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**POPULATION SIZE AND RECOVERY CRITERIA OF THE THREATENED LAKE ERIE WATERSNAKE:  
INTEGRATING MULTIPLE METHODS OF POPULATION ESTIMATION**

**UNPUBLISHED APPENDICES**

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This document consists of four unpublished appendices to King et. al. (2006) providing details of Lake Erie watersnake population estimates generated using the Lincoln-Petersen method (Appendix I), Schumacher's method (Appendix II), Jolly-Seber method (Appendix III), and Bailey's triple-catch method (Appendix IV) and summarized in Table 1 of that publication.

KING, R. B., A. QUERAL-REGIL, AND K. M. STANFORD. 2006. Population size and recovery criteria of the threatened Lake Erie watersnake: integrating multiple methods of population estimation. Herpetological Monographs 20:83-104.

## APPENDIX I

*Population estimates of adult Lake Erie watersnakes generated using the Lincoln-Petersen method. Site numbers correspond to locations shown in Fig. 2. Notation follows Caughley, 1977.*

Site #	Island	Site	Year	<i>M</i>	<i>n</i>	<i>m</i>	<i>N</i>	<i>SE</i>	Comments
<b>Within-year estimates</b>									
1	Kelleys	Long Point	1980	14	15	2	75	34	10+11 vs. 12+13 Jun
4	Kelleys	Southeast Shore	2004	114	78	31	281	38	7 vs. 9 Jun
7	Kelleys	South Shore	2002	46	77	5	598	217	2 vs. 5 Jun
11	Kelleys	Minshall	1997	16	10	1	88	46	23+24 May vs. 22 Jul
14	Kelleys	State Park	2002	12	32	2	132	63	4 vs. 5 Jun
14	Kelleys	State Park	2003	36	26	7	122	34	2+4 vs. 6 Jun
14	Kelleys	State Park	2004	40	15	1	320	173	6 vs. 9 Jun
26	South Bass	East Shore	2002	34	96	5	550	201	21+22+28 vs. 31 May
26	South Bass	East Shore	2003	44	49	2	733	355	27 vs. 30 May
28	South Bass	State Park	2002	50	53	8	300	87	22+28 vs 31 May
28	South Bass	State Park	2003	35	32	10	105	25	25+27 vs. 30 May
28	South Bass	State Park	2004	50	77	13	279	65	2 vs. 10+12+14 Jun
34	Middle Bass	East Point (part)	1997	13	10	1	72	37	17+20 vs. 28+30 May
36	Middle Bass	State Park	2004	47	16	2	266	121	3 vs. 12 June
36	Middle Bass	State Park	2003	25	38	5	163	56	13+26 vs. 29 May
39	Middle Bass	West End (part)	1996	14	11	4	34	10	21 May vs. 3+5 Jun
39	Middle Bass	West End (part)	2002	28	24	6	100	30	23+29 vs. 31 May
39	Middle Bass	West End	2003	37	57	4	429	167	26 vs. 29 May
39	Middle Bass	West End	2004	111	36	6	587	187	3 vs. 12 June
47	North Bass	South Shore	1982	26	22	2	199	93	6+14 May vs. 6 Jun
47	North Bass	South Shore	1983	30	17	1	270	147	5+24 vs. 27 May
47	North Bass	South Shore	1989	29	20	4	122	43	1+4 vs. 27+28 June
47	North Bass	South Shore	2002	24	35	7	108	32	22+23 vs. 30 May
47	North Bass	South Shore	2004	59	27	5	275	92	2+4 vs. 13 Jun
55	Gibraltar	Gibraltar	2004	48	17	4	173	60	5 vs. 14 Jun
	Pelee	Sheridan Point	1983	11	10	2	40	17	17 vs. 20 May
<b>Between-year estimates</b>									
									<b>Unbiased Estimate</b>
1	Kelleys	Long Point	1980	27	26	6	104	32	67
1	Kelleys	Long Point	1981	26	11	1	156	82	103
1	Kelleys	Long Point	1982	11	14	1	83	44	54
1	Kelleys	Long Point	2001	16	30	1	248	138	160
1	Kelleys	Long Point	2002	30	32	3	248	104	159
4	Kelleys	Southeast Shore	2001	183	154	45	617	75	391
4	Kelleys	Southeast Shore	2002	154	118	30	591	90	375
4	Kelleys	Southeast Shore	2003	118	162	28	663	110	420
5	Kelleys	Marina	1997	25	67	15	106	23	68
7	Kelleys	South Shore	1996	15	11	1	90	47	60
7	Kelleys	South Shore	2001	120	107	12	997	250	633
7	Kelleys	South Shore	2002	107	115	9	1241	358	788

7	Kelleys	South Shore	2003	115	73	2	2837	1389	1806
11	Kelleys	Minshall	1996	19	25	3	124	51	80
11	Kelleys	Minshall	1997	23	10	1	127	66	84
11	Kelleys	Minshall	2000	15	36	2	185	89	119
14	Kelleys	State Park	2000	11	33	3	94	39	60
14	Kelleys	State Park	2001	33	41	7	173	52	111
14	Kelleys	State Park	2002	41	76	16	186	39	118
14	Kelleys	State Park	2003	76	65	24	201	31	128
26	South Bass	East Shore	2002	123	103	21	581	108	369
26	South Bass	East Shore	2003	103	68	13	508	117	323
28	South Bass	State Park	1996	21	24	6	75	23	48
28	South Bass	State Park	1997	24	54	4	264	103	169
28	South Bass	State Park	2001	26	90	5	394	144	251
28	South Bass	State Park	2002	90	216	30	630	103	399
28	South Bass	State Park	2003	216	155	73	455	38	289
34	Middle Bass	East Point (part)	1983	15	13	1	105	56	69
34	Middle Bass	East Point (part)	1996	12	22	1	138	76	89
36	Middle Bass	State Park	1982	14	28	1	203	113	131
36	Middle Bass	State Park	1983	28	16	1	238	129	156
36	Middle Bass	State Park	2002	30	71	6	309	104	197
36	Middle Bass	State Park	2003	71	78	8	623	186	397
39	Middle Bass	West End (part)	1996	22	17	2	132	60	86
39	Middle Bass	West End (part)	1997	15	13	1	105	56	69
39	Middle Bass	West End (part)	2001	12	47	1	288	163	184
39	Middle Bass	West End (part)	2002	47	20	3	247	99	160
39	Middle Bass	West End	2002	128	104	12	1034	259	657
39	Middle Bass	West End	2003	103	141	15	914	209	580
47	North Bass	South Shore	1980	43	82	10	324	87	206
47	North Bass	South Shore	1981	82	47	11	328	79	210
47	North Bass	South Shore	1982	47	59	5	470	169	300
47	North Bass	South Shore	1983	59	46	6	396	129	253
47	North Bass	South Shore	1989	45	64	13	209	48	133
47	North Bass	South Shore	2001	14	49	1	350	198	224
47	North Bass	South Shore	2002	49	58	9	289	79	184
47	North Bass	South Shore	2003	58	75	11	367	93	234
53	Sugar	Sugar	1996	18	23	4	86	31	56
55	Gibraltar	Gibraltar	2003	32	61	7	248	77	158
	Johnson	Fingers	1981	17	22	4	78	28	51
	Johnson	Fingers	1982	22	15	1	176	95	115
	Middle	Middle	1980	11	13	3	39	15	25
	Pelee	Fish Point-A	1989	12	18	2	76	35	49
	Pelee	Fish Point-A	1990	18	16	1	153	83	100
	Pelee	Fish Point-B	1980	17	28	2	164	78	106
	Pelee	Fish Point-B	1981	27	35	3	243	102	156

Pelee	Fish Point-B	1982	36	13	1	252	135	166
Pelee	Lighthouse Point	1989	10	22	1	115	63	74
Mainland	Willow Point	1989	39	46	13	131	28	84
Mainland	Willow Point	1990	44	19	8	98	23	64

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## APPENDIX II

*Population estimates of adult Lake Erie watersnakes generated using Schumacher's method. Site numbers correspond to locations shown in Fig. 2. Notation follows Caughley, 1977.*

Site #	Island	Site	Year		$M_i$	$n_i$	$m_i$	$N$ (95% CI)
4	Kelleys	Southeast Shore	2001	19-May	0	84	0	389 (303, 542)
				21-May	84	60	15	
				23-May	129	57	18	
				12-Jun	168	10	4	
4	Kelleys	Southeast Shore	2003	1-Jun	0	38	0	461 (240, 6082)
				2-Jun	38	46	3	
				6-Jun	78	45	8	
7	Kelleys	South Shore	2001	18-May	0	36	0	652 (305, -)
				21-May	36	36	4	
				23-May	68	40	4	
				21-Aug	105	16	2	
11	Kelleys	Minsall	2001	20 & 22 May	0	27	0	123 (48, -)
				11 & 12 Jun	27	10	2	
				21-Aug	35	3	1	
14	Kelleys	State Park	2001	18-May	0	9	0	124 (16, -)
				22 & 23 May	9	18	0	
				21-Aug	28	7	2	
14	Kelleys	State Park	2003	2 & 4 Jun	0	36	0	133(89, 262)
				6-Jun	36	26	7	
				25 Jun & 16 Jul	55	23	8	
				12 & 19 Aug	70	11	7	
14	Kelleys	State Park	2004	6-Jun	0	40	0	261 (92, -)
				9-Jun	40	15	1	
				15-Jun	54	8	3	
				28-Jun	59	6	1	
26	South Bass	East Shore	2003	27-May	0	44	0	780 (327, -)
				30-May	44	49	2	
				9-Jul	91	10	1	
				21-Aug	100	4	1	
28	South Bass	State Park	2003	25 & 27 May	0	35	0	346 (242, 606)
				30-May	35	32	10	
				9 & 10 Jul	57	72	11	
				15-Jul	118	17	7	
				17-Jul	128	13	6	
				15-Aug	135	21	9	
				18 & 19 Aug	147	12	6	
28	South Bass	State Park	2004	Sep	152	104	41	
				3-Jun	0	52	0	
				12-Jun	50	77	13	
				17-19 Aug	114	40	17	

36	Middle Bass	State Park	2003	30-31 Aug	140	46	10	405 (178, -)
				13 & 26 May	0	25	0	
				29-May	24	38	5	
				17-Jun	57	5	1	
				14-Jul	61	5	0	
36	Middle Bass	State Park	2004	20 Aug & 18 Sep	66	5	1	323 (133, -)
				3-Jun	0	47	0	
				12-Jun	47	16	2	
				17-19 Aug	61	10	0	
				30-31 Aug	71	10	3	
39	Middle Bass	West End	2002	23-May	0	14	0	201 (127, -)
				29-May	14	72	4	
				31-May	82	71	10	
47	North Bass	South Shore	1980	17-Jun	0	4	0	561 (194, -)
				18-Jun	4	14	1	
				19-Jun	17	11	5	
				11-Jul	23	8	0	
				30-Jul	31	6	1	
				31-Jul	36	4	1	
				6-Aug	39	5	1	
47	North Bass	South Shore	1981	20-May	0	14	0	134 (47, -)
				21-May	14	17	0	
				22-May	31	17	2	
				2-Jul	46	21	3	
				3-Jul	67	2	1	
				10-Jul	68	6	2	
				14-Jul	71	3	1	
				30-Jul	72	12	2	
				11-May	0	2	0	
				23-May	2	14	1	
47	North Bass	South Shore	1984	25-May	15	4	0	288 (169, 969)
				10-Jul	19	20	2	
				15-Aug	37	13	4	
				11-May	0	20	0	
				17-Jun	20	22	2	
47	North Bass	South Shore	1990	19-Jun	40	11	3	138 (80, 503)
				21-Jun	49	6	1	
				12-Sep	54	13	3	
				12-Jul	0	25	0	
				15 & 25 Jul	25	7	2	
55	Gibraltar	Gibraltar	2003	15, 19, & 21 Aug	30	4	2	212 (136, 488)
				12-Jul	0	25	0	
				12-Jun	0	7	0	
				13-Jun	7	3	1	
				14-Jun	9	2	0	
	Pelee	Fish Point	1981	12-Jun	0	7	0	73 (27, -)
				13-Jun	7	3	1	
				14-Jun	9	2	0	
				15 & 25 Jul	25	7	2	

			15-Jun	11	4	0	
			16-Jun	15	4	1	
			17-Jun	18	4	0	
			17-Jul	22	6	0	268 (49, -)
Pelee	Fish Point	1982	19-May	0	10	0	
			20-May	10	7	0	
			23-May	17	2	1	
			21-Jun	18	6	1	
			23-Jun	23	6	0	
			24-Jun	29	2	0	
			25-Jun	31	4	0	341 (61, -)
Mainland	Willow Point	1989	8-May	0	2	0	
			31-May	2	5	0	
			5-Jun	7	12	1	
			6-Jun	7	12	2	
			7-Jun	18	10	5	
			24-Jun	28	2	0	
			30-Jun	30	1	0	
			1-Jul	31	7	4	58 (30, 756)
Mainland	Willow Point	1990	8-May	0	16	0	
			9-May	0	10	0	
			14-May	26	13	3	
			16-May	26	2	1	
			23-May	34	3	1	
			24-May	34	2	2	
			15-Jun	36	12	8	
			16-Jun	39	2	0	
			18-Jun	42	3	2	
			22-Jun	43	4	4	63 (37, 219)

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APPENDIX III

*Population estimates of adult Lake Erie watersnakes generated using the Jolly-Seber method. Site numbers correspond to locations shown in Fig. 2. Notation follows Caughley, 1977.*

Site #	Island	Site	Year	$n_i$	$R_i$				$N_i$	$SD$	(95% CI)			
1	Kelleys	Long Point (part)				<u>1980 1981 1982</u>								
			1980	27	27									
			1981	26	26	6				75	44	(34, 364)		
			1982	11	11	1	1			80	68	(23, 681)		
1	Kelleys	Long Point	1983	14	14	1	2	1						
						<u>2000 2001 2002</u>								
			2000	16	16									
			2001	30	30	1				208	16	(56, 2069)		
4	Kelleys	Southeast Shore	2002	32	32	1	3							
			2004	9	9	1	1	0						
						<u>2001 2002 2003</u>								
			2001	183	183									
7	Kelleys	South Shore	2002	154	154	45				408	122	(321, 603)		
			2003	118	118	16	30			449	181	(334, 722)		
			2004	162	161	10	22	28						
						<u>1996 1997 1998 2000 2001 2002 2003</u>								
7	Kelleys	South Shore	1996	15	15									
			1997	10	10	1								
			1998	3	3	1	0							
			2000	8	8	1	0	0						
			2001	120	120	0	0	0	2					
			2002	107	107	1	0	1	1	12	1013	398	(548, 2650)	
			2003	115	115	0	0	0	0	11	8	1680	1116	(599, 8514)
			2004	77	77	0	0	0	0	4	3	2		
11	Kelleys	Minshall				<u>1996 1997 1998 2000 2001 2002 2003</u>								
			1996	26	19									
			1997	25	23	3					98	18	(37, 625)	
			1998	10	9	1	1				62	29	(19, 493)	
11	Kelleys	Minshall	2000	15	15	1	1	0				68	17	(23, 519)





		2002	49	49	1	0	0	1			226	14	(88, 1221)
		2003	58	58	0	0	1	2	9		121	28	(75, 319)
		2004	75	75	0	0	0	0	3	11			
	Willow Point				<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>					
		1988	6	6									
		1989	39	39	0								
		1990	46	44	0	13					74	22	(51, 177)
		1991	49	19	0	2	8				91	52	(50, 511)
		1992	6	6	0	0	1	1					
Pelee	Fish Point-south				<u>1980</u>	<u>1981</u>	<u>1982</u>						
		1980	17	17									
		1981	28	27	0								
		1982	35	35	2	3					138	131	(42, 1681)
		1983	13	13	1	0	1						

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## APPENDIX IV

*Population estimates of adult Lake Erie watersnakes generated using the Bailey's triple-catch method. Site numbers correspond to locations shown in Fig. 2. Notation follows Caughley, 1977.*

Site #	Island	Site	Year	$n_0$	$n_1$	$n_2$	$R_{01}$	$R_{02}$	$R_{012}$	$R_{12}$	$M_0$	$M_1$	$M_2$	$m_{01}$	$m_{02}$	$m_{12}$	$N_2$	SE
1	Kelleys	Long Point	1981	27	26	11	6	1	0	1	27	20	9	6	1	1	39	39
1	Kelleys	Long Point	1982	26	11	14	1	2	0	1	26	10	11	1	2	1	60	52
1	Kelleys	Long Point	2001	16	30	32	1	1	0	3	16	29	28	1	1	3	112	112
4	Kelleys	Southeast Shore	2002	183	154	118	37	16	8	22	183	109	72	45	24	22	383	118
4	Kelleys	Southeast Shore	2003	154	118	162	15	22	7	20	154	96	113	22	29	20	686	227
7	Kelleys	South Shore	2002	120	107	115	12	11	1	8	120	94	95	13	12	8	967	456
7	Kelleys	South Shore	2003	107	115	77	7	2	1	2	107	107	72	8	3	2	1379	1019
11	Kelleys	Minshall	1998	23	10	15	1	1	0	0	23	8	14	1	1	0	44	44
14	Kelleys	State Park	2000	22	11	33	1	3	0	3	22	10	27	1	3	3	45	35
14	Kelleys	State Park	2002	33	41	76	7	6	1	16	33	33	53	8	7	16	63	32
14	Kelleys	State Park	2003	41	76	65	9	9	8	16	41	59	32	17	17	16	252	97
26	South Bass	East Shore	2003	124	102	65	16	3	5	8	124	121	49	21	8	8	504	246
28	South Bass	State Park	1997	21	24	54	4	2	2	2	21	18	48	6	4	2	86	60
28	South Bass	State Park	2001	54	26	90	1	8	0	5	54	25	77	1	8	5	450	312
28	South Bass	State Park	2002	26	90	216	1	4	4	28	26	85	180	5	8	28	356	184
28	South Bass	State Park	2003	90	216	177	15	10	13	59	90	188	95	28	23	59	539	158
36	Middle Bass	State Park	2003	30	71	78	5	4	1	7	30	65	66	6	5	7	418	254
39	Middle Bass	West End	1997	16	17	13	2	1	0	1	16	12	11	2	1	1	36	36
39	Middle Bass	West End	2001	13	13	47	0	1	0	0	13	12	46	0	1	0	168	168
39	Middle Bass	West End	2003	128	104	143	10	17	2	13	128	92	111	12	19	13	1008	417
47	North Bass	South Shore	1981	43	82	47	10	3	0	11	43	72	33	10	3	11	136	89
47	North Bass	South Shore	1982	82	47	59	11	4	2	3	82	34	50	13	6	3	175	106
47	North Bass	South Shore	1983	47	59	46	5	3	0	6	47	54	37	5	3	6	231	162
47	North Bass	South Shore	2002	15	49	58	1	2	0	9	14	48	47	1	2	9	240	199
47	North Bass	South Shore	2003	49	58	75	6	2	3	8	14	49	62	9	5	8	161	93
	Johnson	Fingers	1982	17	22	15	4	0	1	0	17	17	14	5	1	0	65	65
	Peele	Fish Point B	1981	17	28	35	2	2	1	2	17	25	30	3	3	2	181	139
	Mainland	Willow Point	1990	39	46	19	13	2	3	5	39	30	9	16	5	5	69	40