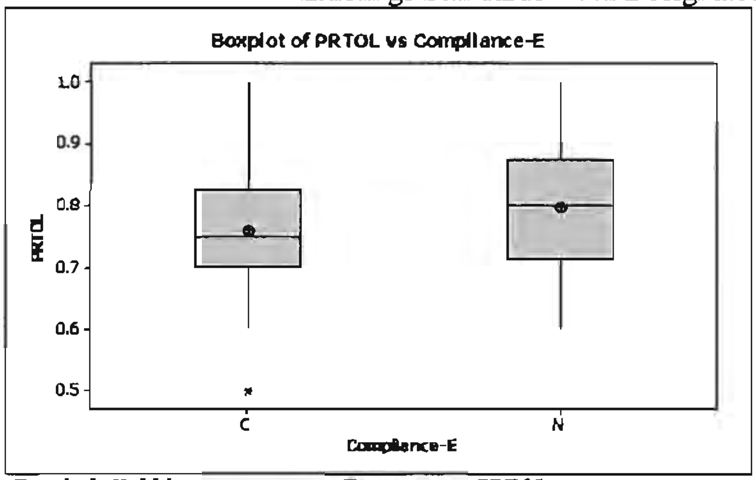
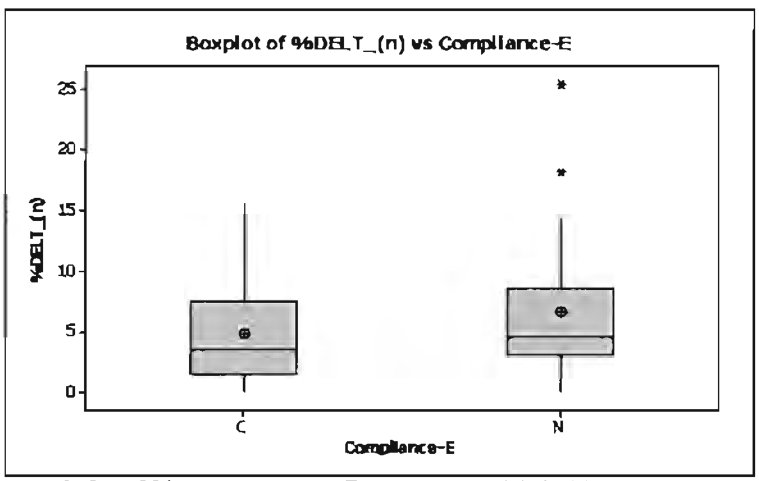
Existings Standards – All Designated Uses



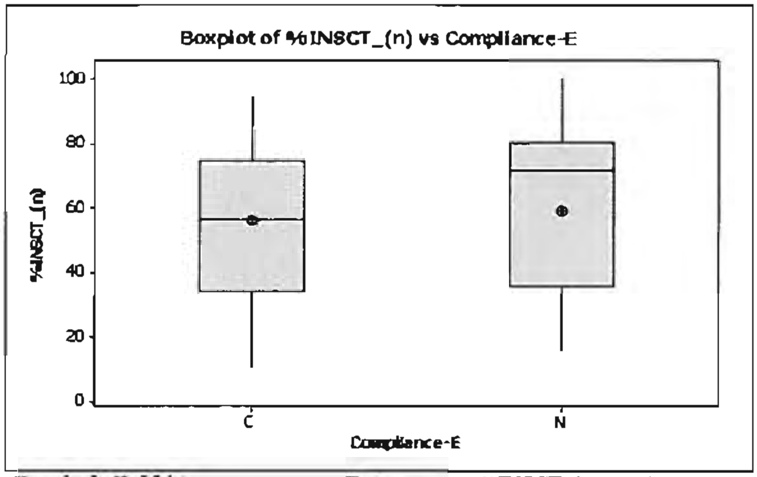
Kruskal-Wallis		Test on	PRTOL		
Compliance	N	Median	Ave Rank	Z	
C	36	0.7575	24.2	-1.37	
N	15	0.8	30.4	1.37	
Overall	51		26		
H = 1.89 DF =		1 P =	0.169		
H = 1.90 DF =		1 P =	0.169		adjusted for ties

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



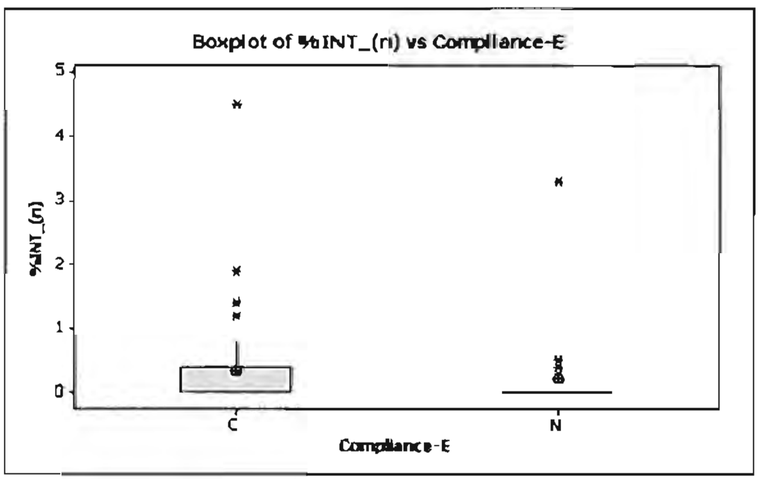
Kruskal-Wallis		Test on	%DELT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	36	3.75	24.7	-0.95	
N	15	4.7	29.1	0.95	
Overall	51		26		
H = 0.90 DF =		1 P =	0.342		
H = 0.91 DF =		1 P =	0.341		adjusted for ties

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



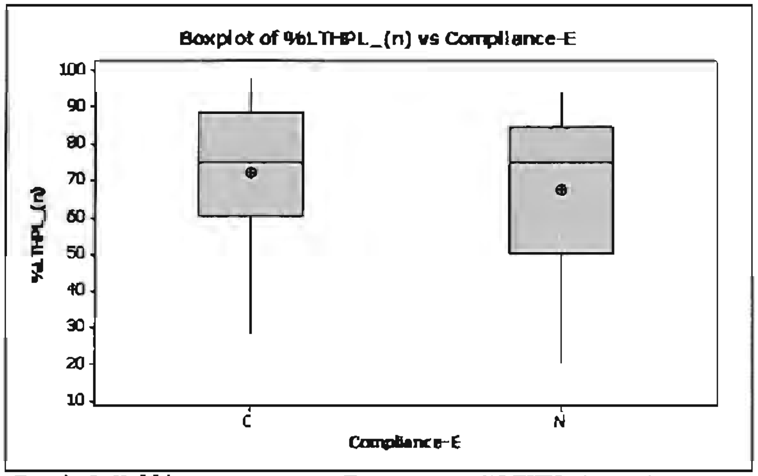
Kruskal-Wallis		Test on	%INSCT_(n)	)	
Compliance	N	Median	Ave Rank	Z	
C	36	67.25	24.7		-0.97
N	15	74.4	29.1		0.97
Overall	51		26		
H = 0.94	DF =	1 P =	0.331		
H = 0.94	DF =	1 P =	0.331		adjusted for ties

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



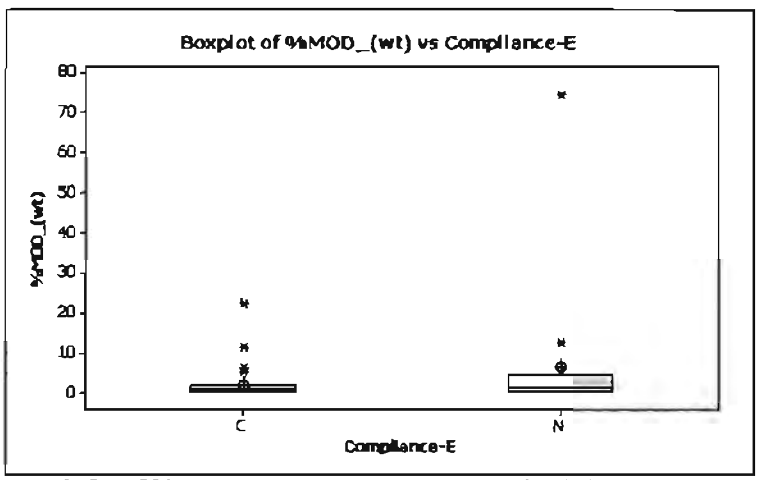
Kruskal-Wallis		Test on	%INT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	36	0	27.9		1.39
N	15	0	21.5		-1.39
Overall	51		26		
H = 1.92	DF =	1 P =	0.166		
H = 3.27	DF =	1 P =	0.07		adjusted for ties

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



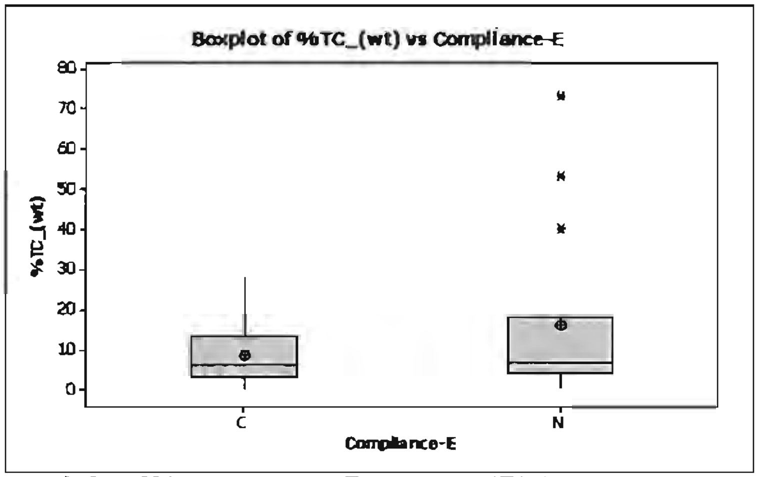
Kruskal-Wallis		Test on	%LTHPL_(n)		
Compliance	N	Median	Ave Rank	Z	
C	36	75.75	27.3		0.95
N	15	73.7	22.9		-0.95
Overall	51		26		
H = 0.90	DF =	1 P =	0.342		
H = 0.90	DF =	1 P =	0.342		adjusted for ties

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



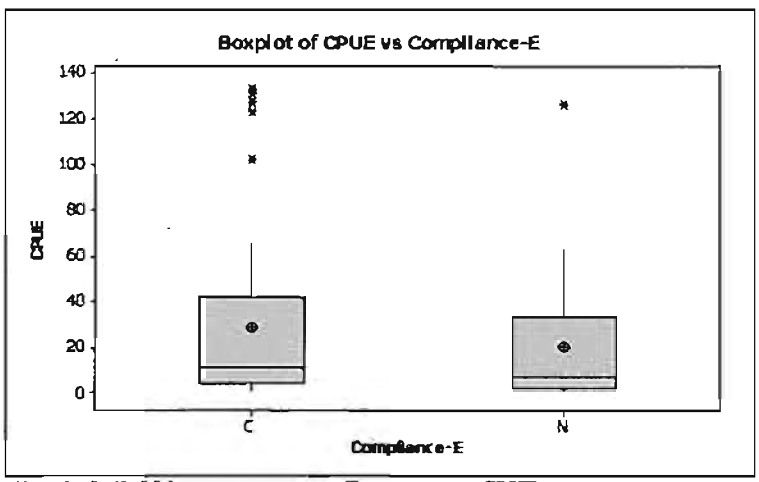
Kruskal-Wallis		Test on	%MOD_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	36	0.85	26.4		0.31
N	15	0.4	25		-0.31
Overall	51		26		
H = 0.10	DF =	1 P =	0.756		
H = 0.10	DF =	1 P =	0.756		adjusted for ties

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



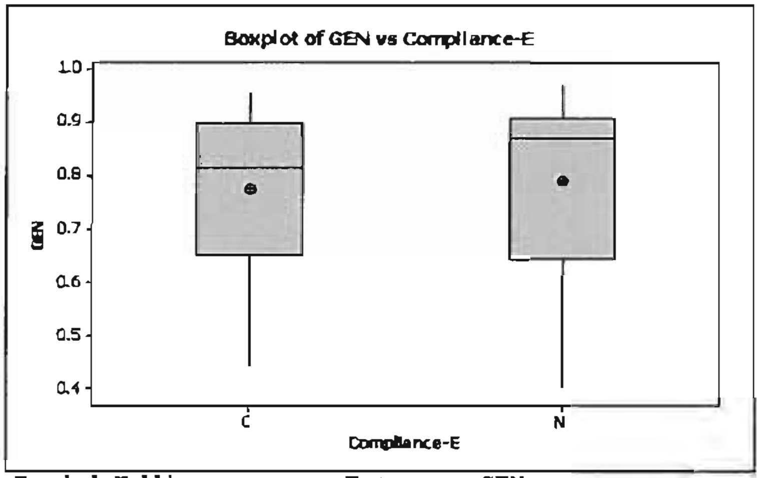
Kruskal-Wallis		Test on	%TC_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	36	8.7	25.6		-0.31
N	15	6.1	27		0.31
Overall	51		26		
H = 0.10 DF =		1 P =	0.756		
H = 0.10 DF =		1 P =	0.756		adjusted for ties

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



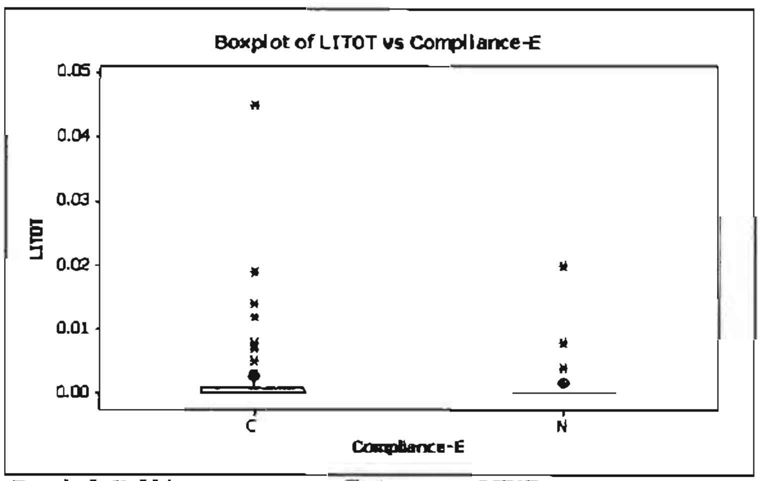
Kruskal-Wallis		Test on	CPUE		
Compliance	N	Median	Ave Rank	Z	
C	36	8	27.9		1.43
N	15	6	21.4		-1.43
Overall	51		26		
H = 2.03 DF =		1 P =	0.154		
H = 2.04 DF =		1 P =	0.153		adjusted for ties

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



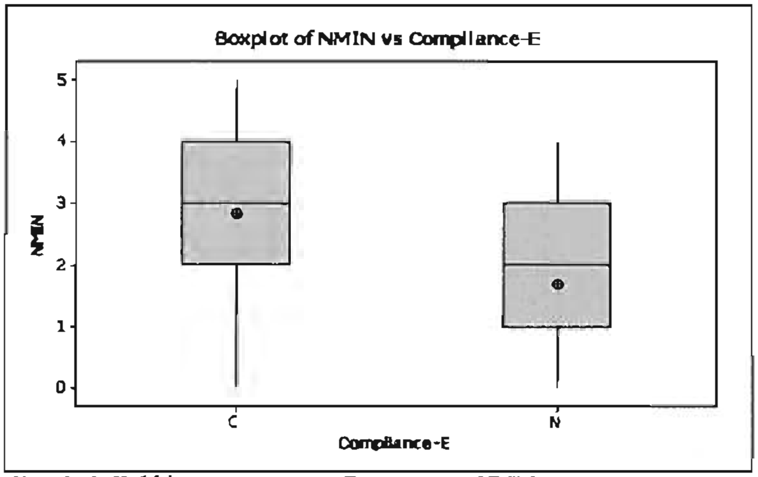
Kruskal-Wallis		Test on	GEN		
Compliance	N	Median	Ave Rank	Z	
C	36	0.798	25.8	-0.17	
N	15	0.833	26.5	0.17	
Overall	51		26		
H = 0.03 DF =		1 P =	0.869		
H = 0.03 DF =		1 P =	0.869		adjusted for ties

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



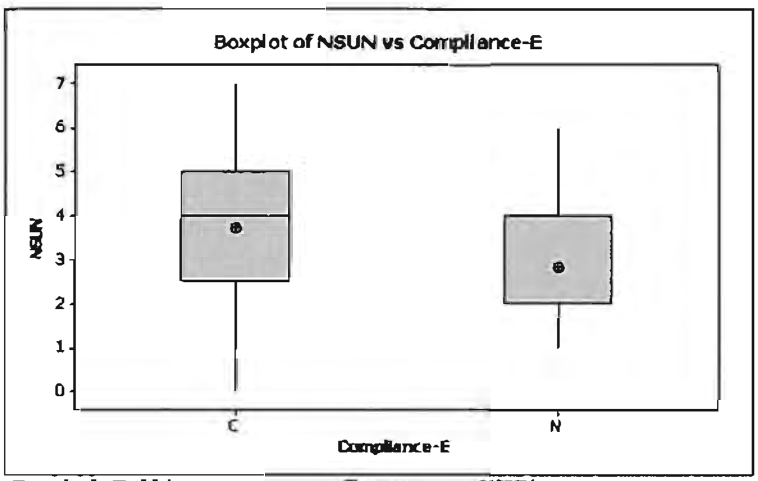
Kruskal-Wallis		Test on	LITOT		
Compliance	N	Median	Ave Rank	Z	
C	36	0	27.1	0.81	
N	15	0	23.4	-0.81	
Overall	51		26		
H = 0.65 DF =		1 P =	0.42		
H = 1.47 DF =		1 P =	0.225		adjusted for ties

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



Kruskal-Wallis		Test on	NMIN		
Compliance	N	Median	Ave Rank	Z	
C	36	3	29.7	2.78	
N	15	1	17	-2.78	
Overall	51		26		
H = 7.73	DF =	1 P =	0.005		
H = 8.13	DF =	1 P =	0.004		adjusted for ties

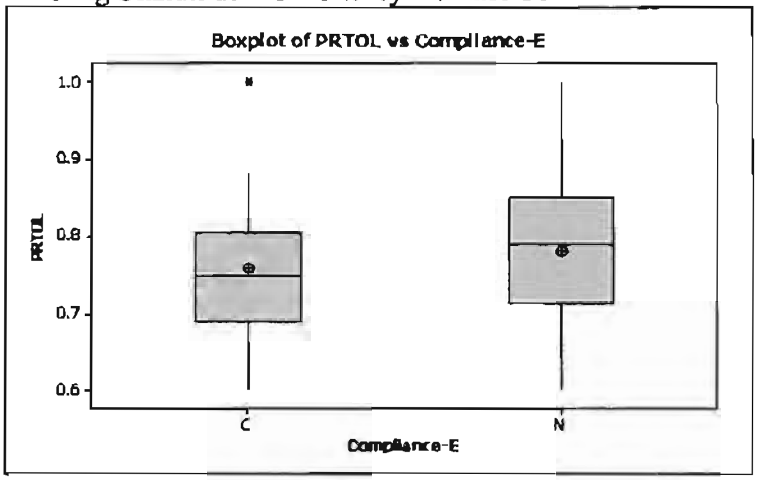
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-Wallis		Test on	NSUN		
Compliance	N	Median	Ave Rank	Z	
C	36	4	29.6	2.68	
N	15	2	17.4	-2.68	
Overall	51		26		
H = 7.17	DF =	1 P =	0.007		
H = 7.40	DF =	1 P =	0.007		adjusted for ties

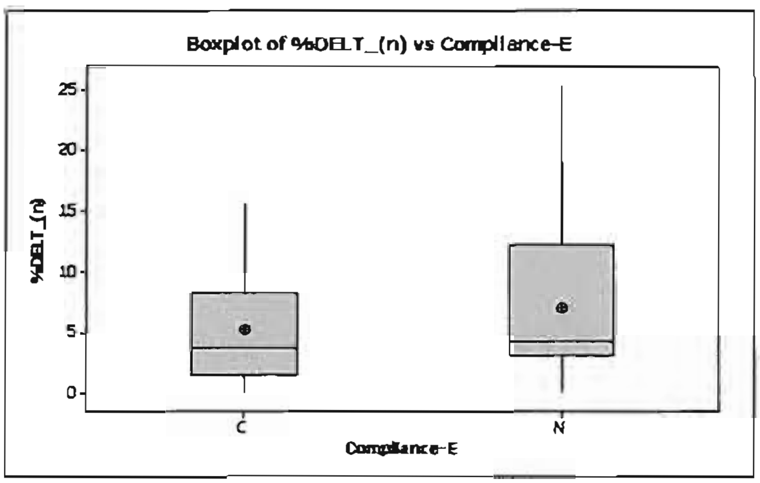
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

Existing Standards – Secondary Contact Use



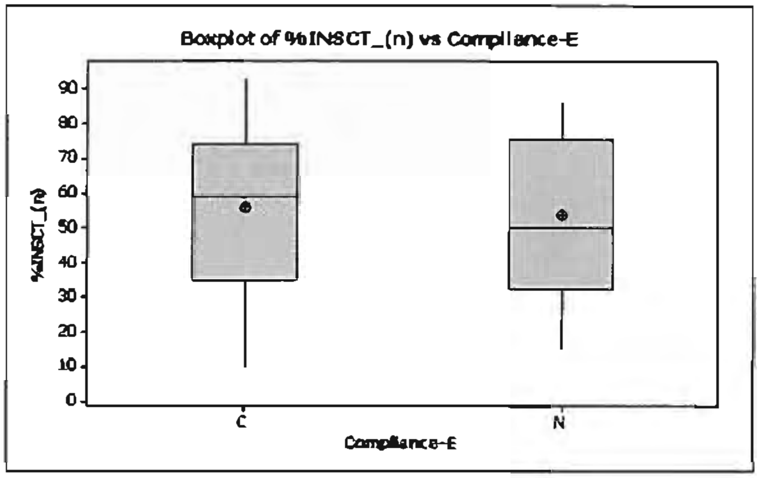
Kruskal-Wallis		Test on	PRTOL		
Compliance	N	Median	Ave Rank	Z	
C	24	0.75	16.8	-1.41	
N	12	0.789	22	1.41	
Overall	36		18.5		
H = 1.99	DF =	1 P=	0.159		
H = 1.99	DF =	1 P=	0.158		adjusted for ties

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



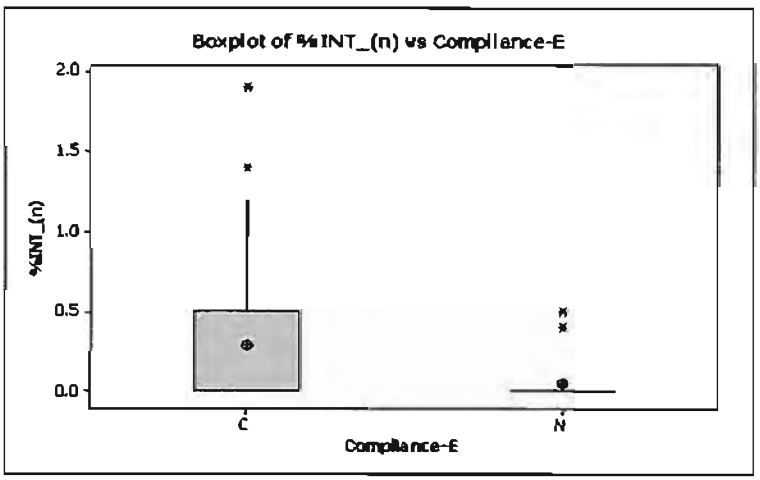
Kruskal-Wallis		Test on	%DELT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	24	3.9	17.4	-0.91	
N	12	4.75	20.8	0.91	
Overall	36		18.5		
H = 0.82	DF =	1 P=	0.365		
H = 0.82	DF =	1 P=	0.365		adjusted for ties

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



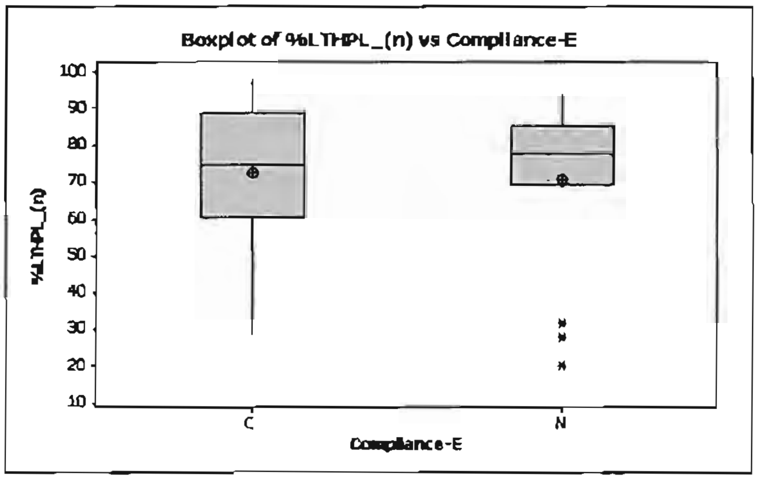
Kruskal-Wallis		Test on	%INSCT_(n)	
Compliance	N	Median	Ave Rank	Z
C	24	69.45	18.5	0.03
N	12	64.35	18.4	-0.03
Overall	36		18.5	
H = 0.00	DF =	1 P=	0.973	

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



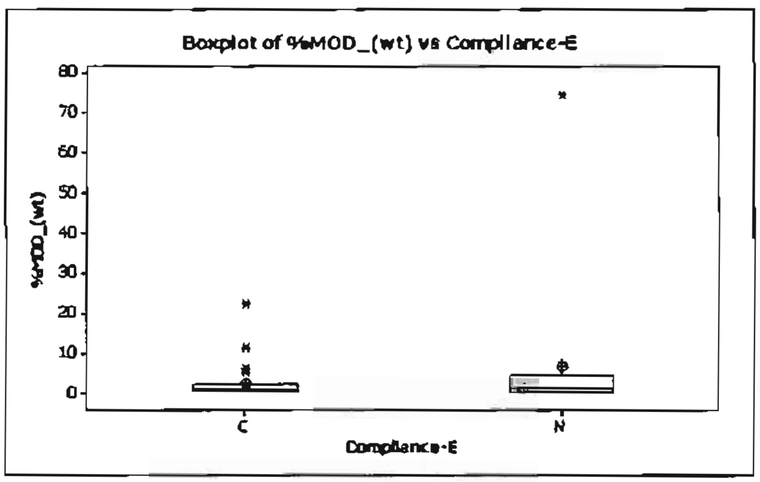
Kruskal-Wallis		Test on	%INT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	24	0	20.8	1.81	
N	12	0	14	-1.81	
Overall	36		18.5		
H = 3.28	DF =	1 P=	0.07		
H = 5.68	DF =	1 P=	0.017		adjusted for ties

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



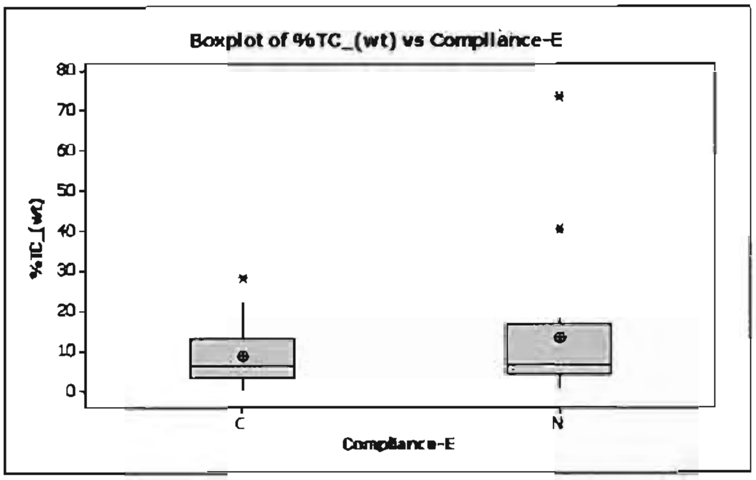
Kruskal-Wallis		Test on	%LTHPL_(n)	
Compliance	N	Median	Ave Rank	Z
C	24	72.75	18.5	-0.03
N	12	76.25	18.6	0.03
Overall	36		18.5	
H = 0.00	DF =	1 P =	0.973	

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



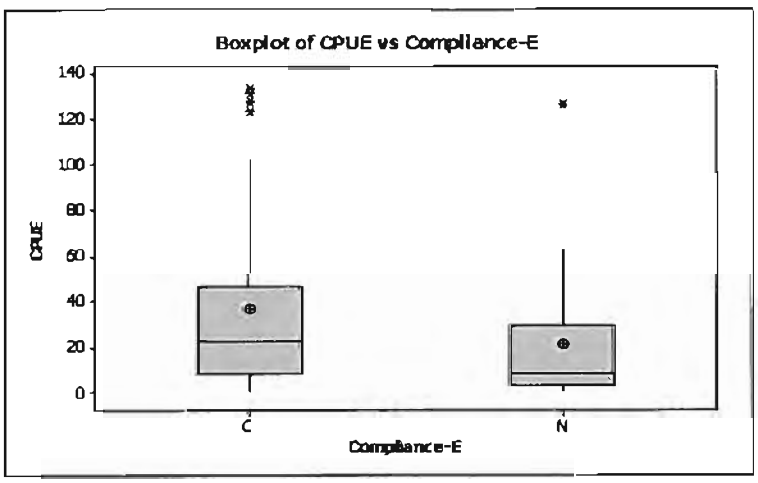
Kruskal-Wallis		Test on	%MOD_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	24	1.05	18.8	0.22	
N	12	0.9	18	-0.22	
Overall	36		18.5		
H = 0.05	DF =	1 P =	0.827		
H = 0.05	DF =	1 P =	0.827		adjusted for ties

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



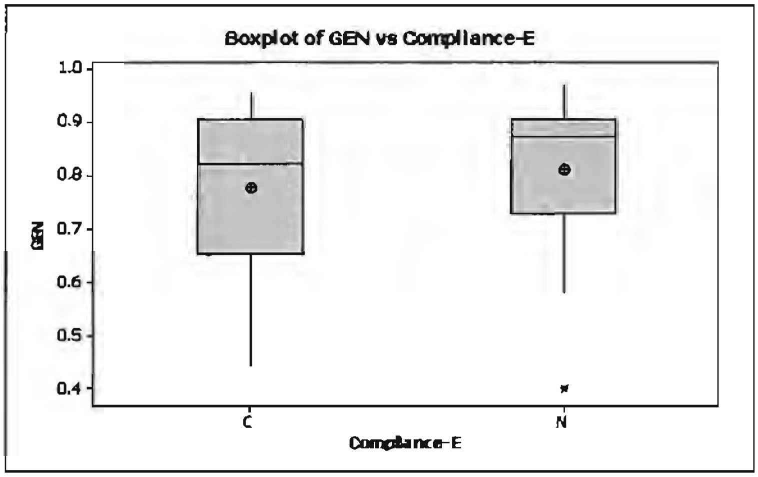
Kruskal-Wallis		Test on	%TC_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	24	10.15	19	0.4	
N	12	5.3	17.5	-0.4	
Overall	36		18.5		
H = 0.16	DF =	1 P=	0.687		
H = 0.16	DF =	1 P=	0.687		adjusted for ties

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



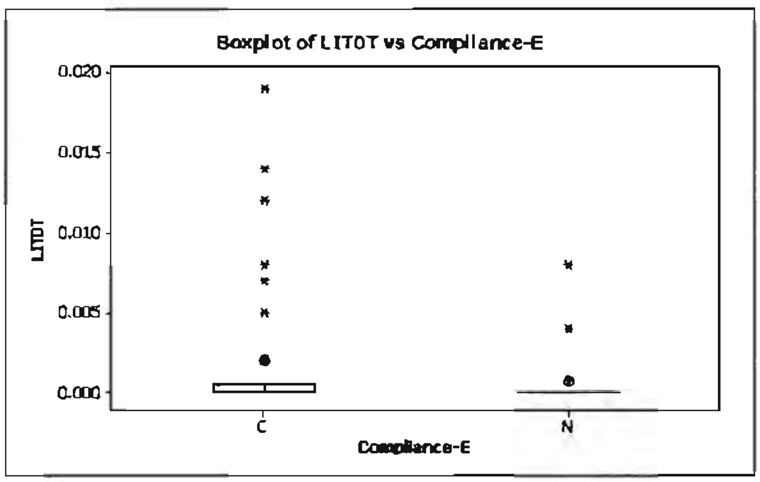
Kruskal-Wallis		Test on	CPUE		
Compliance	N	Median	Ave Rank	Z	
C	24	20.5	20.9	1.9	
N	12	6	13.8	-1.9	
Overall	36		18.5		
H = 3.59	DF =	1 P=	0.058		
H = 3.60	DF =	1 P=	0.058		adjusted for ties

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



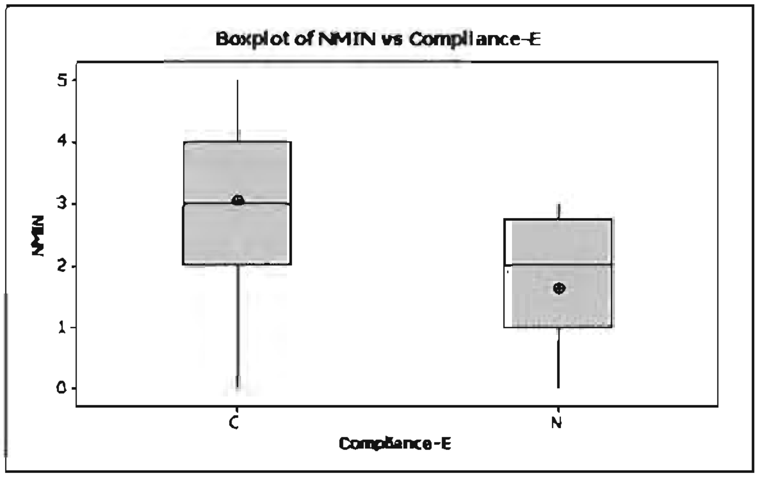
Kruskal-Wallis		Test on	GEN		
Compliance	N	Median	Ave Rank	Z	
C	24	0.763	17.8	-0.59	
N	12	0.854	20	0.59	
Overall	36		18.5		
H = 0.34	DF =	1 P =	0.557		
H = 0.35	DF =	1 P =	0.557		adjusted for ties

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



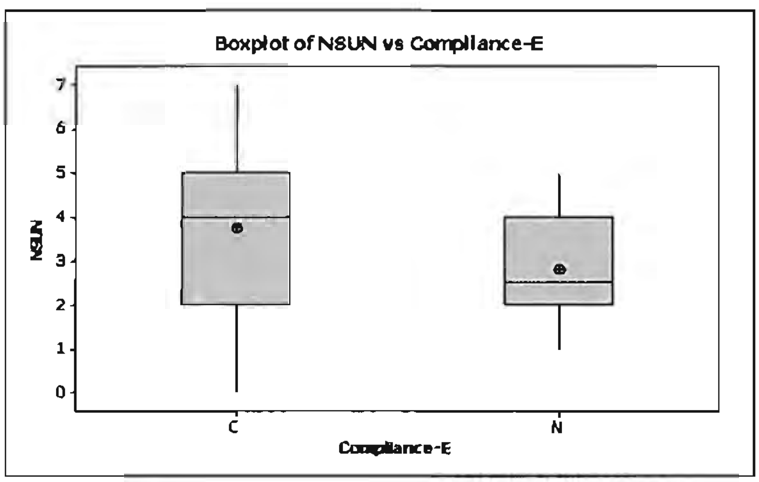
Kruskal-Wallis		Test on	LITOT		
Compliance	N	Median	Ave Rank	Z	
C	24	0	19.8	1.01	
N	12	0	16	-1.01	
Overall	36		18.5		
H = 1.01	DF =	1 P =	0.314		
H = 2.80	DF =	1 P =	0.094		adjusted for ties

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



Kruskal-Wallis		Test on	NMIN		
Compliance	N	Median	Ave Rank	Z	
C	24	3	22.3	3.05	
N	12	1.5	10.9	-3.05	
Overall	36		18.5		
H = 9.33 DF =		1 P =	0.002		
H = 9.71 DF =		1 P =	0.002		adjusted for ties

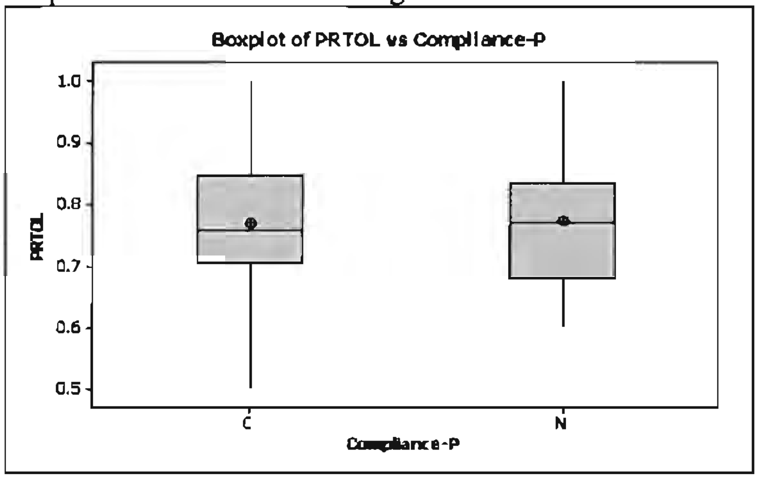
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



Kruskal-Wallis		Test on	NSUN		
Compliance	N	Median	Ave Rank	Z	
C	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 DF =		1 P =	0.014		adjusted for ties

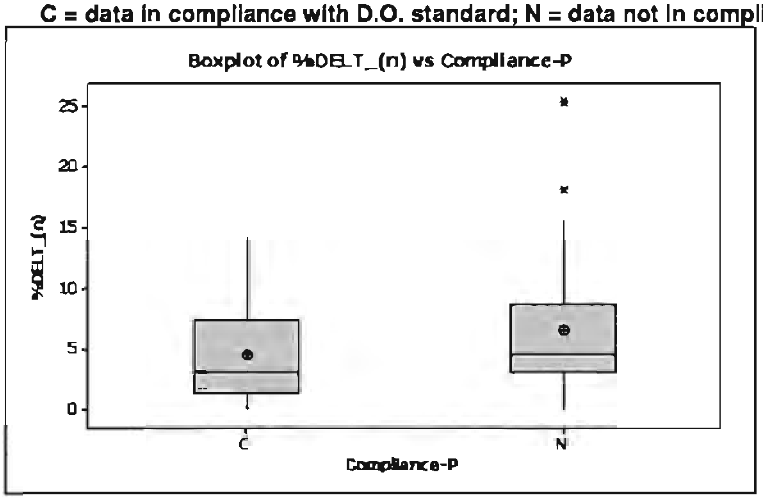
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

Proposed Standards – All Designated Uses



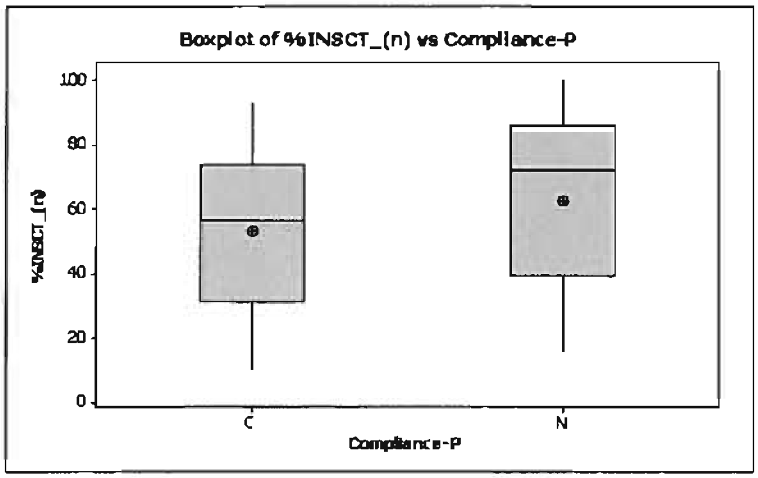
Kruskal-Wallis		Test on	PRTOL		
Compliance	N	Median	Ave Rank	Z	
C	27	0.765	25.7		-0.16
N	24	0.769	26.4		0.16
Overall	51		26		
H = 0.03 DF =		1 P =	0.873		
H = 0.03 DF =		1 P =	0.872	adjusted for ties	

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



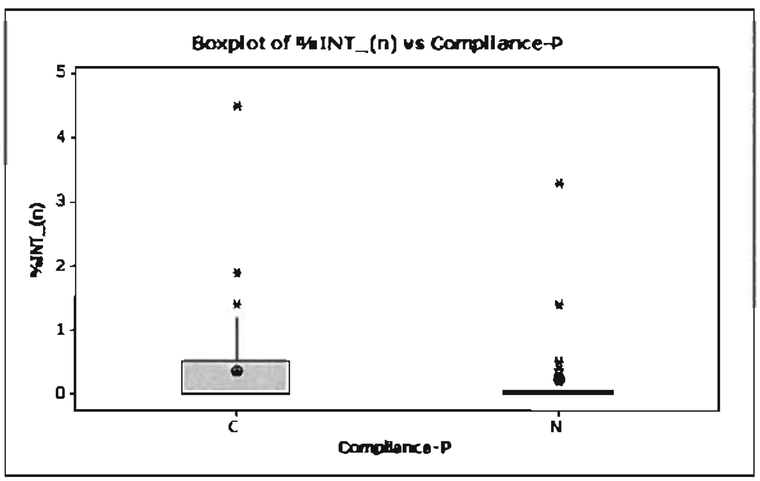
Kruskal-Wallis		Test on	%DELT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	27	3	22.6		-1.75
N	24	4.75	29.9		1.75
Overall	51		26		
H = 3.05 DF =		1 P =	0.081		
H = 3.05 DF =		1 P =	0.081	adjusted for ties	

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



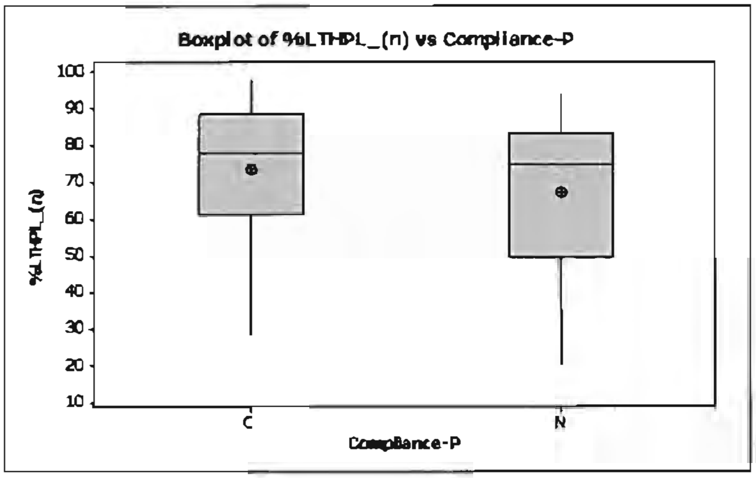
Kruskal-Wallis		Test on	%INSCT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	27	67.1	22.6		-1.76
N	24	71.85	29.9		1.76
Overall	51		26		
H = 3.08	DF =	1 P =	0.079		
H = 3.08	DF =	1 P =	0.079	adjusted for ties	

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



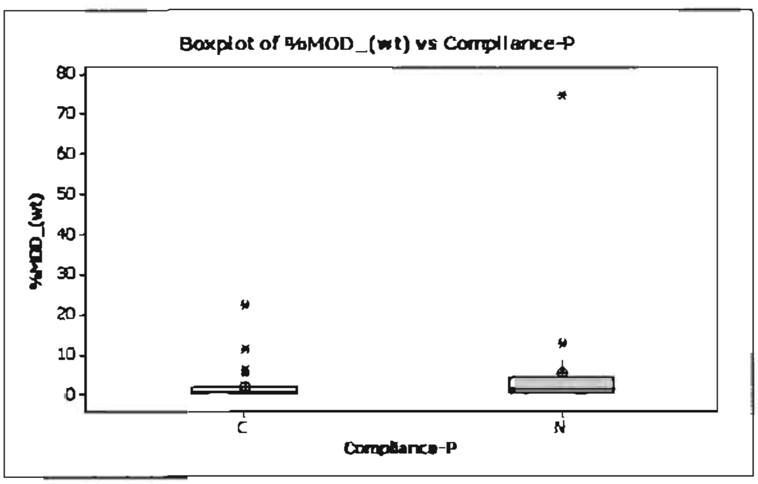
Kruskal-Wallis		Test on	%INT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	27	0	28.1		1.8
N	24	0	23.6		-1.8
Overall	51		26		
H = 1.16	DF =	1 P =	0.282		
H = 1.97	DF =	1 P =	0.16	adjusted for ties	

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



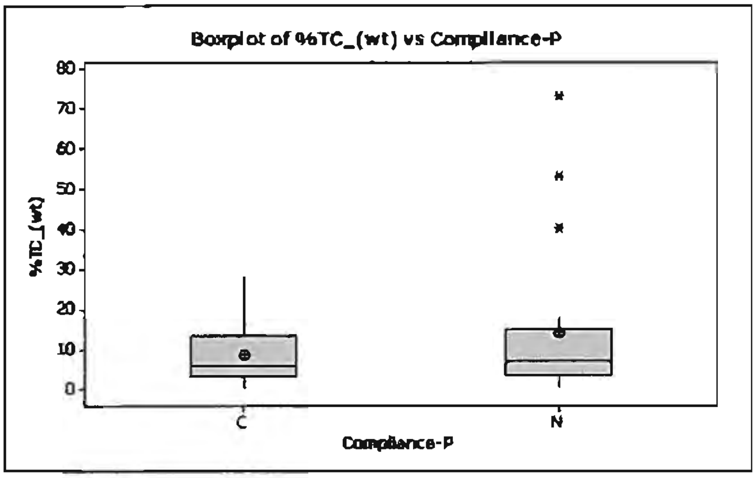
Kruskal-Wallis		Test on	%LTHPL_(n)		
Compliance	N	Median	Ave Rank	Z	
C	27	81.2	28.4		1.23
N	24	74.05	23.3		-1.23
Overall	51		26		
H = 1.50	DF =	1 P =	0.22		
H = 1.50	DF =	1 P =	0.22	adjusted for ties	

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



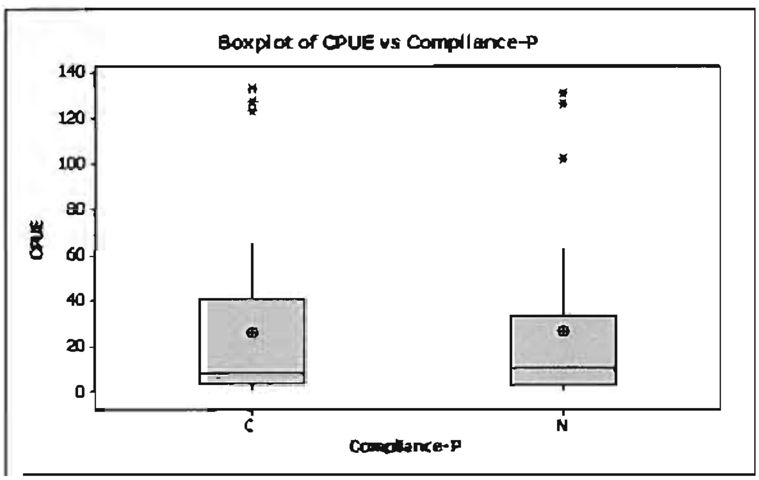
Kruskal-Wallis		Test on	%MOD_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	27	0.8	25.2		-0.39
N	24	1.05	26.9		0.39
Overall	51		26		
H = 0.15	DF =	1 P =	0.699		
H = 0.15	DF =	1 P =	0.698	adjusted for ties	

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



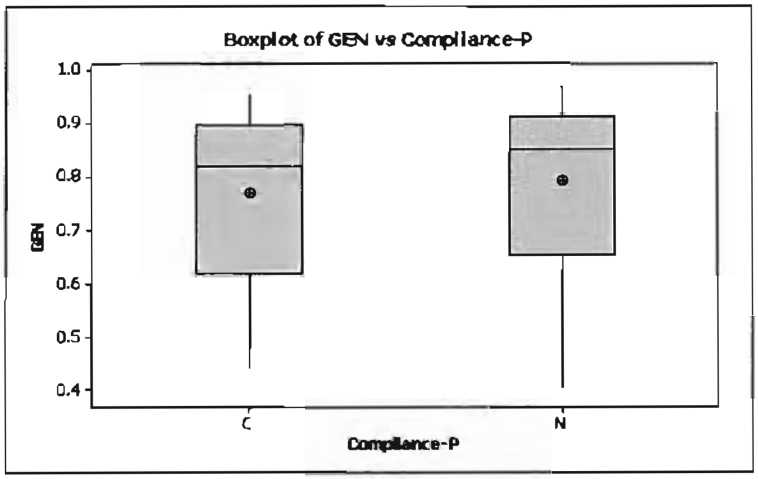
Kruskal-Wallis		Test on	%TC_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	27	9.6	26.9		0.47
N	24	5.7	25		-0.47
Overall	51		26		
H = 0.22	DF =	1 P =	0.637		
H = 0.22	DF =	1 P =	0.637	adjusted for ties	

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



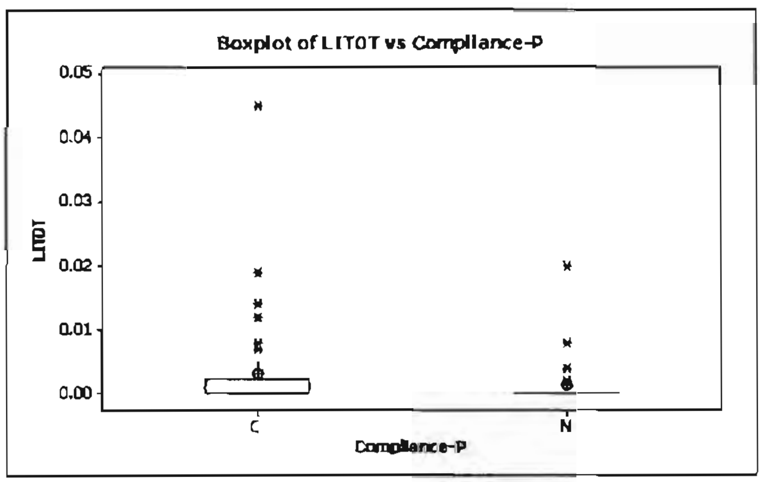
Kruskal-Wallis		Test on	CPUE		
Compliance	N	Median	Ave Rank	Z	
C	27	7	25.7		-0.13
N	24	8	26.3		0.13
Overall	51		26		
H = 0.02	DF =	1 P =	0.895		
H = 0.02	DF =	1 P =	0.895	adjusted for ties	

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



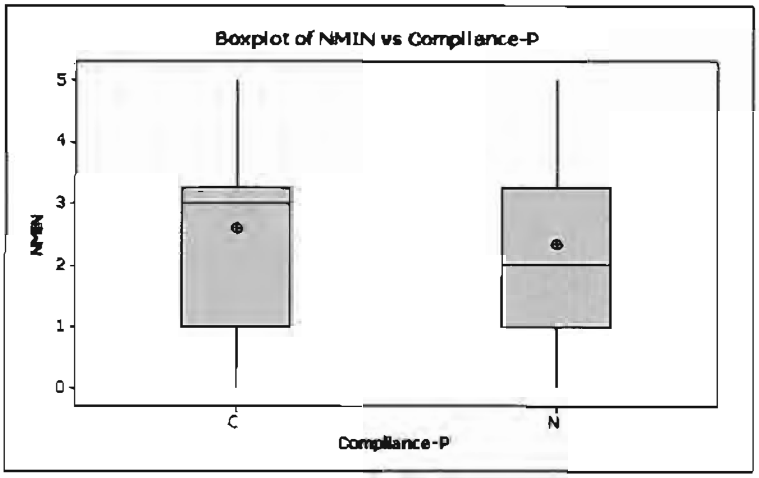
Kruskal-Wallis		Test on	GEN		
Compliance	N	Median	Ave Rank	Z	
C	27	0.787	24.5		-0.78
N	24	0.827	27.7		0.78
Overall	51		26		
H = 0.61	DF =	1 P=	0.434		
H = 0.61	DF =	1 P=	0.433	adjusted for ties	

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



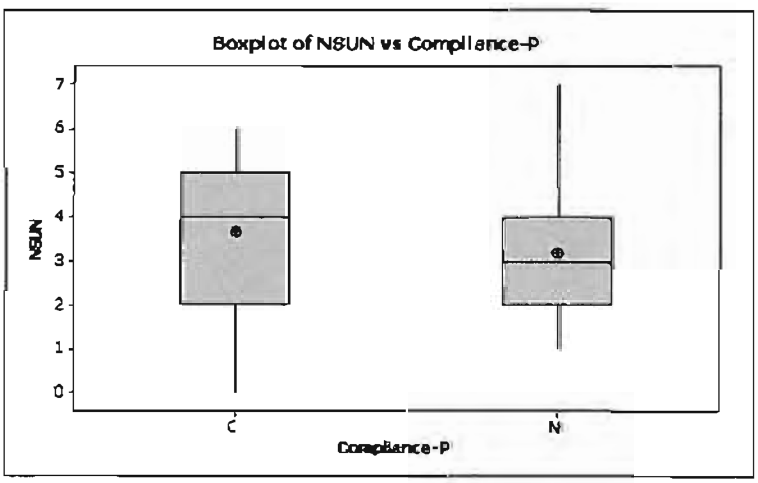
Kruskal-Wallis		Test on	LITOT		
Compliance	N	Median	Ave Rank	Z	
C	27	0	28.1		1.9
N	24	0	23.6		-1.9
Overall	51		26		
H = 1.20	DF =	1 P=	0.274		
H = 2.71	DF =	1 P=	0.1	adjusted for ties	

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



Kruskal-Wallis		Test on	NMIN		
Compliance	N	Median	Ave Rank	Z	
C	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	DF =	1 P=	0.72	adjusted for ties	

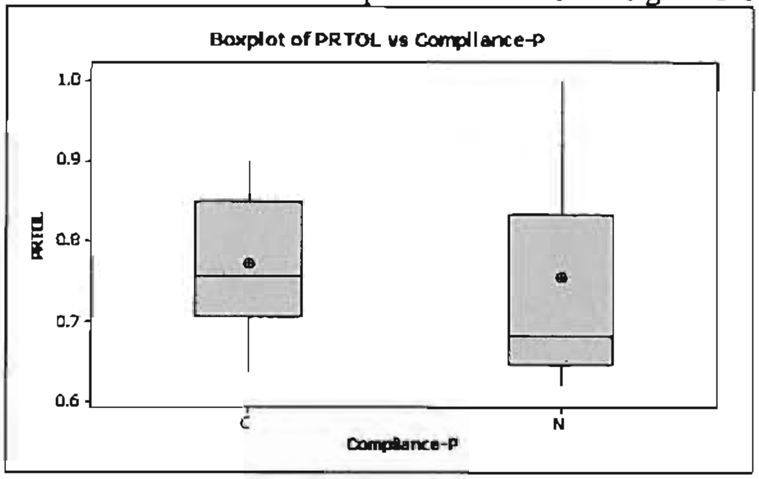
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



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

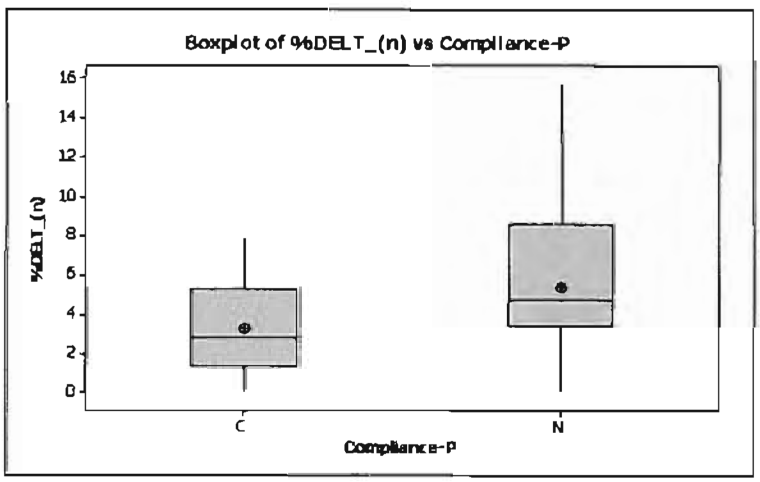
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

Proposed Standards –Designated Use A



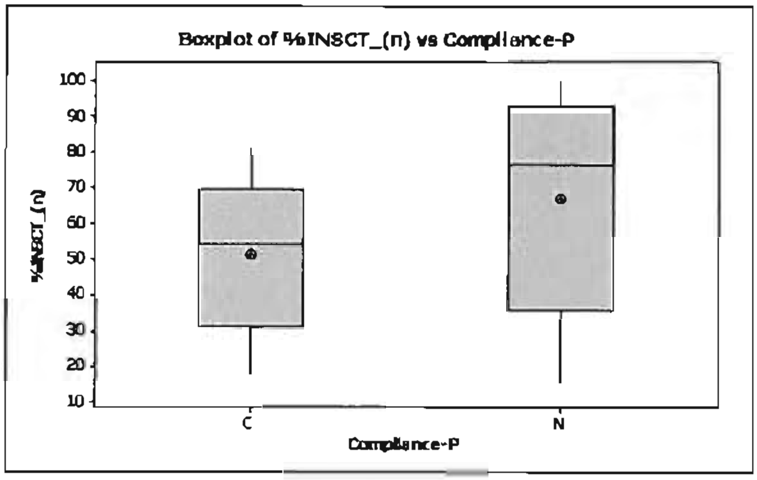
Kruskal-Wallis		Test on	PRTOL		
Compliance	N	Median	Ave Rank	Z	
C	13	0.765	12.7		0.59
N	10	0.751	11.1		-0.59
Overall	23		12		
H = 0.35	DF =	1 P =	0.556		
H = 0.35	DF =	1 P =	0.555		adjusted for ties

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



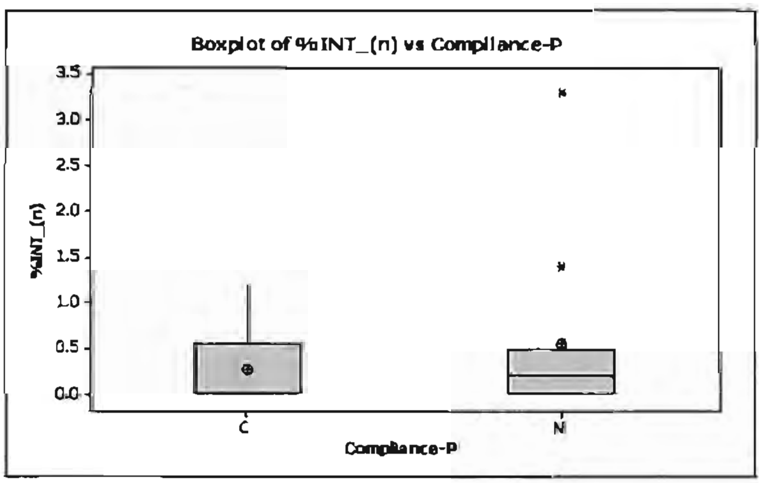
Kruskal-Wallis		Test on	%DELT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	13	2.7	9.8		-1.77
N	10	5	14.9		1.77
Overall	23		12		
H = 3.12	DF =	1 P =	0.077		
H = 3.13	DF =	1 P =	0.077		adjusted for ties

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



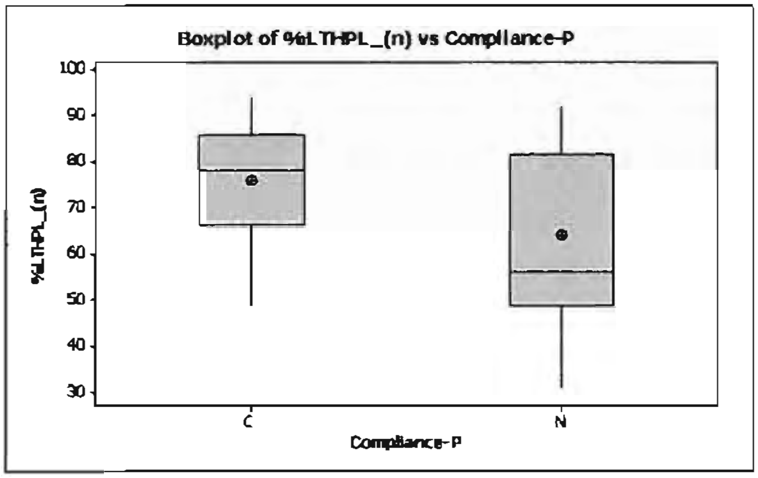
Kruskal-Wallis		Test on	%INSCT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	13	52	8.6	-2.73	
N	10	81.45	16.4	2.73	
Overall	23		12		
H = 7.45 DF =		1 P =	0.006		
H = 7.45 DF =		1 P =	0.006		adjusted for ties

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



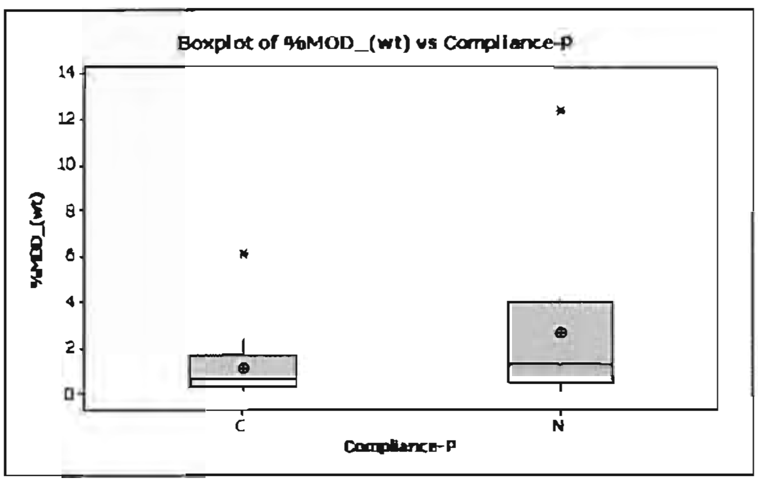
Kruskal-Wallis		Test on	%INT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	13	0	11.9	-0.09	
N	10	0	12.2	0.09	
Overall	23		12		
H = 0.01 DF =		1 P =	0.926		
H = 0.01 DF =		1 P =	0.916		adjusted for ties

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



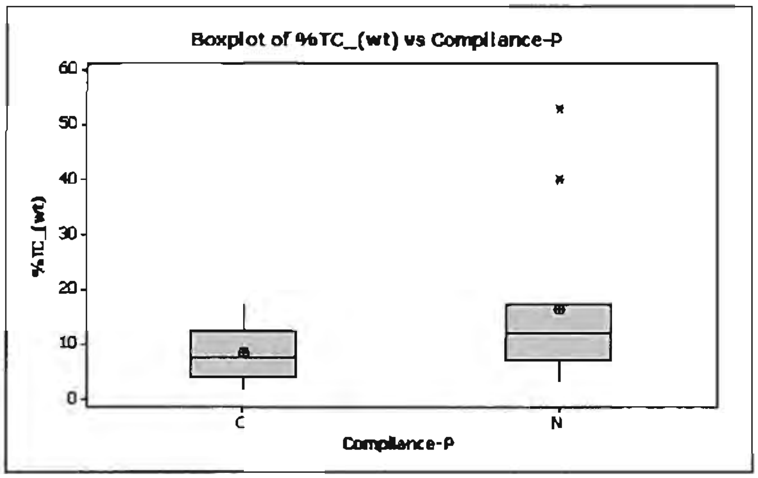
Kruskal-Wallis		Test on	%LTHPL_(n)	
Compliance	N	Median	Ave Rank	Z
C	13	71.7	14.5	2.05
N	10	54.8	8.7	-2.05
Overall	23		12	
H = 4.19	DF =	1 P =	0.041	

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



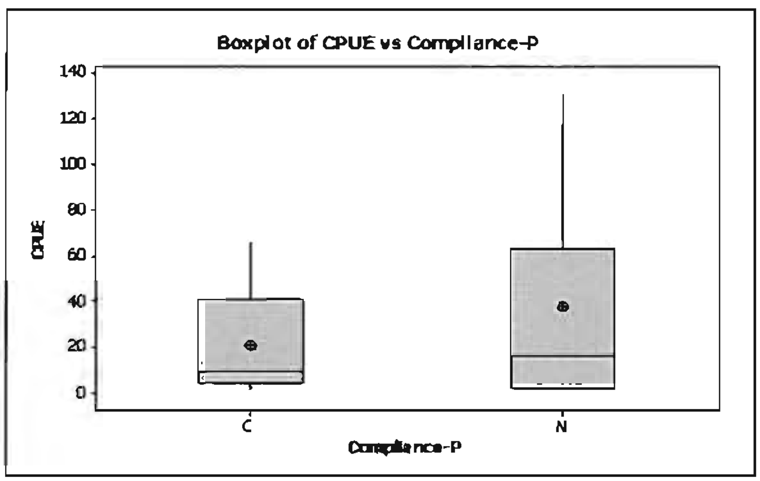
Kruskal-Wallis		Test on	%MOD_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	13	0.8	12	-0.03	
N	10	0.65	12.1	0.03	
Overall	23		12		
H = 0.00	DF =	1 P =	0.975		
H = 0.00	DF =	1 P =	0.975		adjusted for ties

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



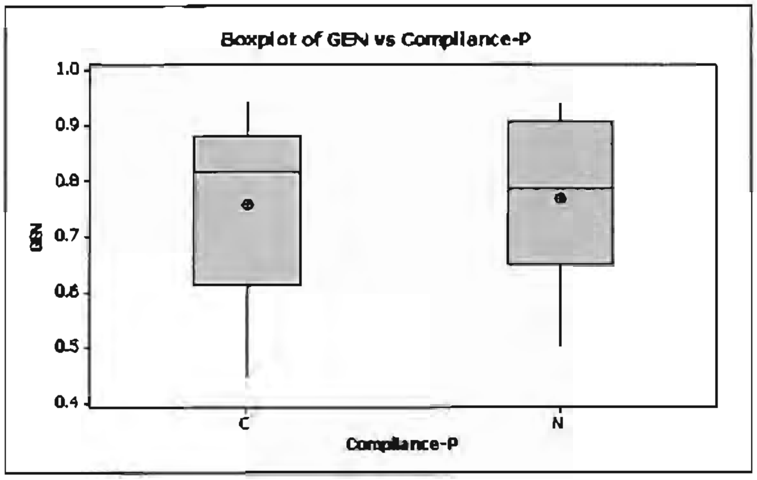
Kruskal-Wallis		Test on	%TC_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	13	9.6	11.4	-0.5	
N	10	10.4	12.8	0.5	
Overall	23		12		
H = 0.25	DF =	1 P =	0.62		
H = 0.25	DF =	1 P =	0.62		adjusted for ties

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



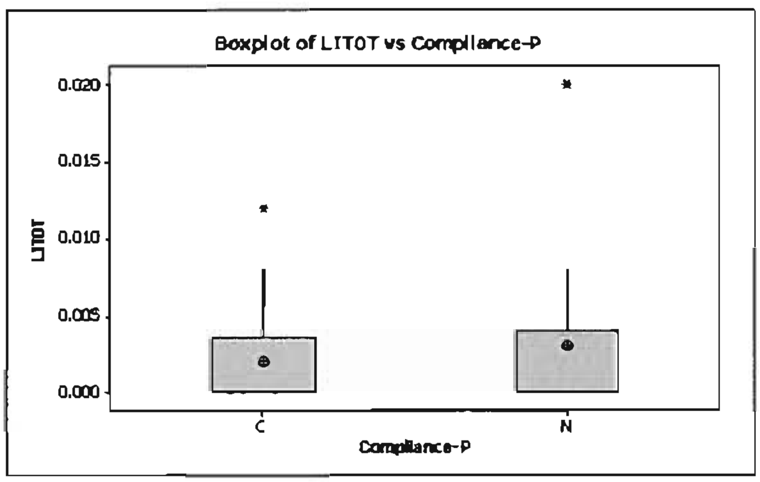
Kruskal-Wallis		Test on	CPUE		
Compliance	N	Median	Ave Rank	Z	
C	13	11	11.8	-0.12	
N	10	9.5	12.2	0.12	
Overall	23		12		
H = 0.02	DF =	1 P =	0.901		
H = 0.02	DF =	1 P =	0.901		adjusted for ties

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



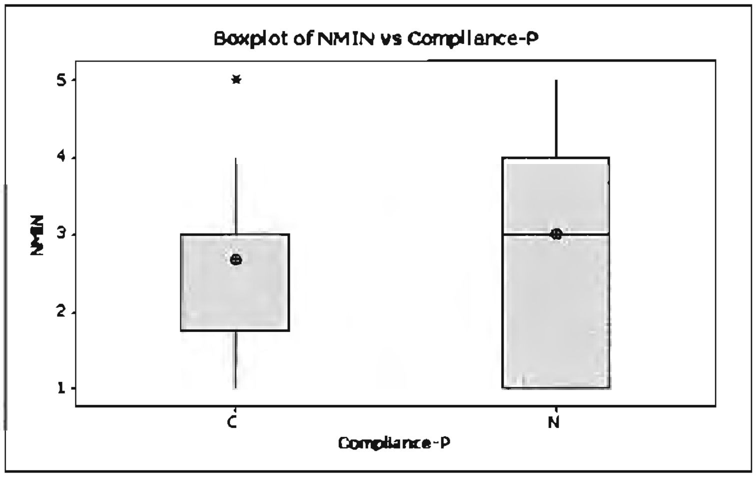
Kruskal-Wallis		Test on	GEN	
Compliance	N	Median	Ave Rank	Z
C	13	0.719	11.3	-0.56
N	10	0.7595	12.9	0.56
Overall	23		12	
H = 0.31	DF =	1 P =	0.577	

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



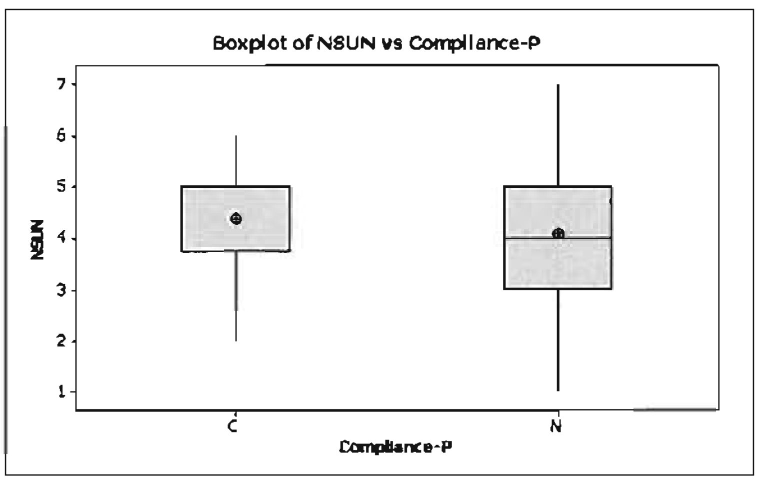
Kruskal-Wallis		Test on	LITOT		
Compliance	N	Median	Ave Rank	Z	
C	13	0	12.2	0.12	
N	10	0	11.8	-0.12	
Overall	23		12		
H = 0.02	DF =	1 P =	0.901		
H = 0.03	DF =	1 P =	0.864		adjusted for ties

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



Kruskal-Wallis		Test on	NMIN		
Compliance	N	Median	Ave Rank	Z	
C	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

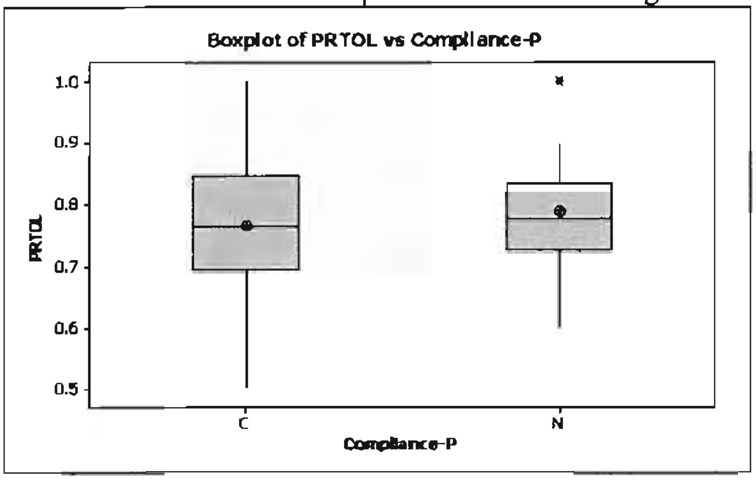
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard



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

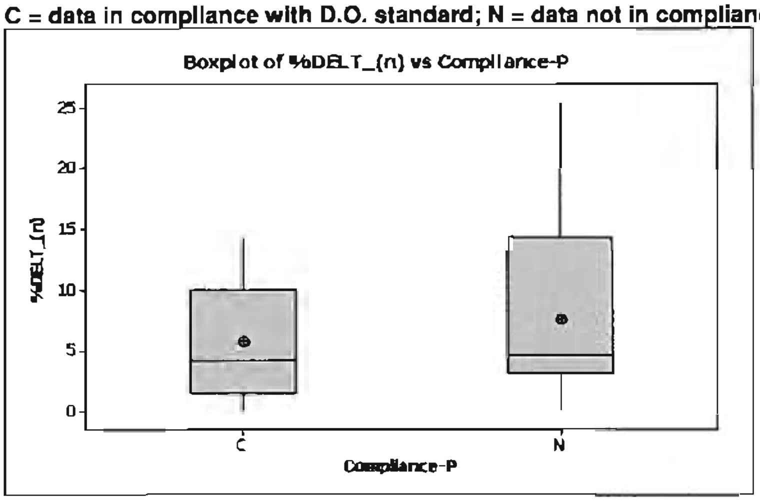
C = data in compliance with D.O. standard; N = data not in compliance with D.O. standard

Proposed Standards –Designated Use B



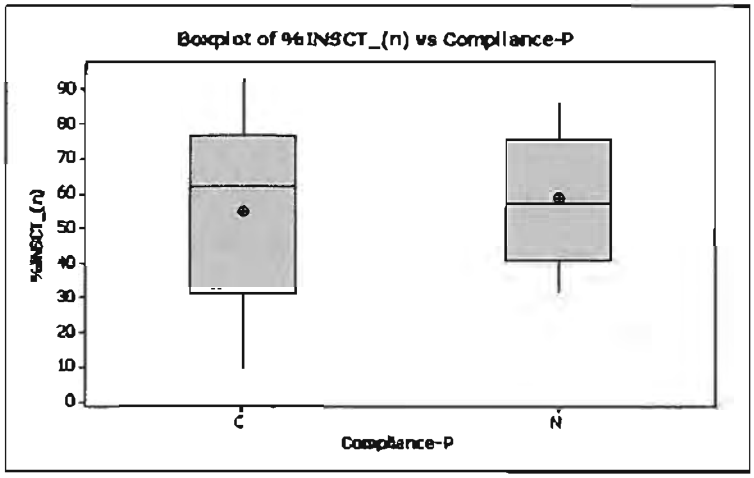
Kruskal-Wallis		Test on	PRTOL		
Compliance	N	Median	Ave Rank	Z	
C	14	0.764	13.8	-0.46	
N	14	0.7735	15.2	0.46	
Overall	28		14.5		
H = 0.21 DF =		1 P =	0.646		
H = 0.21 DF =		1 P =	0.645		adjusted for ties

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



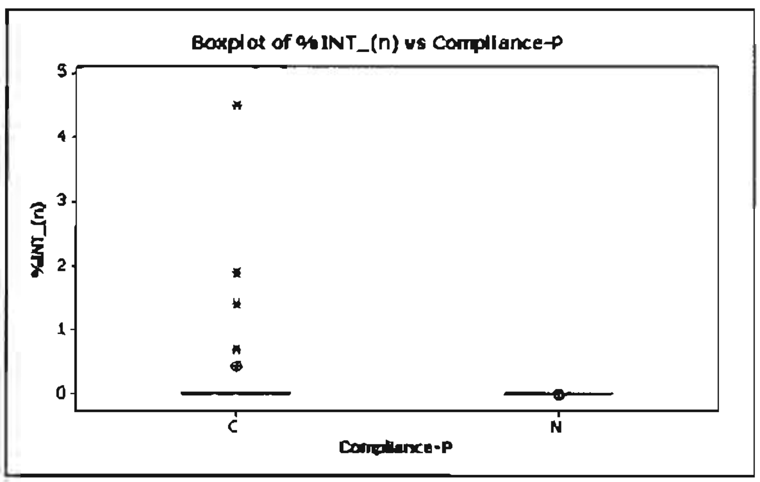
Kruskal-Wallis		Test on	%DELT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	14	4.2	13.3	-0.78	
N	14	4.75	15.7	0.78	
Overall	28		14.5		
H = 0.61 DF =		1 P =	0.435		
H = 0.61 DF =		1 P =	0.434		adjusted for ties

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



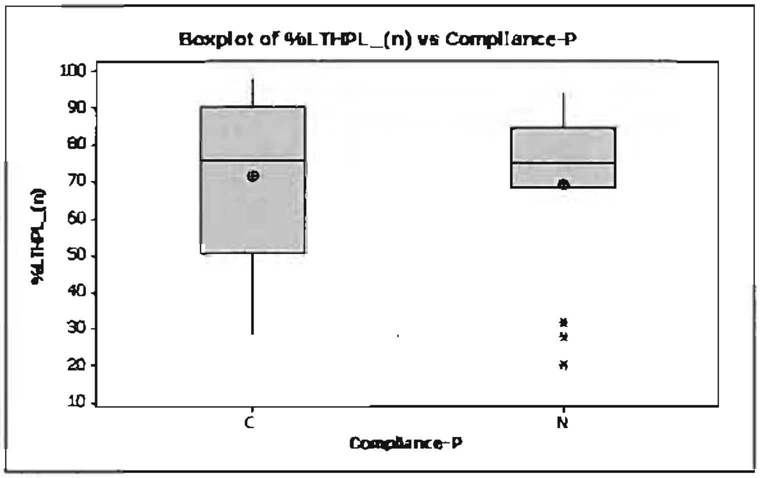
Kruskal-Wallis		Test on	%INSCT_(n)	
Compliance	N	Median	Ave Rank	Z
C	14	69.45	14.2	-0.18
N	14	53.75	14.8	0.18
Overall	28		14.5	
H = 0.03	DF =	I P=	0.854	

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



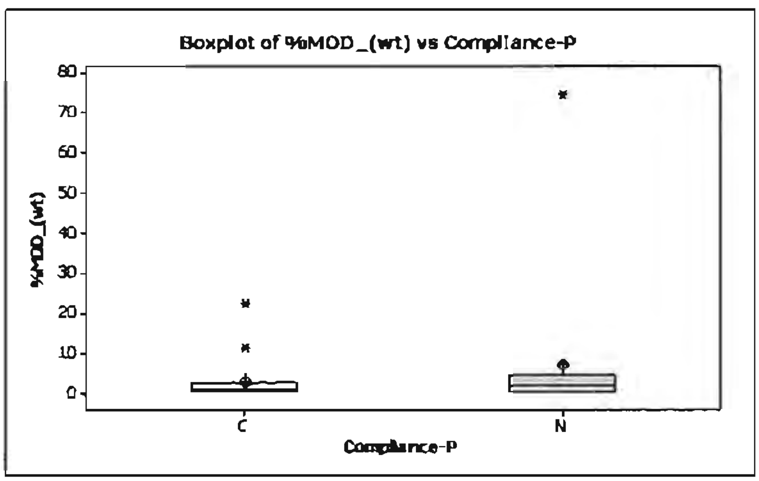
Kruskal-Wallis		Test on	%INT_(n)		
Compliance	N	Median	Ave Rank	Z	
C	14	0	16.5	1.29	
N	14	0	12.5	-1.29	
Overall	28		14.5		
H = 1.66	DF =	I P=	0.198		
H = 4.47	DF =	I P=	0.035		adjusted for ties

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



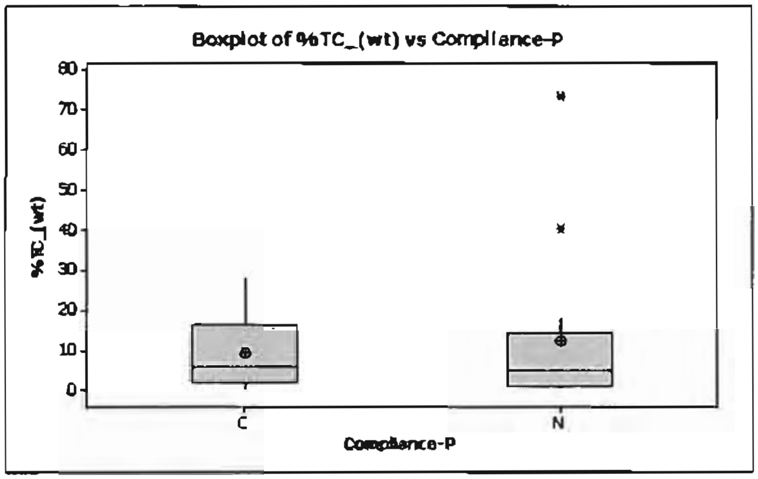
Kruskal-Wallis		Test on	%LTHPL_(n	)	
Compliance	N	Median	Ave Rank	Z	
C	14	83.4	15.3	0.51	
N	14	76.25	13.7	-0.51	
Overall	28		14.5		
H = 0.26 DF =		1 P=	0.613		
H = 0.26 DF =		1 P=	0.613		adjusted for ties

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



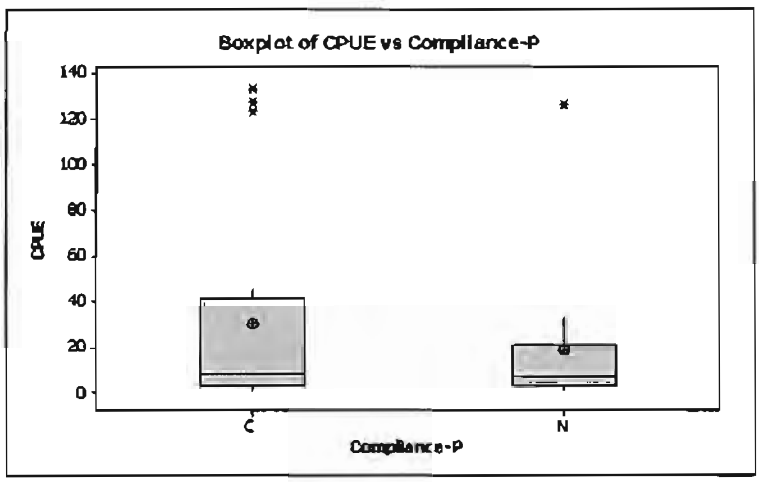
Kruskal-Wallis		Test on	%MOD_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	14	1	13.6	-0.6	
N	14	1.65	15.4	0.6	
Overall	28		14.5		
H = 0.36 DF =		1 P=	0.55		
H = 0.36 DF =		1 P=	0.549		adjusted for ties

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



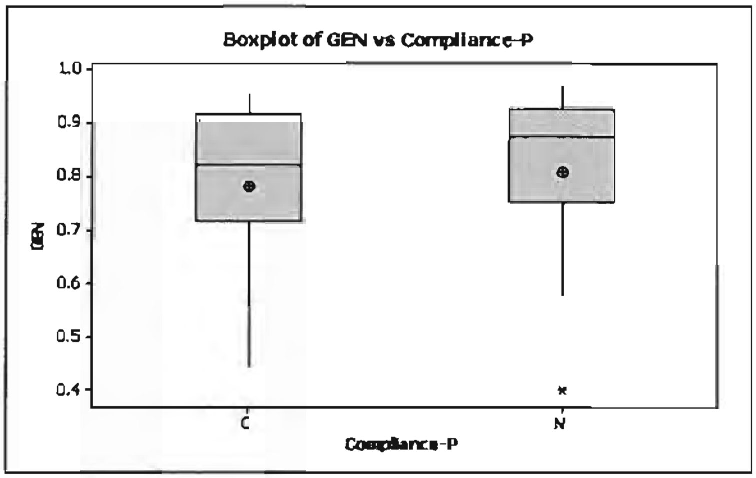
Kruskal-Wallis		Test on	%TC_(wt)		
Compliance	N	Median	Ave Rank	Z	
C	14	9.45	15.7	0.78	
N	14	4.9	13.3	-0.78	
Overall	28		14.5		
H = 0.61 DF =		1 P =	0.435		
H = 0.61 DF =		1 P =	0.434		adjusted for ties

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



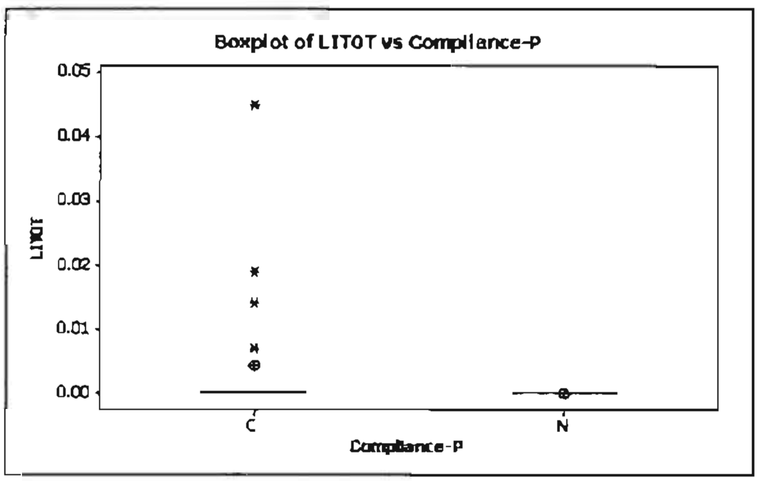
Kruskal-Wallis		Test on	CPUE		
Compliance	N	Median	Ave Rank	Z	
C	14	7	14.4	-0.09	
N	14	6.5	14.6	0.09	
Overall	28		14.5		
H = 0.01 DF =		1 P =	0.927		
H = 0.01 DF =		1 P =	0.927		adjusted for ties

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



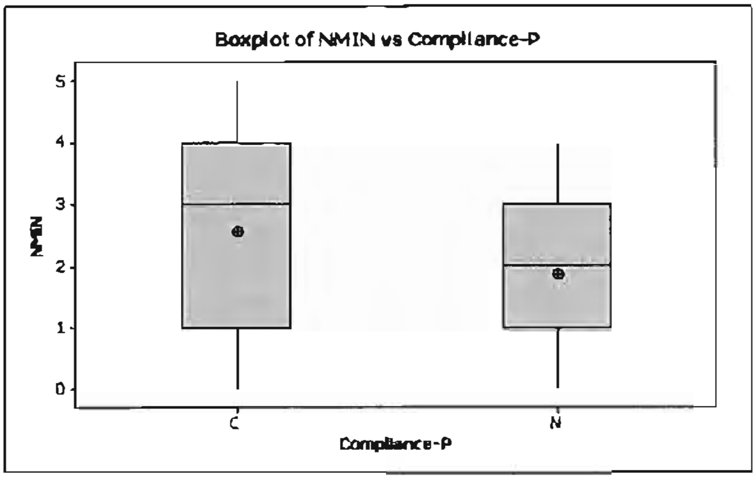
Kruskal-Wallis		Test on	GEN	
Compliance	N	Median	Ave Rank	Z
C	14	0.8205	13.4	-0.71
N	14	0.876	15.6	0.71
Overall	28		14.5	
H = 0.51	DF =	1 P =	0.476	
H = 0.51	DF =	1 P =	0.476	adjusted for ties

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



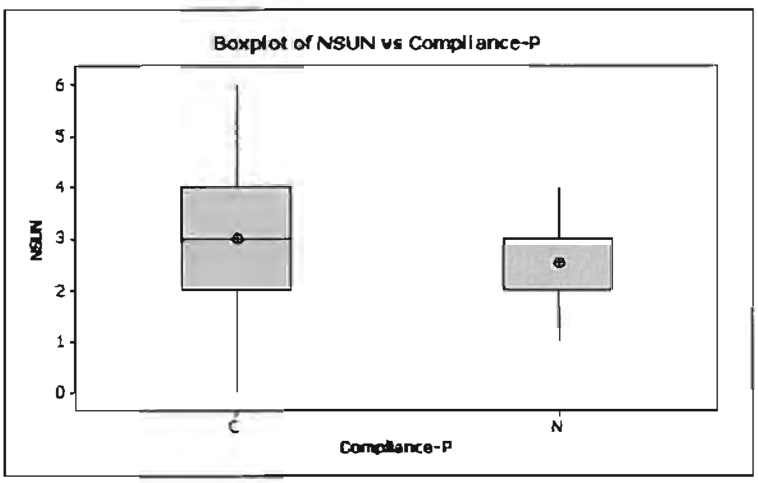
Kruskal-Wallis		Test on	LITOT	
Compliance	N	Median	Ave Rank	Z
C	14	0	16.5	1.29
N	14	0	12.5	-1.29
Overall	28		14.5	
H = 1.66	DF =	1 P =	0.198	
H = 4.47	DF =	1 P =	0.035	adjusted for ties

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



Kruskal-Wallis		Test on	NMIN			
Compliance	N	Median	Ave Rank	Z		
C	14	2		14.7	0.11	
N	14	2		14.3	-0.11	
Overall	28			14.5		
H = 0.01	DF =	1 P =		0.909		
H = 0.01	DF =	1 P =		0.906		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			
Compliance	N	Median	Ave Rank	Z		
C	14	3		16	0.96	
N	14	2.5		13	-0.96	
Overall	28			14.5		
H = 0.93	DF =	1 P =		0.335		
H = 0.97	DF =	1 P =		0.325		adjusted for ties

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

ATTACHMENT B:

REGRESSION PLOTS COMPARING FISH WITH DISSOLVED OXYGEN CONDITIONS

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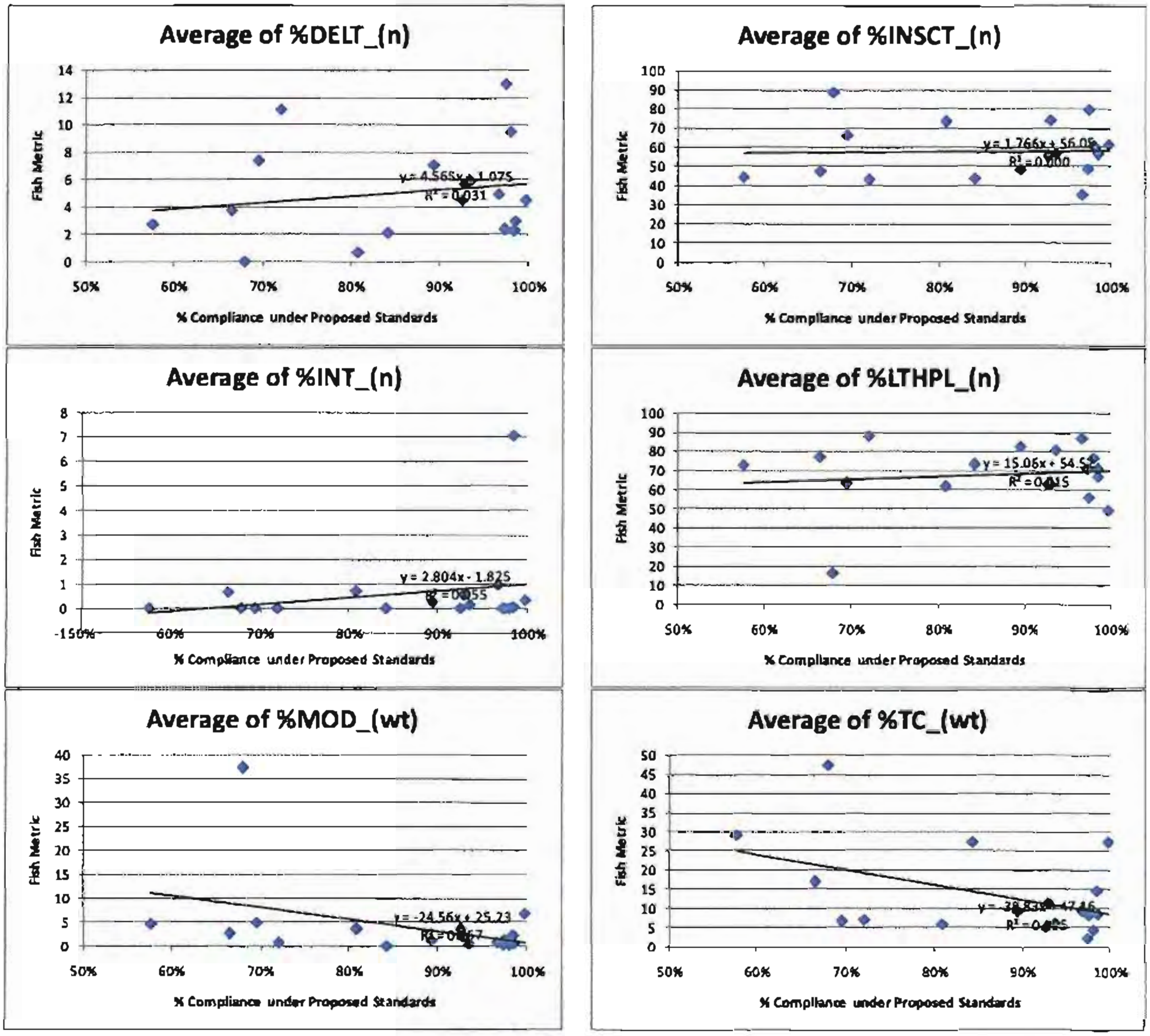
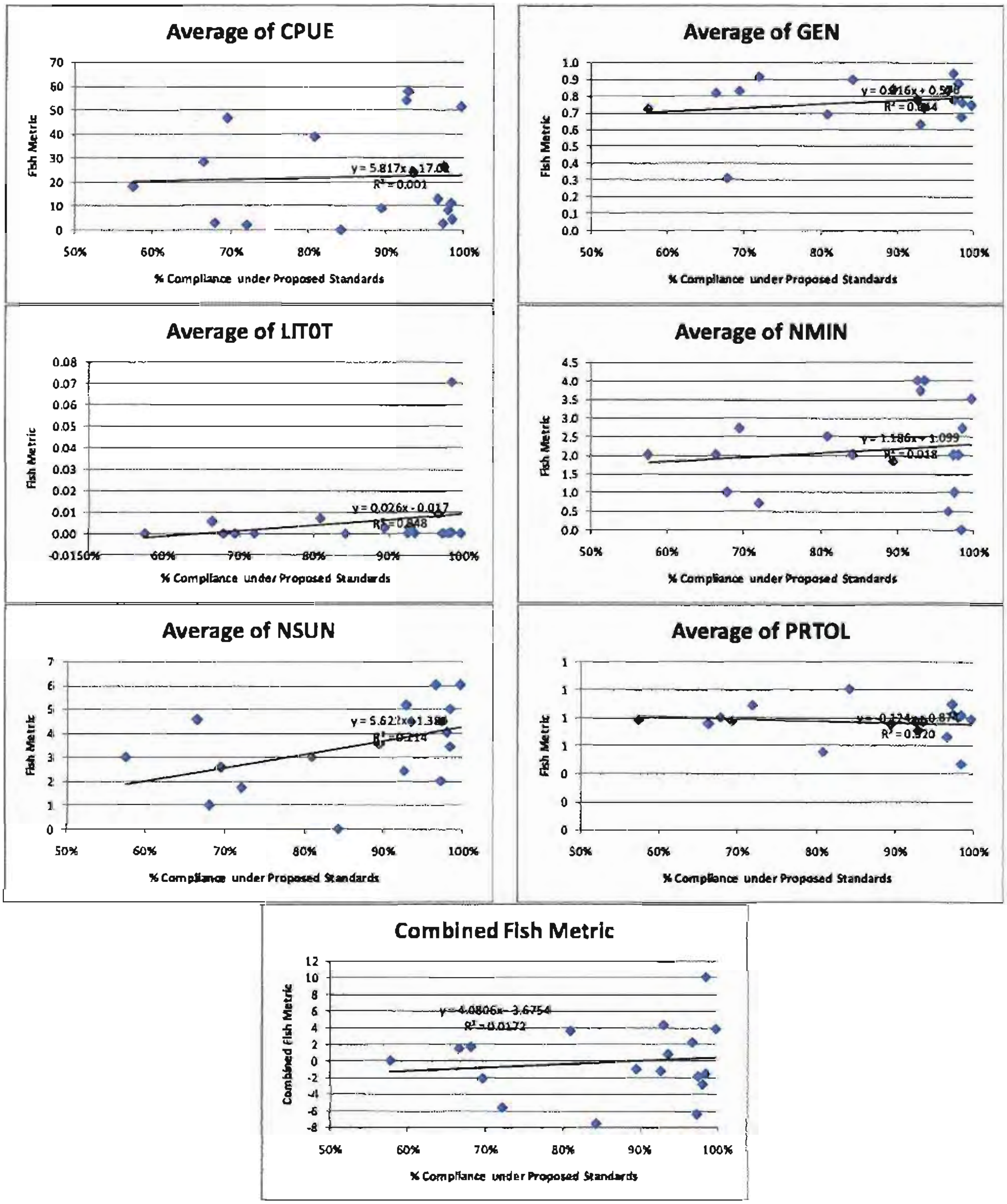
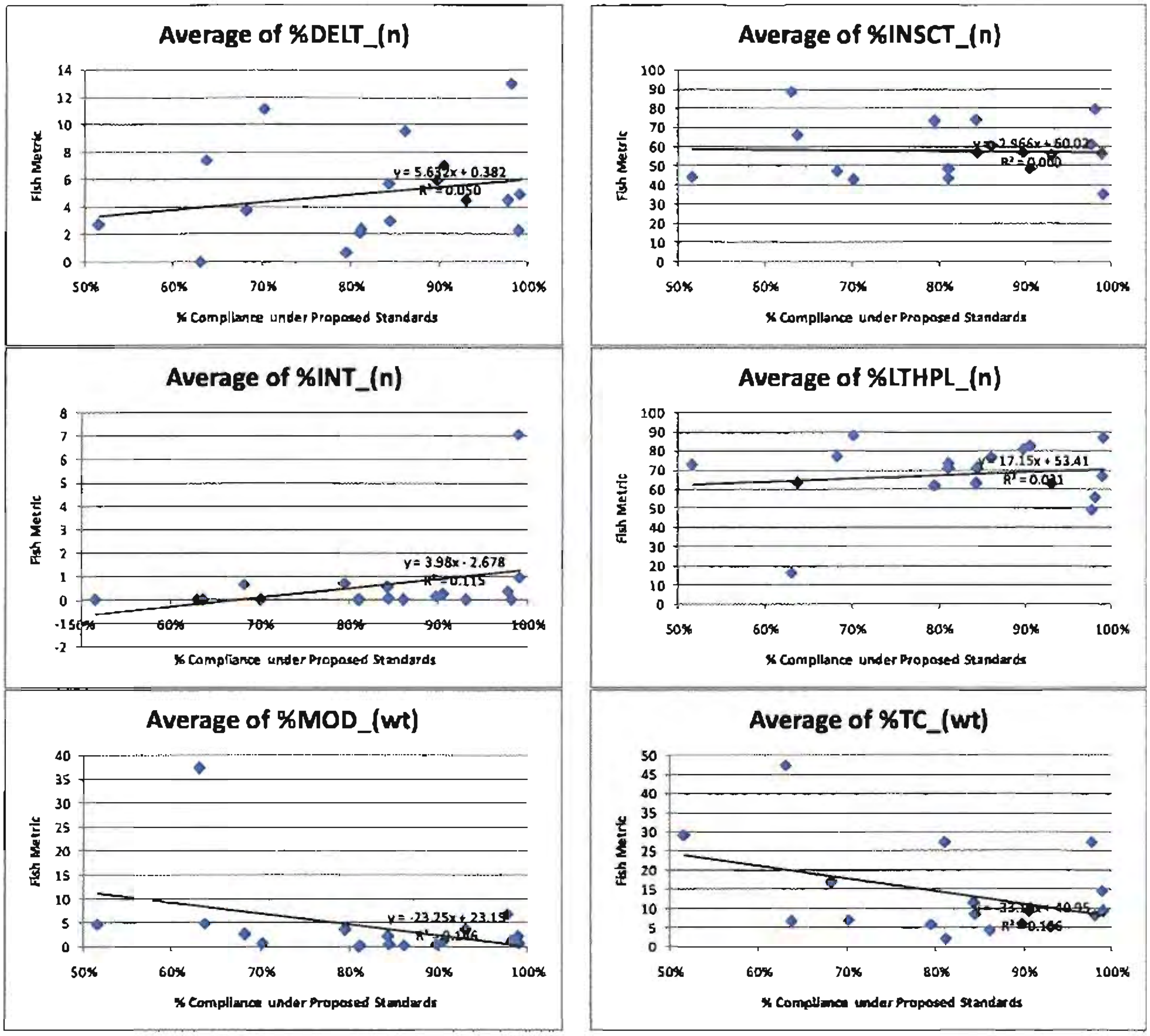


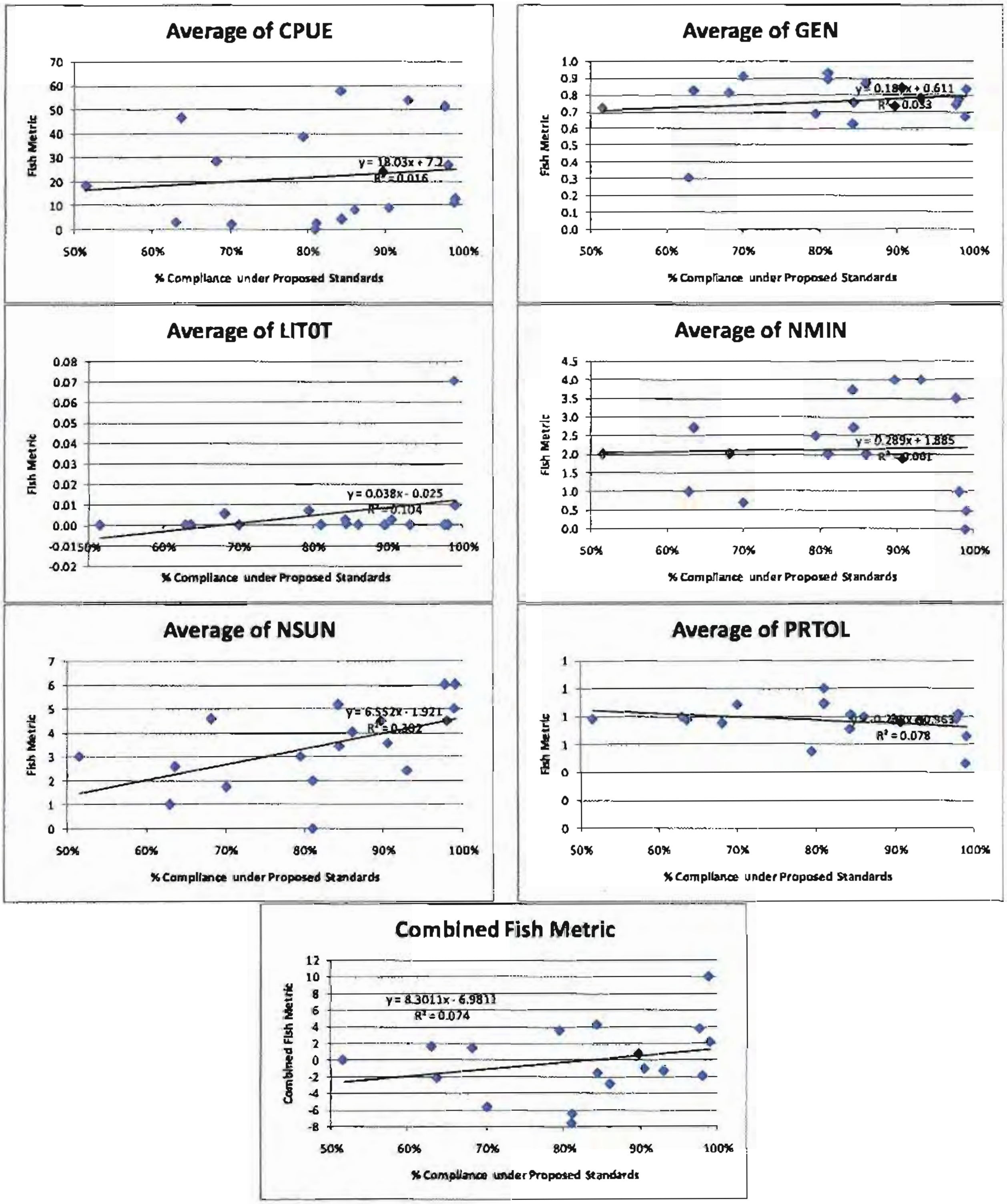
Regression of Fish Metrics and Compliance with Existing Water Quality Standards for Dissolved Oxygen



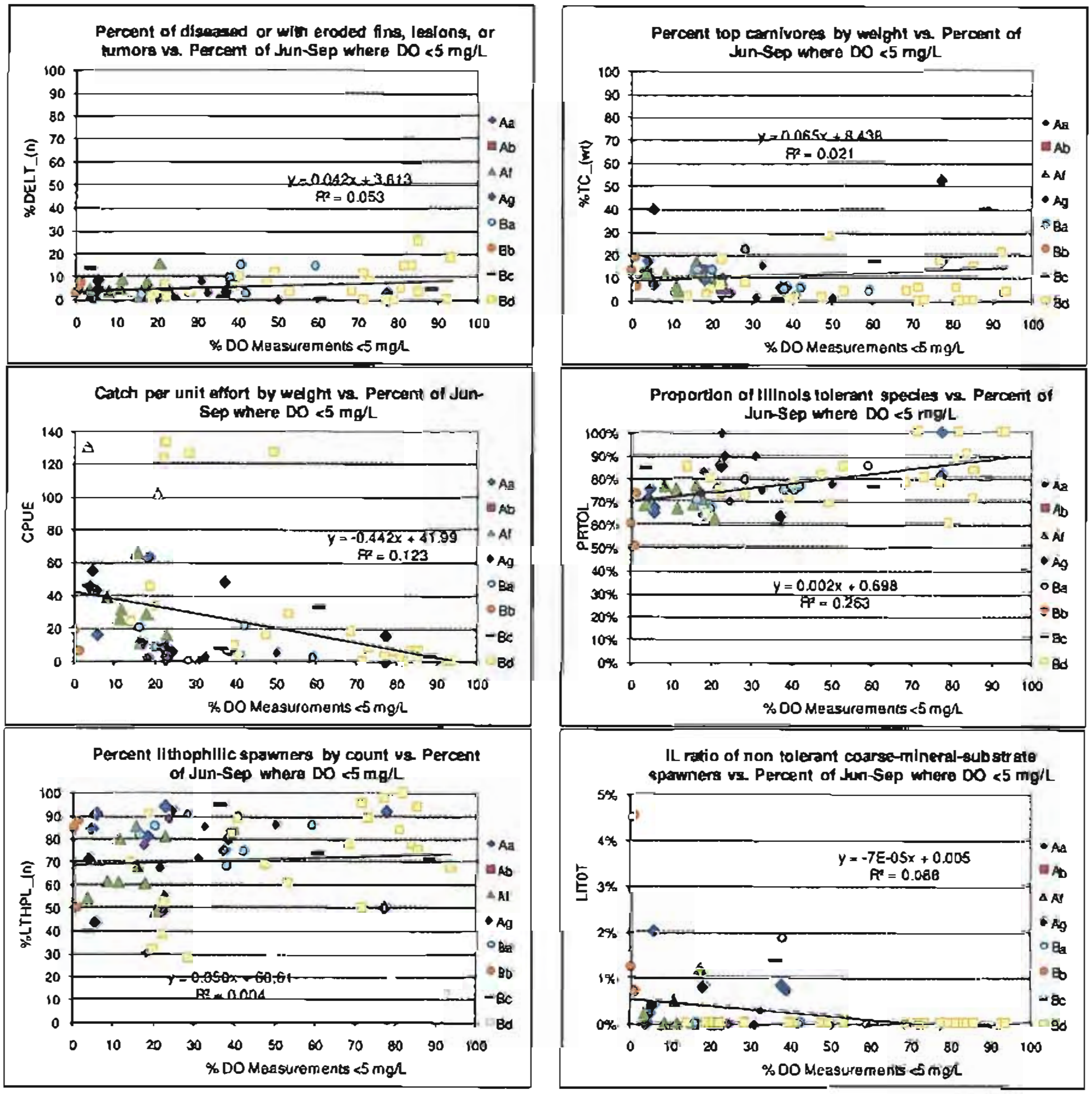
Regression of Fish Metrics and Compliance with Existing Water Quality Standards for Dissolved Oxygen



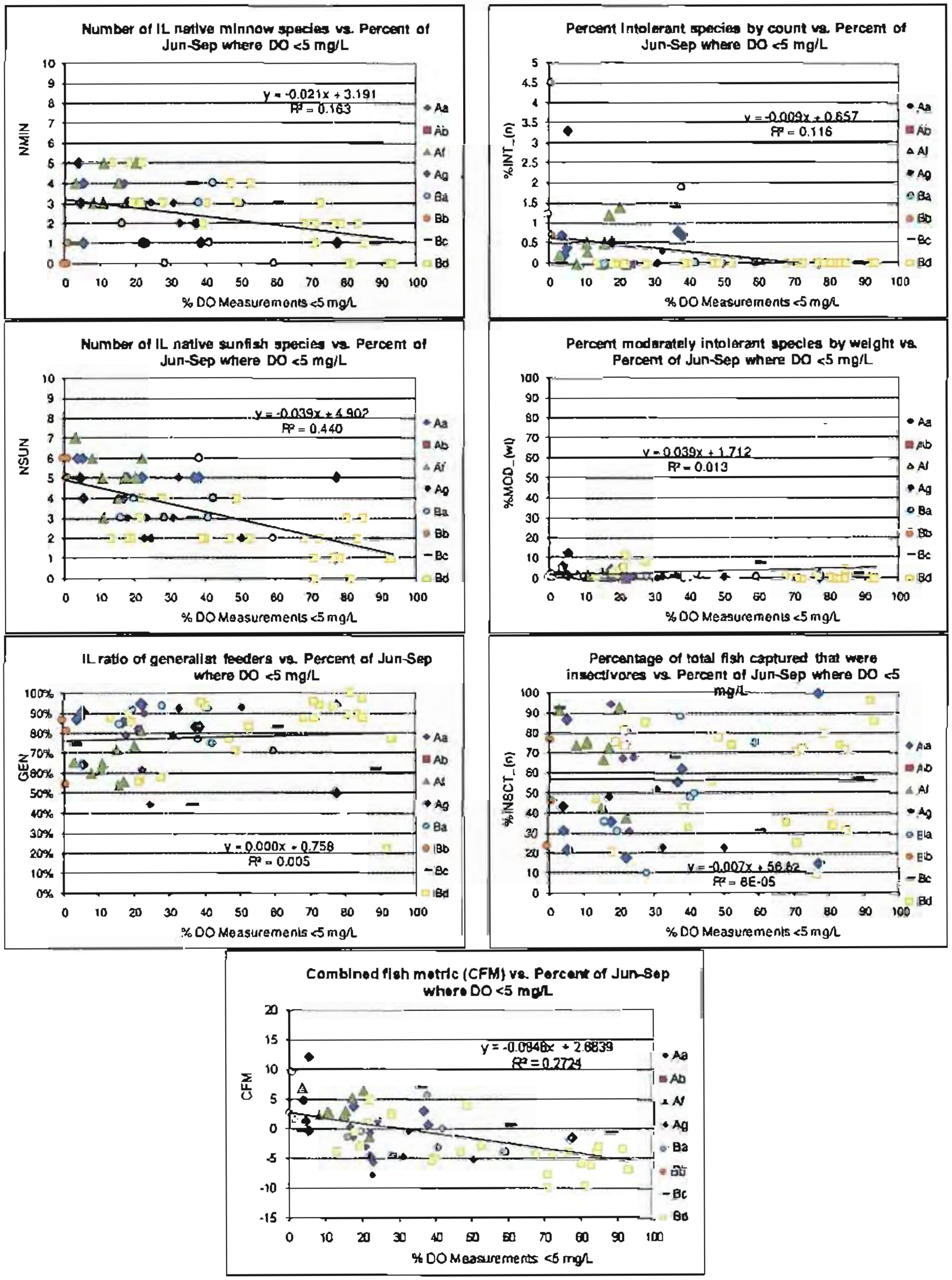
Regression of Fish Metrics and Compliance with Proposed Water Quality Standards for Dissolved Oxygen



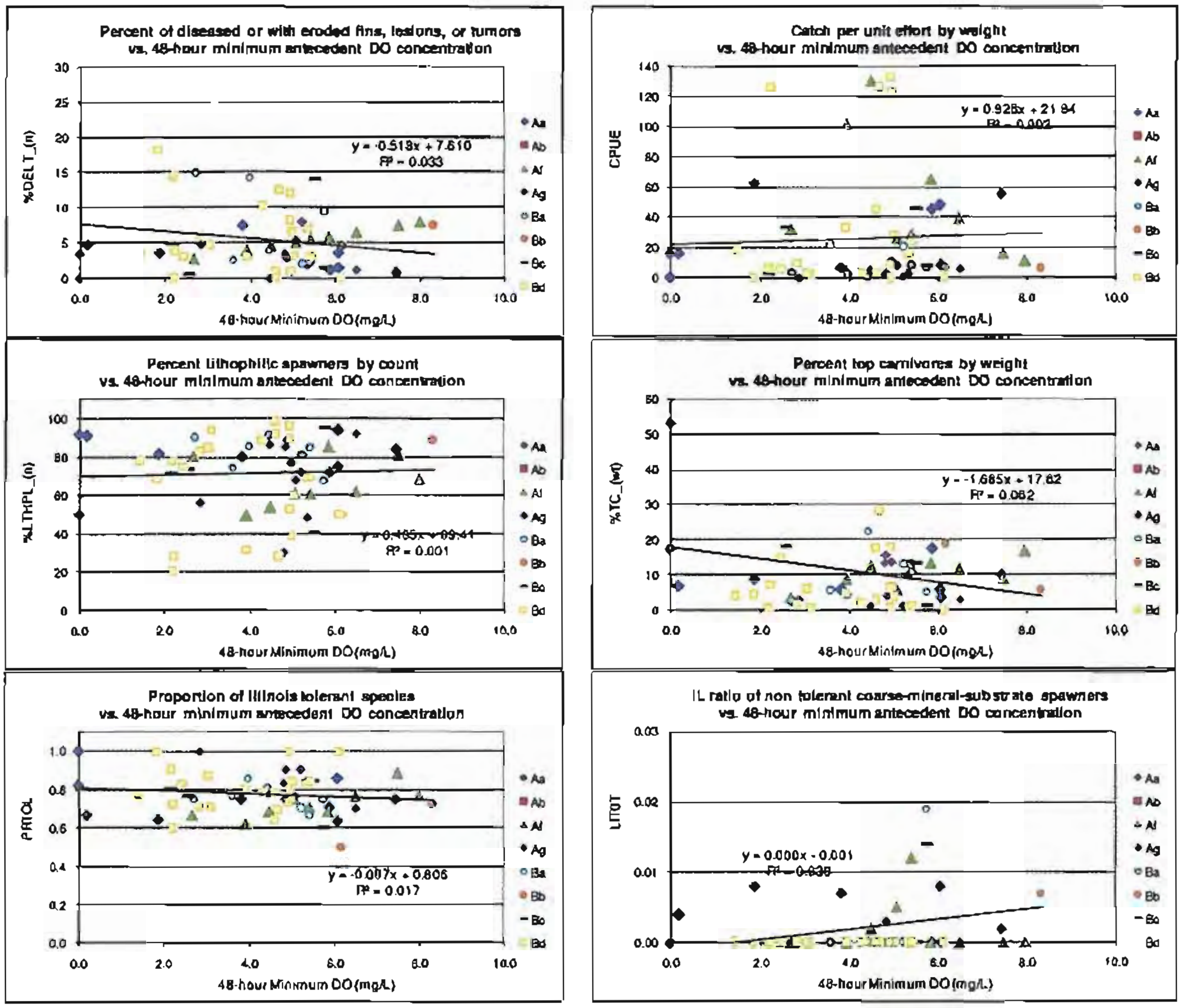
Regression of Fish Metrics and Compliance with Proposed Water Quality Standards for Dissolved Oxygen



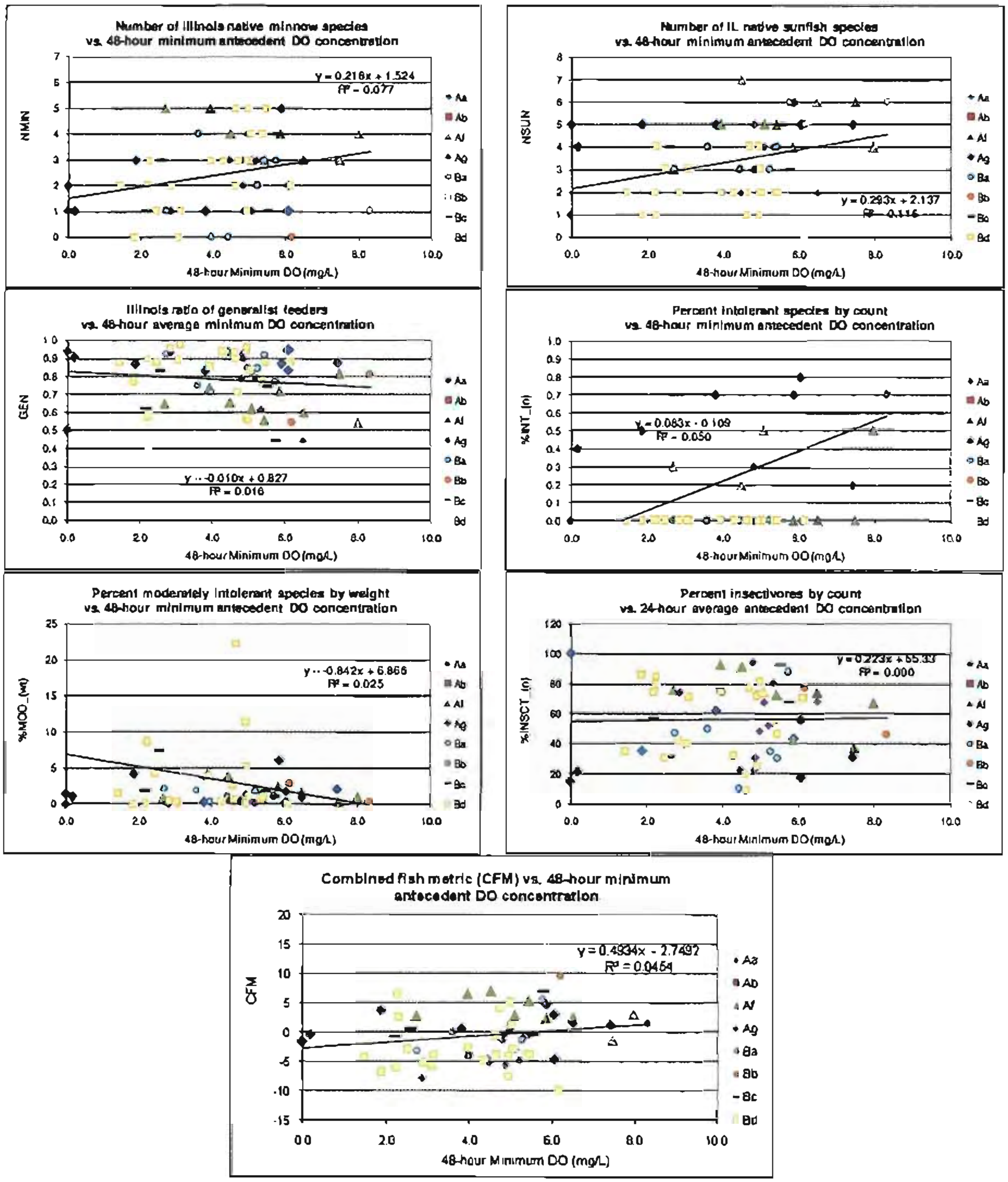
Regression of Fish Metrics and Percent of Time from June through September with Dissolved Oxygen Less Than 5.0 mg/L



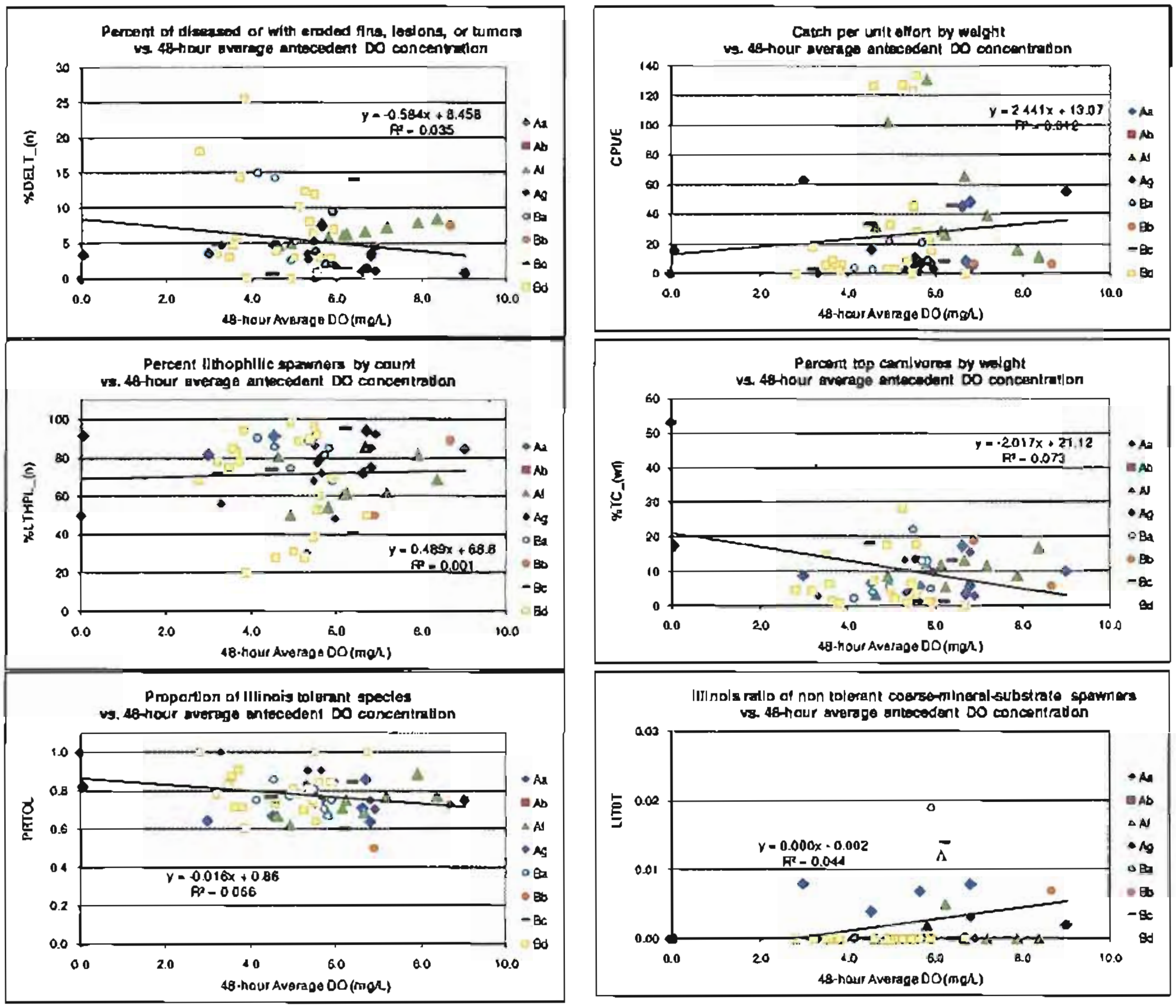
Regression of Fish Metrics and Percent of Time from June through September with Dissolved Oxygen Less Than 5.0 mg/L



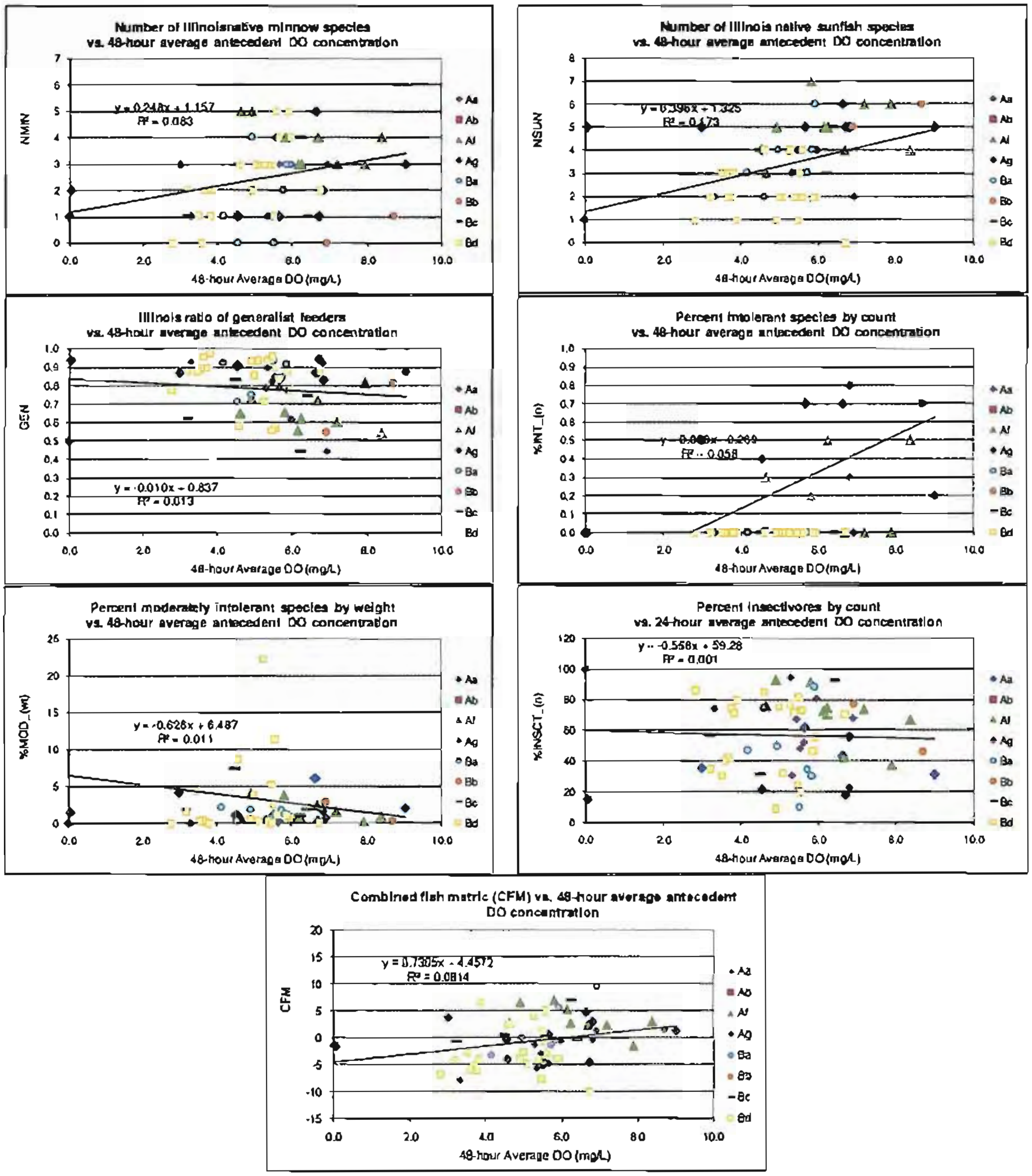
Regression of Fish Metrics and 48-Hour Antecedent Minimum Dissolved Oxygen Concentration



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

ATTACHMENT C:

REGRESSION PLOTS COMPARING FISH WITH TEMPERATURE CONDITIONS

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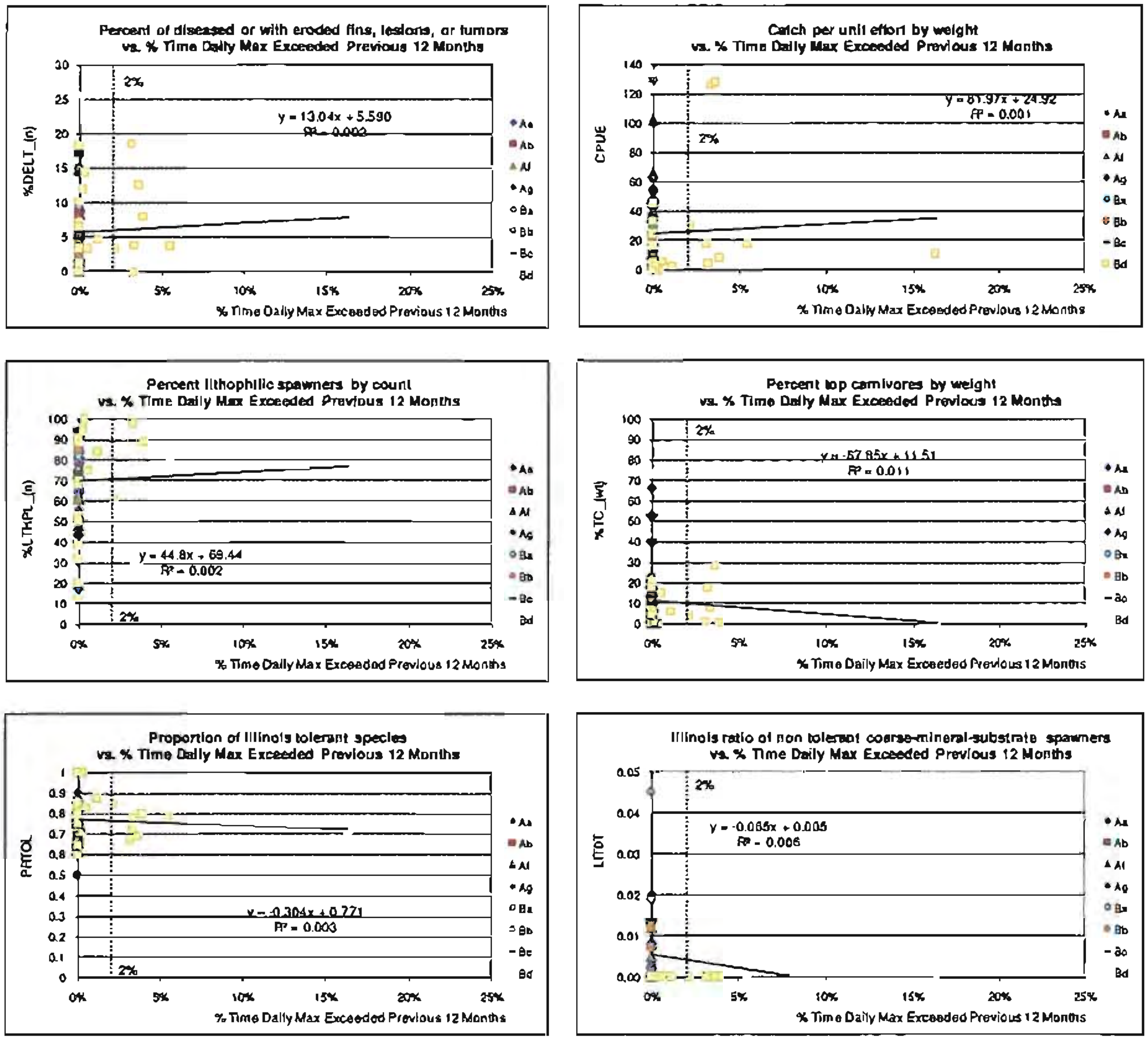
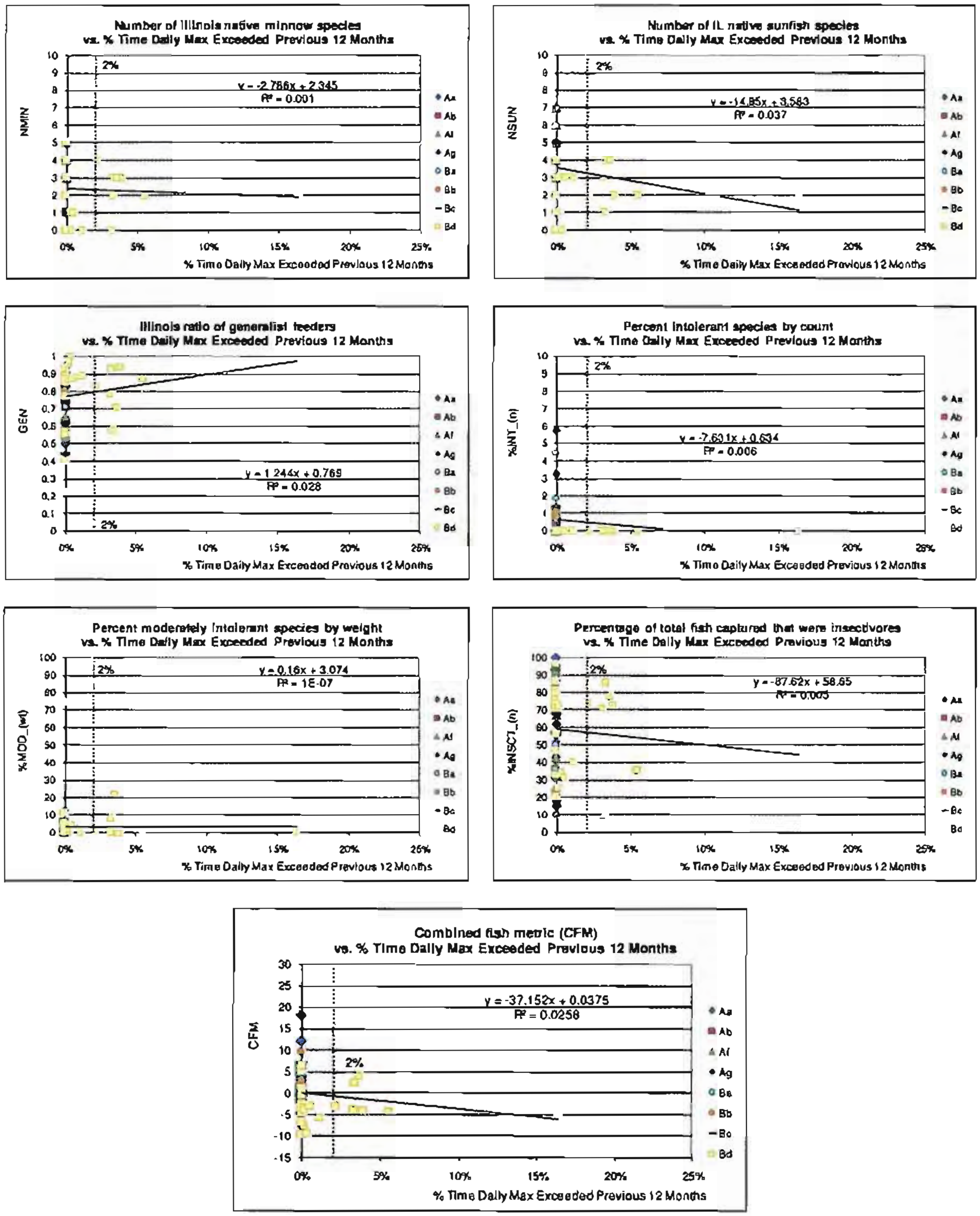
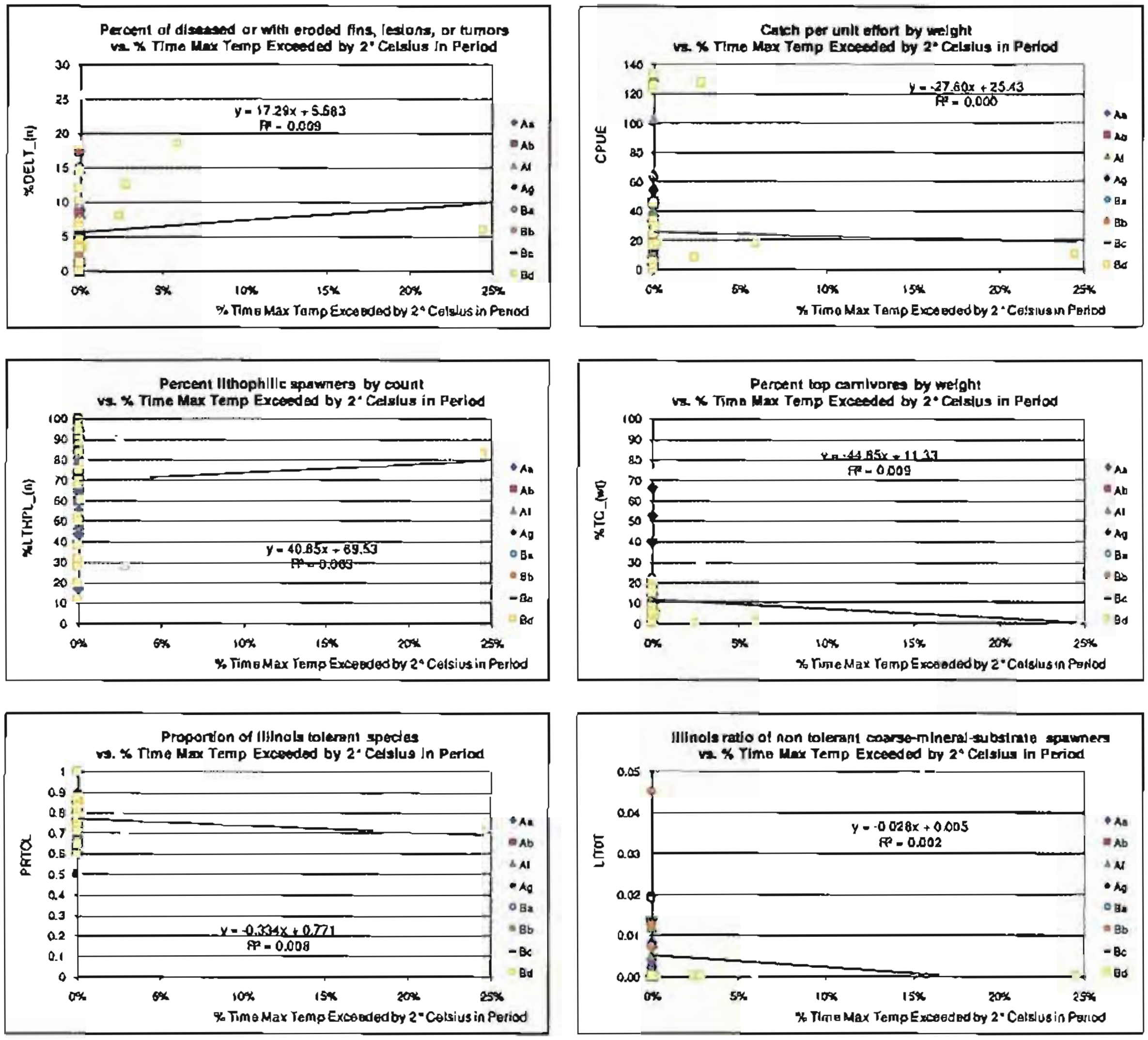


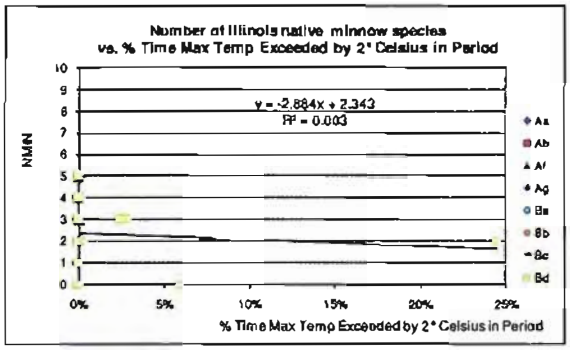
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded (Proposed Water Quality Standards)

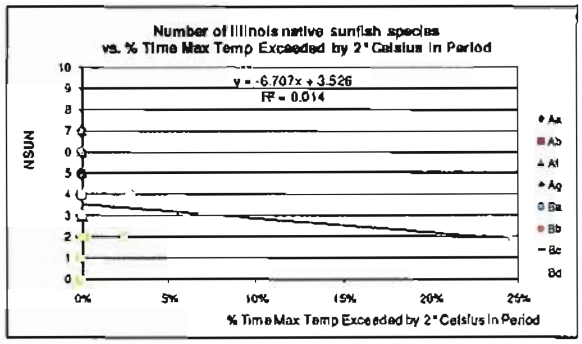


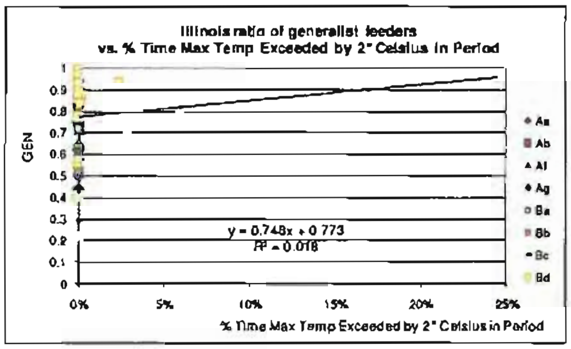
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded (Proposed Water Quality Standards)

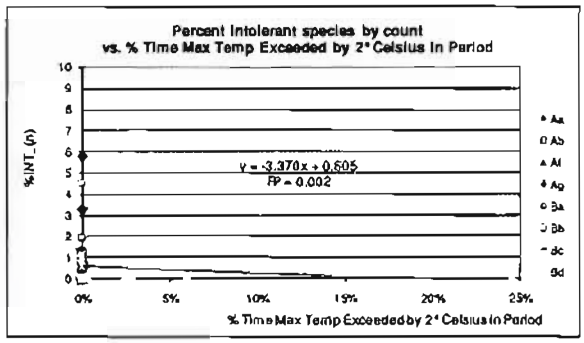


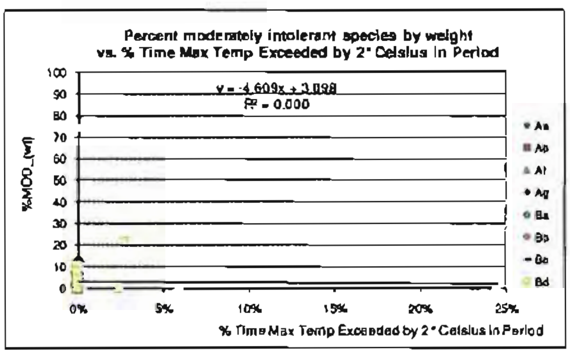
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded by More Than 2°C (Proposed Water Quality Standards)

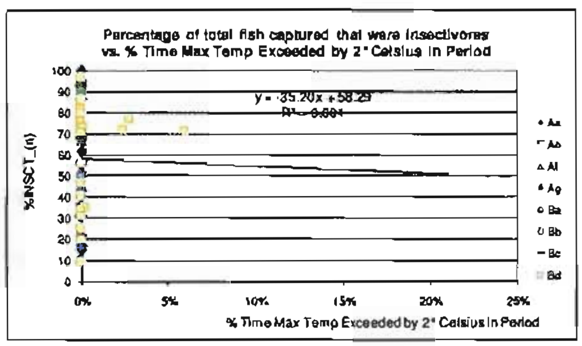

Number of Illinois native minnow species
vs. % Time Max Temp Exceeded by 2° Celsius in Period
y = -2.884x + 2.343
R² = 0.003
NMN
% Time Max Temp Exceeded by 2° Celsius in Period
Aa
Ab
Af
Ag
Ba
Bb
Bc
Bd

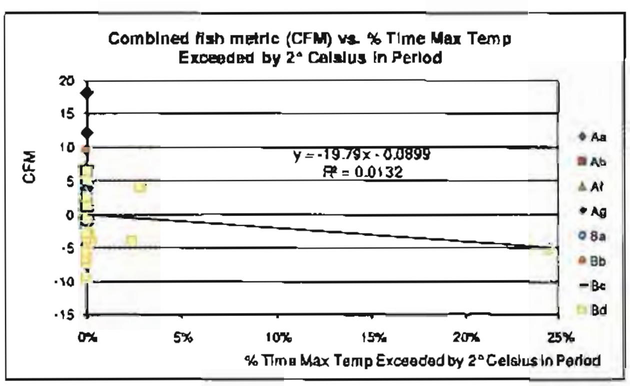

Number of Illinois native sunfish species
vs. % Time Max Temp Exceeded by 2° Celsius in Period
y = -6.707x + 3.526
R² = 0.014
NSUN
% Time Max Temp Exceeded by 2° Celsius in Period


Illinois ratio of generalist feeders
vs. % Time Max Temp Exceeded by 2° Celsius in Period
y = 0.748x + 0.773
R² = 0.018
GEN
% Time Max Temp Exceeded by 2° Celsius in Period

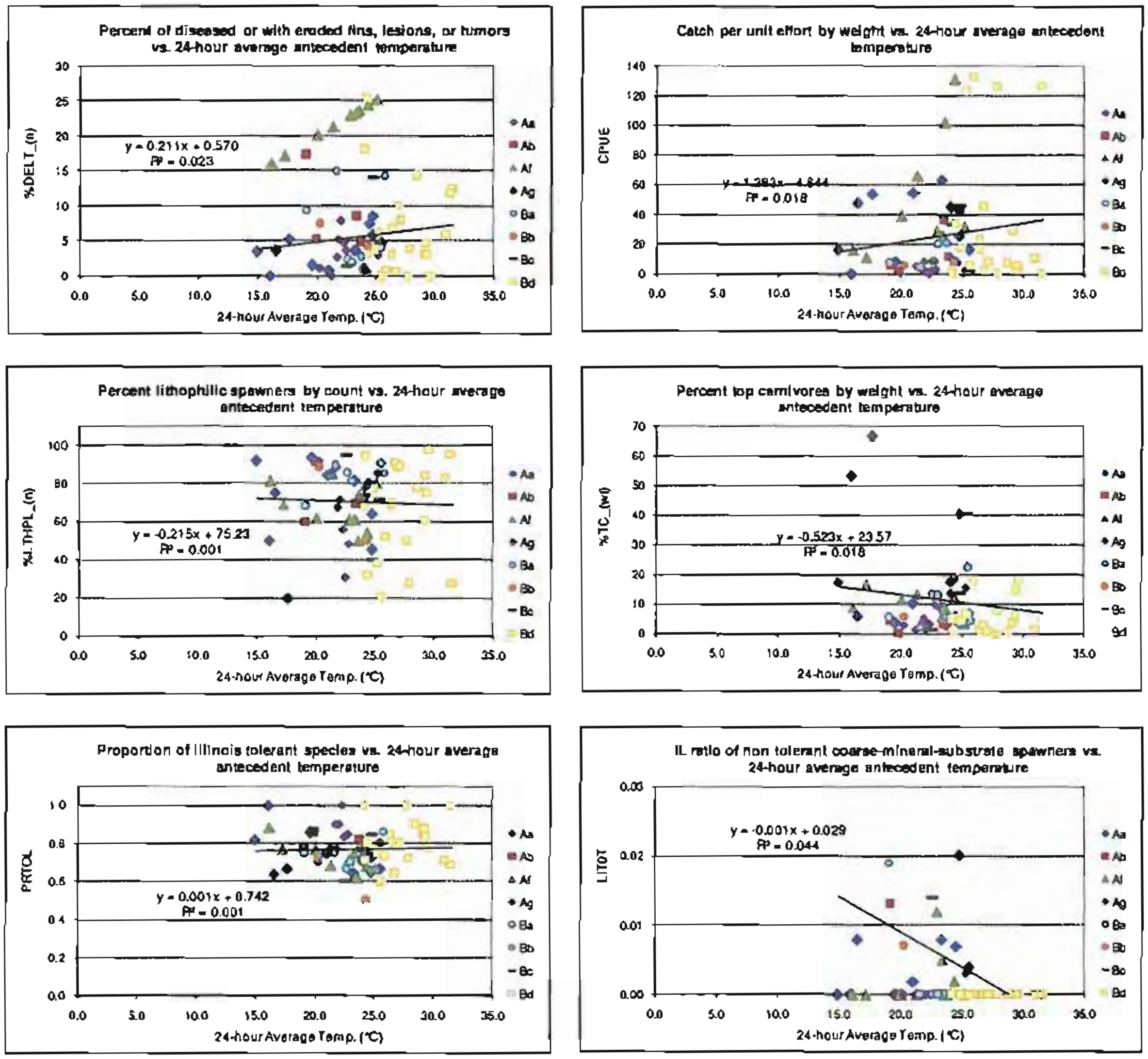

Percent intolerant species by count
vs. % Time Max Temp Exceeded by 2° Celsius in Period
y = -3.370x + 0.605
R² = 0.002
%INT_(n)
% Time Max Temp Exceeded by 2° Celsius in Period


Percent moderately intolerant species by weight
vs. % Time Max Temp Exceeded by 2° Celsius in Period
y = -4.609x + 3.098
R² = 0.000
%MOD_(wt)
% Time Max Temp Exceeded by 2° Celsius in Period

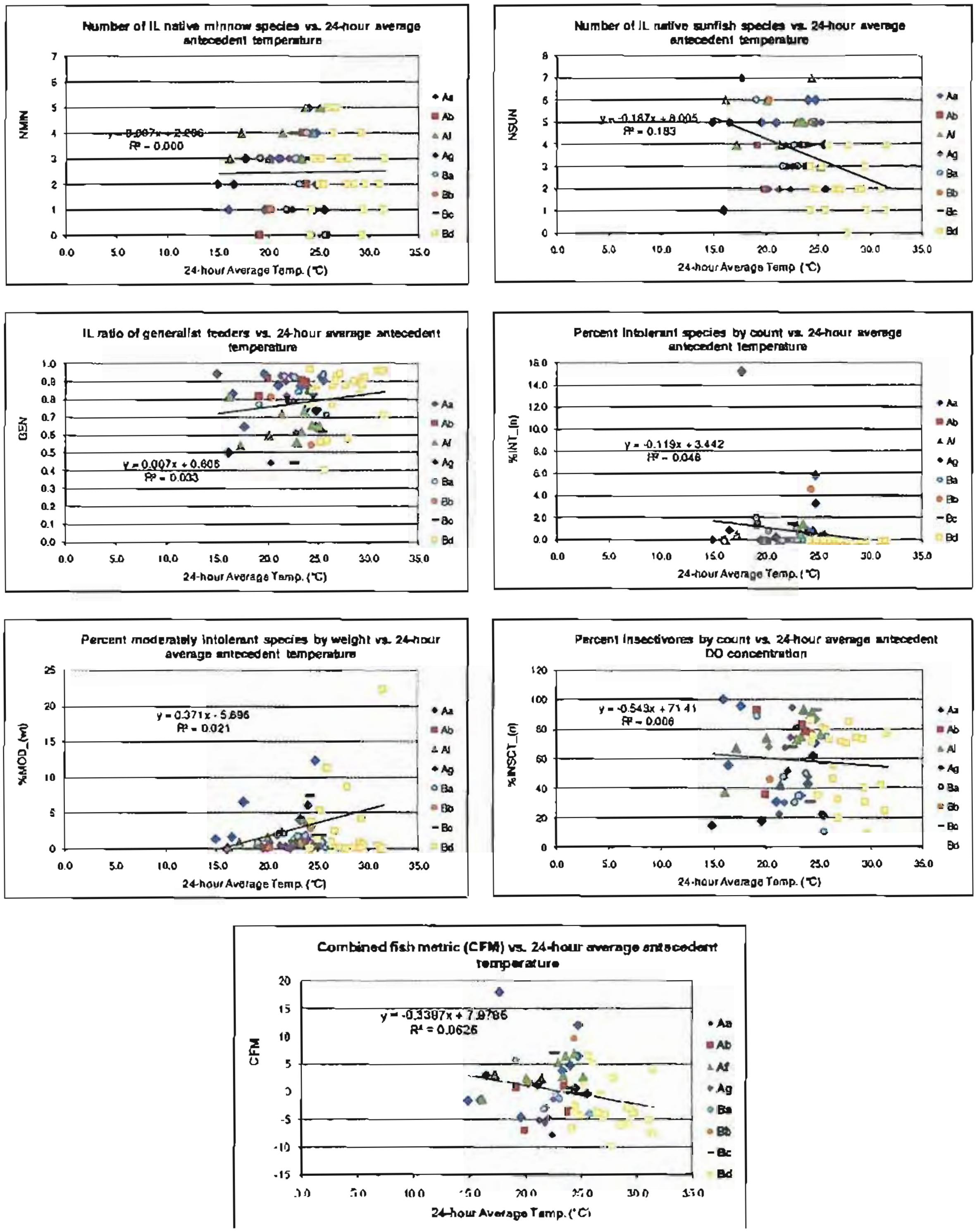

Percentage of total fish captured that were insectivores
vs. % Time Max Temp Exceeded by 2° Celsius in Period
y = -35.20x + 58.29
%INSCT_(n)
% Time Max Temp Exceeded by 2° Celsius in Period


Combined fish metric (CFM) vs. % Time Max Temp
Exceeded by 2° Celsius in Period
y = -19.79x - 0.0899
R² = 0.0132
CFM
% Time Max Temp Exceeded by 2° Celsius in Period
Aa
Ab
Af
Ag
Ba
Bb
Bc
Bd

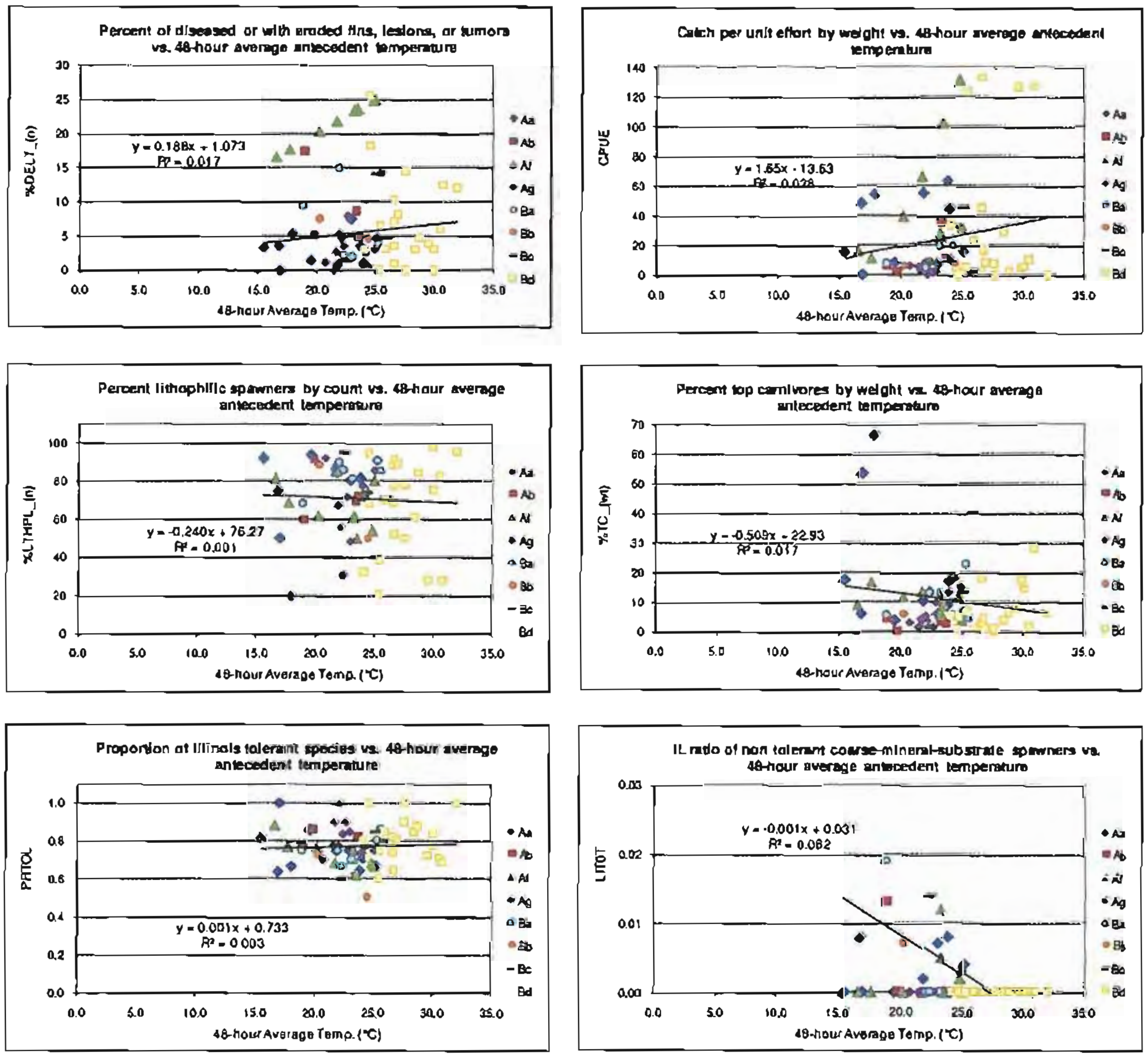
Regression of Fish Metrics and Percent of Time Daily Maximum Temperature Exceeded by More Than 2°C (Proposed Water Quality Standards)



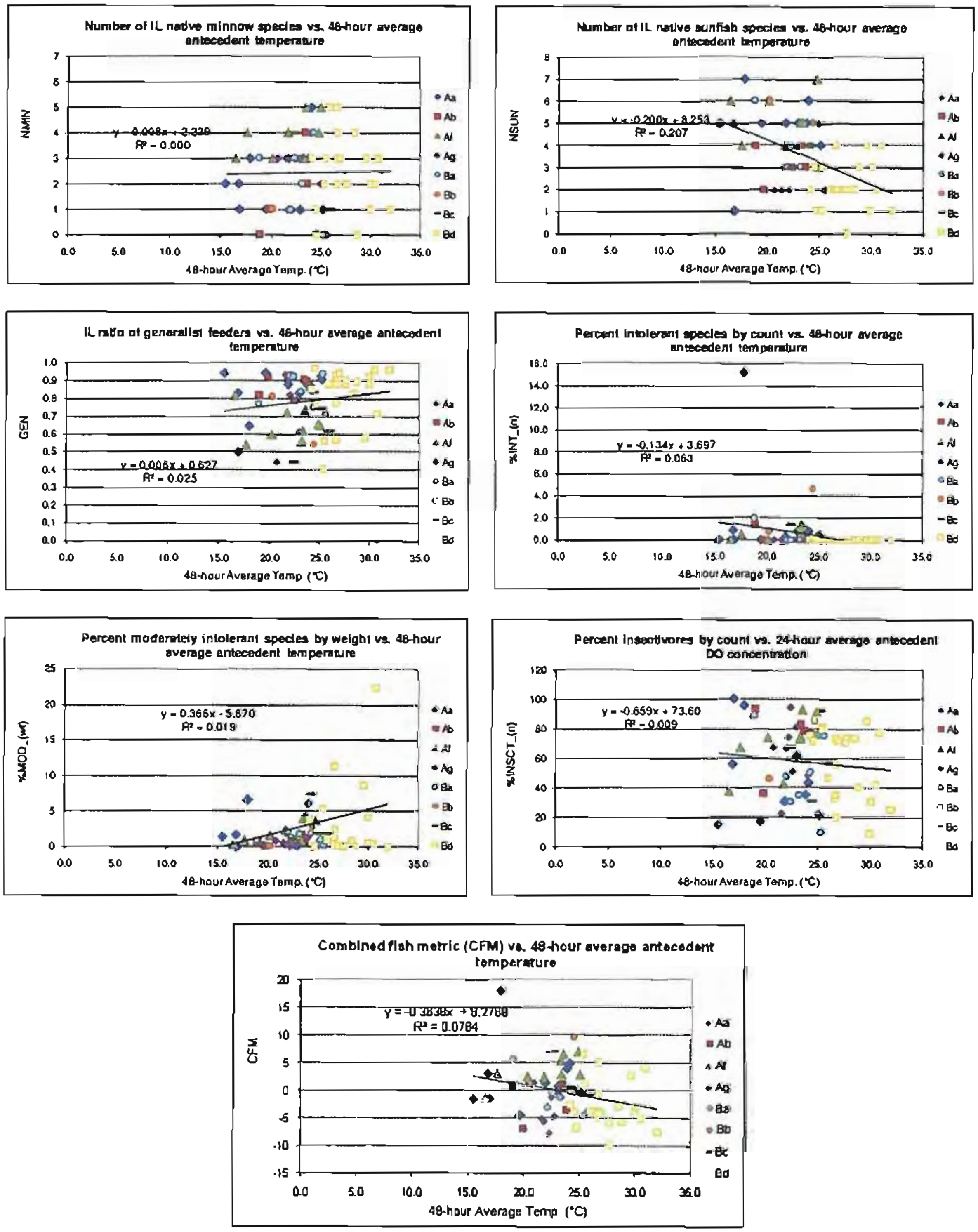
Regression of Fish Metrics and Compliance with 24-Hour Antecedent Temperature



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

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APPENDIX D:

ANALYSIS AND SCREENING OF HABITAT DATA

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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 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.

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	Dominant 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.

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.

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.

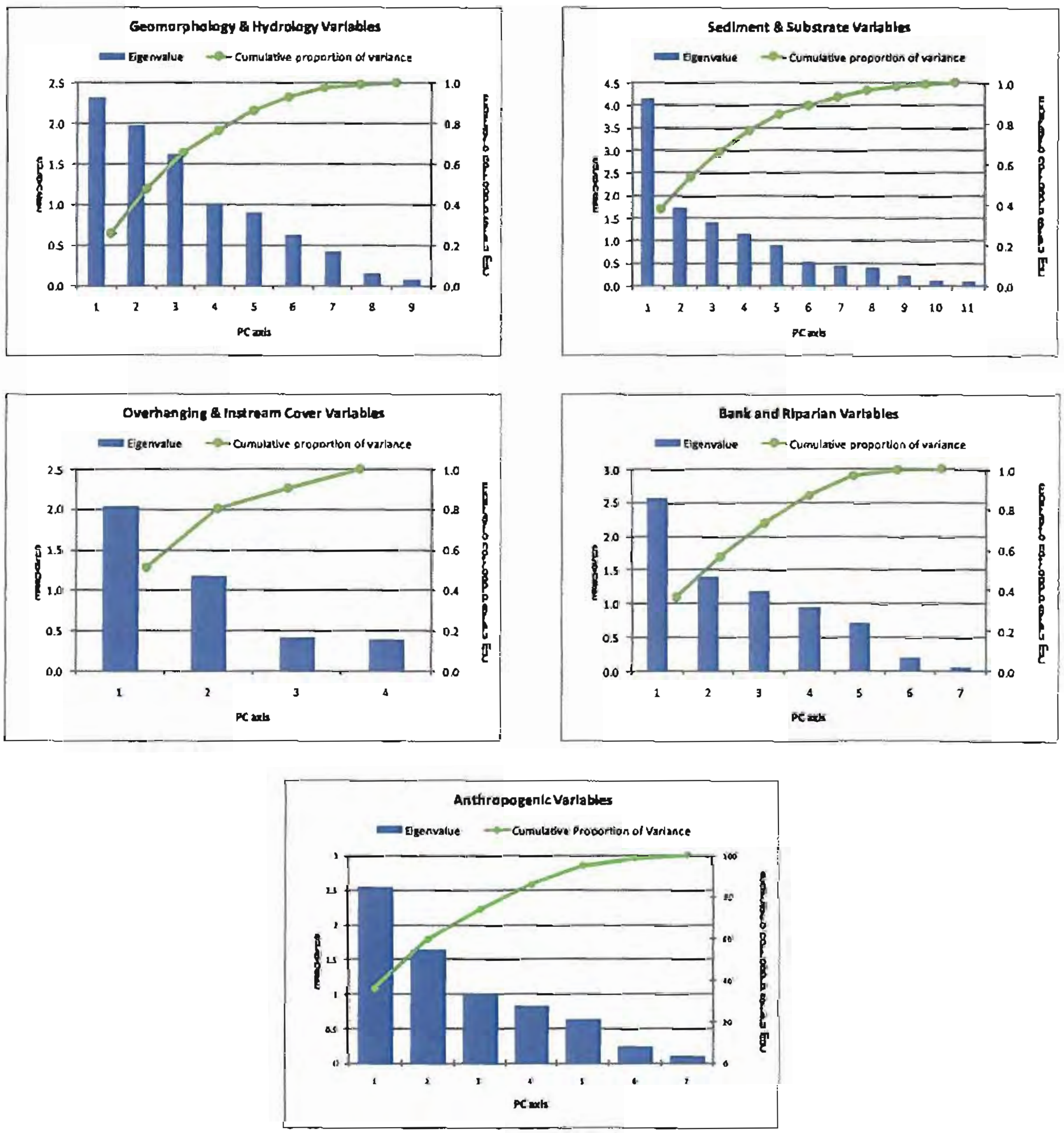

Figure D-1: Principal Components Analysis Scree Plots for CAWS Habitat Variables.

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
In-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

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.

[9] SEM = simultaneously extracted metals

APPENDIX E:

HABITAT VARIABLE TABLES AND SCREENING RATIONALE

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Habitat Variable Reduction: Qualitative Screening

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Variable Group	Variable	Variable Description	Source	Rationale
Geomorphology & Hydrology				
Flow & Velocity	FLASH_W	Flow event rate of 10 to 85% exceedance flows (USGS gage data, 40 years)	Wilhelm et al. 2001	Retained: Modified from USGS data to OUFLOW model output
	FLASH_00	2000 flash index: Q90 Q50 for 2000 water year (USGS gage data)	Wilhelm et al. 2001	Eliminated: Year 2000 precedes period of fish data
	BASEFLOW	Standardized baseflow: Q90 standardized for drainage area (m3/s/km2)	Wilhelm et al. 2001	Eliminated: True baseflow conditions do not exist
	Q50	Average 50% exceedance level for discharge from USGS gage data (cms)	Wilhelm et al. 2001	Retained: Modified from USGS data to OUFLOW model output
	MAD	Mean Annual Discharge from USGS gage data (cms)	Wilhelm et al. 2001	Retained: Modified from USGS data to OUFLOW model output
	Q	Average discharge (XAREA*VEL), calculated with ModCal (cms)	Wilhelm et al. 2001	Eliminated: redundant with Q50 and MAD
	MAX_VEL	Maximum velocity averaged for transects (m/s)	Wilhelm et al. 2001	Retained: Modified from USGS data to OUFLOW model output
	LOCMAXV	Location of maximum velocity as a proportion of the total width	Wilhelm et al. 2001	Eliminated: data not available
	AVG_VEL	Average velocity (Q/XAREA) averaged for transects (m/s)	Wilhelm et al. 2001	Retained: Modified from USGS data to OUFLOW model output
	EPA_5	Channel flow status	Wilhelm et al. 2001	Eliminated: Not applicable
	PSI_3	Velocity-to-depth ratio	Wilhelm et al. 2001	Retained: Modified from USGS data to OUFLOW model output
	PSI_4	Flow stability	Wilhelm et al. 2001	Eliminated: Not applicable
	STAGE	Stage level	MWRDGC PHA	Eliminated: not applicable
	Flow_Power	Power per unit of stream length (W/m)	Short 2005	Eliminated: not applicable
	WATER_LEVEL	CAWS PHA [illegible]	MWRDGC PHA	Eliminated: Not applicable
Channel morphology	DR_AREA	Drainage area (km2)	Wilhelm et al. 2001	Eliminated: Not applicable
	LINK	Stream link calculated in GIS	Wilhelm et al. 2001	Eliminated: not applicable
	ORDER	Stream order, for the Lower Peninsula from [illegible] and Winters 1970	Wilhelm et al. 2001	Eliminated: not applicable
	CAWS_ORDER	CAWS PHA stream order	MWRDGC PHA	Eliminated: not applicable
	TH_DEPTH	Average thalweg depth from measurements every 40 meters (m)	Wilhelm et al. 2001	Eliminated: No thalweg exists in system
	SD_THDEP	Standard deviation of thalweg depths (m)	Wilhelm et al. 2001	Eliminated: No thalweg exists in system
	XAREA	Cross-sectional area [illegible] of wetted channel (m2)	Wilhelm et al. 2001	Retained
	WET_PER	Wetted perimeter [illegible] of wetted channel (m)	Wilhelm et al. 2001	Retained
	HYDR_RAD	Low flow hydraulic radius: XAREA divided by WET_PER (m)	Wilhelm et al. 2001	Retained
	MAX_DEP	Maximum depth averaged for transects (m)	Wilhelm et al. 2001	Retained
	LOCMAXD	Location of maximum depth as a proportion of total width	Wilhelm et al. 2001	Retained
	CWS_W_BO	CAWS width bottom of channel	CAWS Unique	Retained
	CAWS_WIDTH_S	Site channel width as measured for PHA	MWRDGC PHA	Eliminated: new widths measured at stations for consistency
	CAWS_DEPTH	Site depth as measured for PHA	MWRDGC PHA	Retained
	CAWS_CHNLZ	Site channelization for PHA	MWRDGC PHA	Eliminated: most of system is channelized
	AVG_DPTH	Average depth: XAREA divided by WET_WIDTH averaged for transects (m)	Wilhelm et al. 2001	Retained
	BF_WIDTH	Stream width at estimated bankfull condition, averaged for transects (m)	Wilhelm et al. 2001	Eliminated; bankfull condition does not exist
	WETWIDTH	Stream width at low flow wetted channel, averaged for transects (m)	Wilhelm et al. 2001	Retained
	WETWIDTH_ALL	alternate stream width	Wilhelm et al. 2001	Retained
	SD_WW	Standard deviation for wetted width (m)	Wilhelm et al. 2001	Eliminated: wetted width varies little
	WW_X_THD	Mean wetted width times mean thalweg depth (m2)	Wilhelm et al. 2001	Eliminated; No thalweg exists in system
	SD_WWXTH	Standard deviation wetted width times thalweg depth (m2)	Wilhelm et al. 2001	Eliminated; No thalweg exists in system
	WW_DIV_D	Mean wetted width divided by mean depth	Wilhelm et al. 2001	Retained
	BF_TO_WW	Ratio of bankfull width to wetted width	Wilhelm et al. 2001	Eliminated: bankfull condition does not exist
	BF_HGT	Median average bankfull height relative to low flow water level (m)	Wilhelm et al. 2001	Eliminated: bankfull condition does not exist
	SD_BF_HT	Standard deviation of bankfull height (m)	Wilhelm et al. 2001	Eliminated: bankfull condition does not exist
	SINUOS	Sinuosity ratio of stream length to straight-line distance (1:24,000 map)	Wilhelm et al. 2001	Eliminated: sinuosity does not exist
	SINU_PH	Ratio of stream length to straight-line distance (aerial photographs)	Wilhelm et al. 2001	Eliminated; sinuosity does not exist
	SLOPE	Stream gradient: elevation drop divided by stream length (1:24,000 map)	Wilhelm et al. 2001	Eliminated, very low slope, does not vary
	EPA_3	Pool variability	Wilhelm et al. 2001	Eliminated: no pools
	EPA_7	Channel sinuosity	Wilhelm et al. 2001	Eliminated: sinuosity does not exist
	PSI_8	Pools-&-Riffles-Runs-Bends	Wilhelm et al. 2001	Eliminated: no pools & riffles
	OFF_CHAN	Number of tributary, backwater, and off-channel habitats from ground	Wilhelm et al. 2001	Retained
	TRIB_PH	Number of tributary and backwater habitats from aerial photographs	Wilhelm et al. 2001	Retained
	OFF_CH_BAY	Off channel bay areas [illegible]	[illegible] et al 2001* adapted	Retained
	BANK_POC_AREA	Pocket areas within the bank that may serve as refuge for fish from the main channel flow	CAWS Unique	Retained

Habitat Variable Reduction: Qualitative Screening

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Variable Group	Variable	Variable Description	Source	Rationale
Sediment				
Thalweg	BH_TH	% Hard pan, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	BL_TH	% Boulder, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	CB_TH	% Cobble, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	GC_TH	% Coarse Gravel, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	GF_TH	% Fine Gravel, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	SA_TH	% Sand, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	FN_TH	% Fines, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	DOM_TH	Dominant thalweg substrate	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	SBD_THWG	Second most dominant thalweg substrate	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	SAFN_TH	% Sand and Fines, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	BIG_TH	% Substrate fine gravel, coarse gravel, cobble, and boulder, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
	TH_AVGSZ	Average particle size, thalweg	Wilhelm et al. 2001	Eliminated: no thalweg exists in system
Deep	BH_D	% Hard pan, deep	Wilhelm et al. 2001	Retained
	BL_D	% Boulder, deep	Wilhelm et al. 2001	Eliminated: insufficient data
	CB_D	% Cobble, deep	Wilhelm et al. 2001	Eliminated: insufficient data
	GC_D	% Coarse Gravel, deep	Wilhelm et al. 2001	Eliminated: insufficient data
	GF_D	% Fine Gravel, deep	Wilhelm et al. 2001	Eliminated: insufficient data
	SA_D	% Sand, deep	Wilhelm et al. 2001	Eliminated: insufficient data
	FN_D	% Fines, deep	Wilhelm et al. 2001	Eliminated: insufficient data
	DOM_D	Dominant deep substrate	Wilhelm et al. 2001	Retained
	SBD_D	Second most dominant deep substrate	Wilhelm et al. 2001	Eliminated: insufficient data
	SAFN_D	% Sand and Fines, deep	Wilhelm et al. 2001	Retained
	BIG_D	% Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Wilhelm et al. 2001	Retained
Shallow	D16	Particle size of 16th percentile from lateral pebble count	Wilhelm et al. 2001	Eliminated: not applicable
	D50	Median particle size from lateral pebble count	Wilhelm et al. 2001	Eliminated: not applicable
	D84	Particle size of 84th percentile from lateral pebble count	Wilhelm et al. 2001	Eliminated: not applicable
	D84_D16	Ratio of size of 84th:16th percentile; a measure of particle size variability	Wilhelm et al. 2001	Eliminated: not applicable
	BH_S	% Hard pan, shallow	Wilhelm et al. 2001	Retained
	BL_S	% Boulder, shallow	Wilhelm et al. 2001	Eliminated: insufficient data
	CB_S	% Cobble, shallow	Wilhelm et al. 2001	Eliminated: insufficient data
	GC_S	% Coarse Gravel, shallow	Wilhelm et al. 2001	Eliminated: insufficient data
	GF_S	% Fine Gravel, shallow	Wilhelm et al. 2001	Eliminated: insufficient data
	SA_S	% Sand, shallow	Wilhelm et al. 2001	Eliminated: insufficient data
	FN_S	% Fines, shallow	Wilhelm et al. 2001	Eliminated: insufficient data
	DOM_S	Dominant shallow substrate	Wilhelm et al. 2001	Retained
	SBD_S	Second most dominant shallow substrate	Wilhelm et al. 2001	Eliminated: insufficient data
	SAFN_S	% Sand and fines, shallow	Wilhelm et al. 2001	Retained
	BIG_S	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et al. 2001	Retained
Comb. Shallow and Deep	BH_C	% Hard pan, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	BL_C	% Boulder, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	CB_C	% Cobble, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	GC_C	% Coarse Gravel, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	GF_C	% Fine Gravel, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	SA_C	% Sand, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	FN_C	% Fines, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	CAWS_ORSLG	CAWS PHA % Organic Sludge	MWRDGC PHA	Retained
	CAWS_INSLG	CAWS PHA % Inorganic Sludge	MWRDGC PHA	Retained
	CAWS_CLAY	CAWS PHA % Clay	MWRDGC PHA	Eliminated: insufficient data
	CAWS_PLDBR	CAWS PHA % Plant debris	MWRDGC PHA	Retained
	DOM_C	Dominant combined substrate	Wilhelm et al. 2001	Eliminated: insufficient data
	SBD_C	Second most dominant combined substrate	Wilhelm et al. 2001	Eliminated: insufficient data
	SAFN_C	% Sand and Fines combined	Wilhelm et al. 2001	Eliminated: insufficient data
	BIG_C	% Substrate fine gravel, coarse gravel, cobble, and boulder, combined	Wilhelm et al. 2001	Eliminated: insufficient data
	EMBEDD	Mean substrate embeddedness	Wilhelm et al. 2001	Eliminated: insufficient data
	SD_EMBED	Standard deviation substrate embeddedness	Wilhelm et al. 2001	Eliminated: insufficient data
Visual Assessments	CAWS_DPTH_FNS	CAWS PHA Depth of fines	MWRDGC PHA	Retained
	EPA_1	Epifaunal substrate/available cover	Wilhelm et al. 2001	Eliminated: not applicable
	EPA_3	Pool substrate characterization	Wilhelm et al. 2001	Eliminated: not applicable
	EPA_4	Sediment deposition	Wilhelm et al. 2001	Eliminated: not applicable
	PSS_1	Bottom substrate/available cover (also considered within instream cover)	Wilhelm et al. 2001	Eliminated: not applicable
	PSS_2	Embeddedness/Siltation (also considered within instream cover)	Wilhelm et al. 2001	Eliminated: not applicable
	PSS_5	Bottom deposition	Wilhelm et al. 2001	Eliminated: not applicable

Habitat Variable Reduction: Qualitative Screening
(a)

Variable Group	Variable	Variable Description	Source	Rationale
Instream cover				
	AQ_VEG	Number of aquatic vegetation types within area	MWRDGC PHA	Retained
	MCRPH_CD	Average macrophyte coverage (area*density) (m)	Wilhelm et al. 2001	Retained
	SD_MACRO	Standard deviation macrophyte coverage (m)	Wilhelm et al. 2005	Eliminated: insufficient data
	SUB_STR	Number of subsurface structures for potential cover	MWRDGC PHA	Eliminated: insufficient data
	SUB_LRG_R	Number of large subsurface structures	CAWS Unique	Eliminated: insufficient data
	Num_Cover	Number of instream cover type types within area	MWRDGC PHA	Eliminated: insufficient data
	PERC_COV	Percent of canopy cover over water - GIS-derived	MWRDGC PHA	Retained
	PERC_COV_ALT	Percent of canopy cover over water - field-measured	CAWS Unique	Retained
	WIDTH_COV	Measured average width of cover at station	CAWS Unique	Eliminated: replaced by DEPTH_COV
	LENGTH_COV	Measured length of cover at station	CAWS Unique	Retained
	DEPTH_COV	Depth of shade cover	CAWS Unique	Retained
	ALGAE	% Cover algae, littoral plots	Wilhelm et al. 2005	Eliminated: insufficient data
	MACROPHYT	% Cover macrophytes, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	LWD	% Cover large woody debris (LWD), littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	SWD	% Cover small woody debris (SWD), littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	LIVETREE	% Cover live trees-in stream, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	OVHNGVEG	% Cover overhanging vegetation, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	LENGTH_OVR	Measured length of undercut banks at station	CAWS Unique	Retained
	NUM_COV	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique	Retained
	UNDERCT	% Cover undercut banks, littoral plots	Wilhelm et al. 2005	Eliminated: insufficient data
	BOULDER	% Cover boulders, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	ARTIFIC	% Cover artificial substrates, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	FISH_ALL	% Cover (all coverage categories, littoral plots)	Wilhelm et al. 2001	Eliminated: insufficient data
	FISH_VEG	% Cover ALGAE and MACROPHY, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	FISH_BIG	% Cover LWD, BOULDER, OVHNGVEG, ARTIFIC, littoral plots	Wilhelm et al. 2001	Eliminated: insufficient data
	FISH_NAT	% Cover LWD, SWD, LIVETREE, OVHNGVEG, UNDERCT, BOULDER (natural)	Wilhelm et al. 2001	Eliminated: insufficient data
	LWD_VOL	Volume of wood for entire reach (m3/1000 m) from longitudinal survey	Wilhelm et al. 2001	Eliminated: not applicable
	NUM_LWD	Number of pieces of wood counted during longitudinal survey	Wilhelm et al. 2001	Eliminated: not applicable
	AVG_WOOD	Average size wood (m3)	Wilhelm et al. 2001	Eliminated: not applicable
	ISLANDS	Number of islands within 2,000 m reach (counted on site or from aerial photos)	Wilhelm et al. 2001	Eliminated: not applicable
	SECCHI	Secchi depth (m)	Wilhelm et al. 2001	Retained
	SD_SECCHI	Standard deviation secchi depth (m)	Wilhelm et al. 2001	Eliminated: deemed not necessary
	SEC_1.5M	Secchi depth as proportion of 1.5 meters	Wilhelm et al. 2001	Eliminated: deemed not necessary
	SD_SEC1.5	Standard deviation of secchi depth as proportion of 1.5 m	Wilhelm et al. 2001	Eliminated: deemed not necessary
	SEC_VIS	Is secchi disk visible at the stream bottom? (Yes or No)	Wilhelm et al. 2001	Eliminated: not applicable
	EPA_1	Epifaunal substrate/Available cover (also considered within substrate)	Wilhelm et al. 2001	Eliminated: insufficient data
	PSL_1	Bottom substrate/Available cover (Also considered within substrate)	Wilhelm et al. 2001	Eliminated: insufficient data

Habitat Variable Reduction: Qualitative Screening

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Variable Group	Variable	Variable Description	Source	Rationale
Bank and riparian condition				
Land Use	LB_LU	Dominant land use left bank (categorical)	Wilhelm et al. 2001	Retained
	RB_LU	Dominant land use right bank (categorical)	Wilhelm et al. 2001	Retained
	DOM_LU	Dominant land use, both banks combined (categorical)	Wilhelm et al. 2001	Retained
	WALL	Distance-weighted wall, dike, revetment, rip rap, dam	Wilhelm et al. 2001	Eliminated: not applicable
	BLDG	Distance-weighted buildings	Wilhelm et al. 2001	Eliminated: not applicable
	PVMT	Distance-weighted pavement and cleared lots	Wilhelm et al. 2001	Eliminated: not applicable
	ROAD	Distance-weighted roads and railroads	Wilhelm et al. 2001	Eliminated: not applicable
	TRASH	Distance-weighted trash and landfills	Wilhelm et al. 2001	Eliminated: not applicable
	LAWN	Distance-weighted lawns and parks	Wilhelm et al. 2001	Eliminated: not applicable
	CROPS	Distance-weighted crops	Wilhelm et al. 2001	Eliminated: not applicable
	PASTR	Distance-weighted pasture, rangeland, and hay fields	Wilhelm et al. 2001	Eliminated: not applicable
	LOGGING	Distance-weighted logging operations	Wilhelm et al. 2001	Eliminated: not applicable
	MINE	Distance-weighted mining	Wilhelm et al. 2001	Eliminated: not applicable
	OTHER	Distance-weighted other	Wilhelm et al. 2001	Eliminated: not applicable
	DIST_ALL	Distance-weighted all human disturbances combined	Wilhelm et al. 2001	Eliminated: not applicable
	DISTNOAG	Distance-weighted no agriculture (all disturbances except crop and pasture)	Wilhelm et al. 2001	Eliminated: not applicable
	DIST_AG	Distance-weighted agriculture (crops and pasture)	Wilhelm et al. 2001	Eliminated: not applicable
	EPA_6	Channel alteration	Wilhelm et al. 2001	Eliminated: entire system altered
Bank	BNK_ANGL	Average bank angle of both banks	Wilhelm et al. 2001	Retained
	UNDCT_DI	Average distance of undercut banks (m)	Wilhelm et al. 2001	Eliminated: insufficient data
	P_UNDCT	Percentage of banks undercut	Wilhelm et al. 2001	Eliminated: insufficient data
	BNK_EROS	Dominant bank erosion (extreme, extensive, moderate, limited, or none)	Wilhelm et al. 2001	Eliminated: insufficient data
	EPA_8	Bank stability	Wilhelm et al. 2001	Eliminated: insufficient data
	EPA_9	Vegetative protection	Wilhelm et al. 2001	Eliminated: insufficient data
	PSI_7	Bank stability	Wilhelm et al. 2001	Eliminated: insufficient data
	PSI_8	Bank vegetative stability	Wilhelm et al. 2001	Eliminated: insufficient data
	BNK_NAT	Percent natural banks in sampling reach (sloped, no walls, riprap, or other armoring)	CAWS Unique	Retained
	BNK_CONC	Percent vertically walled concrete banks in sampling reach	CAWS Unique	Retained
	BNK_STEEL	Percent vertically walled steel banks in sampling reach	CAWS Unique	Retained
	BNK_WOOD	Percent vertically walled wood banks in sampling reach	CAWS Unique	Retained
	BNK_GRAN	Percent vertically walled stone block banks in sampling reach	CAWS Unique	Retained
	BNK_RIPRAP	Percent rip-rapped banks in sampling reach	CAWS Unique	Retained
	BNK_MARINA	Percent bank length in sampling reach occupied by marina	CAWS Unique	Retained
	BNK_WATER	Percent bank length in sampling reach occupied by open water	CAWS Unique	Retained
Riparian (on-site)	RIP_WDTH	Riparian width measured from field data with a laser rangefinder (m)	Wilhelm et al. 2001	Eliminated: insufficient data
	SD_RIP_W	Standard deviation riparian width (m)	Wilhelm et al. 2001	Eliminated: insufficient data
	P_RIPCSM	Riparian width as a proportion of 25 m; > 25, proportion is 1	Wilhelm et al. 2001	Eliminated: insufficient data
	RIP_MED	Median category riparian width, field data	Wilhelm et al. 2001	Eliminated: insufficient data
	RIP_MODE	Modal category riparian width, field data	Wilhelm et al. 2001	Eliminated: insufficient data
	P_SHADE	% Channel shaded	Wilhelm et al. 2001	Eliminated: insufficient data
	OPEN_CAN	Canopy openness; 180 = fully open; 0 = fully covered	Wilhelm et al. 2001	Eliminated: insufficient data
	LG_TREES	% Large trees riparian plots	Wilhelm et al. 2001	Eliminated: insufficient data
	SM_TREES	% Small trees riparian plots	Wilhelm et al. 2001	Eliminated: insufficient data
	WO_SHRUB	% Woody shrubs riparian plots	Wilhelm et al. 2001	Eliminated: insufficient data
	GRASS	% Grass riparian plots	Wilhelm et al. 2001	Eliminated: insufficient data
	RIP_CAN	Riparian canopy cover (% large and small trees)	Wilhelm et al. 2001	Eliminated: insufficient data
	RIP_LOW	Riparian shrubs and ground cover (% shrubs and grass)	Wilhelm et al. 2001	Eliminated: insufficient data
	RIP_ALL	% Canopy, shrubs, and grass combined (plots)	Wilhelm et al. 2001	Eliminated: insufficient data
	P_CANPY	% Riparian canopy from 10 m transect	Wilhelm et al. 2001	Eliminated: insufficient data
	P_SHRUB	% Shrub from 10 m transect	Wilhelm et al. 2001	Eliminated: insufficient data
	P_GRND	% Ground cover from 10 m transect	Wilhelm et al. 2001	Eliminated: insufficient data
	P_ALLRIP	% Canopy, shrubs, and grass combined - 10 m transect	Wilhelm et al. 2001	Eliminated: insufficient data
	EPA_10	Riparian width	Wilhelm et al. 2001	Eliminated: insufficient data
	PSI_9	Streamside cover	Wilhelm et al. 2001	Eliminated: insufficient data
	P_RIP_VEG	Percent riparian vegetation from site measurements	CAWS Unique	

Habitat Variable Reduction: Qualitative Screening

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Variable Group	Variable	Variable Description	Source	Rationale
Bank and riparian condition - continued				
Riparian (from aerials)	GAP_NUM	Number of gaps per 1000 m reach, both banks combined	Wilhelm et al. 2005	Eliminated: not applicable
	GAP_LS	Total length of gaps in riparian vegetation	Wilhelm et al. 2005	Eliminated: not applicable
	Tot_LS	Total length of riparian vegetation	CAWS Unique	Retained
	GAP_AVG	Average gap length	Wilhelm et al. 2005	Eliminated: not applicable
	P_GAP_MS	Proportion of reach with gaps in riparian (gap length measured)	Wilhelm et al. 2005	Eliminated: not applicable
	P_GAP_42	Proportion of 42 riparian measurements with gaps	Wilhelm et al. 2005	Eliminated: not applicable
	RIPPHOTO	Average of 42 riparian width measurements (25 each bank)	Wilhelm et al. 2005	Eliminated: not applicable
	MD_RIP_PH	Median riparian width	Wilhelm et al. 2005	Eliminated: N/A - [illegible]
	SD_RIP_PH	Standard deviation riparian width	Wilhelm et al. 2005	Eliminated: retained one measure of riparian width
	CV_RIP_PH	Coefficient of variation of riparian width	Wilhelm et al. 2005	Eliminated: retained one measure of riparian width
	MAX_RIP	Maximum riparian width	Wilhelm et al. 2005	Eliminated: retained one measure of riparian width
	MIN_RIP	Minimum riparian width	Wilhelm et al. 2005	Eliminated: retained one measure of riparian width
	RIP_RNG	Range of riparian widths	Wilhelm et al. 2005	Eliminated: retained one measure of riparian width
Anthropogenic impacts				
	EPA_Tox_Sites	Number of EPA toxic release sites (#/reach)*	[illegible] et al. 2005	Eliminated: insufficient data
	RAPPS_D	Distance to RAPPS station	CAWS Unique	Eliminated: only applicable to Bubbly Creek
	MRPS_D	Distance to MRPS	CAWS Unique	Eliminated: only applicable to North Branch Chicago River
	ROADCROSS	Number of road crossings within 1,000 m reach	Wilhelm et al. 2005	Eliminated: not applicable
	PIPE	Distance-weighted pipes - inlet and outlet	Wilhelm et al. 2005	Eliminated: insufficient data
	MAN_Made_Struct	Number of manmade structures at the site	IEPA/IDNR PHA	Retained
	NUM_PIPE	Number of intake and outfall pipes within stream reach	Wilhelm et al. 2005	Eliminated: insufficient data
	NUM_CSO	Number of NPDES permitted CSO outfalls	CAWS Unique	Retained
	NUM_NPS_NOCSO	Number of NPDES permitted non-CSO outfalls	CAWS Unique	Retained
	NUM_TARP	Number of TARP related features	CAWS Unique	Eliminated: insufficient data
	RDCROSSPH	# of road crossings within the reach, from aerial photographs	Wilhelm et al. 2005	Eliminated: not applicable
	Nav_Rel_No	Number reach-level commercial shipping use	[illegible] 2003	Eliminated: insufficient data
	Nav_Rel_Yes	Reach-level commercial shipping use	CAWS Unique	Eliminated: insufficient data
	Nav_Rel_High	High relative shipping use based on lock counts	CAWS Unique	Eliminated: retained NAV_THRU
	Nav_Rel_Med	Medium relative shipping use based on lock counts	CAWS Unique	Eliminated: retained NAV_THRU
	Nav_Rel_Low	Low relative shipping use based on lock counts	CAWS Unique	Eliminated: retained NAV_THRU
	LMICH_D	Distance to nearest US Lake Michigan access point	CAWS Unique	Retained
	NAV_THRU	Commercial tonnage passing	CAWS Unique	Retained
	PUMPSTA_D	Distance to nearest pumping station	CAWS Unique	Retained
	WWTP_D	Distance to nearest wastewater treatment plant	CAWS Unique	Retained
	SED_CD	Chemical contamination in sediment	CAWS Unique	Retained
	SED_SEM	Simultaneously extracted metals in sediment	CAWS Unique	Retained
	SED_TOT_PCB	Total PCBs in sediment	CAWS Unique	Retained

Habitat Variable Reduction; Combination of Like Variables

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Variable Group	Variable	Variable Description	Source	Rationale
Geomorphology & Hydrology				
	FLASH_IN	Flash index: ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al. 2001	
	Q50	Average 50% exceedence level for discharge from USGS gage data (cms)	Wilhelm et al. 2001	
	MAD	Mean Annual Discharge from USGS gage data (cms)	Wilhelm et al. 2001	
	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	
	PS1_3	Velocity-to-depth ratio	Wilhelm et al. 2001	
	XAREA	Cross-sectional area (?((di+di+1)/2*wi)) of wetted channel (m2)	Wilhelm et al. 2001	
	WET_PER	Wetted perimeter (?((di-di+1)2+(wi-wi+1)2)1/2) of wetted channel (m)	Wilhelm et al. 2001	
	HYDR_RAD	Low flow hydraulic radius XAREA divided by WET_PER (m)	Wilhelm et al. 2001	
	MAX_DEP	Maximum depth averaged for transects (m)	Wilhelm et al. 2001	
	LOCMAXD	Location of maximum depth as a proportion of total width	Wilhelm et al. 2001	
	CWS_W_BO	CAWS width bottom of channel	CAWS Unique	
	CAWS_DEPTH	Site depth as measured for PHA	MWRDGC PHA	
	AVG_DPTH	Average depth XAREA divided by WET_WIDTH averaged for transects (m)	Wilhelm et al. 2001	
	WETWIDTH	Stream width at low flow wetted channel, averaged for transects (m)	Wilhelm et al. 2001	
	WETWIDTH_ALT	alternate stream width	Wilhelm et al. 2001	
	WW_DIV_D	Mean wetted width divided by mean depth	Wilhelm et al. 2001	
	OFF_CHAN	Number of tributary, backwater, and off-channel habitats from on-site	Wilhelm et al. 2001	
	TRIB_PH	Number of tributary and backwater habitats from aerial photographs	Wilhelm et al. 2001	
	OFF_CH_BAY	Off channel bay areas (areas connected to main channel, isolated from general flow of main channel, and >5 m sq)	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	

Habitat Variable Reduction: Combination of Like Variables

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Variable Group	Variable	Variable Description	Source	Rationale
Sediment				
	BH_D	% Hard pan, deep	Wilhelm et al. 2001	
	DOM_D	Dominant deep substrate	Wilhelm et al. 2001	
	SAFN_D	% Sand and Fines, deep	Wilhelm et al 2001	
	BIG_D	% Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Wilhelm et al. 2001	
	BH_S	% Hard pan, shallow	Wilhelm et al. 2001	
	DOM_S	Dominant shallow substrate	Wilhelm et al. 2001	
	SAFN_S	% Sand and fines, shallow	Wilhelm et al. 2001	
	BIG_S	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et al. 2001	
	CAWS_INSLG	CAWS PHA % Inorganic Sludge	MWRDGC PHA	
	CAWS_ORSLG	CAWS PHA % Organic Sludge	MWRDGC PHA	
	CAWS_PLDBR	CAWS PHA % Plant debris	MWRDGC PHA	
	CAWS_DPTH_FNS	CAWS PHA Depth of fines	MWRDGC PHA	

Habitat Variable Reduction: Combination of Like Variables

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Variable Group	Variable	Variable Description	Source	Rationale
Instream cover				
	AQ_VEG	Number of aquatic vegetative types within area	MWRDGC PHA	
	MCRPH_CO	Average macrophyte coverage (area*density) (m)	Wilhelm et al. 2001	
	PERC_COV	Percent of canopy cover over water - GIS-derived	MWRDGC PHA	
	PERC_COV_ALT	Percent of canopy cover over water - field-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. 2001	
Bank and riparian condition				
	LB_LU	Dominant land use left bank (categorical)	Wilhelm et al. 2001	
	RB_LU	Dominant land use right bank (categorical)	Wilhelm et al. 2001	
	DOM_LU	Dominant land use, both banks combined (categorical)	Wilhelm et al. 2001	
	BNK_ANGL	Average bank angle of both banks	Wilhelm et al. 2001	
	BNK_NAT	Percent natural banks in sampling reach (sloped, no walls, riprap, or other armoring)	CAWS Unique	
	BNK_CONC	Percent vertically walled concrete banks in sampling reach	CAWS Unique	These variables were combined into one new variable (BNK_WALL) for subsequent analysis.
	BNK_STEEL	Percent vertically walled steel banks in sampling reach	CAWS Unique	
	BNK_WOOD	Percent vertically walled wood banks in sampling reach	CAWS Unique	
	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_MARWA) for subsequent analysis.
	BNK_WATER	Percent bank length in sampling reach occupied by open water	CAWS Unique	
	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 Like Variables

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Variable Group	Variable	Variable Description	Source	Rationale
Anthropogenic impacts				
	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) for subsequent analysis.
	NUM_NPS_NOCSO	Number of NPDES permitted non-CSO outfalls	CAWS Unique	
	LMICH_D	Distance to nearest U/S Lake Michigan access point	CAWS Unique	
	NAV_THRU	Commercial tonnage passing	CAWS Unique	
	PUMPSTA_D	Distance to nearest pumping station	CAWS Unique	
	WWTP_D	Distance to nearest wastewater treatment plant	CAWS Unique	
	SED_CD	Cadmium concentration in sediment	CAWS Unique	
	SED_SEM	Simultaneously extracted metals in sediment	CAWS Unique	
	SED_TOT_PCB	Total PCBs in sediment	CAWS Unique	

Habitat Variable Reduction: Spearman's Correlation Analysis

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Variable Group	Variable	Variable Description	Source	Rationale
Geomorphology & Hydrology				
	FLASH_IN	Flash Index: ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al. 2001	Retained: Modified from USGS data to DUFLOW model output
	Q50	Average 50% exceedence level for discharge from USGS gage data (cms)	Wilhelm et al. 2001	Eliminated: highly correlated with MAX_DEP (> 0.7)
	MAD	Mean Annual Discharge from USGS gage data (cms)	Wilhelm et al. 2001	Eliminated: highly correlated with MAX_DEP (> 0.7)
	MAX_VEL	Maximum velocity averaged for transects (m/s)	Wilhelm et al. 2001	Retained; Modified from USGS data to DUFLOW model output
	AVG_VEL	Average velocity (Q/XAREA) averaged for transects (m/s)	Wilhelm et al. 2001	Retained: Modified from USGS data to DUFLOW model output
	PS1_3	Velocity-to-depth ratio	Wilhelm et al. 2001	Eliminated: highly correlated with AVG_VEL (> 0.7)
	XAREA	Cross-sectional area (?[(di+di+1)/2*wi]) of wetted channel (m2)	Wilhelm et al. 2001	Eliminated: highly correlated with WET_PER (> 0.7)
	WET_PER	Wetted perimeter (?((di-di+1)2+(wi-wi+1)2)1/2) of wetted channel (m)	Wilhelm et al. 2001	Retained
	HYDR_RAD	Low flow hydraulic radius: XAREA divided by WET_PER (m)	Wilhelm et al. 2001	Eliminated: highly correlated with MAX_DEP (> 0.7)
	MAX_DEP	Maximum depth averaged for transects (m)	Wilhelm et al. 2001	Retained
	LOCMAXD	Location of maximum depth as a proportion of total width	Wilhelm et al. 2001	Eliminated; highly correlated with MAX_DEP (> 0.7)
	CWS_W_BO	CAWS width bottom of channel	CAWS Unique	Eliminated; highly correlated with WET_PER (> 0.7)
	CAWS_DEPTH	Site depth as measured for PHA	MWRDGC PHA	Eliminated: highly correlated with MAX_DEP (> 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 (> 0.7)
	WETWIDTH	Stream width at low flow wetted channel, averaged for transects (m)	Wilhelm et al. 2001	Eliminated; highly correlated with WET_PER (> 0.7)
	WETWIDTH_ALT	alternate stream width	Wilhelm et al. 2001	Eliminated; highly correlated with WET_PER (> 0.7)
	WW_DIV_D	Mean wetted width divided by mean depth	Wilhelm et al. 2001	Eliminated: highly correlated with CAWS_CH_RAT (> 0.7)
	OFF_CHAN	Number of tributary, backwater, and off-channel habitats from on-site	Wilhelm et al. 2001	Retained
	TRIB_PH	Number of tributary and backwater habitats from aerial photographs	Wilhelm et al. 2001	Eliminated, highly correlated with OFF_CHAN (> 0.7)
	OFF_CH_BAY	Off channel bay areas (areas connected to main channel, isolated from general flow of main channel, and > 5 m sq)	Afinghaus et al 2002[1] adopted	Retained
	BANK_POC_AREA	Pocket areas within the bank that may serve as refuge for spp from the main channel flow	CAWS Unique	Retained
Sediment				
	BH_D	% Hard pan, deep	Wilhelm et al. 2001	Retained
	DOM_D	Dominant deep substrate	Wilhelm et al. 2001	Retained
	SAFN_D	% Sand and fines, deep	Wilhelm et al. 2001	Retained
	BIG_D	% Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Wilhelm et al. 2001	Retained
	BH_S	% Hard pan, shallow	Wilhelm et al. 2001	Retained
	DOM_S	Dominant shallow substrate	Wilhelm et al. 2001	Retained
	SAFN_S	% Sand and fines, shallow	Wilhelm et al. 2001	Retained
	BIG_S	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et al. 2001	Retained
	CAWS_INSLG	CAWS PHA % Inorganic Sludge	MWRDGC PHA	Eliminated: highly correlated with DOM_D (> 0.7)
	CAWS_ORSLG	CAWS PHA % Organic Sludge	MWRDGC PHA	Retained
	CAWS_PLDBR	CAWS PHA % Plant debris	MWRDGC PHA	Retained
	CAWS_DPTH_FNS	CAWS PHA Depth of fines	MWRDGC PHA	Retained

Habitat Variable Reduction: Spearman's Correlation Analysis

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Variable Group	Variable	Variable Description	Source	Rationale
Instream cover				
	AQ_VEG	Number of aquatic vegetative types within area	MWRDGC PHA	Retained
	MCRPH_CO	Average macrophyte coverage (area*density) (m)	Wilhelm 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	Retained
	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 cover	CAWS Unique	Eliminated: highly correlated with PERC_COV_ALT (> 0.7)
	LENGTH_OVR	Measured length of undercut banks at station	CAWS Unique	Eliminated: highly correlated with PERC_COV_ALT (> 0.7)
	SECCHI	Secchi depth (m)	Wilhelm et al. 2001	Retained
Bank and riparian condition				
	LB_LU	Dominant 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 ?? (> 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 (sloped, no walls, riprap, or other armoring)	CAWS Unique	Retained
	BNK_WALL	Percent vertically walled banks in sampling reach	CAWS Unique	Retained
	BNK_RIPRAP	Percent riprapped banks in sampling reach	CAWS Unique	Retained
	BNK_MARWA	Percent bank length in sampling reach occupied by marina & open water	CAWS Unique	Retained
	P_RIP_VEG	Percent riparian vegetation from site measurements	CAWS Unique	Retained
	Tot_LG	Total length of riparian vegetation	CAWS Unique	Eliminated: highly correlated with P_RIP_VEG (> 0.7)
Anthropogenic impacts				
X	MAN_Made_Struct	Number of manmade structures at the site	MWRDGC PHA	Retained
X	NUM_SUM	Number of NPDES permitted outfalls	CAWS Unique	Retained
X	LMICH_D	Distance to nearest 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	Eliminated: highly correlated with NAV_THRU (> 0.7)
X	WWTP_D	Distance to nearest wastewater treatment plant	CAWS Unique	Retained
X	SED_CD	Cadmium concentration in sediment	CAWS Unique	Retained
X	SED_SEM	Simultaneously extracted metals in sediment	CAWS Unique	Retained
X	SED_TOT_PCB	Total PCBs in sediment	CAWS Unique	Retained

Habitat Variable Reduction: Principal Components Analysis

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Variable Group	Variable	Variable Description	Source	Rationale
Geomorphology & Hydrology				
	FLASH_IN	Flash index: ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al. 2001	Retain for MLR
	MAX_VEL	Maximum velocity averaged for transects (m/s)	Wilhelm et al. 2001	Eliminate: matched with FLASH_IN on PC3; 0.789 corr. w/ NAV_THRU)
	AVG_VEL	Average velocity (Q/XAREA) averaged for transects (m/s)	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	WET_PER	Wetted perimeter (?((dl+dl+1)2+(wl+wl+1)2)1/2) of wetted channel (m)	Wilhelm et al. 2001	Retain for MLR
	MAX_DEP	Maximum depth averaged for transects (m)	Wilhelm et al. 2001	Retain for MLR
	OFF_CHAN	Number of tributary, backwater, and off-channel habitats from on-site	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	OFF_CH_BAY	Off channel bay areas (areas connected to main channel, isolated from general flow of main channel, and >5 m sq)	Allinghaus et al 2001* adopted	Retain for MLR
	BANK_POC_AREA	Pocket areas within the bank that may serve as refuge for spp from the main channel flow	CAWS Unique	Retain for MLR
Sediment				
	BH_D	% Hard pan, deep	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	DOM_D	Dominant deep substrate	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	SAFN_D	% Sand and fines, deep	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	BIG_D	% Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Wilhelm et al. 2001	Retain for MLR
	BH_S	% Hard pan, shallow	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	DOM_S	Dominant shallow substrate	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	SAFN_S	% Sand and fines, shallow	Wilhelm et al. 2001	Retain for MLR
	BIG_S	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et al. 2001	Retain for MLR
	CAWS_ORSLG	CAWS PHA % Organic Sludge	MWRDGC PHA	Retain for MLR
	CAWS_PLDBR	CAWS PHA % Plant debris	MWRDGC PHA	Retain for MLR
	CAWS_DPTH_FNS	CAWS PHA Depth of fines	MWRDGC PHA	Eliminate: not strongest on any PCA axis
Instream cover				
	AQ_VEG	Number of aquatic vegetative types within area	MWRDGC PHA	Eliminate: not strongest on any PCA axis
	MCRPH_CO	Average macrophyte coverage (area*density) (m)	Wilhelm et al. 2001	Retain for MLR
	PERC_COV_ALT	Percent of canopy cover over water - field-measured	CAWS Unique	Retain for MLR
	NUM_COV	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique	Retained
	SECCHI	Secchi depth (m)	Wilhelm et al. 2001	Retain for MLR
Bank and riparian condition				
	DOM_LU	Dominant land use, both banks combined (categorical)	Wilhelm et al. 2001	Retain for MLR
	BNK_ANGL	Average bank angle of both banks	Wilhelm et al. 2001	Eliminate: not strongest on any PCA axis
	BNK_NAT	Percent natural banks in sampling reach (sloped, no walls, riprap, or other armoring)	CAWS Unique	Retain for MLR
	BNK_WALL	Percent vertically walled banks in sampling reach	CAWS Unique	Retain for MLR
	BNK_RIPRAP	Percent riprapped banks in sampling reach	CAWS Unique	Retain for MLR
	BNK_MARWA	Percent bank length in sampling reach occupied by marina & open water	CAWS Unique	Eliminate: not strongest on any PCA axis
	P_RIP_VEG	Percent riparian vegetation from site measurements	CAWS Unique	Retain for MLR
Anthropogenic impacts				
	MAN_Made_Struct	Number of manmade structures at the site	MWRDGC PHA	Retain for MLR
	NUM_SUM	Number of NPDES permitted outfalls	CAWS Unique	Eliminate: not strongest on any PCA axis
	LMICH_D	Distance to nearest U/S Lake Michigan access point	CAWS Unique	Retain for MLR
	NAV_THRU	Commercial tonnage passing	CAWS Unique	Retain for MLR
	WWTP_D	Distance to nearest wastewater treatment plant	CAWS Unique	Eliminate: not strongest on any PCA axis
	SED_CD	Cadmium concentration in sediment	CAWS Unique	Eliminate: not strongest on any PCA axis
	SED_SEM	Simultaneously extracted metals in sediment	CAWS Unique	Retain for MLR
	SED_TOT_PCB	Total PCBs in sediment	CAWS Unique	Eliminate: not strongest on any PCA axis

Habitat Variable Reduction

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Variable Group	Variable	Variable Description	Source	Rationale
Geomorphology & Hydrology				
	FLASH_IN	Flash index ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al 2001	
	WET_PER	Wetted perimeter (?(|di-di+1)2-(wi+wi+1)2)1/2] 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 bay areas (areas connected to main channel, isolated from general flow of main channel, and >5 m sq)	Allnghaus 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	
Sediment				
	BIG_D	% Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Wilhelm et al 2001	
	SAFN_S	% Sand and fines, shallow	Wilhelm et al. 2001	Eliminated: correl. w/ macrophyte cover (0.601)
	BIG_S	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et al 2001	
	CAWS_ORSLG	CAWS PHA % Organic Sludge	MWRDGC PHA	
	CAWS_PLDBR	CAWS PHA % Plant debris	MWRDGC PHA	
Instream cover				
	MCRPH_CO	Average macrophyte coverage (area*density) (m)	Wilhelm et al 2001	
	PERC_COV_ALT	Percent of canopy cover over water - field-measured	CAWS Unique	Eliminated correl. w/ vertical walled banks (-0.600)
	NUM_COV	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique	
	SECCHI	Secchi depth (m)	Wilhelm et al 2001	
Bank and riparian condition				
	DOM_LU	Dominant land use, both banks combined (categorical)	Wilhelm et al, 2001	
	BNK_NAT	Percent natural banks in sampling reach (sloped, no walls, riprap, or other armoring)	CAWS Unique	Eliminated correl w/ macrophyte cover (0.726)
	BNK_WALL	Percent vertically walled banks in sampling reach (concrete, sheet piling, stone blocks)	CAWS Unique	
	BNK_RIPRAP	Percent riprapped banks in sampling reach	CAWS Unique	
	P_RIP_VEG	Percent riparian vegetation from site measurements	CAWS Unique	Eliminate: correlated with DOM_LU (-0.685)
Anthropogenic Impacts				
	MAN_Made_Struct	Number of manmade structures at the site	MWRDGC PHA	
	LMICH_D	Distance to nearest U/S Lake Michigan access point	CAWS Unique	Eliminate: correlated with BANK_POC_AREA (0.645)
	NAV_THRU	Commercial tonnage passing	CAWS Unique	Eliminated: correl w/ maximum depth (0.789)
	SED_SEM	Simultaneously extracted metals in sediment	CAWS Unique	Eliminated. correl. w/ vertical wall banks (0.726)

Final Habitat Variables for Regression with Fish Metric

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Variable Group	Variable	Variable Description	Source
Geomorphology & Hydrology			
	FLASH_IN	Flash index, ratio of 10 to 90% exceedence flows (USGS gage data, all years)	Wilhelm et al. 2001
	WET_PER	Wetted perimeter ($?[(d_i-d_{i+1})^2+(w_i-w_{i+1})^2]^{1/2}$) 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 bay areas (areas connected to main channel, isolated from general flow of main channel, and >5 m sq)	Allinghaus 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
Sediment			
	BIG_D	% Substrate fine gravel, coarse gravel, cobble, and boulder, deep	Wilhelm et al. 2001
	BIG_S	% Substrate fine gravel, coarse gravel, cobble, and boulder, shallow	Wilhelm et al. 2001
	CAWS_ORSLG	CAWS PHA % Organic Sludge	MWRDGC PHA
	CAWS_PLDBR	CAWS PHA % Plant debris	MWRDGC PHA
Instream cover			
	MCRPH_CO	Average macrophyte coverage (area*density) (m)	Wilhelm et al. 2001
	NUM_COV	Recorded presence or absence of in-stream cover (woody debris, boulders, etc.)	CAWS Unique
	SECCHI	Secchi depth (m)	Wilhelm et al. 2001
Bank and riparian condition			
	DOM_LU	Dominant land use, both banks combined (categorical)	Wilhelm 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	CAWS Unique
Anthropogenic Impacts			
	MAN_Made_Struct	Number of manmade structures at the site	MWRDGC PHA