Lower Boise Watershed Council TAC
November 29, 2012

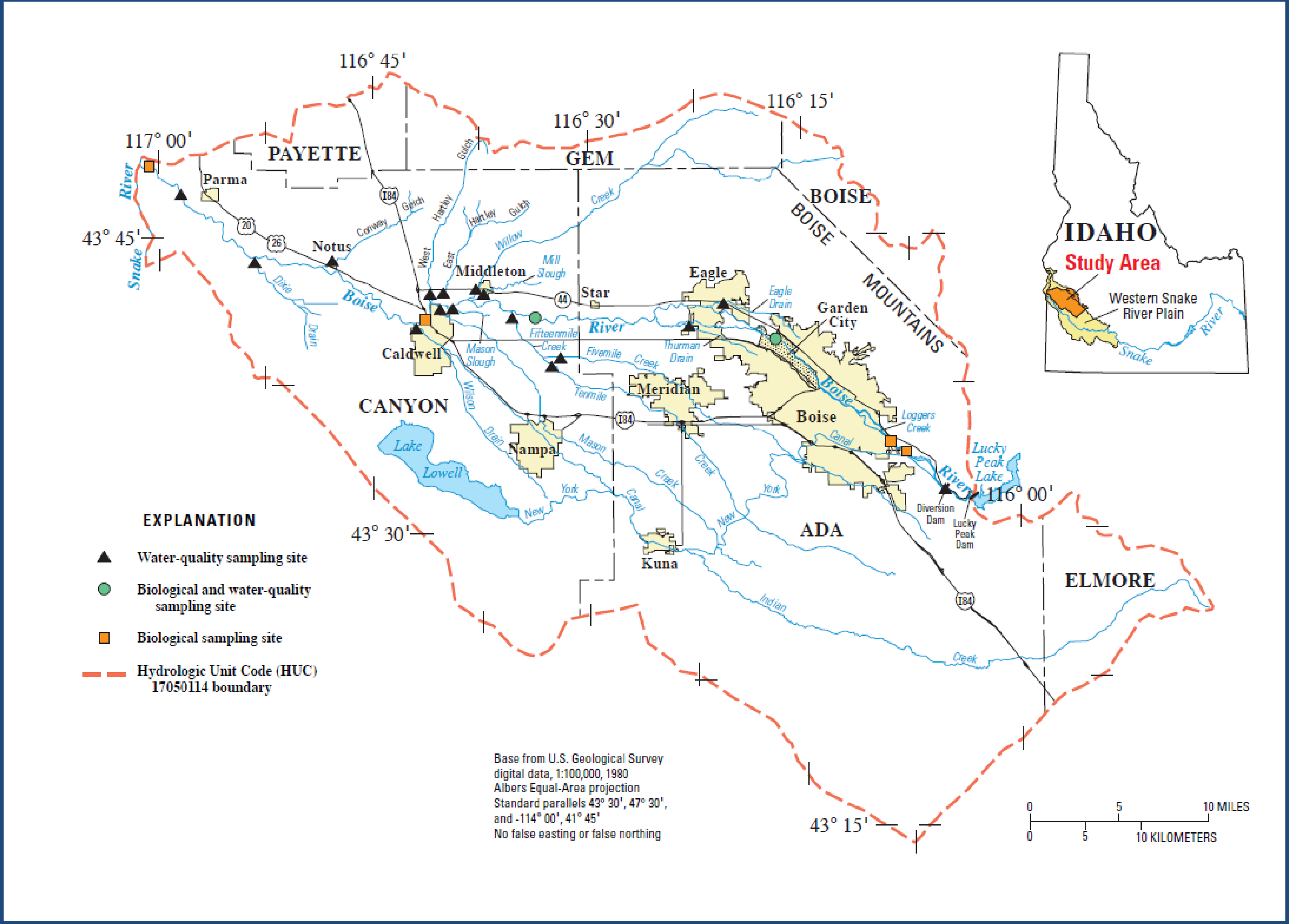
Total Phosphorus TMDL Target Development

"The extent and complexity of the problem does not matter as much as does the willingness to solve it."

-Ralph Marston

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

Lower Boise River Watershed



TMDL Listing and Strategy

Table 1. Phosphorus TMDL Assessment Units in Category 5 of 2010 Integrated Report.

Assessment Unit	Beneficial Use	Impairment
Boise River- Middleton to Indian Creek ID17050114SW005_06b	PCR CWAL	Total Phosphorus
Boise River- Indian Creek to Mouth ID17050114SW001_06	PCR CWAL	Total Phosphorus
Mason Creek-Entire Watershed ID17050114SW006_02	SCR CWAL	Nutrients suspected impairment
Sand Hollow Creek-C-Line Canal to I-84 and Sharp Road -Snake River	SCR	
ID17050114SW016_03	CWAL	Nutrients suspected impairment
ID17050114SW017_06	CWAL	Nutrients suspected impairment(Assessment Data Base)

Idaho Water Quality Standards

- **58.01.02.200.06.** ***Excess Nutrients***. Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.
- What does that mean for the Lower Boise River??

DRAFT Recommendation

Lower Boise River TMDL Targets

- Chl-a: 100 to 150 mg/m^2
- TP: TBD…between 0.07 & $\leq$ 0.15 mg/l

Other Obligations

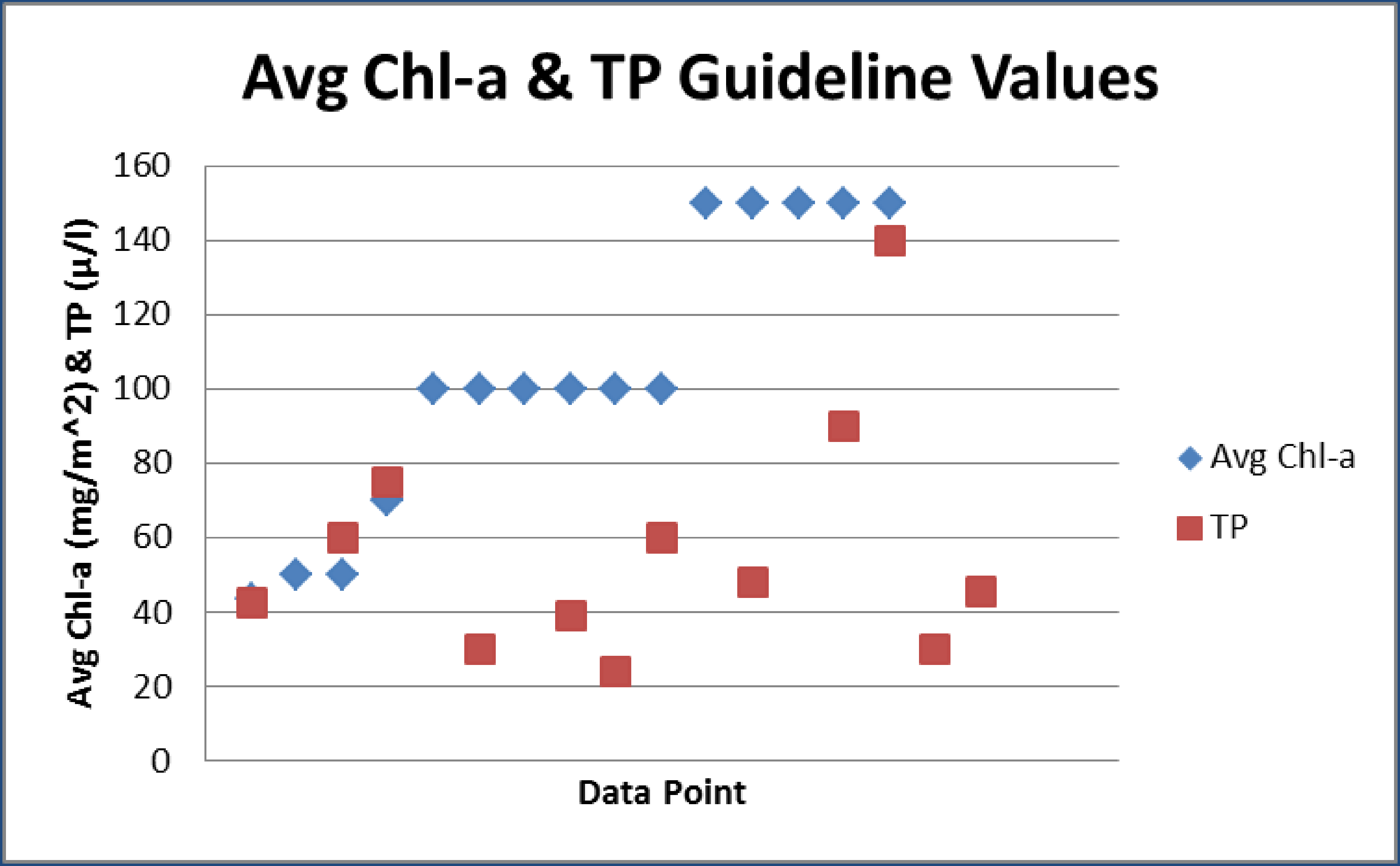
- SR-HC TMDL: 0.07 mg/l TP seasonal (May 1 – September 30)

Table 1. Published Nutrient-Benthic N, P, Sediment, and Algae Targets &/or Correlations in Scientific Literature

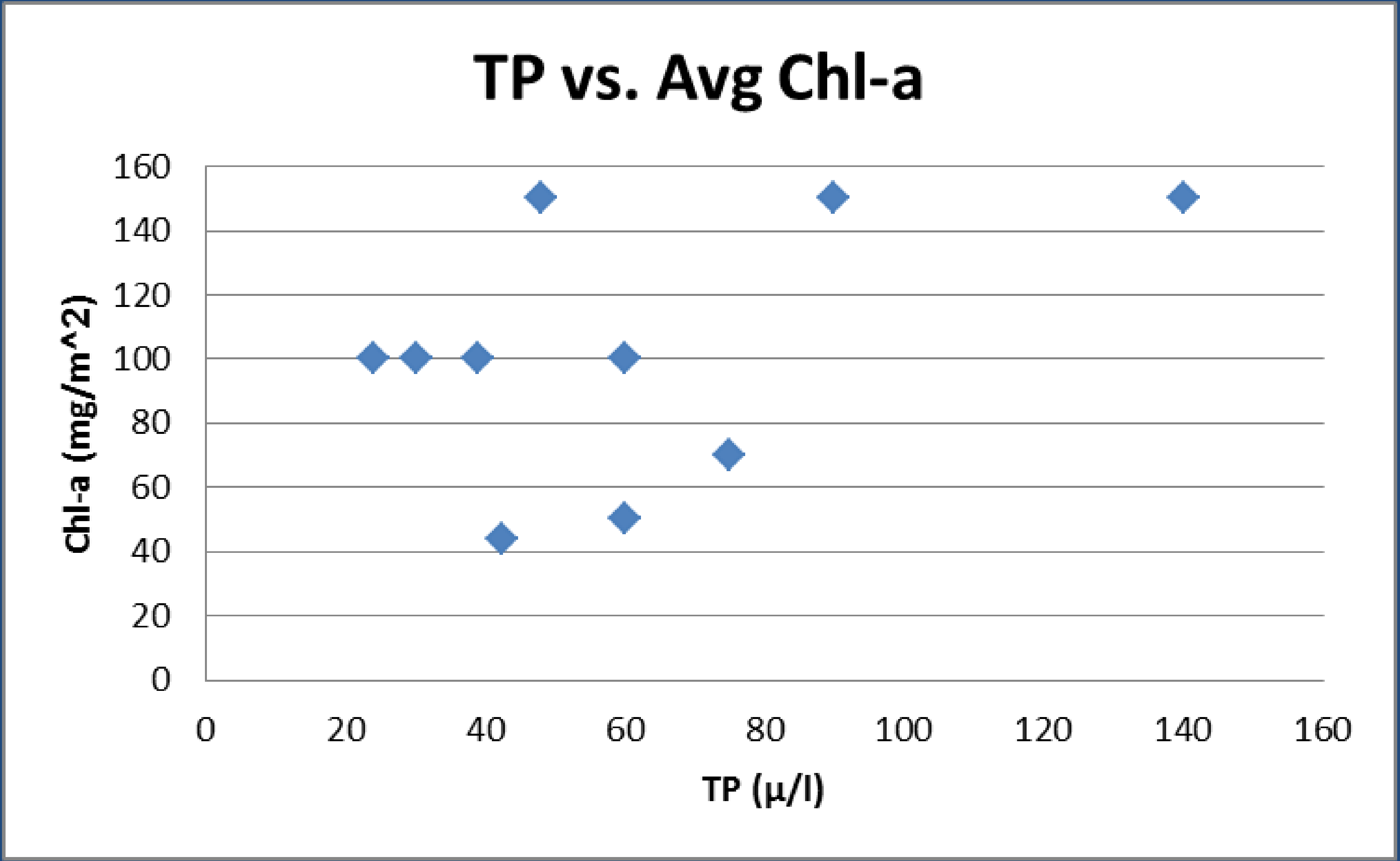
(compiled by Troy Smith, November 16, 2012)

Location	N (TN unless noted)	P (TP unless noted)	Chl-a (Benthic unless noted)	Turbidity	Citation
25 NZ streams and rivers			$\bar{y}$ < 100 mg/m^2 (ben. uses)		Biggs 2000
Clark Fork River, MT	< 350 µ/L	< 30 µ/L	$\bar{y}$ < 100 mg/m^2 y^{max} < 250 mg/m^2		Dodds et al. 1997
200 NA & NZ streams			$\bar{y}$ < 150 mg/m^2		Dodds et al. 1998
Oligotrophic	$\bar{y}$ < 700 µ/L	$\bar{y}$ < 25 µ/L	$\bar{y}$ < 20 mg/m^2 y^{max} < 60 mg/m2		
Mesotrophic	700 < $\bar{y}$ < 1500 µ/L	25 < $\bar{y}$ < 75 µ/L	20 mg/m^2 < $\bar{y}$ < 70 mg/m^2 60 mg/m^2 < y^{max} < 200 mg/m^2		
Eutrophic	$\bar{y}$ > 1500 µ/L	$\bar{y}$ > 75 µ/L	$\bar{y}$ > 70 mg/m^2 y^{max} > 200 mg/m^2		
Published and unpublished data	$\bar{y}$ < 470 µ/L $\bar{y}$ < 3000 µ/L	$\bar{y}$ < 60 µ/L $\bar{y}$ < 400 µ/L	$\bar{y}$ < 50 and y^{max} < 100 mg/m^2 y^{max} < 200 mg/m^2		Dodds and Welch 2000
1 to 82 Snake River Basin streams and rivers	$\bar{y}$ < 544 µ/L (calculated) $\bar{y}$ < 896 µ/L (reported) $\bar{y}$ < 272 µ/L (TKN) $\bar{y}$ < 272 µ/L (NO_{2+3})	$\bar{y}$ < 42.5 µ/L	$\bar{y}$ < 43.9 mg/m^2 $\bar{y}$ < 4.85 µ/L (F) $\bar{y}$ < 3.3 µ/L (T)	1.538 NTU 3.25 FTU	EPA 2000
74 sites in CO	No meaningful relationship between periphyton…and…total or dissolved forms of N or P. Benthic Chl-a more correlated with initial biomass, length of growing season and water temp.				Lewis and McCutchan 2010
12 N. Ozark streams	Benthic Chl-a was positively correlated with both log TN and log TP, and length of flood-free period (graphs provided, but not specific points of correlation).				Lohman et al. 1992
> 100 IL stream and river sites	They could not establish a nutrient-benthic Chl-a relationship.				Royer et al. 2008
MT streams < 6th order, not NE plains	$y^{90th\%}$ < 130 to 320 µ/L $y^{90th\%}$ < 20 to 100 µ/L (NO_{2+3})	$y^{90th\%}$ < 6 to 48 µ/L $y^{90th\%}$ < 2 to 17 µ/L (SRP)	150 mg/m^2 (36 g AFDW/m^2)		Suplee et al. 2008, 2009
MT streams and rivers, not NE plains	$\bar{y}$ < 300 to 1,000 µ/L	$\bar{y}$ < 25 to 140 µ/L	120 mg/m^2 (36 g AFDW/m^2)		Suplee 2012 (February 17, 2012 presentation to Water Pollution Control Advisory Council)
6 WA streams		No relationship with SRP	$\bar{y}$ < 100 to 150 mg/m^2		Welch et al. 1988
BC water quality criteria guidelines	Guidelines based solely on aquatic algal growth because many factors are involved (e.g. water velocity, light, temperature, macroinvertebrate grazing, etc.).		< 50 mg/m^2 – recreation < 100 mg/m^2 – aquatic life		Nordin 1985 (updated 2001)
OR – Statewide			*None for benthic algae *0.015 mg/L for sestonic		Oregon WQS
MT - Clark Fork River Voluntary Nutrient Reduction Plan	$\bar{y}$ < 300 µ/L 15:1 nutrient ratio	$\bar{y}$ < 20 µ/L (upstream) $\bar{y}$ < 39 µ/L (downstream)	$\bar{y}$ < 100 mg/m^2 (summer mean) $\bar{y}$ < 150 mg/m^2 (peak)		Tristate Imp. Council 1998
MT – Clark Fork River	$\bar{y}$ < 350 µ/L	$\bar{y}$ < 45.5 µ/L			Dodds and Smith 1995 (in Clark Fork River Tristate Imp Council 1998)
MT – Clark Fork River	$\bar{y}$ < 300 µ/L	$\bar{y}$ < 20 to 24 µ/L			Suplee et al. 2012

Literature-Based Relationships



Literature-Based Relationships



Montana Survey Results

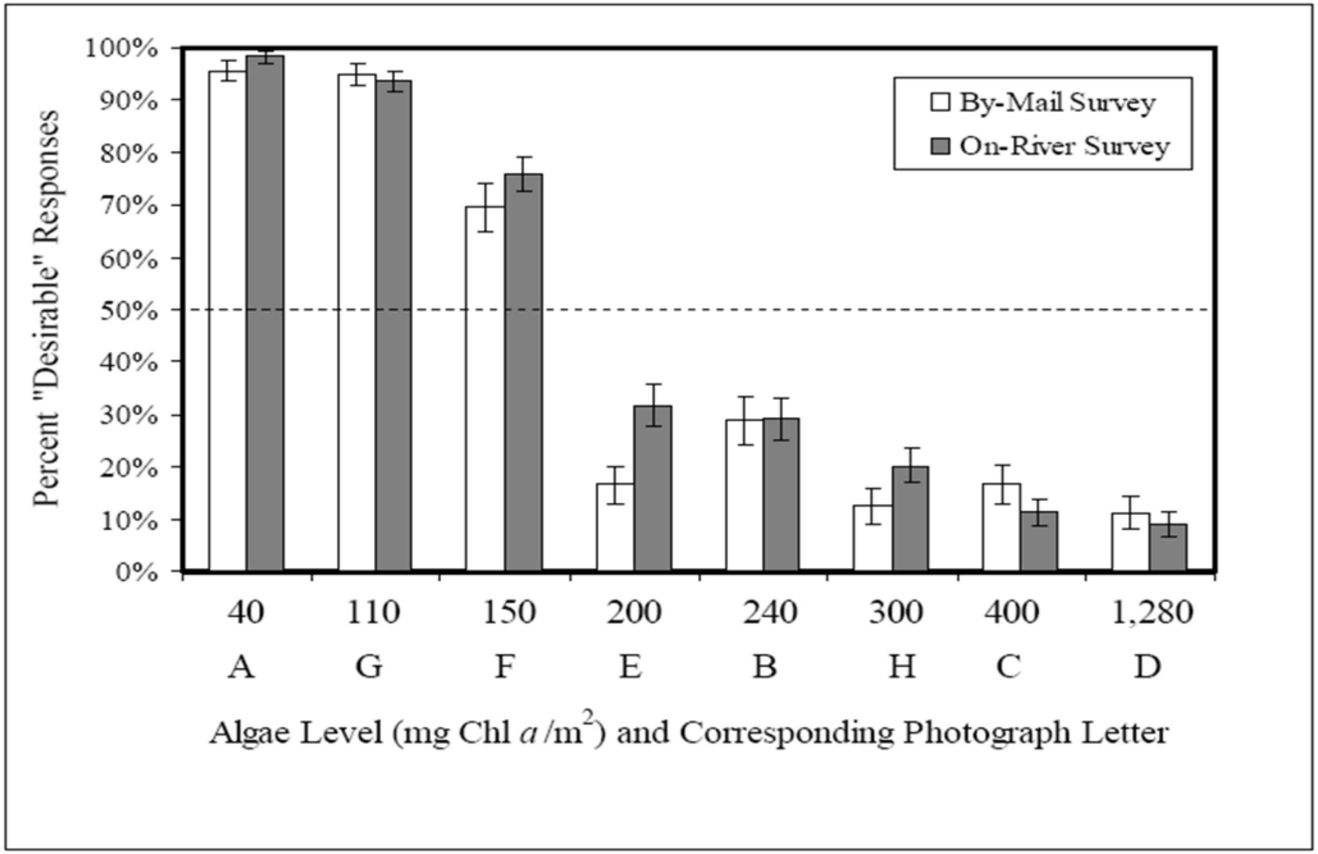


Figure 2. Percent Desirable Responses from the By-Mail and On-River Surveys. Letters designating the survey photographs are sequenced from lowest to highest algae level. Error bars are the 95% confidence level of each proportion, expressed as percent error.

Slide courtesy of Tom Dupuis.

Chl-a ≥ 200 mg/m^2

202

1,276

299

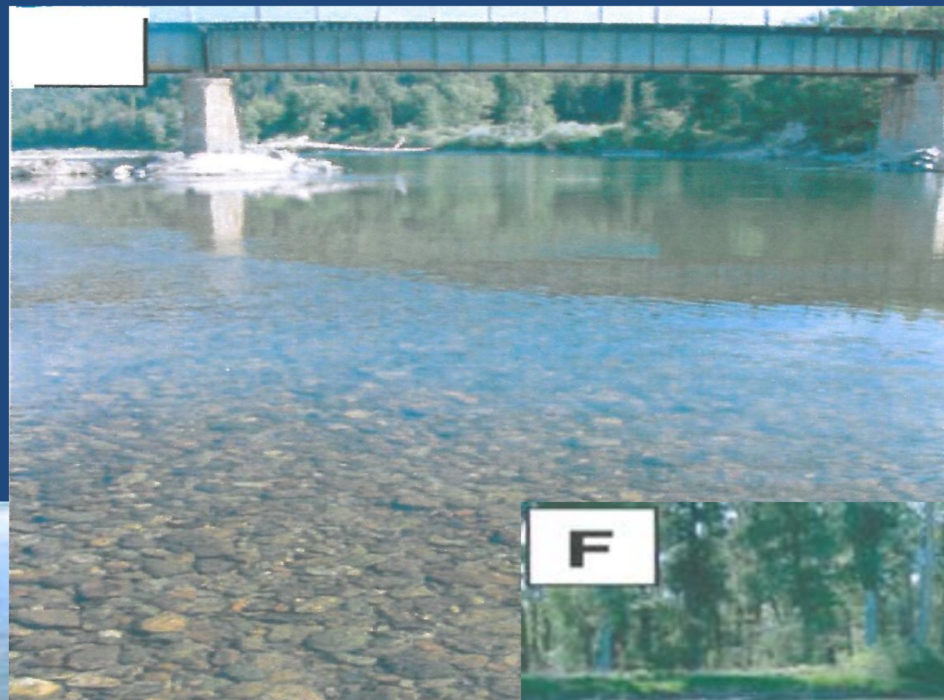
404

235

Photos and data from Suplee et al. 2009

Chl-a $\leq$ 150 mg/m^2

44



112

152

Photos and data from Suplee et al. 2009

Take Home Message from Literature: No Clear TP, Chl-a Relationships

- Why? Confounding factors
  - Geographic location, lab vs. field, temperature, turbidity, stream vs. river, light limitation, flow velocity, duration, magnitude,…
- However…all 100% identified ***Average*** non-nuisance Chl-a as $\leq$ 150 mg/m^2
  - 11 of 15 identified non-nuisance Chl-a as 100 to 150 mg/m^2
- 11 of 13 identified appropriate TP levels as $\leq$ 0.1 mg/l
  - However…Yellowstone River modeled TP targets at 0.09 and 0.14 mg/l

Lower Boise River Data

Table 2. Published Nutrient-Benthic N, P, Sediment, and Algae Correlations on the Lower Boise River
(compiled by Troy Smith, November 16, 2012)

Location	N mg/L	P mg/L	Chl-a Benthic (Benthic unless noted)	TSS	Citation
Diversion	TN 0.15 – 0.51; (0.26) NO_{2+3} 0.05 – 0.31; (0.10)	TP 0.01 – 0.09; (0.04) Ortho. 0.01 – 0.027; (0.01); 45%	<1 – 21; (6)	1 – 38; (4) mg/L	MacCoy 2004 (Median in Parens.)
Glenwood	TN 0.18 – 1.90; (0.45) NO_{2+3} 0.05 – 1.5; (0.26)	TP 0.02 – 0.38; (0.09) Ortho. 0.01 – 0.371; (0.07); 80%	22 – 267; (108)	1 – 107; (5) mg/L	
Middleton	TN 0.38 – 3.51; (0.89) NO_{2+3} 0.18 – 3.0; (0.5)	TP 0.03 – 0.85; (0.15) Ortho. 0.02 – 0.8; (0.13); 88%	23 – 477; (271)	2 – 211; (6) mg/L	
Parma	TN 0.62 – 5.33; (2.17) NO_{2+3} 0.42 – 4.56; (1.62)	TP 0.08 – 0.55; (0.30) Ortho. 0.06 – 0.51; (0.22); 76%	13 – 300; (173)	8 – 245; (45) mg/L	
Diversion	NO_{2+3} 0.06 – 2.6; (0.15)	TP 0.02 – 0.16; (0.04) Ortho. 0.00 – 0.04; (0.01)		4 – 108; (20) mg/L	BOR 1977 (Mean in Parentheses)
Glenwood	NO_{2+3} 0.1 – 0.54; (0.23)	TP 0.04 – 0.86; (0.22) Ortho. 0.01 – 0.78; (0.16)		2 – 64; (15) mg/L	
Middleton	NO_{2+3} 0.26 – 0.37; (0.31)	TP 0.08 – 0.10; (0.09) Ortho. 0.03 – 0.05; (0.04)			
Diversion	TN (0.2)	TP (0.02)		(5) mg/L	Mullins 1998 (Median in Parentheses)
Glenwood	TN (0.4)	TP (0.08)		(12) mg/L	
Middleton	TN (0.7)	TP (0.15)		(7) mg/L	
Parma	TN (2.0)	TP (0.27)		(47) mg/L	
Parma	TN 0.84 – 4.53; (2.24, 2.34) NO_{2+3} 0.49 – 4.15; (1.75, 1.83)	TP 0.15 – 0.53; (0.30, 0.28) Ortho. 0.02 – 0.42; (0.24, 0.22)	2.6 – 22.9; (8.2, 6.1) **(Sestonic)	7 – 99; (35, 46) mg/L	Wood and Etheridge 2011 (Median in Parentheses '09&'10)

Table 6. Summary statistics for data collected at water-quality sampling sites on the lower Boise River, Idaho, 1994–2002

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; C, Celsius; N, nitrogen; P, phosphorus; mg/m², milligrams per square meter; mL, milliliters; MPN, most probable number]

	Diversion				Glenwood				Middleton				Parma			
Constituent	No. of samples	Mean	Me-dian	Range	No. of sam-ples	Mean	Me-dian	Range	No. of samples	Mean	Me-dian	Range	No. of samples	Mean	Median	Range
Instantaneous discharge, cubic feet per second	61	2,165	1,780	144 - 7,800	75	1,629	951	167 - 7,140	57	1,101	445	170 - 5,640	65	1,921	1,110	377 - 8,000
Dissolved oxygen, mg/L	60	11.5	11.6	9.1 - 14.6	74	11.5	11.4	8.4 - 15.8	57	12.1	11.7	8.8 - 15.7	64	10.4	10.2	6.7 - 16.2
Dissolved oxygen saturation, percent	60	110	107	97 - 145	74	115	116	95 - 146	57	119	115	90 - 116	64	106	102	77 - 138
pH, standard units	61	7.6	7.6	6.6 - 8.5	74	8.0	8.0	7.0 - 8.9	56	8.1	8.0	6.7 - 9.1	64	8.1	8.0	7.3 - 8.9
Specific conductance, µS/cm	61	74	75	51 - 109	75	100	90	52 - 197	57	163	136	74 - 314	64	351	343	128 - 585
Water temperature, degrees C	61	10.0	9.2	1.6 - 18.8	75	11.6	11.5	2.8 - 23.0	57	11.6	12	2.7 - 22.5	64	12.6	12.1	3.4 - 31.5
Dissolved ammonia, mg/L as N	61	0.03	0.02	0.02 - 0.07	75	0.03	0.02	0.004 - 0.07	57	0.03	0.02	0.02 - 0.10	62	0.04	0.04	0.02 - 0.21
Total ammonia plus organic, mg/L as N	61	0.16	0.17	0.09 - 0.26	75	0.23	0.20	0.10 - 0.53	57	0.29	0.27	0.13 - 0.64	62	0.50	0.48	0.20 - 1.21
Dissolved nitrite plus nitrate, mg/L as N	61	0.11	0.10	0.05 - 0.31	75	0.34	0.26	0.05 - 1.5	57	1.09	0.5	0.18 - 3.0	62	2.08	1.62	0.42 - 4.56
Total nitrogen, mg/L as N	61	0.27	0.26	0.15 - 0.51	75	0.56	0.45	0.18 - 1.90	57	1.37	0.89	0.38 - 3.51	62	2.57	2.17	0.62 - 5.33
Percent dissolved nitrogen	61	39	38	18 - 68	75	39	57	28 - 79	57	70	66	44 - 92	62	76	75	41 - 94
Total nitrogen load, pounds per day	61	3,629	2,250	151 - 19,250	75	3,710	2,230	650 - 19,980	57	4,550	3,760	856 - 14,820	62	18,990	17,171	4,180 - 51,930
Total phosphorus, mg/L as P	61	0.03	0.04	0.01 - 0.09	75	0.11	0.09	0.02 - 0.38	57	0.25	0.15	0.03 - 0.85	62	0.29	0.30	0.08 - 0.55
Dissolved orthophosphorus, mg/L as P	61	0.02	0.01	0.01 - 0.027	75	0.09	0.07	0.01 - 0.371	57	0.22	0.13	0.02 - 0.8	62	0.23	0.22	0.06 - 0.51
Percent dissolved orthophosphorus	61	54	45	17 - 100	75	75	80	8 - 100	57	81	88	14 - 100	62	75	76	40 - 100
Total phosphorus load, pounds per day	61	400	220	13 - 3,400	75	560	440	82 - 2,690	57	770	710	230 - 3,780	62	2,300	1,980	550 - 7,320
Average chlorophyll-*a*, mg/m²	8	9	6	<1 - 21	8	116	108	22-267	8	264	271	23-477	8	159	173	13-300
Suspended sediment, mg/L	58	6	4	1 - 38	71	12	5	1 - 107	52	15	6	2 - 211	63	53	45	8 - 245
Suspended sediment load, tons per day	58	40	10	1-720	71	90	10	1 - 1,020	52	90.0	10	2.3 - 2,060	63	320.0	140	18 - 1,560
Fecal coliform, colonies per 100 mL	57	2	1	1 - 29	70	89	43	4 - 1,030	53	216	73	3 - 3,950	59	697	440	44 - 3,600
E. Coli, MPN per 100 mL	17	2	1	1 - 8	19	33	23	2 - 150	20	311	42	3 - 4,800	18	208	79	21 - 1,000

MacCoy. 2004. Water-quality and biological conditions in the lower Boise River, Ada and Canyon Counties, Idaho, 1994-2002.

Table 4. Statistical summary of total nitrogen concentrations and instantaneous loads in samples from sites in the lower Boise River Basin, May 1994 through February 1997

[Sampling site locations are shown by reference number in figure 1 and are listed in table 3; N, nitrogen; WTF, wastewater treatment facility]

Sampling site reference number	Site name	Number of samples	Concentration or instantaneous load at indicated percentile			Maximum concentration or instantaneous load
			25	50	75	
Total nitrogen, milligrams per liter as N						
1	Boise River below Diversion Dam	20	0.2	0.2	0.3	0.5
3	Lander Street WTF	18	13.8	14.9	17.1	20.8
4	Boise River at Glenwood Bridge	25	.3	.4	.5	1.9
5	West Boise WTF	18	14.1	19.2	23.0	25.2
6	Eagle Drain at Eagle	5	1.5	1.9	2.5	2.7
7	Thurman Drain near Eagle	5	2.0	2.3	3.9	4.1
8	Boise River near Middleton	20	.5	.7	1.9	3.1
9	Fifteenmile Creek at mouth	18	1.8	3.2	4.9	7.3
10	Mill Slough below Grade Ditch	5	2.1	2.7	4.2	4.3
11	Willow Creek at Middleton	18	.8	1.1	2.3	3.9
12	Mason Slough at mouth	5	2.2	3.7	4.5	4.9
13	Mason Creek at mouth	18	3.75	4.7	5.7	6.9
14	West Hartley Gulch near Caldwell	18	1.6	2.8	4.5	5.8
15	East Hartley Gulch near Caldwell	18	3.0	3.9	5.1	6.0
17	Caldwell WTF	17	9.1	11.1	12.6	15.3
18	Indian Creek at mouth	18	3.1	4.2	7.0	7.7
19	Conway Gulch at Notus	18	3.7	4.9	5.7	6.3
20	Dixie Drain at mouth	18	2.3	2.9	5.3	6.2
21	Boise River near Parma	21	1.2	2.0	3.5	4.6

Mullins. 1998. Water-quality conditions of the lower Boise River, Ada and Canyon Counties, Idaho, May 1994-1997.

Table 5. Statistical summary of total phosphorus concentrations and instantaneous loads in samples from sites in the lower Boise River Basin, May 1994 through February 1997

[Sampling site locations are shown by reference number in figure 1 and are listed in table 3; P, phosphorus; WTF, wastewater treatment facility]

Sampling site reference number	Site name	Number of samples	Concentration or instantaneous load at indicated percentile			Maximum concentration or instantaneous load
			25	50	75	
	Total phosphorus, milligrams per liter as P					
1	Boise River below Diversion Dam	20	0.01	0.02	0.03	0.09
3	Lander Street WTF	18	3.50	3.70	4.60	6.50
4	Boise River at Glenwood Bridge	25	.05	.08	.11	.30
5	West Boise WTF	18	5.52	6.60	8.00	12.00
6	Eagle Drain at Eagle	5	.15	.17	.22	.23
7	Thurman Drain near Eagle	5	.09	.13	.17	.19
8	Boise River near Middleton	20	.07	.15	.40	.85
9	Fifteenmile Creek at mouth	18	.25	.30	.33	.41
10	Mill Slough below Grade Ditch	5	.17	.20	.25	.27
11	Willow Creek at Middleton	18	.17	.19	.29	.34
12	Mason Slough at mouth	5	.16	.35	.49	.62
13	Mason Creek at mouth	18	.20	.22	.40	.93
14	West Hartley Gulch near Caldwell	18	.20	.31	.39	.45
15	East Hartley Gulch near Caldwell	18	.23	.26	.29	.37
17	Caldwell WTF	17	3.70	4.50	4.90	6.70
18	Indian Creek at mouth	18	.36	.43	.52	.82
19	Conway Gulch at Notus	18	.17	.19	.35	.44
20	Dixie Drain at mouth	18	.27	.33	.39	.55
21	Boise River near Parma	21	.17	.27	.38	.55

Mullins. 1998. Water-quality conditions of the lower Boise River, Ada and Canyon Counties, Idaho, May 1994-1997.

Table 6. Statistical summary of suspended sediment concentrations and instantaneous loads in samples from sites in the lower Boise River Basin, May 1994 through February 1997

[Sampling site locations are shown by reference number in figure 1 and are listed in table 3; WTF, wastewater treatment facility]

Sampling site reference number	Site name	Number of samples	Concentration or instantaneous load at indicated percentile			Maximum concentration or instantaneous load
			25	50	75	
	Suspended sediment, milligrams per liter					
1	Boise River below Diversion Dam	20	2	5	7	38
3	Lander Street WTF	18	6	9	12	17
4	Boise River at Glenwood Bridge	25	4	12	23	67
5	West Boise WTF	18	4	7	9	11
6	Eagle Drain at Eagle	5	9	64	82	90
7	Thurman Drain near Eagle	5	11	11	16	20
8	Boise River near Middleton	20	4	7	18	211
9	Fifteenmile Creek at mouth	18	18	66	156	518
10	Mill Slough below Grade Ditch	5	26	48	57	62
11	Willow Creek at Middleton	18	13	59	133	357
12	Mason Slough at mouth	5	64	112	165	202
13	Mason Creek at mouth	18	42	100	209	525
14	West Hartley Gulch near Caldwell	18	11	25	79	248
15	East Hartley Gulch near Caldwell	18	31	55	79	157
17	Caldwell WTF	17	8	11	14	20
18	Indian Creek at mouth	18	35	43	81	176
19	Conway Gulch at Notus	18	37	89	217	425
20	Dixie Drain at mouth	18	29	69	128	460
21	Boise River near Parma	21	19	47	84	245

Mullins. 1998. Water-quality conditions of the lower Boise River, Ada and Canyon Counties, Idaho, May 1994-1997.

Table 1. Means and ranges for selected water-quality constituents reported by the Bureau of Reclamation in 1977 for sites in the lower Boise River Basin that correspond with sites measured by the U.S. Geological Survey from May 1994 through February 1997

[Mean values are listed on the top line for each site; ranges are listed in parentheses; values and ranges are from laboratory analyses unless identified as a field analysis; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Dis., dissolved; col/100 mL, colonies per 100 milliliters; —, no data]

Sampling site name	Field pH (standard units)	Field specific conductance (µS/cm)	Dis. nitrite plus nitrate (mg/L)	Total phosphorus (mg/L)	Dis. ortho-phosphorus (mg/L)	Suspended sediment (mg/L)	Total coliform (col/100 mL)	Fecal coliform (col/100 mL)
Boise River below Lucky Peak Dam[1]	[2]7.2 (6.57–7.61)	77 (50–100)	0.15 (0.06–2.6)	0.04 (0.02–0.16)	0.01 (0–0.04)	20 (4–108)	151 (0–1,030)	1 (0–10)
Boise River at Glenwood Bridge near Boise	[2]7.48 (7.06–7.92)	106 (63–174)	0.23 (0.1–0.54)	0.22 (0.04–0.86)	0.16 (0.01–0.78)	15 (2–64)	4,787 (28–40,000)	886 (0–16,000)
Eagle Drain at Eagle	[2]7.55 (7.20–7.96)	281 (220–360)	1.03 (0.47–1.75)	0.18 (0.09–0.26)	0.12 (0.05–0.17)	23 (4–74)	4,106 (600–22,000)	570 (0–1,940)
Thurman Drain near Eagle	[2]7.89 (7.57–8.38)	493 (380–600)	2.27 (1.12–3.47)	0.15 (0.09–0.20)	0.11 (0.07–0.14)	297 (180–368)	2,203 (80–22,200)	153 (0–1,200)
Boise River near Middleton	7.1 (6.9–7.4)	96 (90–102)	0.31 (0.26–0.37)	0.09 (0.08–0.10)	0.04 (0.03–0.05)	— —	3,150 (400–5,900)	495 (270–720)
Fifteenmile Creek at mouth near Middleton[3]	7.7 (7.0–8.6)	429 (185–705)	1.86 (0.71–3.28)	0.39 (0.13–0.81)	0.27 (0.09–0.45)	64 (2–208)	10,914 (1,000–46,000)	1,829 (0–18,800)
Mill Slough below Grade Ditch near Middleton[4]	7.63 (6.96–8.02)	372 (180–610)	1.62 (0.53–2.91)	0.27 (0.16–0.8)	0.15 (0.02–0.25)	44 (6–180)	6,448 (340–45,000)	1,068 (100–8,200)
Willow Creek at Highway 44 at Middleton	7.5 (7.4–7.7)	265 (100–730)	0.85 (0.15–2.42)	0.41 (0.20–0.84)	0.22 (0.05–0.3335)	165 (2–1,493)	120 (120–49,000)	15 (15–9,000)
Mason Slough at mouth near Caldwell[5]	[2]7.87 (7.42–8.5)	536 (360–740	1.21 (0.53–2.12)	0.35 (0.10–1.21)	0.26 (0.05–1.00)	33 (2–128)	7,403 (100–50,000)	1,142 (2–18,400)
Mason Creek at mouth near Caldwell[6]	8.2 (8.1–8.4)	567 (240–860)	2.92 (1.47–4.83)	0.41 (0.14–1.67)	0.22 (0.08–0.99)	82 (8–264)	14,818 (400–123,000)	3,181 (30–75,200)
West Hartley Drain (Gulch) near Caldwell	7.5 (6.8–8.1)	454 (220–710)	1.95 (0.49–4.13)	0.49 (0.09–1.3)	0.35 (0.04–0.7)	55 (6–160)	14,958 (200–62,000)	2,968 (0–24,000)
East Hartley Drain (Gulch) near Caldwell	[2]7.87 (7.24–8.78)	668 (345–1,000)	2.01 (0.89–3.51)	0.38 (0.26–0.75)	0.24 (0.16–0.36)	82 (15–268)	15,978 (1,600–100,000)	5,148 (0–48,400)
Indian Creek at mouth near Caldwell	7.8 (7.2–8.2)	600 (240–840)	2.42 (0.73–3.93)	0.42 (0.25–0.75)	0.28 (0.08–0.50)	66 (4–338)	30,328 (300–730,000)	2,921 (50–60,000)
Conway Gulch at Notus	[2]7.9 (7.5–8.3)	787 (395–1,145)	2.86 (1.62–4.05)	0.49 (0.17–2.42)	0.22 (0.15–1.1)	173 (6–926)	12,318 (100–164,000)	740 (10–3,300)
Dixie Drain near Wilder	8.2 (8.0–8.4)	649 (330–900)	1.90 (0.75–3.55)	0.43 0.17–1.46)	0.23 (0.08–0.65)	70 (13–214)	134,224 (1,000–1,200,000)	4,180 (50–70,000)

[1] Closest upstream site to Boise River below Diversion Dam.
[2] Lab pH values; no or insufficient field pH values were reported.
[3] Identified as Tenmile Creek in Bureau of Reclamation report (1977).
[4] Combined North and South Middleton Drain in Bureau of Reclamation report (1977).
[5] Combined Mason Creek North Channel and Mason Creek South Channel in Bureau of Reclamation report (1977).
[6] Mason Drain in Bureau of Reclamation report (1977).

Bureau of Reclamation. 1977. Water quality study, Boise Valley, v. 2. 117 p. (Table 1, in Mullins 1998).

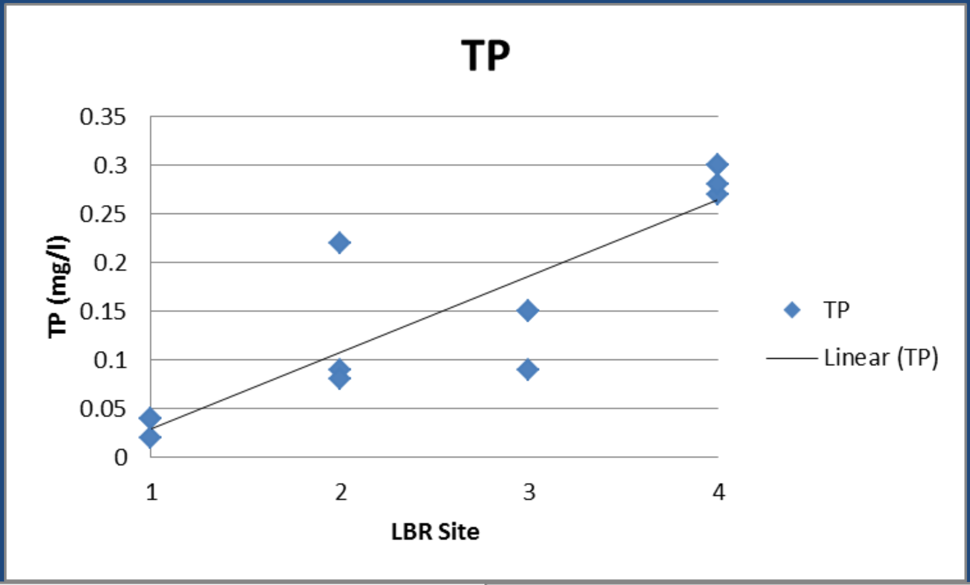
Table 5. Summary of water-quality sample data collected in the Boise River near Parma, Idaho; Snake River near Adrian, Oregon; Snake River at Nyssa, Oregon; Owyhee River; and 301 Drain, water years 2009–10.

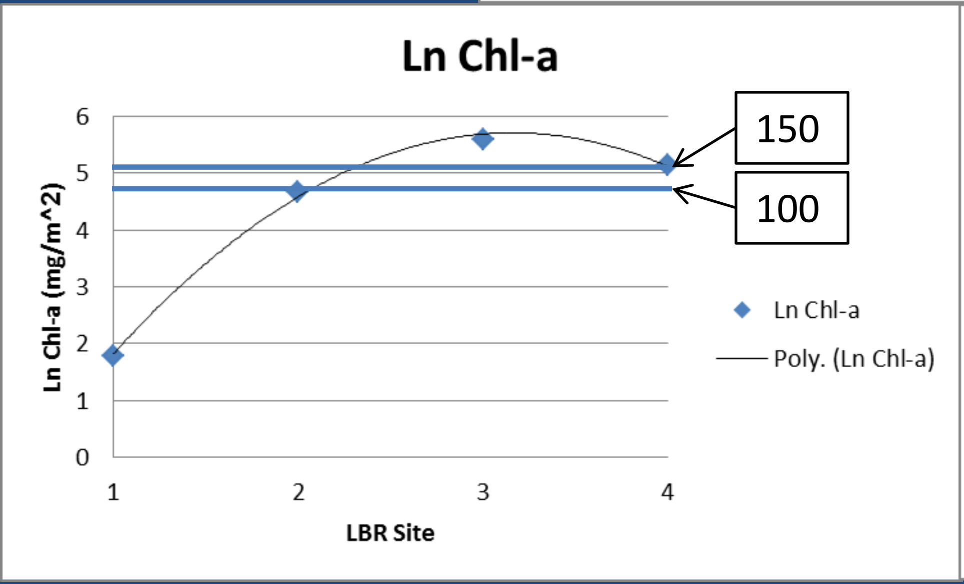
[**Abbreviations**: mg/L, milligrams per liter; µg/L, micrograms per liter, ; WY, water year; EWI, equal width increment; <, less than; E, estimated; –, no data]

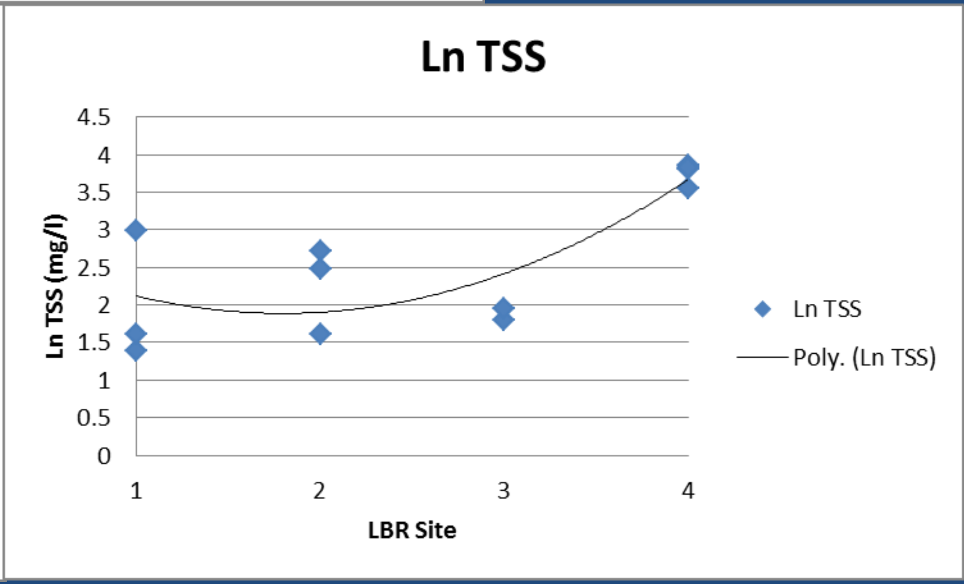
Abbreviated site name	Sample type	Statistic	Total phosphorus (mg/L as phosphorus)	Dissolved orthophosphorus (mg/L as phosphorus)	Total nitrogen (mg/L as nitrogen)	Dissolved nitrate plus nitrite (mg/L as nitrogen)	Dissolved ammonia (mg/L as nitrogen)	Suspended sediment (mg/L)	Chlorophyll-*a* (µg/L)
Parma	EWI	Median, WY09	0.30	0.24	2.24	1.75	0.012 E	35	8.2
		Median, WY10	0.28	0.22	2.34	1.83	0.014 E	46	6.1
		Range	0.15–0.53	0.019–0.42	0.84–4.53	0.49–4.15	<0.01–0.148	7–99	2.6–22.9
		Number of samples	74	73	74	72	73	29	72
	Autosample	Median, WY09	0.34	–	2.44	–	–	–	–
		Median, WY10	0.30	–	2.84	–	–	–	–
		Range	0.09–0.62	–	0.79–4.86	–	–	–	–
		Number of samples	345	–	345	–	–	–	–

Wood and Etheridge. 2011. Water-quality conditions near the confluence of the Snake and Boise Rivers, Canyon County, Idaho.

Lower Boise River-Specific

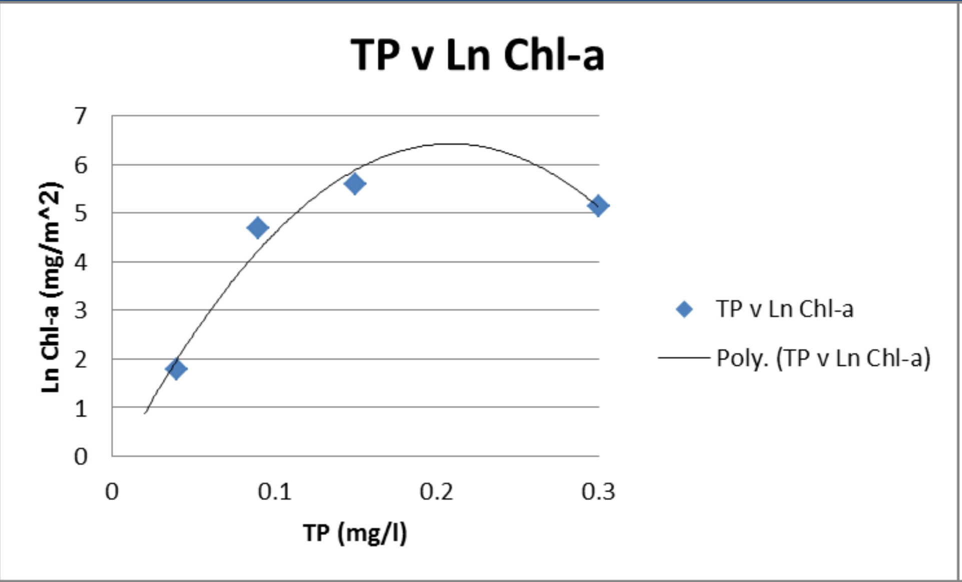


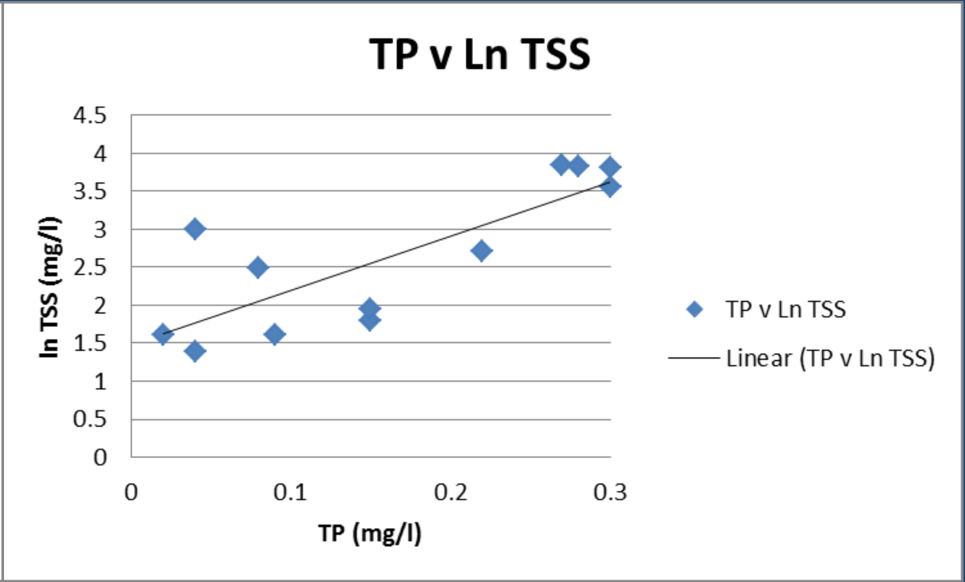


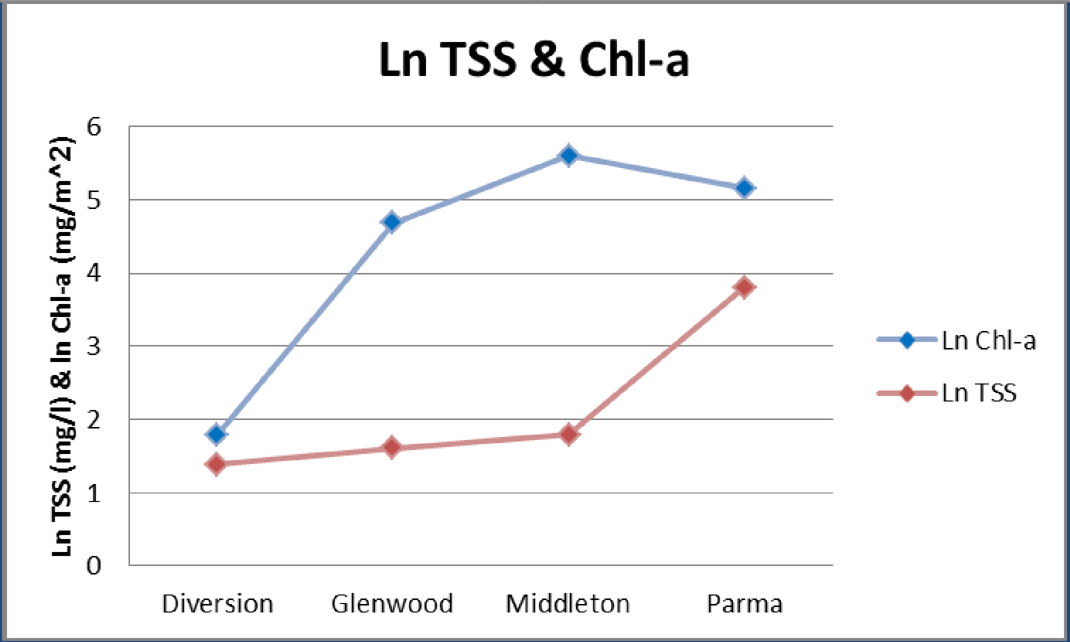


- Data points are means/medians as provided in USGS reports.
- Site 1 = Diversion; Site 2 = Glenwood Bridge; Site 3 = Middleton; Site 4 = Parma.

Lower Boise River-Specific







Take Home Message from Lower Boise River TP, Chl-a, & TSS: It's Messy!

- Chl-a increases with TP…then decreases
- Increasing levels of TSS limit light and Chl-a growth
- At Glenwood, median Chl-a levels of 108 mg/m^2 & TP at 0.09 mg/l
- At Middleton at median Chl-a levels 271 mg/m^2 & TP at 0.15 mg/l

LBWC Feedback

- 6 LBWC target development responses
  - 1 TP recommendation (0.07 mg/l)
  - 2 Chl-a recommendations (100-200 mg/m^2)
  - Several approach recommendations
    - Weight of Evidence
    - EPA Nutrient Criteria
    - Modeling (Mass Balance, AQUATOX, QUAL2K, etc.)
    - Include TN, TP, and other appropriate variables

Other Considerations

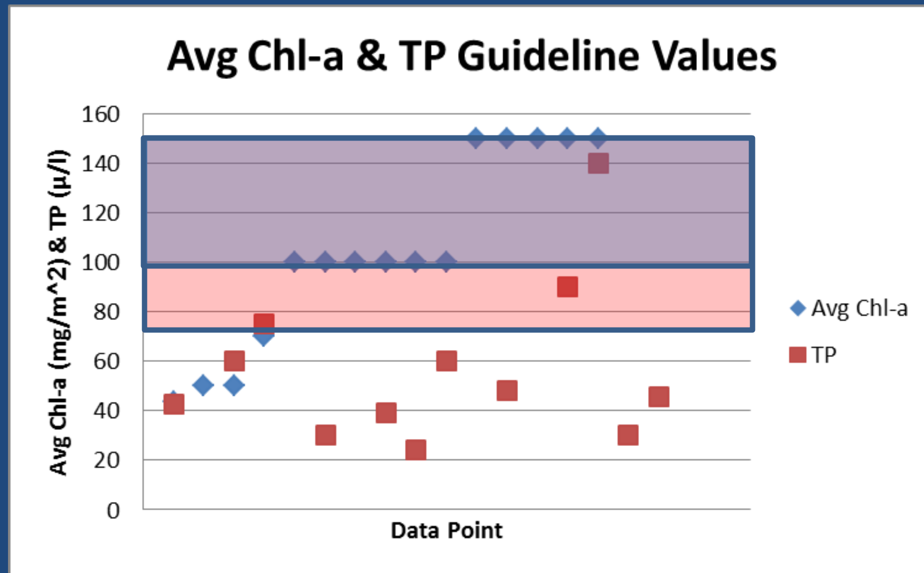
- Snake River-Hell's Canyon TMDL, TP target of 0.07 mg/l at Boise River Confluence
- DEQ Statewide Nutrient & Macrophyte Study (2014)
  - Identify levels of visible slime or nuisance aquatic growths that impair beneficial uses
  - Identify correlations between growths and nutrients (TN and TP) in streams and rivers

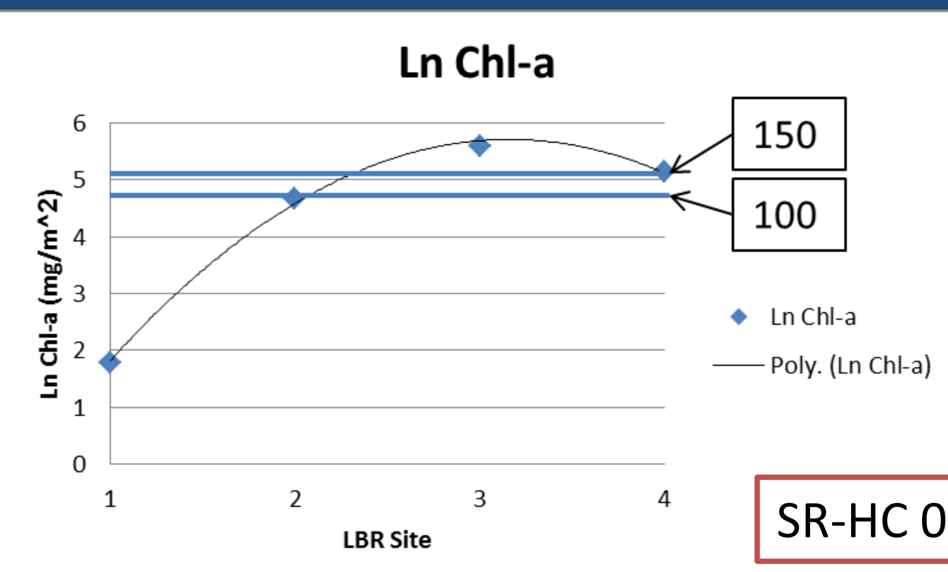
Lower Boise River Target Recommendations

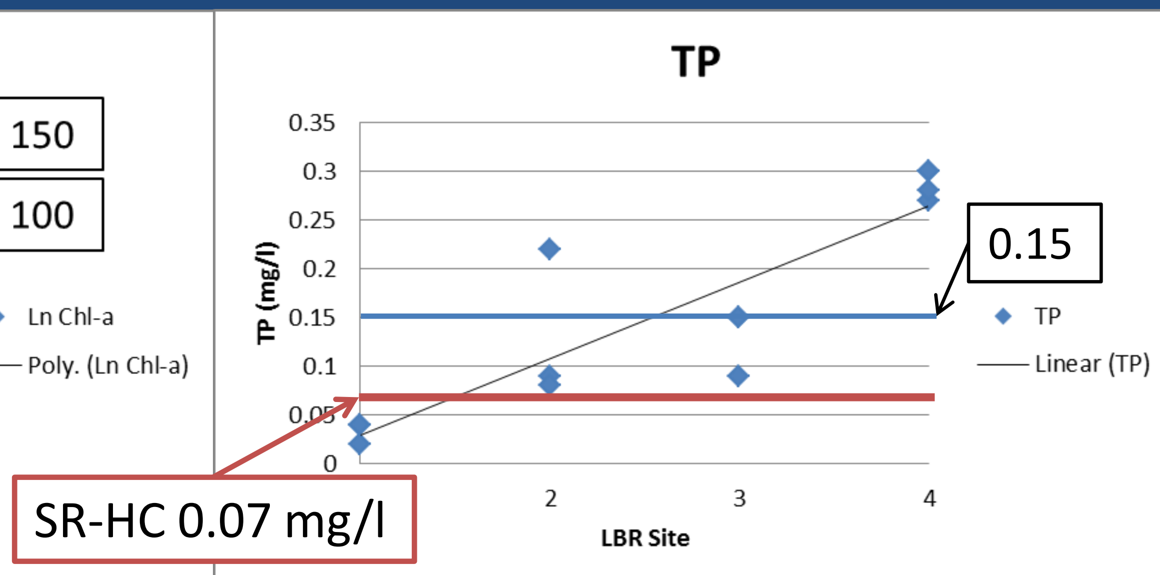
1. Non-nuisance Chl-a:
   - 100 to 150 mg/m^2
   - Based on literature and LBR data

2. TP (non-nuisance Chl-a):
   - TBD…but very likely $\geq$ 0.07 but $\leq$ 0.15 mg/l
   - Based on literature, existing/new LBR data, & modeling

3. SR-HC TP Target:
   - 0.07 mg/l (May 1 – September 30) at the mouth


Avg Chl-a & TP Guideline Values
Avg Chl-a (mg/m^2) & TP (µ/l)
160
140
120
100
80
60
40
20
0
Data Point
Avg Chl-a
TP


Ln Chl-a
Ln Chl-a (mg/m^2)
6
5
4
3
2
1
0
1
2
3
4
LBR Site
150
100
Ln Chl-a
Poly. (Ln Chl-a)


TP
TP (mg/l)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2
3
4
LBR Site
0.15
TP
Linear (TP)
SR-HC 0.07 mg/l

Where to???...?

1. Select a nuisance level Chl-a target
   - Identify preliminary corresponding TP sideboards

2.a. Examine LBR TP & Chl-a relationships

- Modeling and validation (AQUATOX, QUAL2K, etc.)
- New and existing LBR data

2.b. Calculate allocations per SR-HC 0.07 mg/l

- Mass balance models
- New and existing LBR data

Contact Information

Troy Smith
Idaho Department of Environmental Quality
Boise Regional Office
1445 N. Orchard St.
Boise, ID 83706
208-373-0434
Troy.Smith@deq.idaho.gov