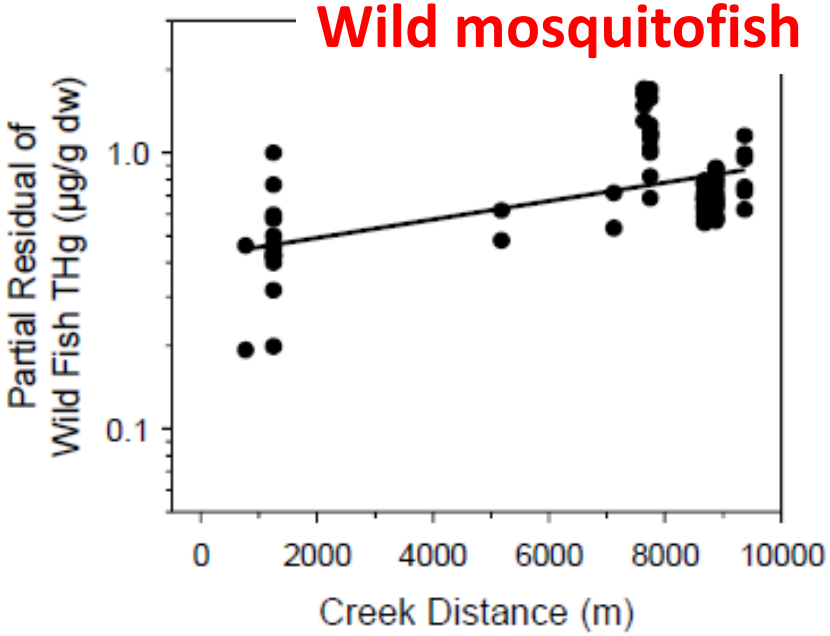


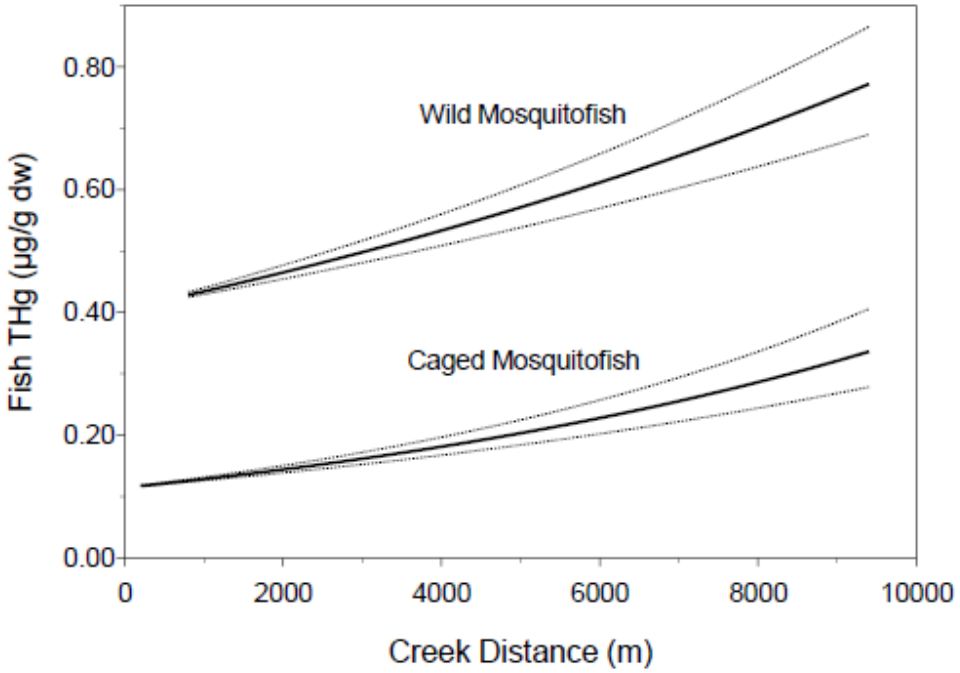
Alpers et al. (in review)

Caged mosquitofish



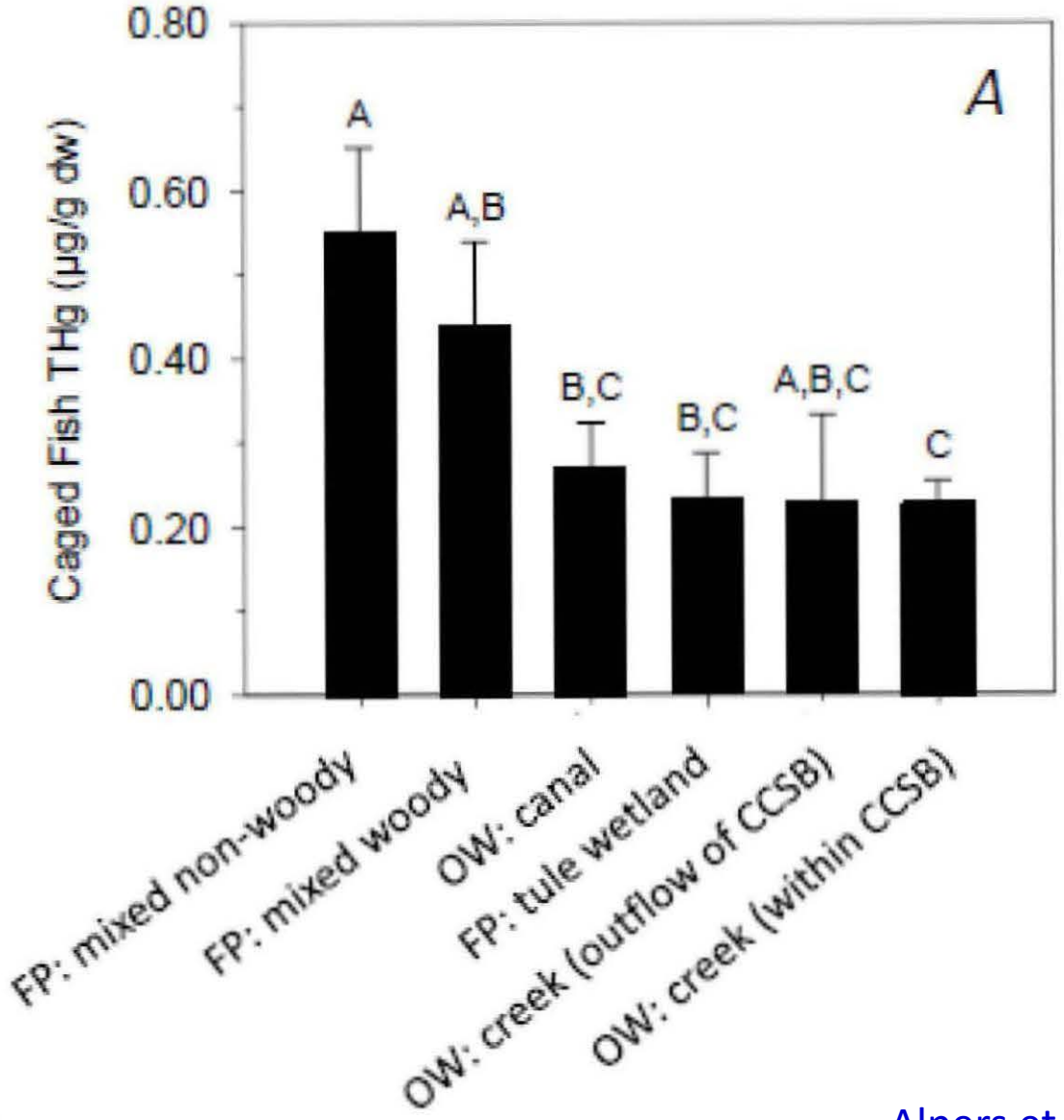
Wild mosquitofish





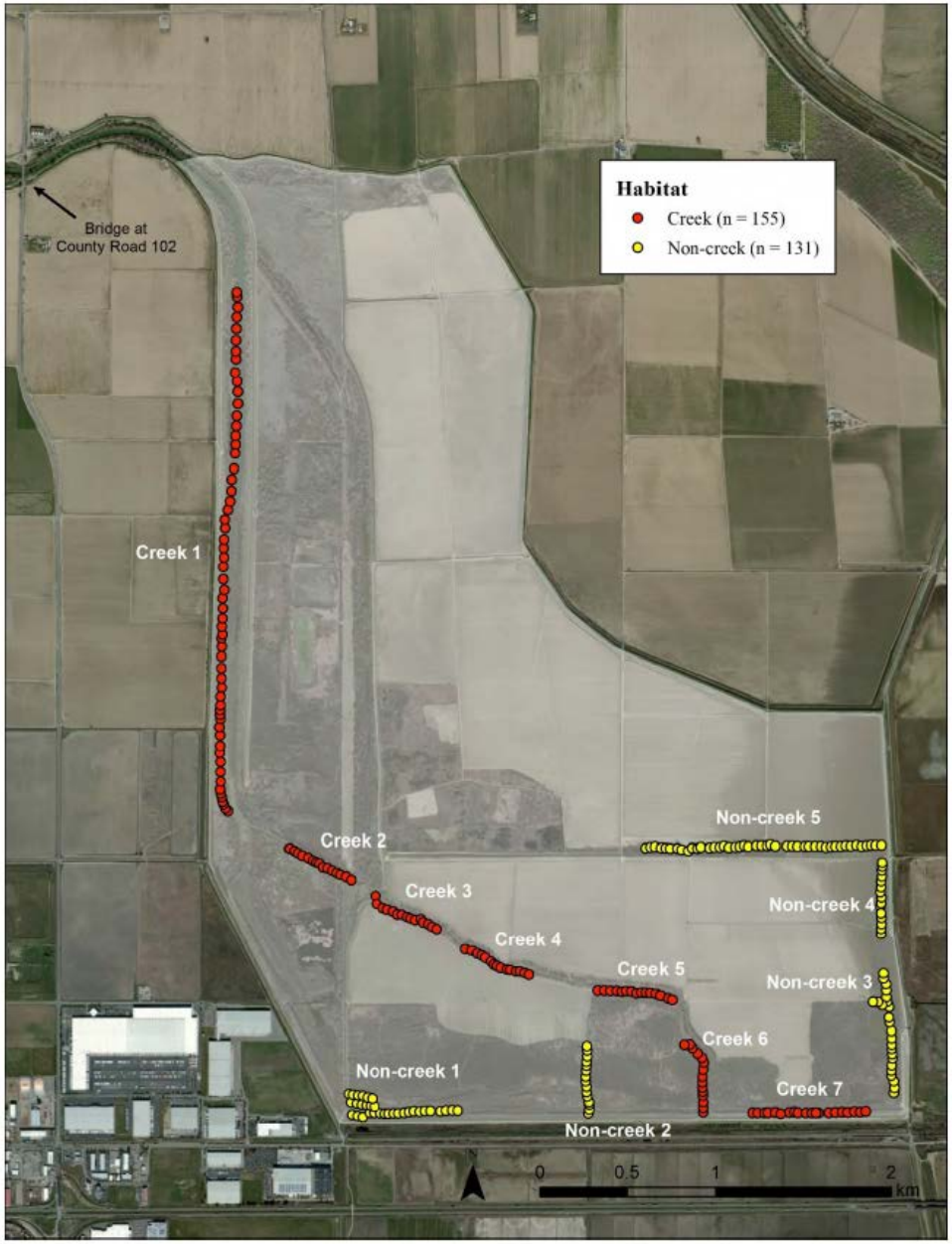
Alpers et al. (in review)

Caged mosquitofish – Response depended on habitat



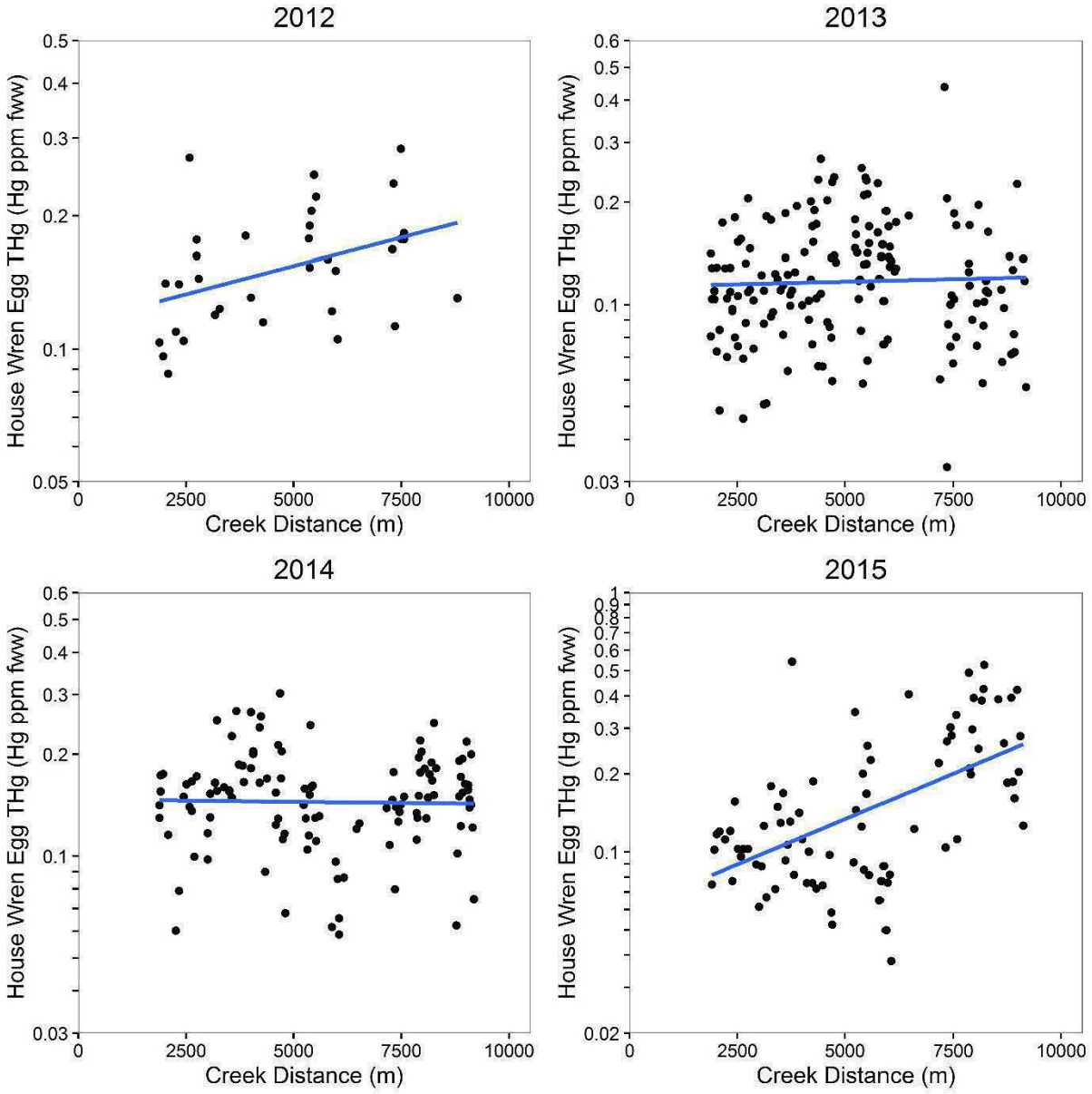
Alpers et al. (in review)

Bird egg sampling – nest boxes, 2012-15



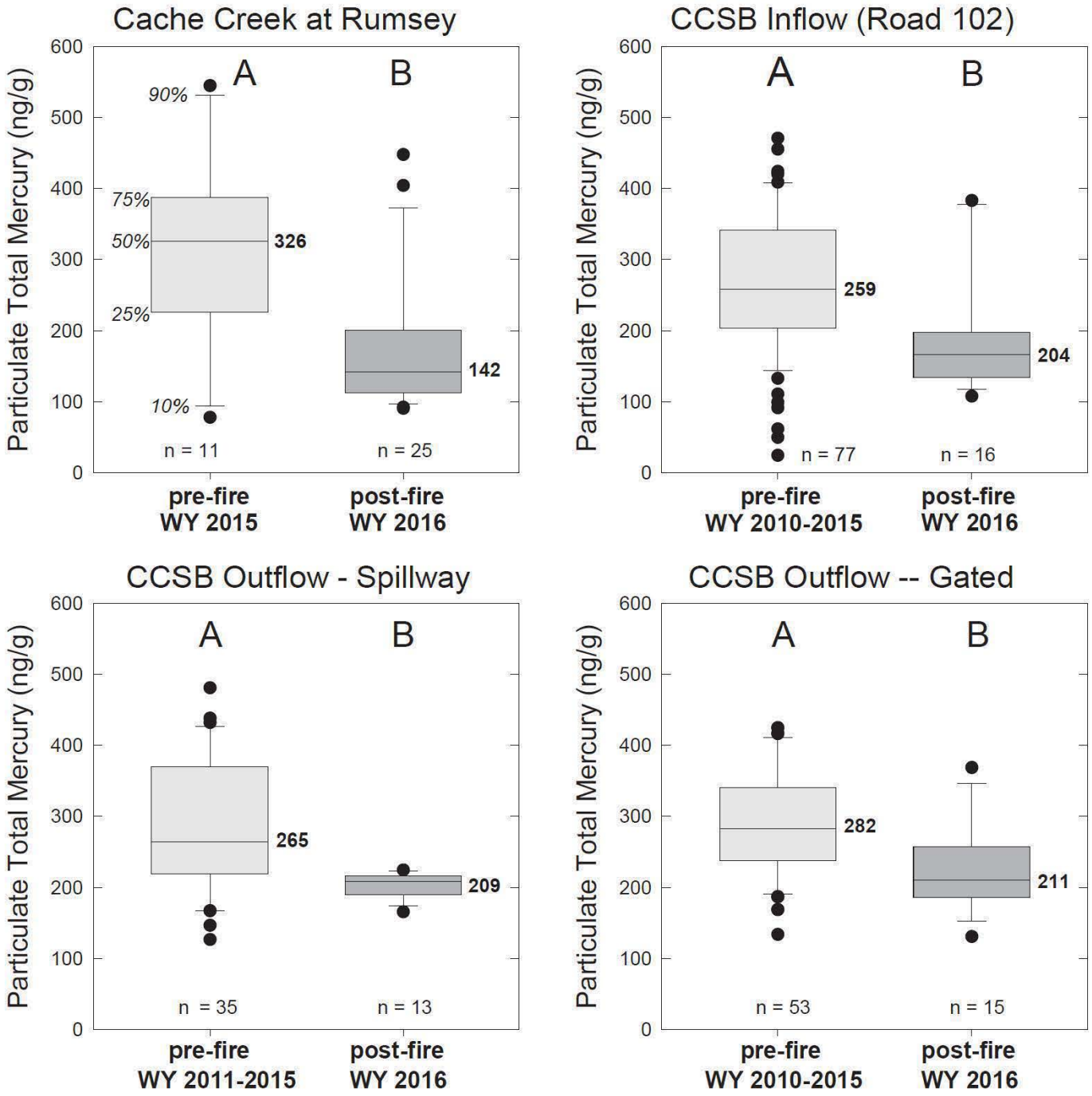
Alpers et al. (in review)

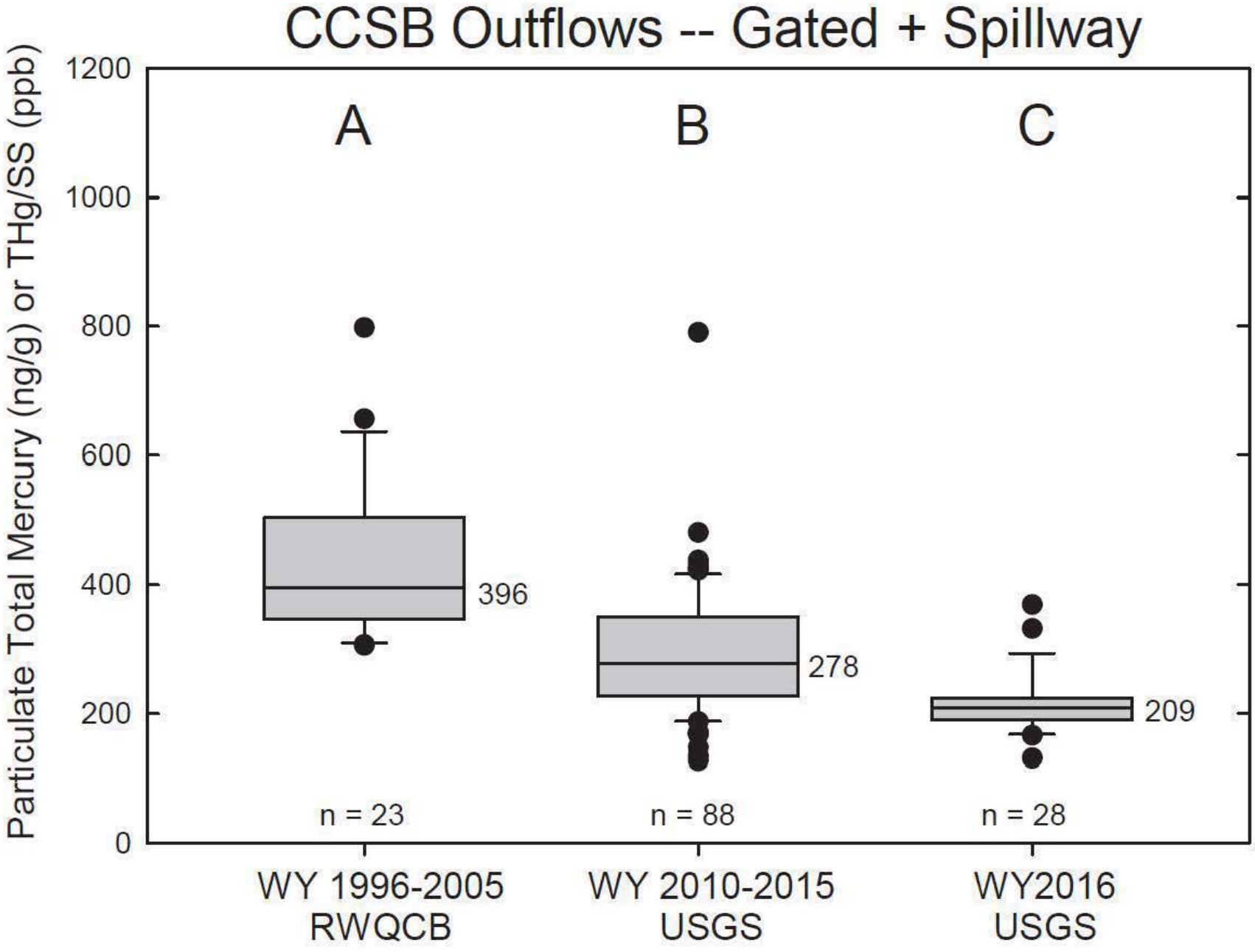
Hg in Bird Eggs – increased with distance downstream in some years

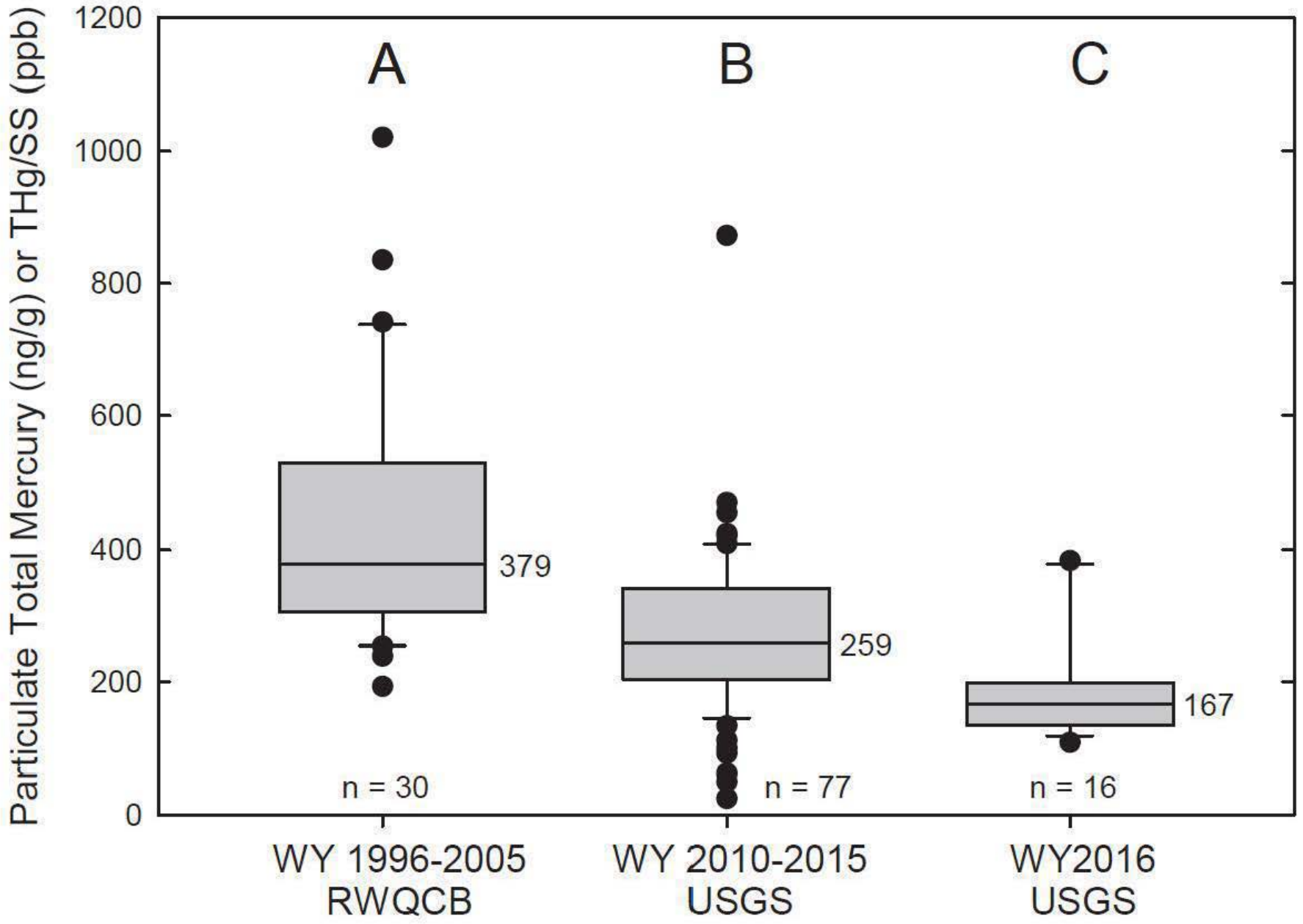


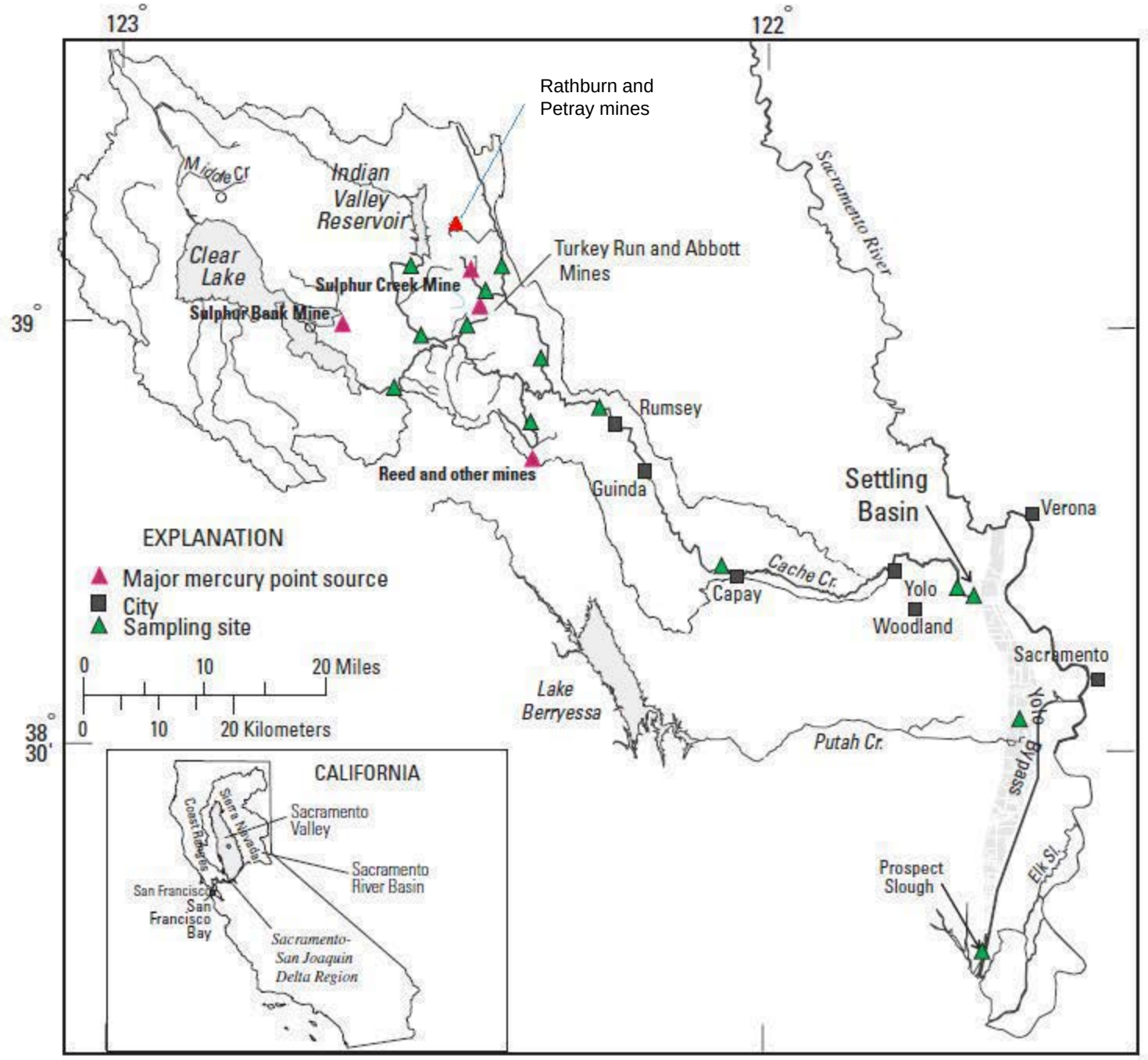
Conclusions

- CCSB trap efficiency varied by parameter (WY2010-14)
  - ~65% for particulates: SS, P-THg, P-MeHg, P-RHg(II)
  - ~50% for whole water THg (P-THg + F-THg)
- Filter-passing MeHg increased within CCSB
- Spatial and temporal variations in sediment MeHg strongly influenced by habitat and land use
  - Lower in Agricultural (row crops) and Stream channel
  - Higher in Floodplain and Riparian areas
  - %MeHg (MeHg/THg) increased along flow path
- Hg in fish and birds also increased along flow path
- Transfer value to other parts of Bay-Delta
  - CCSB habitats are representative of other areas


Cache Creek at Rumsey
Particulate Total Mercury (ng/g)
600
500
400
300
200
100
0
A
B
90%
75%
50%
25%
10%
326
142
n = 11
n = 25
pre-fire
WY 2015
post-fire
WY 2016
CCSB Inflow (Road 102)
Particulate Total Mercury (ng/g)
A
B
259
204
n = 77
n = 16
pre-fire
WY 2010-2015
post-fire
WY 2016
CCSB Outflow - Spillway
Particulate Total Mercury (ng/g)
A
B
265
209
n = 35
n = 13
pre-fire
WY 2011-2015
post-fire
WY 2016
CCSB Outflow -- Gated
Particulate Total Mercury (ng/g)
A
B
282
211
n = 53
n = 15
pre-fire
WY 2010-2015
post-fire
WY 2016


CCSB Outflows -- Gated + Spillway
Particulate Total Mercury (ng/g) or THg/SS (ppb)
1200
1000
800
600
400
200
0
A
B
C
396
278
209
n = 23
n = 88
n = 28
WY 1996-2005
RWQCB
WY 2010-2015
USGS
WY2016
USGS

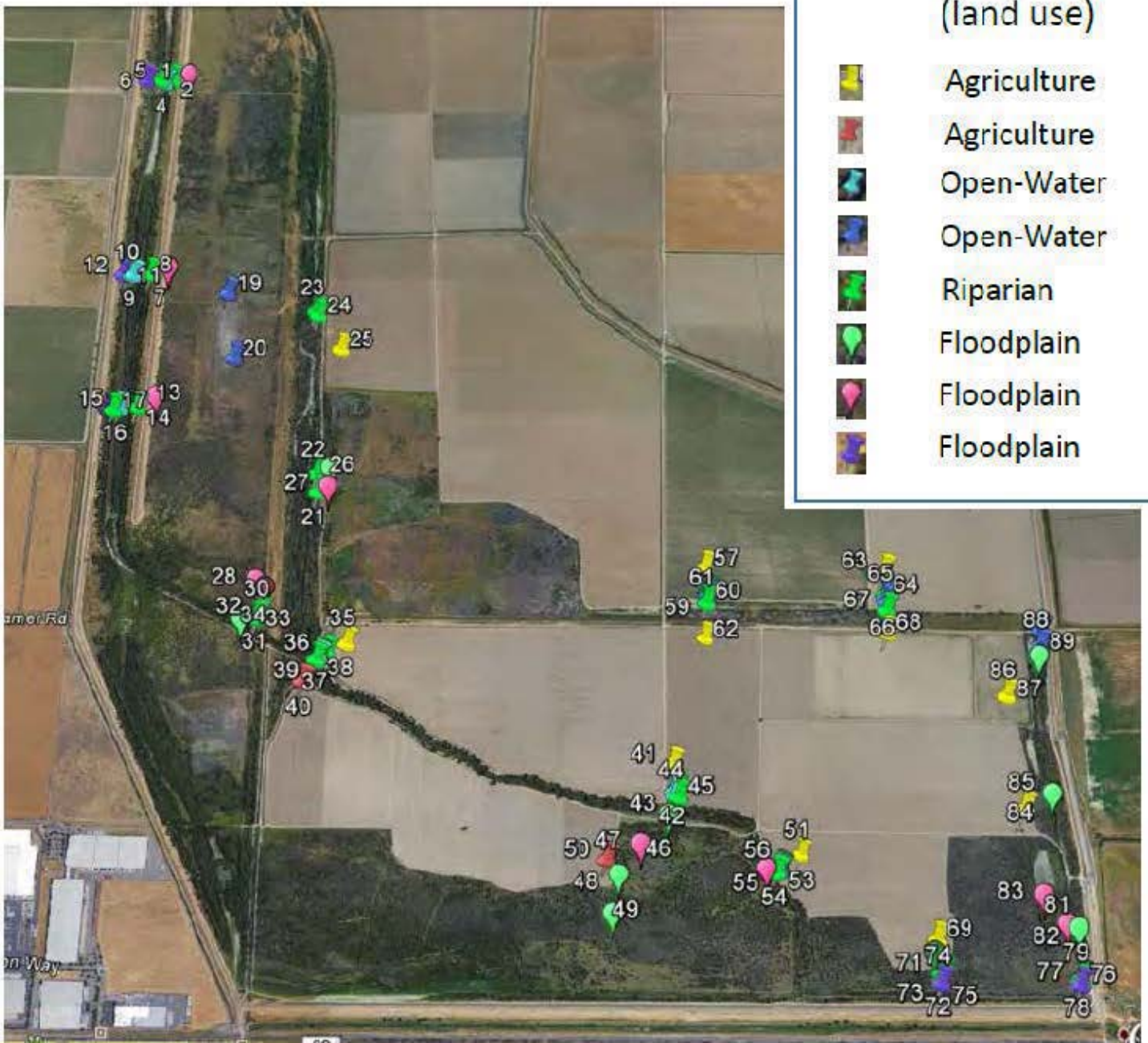

CCSB Inflow -- Road 102
Particulate Total Mercury (ng/g) or THg/SS (ppb)
1200
1000
800
600
400
200
0
A
B
C
379
259
167
n = 30
n = 77
n = 16
WY 1996-2005
RWQCB
WY 2010-2015
USGS
WY2016
USGS



Cache Creek watershed – adapted from: Domagalski et al. (2004)

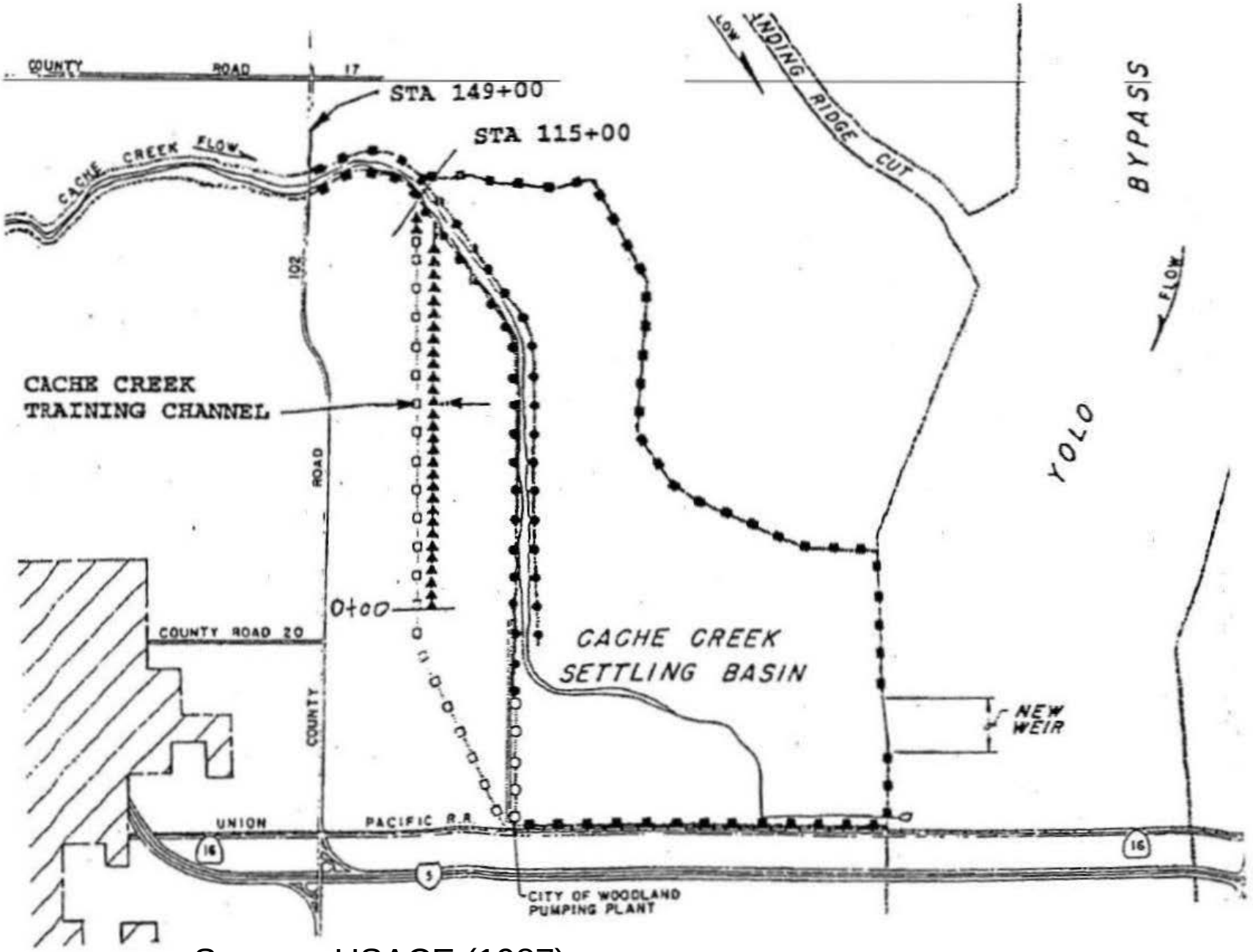

Inflow – Road 102
11452600
Co Rd 102
Training levee
Weir – north abutment
384115121402501
Co Hwy E8
E Kentucky Ave
Co Rd 20
Weir – south abutment
11452800
E Beamer St
Co Rd 2
5
113
© 2013 Google
Outflow gate
11452900
Pioneer Ave
E Main St
County Road 22
Imagery Date: 9/1/2012 lat 38.702586° lon -121.702197° elev 32 ft eye alt 28200 ft

Shallow sediment sites, 2013-15 (4 events)



Level 1 (land use)	Level 2 (sub-habitat)
Agriculture	corn
Agriculture	tomato
Open-Water	creek
Open-Water	tule wetland
Riparian	mixed woody
Floodplain	mixed woody
Floodplain	mixed non-woody
Floodplain	mowed

Alpers et al.
(in review)
USGS SIR



Source: USACE (1987)

History of CCSB – Sediment Trapping

- Originally built in 1937 by USACE
  - Intended to keep Cache Creek sediment from accumulating in Yolo Bypass, a flood conveyance
    - Also, to lower dredging costs in Sacramento River and SF Bay
  - Cobble weir built in 1944, raised 2 ft in 1973
  - Levees extended upstream to Yolo in 1961, design flow 30,000 cfs
- Major modifications by USACE in 1993
  - Levees raised, concrete weir installed at 32.5 ft elevation ASL
  - Western boundary and training levee moved ½ mile to west
    - Current area = 3,600 acres
  - Sediment transport modeled by USACE
    - Design sediment trap efficiency 30% – 70%
    - Sediment trap efficiency < 30% expected after ~25 years (now)
- Ongoing maintenance by California DWR

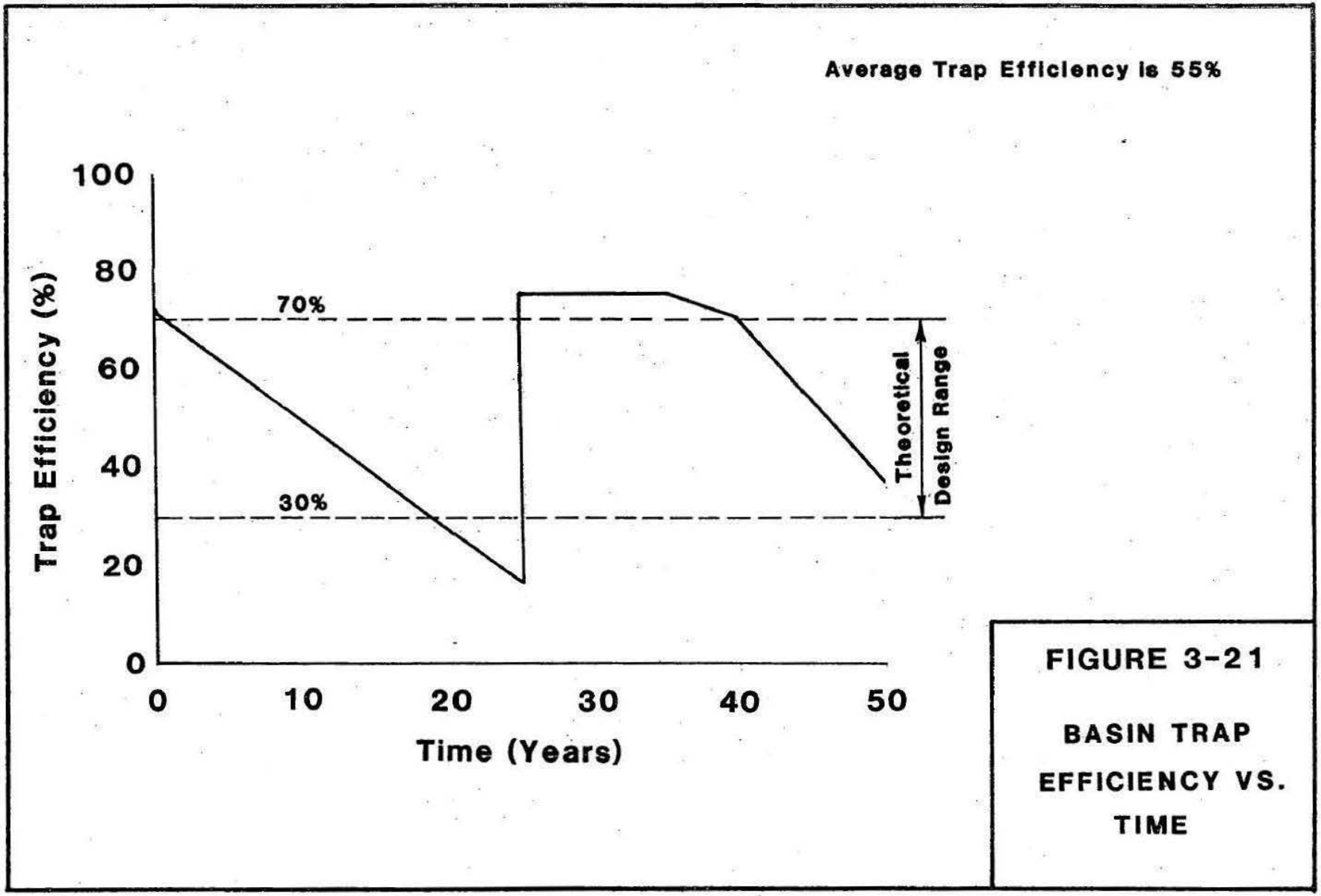


FIGURE 3-21

BASIN TRAP EFFICIENCY VS. TIME

USACE (1987)

Inflow

January 22, 2010

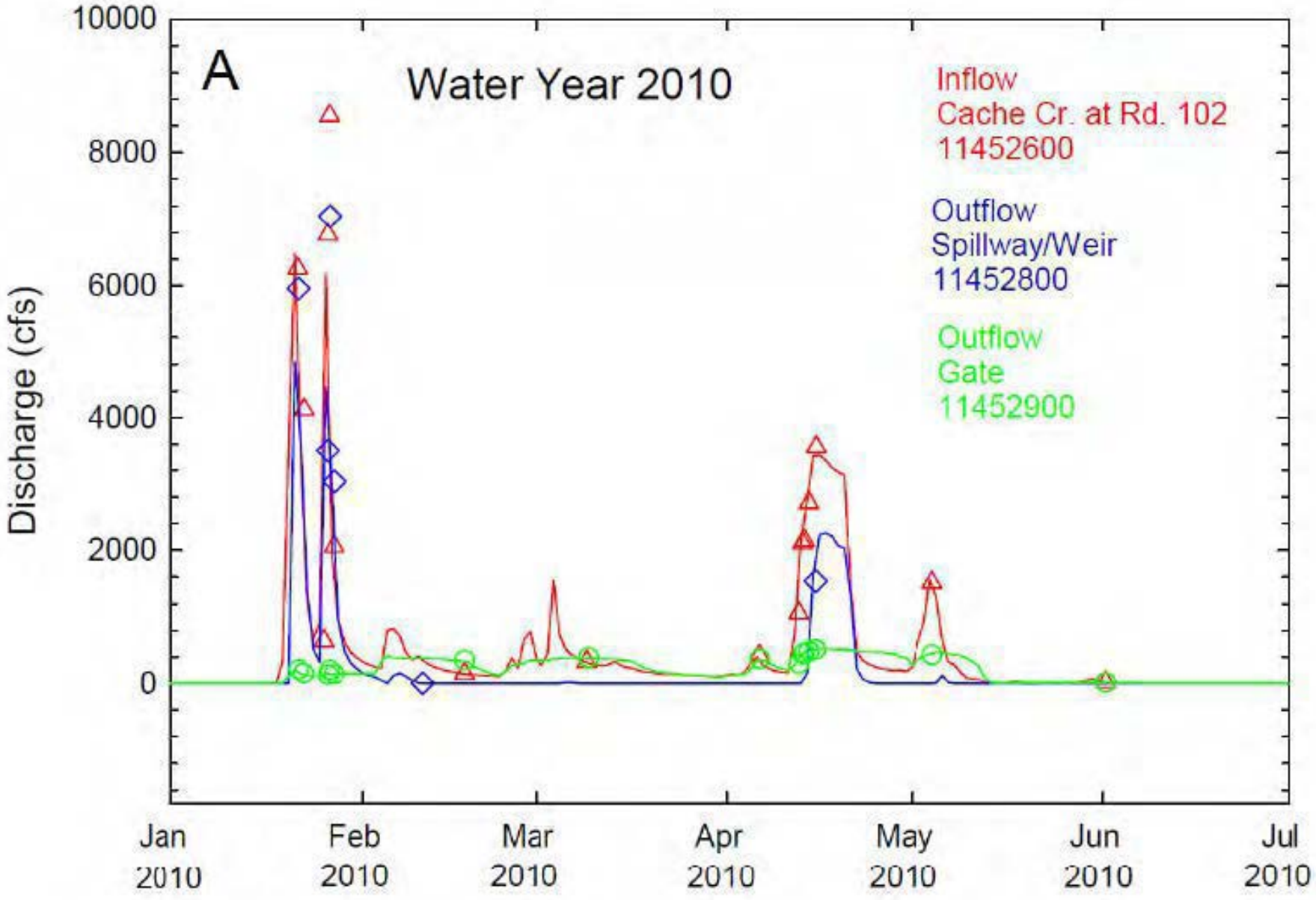
Discharge: ~3,000 ft^3/s
~85,000 L/s

Outflow - gate

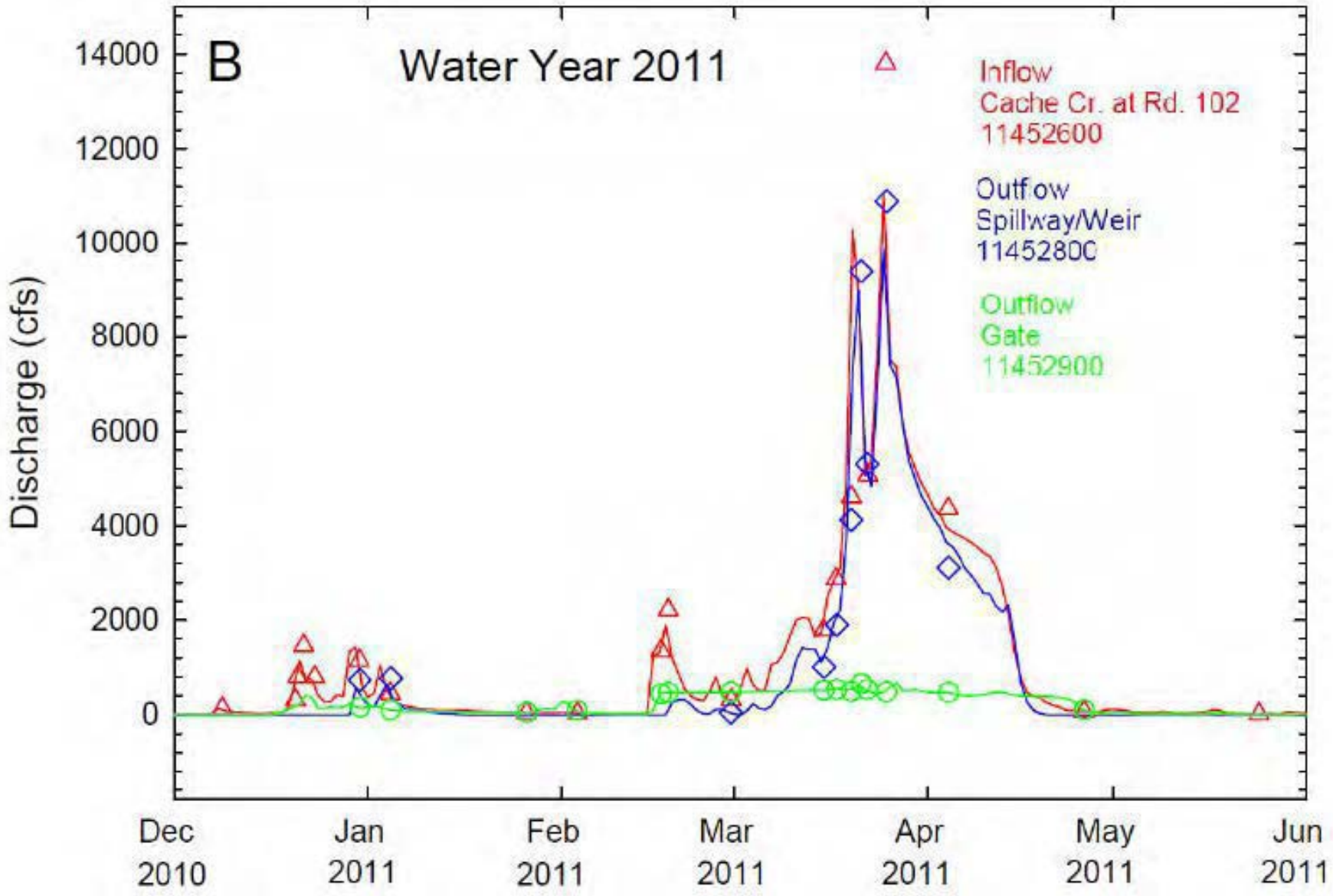
Outflow - weir

Water-quality sampling

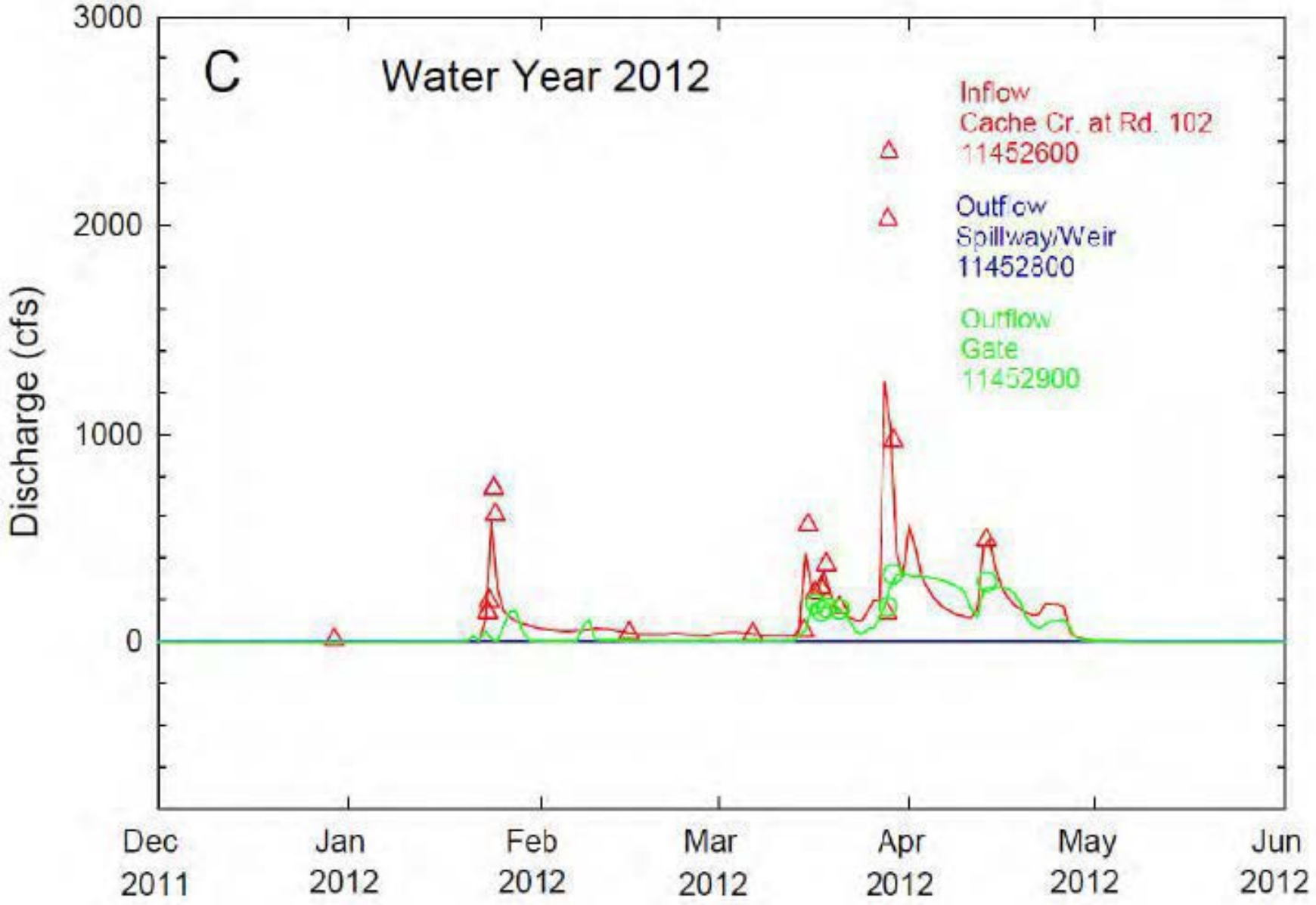
- Four sampling locations:
  - Cache Creek @ Rd. 102, CCSB Outlet & CCSB Spillway (weir) - N & S abutments
- "Baseline" sampling at 3-wk intervals during wet season
- Storm event sampling: 8-10 samples per year (rising, peak, falling)
- Parameters:
  - THg, filtered and and particulate
  - MeHg, filtered and particulate
  - RHg(II), particulate
  - Suspended sediment concentration (SSC) w/sand break
    - Plus detailed size distribution with Coulter counter
  - DOC & optical properties (F-DOM, SUVA)
  - Field parameters (T, SC, pH, DO, turbidity)
  - *Major cations, major anions, alkalinity, trace elements
  - *Chlorophyll-a & pheophytin-a
  - *Stable isotopes (H and O in water, S and O in sulfate)
    - * selected samples only



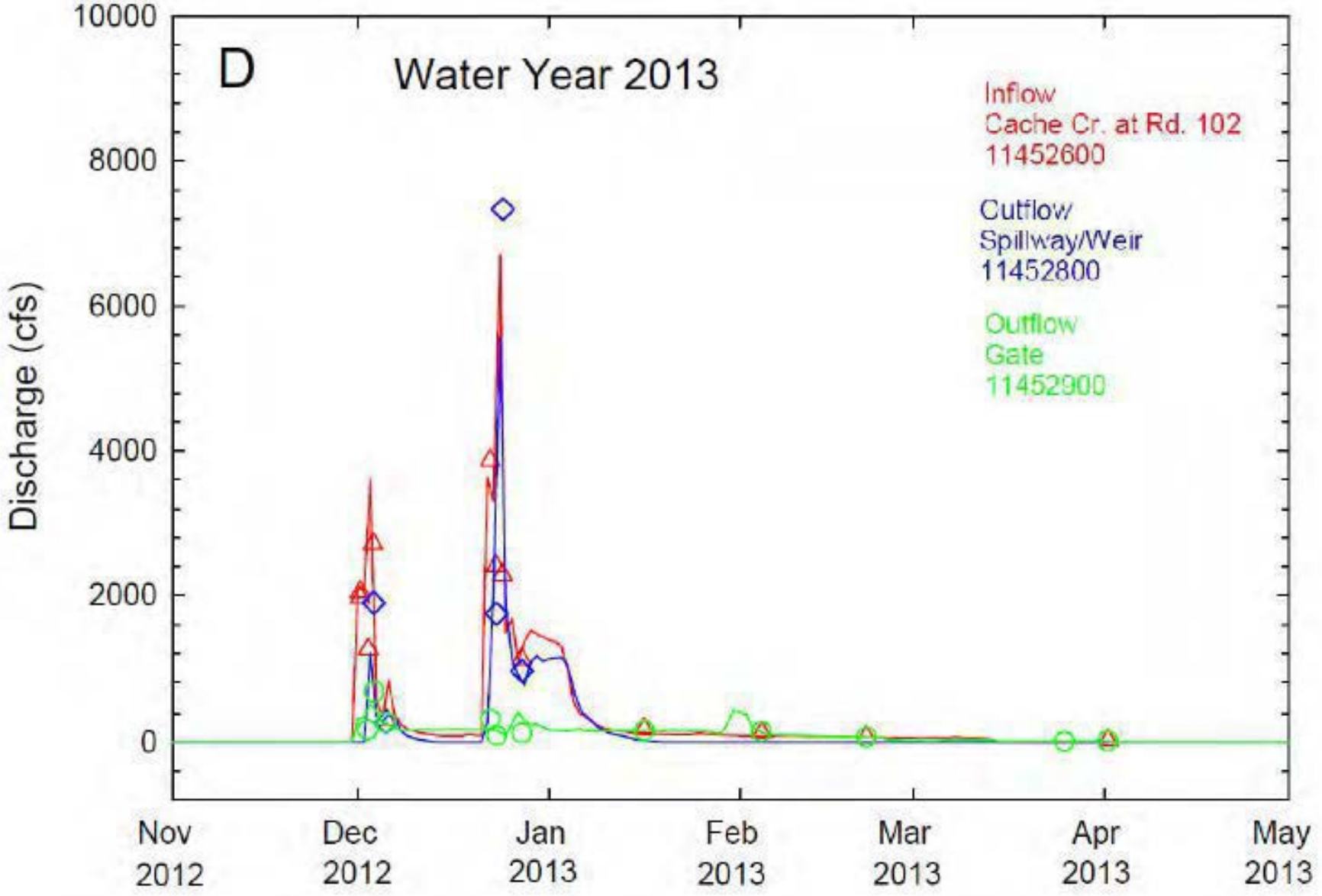
Alpers et al. (in review) USGS SIR



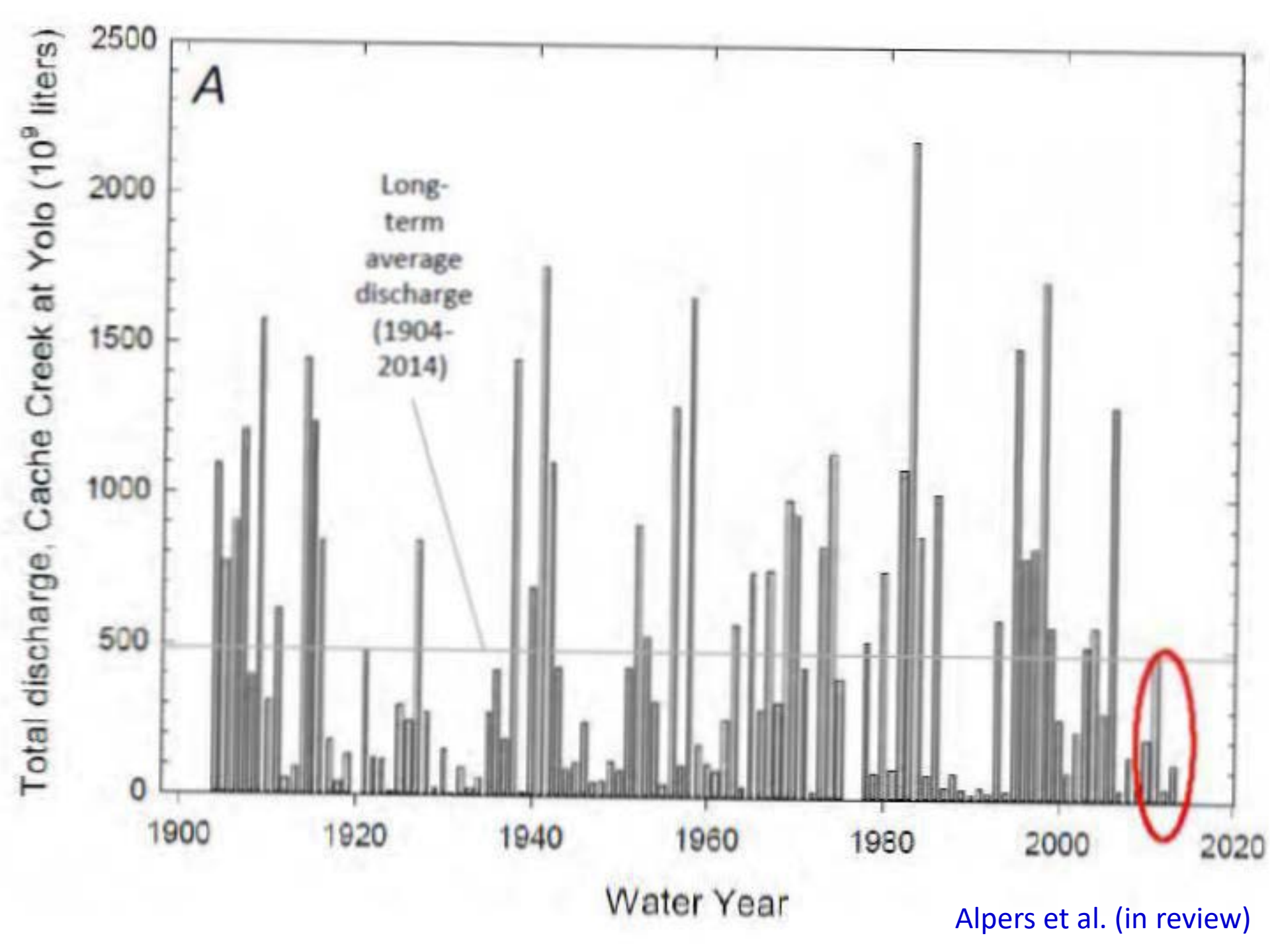
Alpers et al. (in review)



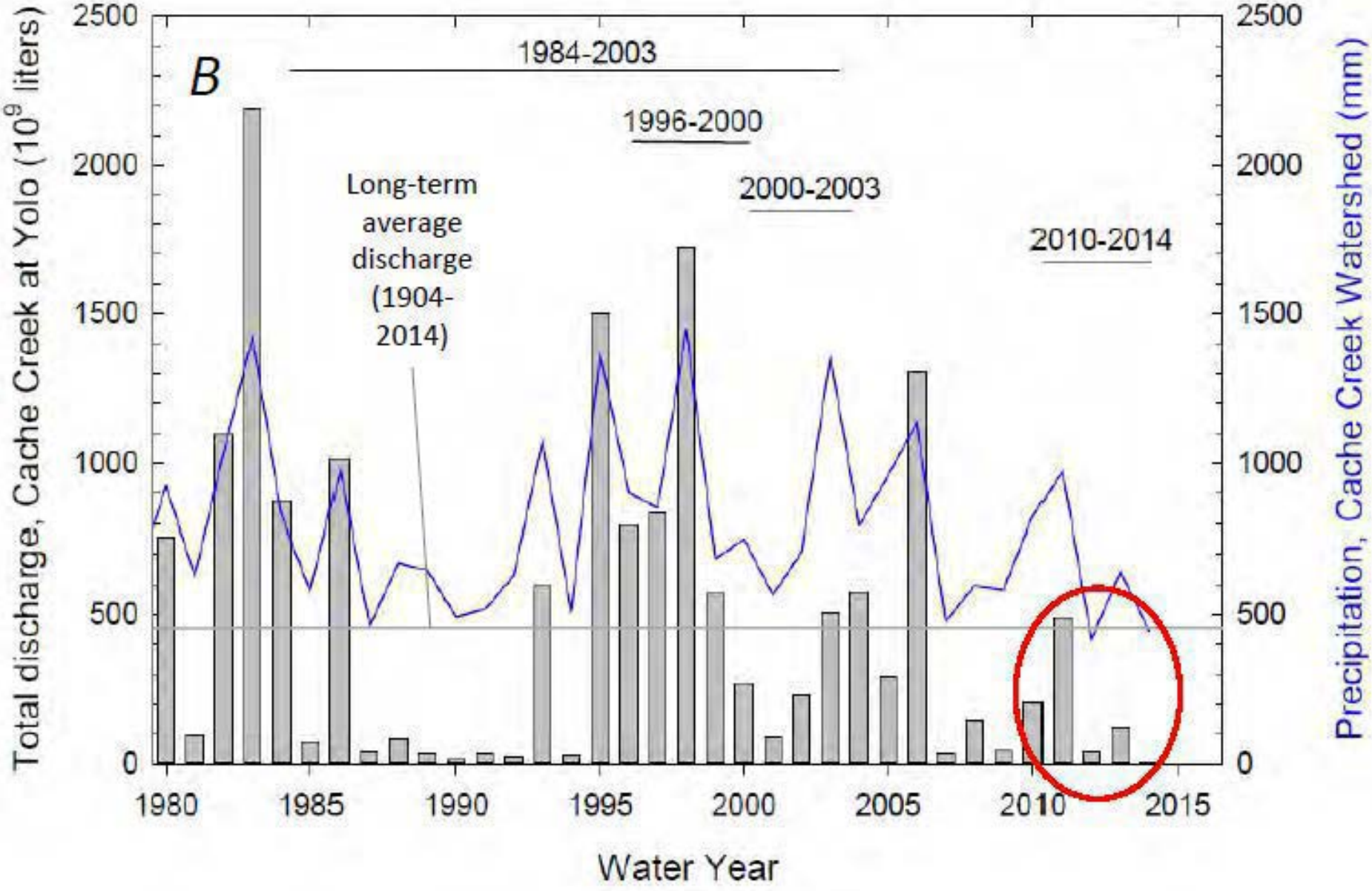
Alpers et al. (in review)



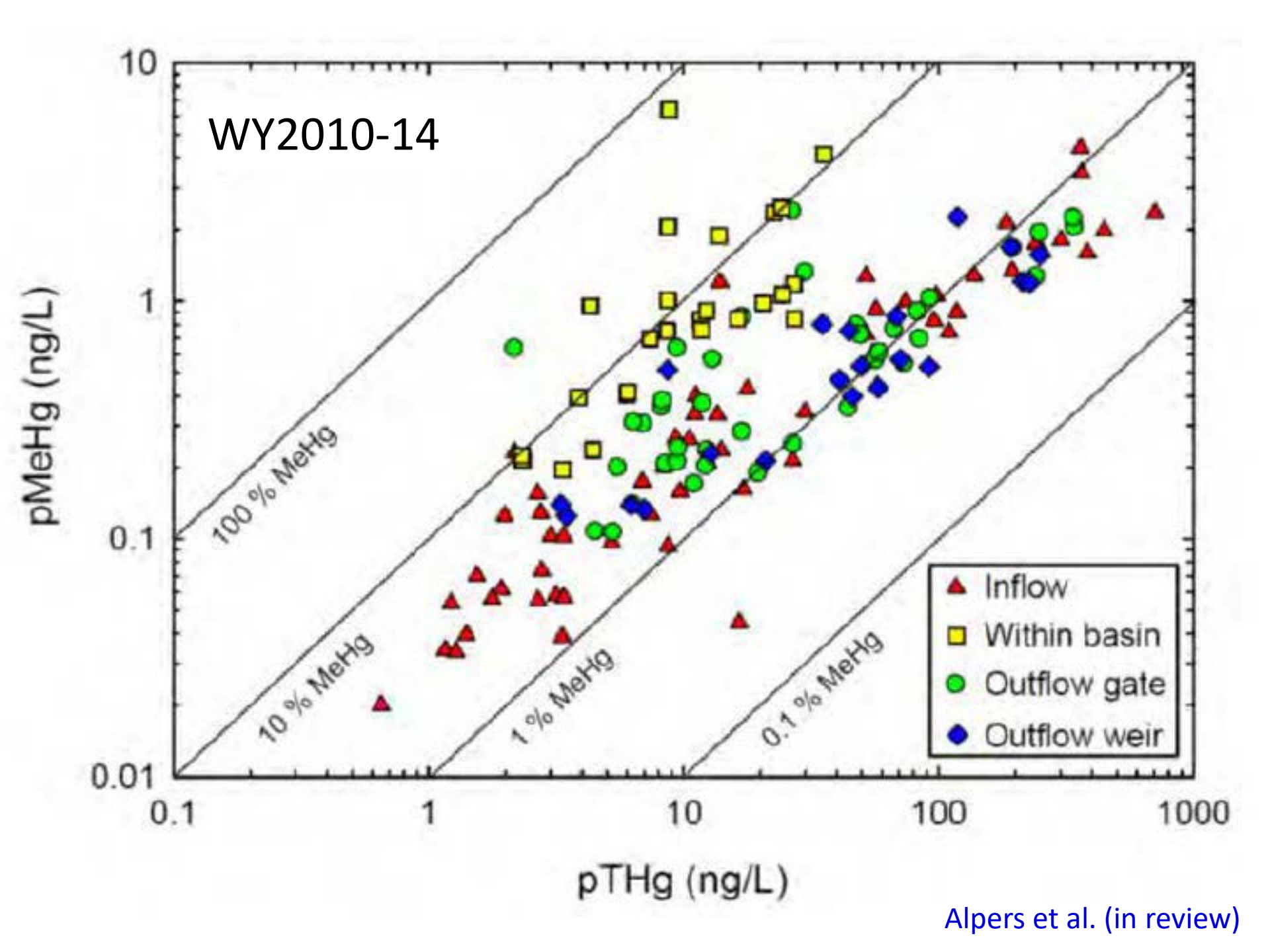
Alpers et al. (in review)



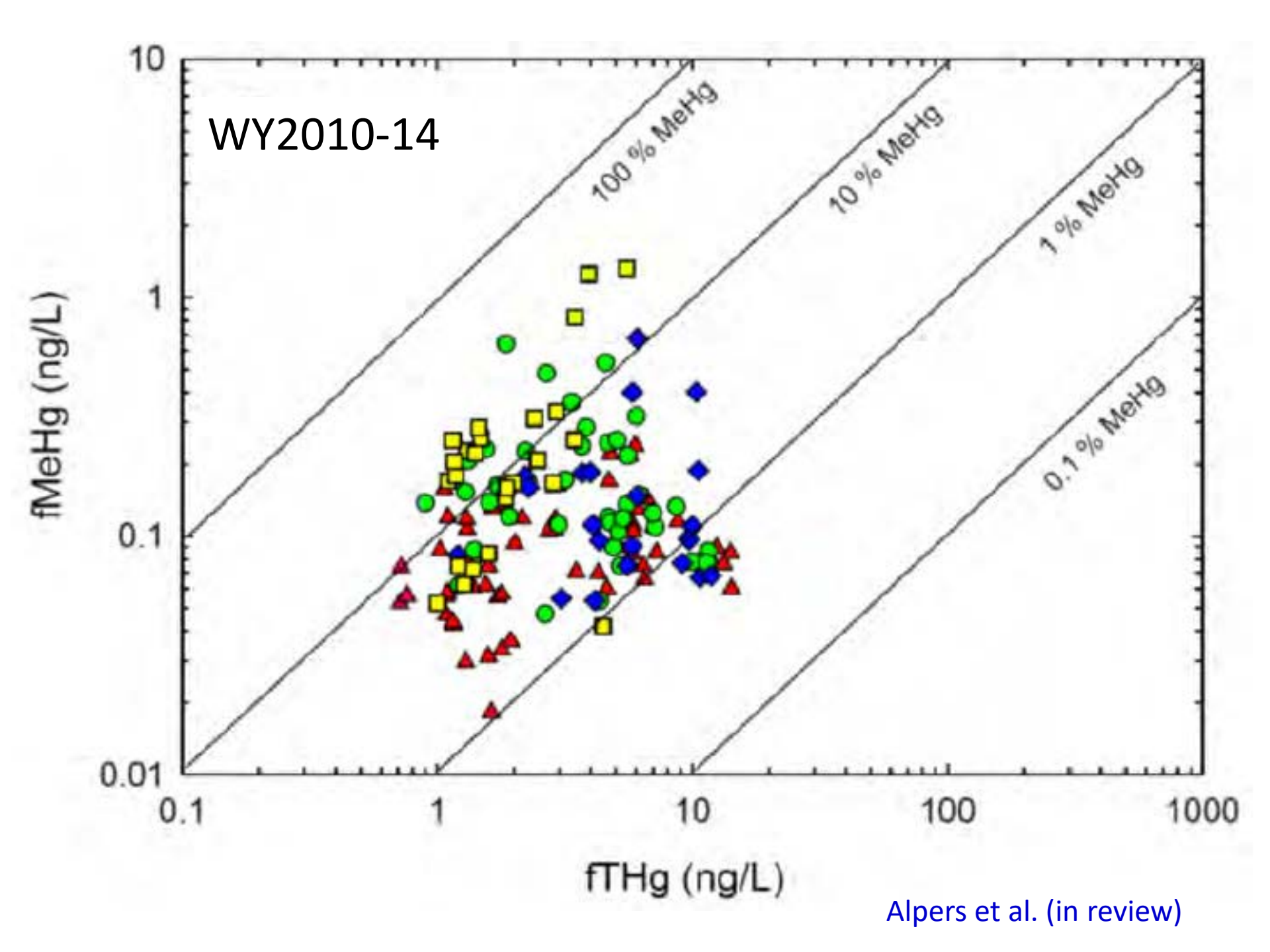
Alpers et al. (in review)



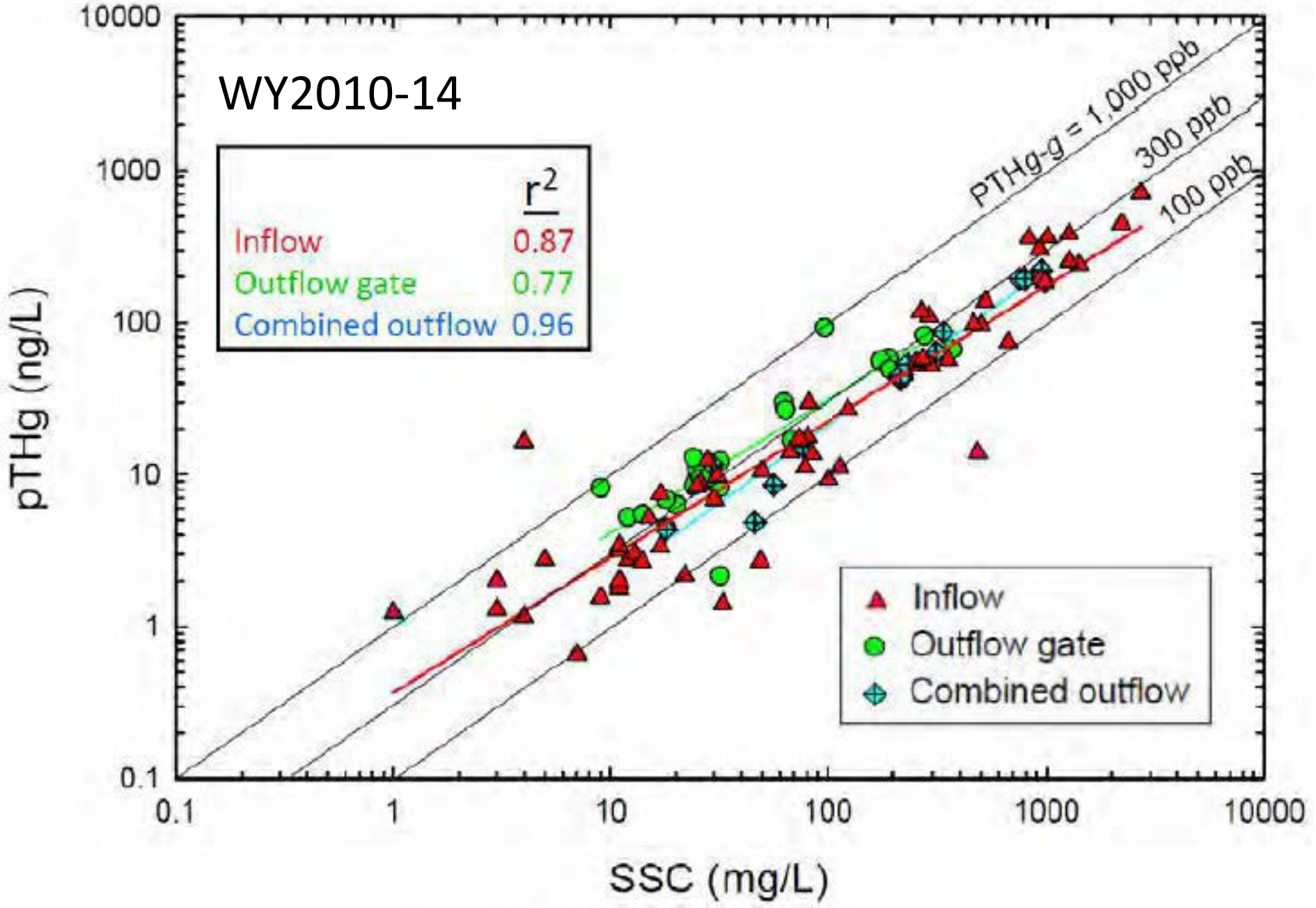
Alpers et al. (in review)



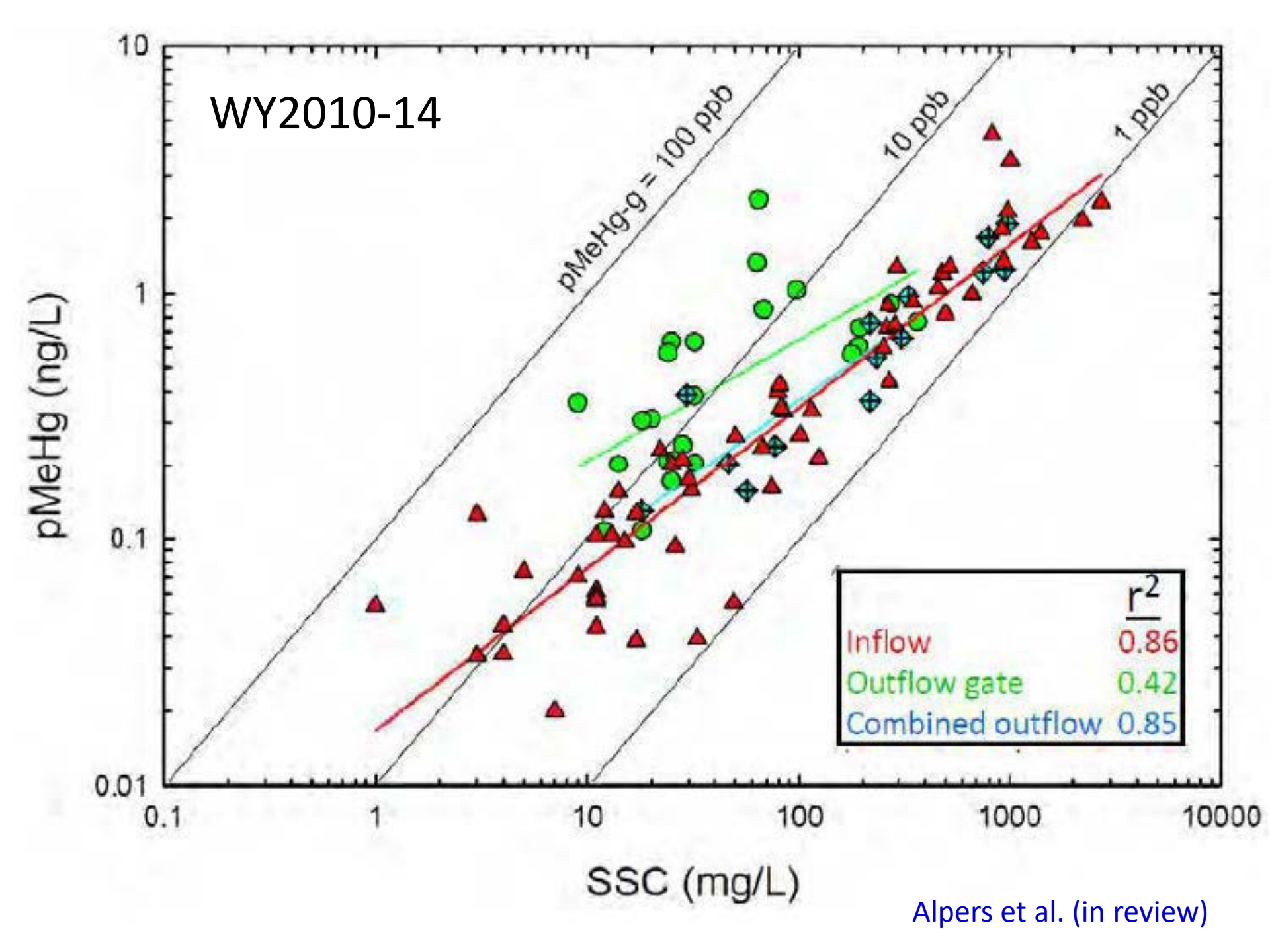
Alpers et al. (in review)



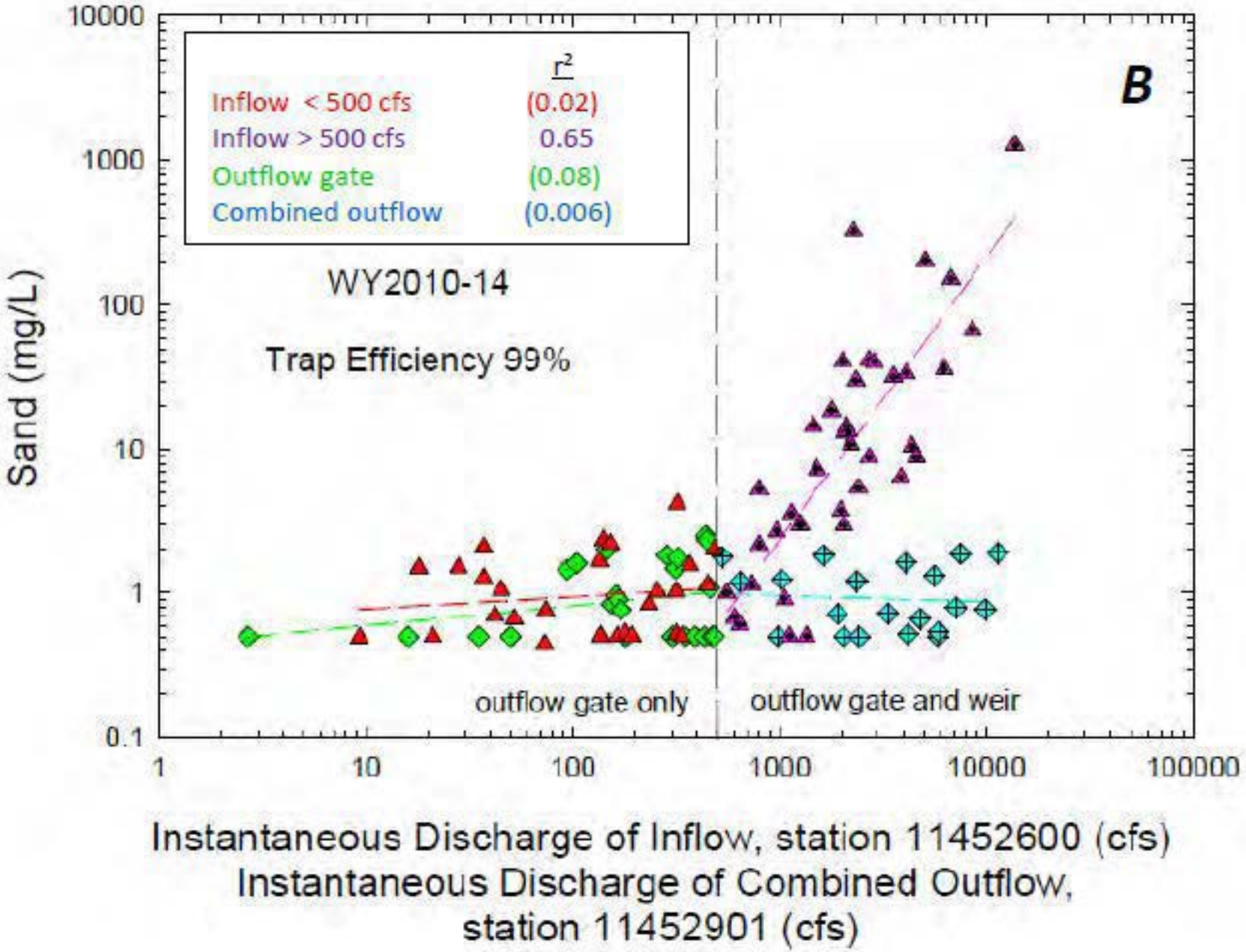
Alpers et al. (in review)



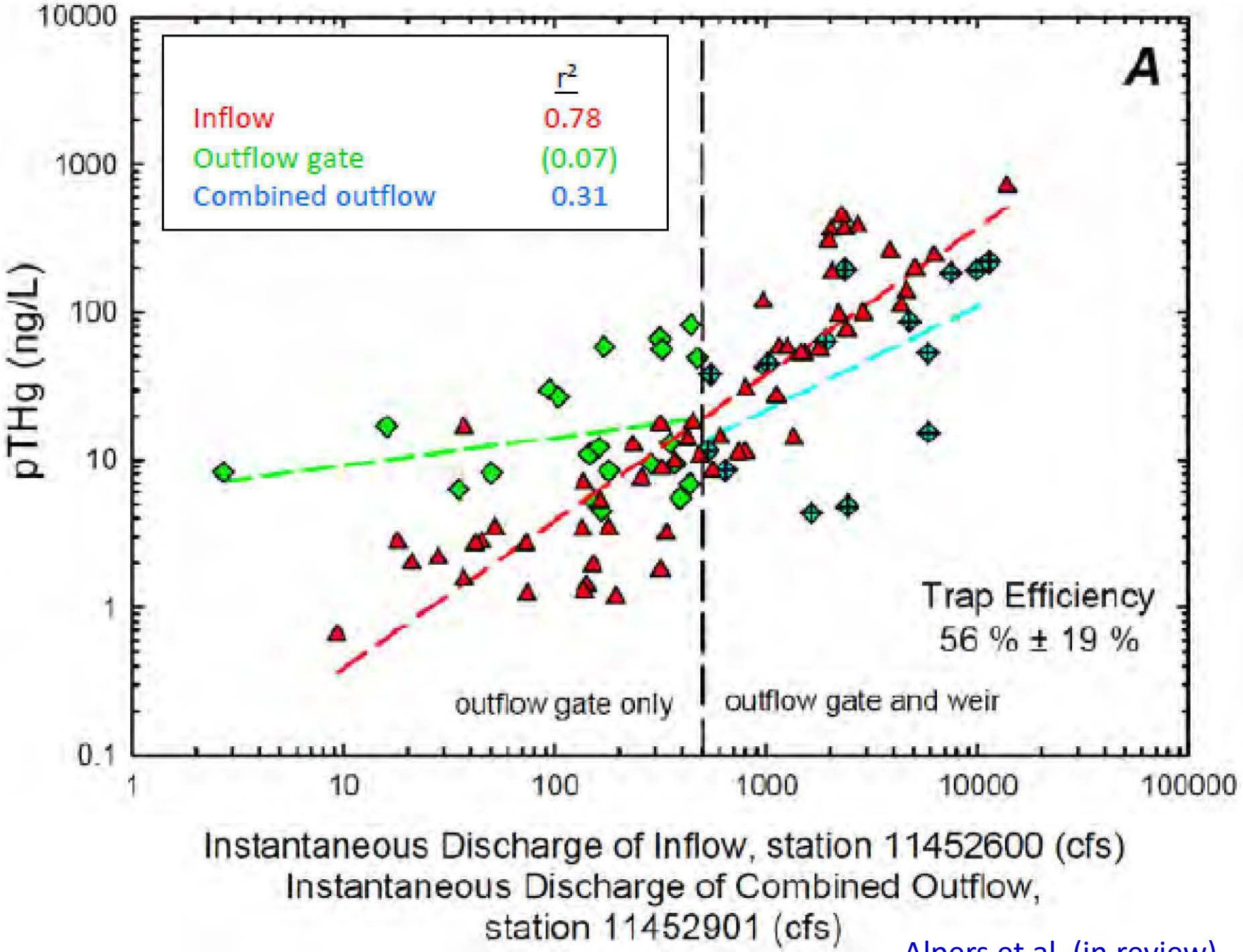
Alpers et al. (in review)



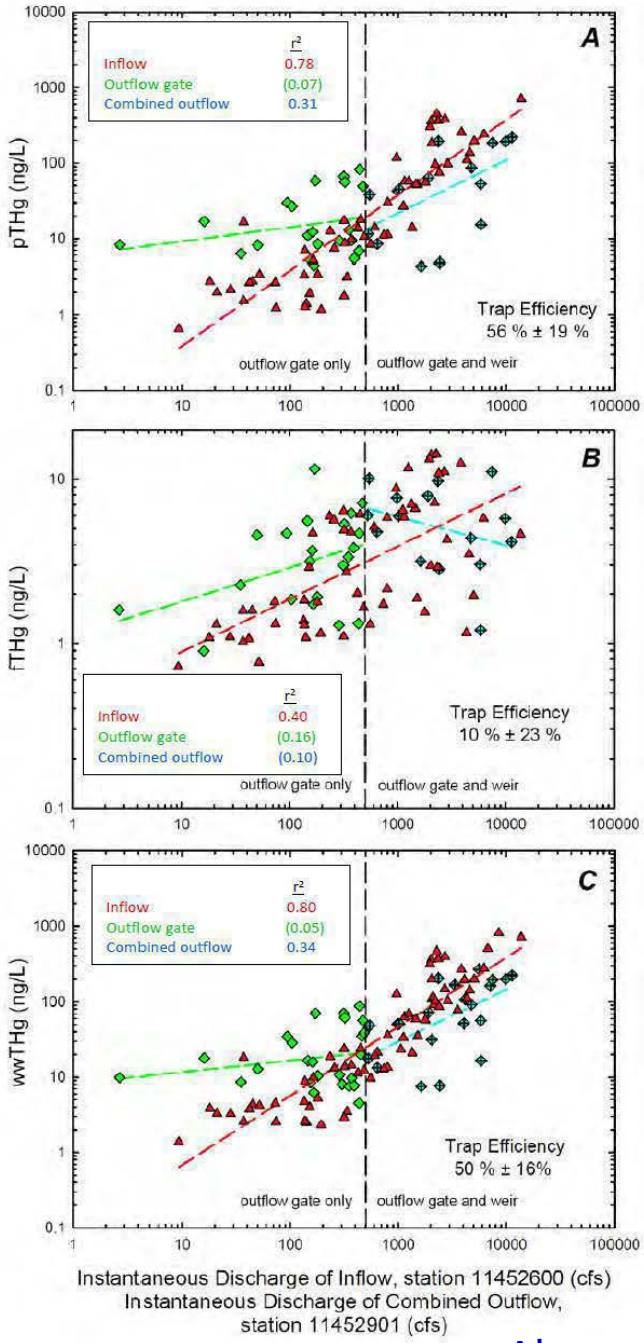
Alpers et al. (in review)

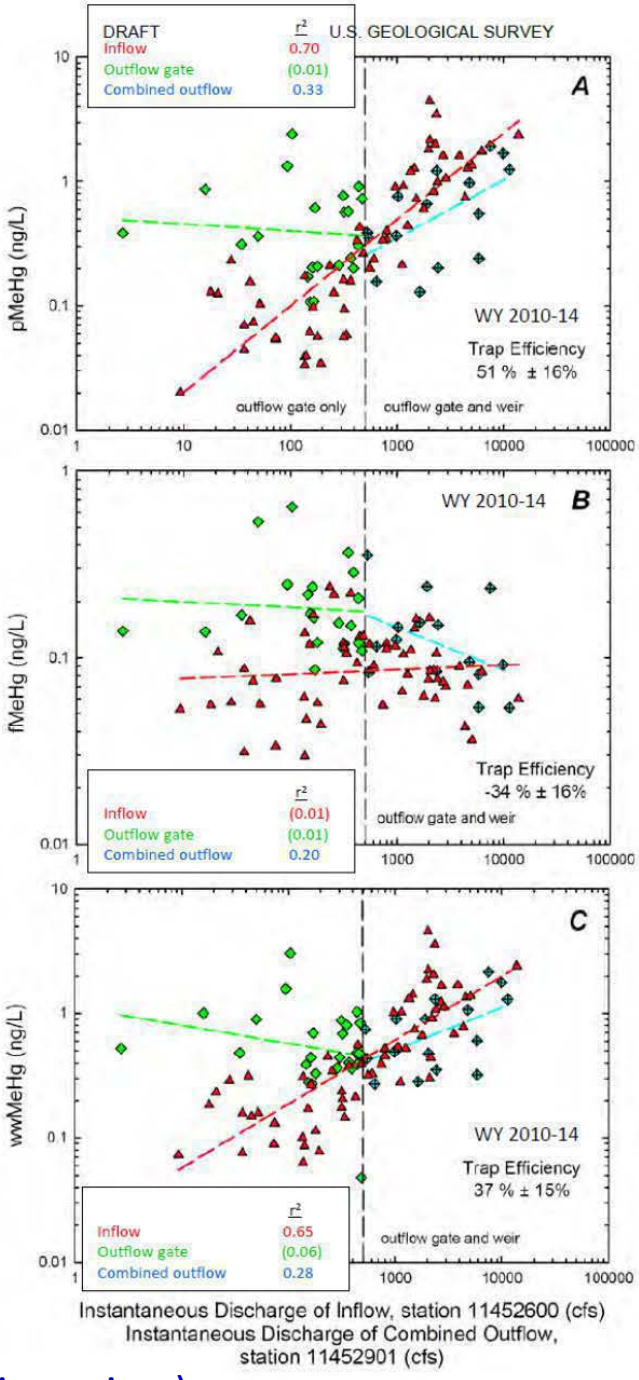


Alpers et al. (in review)



Alpers et al. (in review)





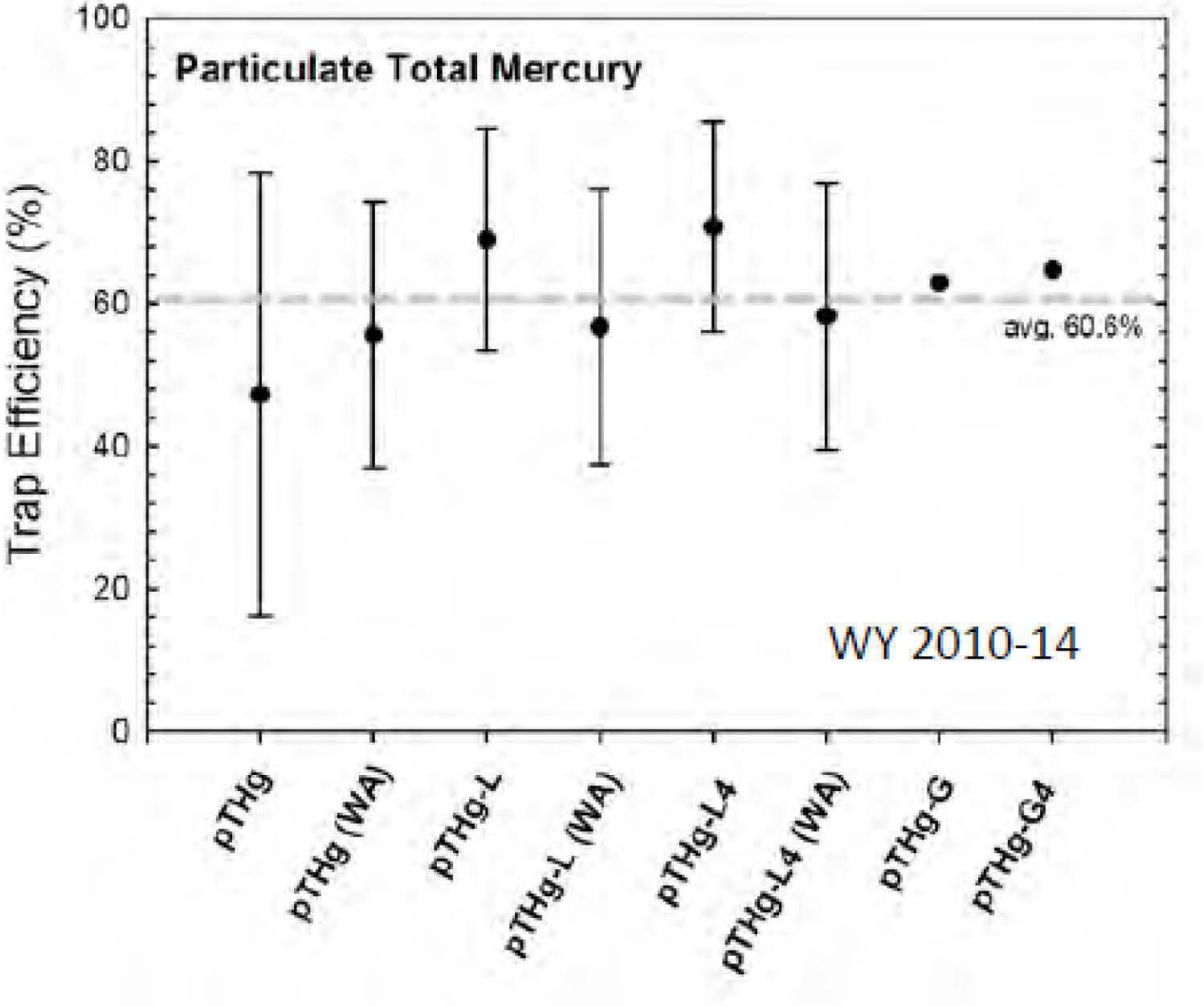
Alpers et al. (in review)

	pTHg + fThg	WWTHg	pTHg-L + fTHg	pTH-L4 + fTHg	pTH-G + fTHg	pTH-G4 + fTHg	Average (n=6)	
Water Years	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**	
CCSB INFLOW								
2010	19	21	33		44			kg/yr
2011	100	105	119		81			kg/yr
2012	1	1	1		1			kg/yr
2013	17	17	27		21			kg/yr
2014	0	0	0		0			kg/yr
2010-2014	137	144	180	198	146	159	161	kg / 5 yr
2010-2014 avg.	27	29	36	40	29	32	32	kg/yr

CCSB OUTFLOW (sum of Gate & Spillway)

2010	11	13	13		13			kg/yr
2011	43	64	30		27			kg/yr
2012	0.4	0.6	0.3		0.5			kg/yr
2013	7.4	12	11		12			kg/yr
2014	0	0	0		0			kg/yr
2010-2014	73	90	55	57	53	55	65	kg / 5 yr
2010-2014 avg.	15	18	11	11	11	11	13	kg/yr

THg Trap Efficiency	47%	38%	69%	71%	64%	65%	60%



Alpers et al. (in review)

Table 7.17: Mercury to Suspended Sediment Ratios for Delta Inputs and Exports

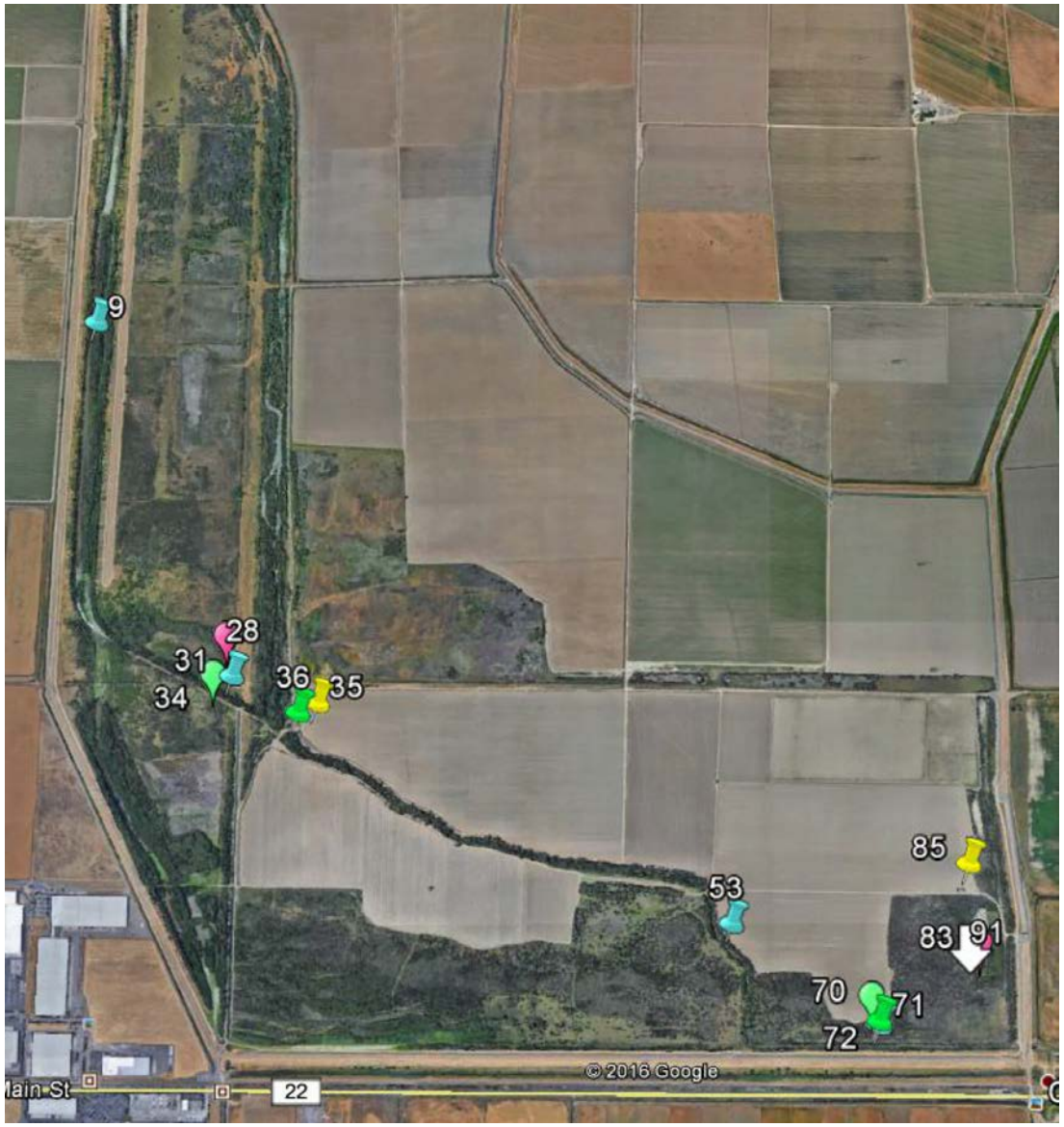
	# of TotHg/TSS Paired Samples	Method A [a] TotHg Load ÷ TSS Load		Method B Linear Regression Slope for Paired TotHg/TSS [b]	Method C Median of TotHg/TSS Paired Sample Results
		WY2000-2003	WY1984-2003		
TRIBUTARIES TO THE SACRAMENTO BASIN [Sacramento River + Yolo Bypass]					
American River	109	0.50	0.27	0.20	0.41
Cache Creek Settling Basin	21	0.39	0.45	0.48	0.36
Colusa Basin Drain	56	0.09		0.09	0.07
Feather River	60	0.29	0.31	0.26	0.33
Natomas East Main Drain (Arcade Ck.)	8	0.64		0.38	0.45
Putah Creek	29	0.45	0.55	0.26	0.30
Sacramento River above Colusa	47	0.12	0.12	0.12	0.11
Sutter Bypass (Sacramento Slough)	52	0.14		0.13	0.13

Wood et al. (2010) Delta MeHg TMDL Draft Staff Report

Tasks 3 & 4 – Water, Sediment, and Biota:
Spatial and temporal variation of MeHg within CCSB

- Phase 1 (WY 2010-12) – water and sediment
  - 8 locations (4 ag, 4 non-ag), 6 sampling events
- Phase 2 (WY 2013-16) – water, sediment, and biota
  - Sediment at 90+ locations (7 habitats)
    - 4 seasonal sampling events at 90+ sites
    - 18 monthly sampling events at 12 sites (5 habitats, east & west)
  - Caged fish experiment – March-April 2013
    - 40 cages with mosquito fish
    - Water sampled at 25 cages, plus inflow and outflow
  - Bird eggs – 2012-15
    - House wrens occupying nest boxes most abundant
    - Several other species sampled

Shallow Sediment Time Series
2010 - 2016



	Level 1 (land use)	Level 2 (sub-habitat)
2	Agriculture	corn
4	Open-Water	creek
2	Riparian	mixed woody
2	Floodplain	mixed woody
2	Floodplain	mixed non-woody
1	Floodplain	changed from mixed woody to mixed non-woody in summer 2014

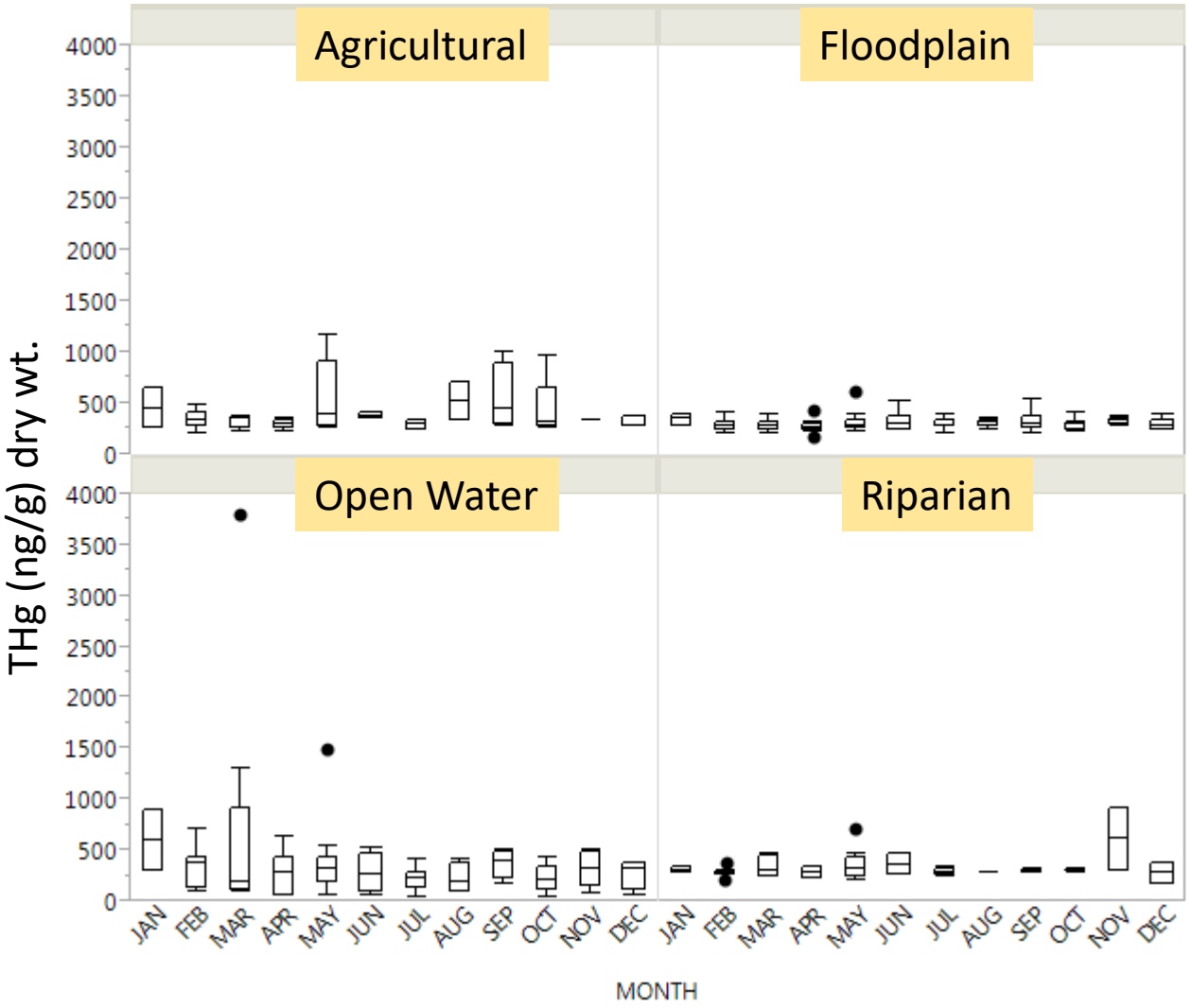
13 sites

20-27 sampling events during 2010-16
- Seasonal (n = 10), 2010-14
- Monthly (n = 17), 2015-16

288 samples (including replicates)

Total Mercury By MONTH & HABITAT (2010-2016 Data)

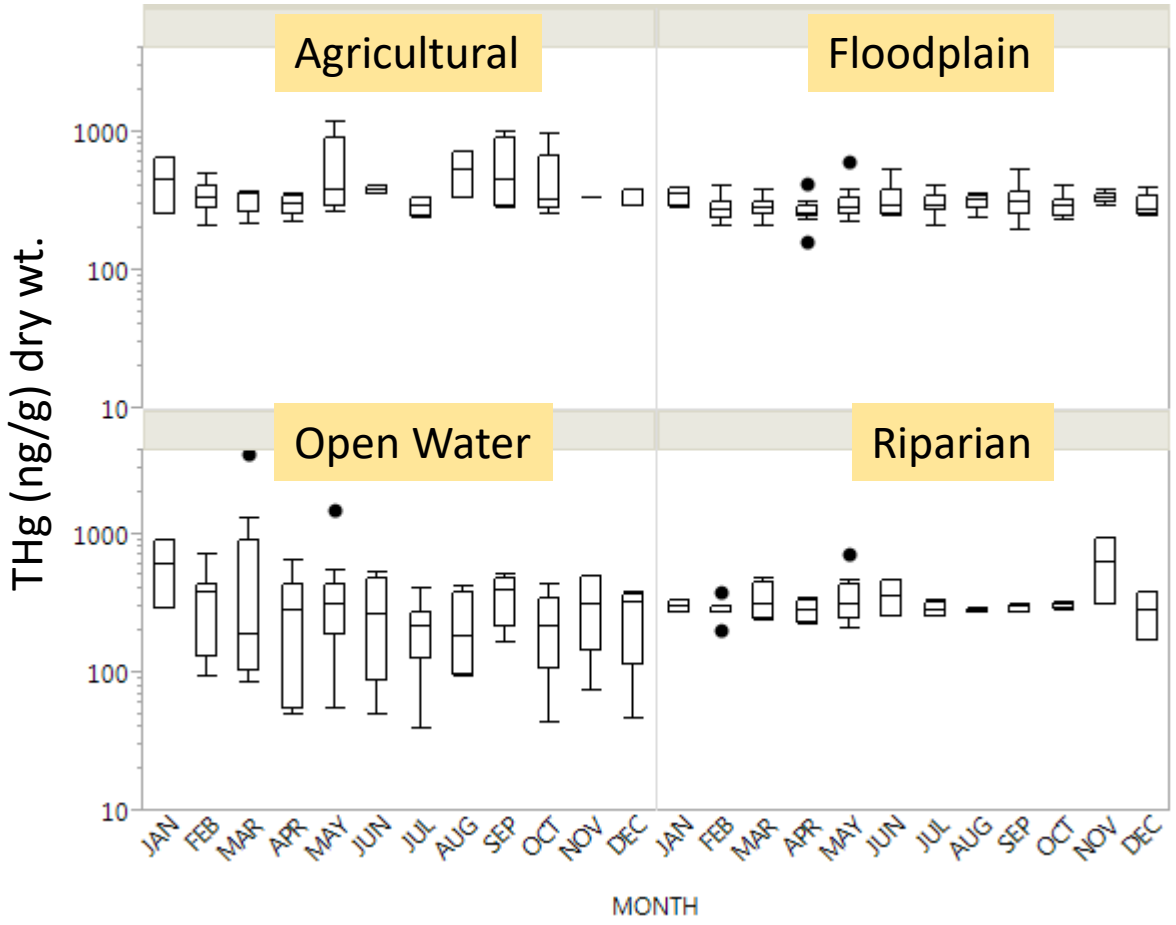
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Total Mercury By MONTH & HABITAT (2010-2016 Data)

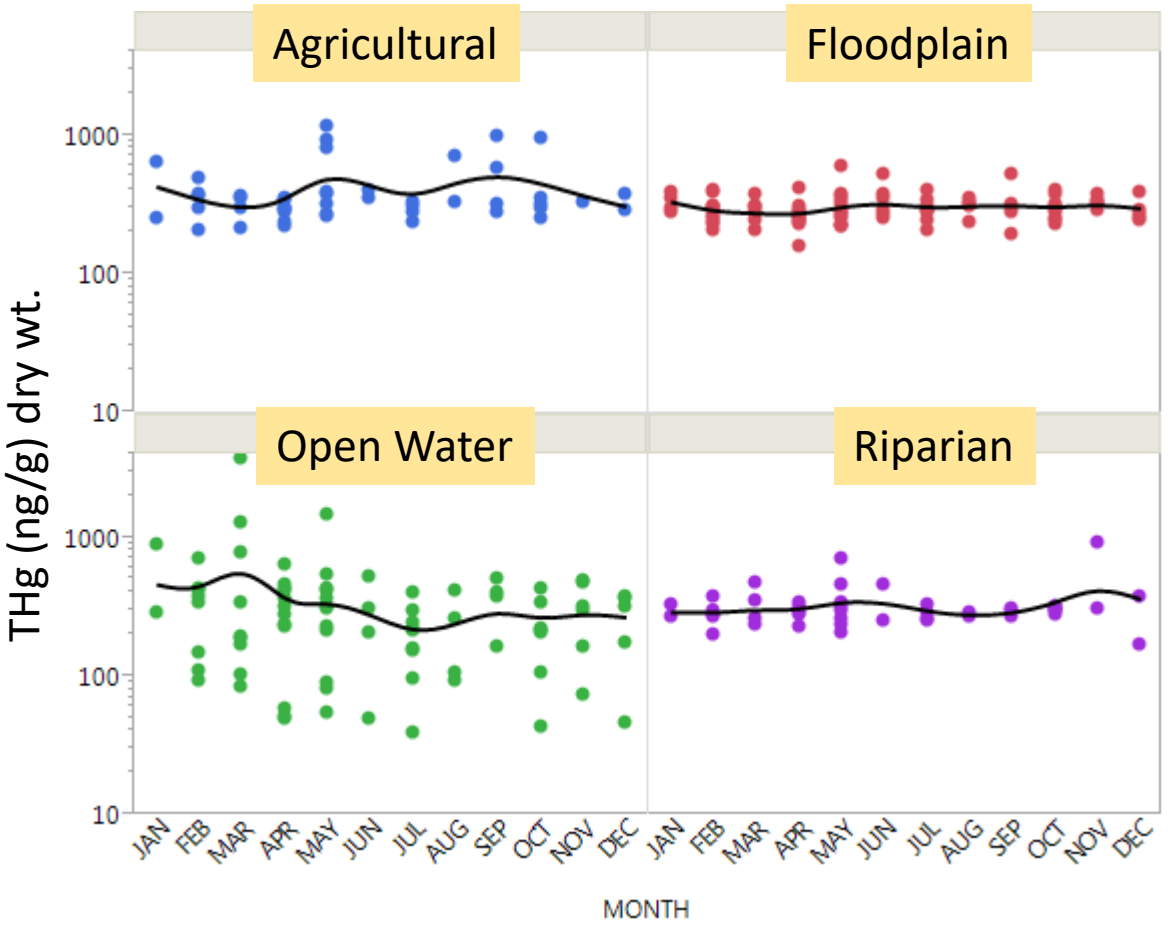
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Total Mercury
By MONTH & HABITAT
(2010-2016 Data)

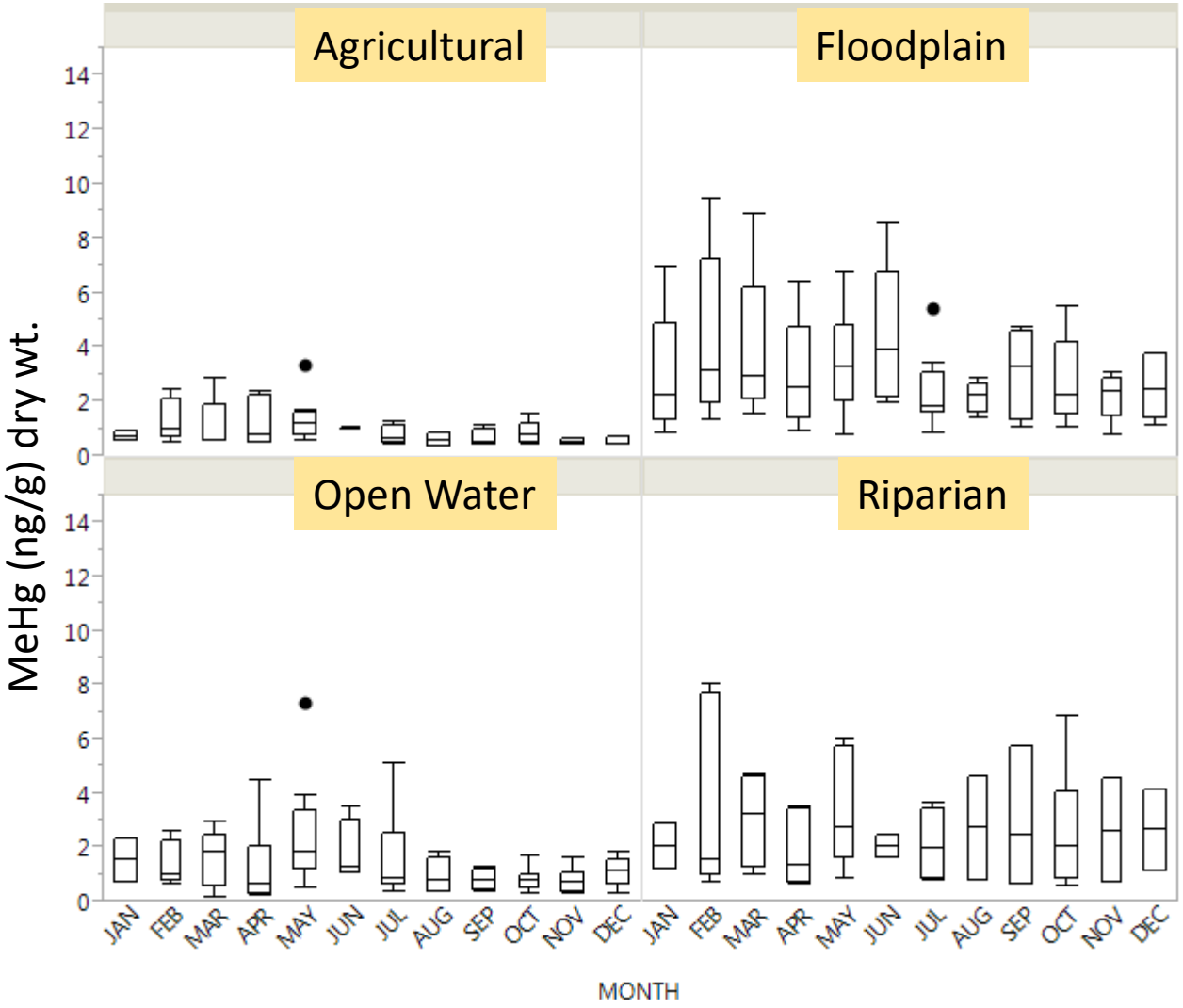
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Methylmercury By MONTH & HABITAT (2010-2016 Data)

Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Methylmercury By MONTH & HABITAT (2010-2016 Data)

Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
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CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
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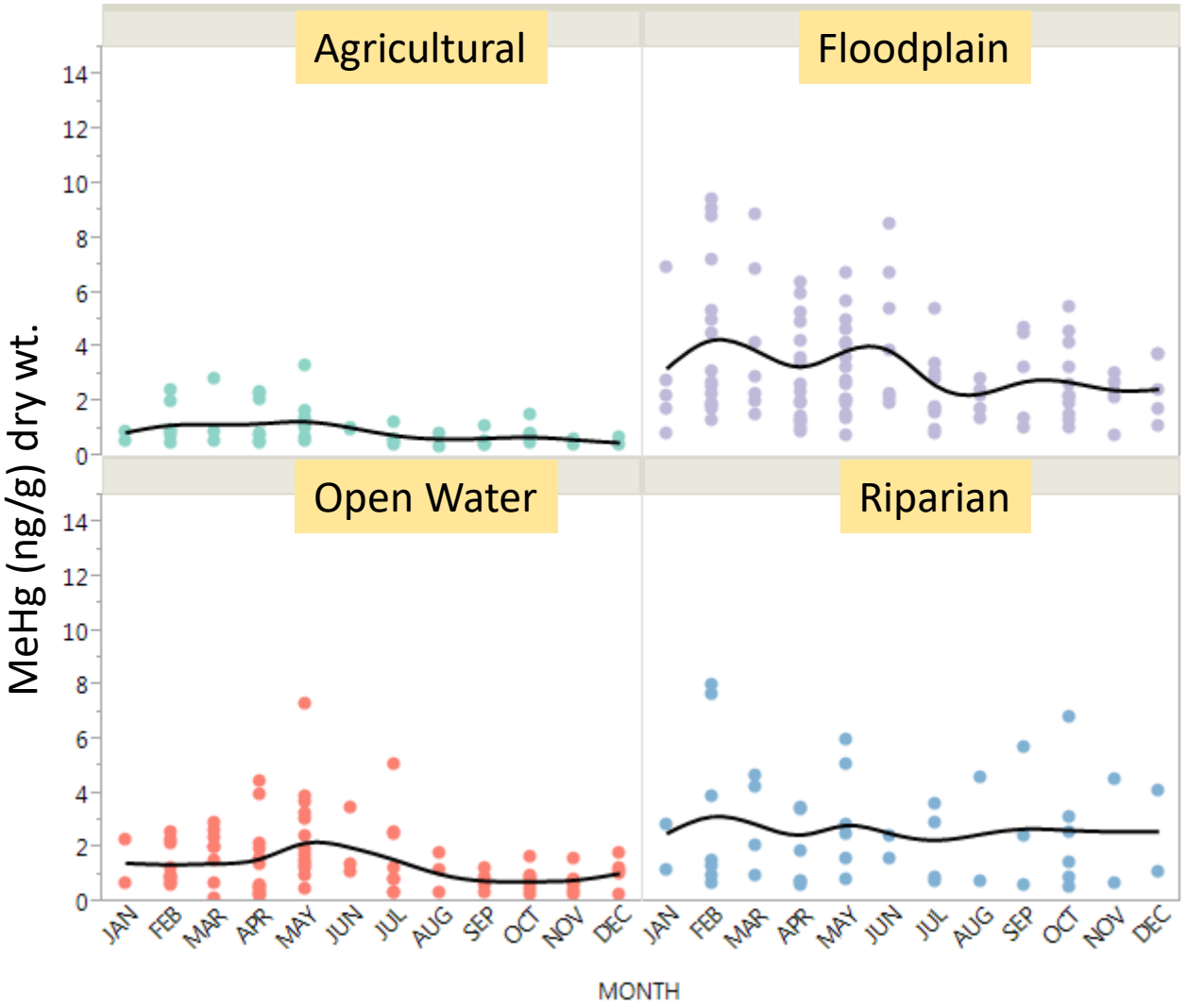
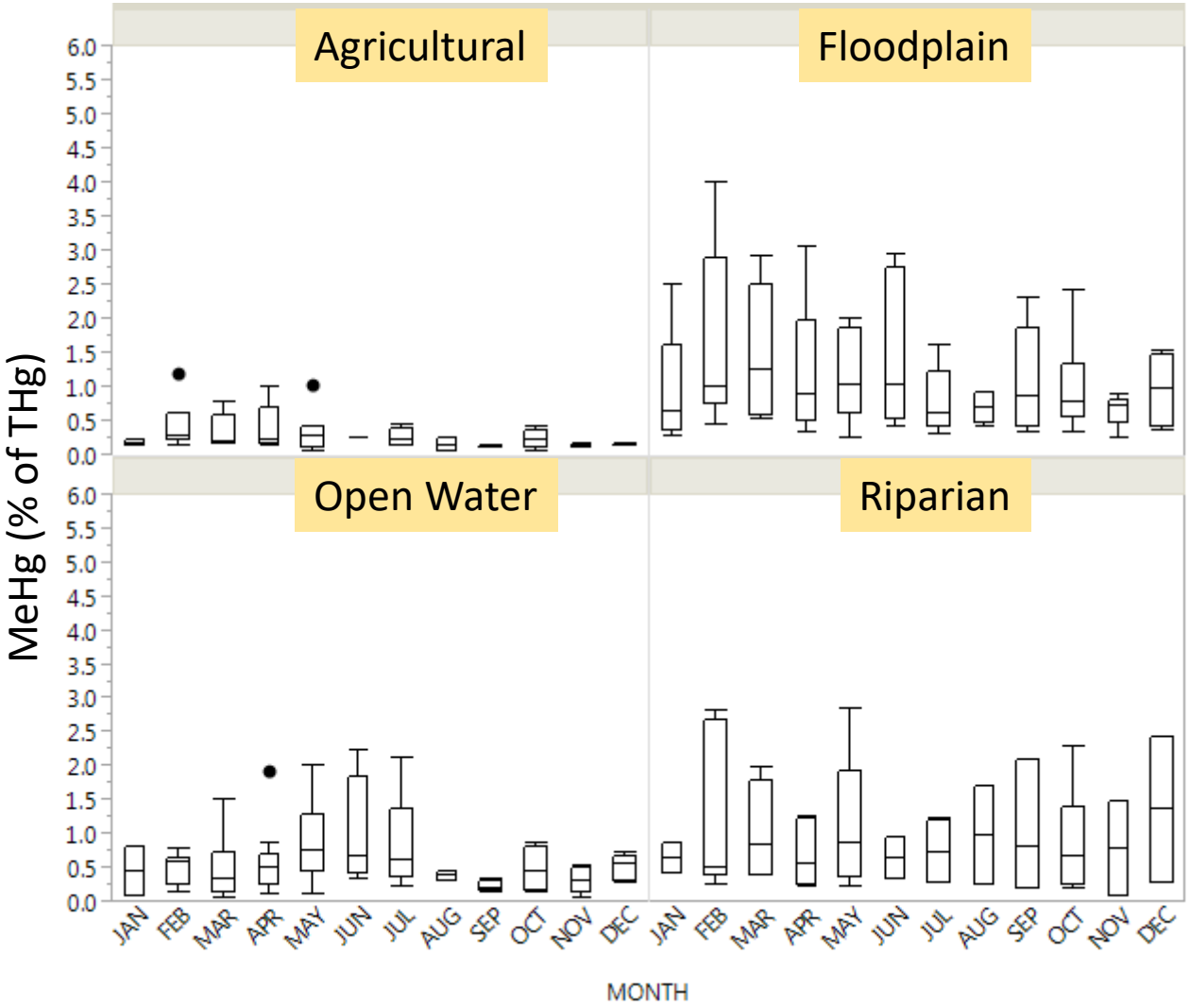
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Percent Methylmercury By MONTH & HABITAT (2010-2016 Data)

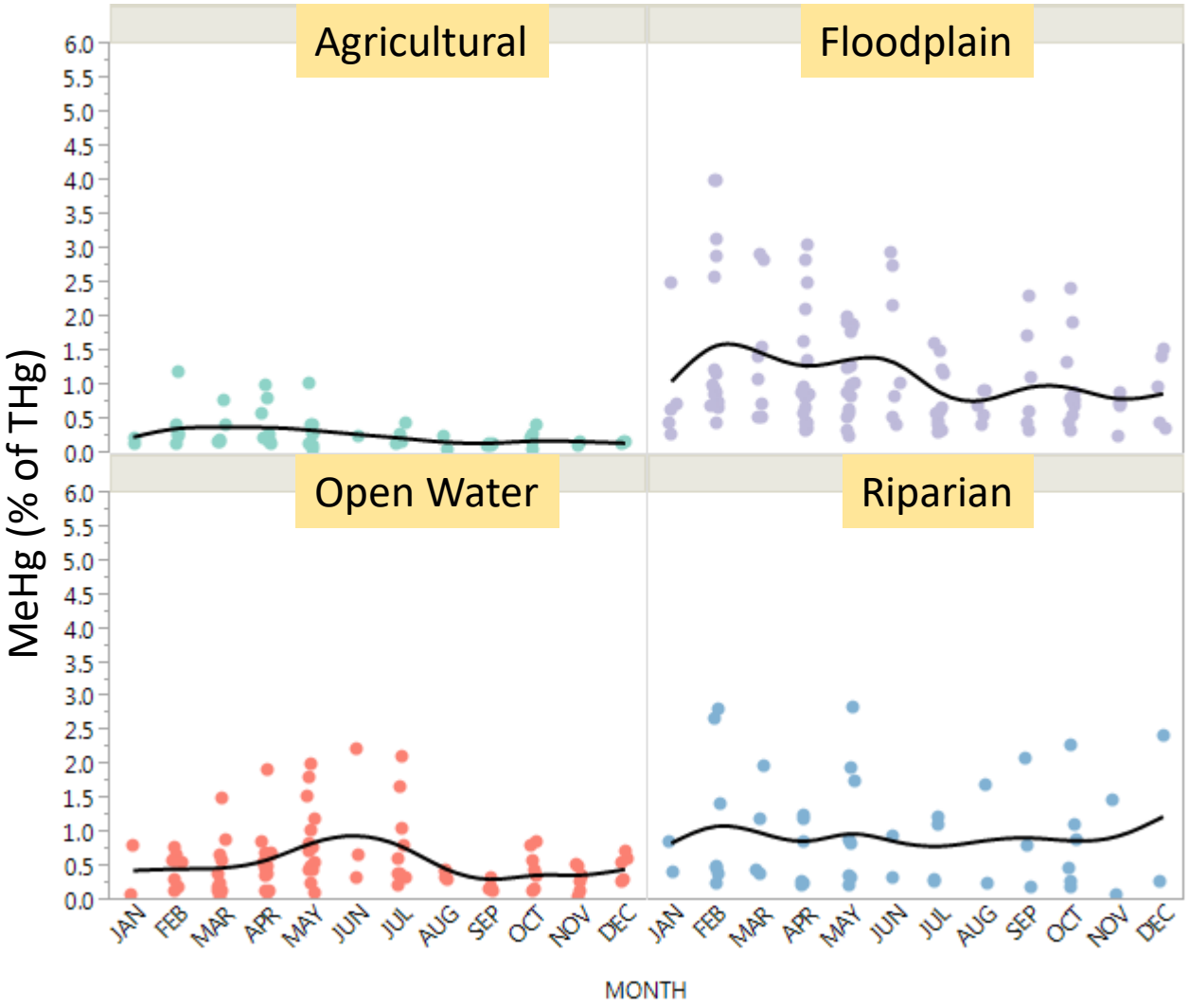
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Percent Methylmercury By MONTH & HABITAT (2010-2016 Data)

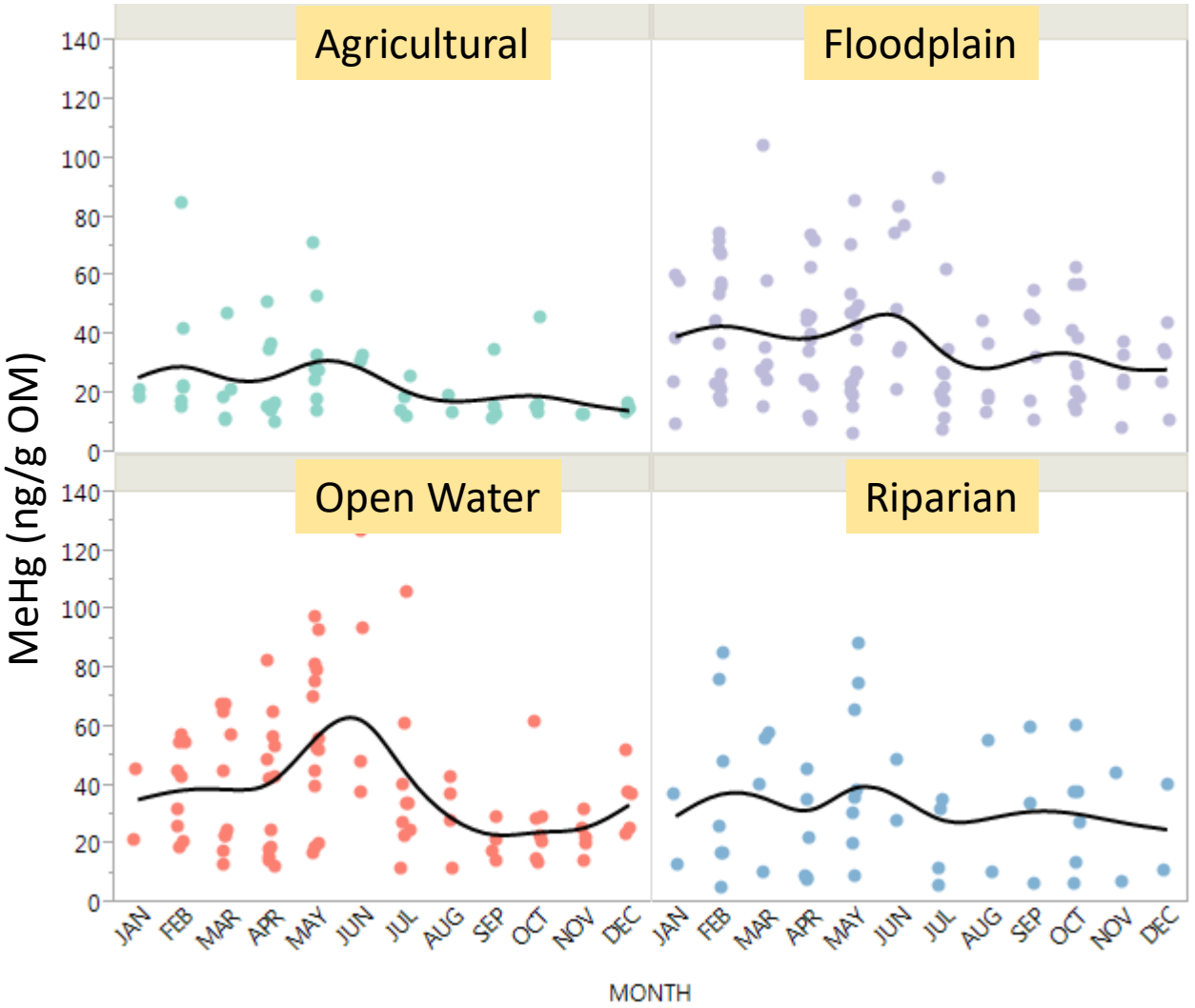
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Methylmercury (normalized by Organic Matter) By MONTH & HABITAT (2010-2016 Data)

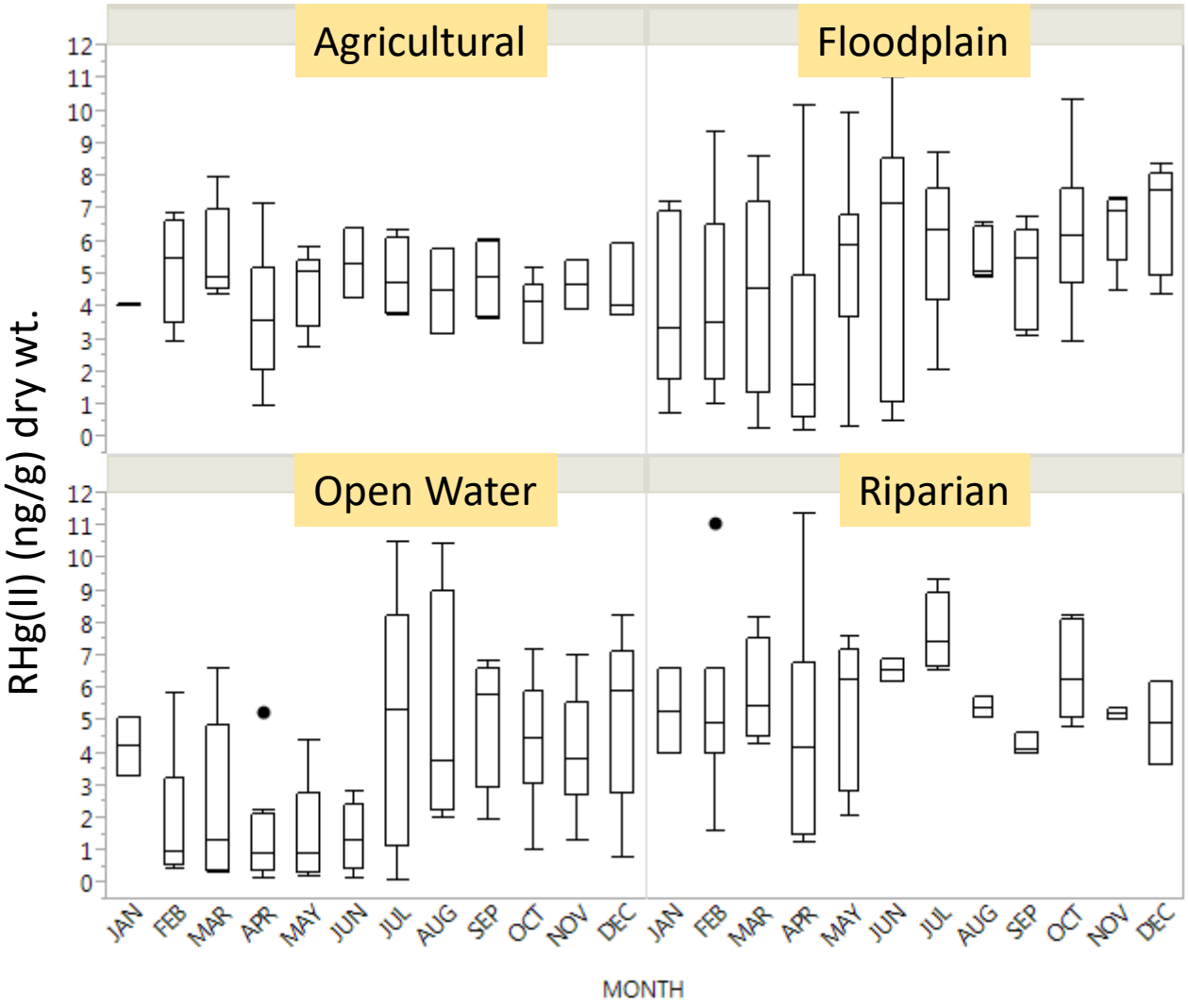
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Reactive Mercury By MONTH & HABITAT (2010-2016 Data)

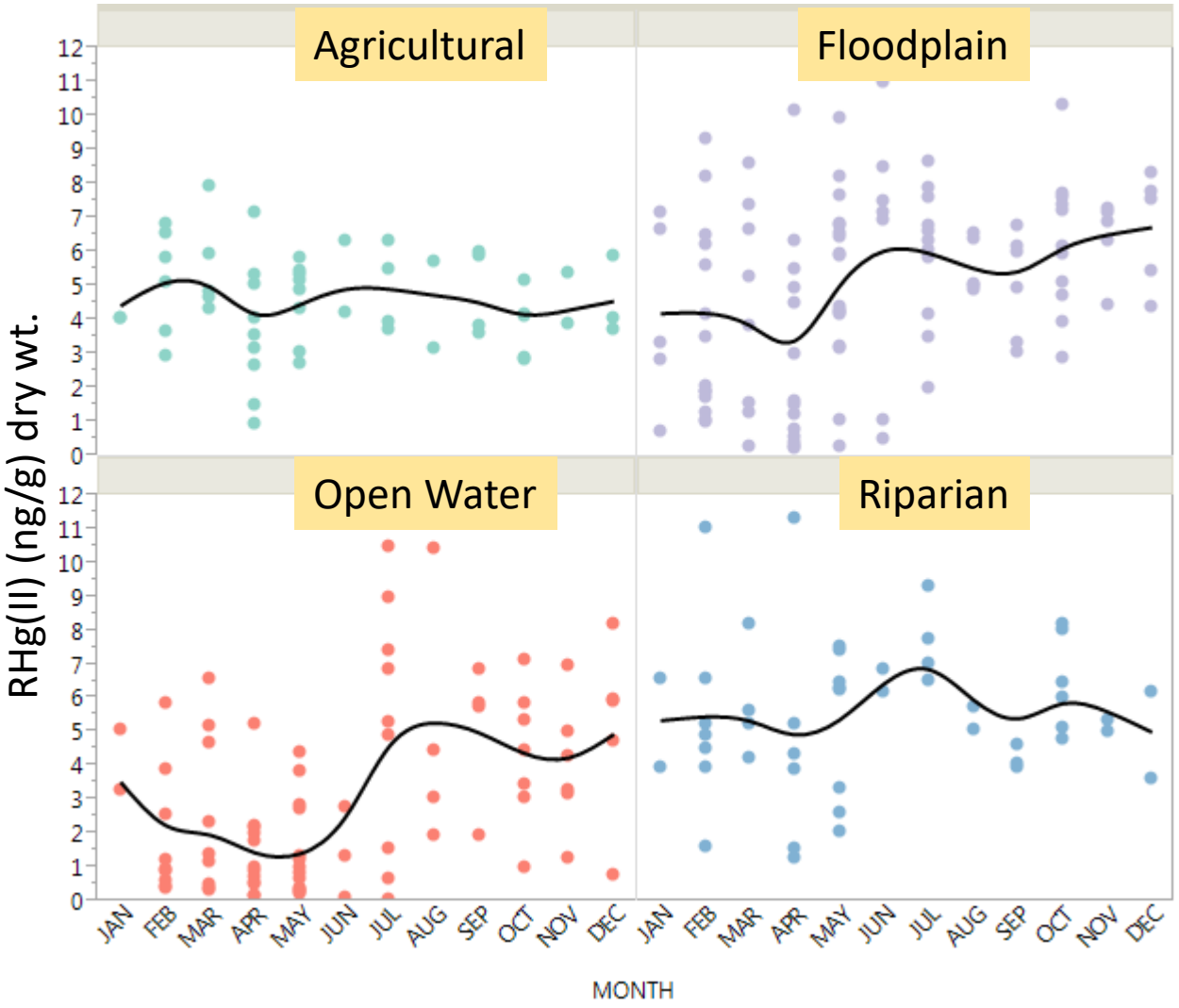
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Reactive Mercury
By MONTH & HABITAT
(2010-2016 Data)

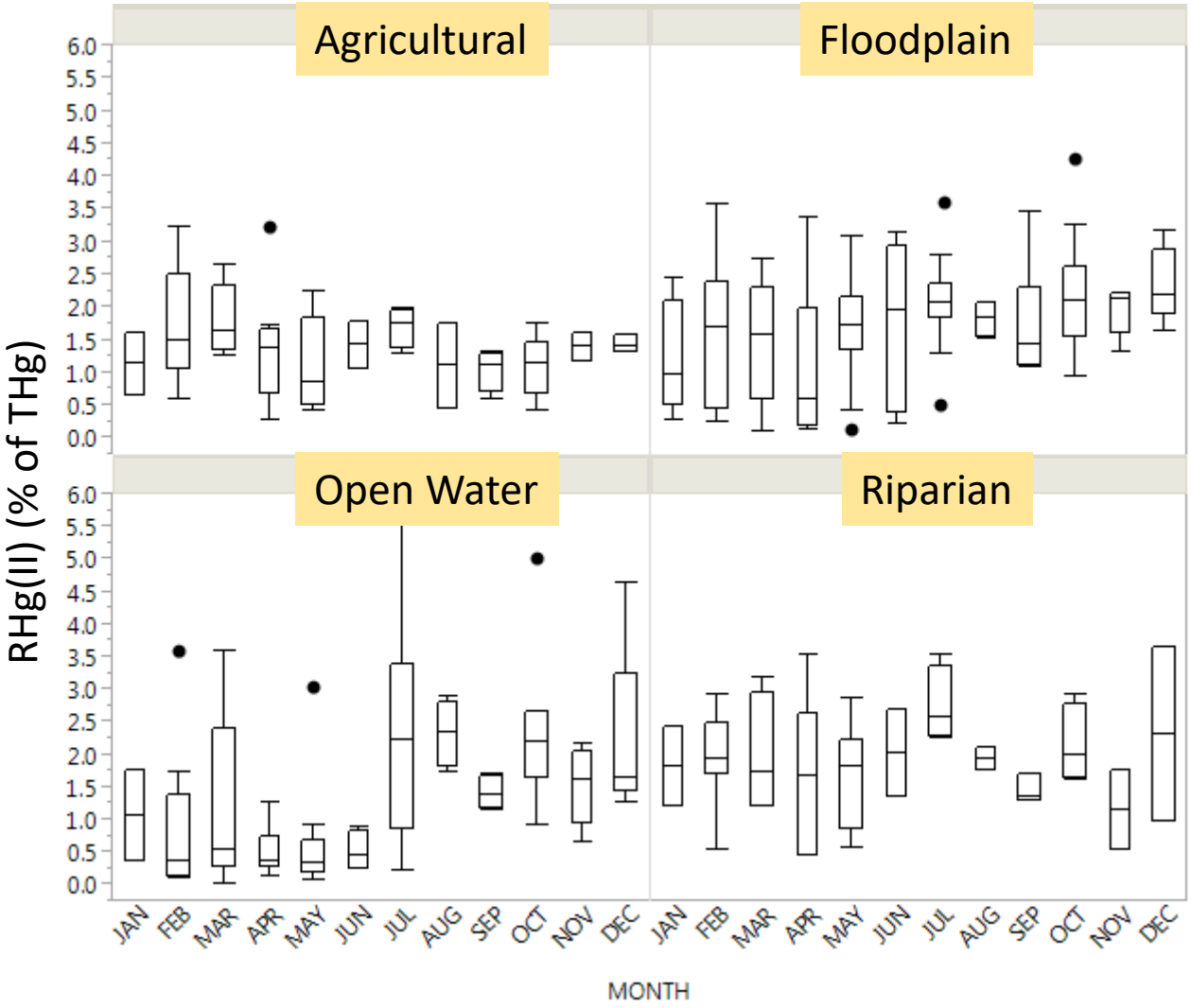
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Percent Reactive Mercury By MONTH & HABITAT (2010-2016 Data)

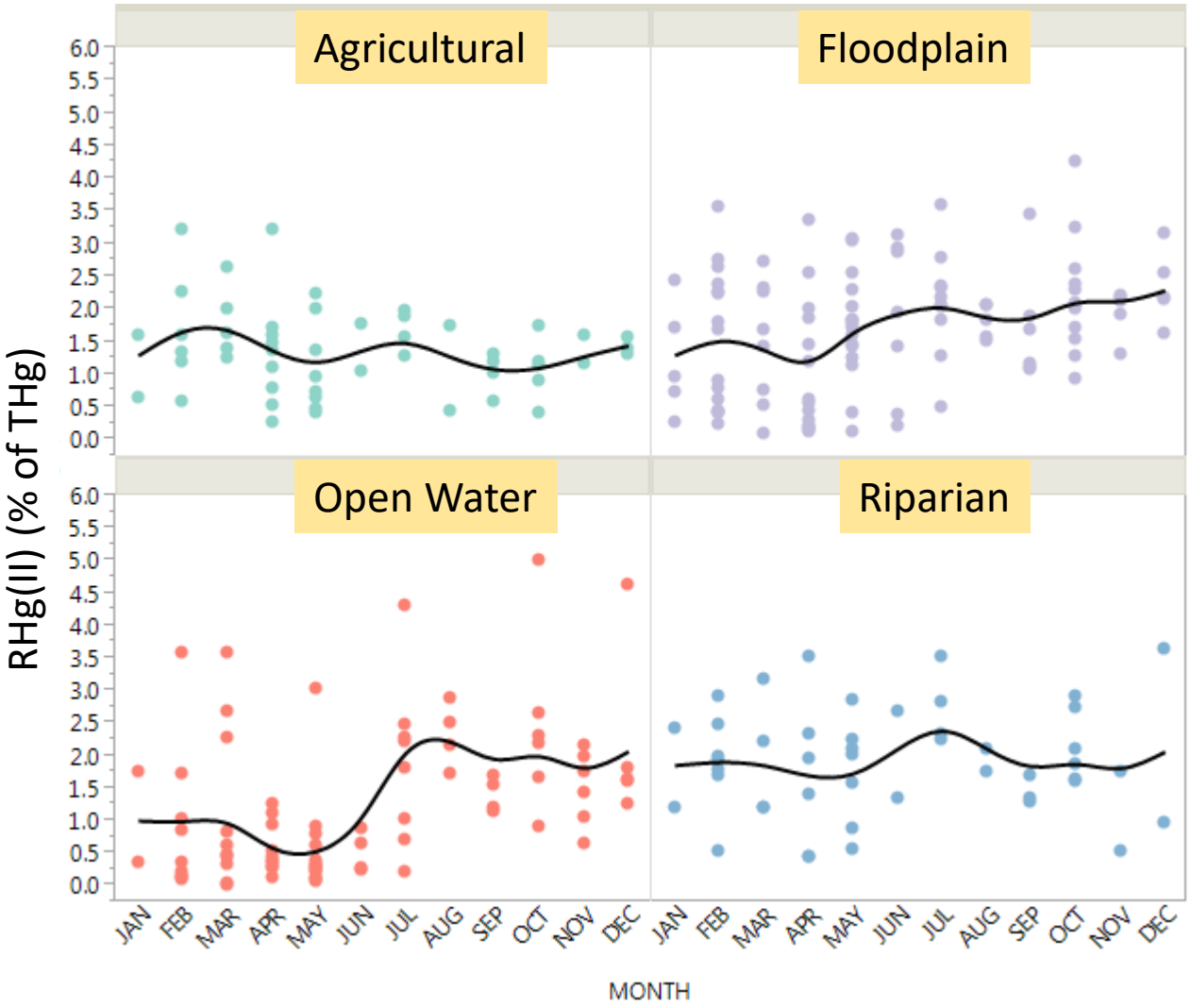
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



Box and Whisker Version with Outliers

Percent Reactive Mercury By MONTH & HABITAT (2010-2016 Data)

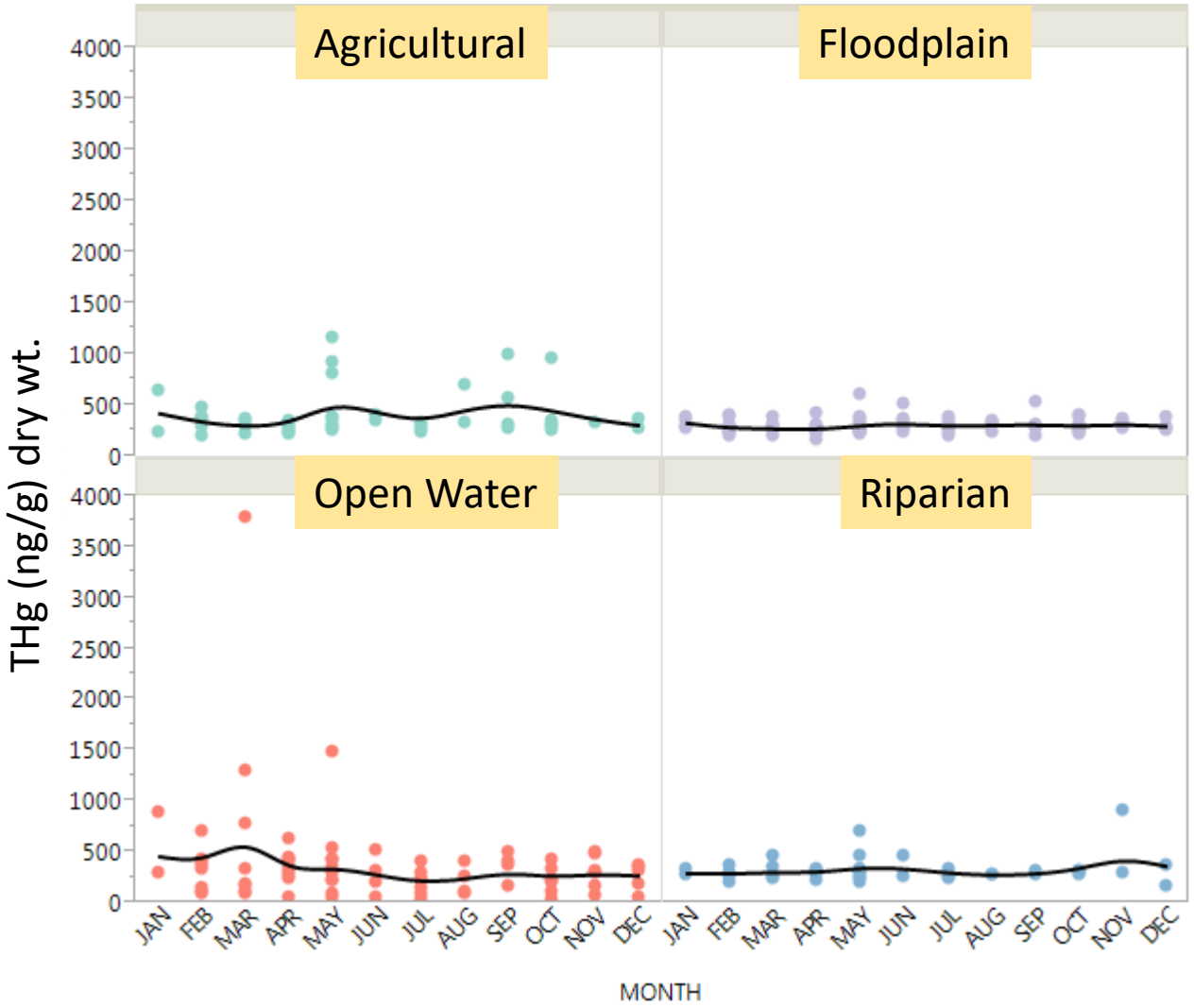
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Total Mercury By MONTH & HABITAT (2010-2016 Data)

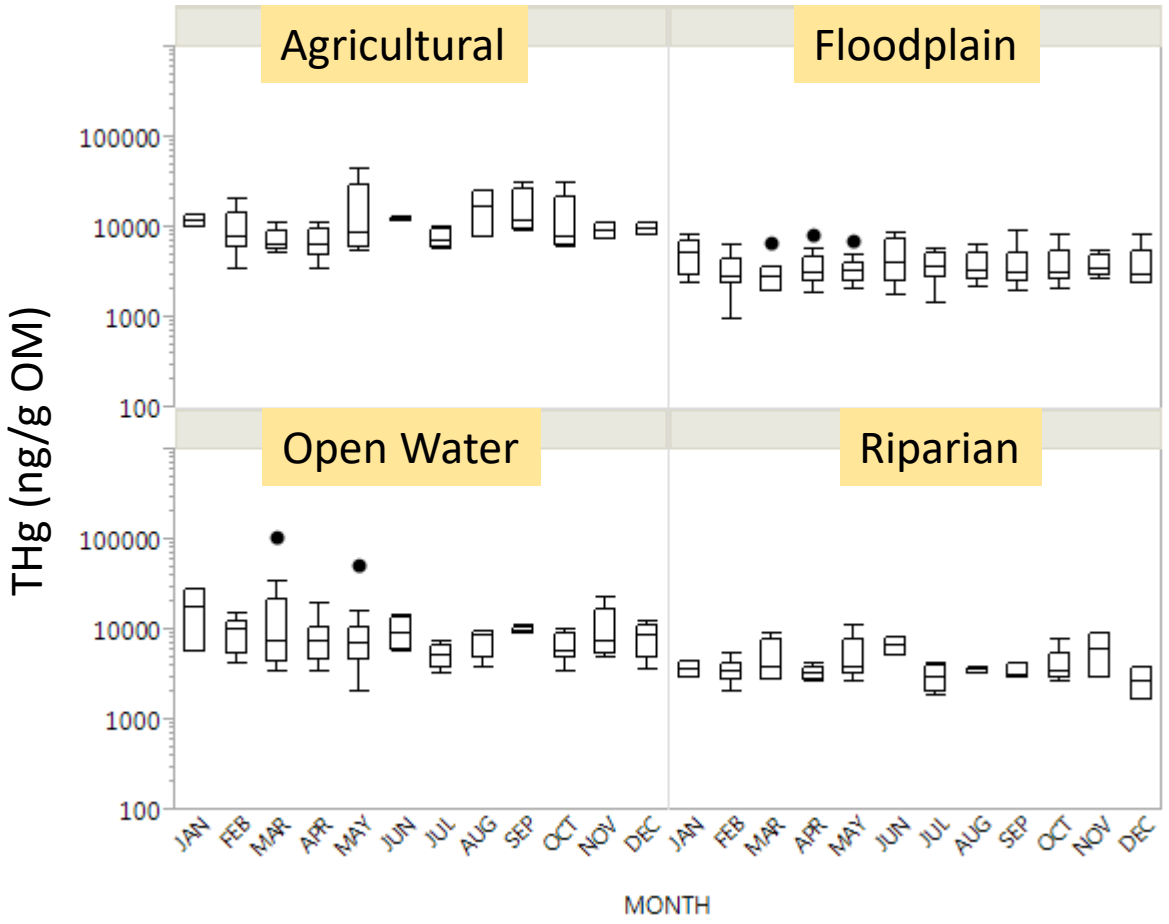
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Total Mercury (normalized by Organic Matter) By MONTH & HABITAT (2010-2016 Data)

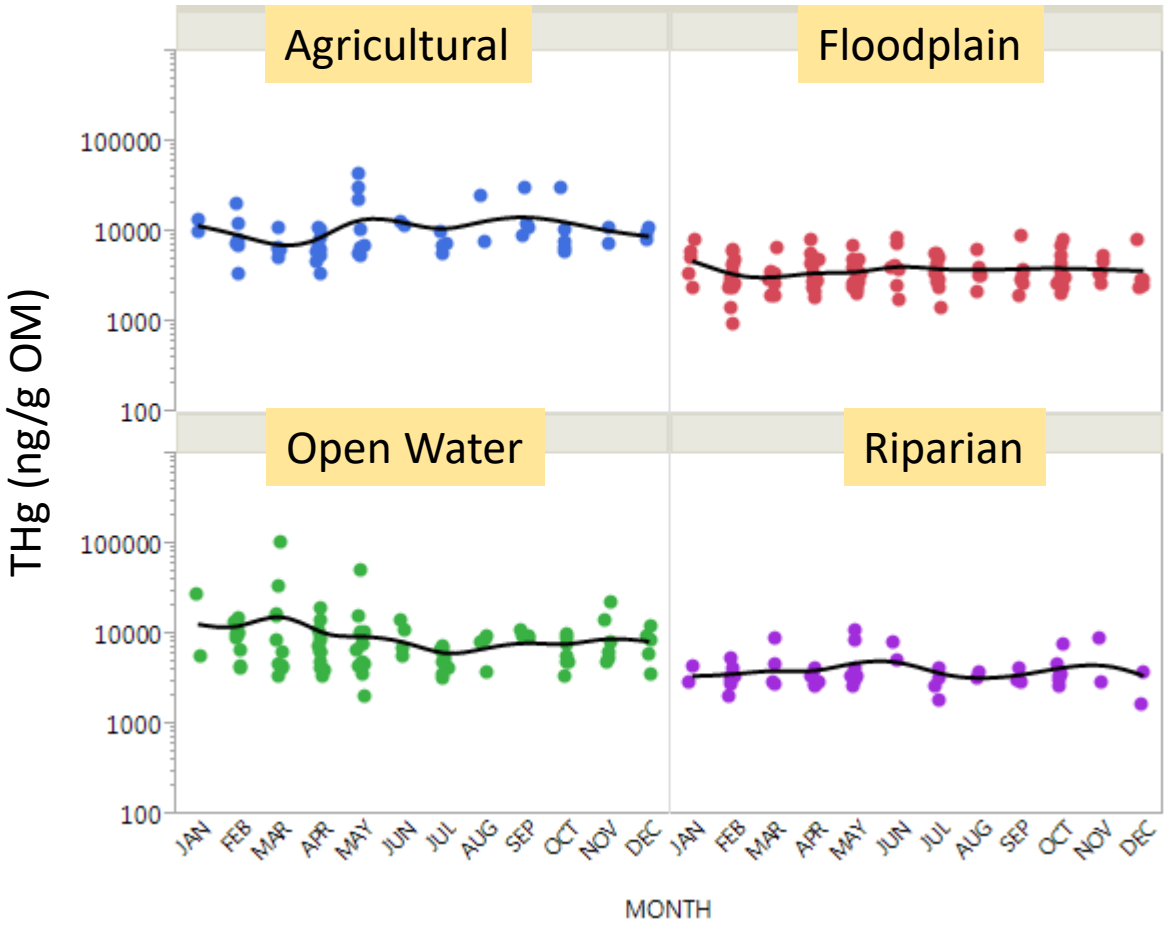
Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Total Mercury (normalized by Organic Matter) By MONTH & HABITAT (2010-2016 Data)

Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
CCSB-T2-LA	Open Water	22
CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
CCSB-T11-LB	Riparian	22
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Reactive Mercury (normalized by Organic Matter) By MONTH & HABITAT (2010-2016 Data)

Site	Habitat	N
CCSB-T11-LC	Floodplain	20
CCSB-T5-LD	Floodplain	20
CCSB-T12-Q	Floodplain	21
CCSB-T5-RC	Floodplain	22
CCSB-T12-H	Floodplain	28
CCSB-T5-LA	Open Water	21
CCSB-T8-LA	Open Water	21
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CCSB-T11-LA	Open Water	23
CCSB-T6-LB	Riparian	26
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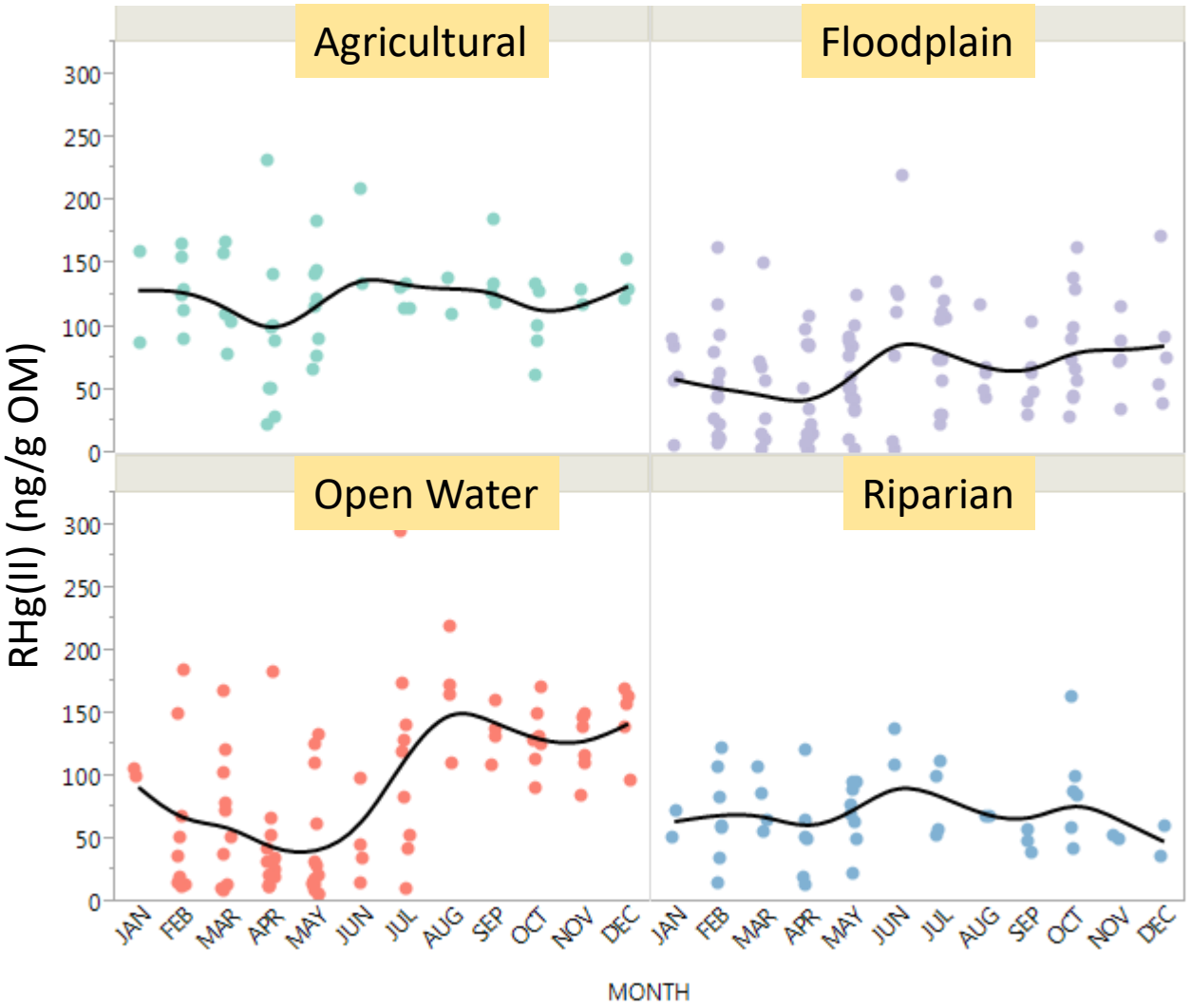
CCSB-T6-LC	Agriculture	29
CCSB-T12-J	Agriculture	23



All data with Smoothing Line

Concluding Remarks

- Mercury studies at CCSB represent a large, multi-disciplinary effort over several years (2010–)
- First comprehensive data on Hg and MeHg loads, trap efficiency
- Spatial and temporal variations in MeHg within basin in shallow sediment and biota (and water)
  - Strong habitat effect
    - Highest MeHg (and organic C) in floodplain & riparian
    - Lowest MeHg (and organic C) in open water & agricultural
  - Temporal trends (seasonal, inter-annual) still being evaluated
- Other aspects of project not discussed today
  - Coring within basin
  - Variations in DOM quantity and quality related to THg and MeHg
  - Bird eggs (2012–15)
  - Effectiveness of coagulants and floc stability