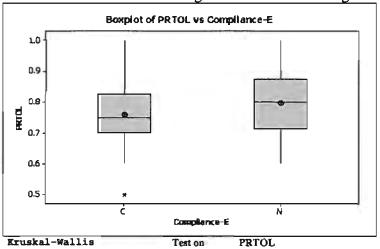
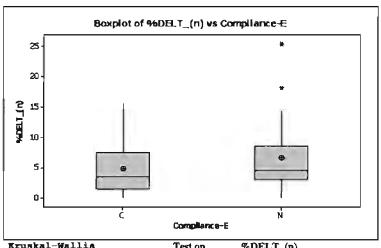
Existings Standards - All Designated Uses



Kruskal-Wallis		Test on	PRTOL	
Complianc	e N	Median	Ave Rank	Z
С	36	0.7575	24.2	-1.37
Ŋ	15	0.8	30.4	1.37
Overall	51		26	
H = 1.89	OF =	i P =	0.169	
H = 1.90	DF =	1 P=	0.169	

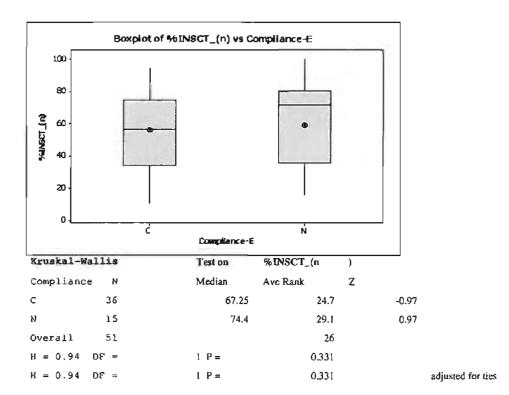
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

adjusted for ties

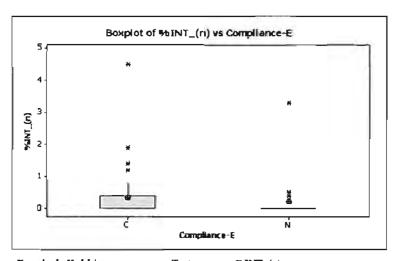


Kruskal-Wallis	i est on	%DEL1_(n)	
Compliance N	Median	Ave Rank Z	
C 36	3.75	24.7	-0.95
N 15	4.7	29.1	0.95
Overall 51		26	
H = 0.90 DF =	1 P=	0.342	
H = 0.91 OF =	1 P=	0.341	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

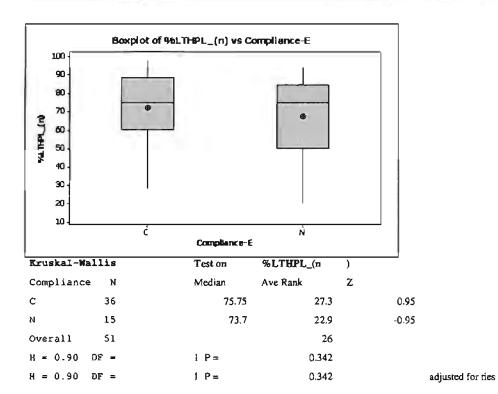


C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

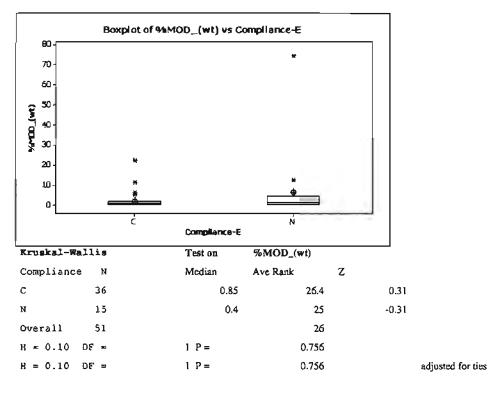


Kruskal-Wallis	Test on	% INT_ (n)			
Compliance N	Median	Avc Rank	Z		
C 36	0	27.9	1.39		
N 15	0	21.5	-1.39		
Overall 51		26			
H = 1.92 DF =	[P =	0.166			
H = 3.27 DF =	1 P=	0.07		adjusted for ties	

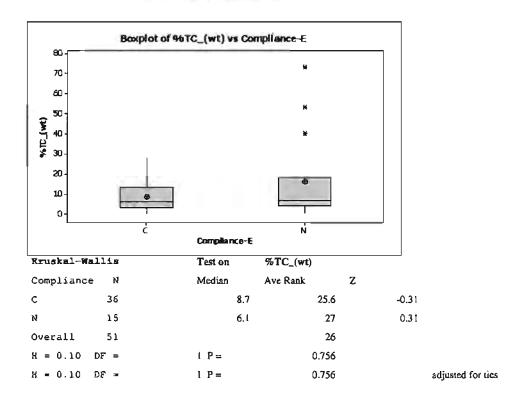
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



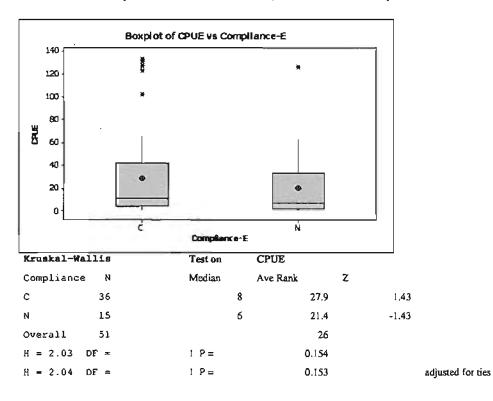
C = data in compliance with D.O. standard; N = data not In compliance with D.O. standard



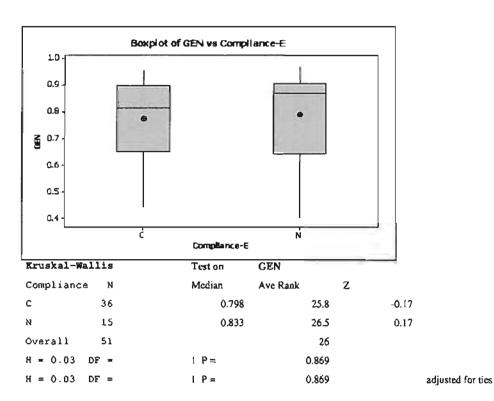
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



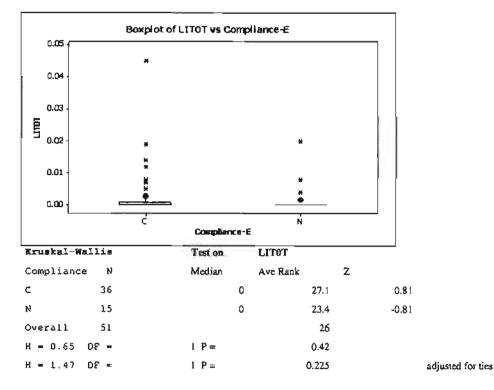
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



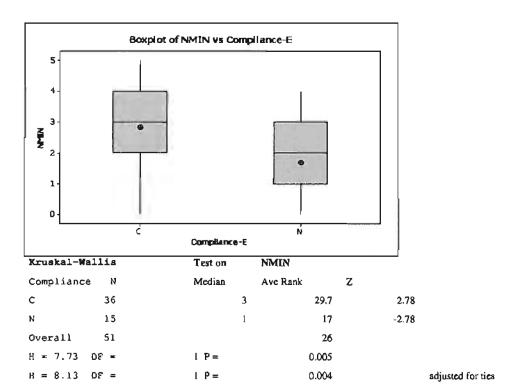
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



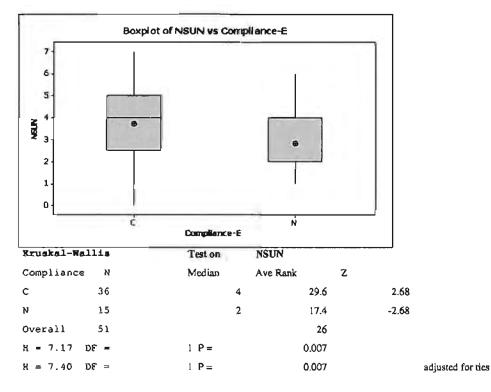
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



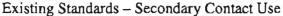
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

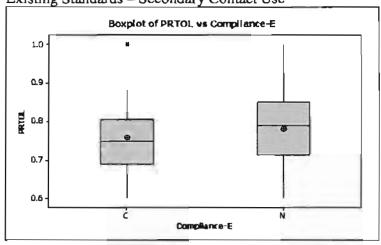


C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



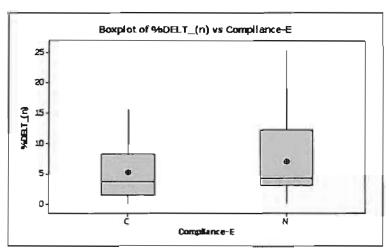
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard





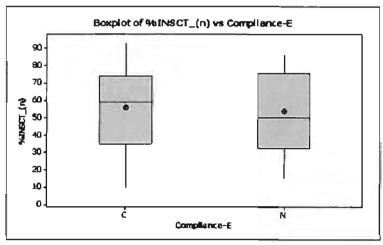
Kruskal-W	Mallis	Test on	PRTOL		
Complianc	e N	Медіал	Ave Rank	2	
С	24	0.75	16.8	-1.41	
N	12	0.789	22	1.41	
Overall	36		18.5		
H = 1.99	DF =	1 P=	0.159		
H = 1.99	DF =	1 P=	0.158		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



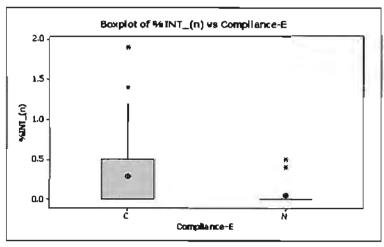
Kruskal-W	Tallis	Test on	%DELT_(n)		
Complianc	e N	Median	Ave Rank	2	
С	24	3.9	17.4	-0.91	
Ň	12	4.75	20.8	0.91	
Overall	36		18.5		
H = 0.82	DF =	1 P=	0.365		
a = 0.82	DF =	1 P=	0.365		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



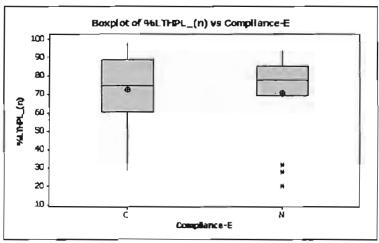
Kruskal-Wallis		Test on	%INSCT_(n)	
Compliance	Ŋ	Median	Ave Rank	2	
С	24	69.45	18.5		0.03
N	12	64.35	18.4		-0.03
Overall	36		18.5		
H = 0.00 D	F =	1 P=	0.973		

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



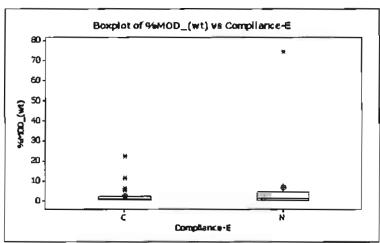
Kruskal-W	Tallis	Test on	% INT_(n)		
Complianc	e N	Median	Ave Rank	Z	
С	24	0	20.8	1.81	
N	12	0	14	-1.81	
Overall	36		18.5		
H = 3.28	DE =	1 P=	0.07		
H = 5.68	DF -	l P=	0.017		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



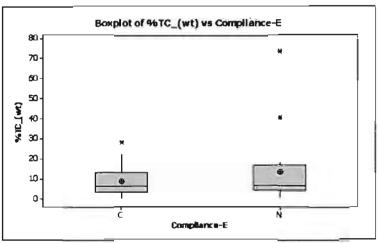
Kruskal-Wallis		Test on	%LTHPL_(n)
Compliance	И	Median	Ave Rank	2
c	24	72.75	18.5	-0.03
И	12	76.25	18.6	0.03
Overall	36		18.5	
H = 0.00 1	DF =	1 P=	0.973	

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



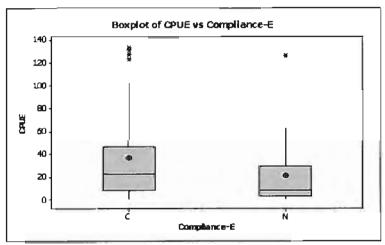
Kruskal-Wallis		Test on	%MOD_(wt)		
Complianc	ce N	Median	Ave Rank	2	
С	24	1.05	18.8	0.22	
и	12	0.9	18	-0.22	
Overall	36		18.5		
H = 0.05	DF =	1 P=	0.827		
H = 0.05	D£ =	1 P=	0.827		adjusted for

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



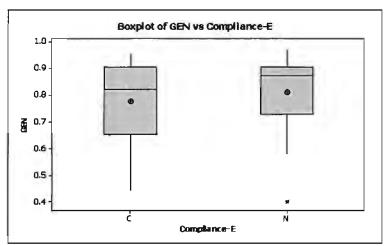
Kruskal-V	Vallis	Test on	%TC_(wt)		
Complianc	ce N	Median	Avc Rank	2	
С	24	10.15	19	0.4	
N	12	5.3	17.5	-0.4	
Overall	36		18.5		
H = 0.16	OF =	1 P=	0.687		
B = 0.16	DF =	1 P=	0.687		adjusted

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



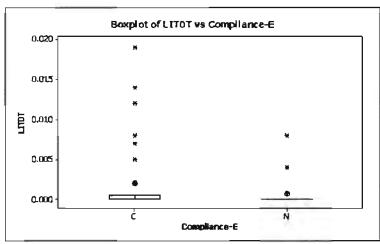
Kruskal-W	allis	Test on	CPUE		
Complianc	e N	Median	Ave Rank	Z	
c	24	20.5	20.9	1.9	
N	12	6	13.8	-1.9	
Overall	36		18.5		
я = 3.59	OF =	l P=	0.058		
H = 3.60	DF =	1 P=	0.058		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



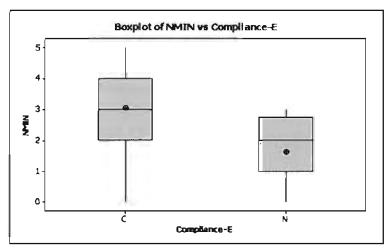
Kruskal-Wallis		Test on	GEN		
Compliand	e N	Median	Ave Rank	Z	
С	24	0.763	17.8	-0.59	
N	12	0.854	20	0.59	
Overall	36		18.5		
H = 0.34	DF =	l P=	0.557		
н = 0.35	DF =	l P=	0.557		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



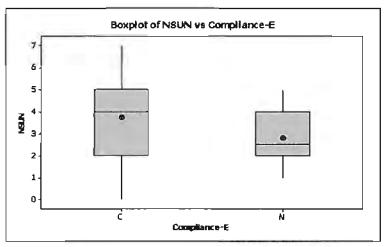
Kruskal-I	Wallis	Test on	LITOT		
Compliand	ce N	Median	Ave Rank	Z	
С	24	0	19.8	1.01	
N	12	0	16	-1.01	
Overall	36		18.5		
H = 1.01	DF =	1 P=	0.314		
H = 2.80	DF =	1 P=	0.094		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



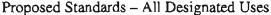
Kruskal-W	<i>l</i> allis	Test on	NMIN		
Complianc	e N	Median	Ave Rank	Z	
С	24	3	22.3	3.05	
N	12	1.5	10.9	-3.05	
Overall	36		18.5		
R = 9.33	DF =	1 P=	0.002		
H = 9.71	DF =	1 P=	0.002		adjusted for ties

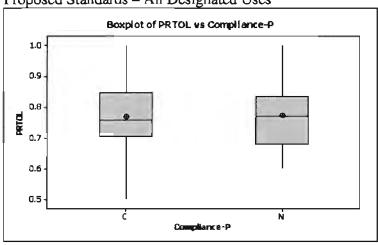
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-W	allis	Test on	NSUN		
Complianc	e N	Median	Ave Rank	z	
С	24	4	21.5	2.43	
N	12	2	12.5	-2.43	
Overall	36		18.5		
H = 5.92	DF =	1 P=	0.015		
H = 6.10	08 =	1 P=	0.014		adjusted for ties

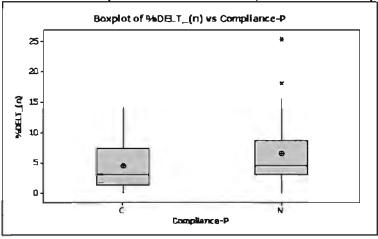
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard





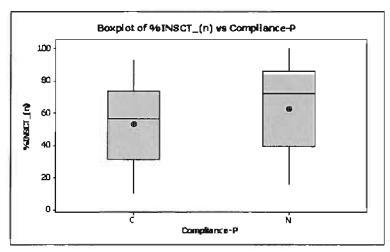
Kruskal-W	allis	Test on	PRTOL	
Complianc	e N	Median	Avc Rank	z
С	27	0.765	25.7	-0.16
N	24	0.769	26.4	0.16
Overall	51		26	
H = 0.03	DE =	l P =	0.873	
H = 0.03	DF =	1 P=	0.872	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



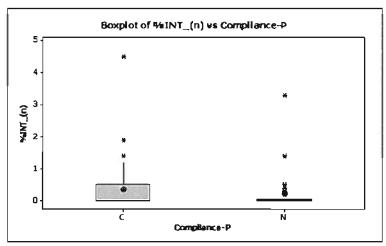
Kruskal-W	allis	Test on	%DELT_(n)	
Complianc	e N	Median	Ave Rank	Z
С	27	3	22.6	-1.75
N	24	4.75	29.9	1.75
Overall	51		26	
H = 3.05	OF =	1 P=	0.081	
H = 3.05	OF =	1 P =	0.081	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



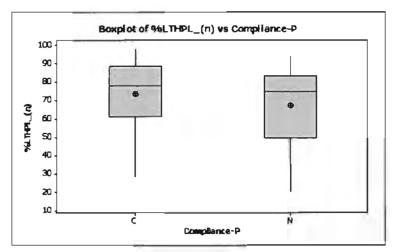
Kruskal-Wallis	Test on	%INSCT_(n)
Compliance N	Median	Ave Rank	Z
C 27	67.1	22.6	-1.76
N 24	71.85	29.9	1.76
Overall 51		26	
H = 3.08 DF =	1 P=	0.079	
H = 3.08 DF =	l P=	0.079	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



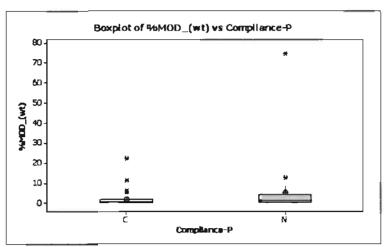
Kruskal-W	allis	Test on	% INT_(n)	
Complianc	e N	Median	Avc Rank	Z
С	27	0	28.1	1.8
N	24	0	23.6	-1.8
Overall	51		26	
H = 1.16	DE =	1 P=	0.282	
H = 1.97	DF =	1 P=	0.16	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



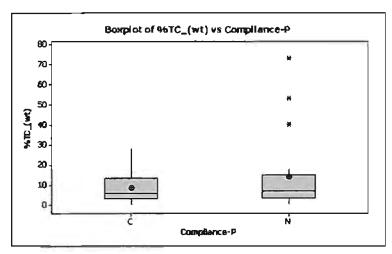
Kruskal-Wallis	Test on	%LTHPL_(n)	
Compliance N	Median	Ave Rank	Z	
C 27	81.2	28.4	1.23	
N 24	74.05	23.3	-1.23	
Overall 51		26		
H = 1.50 OF =	1 P=	0.22		
H = 1.50 DF =	1 P=	0.22	adjusted for ties	

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



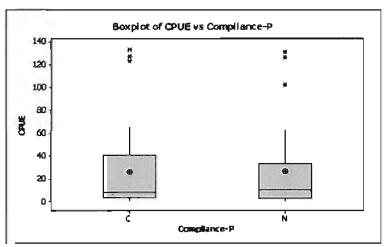
Kruskal-W	Vallis	Test on	%MOD_(wt)	
Compliano	e N	Median	Ave Rank	Z
С	27	0.8	25.2	-0.39
N	24	1.05	26.9	0.39
Overall	51		26	
H = 0.15	DF =	1 P=	0.699	
H = 0.15	OF =	1 P=	0.698	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



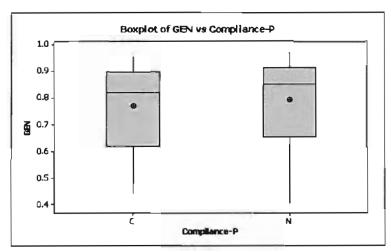
Kruskal-W	rallis	Test on	%TC_(wt)	
Complianc	e N	Median	Ave Rank	Z
c	27	9.6	26.9	0.47
N	24	5.7	25	-0.47
Overall	51		26	
H = 0.22	DF =	l P=	0.637	
H = 0.22	DF =	l P=	0.637	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



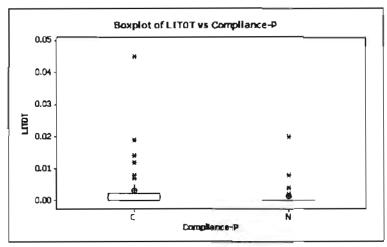
Kruskal-W	allis	Test on	CPUE	
Complianc	e N	Median	Ave Rank	Z
С	27	7	25.7	-0.13
N	24	8	26.3	0.13
Overall	51		26	
H = 0.02	DF =	1 P=	0.895	
H = 0.02	DF =	1 P=	0.895	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



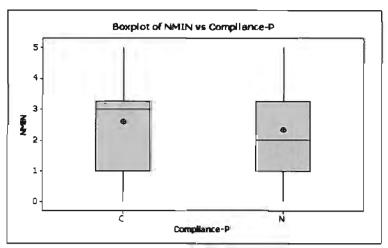
Kruskal-W	/allis	Test on	GEN	
Complianc	e N	Medîan	Ave Rank	Z
С	27	0.787	24.5	-0.78
N	24	0.827	27.7	0.78
Overall	51		26	
H = 0.61	DF =	1 P ≃	0.434	
H = 0.61	DF =	I P=	0.433	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



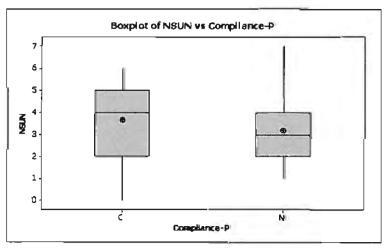
Kruskal-Wallis		Test on	LITOT		
Complianc	e N	Median	Ave Rank	z	
c	27	0	28.1	1.9	9
N	24	0	23.6	-1.5	9
Overall	51		26		
H = 1.20	DF =	1 P=	0.274		
H = 2.71	DF =	I P=	1,0	adjusted for ties	

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-Wallis		Test on NMIN		
Complianc	e N	Median	Ave Rank	Z
С	27	3	26.7	0.35
N	24	2	25.2	-0.35
Overall	51		26	
H = 0.12	DF =	1 P=	0.727	
H = 0.13	D F =	1 P=	0.72	adjusted for ties

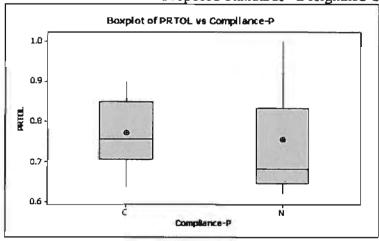
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-Wallis		Test on	NSUN	
Complianc	e N	Median	Ave Rank	Z
С	27	4	28.7	1.38
N	24	3	23	-1.38
Overall	51		26	
X = 1.90	DF =	1 P =	0.168	
H = 1.96	DF =	l P=	0.162	adjusted for ties

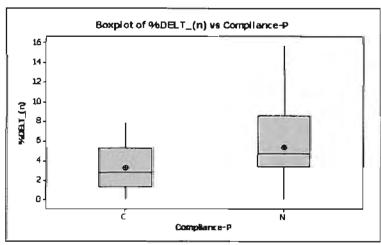
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

Proposed Standards -Designated Use A



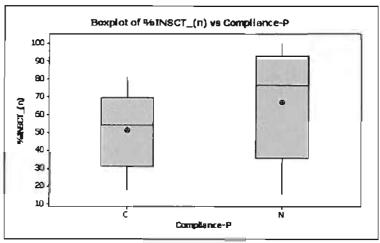
Kruskal-V	Tallis	Test on	PRTOL		
Compliand	ce N	Median	Avc Rank	Z	
С	13	0.765	12.7	0.59	
N	10	0.751	11.1	-0.59	
Overall	23		12		
H = 0.35	DF =	1 P =	0.556		
ដ = 0.35	OF =	1 P =	0.555		adjusted for tie

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



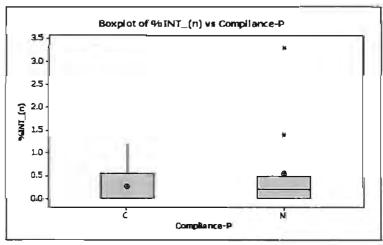
Kruskal-V	Mallis	Test on	%DELT_(n)		
Complian	ce N	Median	Ave Rank	Z	
С	13	2.7	9.8	-1.77	
N	10	5	14.9	1.77	
Overall	23		12		
H = 3.12	DF =	1 P=	0.077		
H = 3.13	DF =	l P=	0.077		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



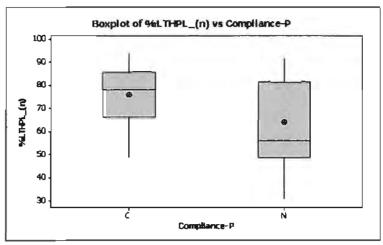
Kruskal-W	Mallis	Test on	%INSCT_(n)	
Complianc	e N	Median	Ave Rank	Z	
С	13	52	8.6	-2.73	
N	10	81,45	16.4	2.73	
Overall	23		12		
H = 7.45	DF =	1 P=	0.006		
H = 7.45	DE =	1 P =	0.006		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



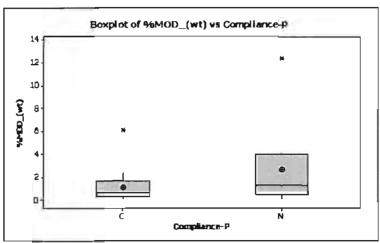
Kruskal-W	allis	Test on	% INT_ (n)		
Complianc	e N	Median	Ave Rank	2	
С	13	0	11.9	-0.09	
N	10	0	12.2	0.09	
Overall	23		12		
H = 0.01	OF =	1 P=	0.926		
H = 0.01	DF =	1 P=	0.916		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



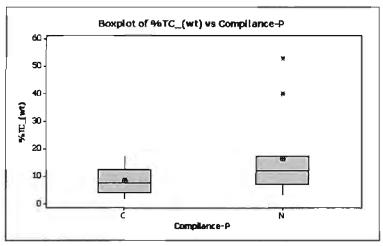
Kruskal-Wal	lis	Test on	%LTHPL_(n)
Compliance	N	Median	Ave Rank	Z
С	13	71.7	14.5	2.05
N	10	54.8	8.7	-2.05
Overall	23		12	
H = 4.19 D	F =	1 P=	0.041	

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



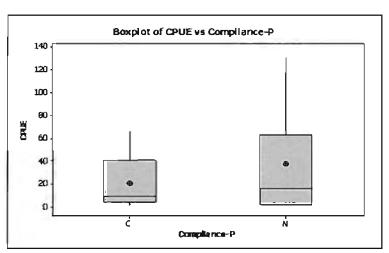
Kruskal-W	Wallis	Test on	%MOD_(wt)		
Compliand	e N	Median	Ave Rank	Z	
С	13	0.8	12	-0.03	
И	10	0.65	12.1	0.03	
Overall	23		12		
H = 0.00	DF =	1 P=	0.975		
B = 0.00	DF =	1 P=	0.975		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



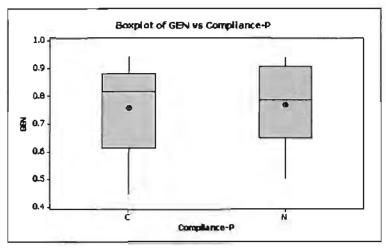
Kruskal-W	allis	Test on	%TC_(wt)		
Complianc	e N	Median	Ave Rank	Z	
c	13	9.6	11.4	-0.5	
N	10	10.4	12.8	0.5	
Overall	23		12		
H = 0.25	DF =	l P =	0.62		
H = 0.25	DE =	1 P=	0.62		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



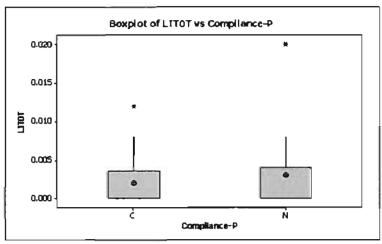
Kruskal-Wallis	Test on	CPUE		
Compliance N	Median	Ave Rank	Z	
C 13	11	11.8	-0,12	
N 10	9.5	12.2	0.12	
Overall 23		12		
H = 0.02 DF =	1 P=	0.901		
H = 0.02 DF =	1 P=	0.901		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



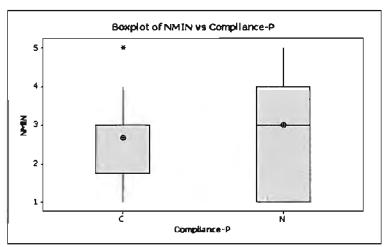
Kruskal-Wallis		Test on	GEN	
Compliance	N	Median	Ave Rank	Z
c	13	0.719	11.3	-0.56
N	10	0.7595	12.9	0.56
Overall	23		12	
H = 0.31 E)F =	1 P=	0.577	

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



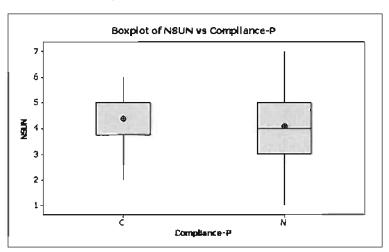
Kruskal-W	allis	Test on	LITOT		
Complianc	e N	Median	Ave Rank	Z	
С	13	0	12.2	0.12	
N	10	0	11.8	-0.12	
Overall	23		12		
H = 0.02	OF =	1 P≃	0.901		
H = 0.03	DF =	1 P=	0.864		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-W	M allis	Test on	NMIN		
Compliand	e N	Median	Ave Rank	Z	
С	13	3	11.5	-0.4	
N	10	3.5	12.7	0.4	
Overall	23		12		
H = 0.16	DF =	1 P=	0.687		
H = 0.18	DF =	1 P=	0.671		adjusted for ties

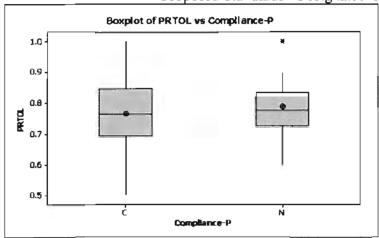
C = data in compliance with D.O. standard; N = data not In compliance with D.O. standard



Kruskal-Wa	llis	Test on	NSUN		
Compliance	N	Median	Ave Rank	Z	
С	13	4	12.7	0.53	
N	10	4	11.2	-0.53	
Overall	23		12	•	
H = 0.28	סד =	1 P=	0.598		
H = 0.29	DF =	l P=	0.592		adjusted for ties

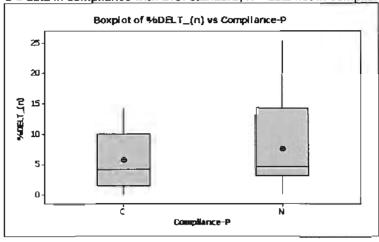
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

Proposed Standards - Designated Use B



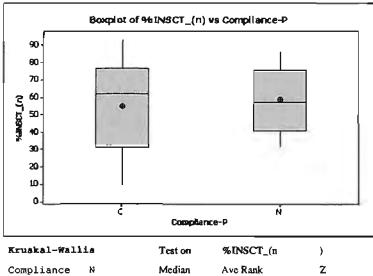
Kruskal-Wallis	Test on	PRTOL		
Compliance N	Median	Ave Rank	2	
C 14	0.764	13.8	-0.46	
N 14	0.7735	15.2	0.46	
Overall 28		14.5		
H = 0.21 DF =	1 P=	0.646		
H = 0.21 DF =	1 P=	0.645		adjusted for tie

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-W	allis	Test on	%DELT_(n)		
Compliance	א פ	Median	Ave Rank	2	
С	14	4.2	13.3	-0.78	
N	14	4.75	15.7	0.78	
Overall	28		14.5		
H = 0.61	D8 =	1 P=	0.435		
H = 0.61	DF =	1 P=	0.434		adjusted for tie

C = data in compliance with D.O. standard; N = data not in compliance with D.O. Standard



Compliance N Median Ave Rank Z

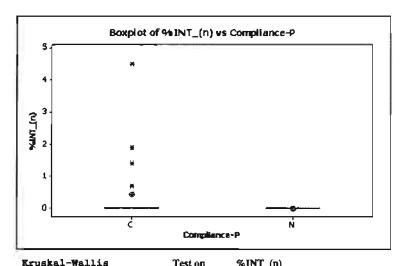
C 14 69.45 14.2 -0.18

N 14 53.75 14.8 0.18

Overall 28 14.5

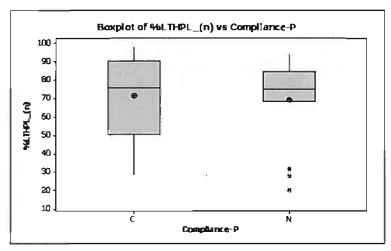
H = 0.03 DF = I P= 0.854

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



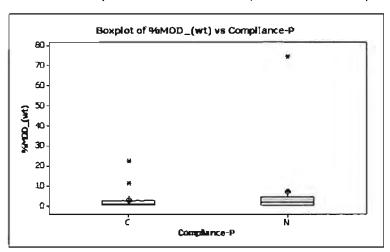
VI DEVOT-MOT	TITO	1 est on	жил г – (n)		
Compliance	И	Median	Ave Rank	Z	
С	14	0	16.5	1.29	
N	14	0	12.5	-1.29	
Overall	28		14.5		
H = 1.66 C	OF =	! P=	0.198		
H = 4.47 C	OF =	P=	0.035		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-W	allis	Test on	%LTHPL_(n)	
Complianc	в и	Median	Ave Rank	Z	
С	14	83.4	15.3	0.51	
N	14	76.25	13.7	-0.51	
Overall	28		14.5		
H = 0.26	DF =	1 P=	0.613		
R = 0.26	DF -	1 P=	0.613		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

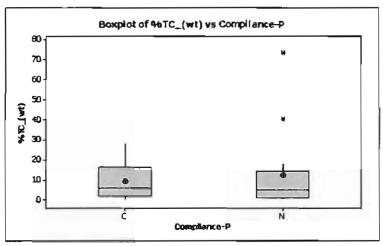


Kruskal-Wallis		Test on %MOD_(wt)			
Compliance	И	Median	Ave Rank	Z	
С	14	1	13.6	-0.6	
N	14	1.65	15,4	0.6	
Overall	28		14.5		
H = 0.36	DF =	1 P=	0.55		
H = 0.36	DF =	1 P=	0.549		adjusted

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

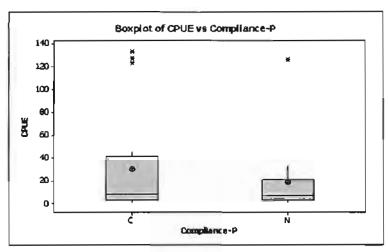
LimnoTech A-27

for ties



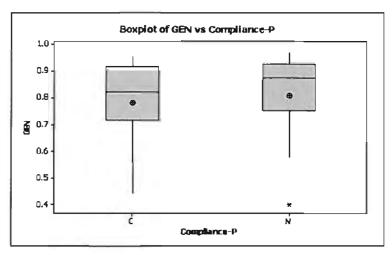
Kruskal-W	allis	Test on	%TC_(wt)		
Complianc	e N	Median	Ave Rank	2	
c	14	9.45	15.7	0.78	
И	14	4.9	13.3	-0.78	
Overall	28		14.5		
H = 0.61	DF =	1 P=	0.435		
H = 0.61	DF =	1 P=	0.434		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



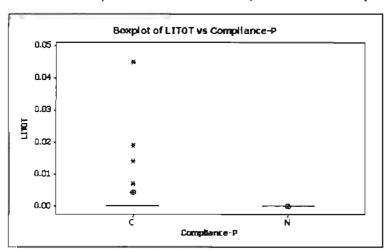
Kruskal-Wa	1115	Test on	CPUE		
Compliance	Ņ	Median	Ave Rank	2	
c	14	7	14.4	-0.09	
N	14	6.5	14.6	0.09	
Overall	28		14.5		
H = 0.01	DF ≃	l P=	0.927		
H = 0.01	DF ≂	1 P=	0.927		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



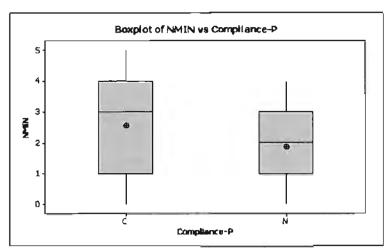
Kruskal-W	allis	Test on	GEN		
Complianc	e N	Median	Ave Rank	Z	
С	14	0.8205	13.4	-0.71	
N	14	0.876	15.6	0.71	
Overall	28		14.5		
H = 0.51	08 =	1 P =	0.476		
H = 0.51	DF =	1 P=	0.476		adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



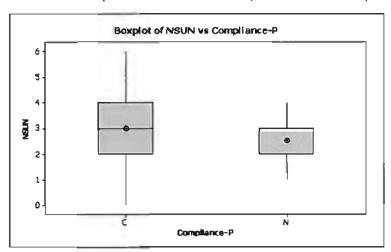
Kruskal-Wal	lis	Test on	LITOT	
Compliance	N	Median	Avc Rank	Z
С	14	0	16.5	1.29
N	14	0	12.5	-1.29
Overall	28		14.5	
H = 1.66 D)£ =	1 P=	0.198	
H = 4.47 D)F =	1 P=	0.035	adjusted for ties

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-Wallis	Test on	NMUN		
Compliance N	Median	Ave Rank	Z	
C 14	2	14.7	0.11	
N 14	2	14.3	-0.11	
Overall 28		14.5		
R = 0.01 DF =	1 P=	0.909		
H = 0.01 DF =	1 P=	0.906		adjusted for ti

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-Wallis		Test on	NSUN			
Complianc	e N	Median	Ave Rank	2		
С	14	3		16	0.96	
И	14	2.5		13	-0. 9 6	
Overall	28			14.5		
R = 0.93	DF =	l P =		0.335		
B = 0.97	OF =	1 P =		0.325		adjusted for tie

C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

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Analysis of the Relationship Between Fish and Water Quality in the Chicago Area Waterway System
Chicago Area Waterway System Habitat Evaluation and Improvement Study

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ATTACHMENT B:

REGRESSION PLOTS COMPARING FISH WITH DISSOLVED OXYGEN CONDITIONS

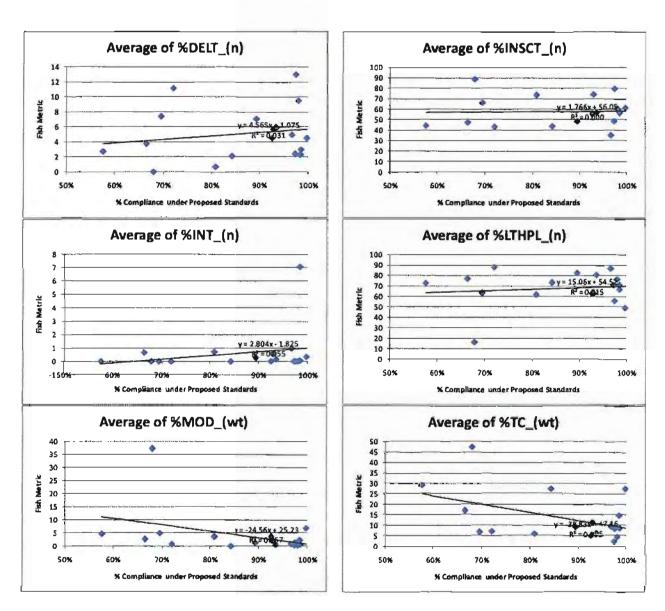
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Analysis of the Relationship Between Fish and Water Quality in the Chicago Area Waterway System

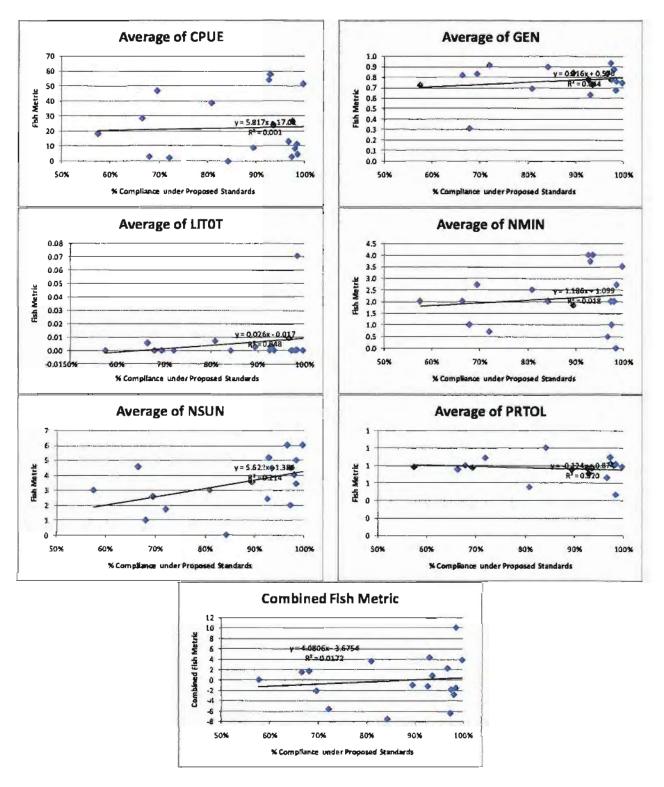
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December 8, 2009

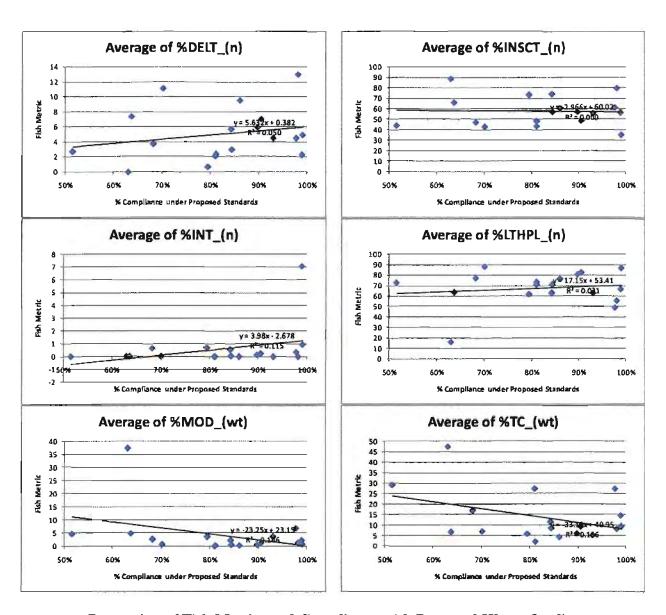
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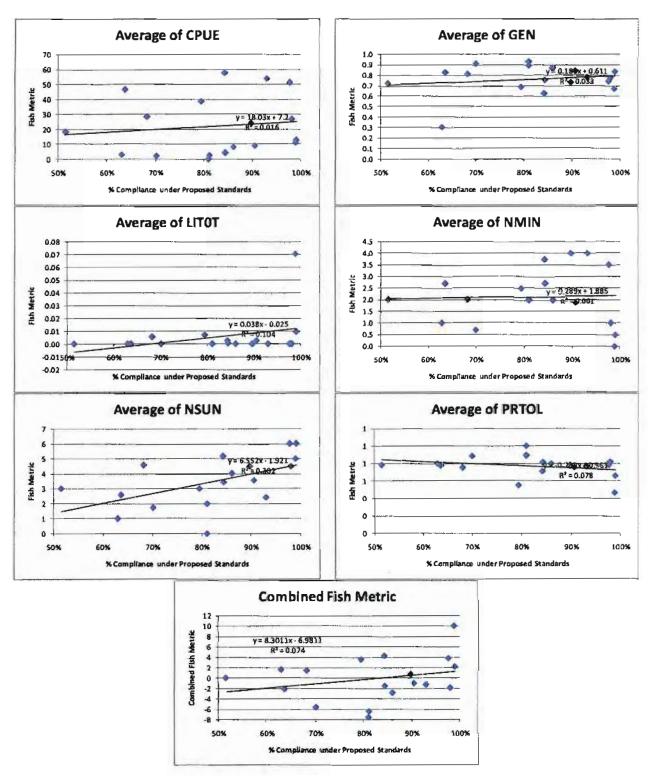
Regression of Fish Metrics and Compliance with Existing Water Quality Standards for Dissolved Oxygen



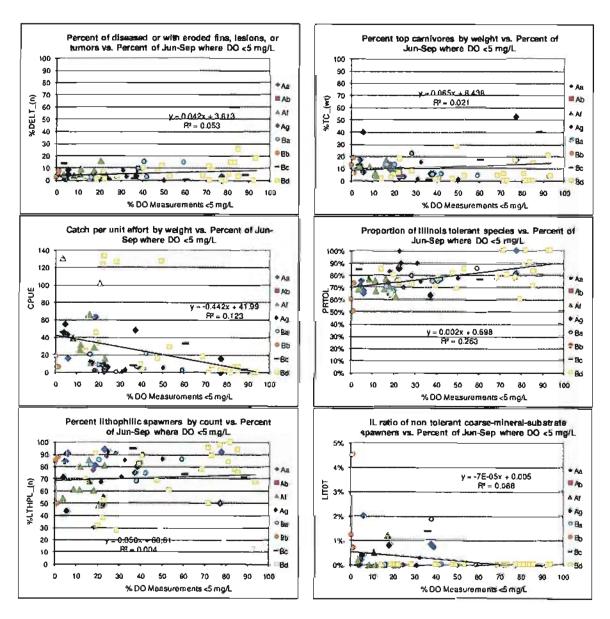
Regression of Fish Metrics and Compliance with Existing Water Quality Standards for Dissolved Oxygen



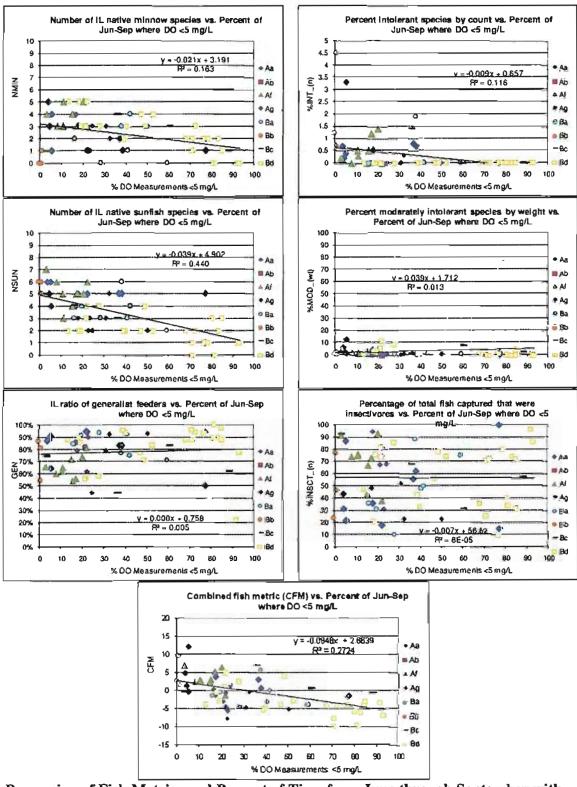
Regression of Fish Metrics and Compliance with Proposed Water Quality Standards for Dissolved Oxygen



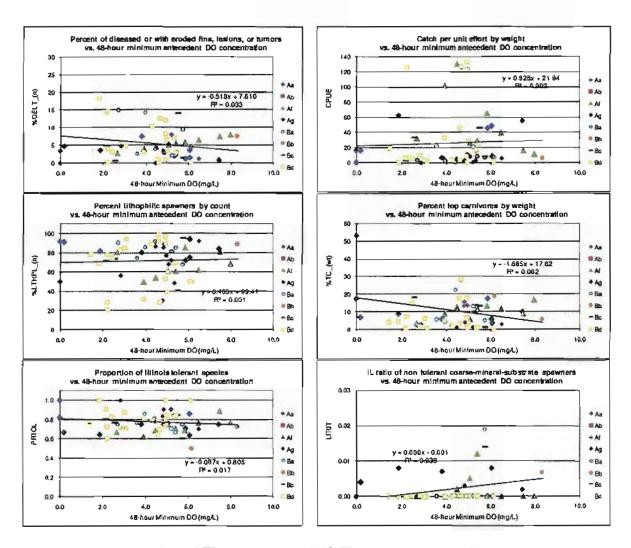
Regression of Fish Metrics and Compliance with Proposed Water Quality Standards for Dissolved Oxygen



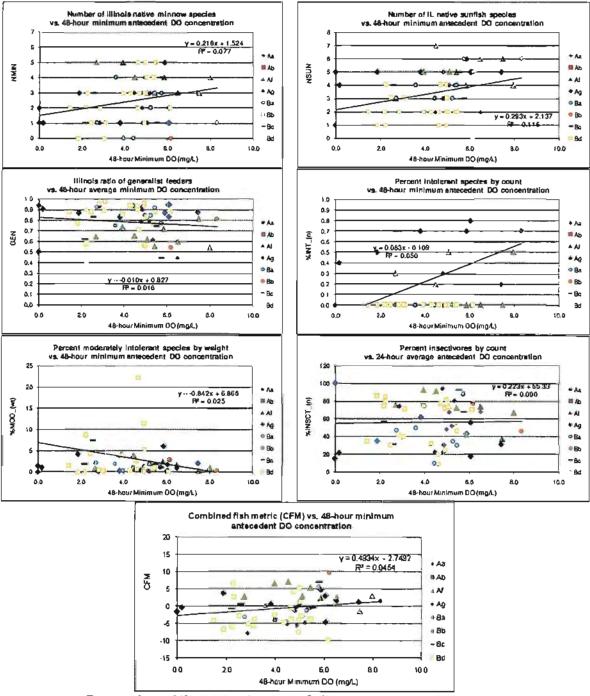
Regression of Fish Metrics and Percent of Time from June through September with Dissolved Oxygen Less Than 5.0 mg/L



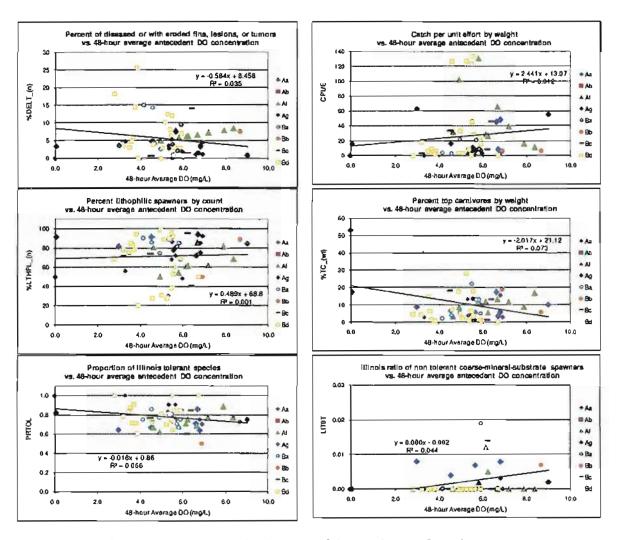
Regression of Fish Metrics and Percent of Time from June through September with Dissolved Oxygen Less Than 5.0 mg/L



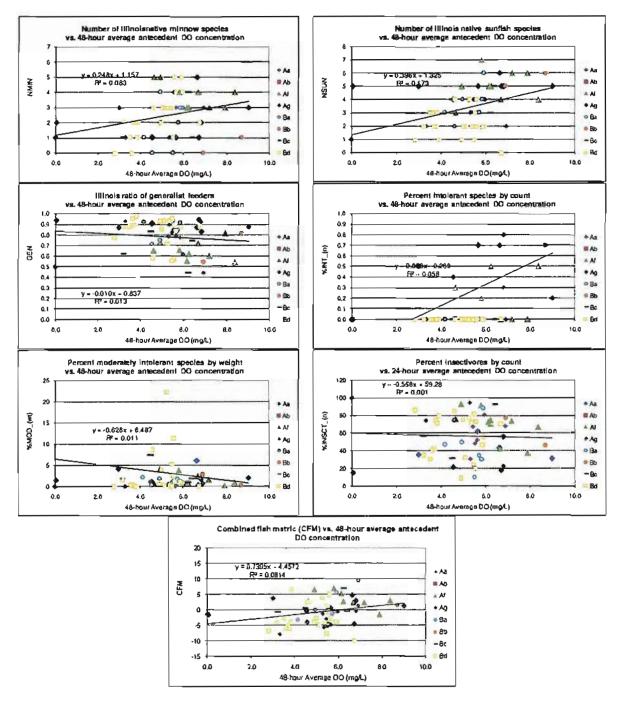
Regression of Fish Metrics and 48-Hour Antecedent Minimum Dissolved Oxygen Concentration



Regression of Fish Metrics and 48-Hour Antecedent Minimum
Dissolved Oxygen Concentration



Regression of Fish Metrics and 48-Hour Antecedent Average Dissolved Oxygen Concentration



Regression of Fish Metrics and 48-Hour Antecedent Average Dissolved Oxygen Concentration

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Analysis of the Relationship Between Fish and Water Quality in the Chicago Area Waterway System

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ATTACHMENT C:

REGRESSION PLOTS COMPARING FISH WITH TEMPERATURE CONDITIONS

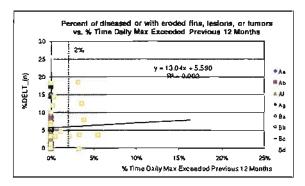
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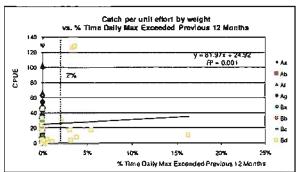
Analysis of the Relationship Between Fish and Water Quality in the Chicago Area Waterway System

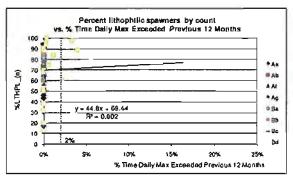
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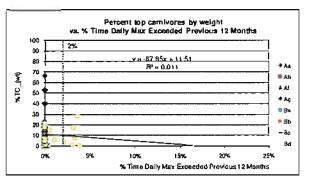
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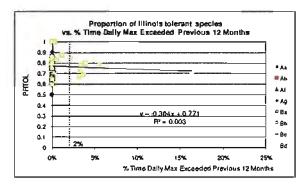
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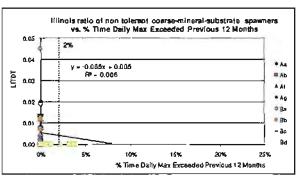




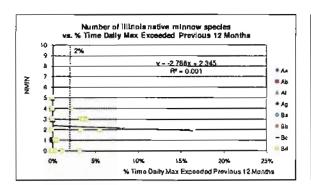


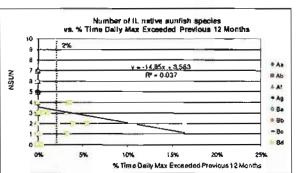


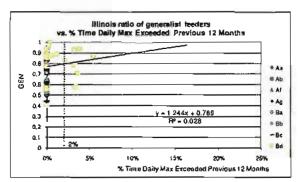


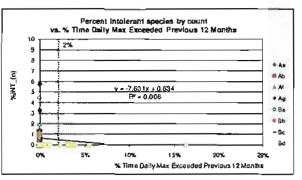


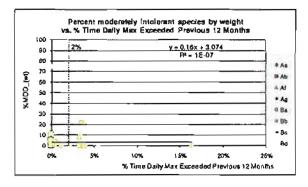
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded (Proposed Water Quality Standards)

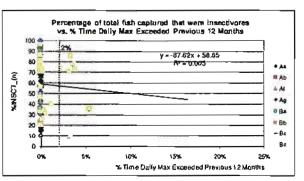


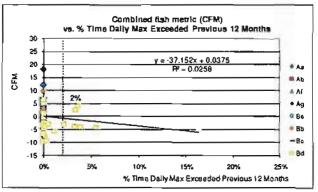




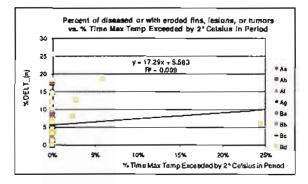


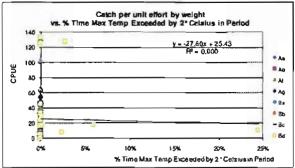


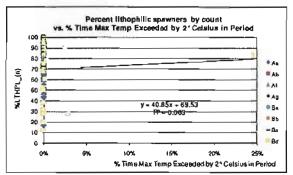


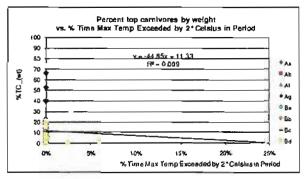


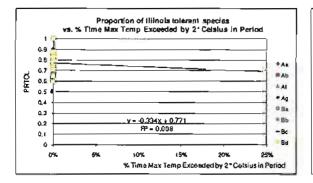
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded (Proposed Water Quality Standards)

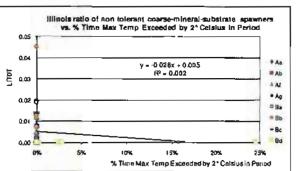




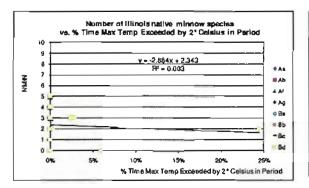


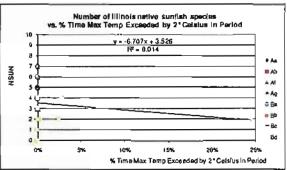


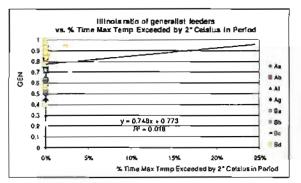


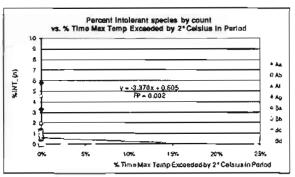


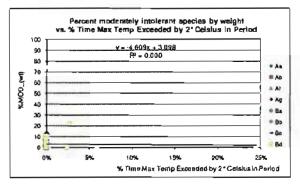
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded by More Than 2°C (Proposed Water Quality Standards)

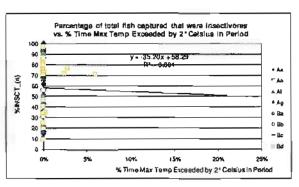


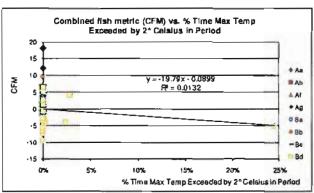












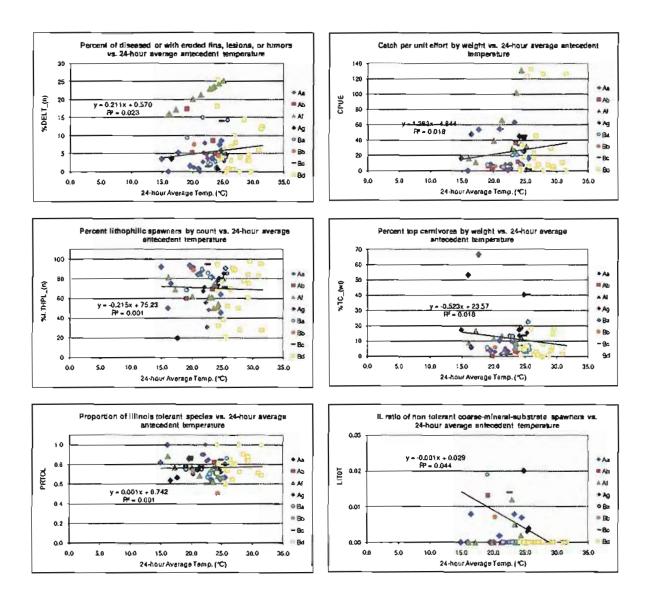
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Analysis of the Relationship Between Fish and Water Quality in the Chicago Area Waterway System

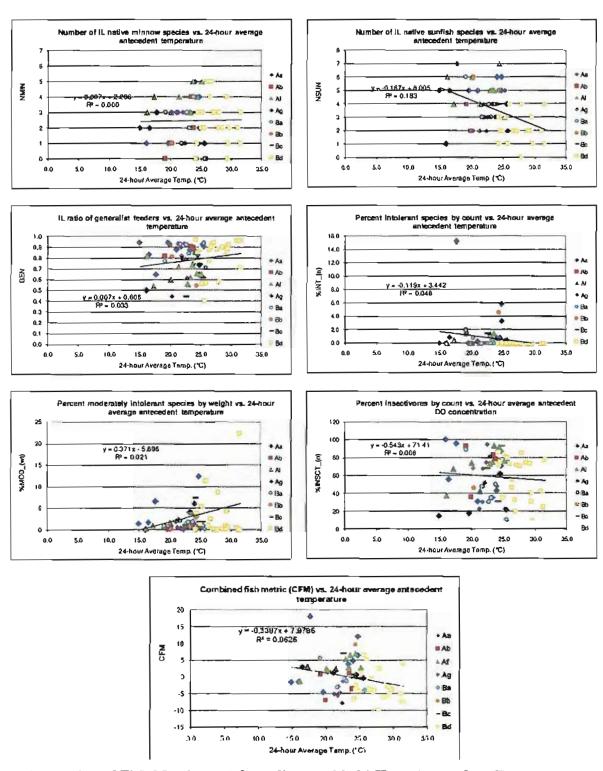
Chicago Area Waterway System Habitat Evaluation and Improvement Study

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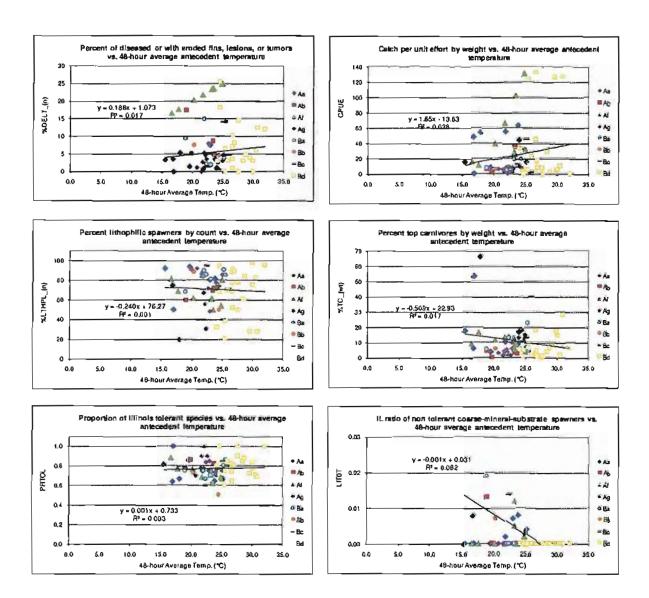
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded by More Than 2°C (Proposed Water Quality Standards)



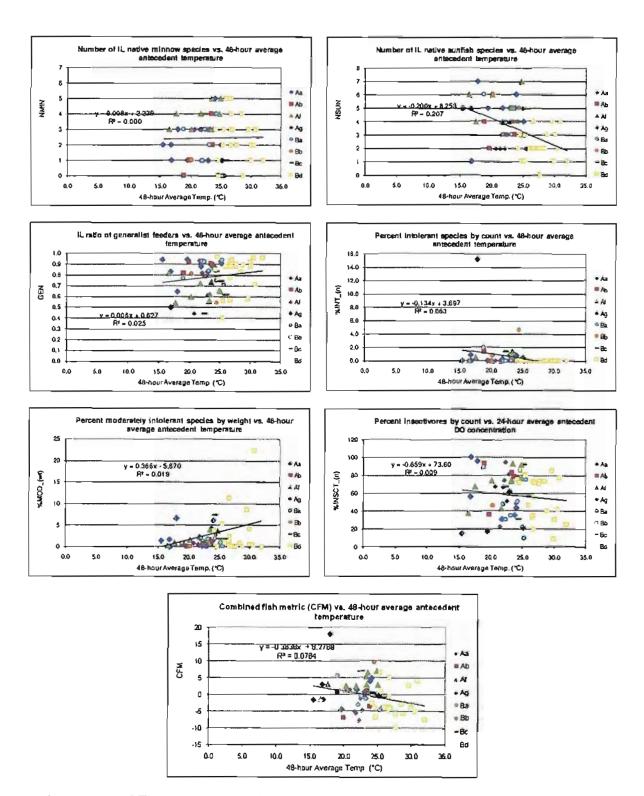
Regression of Fish Metrics and Compliance with 24-Hour Antecedent Temperature



Regression of Fish Metrics and Compliance with 24-Hour Antecedent Temperature



Regression of Fish Metrics and Compliance with 48-Hour Antecedent Temperature



Regression of Fish Metrics and Compliance with 48-Hour Antecedent Temperature

LimnoTech

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APPENDIX D:

ANALYSIS AND SCREENING OF HABITAT DATA

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January 4, 2010

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January 4, 2010

SCREENING AND REDUCTION OF HABITAT VARIABLES

This appendix discusses in detail the process used to reduce the initial list of 241 habitat variables to the final set of 16 variables that were used in multiple linear regression with fish data. Tables in Appendix E summarizes the variables eliminated and remaining at each step in the process.

D.1 Screening of Habitat Variables Not Applicable to the CAWS

The initial list of 241 variables was reviewed to identify any variables that were not applicable for use in the CAWS because of conditions in the CAWS, for which there was insufficient data, or that represented a condition that was adequately described by another variable. Some professional judgment was used in this step, but many screening selections were obvious choices. The tables in Appendix E include the rationale for elimination of variables at this stage in the process. Some examples of variables eliminated in this step include:

- Variables associated with thalweg measurements were eliminated in this step because a thalweg does not exist in most parts of this system.
- Variables associated with bankfull flow were eliminated. Most of the CAWS
 consists of canals and constructed channels. No natural hydrologic regime
 exists, so the concept of bankfull flow is not meaningful in this system.
- Large woody debris was eliminated because large woody debris is intentionally removed by maintenance crews from most of the system.
- Many variables were eliminated due to the lack of data, including many variables that characterize bed conditions. Some substrate variables were retained, but the depth and turbidity of the system do not allow direct observation of bed conditions and grab sampling can only yield limited data.

This screening process was affected largely by the nature of the CAWS and the conditions therein. As stated above, the table in Appendix C provides a summary of the reasons for eliminating variables at this stage. The habitat variable list was reduced from 241 to 66 in this step.

D.1 Correlation Analysis of Habitat Variables

Correspondence analysis was used to identify variables that are highly correlated with each other and that may be redundant. The 66 variables remaining after qualitative screening were then statistically analyzed using Spearman's correlation analysis. This revealed variables within each of the five categories that were significantly correlated with each other with a correlation coefficient of 0.7 or greater. Matrices of Spearman correlation coefficients for each of the five habitat variable categories are included in Appendix E, along with a table listing the variables evaluated in the correlation

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analysis and notations on variables eliminated in this step. In selecting between two correlated habitat variables, correlation of the habitat variables with fish metrics, coefficients of variation of habitat variables, and potential to be improved in the CAWS were also considered. One habitat variable was selected from each set of correlated variables, considering both degree of variation (higher coefficients of variation were preferred) and correlation with fish (stronger correlation with fish was preferred). This process eliminated 22 habitat variables.

During this step it was also noted that several variables represented similar habitat conditions in the system:

- Habitat variables representing percent concrete walls, percent steel sheet pile
 walls, percent stone block walls, and percent wooden bulkhead walls all
 represent conditions where banks consist of vertical walls. These variables
 were combined to a new single variable to represent the functional effect of
 these conditions on fish.
- Similarly, two variables connected off-channel open water and marinas
 represent conditions where solid banks open to larger connected water areas
 and were combined to a single variable.
- Two separate variables representing number of NPDES-permitted CSO discharges and number of other non-CSO NPDES permitted discharges were combined to a single variable.

These reductions further reduced the set of habitat variables by 5, which left 39 habitat variables to carry forward in the process. Two anthropogenic variables representing distance from Lake Michigan and commercial tonnage passing were highly correlated (Spearman's coefficient = 0.733; p < 0.0001), but both were carried forward because both were suspected of possibly affecting fisheries based on data observations and the desire to be able to examine both subsequently.

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Table D-1: Variables Used in Principal Components Analysis.

Variable Category	Habitat Variable			
Geomorphology & Hydrology ⁸	Flashiness index (ratio of 10% to 90% exceedance flows)			
	Maximum velocity			
	Average velocity			
	Wetted perimeter of channel			
	Maximum depth in reach			
	Number of tributary, backwater, and off-channel habitats from field observation			
	Number of off-channel bays (areas isolated from main channel >5 sq. m.			
	Bank "pockets" or similar areas that may serve as fish refuge along banks			
Sediment & Substrate	Domínant substrate in shallow part of channel			
	Dominant substrate in deep part of channel			
	% Hardpan, shallow			
	% Hardpan, deep			
	% Sand and fines, shallow			
	% Sand and fines, deep			
	% Gravel, cobbles, boulders, shallow			
	% Gravel, cobbles, boulders, deep			
	% Plant debris on bed, from District PHA			
	% Organic sludge, from District PHA			
	Depth of fines, from District PHA			
In-Stream Cover	Number of aquatic vegetation types			
	Average macrophyte cover			
	In-stream cover present			
	% of canopy over water in reach ~ field measured			
	Secchi depth			
Bank & Riparian Condition	Dominant riparian land use			
	Bank angle			
	% Natural banks in reach (earth banks with vegetation)			
	% Vertical walled banks in reach (steel, wood, stone, etc.)			
	% Riprap banks in reach			
	% Bank length occupied by open water (marinas, etc.)			
	% Riparian vegetation			
Anthropogenic Impacts	Manmade structures (bridge abutments, dolphins, etc.)			
	Number of NPDES discharges			
	Distance from Lake Michigan			
	Distance to nearest wastewater treatment plant			
	Cadmium concentration in sediment			
	Total PCB concentration in sediment			
	Simultaneously extracted metals in sediment			

⁸ All hydrologic variables were determined from DUFLOW model output.

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D.2 Principle Component Analysis of Habitat Variables

Principal component analysis (PCA) was used to further reduce the list of variables from the 39 remaining after correlation analysis. PCA is a statistical technique commonly used to identify which variables explain the most variance in the data set. It is frequently used to analyze habitat and biological data (Blocksom and Flotemersch, 2005; Fitzpatrick et al., 1998; Hall et al., 1999; Wilhelm et al., 2005). The PCA was conducted on each of the five variable categories independently, because of a desire to retain at least one variable from each category for the multiple linear regression. The variables representing presence or absence of in-stream cover and high navigation were not included in the PCA, because they are categorical variables. Procedures for using categorical and continuous variables together in PCA are not well established and may give misleading results. The variables used in the PCA are listed in Table D-1.

PCA is a variable reduction procedure used to transform a set of variables into new, artificial variables that are not correlated to each other. By transforming the original variables into new, non-correlated variables, the amount of data variance explained by each new variable can be calculated. Each of the new, transformed variables is called a principal component or principal component "axis" and the method is structured to identify which principal component explains most of the data variation (called the first principal component), which explains the second most data variation (called the second principal component), and so on.

The method also calculates the weight with which each original variable is associated with each principal component, using linear algebra to calculate each variable's eigenvalue. The eigenvalue of each variable is referred to as its "load" and the original variable that has the highest load on a given principal component axis is the variable most strongly associated with that axis. Original variables that have relatively low loads on principal components axis are the variables that are more highly correlated with other variables, suggesting that they can be eliminated without losing significant explanatory power of the data.

The plots in Figure D-1 (called scree plots) show some of the results of the PCA, including the following:

- The number of columns on each plot indicates how many principal component axes were needed to explain 100% of the variance in the data.
- The height of the columns indicates the eigenvalue or principal component load for each axis, which was used as a screening measure to indicate how many axes to use in variable retention. Variables were retained only from axes with eigenvalues of 1 or greater.
- The line plots show the cumulative proportion of variance explained by the principle components.

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In PCA, it is generally desirable to have the first three or four axes explain most of the data variance. In the case of the CAWS habitat data, between two and four axes were required to explain more than 70% of the data variance, as outlined below.

- Geomorphology and hydrology variables: The first four axes of the PCA explained 76% of the data variance and inclusion of a fifth axis did not significantly improve the variance explained. This indicates that the majority of the variability of the nine variable set can be described with fewer than nine variables. To ensure that we selected variables that described the variance of the complete data set well, we chose to eliminate variables with low loading on the first four axes. After reviewing the PCA results, three variables were eliminated from this category.
- Sediment variables: The first four axes of the PCA in this category also
 explained 76% of the data variance for this category, suggesting retention of
 at least four variables from this category. Two of the variables, representing
 organic sludge and plant debris, scored very close to each other, so the
 decision was made to combine these two into a single variable representing
 organic sediment. Six variables were eliminated from this category based on
 the PCA results.
- Overhanging and in-stream cover variables: The first two PCA axes explained 80% of the data variance, suggesting that two of the four variables could be eliminated. However, because of the perceived importance of in-stream cover in the system, only one variable was eliminated from this group.
- Bank and riparian variables: The first three PCA axes explained 73% of data variance. Close ranking among variables indicated retention of more than three variables, so only two variables were eliminated from this group.
- Anthropogenic variables: The first three axes explained 74% of data variance, suggesting retention of three variables from this group; four variables were eliminated.

The results of the PCA screening of habitat variables are summarized in Table D-2.

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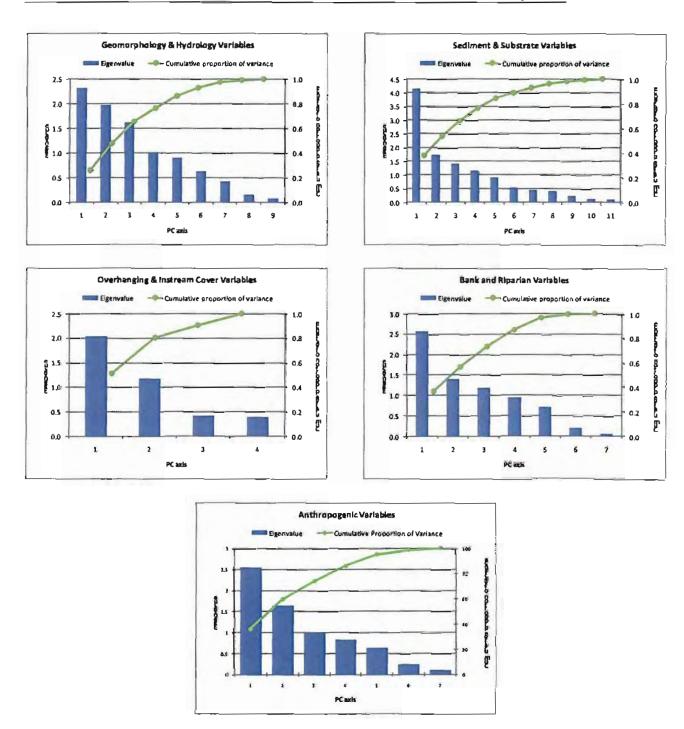


Figure D-1: Principal Components Analysis Scree Plots for CAWS Habitat Variables.

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Table D-2: Results of Screening Habitat Variables Using Principal Components Analysis.

Variable Category	Habitat Variable	
Geomorphology & Hydrology	Flashiness index	Retained
	Maximum velocity	Eliminated: even with Flashiness on PC3, correl, w/nav.
	Average velocity	Eliminated: rel. low load on all PC axes
	Wetted perimeter of channel	Retained
	Maximum depth in reach	Retained
	Number of off-channel habitats	Eliminated: rel. low load on all PC axes
	Number of off-channel bays	Retained
	Bank "pocket" areas	Retained
Sediment & Substrate	Dominant shallow substrate	Eliminated: rel. low load on all PC axes
	Dominant deep substrate	Eliminated: rel. low load on all PC axes
	% Hardpan, shallow	Eliminated: rel. low load on all PC axes
	% Hardpan, deep	Eliminated: rel. low load on all PC axes
	% Sand and fines, shallow	Retained
	% Sand and fines, deep	Eliminated; rel. low load on all PC axes
	% Gravel, cobbles, boulders, shallow	Retained
	% Gravel, cobbles, boulders, deep	Retained
	% Plant debris on bed	Retained
	% Organic sludge	Retained
	Depth of fines	Eliminated: rel. low load on all PC axes
n-Stream Cover	Number of aq. vegetation types	Eliminated: rel. low load on all PC axes
	Average macrophyte cover	Retained
	% overhanging veg. cover in reach	Retained
	Secchi depth	Retained
Bank & Riparian Condition	Dominant riparian land use	Retained
	Bank angle	Eliminated: rel. low load on all PC axes
	% "Natural" banks in reach	Retained
	% Vertical walled banks in reach	Retained
	% Riprap banks in reach	Retained
	% Bank with open water	Eliminated: rel. low load on all PC axes
	% Riparian vegetation	Retained
Anthropogenic Impacts	Manmade structures	Retained
	Number of NPDES discharges	Eliminated: rel. low load on all PC axes
	Distance from Lake Michigan	Retained
	Distance to nearest WRP	Eliminated: rel. low load on all PC axes
	Cadmium conc. In sediment	Eliminated: rel. low load on all PC axes
	Total PCB conc. in sediment	Eliminated: rel. low load on all PC axes
	Simultaneously extracted metals in sed.	Retained

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D.3 Habitat Variable Correlation Across Categories

After PCA, 23 habitat variables remained, including commercial navigation, representing a variable-to-data ratio of 0.28. To this point in the variable reduction process, habitat variables had been segregated in the five categories. As a final screening step before regression with fish data, the correlation of the remaining habitat variables with all other remaining habitat variables was evaluated using Spearman's correlation. Variables were evaluated for potential elimination if they had a Spearman's correlation coefficient with another variable of 0.6 or greater. Commercial navigation was included as an anthropogenic variable in this process. Six additional variables were eliminated because of strong correlation with other variables in other categories, as explained in Table D-3.

Table D-3: Results of Correlation of Habitat Variables Across Categories.

Variable Category	Habitat Variable	
Geomorphology & Hydrology	Flashiness index	Retained
	Wetted perimeter of channel	Retained
	Maximum depth in reach	Retained
	Number of off-channel bays	Retained
	Bank "pocket" areas	Retained
Sediment & Substrate	% Sand and fines, shallow	Eliminated: correl. w/ macrophyte cover (0.601)
	% Gravel, cobbles, boulders, shallow	Retained
	% Gravel, cobbles, boulders, deep	Retained
	% Plant debris on bed	Retained
	% Organic sludge	Retained
In-Stream Cover	Average macrophyte cover	Retained
	% overhanging veg. cover in reach	Eliminated: correl. w/ vertical walled banks (-0.600)
	In-stream cover present	Retained
	Secchi depth	Retained
Bank & Riparian Condition	Dominant riparian land use	Retained
	% "Natural" banks in reach	Eliminated: correl. w/ macrophyte cover (0.726)
	% Vertical walled banks in reach	Retained
	% Riprap banks in reach	Retained
	% Riparian vegetation	Eliminated: correl. w/ % dominant land use (-0.665)
Anthropogenic Impacts	Manmade structures	Retained
	Distance from Lake Michigan	Eliminated: correl. w/ bank pocket areas (0.645)
	Commercial navigation	Eliminated: correl, w/ maximum depth (0.789)
	SEM ⁹ in sediment	Eliminated: correl. w/ vertical wall banks (0.726)

This process reduced the set of habitat variables to 16, which represented a variable-to-data ratio of about 0.2. These 16 variables were carried forward for comparison to fish data, described in the following section.

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⁹ SEM = simultaneously extracted metals

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APPENDIX E:

HABITAT VARIABLE TABLES AND SCREENING RATIONALE

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Chicago Area Waterway System Habitat Evaluation and Improvement Study Habitat Evaluation Report

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	PASH BAS	's Great CHIC, ECYLDISE DYNAMING ASCINC; Yourse place	Withelm et al. 2001	Eliminated Insufficient data
	PASH MAY	N. Communication Control Control Control Control Control Control	Marketine et al. 2001	District Indian day
	TAND NOT	National of wood for makes youth (and/2000 m) from languaged survey	WPs.dom.m at 2001	Contract of spiketin
	MIN (MD	Marrier of place of word particle printing beginning to the	William et al. 2001	
	AVG WOOD	Average the wood (m3)	William et al. 2001	Christian van appropria
	SLANOS	Number of Stands which 2,000 is report (counted on title or from social photos)	Williams of al. 2001.	Command: not applicable
	SECOF	Second days (m)	Wilhalm or at 1601	Bruned
	CO CLOCK	Standard docustion sects depth (m)	Wilhelm et al. 7001	Electronic desired not receivery
	MC 1 JM	Section And as presenting of 1.5 sectors	William et al. 2001	General American Street
	SO SECTS	Bonderi Strictor of matri dept as presentes of 1.5 m	Wilselm et al. 2023	Control and or markey
	MC AN	In sealth' diek weight at the stresses bedrave! (No. or No.)	Whater or at. Thir:	Description of specific
	EPA 1	(a barel pantyle/lephide over join professor with natural	Whole of J. 7001	Circumst Inselfation Acts
	PSL 1	Better many health gay the coning of white a highest	Wilhalm of al. 1001	Commend profiting Arm

Habitat Variable Reduction: Chalitative Screenies

raide Grang	Variable .	Varta ján Descrigition	Source	(Luciony)s
mik and riparish specific	1			The state of the s
(and i	Jan (B till	Demonstration (or last born (or legislatur)	wahelm gr at. 700	Reserved
	m m	Described and the order made (congression)	everyth of pl. 2003	Record
	DOM LU	Description (and the banks banks combined (cotopings)	Water of M 7007	Returned
	WALL	tocore suggest not the overnor to top den	00 abpairs or al 2007	Change of red harder the
	60.04	Decreased proof authory	Williams at 2001	Desirated to copies to
	PANT	Chicago angland propriet and disord little	Marin W St. 7001	Chesinosari: ragi application
	NOND	Online angles such and chirals	(ar Paules at 10, 100)	Contract out probation
	THACH	Chromosomignani Dank and brodiffer	Authorities and 20, 2002)	filminated and highlight
A	LAWN	Distance-configurate former and parties	1001 a minima	Circumsted and hapfacetts
	CROPS	China migrai our	Militaria et 21.2003.	Elizabethé rad kapitation
	PASTA	Charge-co-configurat payment, recognismed, and here haven	Weeks at at any	District on replaces
	LOGGING	Congress regional regarding spacetimes	10*0-00% at al. 2000)	Ciminated: age systeming
	Mint	International street	Photo a st NO.	Emission of April 1988
	OTHER	la magni and	Williams at al. 2007.	Description of the same of the
	DIST_ALL	(Section registed of Frames distributing companied	Whom a d. 7907	Description of the second
	DATMON	(Materia-supplied on Appendixes (all distributions maked units and maked)	When 4 5, 1001	Shahatai tat makain
	DAT AG	District original agreement (page and pattern)	Agency 10 to 7000	Disabut of your oppication
	DA K			Elmented Intra Britan should
Acr		derrogs took orgin of back to tak.	William Hall JOET	Rate and
-	UNDET DI	Simming afficiency of London Linds (m)	PROPERTY NAMED	Command: residence data
-	P NACCT	Percency of meta periods	Whomas and	Comment management data
	BACK ENCIS	Desired had seein justices, arrivale, made as, hedd at week	When m st. 2001	Emerged Inglitzers day
	DA S	See as my	Williams of the Party	Empation Institute data
	04.5	NATION AND DESCRIPTION		Chinated Vestions date
	P13 7	had confry	Wilhelm 25 20. 2001	
	PU I	Standa requestatives and markets	W/Redott on al. 2001	Desirated transferred data
	SHE MAT			Elemental transferred data
	PHE COME	heromet netwest bents to semaling reach (played, na wells, / grep, or other amone) Persons we totally us feel compatio banks as sampling leach.	Cont times	facered
	MIC STEEL		Crist Chape	Rycored
	INE WOOD	Moreont motically walled show hands in sampling reach	CAN'S LIVING	firement
		Person concern unlied wood hards or carrying confe	CANTIONNE	Research
	ANK GAAN	Persons works by making stone broks to simplify much	CAWA Shipper	Research
	BAL HINE	Barcaul into hibbring program to advand topics	CARS Drope	Record
	BALL INVESTIG	Percent such larges or sampling reach securing by manny	CAMS Unque	Reserved
	INC WATER	Forcers bank langth an campling reach accusined by open water	CAMS (Imput	Record
Riperion (ex-si		Stor-to with memoral from Gold detd with a later range from [mg	IN Breaten at al. 2001	Francisco productions of the
	SD MP W	Standard Signature regardan width (m)	within at al. 2001	Eleverate insufficient date
	P NPCSM	Appellation of properties of 25 may 25 properties in 1	Wilhelm at al. 2003	Oreman medicine into
	NO MED	Charles collegarly species width, field then	Jacobson de hy 32013	(hydronic productor gate
_	NO MODE	Under congress Aparton and St. Table Sect.	19 Th-east, as al., 2007	Community impullicated also
	P DIAM	If Owney Poded	Wilhelm of all 2001	Charles Att
	DPEN CAN	Consequence (180 a fully server 0 is fully servered	Witholes et al., 2001	Character to Character Arts
	LG THEES	Si Large tress riperant pilots	Witholm or at, 2001	Distanced: Insufficient data
	DM TUDS	N Small crass rejector place	Water at al. 1901	Element institute are
	MO SHITH	2 Wandy abouts rigorous plans	W Studies or, al. 2002	Donwood: stanificant data
	SIAIS	A from opening paint	Wilder of al. 2025	Directorial insufficient exts
	RF CAN	Special control (see all part to the control to the	0-00mle of al. 2001	Descript: insufficient data
	FIR YOM	Reporter stands and proceed grown (TA stands and grown)	wada ya kazi	(Inniversely, Inquitiplant, phys
	MF ALL	الارسوم بسعر سا ومو حسانده (يانم)	Market at al. Mills	Alternational; transferred and
	P_CAMPY	M. Riperior cornerly impro 50 m (romant)	William at at 2007,	(Desirated: Healfichers data
	P SHAUE	To Decid Squar 50 m Streets	WPpdm et al. 1007;	(Reinsted: Peufficiers date
	P_GRAD	% Grand may You M in propert	WP # 4, TOP;	(Transled: Posticions data
	P ALLEY	N Consey, Analog, and pros-sentenced - Mil As Interest	WHERE & 1001	Desirated Insufficient data
	EPA ID	Special vides	When # 4 700)	Flatented buildings days
	751 9		W = 1001	(Fireman spullpart drop
	P IUP VEG	Persons riggroun supersisted Part with measuranteents	CANY LINGS	(134)

Habitan Variable Andustion: Qualitative Sections

vyrtabile Group	WANN	Vertable Description	Source	Rationals
bank and reserve constitues -	Contraced			
Sporter (hose mires)	OU NOW	Marriage of paper part 2000 to resuch, batch baseler combined	MARIN of al. 2001	Character on application
	CAP ILE	Pagal langur of page in riscolari segrecaçãos	W Padra at al. 2001	Chairman and Carbonia
	You va	Test leggs of rigorum vaporation	CAMA LIVER	Non-read
	GAP AVE	Secretaria Bis prility	White at all 1994	(Charles of the party)
	F GAD MS	Properties of Feet, selps gaps in species (gap larges income (ed)		(Sechand not applicable
	P GAP 41	Properties of 27 (300°bs, properties) with graph	Web-serr M at 20021	Desirated the applicable
	MANAGED	Awards of 42 courses when a security [25 page break]	W Martin pt at 2003	Description foot any of the
	MD UP PR	Marian April 1990	White a 1- 1001	Districted, NV - est, Commercian of Units Press (N-1764
	SO MP PH	travilled designer Asserts wiggs	Williams at N. 1905	Comment represed one preserve of charges wider.
	CV RIP PN	Confident of margins of Parties width	Purtharm as at 1001	Districted operations make a district value
	MAY NIP	Mariana American which	William at al. 2001	Downsond: TER York own Donnales of All Print worth.
	MIN AP	Marinest Appelled width	Widness of al, Beari	Francisco (1931 and may haven a of marine wells.
	No. 1000	Samp of right-year politics	Witnesser og pl. 2007)	December with the second report of the
Anthropografic Impacts				
	Us To Ston	Surgice of (PA type related to the PA to the PA	Frend SE	Constant Institute days
	SAPE A	Distance to SAFFI statum	Chart Group	Ebermand only abgitable in details Comi.
	HEN D		Chair United	Description of any angles in state brack Chicago Sale
	BOANCBOSS	Marrier of read Commings which \$4000 is read?	William of all 2000	Decimand: pag applicable
	100	Districts on the first of the said and a	Woods at all 2001	Christian bradings from
	MAN Muce Scroot	Duringer of Mannado structures at the site	LANGUE PALA	Served
	HUM PIME	Shorter of horse and surple not settled about reach	Withalm et al. 2001	Commend resident tro
	WIN CO	Name of AFOC parented CIO and the	CAMP Desput	Anne
	ALM HE MOOR	Surrey of AFGE printing age-CSC audian	CANADA	Arrived
	THE THE	Martine of Table reference for the same	CAN'S Prime	Ginhard baffour drill
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	Nor he its	and same description of the same production of the same same same same same same same sam		Demograd and approach?
		Name and pull common spirit an	Well and Administration 2023	Desirated resilicant at the
	Nov Let Ves	The party of the p	Charl Colons	United Indiana dri
	Mary feet 19 lets	Night reducing subspaces and broad on leaft bounds		Direction of the State of the S
	HERV_Het_Head	Street Street Street and Street Stree	Charl tamps	Command retrieved MAN STORY
	Nav_Ref_low	The witten spring on person on play about	And the land	Directed Visited RAY THEY
	UMICH_D	Distance to reserved MVI have Middle for project from	CAWS Unique	Road
	NAME TO THE	Commercial Introduction and Studies	CAWS UN AS	Dien
	PUMPSYA D	parado men but laca	CVIM Coulty	Arred
	WWITP 6	Defines to attends emparates (at spanish lights)	CAMA CHICAM	loured
	110.00	Coprosed concepts from in profession	CAMP Unique	Antony
	SED SOM	Specific special achacing integr is propied a	DAWN Under	Ascend
	SO TOT DO	Epid PCIs in sudment	CAMPLINGS	Record

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Habitat Variable Reduction; Combination of Like Variables

Variable Group	Variable	Variable Description	Source	Rationale
eomarphology & H	lydrology			
	FLASH IN	Plash index: ratio of 10 to 90% exceedance flows (USGS gage data, all years)	Wilhelm et al. 2003	
	050	Average SIN exceedance level for discharge from USGS gage data (cms)	Wilhelm et al. 2001	
·	MAD	Mean Annual Discharge from USGS gage data (cms)	Wilhelm et al. 2003	
	MAX_VEL	Maximum velocity averaged for transects (m/s)	Wilhelm et al. 2001	
	AVG_VEL	Average velocity (Q/XAREA) averaged for transects (m/s)	Wilhelm et al. 2001	
	251_3	Visinoity to-depth ratio	Withelm et al. 2001	
	XAREA	Cross-sectional area (7((d)-dis)/2"will of wetted channel (m2)	Wilhelm et al. 2001	
	WET_PER	Wested perimeter (?((dird(+1)2+(whow(+1)2))/2) of wetted channel (m)	Wilhelm et al. 2003	
	HYDR_RAD	tow flow trydrautic radius. XAREA divided by WET_PER (m)	Wilhelm et al. 2003	
	MAX_DEP	Maximum depth averaged for (randers (m)	Wilhelm et.al, 2001	
	LOCMAXO	Localism of maximum depth as a proportion of local width	Wilhelmet al. 2001	
	CW\$_W_80	CAWS width bottom of changes	CAWS Unique	
	CAWS_DEPTH	Site depin as measured for PHA	MWRDGC PHA	
	AVG_OPTH	Average depth XAREA divided by WET_WIDTH averaged for transects (m)	Wilhelm et 1), 2001	<u> </u>
	WETWIDTH	Stream width at low flow wetted channel, averaged for transects (m)	Withelm et al. 2001	
	WETWIOTH_ALT	alternate stream width	Wilhelm et al 2003	
	ww_biv_b	Mean wetted width divided by mean depth	Wilniam et al. 2003	
	OFF_CHAN	Number of tributary, backwaler, and off-channel habitats from on-site	Wilhelm et al. 2001	
	TRIB_PH	Number of tributary and backwater habitats from aerial photographs	Withelm et al. 2001	
	OFF CH_BAY	Off channel bay areas (was connected to man channel, isolated from general flow of main channel, and 25 mag)	Alinghous et al 2002* adopted	
	BANK POC AREA	Pocket areas within the bank that may serve as refuse for sop from the main channel flow	CAWS Unique	- 100

Habitat Variable Reduction: Combination of Like Variables

	66				
Variable Group	Variable	Variable Description	Source	Rationale	
Sediment					
	BH_D	% Hard Dag, deep	Wilhelm et x1, 2001		
	DOM_D	Dominant deep sybstrate	Wilhelm in at 2001		
	SAFN_D	% Sand and Fines, deep	Wilhelmet at 2001		
	81G_0	& Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Withelm et al. 2001		
	BH_S	% Hans pap, shallow	Wilhalm et al. 2001		
	DOM_S	Dominant shallow substrate	Withelm et al. 2003		
	SAFN_S	% Sand and fines, shallow	Withelm et al. 2001		
	81G_5	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et at, 2001		
	CAWS_INSLG	CAWS PHA % Inorganic Sludge	MWRDGC PHA		
	CAWS_ORSUG	CAWS PHA & Organic Sludge	MWRDGCPHA		
	CAWS_PLOBR	CAWS PHA W Plant debris	MWROGC PHA		
	CAWS_DPTH_FNS	CAWS PHA Depth of fines	MWRDGC PHA		

Habitat Variable Reduction: Combination of Like Variables

Variable Group	Variable	Variable Description	Source	Rationale
	Anuanid	Versione Description	and the	Ref of lat
(URTIGATE CONST	40.000	In the state of th	MWRDGC PHA	
	AQ_VEG	Number of aquatic vegerative types within area	Wilhelm et al. 2001	
-	MCIPH_CO	Average matrophyle coverage (area density) (m)	MWRDGC PHA	
	PERC_COV	Percent of canapy cover over water - Gid-derived		
<u> </u>	PERC_COV_ALT	Percent of canopy cover over water - livid-measured	CAWS Unique	
	LENGTH_COV	Mesured length of cover at station	CAWS Unique	
	NUM_COV	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique	Retained
	DEPTH_COV	Depth of shade cover	CAWS Unique	
	LENGTH_OVR	Measured length of undercut banks at station	CAWS Unique	
	SECCHI	Secchi depth (m)	Wilhelm et al. 2003	
Bank and riparian co	ndition			
	LB_LU	Dominant land use left bank (categorical)	Wilhelm et al. 2001	
	RB LU	Dominant land use right bank (rategorical)	Wilhelm et al. 2001	
	DOM LU	Dominant land use, both banks combined (cutegorical)	Wilhelm et al. 2003	
`	BNK ANGL	Average bank angle of both banks	Wilhelmer 11, 2001	
	BNK NAT	Percent natural banks in sampling reach (stoped, no walls, riprap, or other armoning)	CAWS Unique	
	BNK CONC	Percent vertically walled concrete banks in sampling reach	CAWS Unique	
	BNK STEEL	Percent vertically walled steel banks in sampling reach	CAWS Unique	These variables were combined into one new variable (BNK_WALL
	BNK_WOOD	Percent vertically walled wood banks in sampling reach	CAWS Unique	for subsequent analysis.
	BNK GRAN	Percent vertically walled stone block banks in sampling reach	CAWS Unique	
	BNK RIPRAP	Percent riprapped banks in sampling reach	CAWS Unique	
	BNK MARINA	Percent bank length in sampling reach occupied by marina	CAWS Unique	These variables were combined into one new variable
	BNK WATER	Percent bank length in sampling reach occupied by open water	CAWS Unique	(BNK_MARWA) for subsequent analysis.
***	P_RIP_VEG	Percent riparian vegetation from site measurements	CAWS Unique	
	Tot_LG	Total length of riparian vegetation	CAWS Unique	

Habitat Variable Reduction: Combination of Uke Variables

	66			
Variable Group	Variable	Variable Description	Saurce	Rationale
Anthropogenic impact				
	MAN_Made_Struct	Number of manmade structures at the site	MWRDGC PHA	
	NUM_CSO	Number of NPDES permitted CSO outfalls	CAWS Unique	These variables were combined into one new variable (NUM_SUM)
	NUM_NPS_NOCSO	Number of NPDES permitted non-CSO outfalls	CAWS Unique	for subsequent analysis.
	LMICH_D	Distance to nearest U/S Lake Michigan access point	CAWS Unique	
100	NAV_THRU	Commercial tonnage passing	CAWS Unique	
	PUMPSTA_D	Distance to nearest pumping station	CAWS Unique	
	WWTP D	Distance to nearest westewater treatment plant	CAWS Unique	
	SED_CD	Cadmium concentration in sediment	CAWS Unique	
	SED_SEM	Simultaneously extracted metals in sediment	CAWS Unique	
	SED_TOY_PCB	Total PCBs in sediment	CAWS Unique	

Habitat Variable Reduction: Spearman's Correlation Analysis

ariable Group	Variatie	Variable Description	Source	Raylonzie
естогразову & н	Adlerotok			
	FLASH IN	Flash Index calls of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al. 2003	Retained: Modified from USGS data to DUFLOW model output
	050	Average SOX exceptence level for discharge from USSS gage data (cma)	Withelm et al. 2001	Eliminated: highly correlated with MAX_DEP (> 0.7)
	MAD	Mean Annual Olscharge from USGS gage data (cms) .	Withelm et al. 2001	Ellen Insted: highly correlated with MAX_DEP (> 0.7)
	MAX_VEL	Maximum velocity averaged for transects (m/s)	Withelm et al 2001	Retained; Modified from USGS data to DUFLOW model output
	AVG VEL	Average velocity (Q/XAREA) averaged for instructs (m/s)	Withelm et al. 2001	Retained: Modified from USGS data to DUFLOW model output
	951_3	Velocity-to-depth ratio	Withelm et al. 2001	Eliminated: highly correlated with AVG_VEL (> 0.7)
	XAREA	Cross-sectional area (7(d+d+1)/2 wi) of wested channel (m2)	Withelm et al. 2001	Eliminated: h 3) ly correlated with WET PER (> 0.7]
	WEY_PER	Wetted perimeter (?((dl+di+1 Z+(w/+w/+ 1)2)1/2) of wetted channel (m)	Wilhelm et al. 2001	Retained
	HYDR_RAD	Law flow hydraulic radius: XAREA divided by WET_PER (m)	Withelm et al. 2003	Eliminated: highly correlated with MAX_DEP (> 0.7)
	MAX_DEP	Maximum depth averaged for transects (m)	Wilhelm Pt at, 2003	Rétained
	CXAMOOS	Location of maximum depth as a proportion of total width	Wilhelm et al. 2001	Eliminated; Mutily correlated with MAX, DEP (> 0.7)
	CWS_W_BO	CAWS width bostom of channel	CAWS Unique	Eliminated; highly correlated with WET_PER (> 0.7)
	CAWS DEPTH	Site depth as measured for PHA	MWROGCPHA	Eliminated: highly correlated with MAX_DEF (> 0.7)
	AVG_DPTH	Average depth: XAREA divided by WET_WIDTH averaged for transects (m)	Wilhelm et al. 2001	Eliminated: highly correlated with MAX_DEP (> Q.Y)
	WETWIDTH	Stream width at few flow wetted channel, averaged for transects (m)	Withelm at al, 2001	Eliminated; highly correlated with WET_PER (> 0.7)
	WETWIDTH_ALT	alternate stream width	Withelm et al, 2001	Eliminated; highly correlated with WET_PER (> 0.7)
	WW_DIV_D	Mean wetted wisth divided by mean depth	Withelm et al. 2005	Elliminated: highly correlated with CAWS OI RAT (> 0.7)
	OFF_CHAN	Number of Industry, backwater, and off-channel habitats from on-site	With eigs et al, 2001	Relained
	TRIB_PH	Number of tributary and back-saver habitats from abrial photographs	Wilhelm et al. 2001	Eliminated, highly correlated with OFF_CHAN (> 0.7)
	OFF CH BAY	Off channel bay 1/611 (areas corrected to main channel, iterated from general from at main channel, and 76 m sq.)	Alinghaus et al 2002' anopted	Retained
	BANK POC AREA	Pocket areas within the bank that may serve as refuge for spp from the main channel flow	CAWS Unique	Retained
liment				
	BH_O	X Halid pan, direg	Wittelm et al. 2003	Retained
	DOM_D	Dominant deap substrate	Wilnelm et al. 2001	Retained
	SAFN_D	% Sand and Fines, deep	With eirs et at 2001	Retained
	B(G_D	% Substrate fine gravet, coarse gravet, cobble, and boulder, dieep	Wilhelmer at, 2001	Relained
	BH_S	% Hard pan, shallow	Withelm et al 2001	Retained
	DOM_S	Dominani shallow substrate	With elm et al. 2001	Retained
	SAPN_S	X Sand and fines, shaflow	Witheligh et al. 2001	Retained
	BIG_S	% Substrate fine gravel, course gravel, cobbie, and boulder, shallow	Wilhelm et al. 2003	Ketained
	CAWS_INSLG	CAWS PHA % Inargunic Studies	MWRDGC PHA	Eliminated: highly correlated with DOM_0 (> 0.7)
	CAWS ORSEG	CAWS FHA % Organic Sludge	MWRDGC PHA	Retained
	CAWS_PLOBR	CAWS PHA X Plant debris	MWKDGC PHA	Retained
	CAWS OPTH FNS	CAWS PHA Depth of fines	MWRDGC PHA	Retained

Habitat Variable Reduction: Spearman's Correlation Analysis

Variable Group	Vadable	Variable Description	Source	Rezionate
instream cover				
	AQ_VEG	Number of aquatic vegetative types within area	MWRDGC PHA	Retained
	MCRPH_CO	Average macrophyte coverage (area "density) (m)	Withelm et al. 2001	Retained
	PERC_COV	Percent of canopy cover over water - GIS-derived	MWRDGC PHA	Eliminated: highly correlated with PERC_COV_ALT (> 0.7)
	PERC_COV_ALT	Percent of canopy cover over water - field-measured	CAWS Unique	Resalned
	LENGTH COV	Mesured length of cover at station	CAWS Unique	Eliminated: highly correlated with PERC_COV_ALT (> 0.7)
	NUM_COV	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique	Retained
	DEPTH_COV	Depth of shade ower	CAWS Unique	Eliminated: highly correlated with PERC_COV_ALT (> 0.7)
	LENGTH_OVR	Measured length of undercut banks at exaction	CAWS Unique	Eliminated: highly correlated with PERC_COV_ALT (> 0.7)
	SECCHI	Seach(depth (m)	Wilhelm et al 2001	Retained
Bank and riparian co	ndition			
T	LB_LU	Cominant land use left bank (categorical)	Wilhelm et al. 2001	Eliminated: highly correlated with DOM_LU (> 0.7)
	RB_LU	Dominant land use right bank (categorical)	Wilhelm et al. 2001	Eliminated; highly correlated with 77 (> 0.7)
	DOM_LU	Dominant land use, both banks combined (categorical)	Wilhelm et al. 2001	Retained
	BNK_ANGL	Average bank angle of both banks	Wilhelm et al. 2001	Retained
	BNK_NAT	Percent natural banks in sampling reach [slaped, no walls, riprap, or other armoring)	CAWS Unique	Retained
	BNK_WALL	Percent vertically walled banks in sampling reach	CAWS Unique	Retained
	BNK_RIPRAP	Percent Aprapped banks in sampling reach	CAWS Unique	Retained
	BMX_MARWA	Percent bank length in sampling reach occupied by marina & open water	CAWS Unique	Retained
	P_RIP_VEG	Percent riparian yegetation from site measurements	CAWS Unique	Retained
	Tot_LG	Total length of Aparian vegetation	CAWSUnique	Eliminated; highly correlated with P RIP VEG (> 0.7)
Anthropogenic impa	ru .		A Comment of the Comm	
K	MAN_Made_Struct	Number of manmade structures at the site	MWRDGC PHA	Retained
X	NUM_SUM	Number of MPDES permitted outfalls	CAWS Unique	Retained
X	LMICH_D	Distance to newfest U/S Lake Michigan access point	CAWS Unique	Retained
X	NAV THRU	Commercial tonnage passing	CAWS Unique	Retained
	PUMPSTA_D	Distance to nearest pumping station	CAWS Unique	Elinninated: highly correlated with NAV_THRU (> 0.7)
×	WWTP B	Olstance to nearest wastewater treatment plant	CAWS Unique	Retained
X	SED_CD	Cadmium concentration in sediment	CAWS Unique	Retained
X	SEO_SEM	Simultaneously extracted metals in sediment	CAWS Unique	Retained
x	SED TOT PEB	Total PCBs in sediment	CAWS Unique	Retained

Habitat Variable Reduction: Principal Components Analysis

Variable Group	Vzdable	Variable Description	Source	Rationale
enmorphology & H	ydrology			
	FLASH IN	Firsh Index ratio of 10 to 90% extradence flows (USGS gage date, all years)	Willhalm et al. 2001	Retain for MLR
	MAX VEL	Maximum velocity averaged for transacts (m/s)	William of all 2001	(Krishate: matched with FLASH IN on PC); 0.789 com. w/ NAY_THAU)
	AVG VEL	Average velocity (Q/XAREA) averaged for transects (m/s)	100K Js to relative	Elleninate: not strongest on any PCA sult
	WET_PER	Wetter perimeter (7([died +1)2+ wi+wi+1)2())/2) of wetter channel (m)	without as at 100 I	Reuin for Milk
	MAX_DEP	Maximum depth averaged for transacts (m)	Wilhelm of all 2001	Results for MLR
	OFF CHAN	Humber of Influtury, backwater, and off-channel habitets from on-site	William of al. 2001	Eliminate: not strongest on any PCA axis
	OFF CH BAY	Off Channel bay areas (seem connected to main channel, isolated from general flow of main channel, and >5 m to)	Almphase et al 1001' adopt	RECOIN for MUR
	BANK POC AREA	Pocket areas within the bank that may salve as refuge for sop from the main channel flow	CANG UMQUE	Retain for MUR
ediment				
_	BH O	16 Hard pan, deep	withdra et al. 2001	Eliminate: not strongest on any PCA axis
	DOM D	Dominant deep substrate	William of all 2001	Eliminate: not strongest on any PCA axis
	SAFH D	% Sand and Fines, deep	William or at 2001.	Eliminate, nat strongest on any PCA axis
_	BIG_D	% Substrate fine grant, coarse gravel, cobble, and boulder, deep	wDuden et al. 2001	Retain for MLR
	BH S	K Hard pan, shallow	Antibodies or al. 2003	Eliminate: not strongest on any PCA min
	DOM 5	Dominant shallow substrate	Williams or al. 2003	Eliminate; not strongest on any POA ands
	SAFN S	% Sand and fines, shallow	Wilhelm et al. 2001	Retain for MLR
	BIG S	% Subscrate fine gravel, coarse gravel, cooble, and boolder, shallow	Wilhelm et al. 2001	Recain for MLR
	CAWS ORSEG	CAWS PHA & DYZANIC Sudge	MYNTOGE PHA	Retain for MuR
	CAWS PLOBR	CAWS PHA K Plant debris	MWADGC PHA	Retain for MIR
	CAWS DPTH FAS	CAWS PILA Depth of fines	ADMINISC PHA	Eliminate; not strongest on any PCA axis
INSTARSAL COMPA		THE CONTRACT OF THE PARTY OF TH	WHAT THE PERSON	-
-	AQ VEG	Number of equation equation types within area	MINNEGE PHA	Eliminate: not strongest on any PCA axis
	MCROH CO	Average macrophyte coverage (ama*dens(s)) (m)	Winds call 1001	Retain for MLR
	PERC CON ALT	Percent of canopy cover over water - field-measured	Calles Unique	Retain for MAR
	NUM COV	Recorded presence or absence of in-stream sower (woody debris, boulders, etc.)	CAWS Unique	Retained
	56000	Secchi depth (m)	prefreim at all 2001	Retain for MLA
lank and riparian co	ndition			
	DOM IN	Operinant land use, both banks combined (categorical)	Withelm et al 2001	Retain for MLR
	BNK ANGL	Average bank angle of both banks	withdows at al. 2001	Eliminate: not strongest on any PCA sxis
	BNK NAT	Percent matura) canta in sampling reach (sloped, no walls, riprap, or other atmoding)	CANG UNID-O	Retain for MLA
	BNK WALL	Percent vertically walled banks in campling reach	CAWS U-	Retain for MLA
	BAK RIPRAP	Percent represent hanks in sampling reach	CAWS Unique	Retain for MIR
	BNK MARWA	Parcent bank length in sampling reach occupied by marina & open water	CANS Unique	Climinate: not strongest on any PCA axis
	P RIP VEG	Percent riparian vegetation from site measurements	CANAS Unique	Retain for MUI
athropogenic impa	rts			
	MAN Made Struct	Number of manmade structures at the kits	MWADSC PILL	Retain for MER
	NUM SUM	Number of NPOES permitted outfalls	CAWS UNIQUE	Eliminate: not strangest on any PCA axis
	(MICH D	Dutance to nearest U/S Lake Michigan access point	CANG Unique	Retain for MILR
-	MAY THRU	Commercial (paners) planting	CAWS Unique	Resalt for MUR
-	WWTP D	Distance to pearest wastewater treatment plant	CAWS Unique	Eliminate: not strongers on any ACA wats
	SED CO	Cadmium concentration in sediment	CANA Green	Elimbrate: not strongest on any PCA sub
	SED SEM	Simplian rously extracted metals in sediment	CANS Chapm	Retain for MLR

Habitat Variable Reduction

Variable Group	Variable	Variable Description	Saurce	Rationale
Scomorphology & H	drology			
	FLASH_IN	Flash (ndex ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al 2001	
	WET_PER	Wetted perimeter (Y(di+di+1)2=(wi+wi+1 2)(/2) of wetted channel (m)	Wilhelm et al 2001	
_	MAX DEP	Maximum depth averaged for transects m	Wilhelm et al. 2001	
	OFF_CH BAY	Off channel day \$1932, provided to make channel, biolated from general flow of main channel, and is in up)	Alinghaus et al 2002" adopted	
	BANK_POC_AREA	Pocket areas within the bank that may serve as refuge for spp from the main channel flow	CAWS Unique	
ediment		A CONTRACTOR OF THE CONTRACTOR		
	BIG_D	¥ Substrate fine gravel, coarse gravel, coobile, and boulder, deep	Wilhelm et at 2001	
	SAFN_S	% Sand and fines, shallow	Wilhelm et al. 2001	Eliminated: correl. w/ macrophyre cover (0.601)
	BVG_5	% Substrate fine gravel, coarse gravel, cobbie, and boulder, shallow	Withelm et al 2001	
	CAWS_ORSLG	CAWS PHA % Organic Studge	MWRINGE PHA	
	CAWS, PLOSE	CAWS PHA % Plant debric	MWRDGE PHA	
AM/cam cover				
	MCRPH_CO	Average macrophyte coverage (area*density) (m)	Withelm et al. 2001	
_	PERC_COV_ALT	Percent of canapy cover over water - field-measured	CAWS Unique	Eliminated correl. w/ vertical walled banks (-0.600)
	MUM_COV	Recorded presence or absence of in-stream cover (woody debr.s, boulders, etc.)	CAWS Unique	
	SECCHI	Secon depth (m)	Wilhelm et al. 2001	
and riparran co.	idition			
	DOW_IN	Dominant land use, both banks combined (extegorical)	Wilhelm et al. 2001	
	BMX_NAT	Percent natural banks in sampling reach (sloped, no walls, riprap, or other armoring)	CAWS Unique	Eliminated correl w/ macrophyse cover (0.726)
1000	BNK_WALL	Percent vertically walled banks in sampling reach (concrete, sheet piling, stone blocks)	CAWS Unique	
	BNK_RIPRAP	Percent Aprapped banks in sampling reach	CAWS Unique	
	P RIP VEG	Percent riparian vegetation from site measurements	CAWS Unique	21minate: correlated with DOM_CU (-0.685)
Anthropogenic impa	מ			
	MAN_Made_Struct	Number of manimade structures at the cite	MWRDGC PHA	
	LMICH_D	Distance to nearest U/S Lake Michigan access point	CAWS Unique	Eliminate: comebbed with BAHK_POC_AREA (0.645)
	NAV_THAU	Commercial torinage passing	CAWS Unique	Eliminated: correl w/ maximum depth (0.789)
	SED SEM	Simultaneously extracted metals in sectment	CAWS Unique	Eliminated, correl, w/ vertical wall banks (0.726)

Final Habitat Variables for Regression with Fish Metric

Variable Group	Variable	Variable Description	Source
Geomorphatogy & H	ydralogy		
	FLASH_IN	Flash Index, ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al 2001
	WET PER	Wetted perimeter (?([diedi+1]2+(wi+wi+1)2]1/2) of wetted channel (m)	Wilhelm et al. 2001
	MAX_0EP	Maximum depth averaged for (randerts (m)	Wilhelmet al. 2001
	OFF_CH_BAY	Off channel bay areas (seese toompored to main channel, isolated from general flow of main channel; and vis miss)	Alinghous et al 2002+ adopted
	BANK_POC_AREA	Pocket areas within the bant that may serve as refuge for app from the main channel flow	CAWS Unique
Sediment	10000		
	BIG_D	% Substrate fine gravel, coarse gravel, coable, and boulder, deep	Wilhelm et al. 2001
	BIG_5	% Substrate fine gravel, coarse gravel, costile, and boulder, shallow	Withelm et al. 2001
	CAWS_DRSLG	CAWS PHA % Organic Studys	MWRDGC PHA
	CAWS_PLOBR	CAWS PHA & Plant debin	MWRDGC PHA
Instream cover			
	MCRPH_CO	Average macrophyte coverage (area density) (m)	Wilhelm et al 2003
	NOW COA	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique
	SECOHI	Secchi depth (m)	Wilhelm et al. 2001
Bank and riparian co.	ndition		
	DOM_LO	Commant land use, both bants combined (categorical)	Wilkelm et al. 2001
	BNK WALL	Percent vertically walled banks in sampling reach (concrete, sheet piling stone blocks)	CAWS Unique
	BNK RIPRAP	Percent riprapped banks in sampling reach	CAN'S Unique
Anthropogenk Impa			
	MAN Made Struct	Number of manmade structures at the site	MWROGC PHA