

**2009 FISHERIES SURVEYS
VALENTINE NATIONAL WILDLIFE REFUGE, NEBRASKA**



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TABLE OF CONTENTS

INTRODUCTION	A-2
METHODS.....	A-4
CLEAR LAKE.....	B-1
Lake Description.....	B-1
Results and Discussion	B-2
Summary	B-14
Management Recommendations	B-15
DEWEY LAKE.....	C-1
Lake Description.....	C-1
Results and Discussion	C-2
Summary	C-18
Management Recommendations	C-18
HACKBERRY LAKE.....	D-1
Lake Description.....	D-1
Results and Discussion	D-2
Summary	D-9
Management Recommendations	D-9
PELICAN LAKE.....	E-1
Lake Description.....	E-1
Results and Discussion	E-2
Summary	E-16
Management Recommendations	E-16
DUCK LAKE	F-1
Lake Description.....	F-1
Results and Discussion	F-2
Summary	F-9
Management Recommendations	F-9
WATTS LAKE	G-1
Lake Description.....	G-1
Results and Discussion	G-2
Summary	G-11
Management Recommendations	G-11
Acknowledgements	H-1
References	I-1
Appendix A. Fish stocking history	J-1
Appendix B. Summary of fishing regulations.	J-4
Appendix C. Glossary of fishery terms.....	J-5
Appendix D. Data collection and analysis protocol	J-7
Appendix E. Mean lake levels	J-9
Appendix F. Northern pike food habit data	J-12
Appendix G. Turtle catches on Valentine NWR.....	J-13

INTRODUCTION

The Valentine National Wildlife Refuge (NWR) was established in 1935 to provide feeding and resting areas for migrating waterfowl. Public recreation that is compatible with the purposes of the refuge, including hunting and fishing, is promoted. Management of the fisheries is defined in a 1978 Cooperative Agreement between the U. S. Fish and Wildlife Service (USFWS) and Nebraska Game and Parks Commission (NGPC).

The Valentine NWR contains 39 lakes. The majority of the lakes are small, shallow, potholes that are subject to frequent winter-kills. Nine Lakes are open to fishing: Pelican, Hackberry, Dewey, Clear, Willow, Watts, Duck, Rice, and West Long (Figure A-1). These lakes have varying degrees of potential for fisheries management. All of the designated fishing lakes, except Rice Lake, are accessible by vehicles.

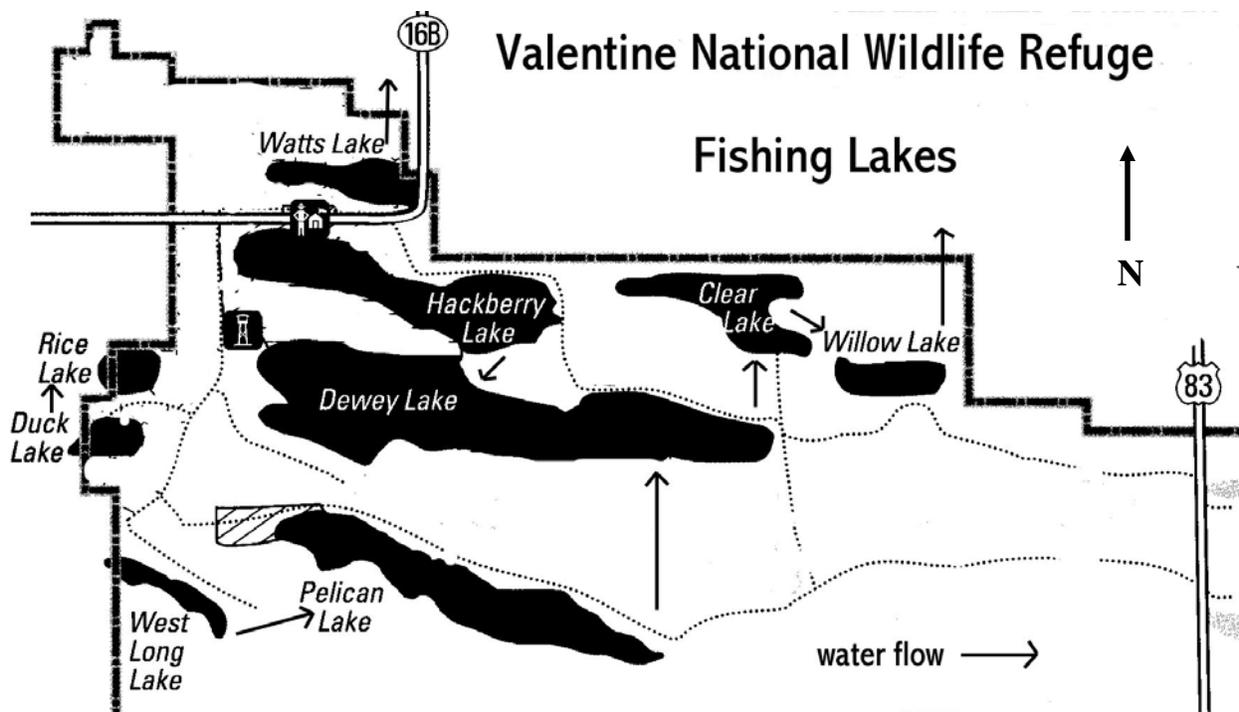


Figure A-1. Map of nine lakes open to fishing on the Valentine NWR. Direction of water flow is depicted by arrows and refuge trails are depicted by dotted lines.

Common carp (*Cyprinus carpio*) gained access to the Valentine NWR lake system through Gordon Ditch, which was dug during the 1930's. Common carp reproduce well in the shallow, highly-vegetated refuge lakes and generally dominate the fishery within 10 years after introduction. Degradation of aquatic habitats by carp is well documented especially for waterfowl (Chamberlain 1948; Robel 1961) and game fish habitat (Cahn 1929). These refuge lakes have a long history of chemical renovation to remove carp. Historically, for about five years after a renovation and re-stocking of game fish (Appendix A), angling is excellent, duck use is high, and then both decline due to carp-induced habitat degradation. Fisheries biologists from the USFWS and NGPC have experimented with the use of northern pike (*Esox lucius*) as a

biological carp-control. Early attempts were unsuccessful because northern pike were introduced after carp were well established and subsequently too large to be controlled by predation.

In 1988, northern pike and largemouth bass (*Micropterus salmoides*) length limits were changed for Valentine NWR lakes in an attempt to increase abundance and size structure of predators (Appendix B). The size restrictions appeared to be successful as common carp numbers stabilized in lakes where the restrictions were enacted. However, strong year classes of carp during years where northern pike populations were low have led to recruitment and increased abundance of carp populations in some lakes. Success has not been without perceived drawbacks. Predation by northern pike have reduced the abundance and altered the size structure of largemouth bass, yellow perch (*Perca flavescens*), and bluegills (*Lepomis macrochirus*) (Paukert and Willis 2003; Paukert et al. 2003; Jolley et al. 2008). Environmental conditions have significant affects on recreational fisheries in these shallow lakes such as a 1987-88 winter-kill, low reproduction and recruitment due to drought conditions during the summers of 1989 – 1990 and 2002-2007, and an extremely cool spring and summer (< 21°C) during 1992, 1993, 2008, and 2009. The springs of 1994-1997 were exceptionally wet, and these conditions provided good habitat and conditions for strong year classes for most fish species. However, high water levels also connected lakes that are usually isolated, which allowed fish movement.

Northern pike have been identified as a possible tool for controlling common carp, and evaluating their potential is a high priority for the Refuge's fisheries. Many of the results from fishery assessments identified in this report are directed at: 1) evaluating northern pike as a biological control agent for carp, 2) evaluating northern pike recruitment and condition in response to the special regulation allowing harvest of northern pike less than 28 in. (710 mm) total length (TL), and 3) evaluating the impacts of the special northern pike regulations on other game fish populations.

Glossary of fishery terms are summarized in Appendix C and data collation and analysis techniques are summarized in Appendix D. Mean lake levels are presented in Appendix E. Northern pike food habits data are presented in Appendix F. Due to the abundance of turtles collected in trap nets, monitoring of the painted (*Chrysemys picta*), snapping (*Chelydra serpentina*), and blanding's (*Emydoidea blandingii*) turtles during the fisheries sampling began in 2008. Turtle data is presented in Appendix G.

METHODS

Standardized fisheries surveys on Valentine NWR began in 1992 using gill nets, trap nets, and electrofishing. Gill nets have been deployed during the fall, generally in the last week of August to the second week of September each year since 1992. Electrofishing was also conducted in the larger lakes (Clear, Dewey, Hackberry, and Pelican lakes) during the fall from 1992 to 2004. Electrofishing has occurred during the spring during the last two weeks of May since 2005. Trap nets were conducted during the fall from 1992 to 2005 and have been conducted during the spring since 2006. Electrofishing and trap nets were conducted during the spring since 2001 in the smaller lakes (Duck and Watts).

In 2009, electrofishing and trap net surveys were conducted 18-20 May and gill net surveys were conducted 26-27 August in Clear, Dewey, Hackberry, Pelican, Duck, and Watts lakes (Table A-1). Night-time electrofishing was conducted with a Smith and Root model 5.0 GPP electrofishing system rated at 5,000 watts of output power, using pulsed DC at 4-6 amps and 60 pulses per second. Electrofishing was conducted in 10 or 15 minute transects along the shoreline. Trap nets consisted of a lead set at the shoreline that is 15.2 m (50 ft) in length by 1 m (3 ft) in height, two 1.2 m (4 ft) wide and 1 m (3 ft) high rectangular steel frames, and two 1 m (3 ft) diameter circular hoops with 13 mm (0.5 in) nylon mesh. A green protective coat was applied to the nylon mesh. Trap nets were set overnight for a maximum of 24 h with leads set perpendicular to the shore. Gill nets were experimental monofilament nets that were 38.1 m (125 ft) in length, 1.8 m (6 ft) in depth, with five 8-m (25 ft) long panels with bar mesh sizes, in order, of 19 mm (0.75 in), 25 mm (1 in), 38 mm (1.5 in), 51 mm (2.0 in), and 76 mm (3 in). Float lines were 1.3 cm poly-foamcoare and lead lines were 22.7 kg leadcore. Gill nets were always set with the small mesh closest to the shore.

Table A-1. Effort for each gear in each lake sampled on the Valentine NWR during 2009.

Lake	Electrofishing (min)	Spring trap nets (N)	Fall gill nets (N)
Clear	120	10	5
Dewey	80	10	5
Hackberry	85	10	5
Pelican	120	12	7
Duck	45	5	3
Watts	60	7	3

CLEAR LAKE

Lake Description

Clear Lake is accessed by gravel roads from County Highway 16B or U.S. Highway 83. Ice fishing is popular during winter with good ice, although heavy snow sometimes cause road closures and limits access to this lake. During the spring and again during fall, northern pike fishing is popular.

Clear lake is in the middle of a series of four lakes on the refuge connected by natural drainage and man-made ditches. A ditch dug from Dewey Lake (upstream from Clear Lake) feeds into Clear Lake. The interconnection of these lakes has created problems with controlling inter-lake fish movement in past years. The spring of 1995 and 1997 were years of high run-off resulting in extremely high lake levels. Water flowed from Clear Lake downstream to Willow Lake for much of the spring and summer and inter-lake fish movement was observed.

Clear Lake is 172 surface ha (424 acres) with a maximum depth of 3.5 m (10.2 ft.) and mean depth of 1.7 m (6 ft.) during full pool. A dike on the east end can hold the lake about 1.2 m higher than the natural pool level. The added area is primarily flooded sand dunes and provides little fisheries habitat. The bottom is relatively flat with few drop-offs or depressions. Most of the bottom is sandy, but a small bay on the east end of the lake contains an expanse of highly organic bottom. The surrounding shoreline is predominately grass with a few willows (*Salix spp.*) and cottonwood (*Populus deltoids*) trees. High water levels are required to flood shoreline vegetation for spring spawning sites. The limited littoral area reduces spawning and subsequent survival for most of the lake's game fish species. Aquatic vegetation is sparse around the edges. Less than 2% of the lake contains emergent vegetation (primarily cattails [*Typha spp.*]), and submergent vegetation is nearly absent. The lack of vegetation is related to an infertile sandy bottom and high turbidity. Surface water quality parameters measured in Clear Lake during each survey (Table B-1) are conductivity, which averages 567 $\mu\text{S}/\text{cm}$, total alkalinity averages 280 mg/L, phenolphthalein alkalinity averages 9 mg/L, the lake's pH averages 8.5 through most of the year, and Secchi disk averages about 0.3 m. The lake is too shallow to develop a thermocline.

The lake was chemically renovated with rotenone in 1983 and restocked with game fish, such as northern pike, largemouth bass, yellow perch, bluegill, and black crappie (*Pomoxis nigromaculatus*) (Appendix A). During the 1986 survey, sub-adult carp were collected for the first time since that renovation. Northern pike greater than 28 in (710 mm) have been protected since 1993. Since enactment of these regulations, fall surveys generally indicated improved size structure and condition of northern pike during the high water years during the 1990's. Since then, a trend has developed as overall relative abundance has declined. Mean W_r of northern pike has been stable across the years. Since the size limit was enacted in 1993, the most notable difference has been the increase of memorable to trophy length northern pike. Fish in this length category have been collected every year since 1996 with incremental RSD-M values ranging from 5 to 27.

Primary fish species in Clear Lake include: northern pike, common carp, largemouth bass, bluegill, yellow perch, black bullhead (*Ameiurus melas*), and black crappie. The lake has been described as having a boom or bust fishery.

Table B-1. Clear Lake surface water quality parameters from 1999 to 2009.

Date	Time	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
08/2009	1230	23	8.4		8.9		0	239	558
06/2009	2100	17	8.9	57	8.4		34	202	522
05/2009	1745	20	7.7	180	9.0		17	238	548
09/2008		19	9.7		8.9	0.34	0	308	615
05/2008			11.3			0.30	17	222	466
05/2007		19	8.7	91	7.0	0.30	17	308	666
08/2006		21	8.1		7.1	0.30	0	257	649
08/2005		22			7.2		0	290	
09/2003			9.2						
09/2002		21	6.0		8.1		0	513	500
09/2001		18		60	7.2		0	205	486
07/2001	1800	26	13.0		7.7		60	196	
07/2001	0700	23	7.4		9.5		0	196	
09/2000		17		30	8.4		0	308	590
09/1999		16			8.2				

Results and Discussion

Low water levels did not allow for effective sampling with electrofishing or trap nets during the springs of 2007 and 2008. Therefore, among year comparisons were limited for black crappie, bluegill, and largemouth bass.

Common carp

The relative abundance of stock length (≥ 280 mm) common carp was substantially lower from 2007 to 2009 (gill net mean CPUE ≤ 5.0 fish/net-night; SE = 1.3) after all time highs from 2005 and 2006 (gill net mean CPUE ≥ 8.6 fish/net-night; SE = 1.7) (Figure B-1). An estimated 2,735 common carp were trapped and removed from Clear Lake in 2008. However, carp did successfully spawn in Clear Lake in 2009 as high numbers of young of the year (YOY) were collected in gill nets (Figure B-2). No YOY carp were collected in any other Refuge lake in 2009. A substantial increase in water levels in Clear Lake likely increased the productivity and subsequent forage availability, and the additional inundated terrestrial vegetation added habitats for spawning, nursery, and refuge from predators that led to spawning success and recruitment (Phelps et al. 2008).

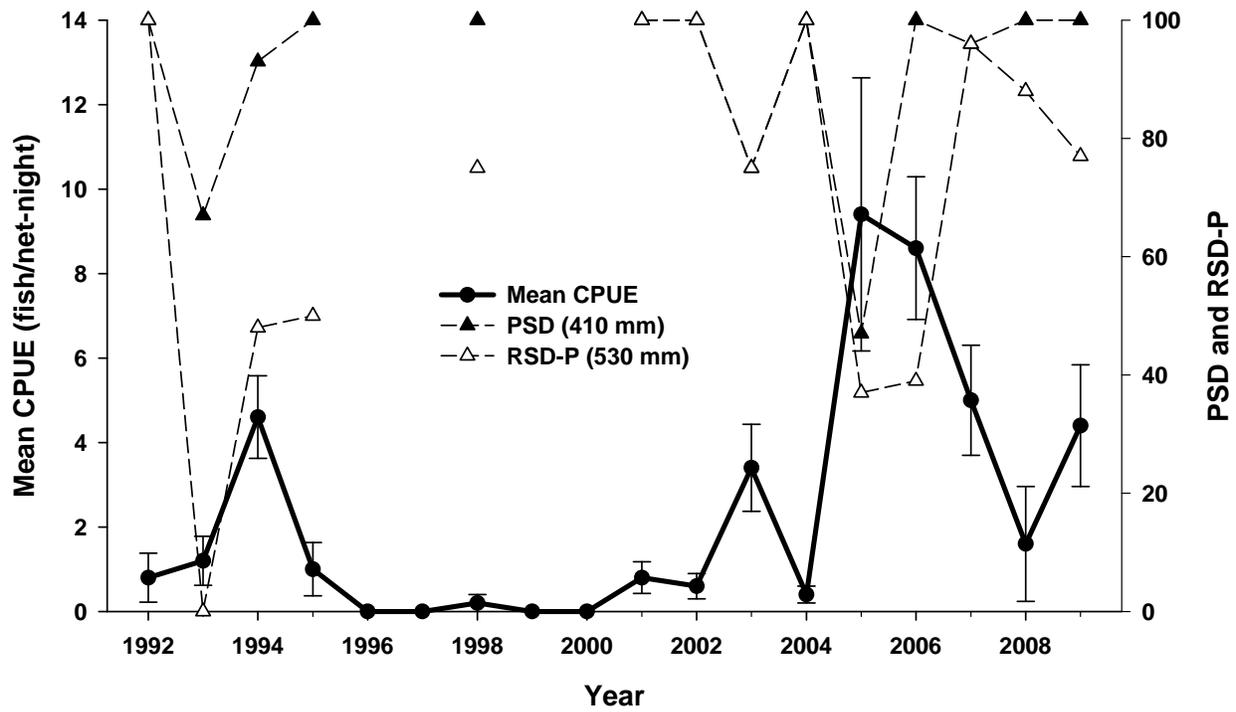


Figure B-1. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp captured by gill nets in Clear Lake from 1992 to 2009. Mean catch per unit effort (CPUE) calculated for carp \geq stock length (280 mm) only.

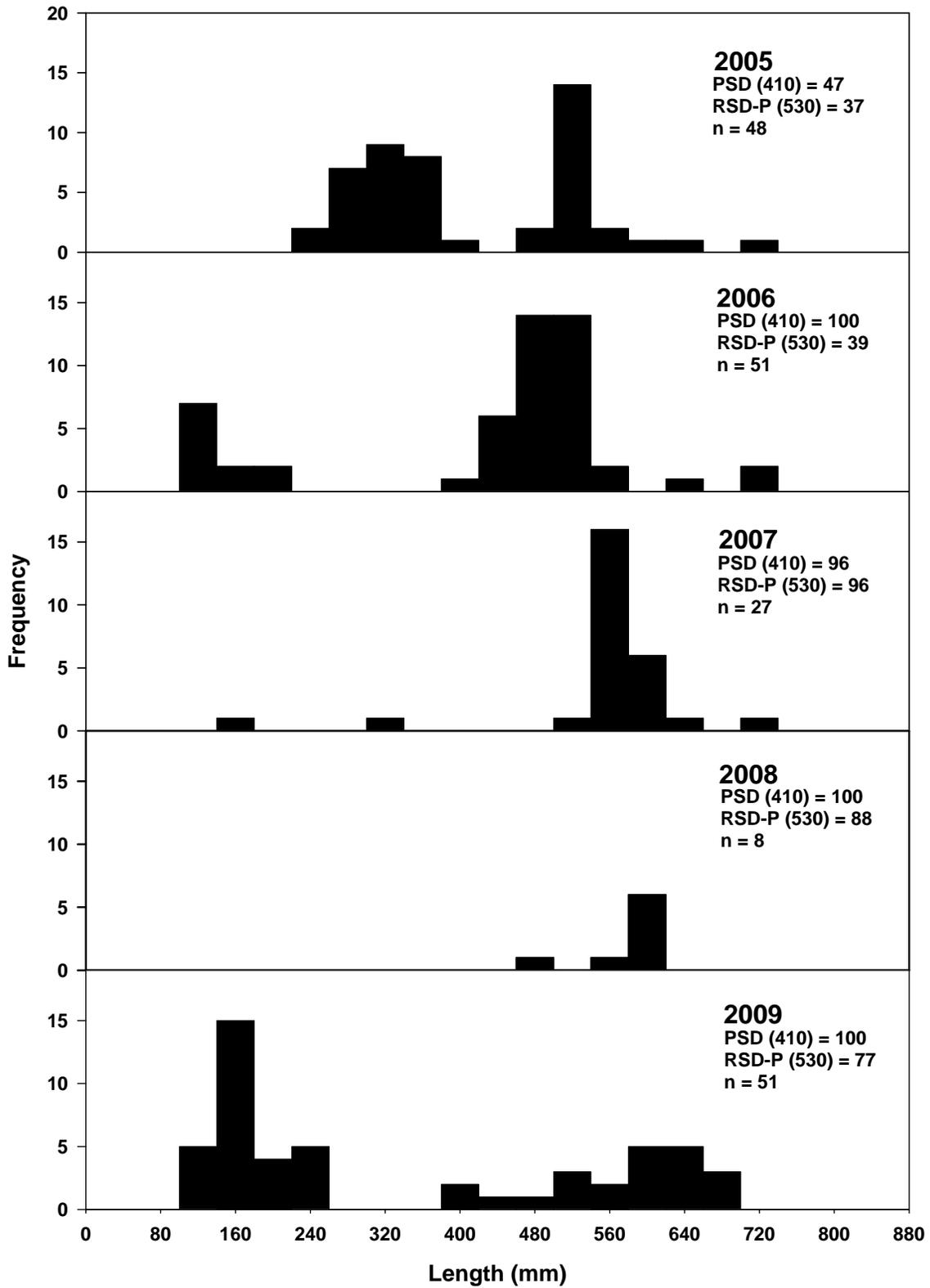


Figure B-2. Length frequency distribution (40-mm length groups) of common carp captured in gill nets in Clear Lake, Valentine NWR, from 2005 to 2009.

Northern Pike

The size structure has not substantially changed over the past five years with PSD ranging from 96 to 100 and RSD-P ranging from 35 to 83 (Figure B-3). However, relative abundance was significantly higher in 2009 (gill net mean CPUE = 13 fish/net-night; SE = 5.2) compared to the previous two years and was the second highest gill net mean CPUE since standardized surveys began in 1992 (Figure B-4). The northern pike population was dominated by quality to preferred length fish; however, Clear Lake continues to have the highest relative abundance of preferred length fish compared to other Refuge lakes (Figure B-5). Mean W_r was stable (Table B-2) and was similar to other Sandhill lakes (Paukert and Willis 2003). Since the 28 in. maximum size limit in 1993, the most notable differences in RSD values have occurred for memorable to trophy length fish. Fish in this length category have been collected every year since 1996 with incremental RSD-M values ranging from 5 to 27 (Table B-2).

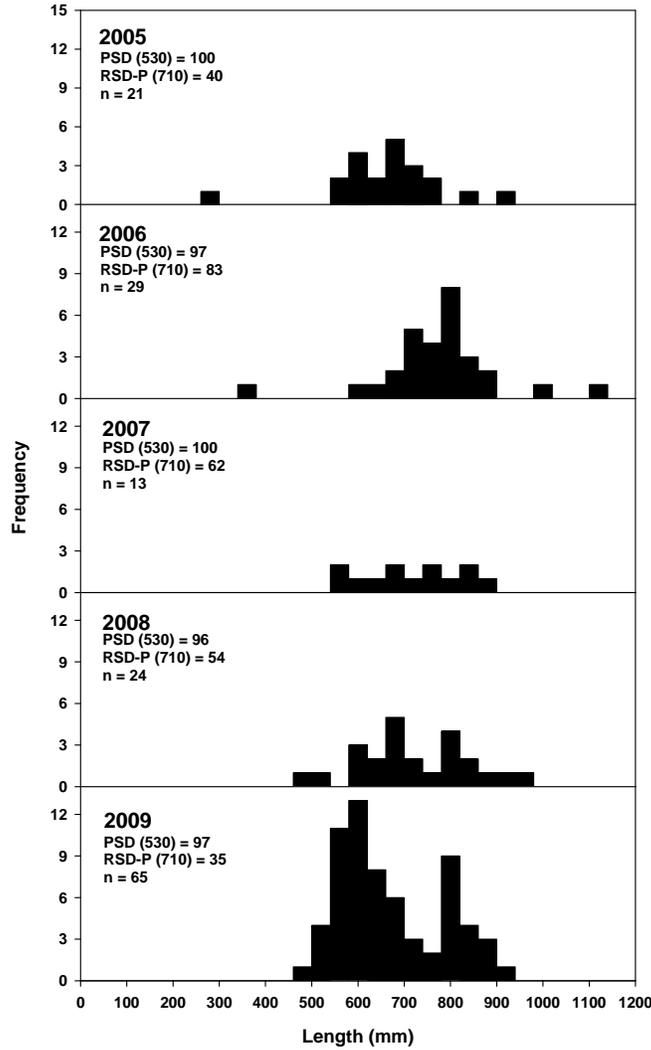


Figure B-3. Length frequency distribution (40-mm length groups) of northern pike captured by gill nets during the fall in Clear Lake from 2005 to 2009.

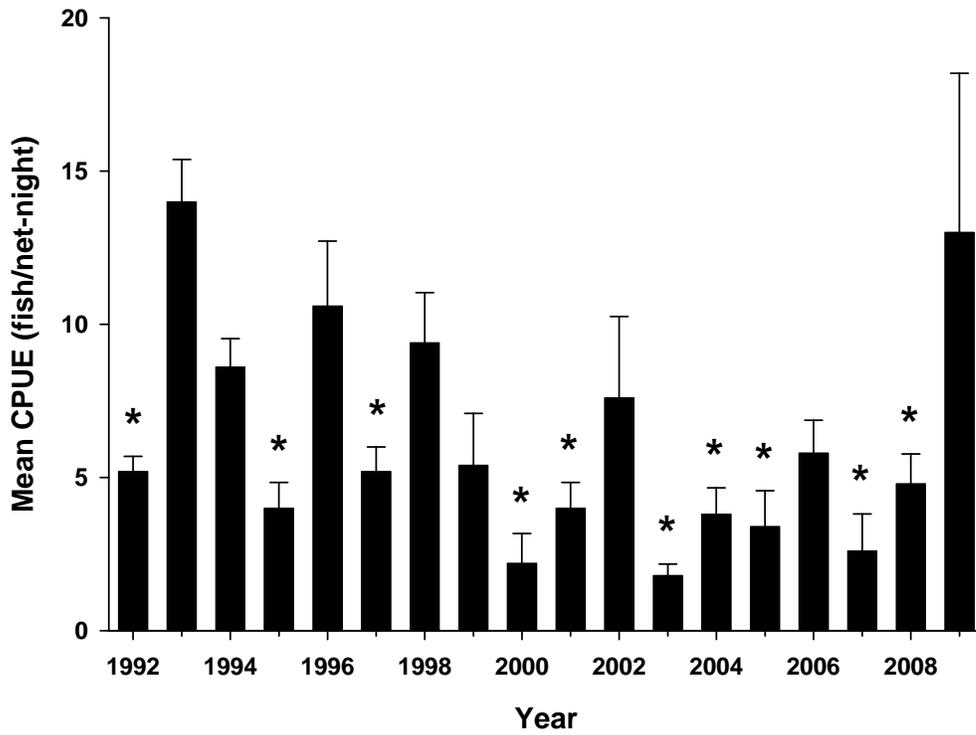


Figure B-4. Northern pike gill net mean catch per unit effort (CPUE) in Clear Lake from 1992 to 2009. Years with an asterisk are significantly different ($P > 0.20$) from 2009 using ANOVA with Tukey-Kramer multiple comparison tests.

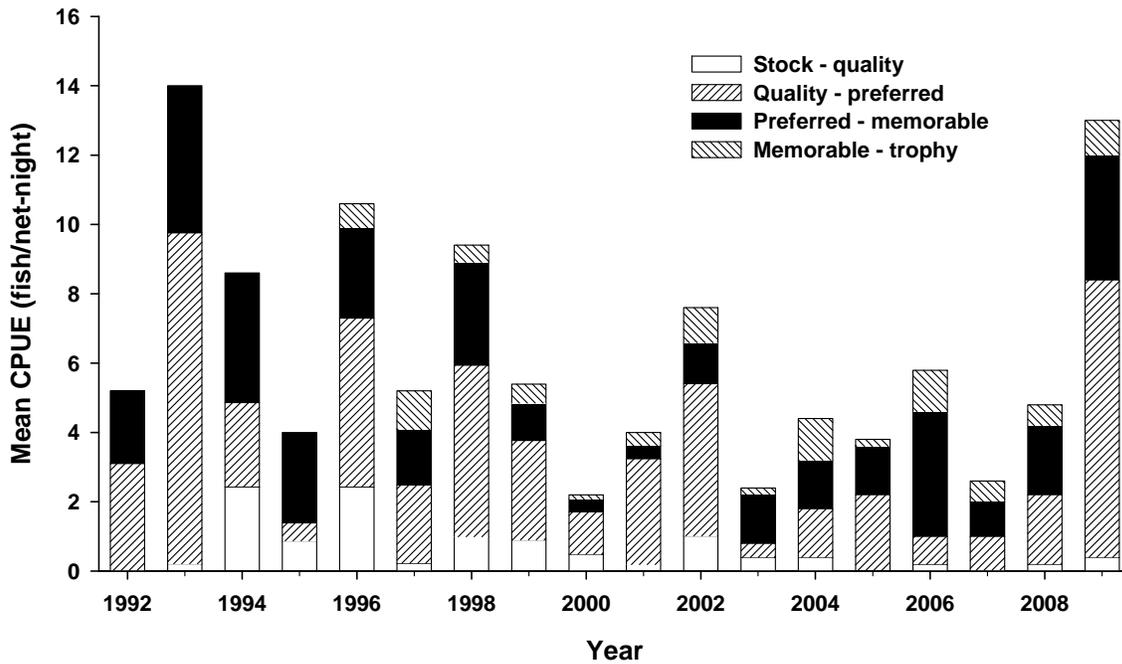


Figure B-5. Gill net mean catch per unit effort (CPUE) for northern pike by length category in Clear Lake from 1992 to 2009.

Table B-2. Population size structure, traditional proportional stock density (PSD) and incremental relative stock density (RSD) with relative weights (W_r) of northern pike in Clear Lake during the fall. 2006 – 2009 data for gill netting only. Data are pooled for fall trap and gill nets from 1988 to 2005. Data are summarized by length categories with 80% confidence intervals (+/-) and “a” denotes small sample size, confidence intervals could not be calculated (Gustafson 1988).

Year	% \geq Quality		Stock - Quality (350-530mm) (14-21 in)			Quality to Preferred (530-710mm) (21-28 in)			Preferred to memorable (710-860mm) (28-34 in)			Memorable to trophy (860-1120mm) (34-44 in)		
	PSD	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r
2009	97	99	3	a	93	62	9	101	28	8	97	8	6	94
2008	96	99	4	a	114	42	18	106	42	18	93	13	a	89
2007	100	96	0	a		38	a	98	38	a	97	23	a	87
2006	97	93	3	a	123	14	a	98	62	22	94	17	a	83
2005	100	93	0	a		60	a	92	35	a	95	5	a	86
2004	91	106	9	a	102	32	a	113	32	a	104	27	a	101
2003	83	89	17	a	89	17	a	100	58	a	88	8	a	79
2002	87	86	13	a	86	58	16	88	16	a	85	13	a	83
2001	95	87	5	a	100	76	16	87	10	a	74	10	a	98
2000	77	79	23	a	87	59	5	76	18	a	74	6	a	76
1999	80	84	20	a	83	53	14	82	20	12	87	10	a	94
1998	89	90	10	6	95	53	10	91	32	9	89	5	a	82
1997	96	94	4	a	100	46	7	105	29	6	93.0	21	6	97
1996	76	101	24	14	101	48	13	102	25	14	101	6	a	88
1995	78	95	22	14	99	13	13	98	63	15	92	0	a	
1994	71	105	28	9	115	28	9	98	43	11	95	0	a	
1993	98	97	1	a	97	68	11	101	30	9	98	0	a	
1992	100	96	0	a		60	9	96	40	9	97	0	a	
1991	100	92	0	a		87	a	94	13	a	90	0	a	
1990														
1989	93	90	7	a	95	68	a	90	23	a	80	2	a	87
1988	55	110	45	a	115	30	a	110	15	a	95	0	a	

Black crappie

Over 365,000 black crappie (fry, fingerlings, and adults combined) were stocked in Clear Lake from 2004 to 2006. This stocking program has had limited success as only ten sub-stock length fish were collected in 2005, four fish in 2006, and no black crappie were collected in the 2007 and 2008 surveys. However, sub-stock length fish were collected in spring trap nets and stock length fish were collected in fall gill nets in 2009 (Figure B-6). This evidence suggests that there was successful spawning, but recruitment to larger sizes has been nonexistent. The open water in Clear Lake likely makes black crappie susceptible to predation by both northern pike and largemouth bass.

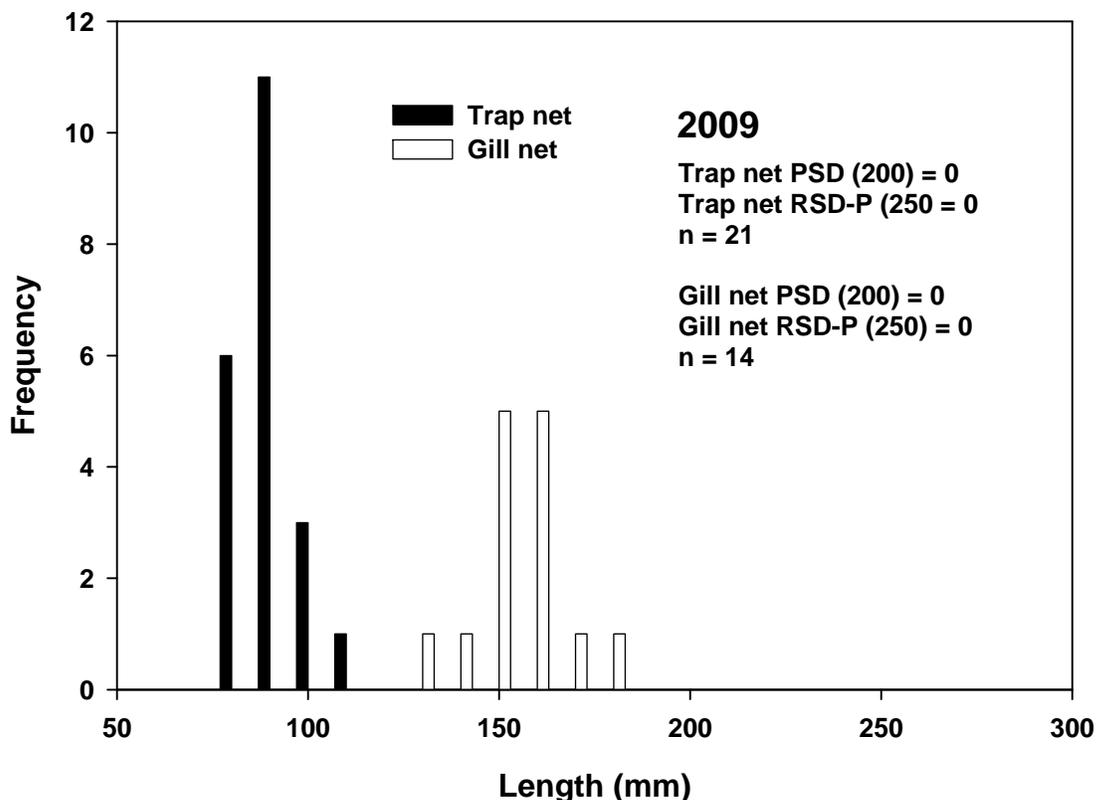


Figure B-6. Length frequency distribution (10-mm length groups) for black crappie captured by spring trap nets (black bars) and fall gill nets (white bars) in Clear Lake during 2009.

Bluegill

For the first time since 2006, water levels were high enough to effectively sample bluegills with electrofishing gear in 2009. The relative abundance of bluegill in Clear Lake was substantially lower compared to 2005 and 2006 (Figure B-7). The bluegill population was dominated by stock to quality length fish (Figure B-8), which has been the history for bluegills in Clear Lake. As with black crappie, the lack of vegetation across much of Clear Lake likely makes bluegill susceptible to predation by both northern pike and largemouth bass.

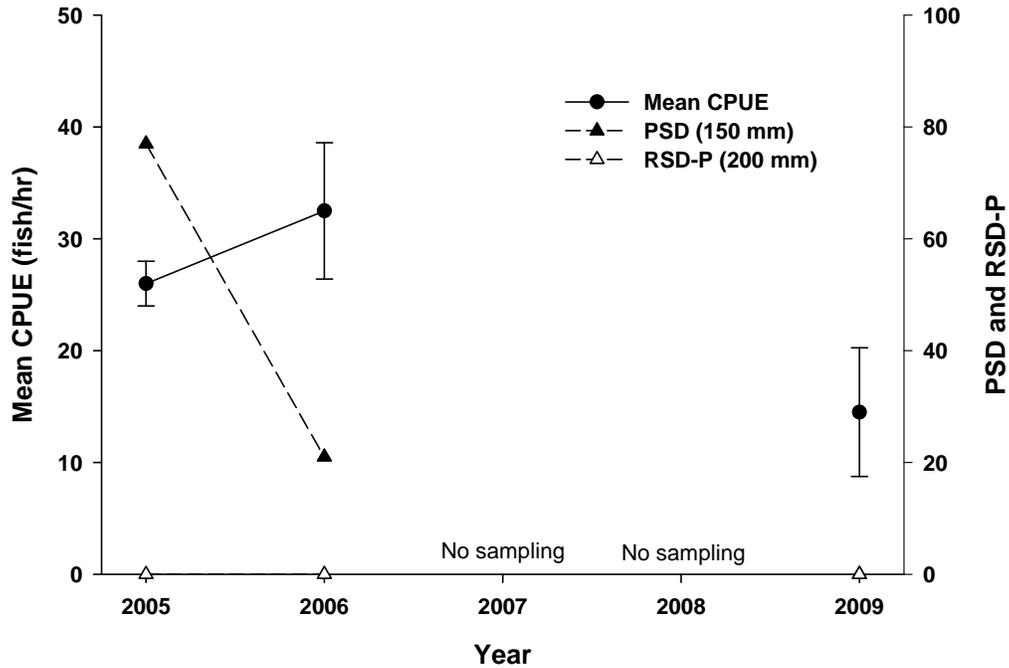


Figure B-7. Annual relative abundance (fish/hr), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing during the spring in Clear Lake during 2005, 2006, and 2009. Water levels were too low to effectively sample with electrofishing gear from 2007 to 2008. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

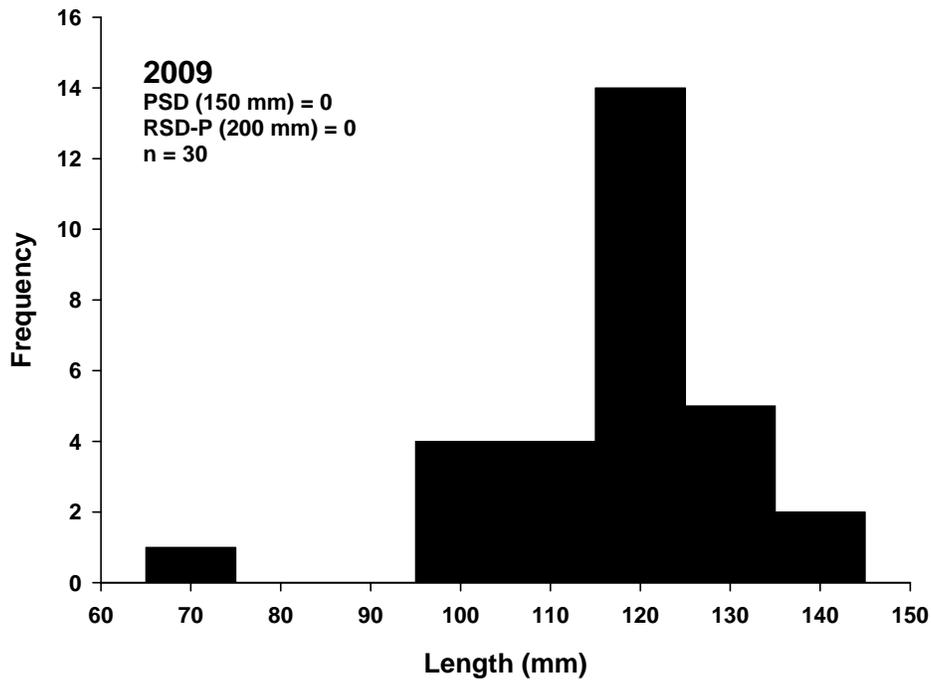


Figure B-8. Length frequency distribution (10-mm length groups) of bluegill collected by electrofishing in Clear Lake during 2009.

Table B-3. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Clear Lake from 1992 to 2009. Sampling occurred during fall from 1993 to 2004 and during the spring from 2005 to 2009.

Year	Overall W_r	Stock - Quality (80-150 mm) (3-6 in)	Quality - Preferred (150-200 mm) (6-8 in)	Preferred - Memorable (200-250 mm) (8-10 in)	Memorable - Trophy (250-300 mm) (10-12 in)
2009	a	a	a	a	a
2008	a	a	a	a	a
2007	a	a	a	a	a
2006	115 (2.0)	116 (2.4)	114 (4.0)	b	b
2005	121 (3.2)	124 (5.4)	118 (2.8)	b	b
2004	a	a	a	a	a
2003	113 (22.9)	113 (22.9)	b	b	b
2002	99 (2.3)	100 (2.4)	86 (1.4)	b	b
2001	110 (2.1)	108 (2.0)	113 (6.5)	120 (9.7)	b
2000	113 (2.0)	112 (2.4)	113 (3.9)	124 (2.4)	b
1999	116 (1.5)	117 (2.2)	118 (1.9)	113 (3.9)	b
1998	107 (3.0)	99 (3.7)	120 (4.0)	115 (5.2)	b
1997	110 (4.2)	108 (2.6)	122 (15.9)	b	b
1996	117 (2.7)	113 (4.1)	112 (3.1)	123 (2.6)	b
1995	111 (1.8)	110 (2.1)	115 (3.3)	123 (2.5)	b
1994	133 (4.6)	115 (4.2)	142 (5.2)	153 (4.9)	b
1993	107 (6.7)	107 (6.7)	b	b	b
1992	b	b	b	b	b

a = Sampling did not occur or weights were not recorded during that year.

b = Category had less than two samples for mean and SE calculations.

Golden shiner

No golden shiners (*Notemigonus crysoleucas*) were collected in 2009. Only one 85 mm fish was collected in 2008. Golden shiners are likely in low abundance in Clear Lake, while providing a additional prey source for northern pike and largemouth bass.

Largemouth bass

The 2009 relative abundance of stock length largemouth bass (≥ 200 mm) was high (mean CPUE = 13.5 fish/hr; SE = 3.1) for Clear Lake (Figure B-9), but most fish were < 300 mm (< 12 in.) (Figure B-10). Based on lengths, there appears to be 4 age classes indicating recruitment nearly every year (Figure B-10). Historically, Clear Lake has never had a high abundance of stock length largemouth bass compared to other Refuge lakes. Nearly every year, largemouth bass successfully spawn in Clear Lake, but few recruit to larger sizes. Mean W_r was high, which indicated abundant prey (Blackwell et al. 2000) (Table B-4).

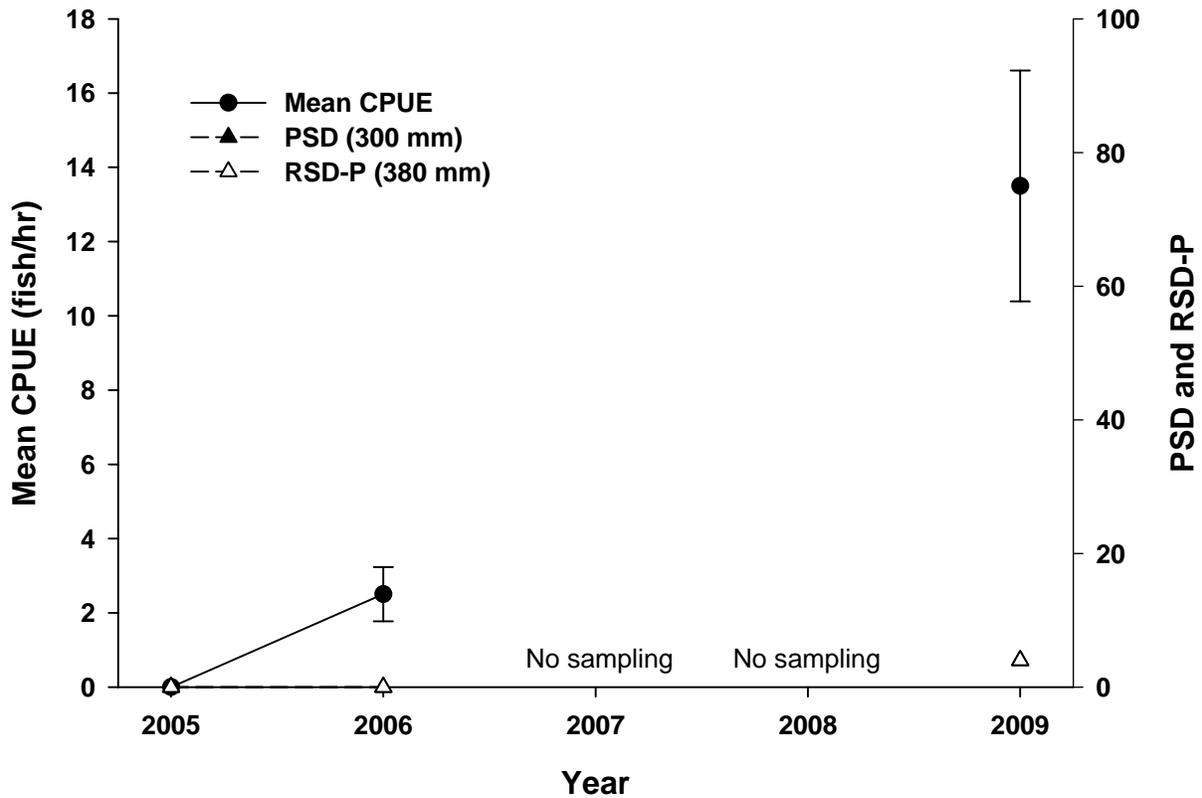


Figure B-9. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing during the spring in Clear Lake during 2005, 2006, and 2009. Mean catch per unit effort (CPUE) calculated for largemouth bass \geq stock length (200 mm) only.

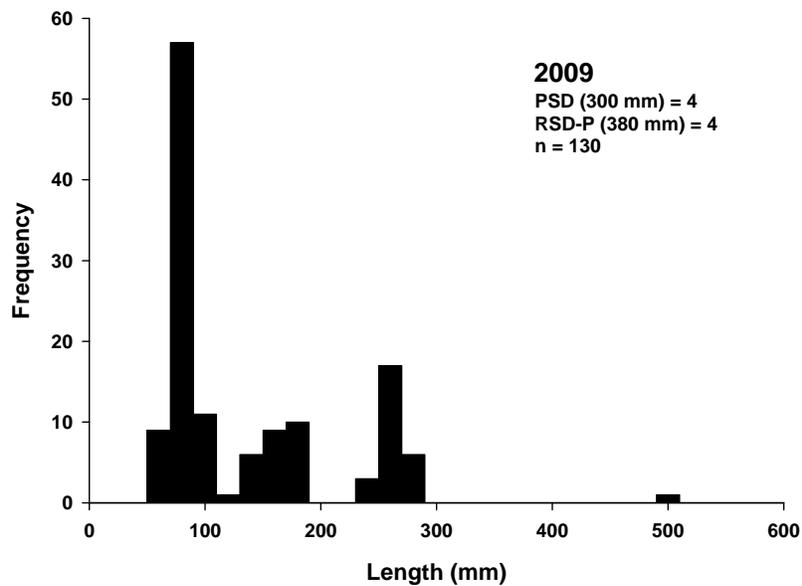


Figure B-10. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing during the spring in Clear Lake in 2009.

Table B-4. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing in Clear Lake from 1992 to 2009. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2009.

Year	Overall W_r	Stock - Quality (200-300 mm) (8-12 in)	Quality - Preferred (300-380 mm) (12-15 in)	Preferred - Memorable (380-510 mm) (15-20 in)	Memorable - Trophy (510-630 mm) (20-25 in)
2009	154 (4.3)	139 (2.3)	b	b	b
2008	a	a	a	a	a
2007	a	a	a	a	a
2006	114 (2.9)	102 (7.3)	b	b	b
2005	116 (13.9)	94 (11.4)	b	137 (10.2)	b
2004	a	a	a	a	a
2003	b	b	b	b	b
2002	b	b	b	b	b
2001	140 (5.8)	b	b	b	b
2000	119 (9.6)	b	b	119 (9.6)	b
1999	136 (1.6)	136 (1.6)	b	122 (5.9)	b
1998	b	b	b	b	b
1997	b	b	b	b	b
1996	180 (18.4)	223 (4.8)	127 (2.3)	b	b
1995	120 (5.3)	b	113 (7.8)	b	b
1994	153 (2.1)	153 (2.2)	b	134 (1.2)	b
1993	79 (13.6)	b	b	b	b
1992	142 (4.6)	b	138 (4.3)	145 (9.20)	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall W_r .

Yellow perch

Relative abundance of stock length yellow perch (≥ 130 mm) has remained low every year since 2003. Spawning was successful in 2008 as the population in 2009 was dominated by stock to quality length fish. The strong year class produced in 2004 has been nearly extirpated by angling or predation (Figure B-12). Yellow perch mean W_r in Clear Lake was average (Table B-5), but was the lowest among the six Refuge lakes surveyed in 2009.

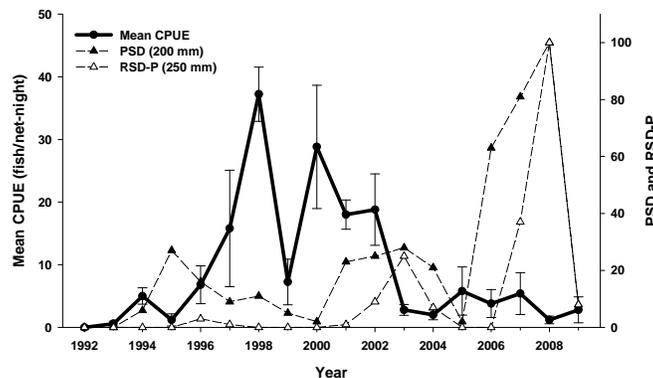


Figure B-11. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch caught by gill nets in Clear Lake from 1992 to 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

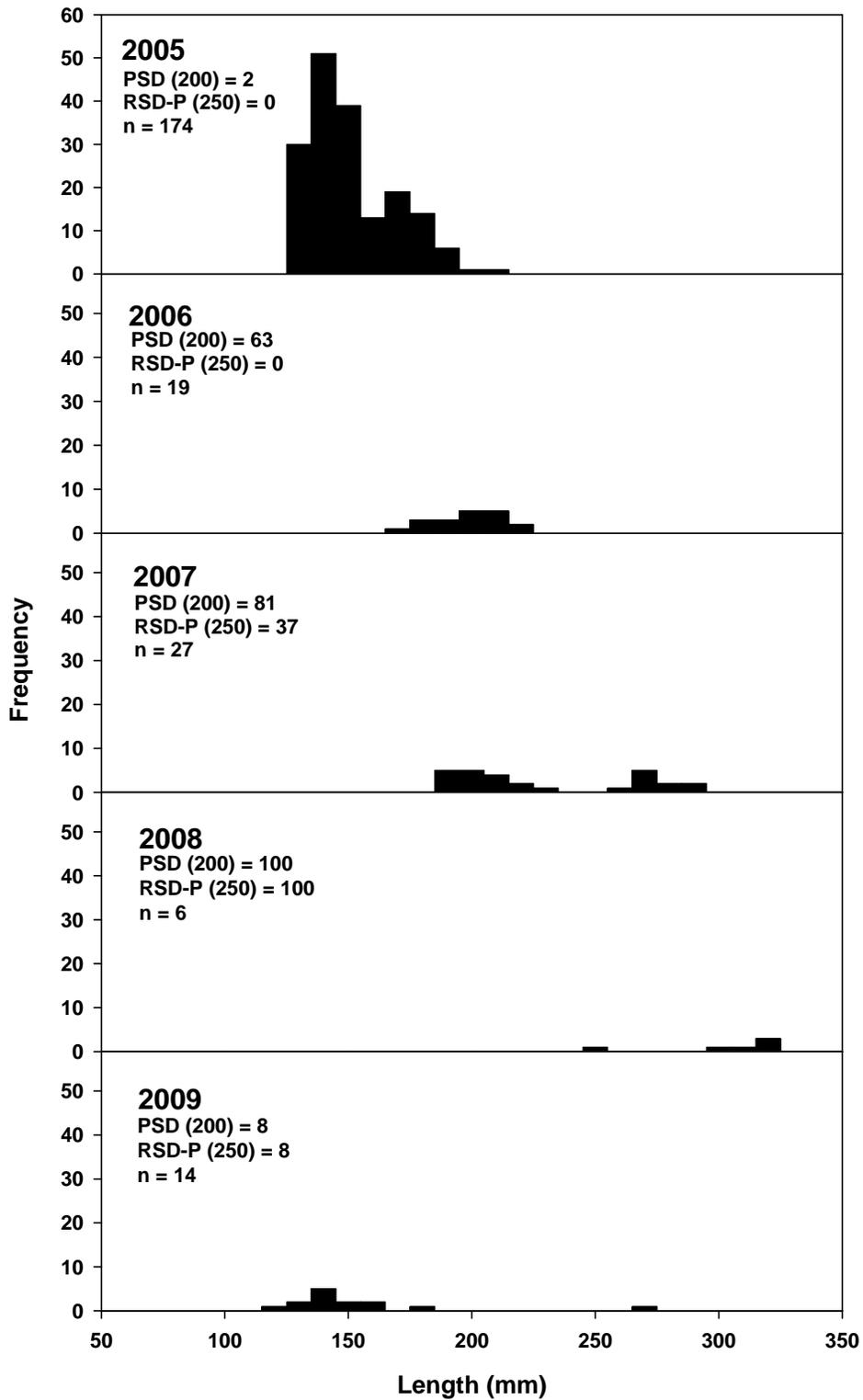


Figure B-12. Length frequency distribution (10-mm length groups) for yellow perch captured in gill nets during the fall in Clear Lake from 2005 to 2009.

Table B-5. Yellow perch mean relative weight (W_r) with standard errors (SE) in parenthesis by length category captured by gill nets in Clear Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (130-200 mm) (5-8 in)	Quality - Preferred (200-250 mm) (8-10 in)	Preferred - Memorable (250-300 mm) (10-12 in)	Memorable - Trophy (300-380 mm) (12-15 in)
2009	90 (3.0)	88 (3.0)	b	b	b
2008	121 (3.6)	b	b	b	119 (3.7)
2007	93 (1.6)	86 (2.9)	93 (2.7)	97 (1.5)	b
2006	100 (2.4)	108 (2.2)	96 (2.9)	b	b
2005	98 (2.0)	98 (2.0)	93 (2.7)	b	b
2004	105 (7.6)	110 (9.0)	82 (8.0)	b	b
2003	101 (2.2)	101 (3.4)	b	102 (1.6)	b
2002	91 (1.2)	87 (1.1)	93 (2.4)	100 (2.1)	106 (4.8)
2001	88 (1.3)	92 (1.8)	83 (1.4)	80 (1.2)	b
2000	94 (1.0)	94 (1.1)	94 (2.1)	b	b
1999	93 (1.6)	94 (1.8)	88 (1.3)	b	b
1998	103 (1.6)	99 (1.9)	111 (2.4)	99 (2.9)	b
1997	92 (1.7)	93 (1.9)	87 (4.2)	91 (0.0)	b
1996	96 (2.1)	99 (2.9)	93 (3.1)	88 (7.1)	b
1995	103 (7.4)	107 (9.9)	92 (1.9)	b	b
1994	94 (2.3)	91 (1.7)	115 (4.2)	b	b
1993	89 (4.2)	89 (4.2)	b	b	b
1992	b	b	b	b	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Summary

Common carp – There was no change in the relative abundance of stock length common carp from 2007 to 2009. However, a strong year class was produced in 2009 most likely from the substantial increase in lake water levels that improved spawning and nursery habitats.

Northern pike – Northern pike relative abundance in 2009 was the second highest since standardized surveys began in 1992. Clear Lake continues to have the highest abundance of preferred length (≥ 710 mm [28 in]) northern pike among the Refuge lakes.

Black crappie – Black crappie appear to be successfully spawning in Clear Lake. However, there is no evidence that these fish recruit to sizes preferred by anglers. Predation is likely limiting the number of fish > 200 mm (8 in).

Bluegill – The bluegill population in Clear Lake continues to be dominated by stock to quality length fish (80 - 150 mm [3 - 6 in]). Less than 0.5% of the bluegill collected with trap nets or electrofishing gear have been ≥ 200 mm (8 in) and only one fish was ≥ 250 mm (10 in.) since standardized surveys began in 1992.

Golden shiner – Although low in abundance, golden shiners when present do provide additional forage for predators.

Largemouth bass – Although relative abundance of stock length largemouth bass was high for Clear Lake, it had the lowest mean CPUE among all Refuge lakes. Nearly every year, largemouth bass successfully spawn in Clear Lake, but few recruit to lengths preferred by anglers.

Yellow perch – The relative abundance of yellow perch has remained low since 2003. A strong 2008 year class (120-160 mm) dominated the population during the 2009 fall gill net samples.

Management Recommendations

1. Continue the 28 in maximum size limit for northern pike. Encourage catch and release for northern pike to maintain and increase the adult population.
2. Continue to use Clear – Dewey ditch as a means for trapping and removing common carp when water conditions permit. Install finger traps in ditch to prevent common carp from re-entering Clear Lake after they move into the ditch.
3. Continue moving northern pike from West Long Lake to Clear Lake to supplement the adult population. Consider moving northern pike from Watts Lake into Clear Lake. Watts Lake panfish populations will benefit from the mechanical removal of northern pike (Jolley et al. 2008).
4. Build a handicap accessible fishing dock off the point just east of the boat ramp.
5. Record water levels in a consistent standardized manner to evaluate effects on spawning success.
6. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.
7. Continue annual surveys.

DEWEY LAKE

Lake Description

Dewey Lake is accessible by gravel roads from County Highway 16B or U.S. Highway 83. The lake is heavily utilized during the ice fishing season when accessible, which can be difficult during rare winters with heavy snow. Angling pressure can also be heavy during spring and fall, but fishing pressure declines during summer when dense submergent vegetation covers much of the lake.

Dewey Lake is in the middle of a series of four lakes on the refuge connected by natural drainage or man-made ditches. A man made ditch connects Hackberry Lake (the first in the series) to Dewey Lake and another ditch connects Dewey Lake downstream to Clear Lake. The interconnection of these lakes has created problems with controlling inter-lake fish movement in past years.

Dewey Lake is 223 surface ha (560 acres) with a maximum depth of 2.7 m (8 ft) and a mean depth of 1.4 m (4 ft). A dike on the east end of Dewey Lake allows the water to be held about 1.3 m above natural pool. The surrounding shoreline is predominately grassland with few willows and cottonwoods. The west end of the lake has an organic bottom comprised of a broad area of littoral vegetation with small areas of open water. The lake bottom on the north-east edge is sandy and sparsely vegetated; the south-east edge has an organic bottom and is heavily vegetated with emergent vegetation such as cattails and bulrushes (*Scirpus spp.*). During summer, submergent and emergent vegetation is abundant in a band around the lake's edge and is often referred to as "weed choked". The bottom of Dewey Lake is relatively flat with few drop-offs or depressions. The lake is too shallow to develop a summer thermocline. Summer surface water temperatures often exceed 30 °C (80 °F) and dense algae blooms have been reported. Primary fish species include: yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and common carp.

Dewey Lake was chemically renovated with rotenone in 1981 and restocked with game fish the following year (Appendix A). However, the renovation was either not 100% successful or common carp migrated into Dewey Lake from other lakes as a fisherman reported catching a carp in 1984. In the spring of 1993, large numbers of common carp were noted in the ditch between Dewey and White Water lakes, likely making an upstream spawning migration. These carp were removed with an estimated biomass of several tons. Large numbers of carp were also removed in 2008. Northern pike size restrictions changed four times from 1987 to 1993 (Appendix B) to improve their abundance and size structure in an effort to biologically control the common carp population. Northern pike greater than 28 in. have been protected since 1993 and the long-term trend since then appears to be stable.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table C-1).

Table C-1. Dewey Lake surface water quality parameters from 1999 to 2009.

Date	Time	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
08/2009	1520	22.4	15.0		9.8		34	86	272
05/2009	1728	21.6	8.0	45	8.7		0	170	323
09/2008		21.3	20.4		10.0	0.2	51	120	315
05/2008		12.7	10.6			0.2	17	154	296
05/2007		20	7.4		7.4	0.2	0	205	304
08/2006		21	11.7		8.1	0.2	0	188	395
08/2005		23			8.5		0	240	320
09/2004		20		42	8.7		0	139	
09/2003		21	9.2						
09/2002		21	9.5		9.8		0	410	320
09/2001		18		66	7.0		0	145	346
07/2001	1830	27	11.2		7.3		0	171	
07/2001	0645	23	7.2		8.2		0	154	
09/2000		18		60	9.5		0	308	344
09/1999		15			11.5				

Results and Discussion

Common carp

The strong 2006 year-class of common carp is likely dominating the population in Dewey Lake. Those fish that appeared in the 2007 gill net samples (Figure C-1) were not of stock length during 2007 spring trap nets that year, but appeared in the 2008 trap net sample (Figure C-2). Relative abundance has not changed since 2008 after an estimated 1,300 common carp were trapped and removed that spring. Spawning was successful in 2008; however, that year class was not detected in 2009 trap or gill nets and likely had low recruitment to the population (Figure C-3).

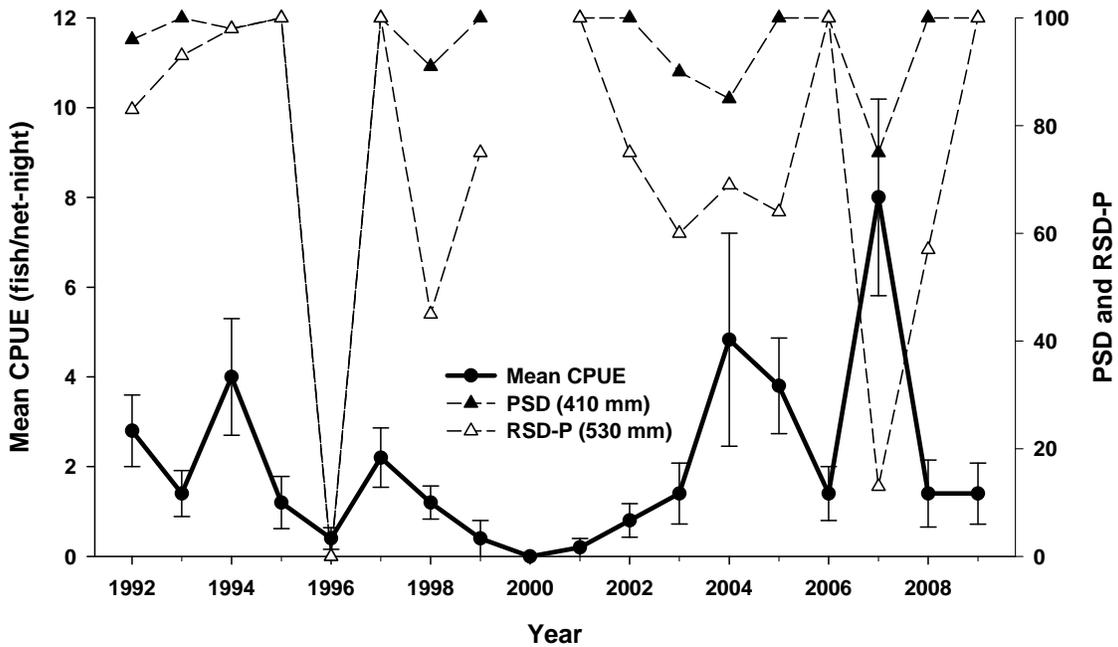


Figure C-1. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp caught by gill nets during the fall in Dewey Lake from 1992 to 2009. Mean catch per unit effort (CPUE) calculated for common carp \geq stock length (280 mm) only.

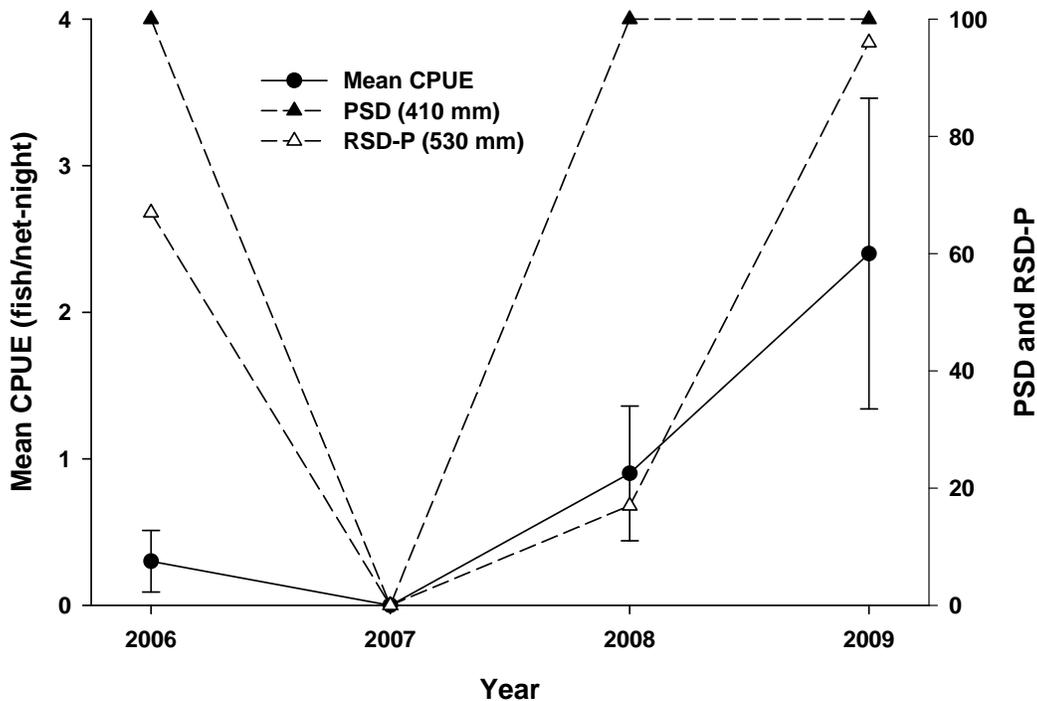


Figure C-2. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp captured by trap nets during the spring in Dewey Lake from 2006-2009. Mean catch per unit effort (CPUE) calculated for common carp \geq stock length (280 mm) only.

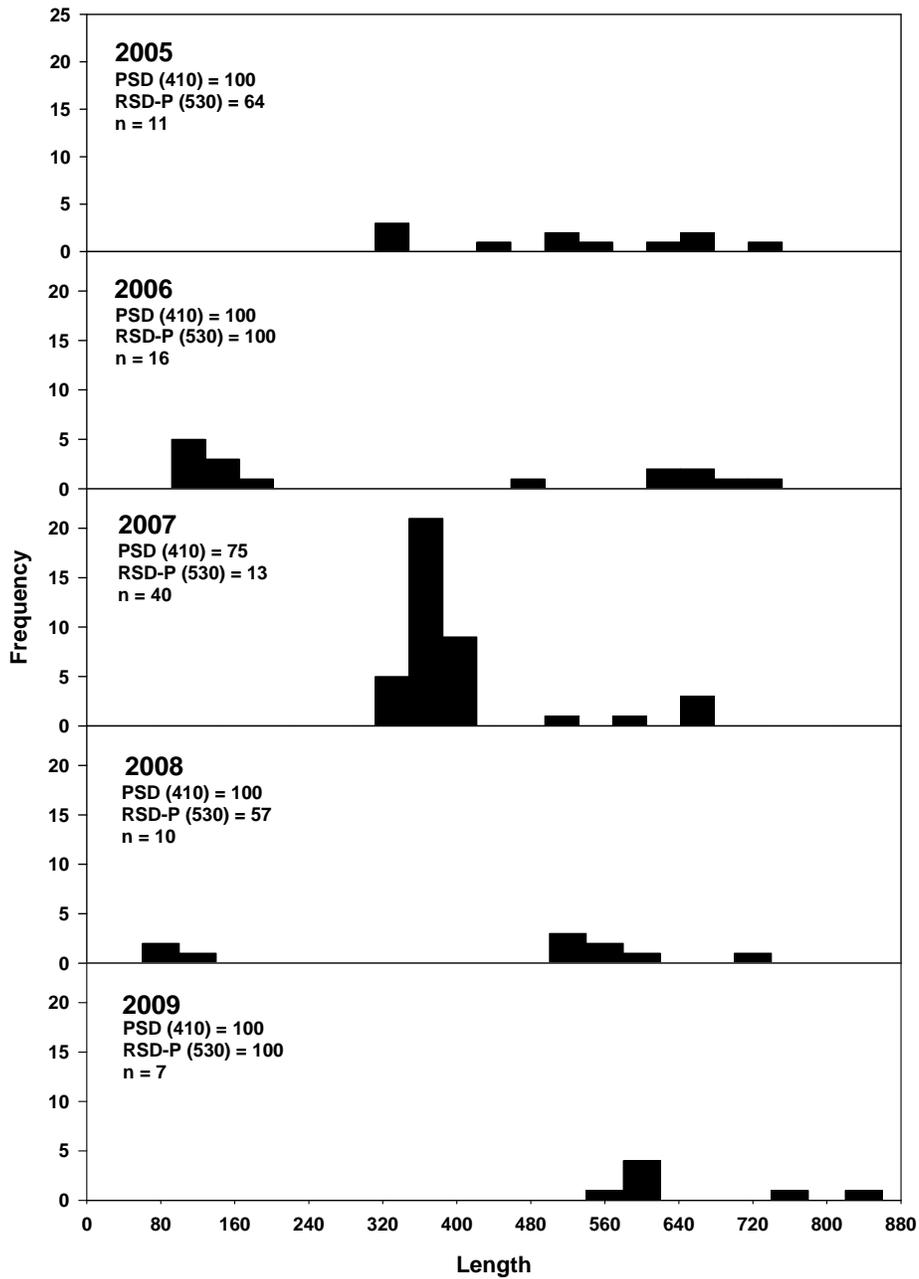


Figure C-3. Length frequency distribution (40-mm length groups) of common carp captured in gill nets during the fall in Dewey Lake from 2005 to 2009.

Northern pike

There has been no significant changes in relative abundance of northern pike from 2006 to 2009 based on trap net (Figure C-4) and gill net (Figure C-5) catches. However, there has been a decreasing trend in relative abundance since 2007 for both gears. The northern pike population is dominated by quality length fish with evidence of spawning success and recruitment nearly every year (Figures C-6 and C-7). Mean W_r remains normal and similar to other Refuge lakes (Table C-2).

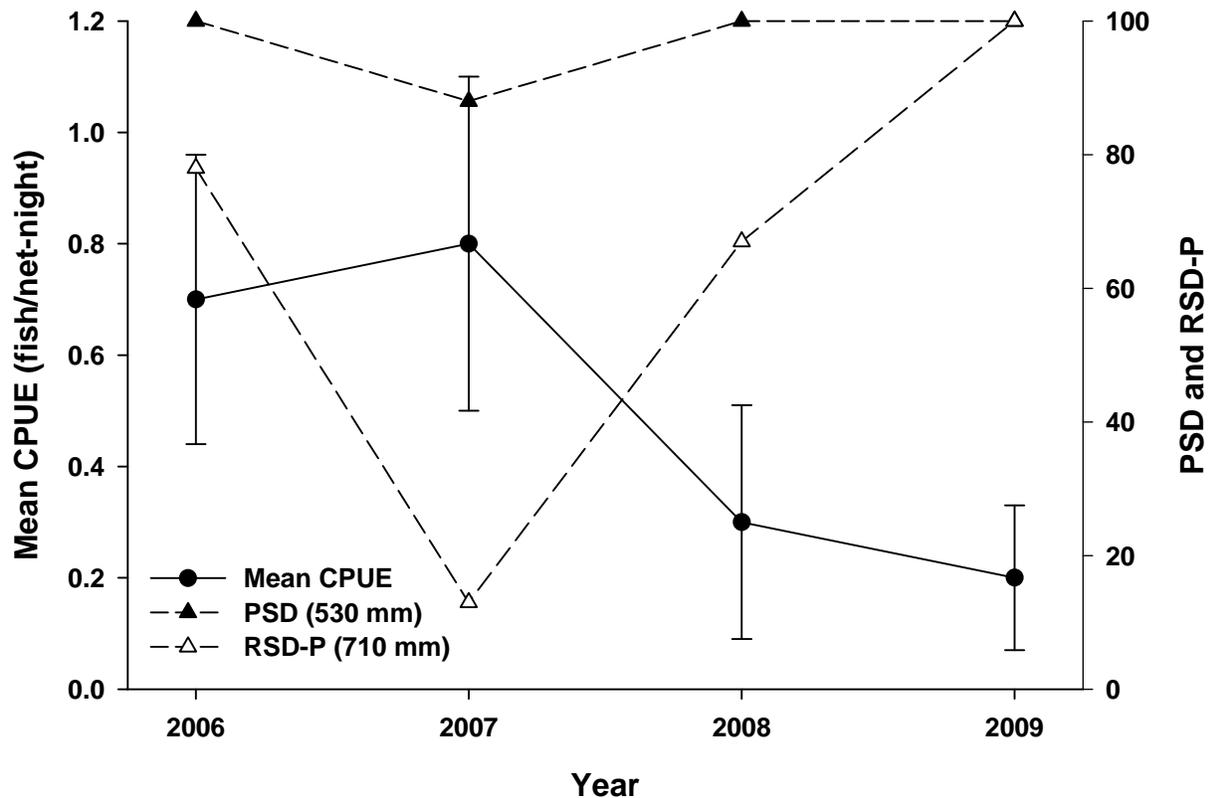


Figure C-4. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of northern pike captured by trap nets during the spring in Dewey Lake from 2006-2009. Mean catch per unit effort (CPUE) calculated for northern pike \geq stock length (350 mm) only.

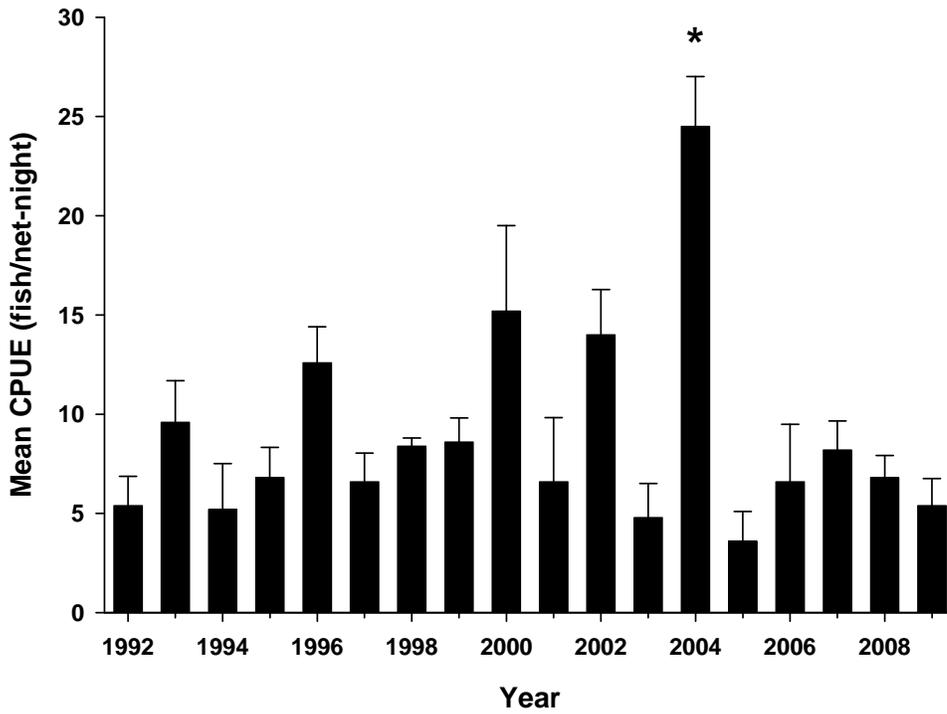


Figure C-5. Northern pike gill net mean catch per unit effort (CPUE) with SE bars for Dewey Lake from 1992 to 2009. Years with an asterisk are significantly different ($P > 0.20$) from 2009 using ANOVA with Tukey-Kramer multiple comparison tests.

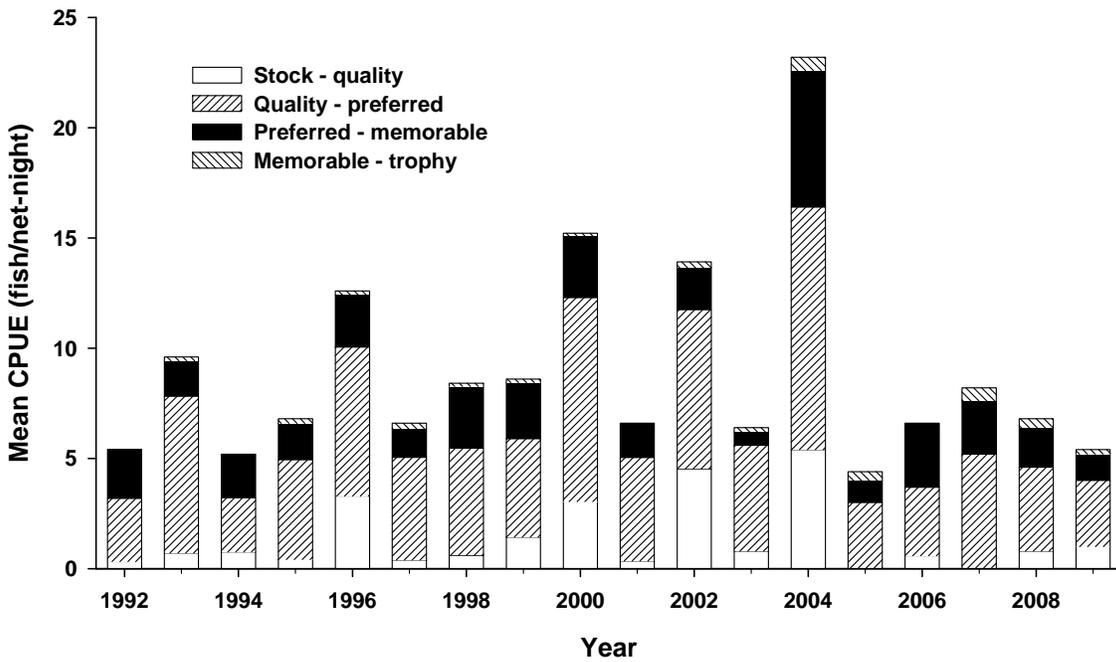


Figure C-6. Gill net mean catch per unit effort (CPUE) for northern pike by length category in Dewey Lake from 1992 to 2009.

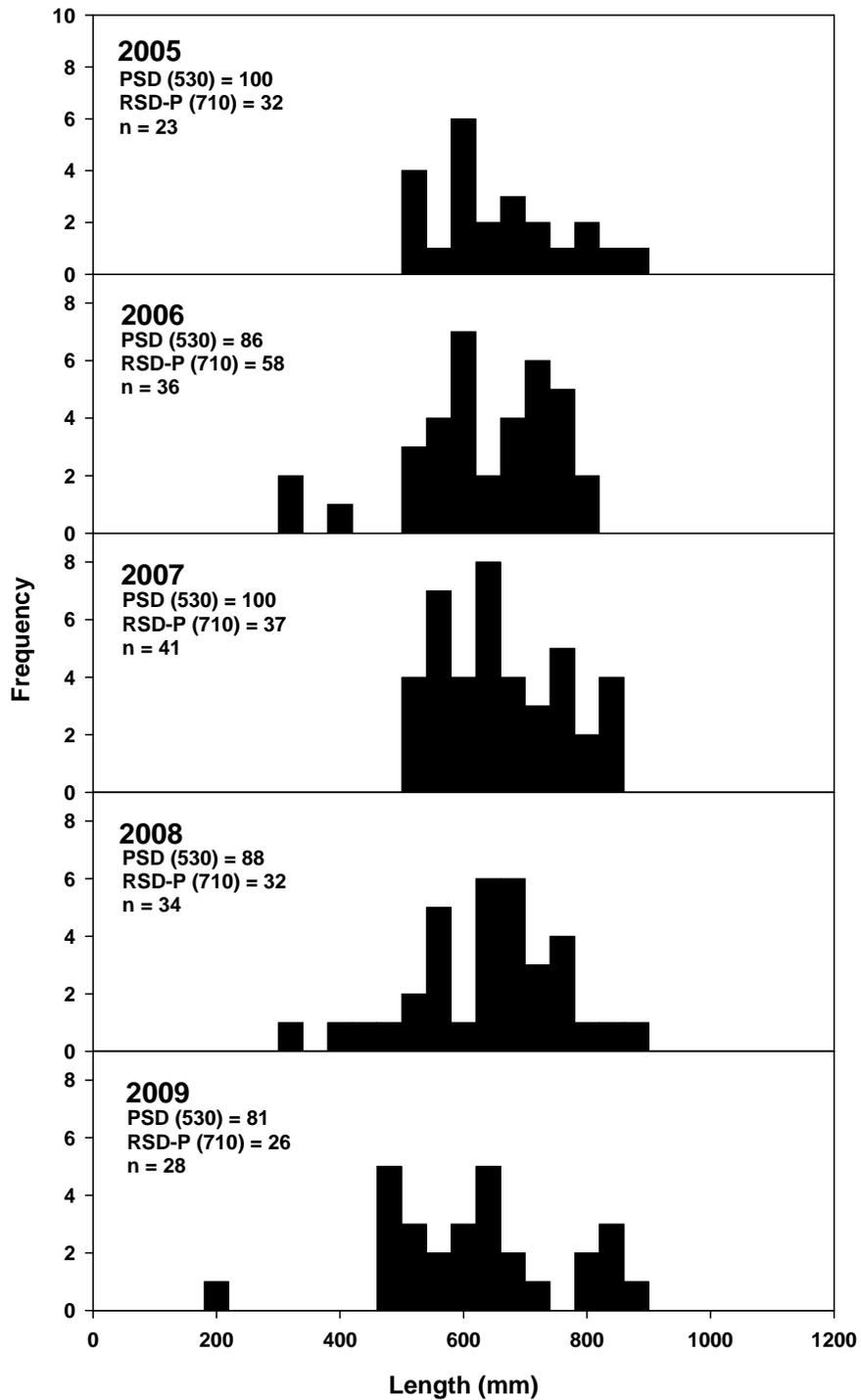


Figure C-7. Length frequency distribution (40-mm length groups) for northern pike captured in gill nets during the fall in Dewey Lake from 2005 to 2009.

Table C-2. Population size structure, traditional proportional stock density (PSD) and incremental relative stock density (RSD) with relative weights (W_r) of northern pike in Dewey Lake, Valentine NWR during the fall. 2006 to 2009 data for fall gill netting only. Data are pooled for trap and gill nets from 1987 to 2005. Data are summarized by length categories with 80 % confidence intervals (+/-) and “a” denotes small sample size, confidence intervals could not be calculated (Gustafson 1988).

Year	% \geq Quality		Stock - Quality (350-530mm) (14-21 in)			Quality to Preferred (530-710mm) (21-28 in)			Preferred to memorable (710-860mm) (28-34 in)			Memorable to trophy (860-1120mm) (34-44 in)		
	PSD	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r
2009	81	94	19	13	99	56	16	97	22	13	87	5	a	77
2008	88	93	12	15	96	56	20	94	26	18	94	6	a	86
2007	100	100	0	a		63	16	104	29	a	95	7	a	81
2006	91	98	9	a	133	47	a	111	44	22	76	0	a	
2005	100	89	0	a	a	100	a	93	32	a	81	9	a	78
2004	79	97	21	11	98	47	9	103	27	11	92	3	a	88
2003	88	94	12	a	104	75	12	94	9	a	89	3	a	86
2002	62	84	38	13	80	40	12	87	19	a	88	3	a	89
2001	95	95	5	a	109	71	99	90	24	10	85	0	a	
2000	80	90	20	9	87	62	7	71	17	6	79	1	a	84
1999	78	91	22	7	88	52	10	91	30	9	94	2	a	91
1998	89	92	11	7	90	54	10	92	33	9	92	2	a	80
1997	87	100	13	8	105	63	10	102	25	9	96	5	a	99
1996	69	103	31	9	101	48	11	105	19	9	104	1	a	96
1995	93	107	7	9	122	61	12	107	28	11	106	4	9	103
1994	86	103	14	9	115	47	12	103	38	12	97	0	a	
1993	92	98	8	9	111	71	8	99	21	a	98	0	a	
1992	94	85	6	8	100	51	9	85	43	8	83	0	a	
1991	95	88	5	a	94	59	a	91	36	a	86	0	a	
1990	96	90	4	a	84	72	a	87	24	a	93	0	a	
1989	88	103	12	a	95	65	a	97	19	a	102	4	a	109
1988	85	110	15	a	110	75	a	105	10	a	105	0	a	
1987	17	110	83	a	95	12	a	90	5	a	96	0	a	

Black bullhead

Seven black bullhead that ranged in length from 79 to 181 mm (mean = 143 mm; SD = 35.5) were captured in trap nets during spring 2009. Three fish were collected in trap nets during spring 2008, which were of similar length. 2008 was the first year black bullheads were detected in Dewey Lake since 1997.

Bluegill

Electrofishing mean CPUE has remained unchanged (Figure C-8), while trap net indices suggest an increase in relative abundance of bluegills in Dewey Lake (Figure C-9). The size structure remained unchanged from 2008 to 2009 with the population dominated by quality to preferred length fish (Figure C-10).

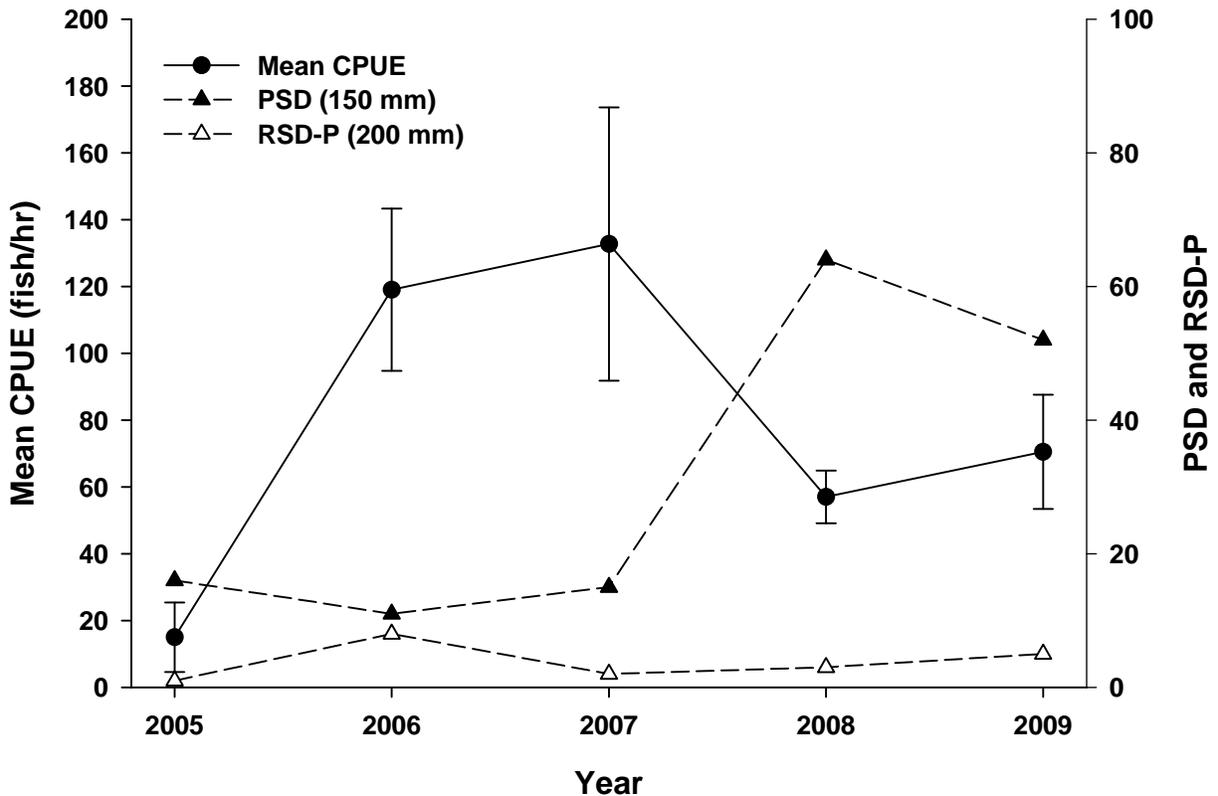


Figure C-8. Annual relative abundance (fish/hr), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing during the spring in Dewey Lake from 2005 to 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

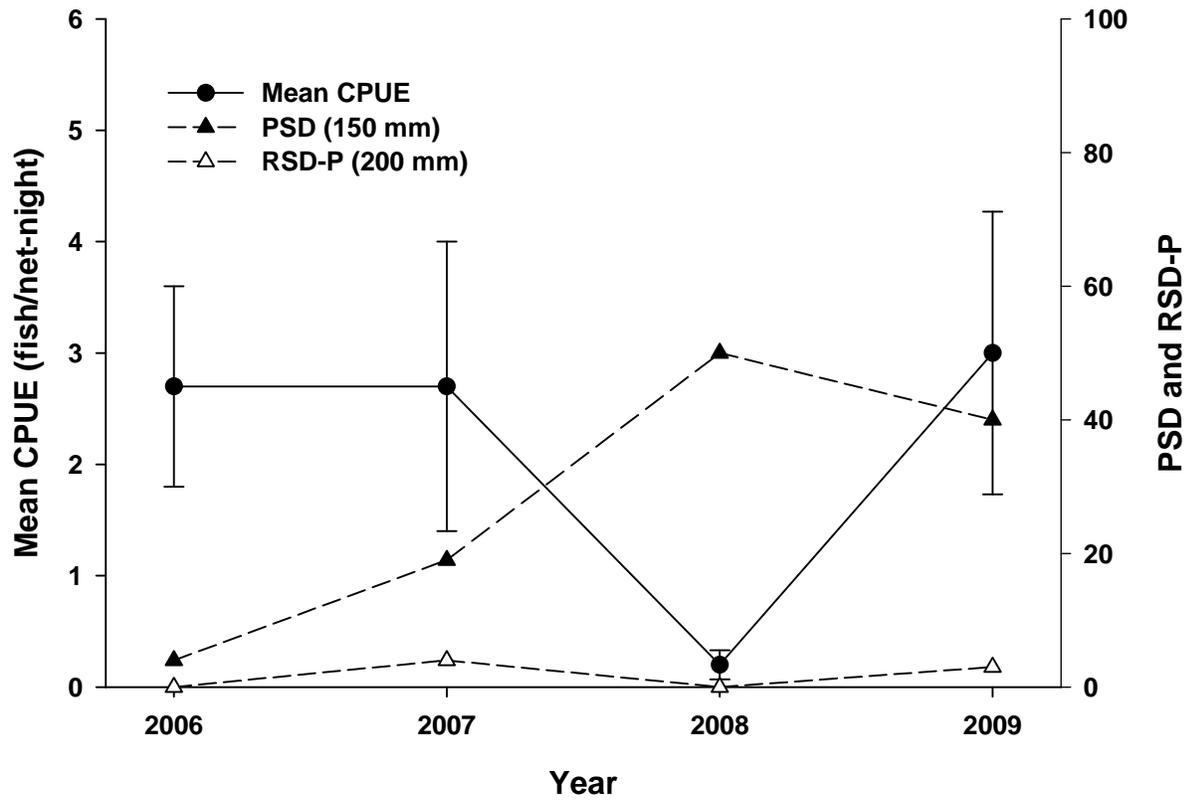


Figure C-9. Annual relative abundance (fish/net-night), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by trap nets during the spring in Dewey Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

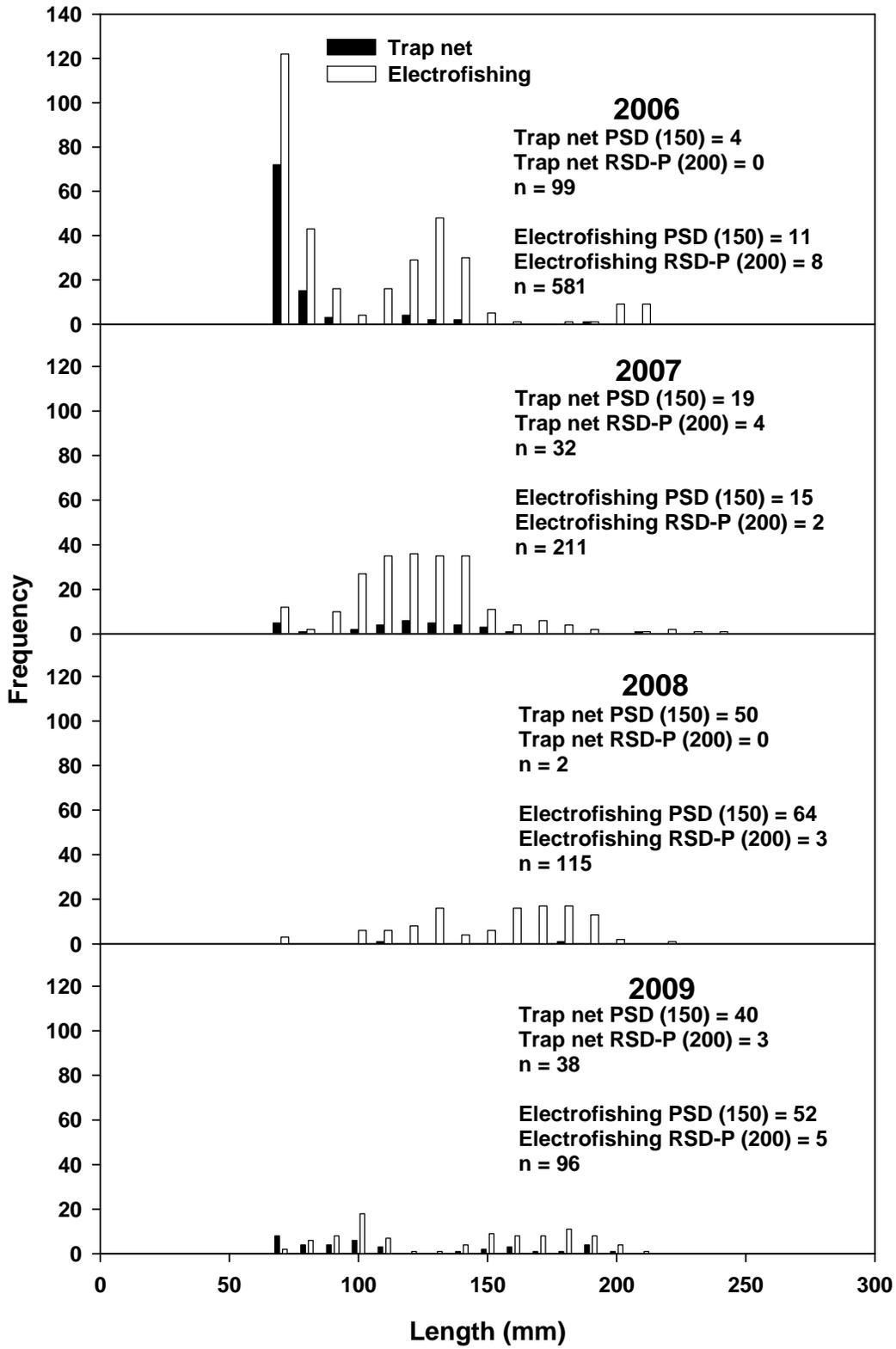


Figure C-10. Length frequency distribution (10-mm length groups) for bluegill captured by trap nets (black bars) and electrofishing (white bars) during the spring in Dewey Lake from 2006 to 2009.

Table C-3. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Dewey Lake from 1992 to 2009. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2009.

Year	Overall W_r	Stock - Quality (80-150 mm) (3-6 in)	Quality - Preferred (150-200 mm) (6-8 in)	Preferred - Memorable (200-250 mm) (8-10 in)	Memorable - Trophy (250-300 mm) (10-12 in)
2009	a	a	a	a	a
2008	120 (1.7)	118 (2.8)	122 (2.2)	117 (6.8)	b
2007	122 (2.1)	125 (2.7)	118 (3.7)	116 (5.2)	b
2006	120 (1.5)	119 (1.7)	126 (3.1)	119 (4.9)	b
2005	114 (1.5)	115 (1.8)	113 (2.6)	b	b
2004	117 (1.4)	114 (1.7)	119 (2.2)	128 (2.1)	b
2003	115 (2.1)	116 (2.6)	115 (3.8)	b	b
2002	115 (1.4)	115 (1.9)	117 (2.1)	b	b
2001	118 (2.9)	118 (3.1)	b	111 (4.5)	b
2000	114 (2.2)	111 (4.0)	118 (2.2)	114 (3.5)	b
1999	124 (1.7)	123 (2.0)	124 (6.4)	123 (1.7)	b
1998	119 (2.1)	118 (3.4)	123 (3.2)	109 (3.6)	b
1997	115 (1.5)	116 (2.7)	114 (1.9)	119 (4.8)	b
1996	121 (1.9)	123 (3.1)	119 (1.9)	117 (2.1)	b
1995	120 (2.2)	116 (1.6)	138 (9.5)	129 (6.0)	b
1994	125 (2.7)	115 (3.0)	140 (2.3)	147 (0.5)	b
1993	114 (2.5)	119 (3.2)	106 (3.3)	b	b
1992	108 (1.3)	107 (1.6)	112 (2.9)	115 (1.4)	b

a = Sampling did not occur or weights were not recorded during that year.

b = Category had less than two samples for mean and SE calculations.

Largemouth bass

The largemouth bass relative abundance improved (Figure C-11) and size structure became more balanced in 2009 (Figure C-12). Mean W_r remains above average compared to other Sandhill lakes (Table C-4).

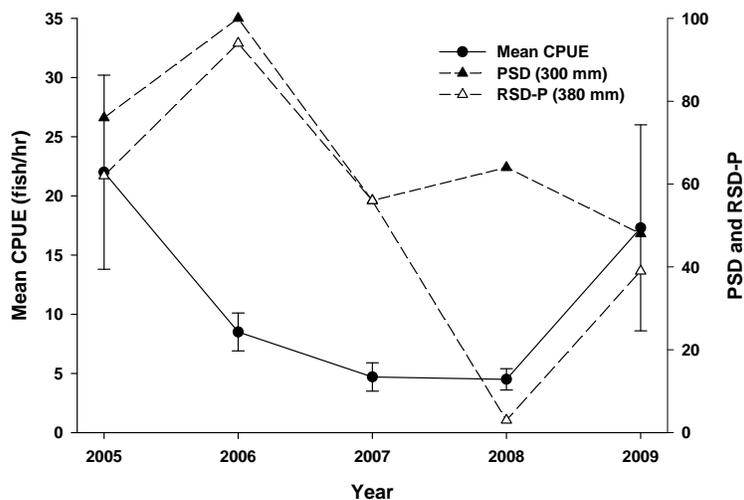


Figure C-11. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing during the spring in Dewey Lake from 2005 to 2009. Mean catch per unit effort (CPUE) calculated for largemouth bass \geq stock length (200 mm) only.

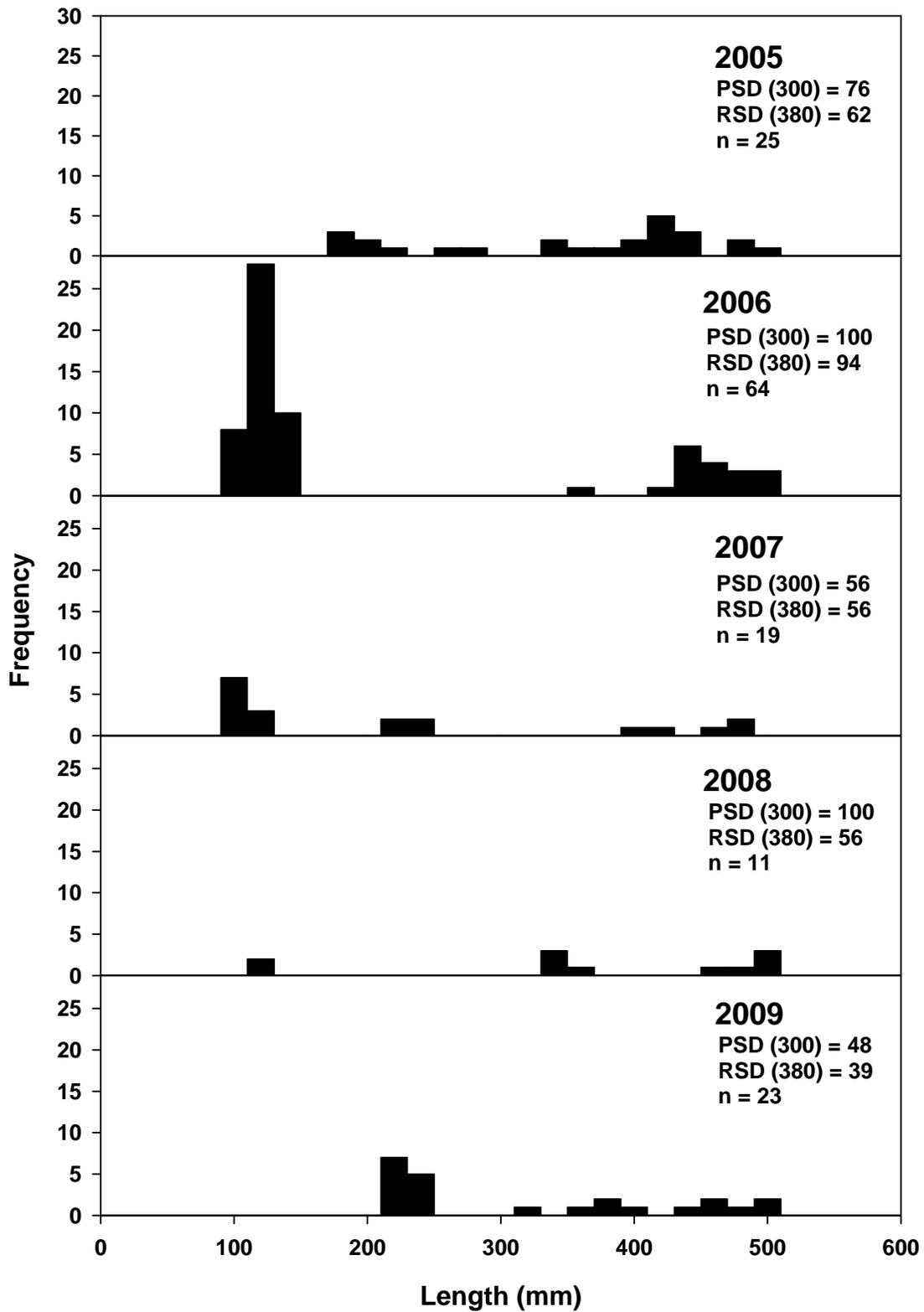


Figure C-12. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing during the spring in Dewey Lake from 2005 to 2009.

Table C-4. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing in Dewey Lake from 1992 to 2009. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2009.

Year	Overall W_r	Stock - Quality (200-300 mm) (8-12 in)	Quality - Preferred (300-380 mm) (12-15 in)	Preferred - Memorable (380-510 mm) (15-20 in)	Memorable - Trophy (510-630 mm) (20-25 in)
2009	121 (4.2)	130 (3.2)	80 (36.9)	119 (3.6)	b
2008	125 (2.2)	b	129 (2.8)	129 (3.7)	121 (4.2)
2007	129 (4.0)	115 (2.2)	b	135 (5.8)	b
2006	108 (3.3)	b	b	108 (4.2)	119 (1.7)
2005	135 (2.2)	128 (4.0)	142 (2.7)	135 (3.0)	b
2004	130 (2.1)	130 (3.3)	122 (4.1)	132 (2.9)	b
2003	117 (13.7)	b	b	b	b
2002	127 (2.5)	129 (4.1)	b	125 (3.3)	b
2001	b	b	b	b	b
2000	118 (4.0)	123 (3.7)	100 (7.1)	122 (5.7)	b
1999	131 (1.6)	131 (2.0)	128 (2.5)	b	b
1998	b	b	b	b	b
1997	93 (1.1)	130 (2.6)	b	131 (10.7)	b
1996	135 (2.3)	138 (2.6)	133 (3.4)	117 (5.6)	b
1995	137 (3.4)	137 (3.6)	b	b	b
1994	154 (6.4)	110 (1.9)	163 (9.2)	146 (3.8)	b
1993	131 (8.4)	122 (3.3)	141 (15.2)	b	b
1992	106 (12.5)	106 (12.5)	b	b	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Yellow perch

Relative abundance (Figure C-13 and C-14), size structure (Figure C-15), and mean W_r (Table C-5) improved from 2008 to 2009. Multiple year-classes of yellow perch are evident based on modes in the length frequency (Figure C-15). Yellow perch gill net mean CPUE and mean W_r in Dewey Lake was the highest among the Refuge lakes surveyed in 2009. Dewey and Hackberry lakes most likely will provide the best angling opportunities for yellow perch among Refuge lakes based on abundance and size structure.

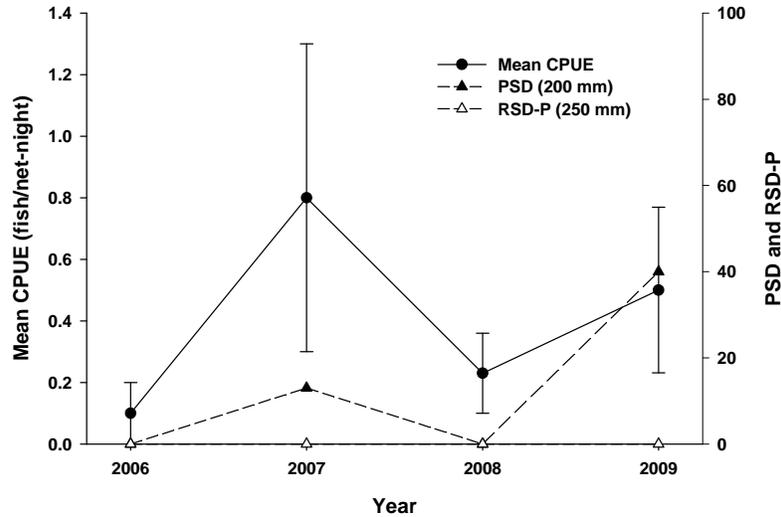


Figure C-13. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by trap nets during the spring in Dewey Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for perch \geq stock length (130 mm) only.

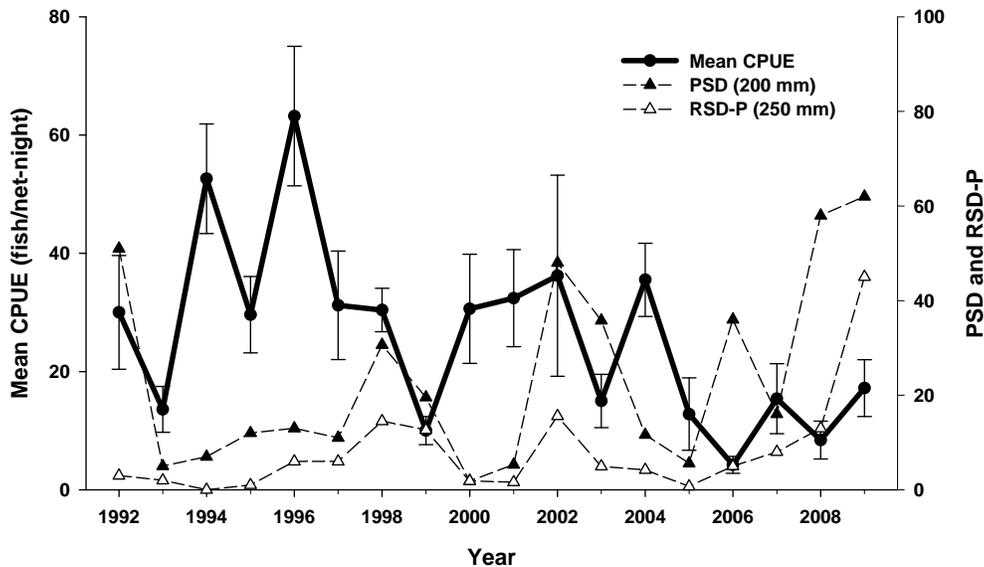


Figure C-14. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets during the fall in Dewey Lake from 1992 to 2009. Mean catch per unit effort (CPUE) calculated for perch \geq stock length (130 mm) only.

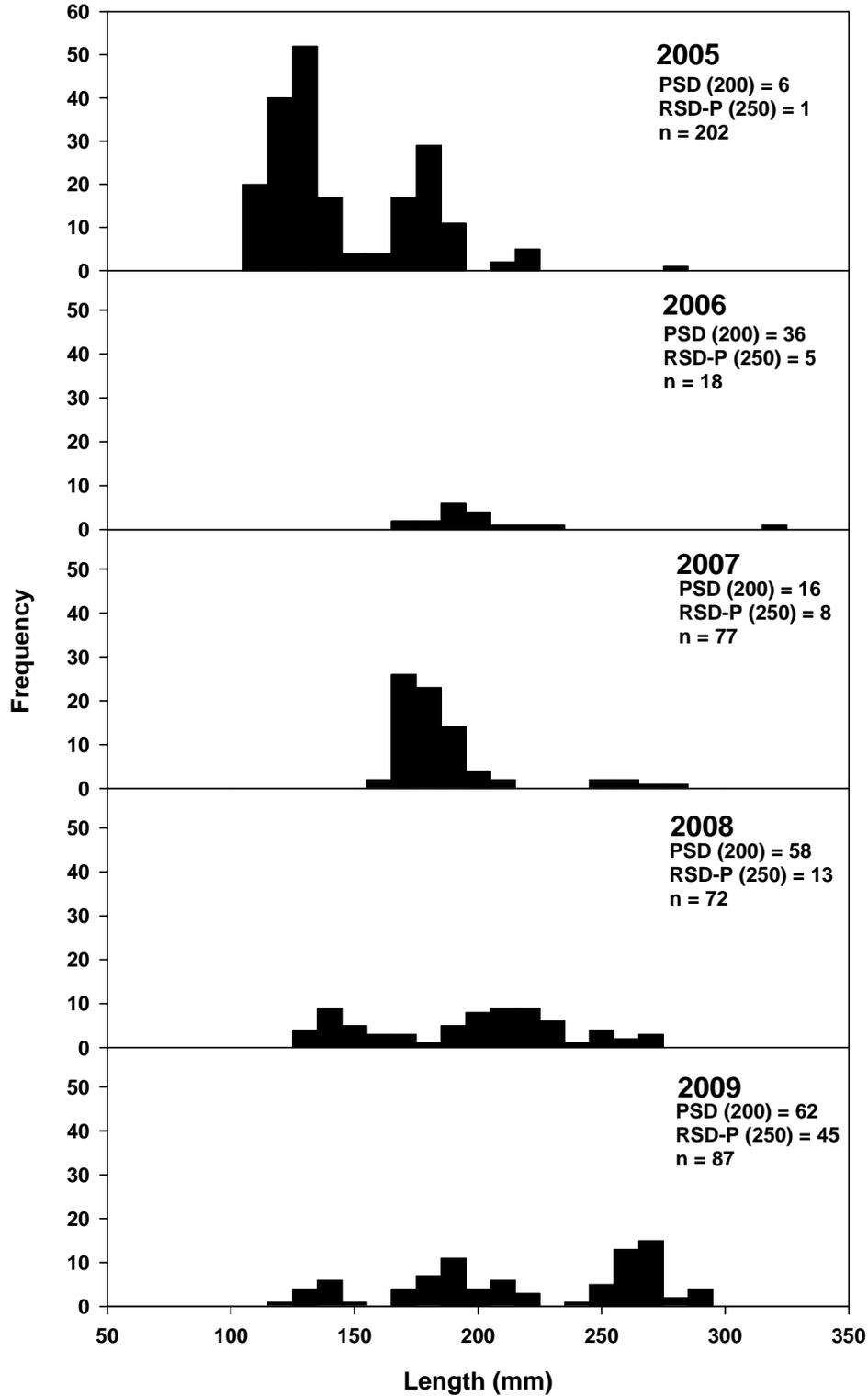


Figure C-15. Length frequency distribution (10-mm length groups) of yellow perch captured in gill nets during the fall in Dewey Lake from 2005 to 2009.

Table C-5. Yellow perch mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by gill nets during the fall in Dewey Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (130-200 mm) (5-8 in)	Quality - Preferred (200-250 mm) (8-10 in)	Preferred - Memorable (250-300 mm) (10-12 in)	Memorable - Trophy (300-380 mm) (12-15 in)
2009	99 (1.0)	98 (1.3)	102 (2.4)	97 (1.5)	b
2008	94 (1.5)	94 (2.0)	98 (2.3)	86 (3.5)	b
2007	98 (1.9)	102 (2.0)	92 (3.8)	87 (4.2)	b
2006	94 (2.5)	116 (5.2)	95 (3.8)	b	b
2005	96 (0.9)	97 (1.0)	93 (1.2)	b	b
2004	97 (2.1)	88 (2.1)	106 (5.0)	100 (2.6)	b
2003	101 (2.0)	97 (1.6)	104 (5.3)	110 (3.6)	b
2002	98 (1.2)	97 (2.1)	102 (1.5)	103 (2.3)	b
2001	115 (1.4)	95 (2.1)	82 (3.4)	b	101 (3.7)
2000	92 (1.3)	93 (1.30)	b	86 (4.6)	84 (0.1)
1999	99 (1.2)	96 (1.4)	105 (2.3)	102 (2.8)	108 (3.8)
1998	99 (1.0)	95 (1.1)	103 (2.0)	103 (2.3)	101 (2.1)
1997	106 (2.0)	102 (1.5)	112 (7.0)	111 (2.7)	109 (1.2)
1996	102 (1.4)	99 (1.4)	107 (2.6)	103 (3.8)	100 (1.5)
1995	106 (0.9)	103 (1.2)	109 (1.2)	106 (2.9)	b
1994	109 (1.5)	108 (2.1)	110 (1.9)	b	b
1993	108 (2.8)	111 (2.7)	85 (8.7)	98 (8.5)	b
1992	98 (1.3)	100 (2.3)	96 (1.8)	94 (2.3)	102 (6.3)

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Summary

Common carp – Common carp relative abundance remains low and the last strong year class was evident in 2006.

Northern pike – A trend of decreasing relative abundance since 2007 is evident. Size structure has remained unchanged from 2006 to 2009.

Bluegill – The bluegill population was generally stable over the last four years with only a few preferred length fish in the population.

Largemouth bass – The relative abundance and size structure improved in 2009 providing excellent largemouth bass angling opportunities.

Yellow perch – The relative abundance and size structure improved in 2009 providing excellent yellow perch angling opportunities.

Management Recommendations

1. Continue the 28 in maximum size limit for northern pike. Encourage catch and release for northern pike to maintain and increase the adult population.
2. Continue to use Dewey - Whitewater ditch as a means for trapping and removing common carp when water conditions permits. Improve finger trap structure in ditch to improve trap effectiveness.
3. Control water levels in Clear Lake to improve fish spawning habitat. This may need to be performed every other year to produce strong year classes those years.
4. Record water levels in a consistent standardized manner to evaluate effects on spawning success.
5. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.
6. Continue annual surveys.

HACKBERRY LAKE

Lake Description

Hackberry Lake is adjacent to the Refuge's headquarters and is easily accessible from State Highway 16B. This lake receives heavy fishing pressure during winters when other refuge trails and fishing lakes are inaccessible. Angling is greatest during the ice fishing season through late spring/early summer and then declines as the lake becomes heavily vegetated.

Hackberry Lake is the first in a series of four lakes on the refuge that are connected by natural drainage or man-made ditches. In high water years, a water control structure between Hackberry and Dewey lakes (the next lake downstream) controls water levels in Hackberry. During the spring and summer of 1995-1997, lake levels were near record highs and many lakes and creeks were connected. These connections allowed common carp migration.

Hackberry Lake is 275 surface ha (680 ac). Maximum and mean depths are 1.8 m (5 ft.) and 1.0 m (3 ft.), respectively. The lake bottom is relatively flat and highly organic. The lake is too shallow to thermally stratify. Abundant decaying organic matter has reduced dissolved oxygen levels to less than 1 ppm during winters with extended ice cover resulting in periodic winter-kills. Summer-kills have also been noted but are usually less severe. Emergent vegetation (cattail and bulrush) dominates the entire lake edge. Because the lake is shallow, heavily vegetated, and relatively alkaline, dense algae blooms are common and likely contribute to the periodic summer fish kills. During summer, the entire lake is essentially a large littoral area with dense submergent vegetation. Specific conductivity averages 407 $\mu\text{S}/\text{cm}$, total alkalinity averages 204 mg/L, phenolphthalein alkalinity averages 38 mg/L, pH ranges from 8.5 during winter/spring to 10 during summer. Secchi disk averages 0.3 m during summer. The surrounding watershed consists of mixed grass sandhills, which are lightly grazed by cattle.

Hackberry Lake has a history of high common carp abundance. In 2004, the Refuge and NGPC cooperated in a joint effort to lower Hackberry Lake and chemically renovate the fishery. Draw down began in August of 2004 and the lake was chemically renovated using rotenone. By October 2004, Hackberry Lake was declared carp free and fish stockings were initiated during the fall of 2004 with additional stockings since (Appendix A). The last chemical renovation prior to 2004 was conducted in 1975. Hackberry Lake was presumed to be carp free until carp were captured during the 1988 surveys. From 1988 to 1992, Hackberry Lake was identified as the "control lake" for evaluating northern pike as a biological agent for controlling carp recruitment and followed state size and bag limits. During January 1992, the 36 in (910 mm) northern pike minimum size limit was extended to include Hackberry Lake. During the 1992 northern pike spawning operation, approximately 1,000 northern pike collected from Pelican Lake were transferred to Hackberry Lake to increase the northern pike population in the lake. Beginning January 1993, regulations were implemented to allow the harvest of northern pike 28 in or less (Appendix B). The primary fish species in Hackberry Lake are largemouth bass, yellow perch, bluegill, northern pike, and common carp.

Historical surface water quality parameters are reported in Table D-1.

Table D-1. Hackberry Lake surface water quality parameters.

Date	Time	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
08/2009	0900	21.9	6.0		8.2		0	171	392
05/2009	2100	22.0	11.8	120	9.1		34	153	403
09/2008		18.5	11.9		8.8	0.22	0	222	402
05/2008			7.7			0.2	0	205	345
08/2002		20	11.0		9.7		137	393	430
09/2001		18		75	7.2		8	154	368
07/2001	1915	28	12.0		7.1		17	137	
07/2001	0745	23	4.0		8.0		17	137	
09/2000		18		30	8.5		10	200	425
09/1999		16			7.1				

Results and Discussion

Common carp

Common carp were first detected in Hackberry Lake in 2008 since the renovation in 2004. Hackberry Lake continues to have the highest density of stock length (≥ 280 mm) common carp per gill net of all the Refuge lakes. Mean CPUE increased from the previous high in 2008 of 10.4 fish/net-night (SE = 2.5) to 11.0 fish/net-night (SE = 3.7) in 2009. Essentially, there was no change in the relative abundance of common carp in Hackberry Lake from 2008 to 2009. The common carp population is now dominated by preferred length fish (Figure D-1). Based on lengths, it appears that most, if not all fish are from the same year class and likely age-3 (Coulter et al. 2008).

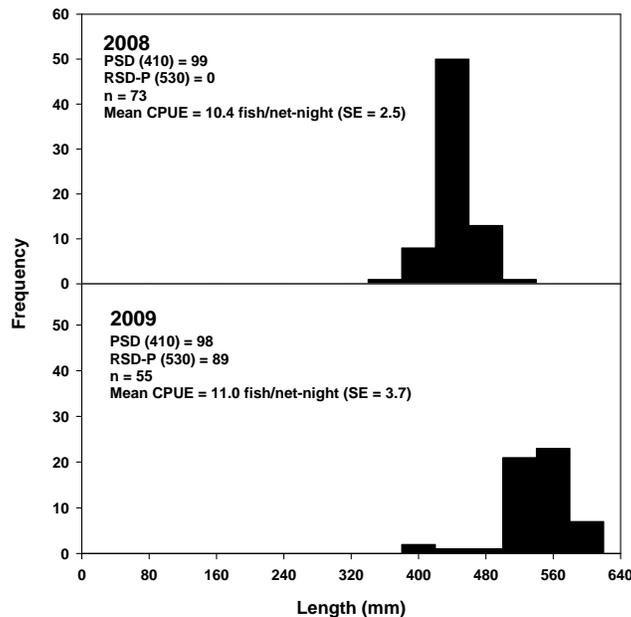


Figure D-1. Length frequency distribution (40-mm length groups) of common carp captured in gill nets in Hackberry Lake in 2008 and 2009.

Northern pike

Northern pike remain in low abundance in Hackberry Lake as only two northern pike (639 and 690 mm) were collected in fall gill nets in 2009. Only two northern pike (613 and 672 mm) were captured in gill nets in 2008. After the renovation in 2004, the first detection of northern pike occurred during the 2008 spring electrofishing surveys.

Bluegill

The stocking of nearly 180,000 bluegills in 2007 and 52,000 fish in 2008 was successful. Bluegill relative abundance continues to increase in Hackberry Lake (Figure D-2). The size structure also improved from 2008 to 2009 with a PSD ≥ 42 for both trap nets and electrofishing in 2009 (Figure D-3). Angling for bluegill should be excellent within the next year. Relative weights were not calculated in 2009 (Table D-2).

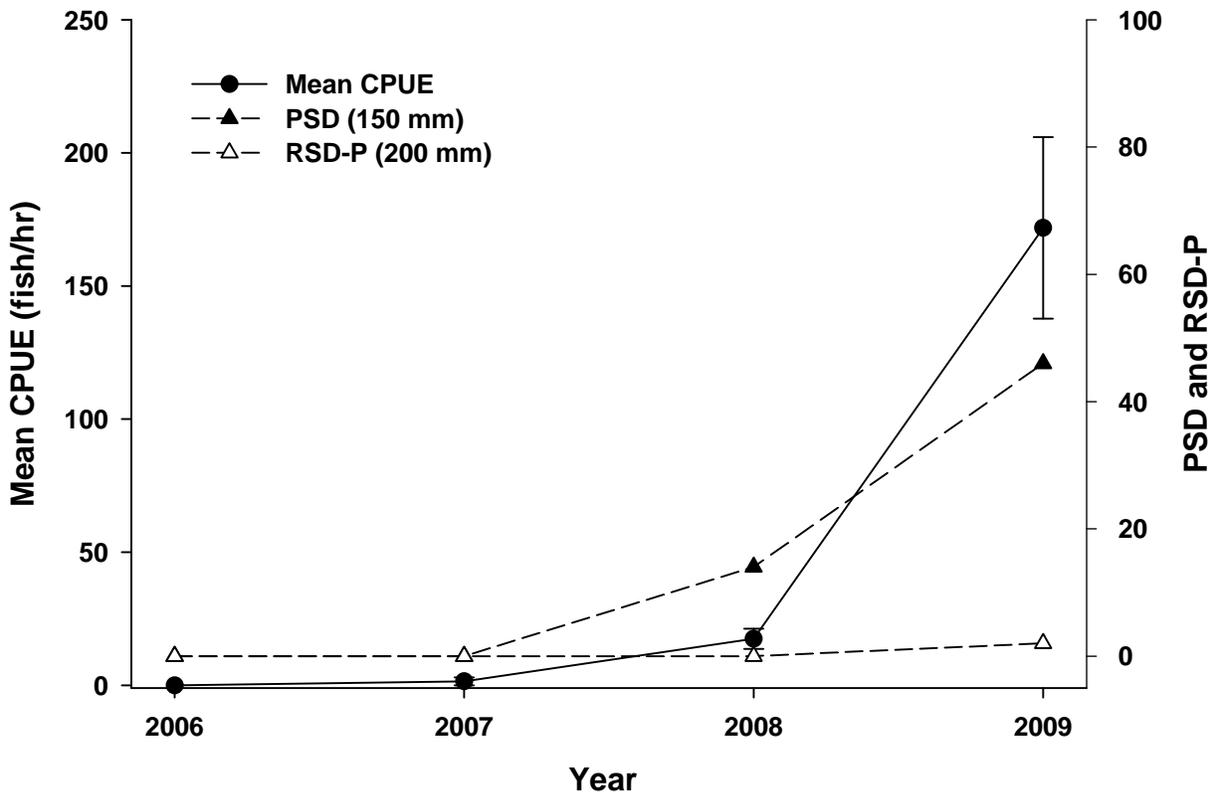


Figure D-2. Annual relative abundance (fish/hr), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing during the spring in Hackberry Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

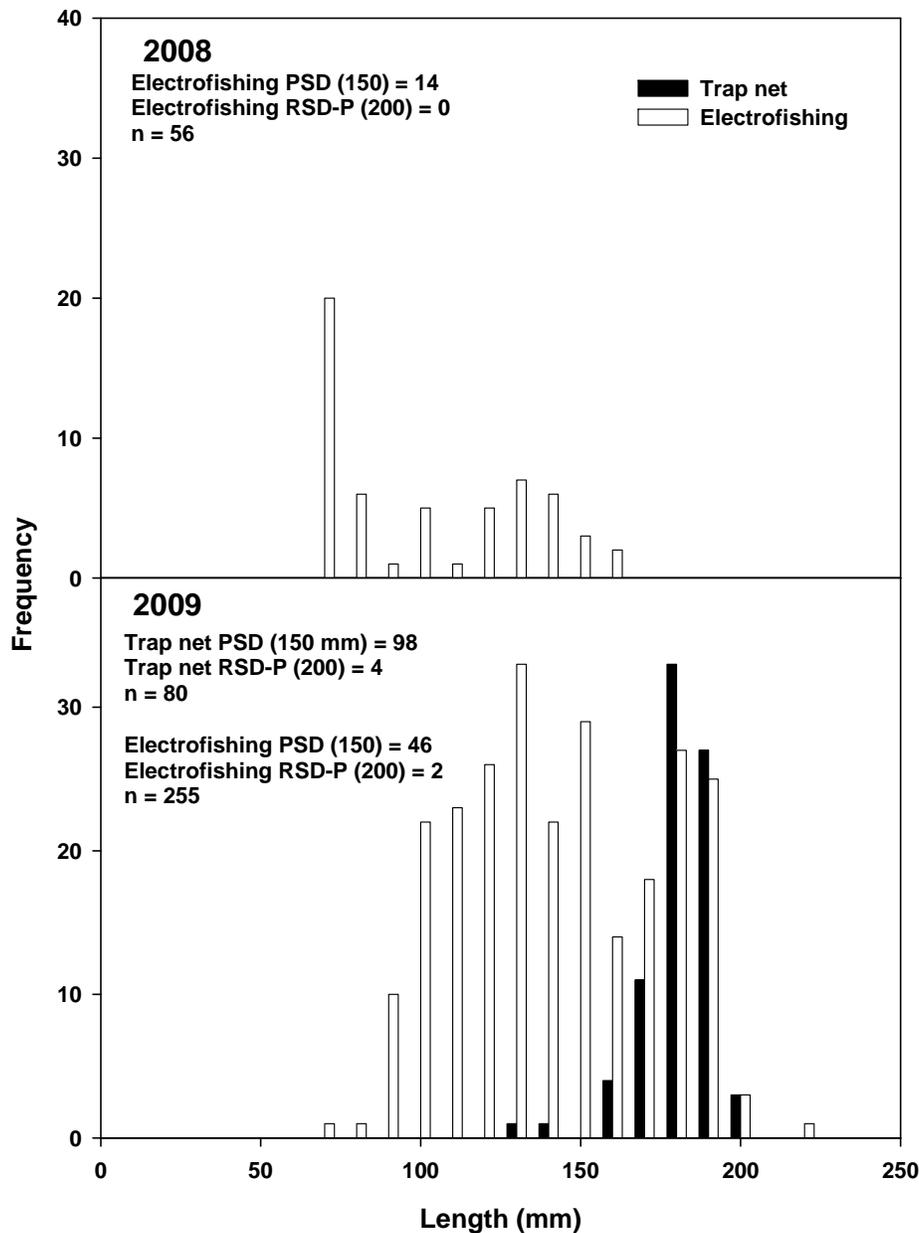


Figure D-3. Length frequency distribution (10-mm length groups) for bluegill in Hackberry Lake captured by trap nets (black bars) in May 2009 and electrofishing (white bars) in May 2008 and 2009.

Table D-2. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Hackberry Lake from 2008 to 2009.

Year	Overall W_r	Stock - Quality (80-150 mm) (3-6 in)	Quality - Preferred (150-200 mm) (6-8 in)	Preferred - Memorable (200-250 mm) (8-10 in)	Memorable - Trophy (250-300 mm) (10-12 in)
2009	a	a	a	a	a
2008	126 (3.1)	125 (3.4)	132 (6.2)	b	b

a = Sampling did not occur or weights were not recorded during that year.

b = Category had less than two samples for mean and SE calculations.

Largemouth bass

It appears that the stocking of > 40,000 fingerling largemouth bass in 2007 was successful as the relative abundance of stock length fish substantially increased in 2009 (Figure D-4). The population was dominated by sub-stock length fish in 2008 and these fish have recruited to stock length in 2009 with a few quality length fish present from previous stockings (Figure D-5). However, we can not exclude the possibility that a few adult largemouth bass may have naturally produced a strong year-class in 2007. Based on the number of sub-stock fish, largemouth bass are successfully spawning in Hackberry Lake. Relative weight for largemouth bass remains excellent (Table D-3).

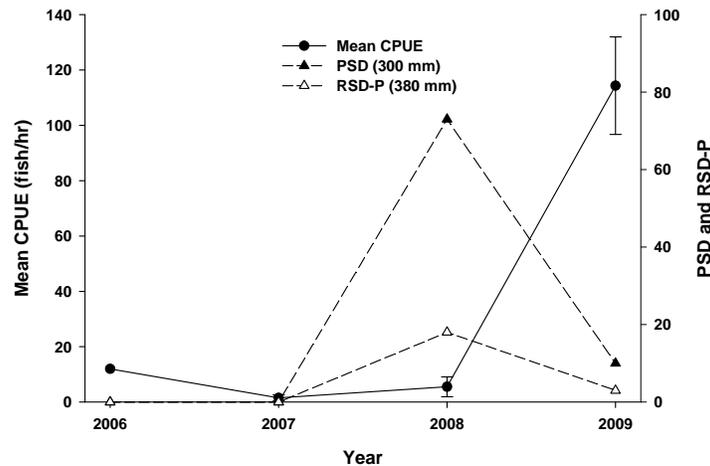


Figure D-4. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing during the spring in Hackberry Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for largemouth bass \geq stock length (200 mm) only.

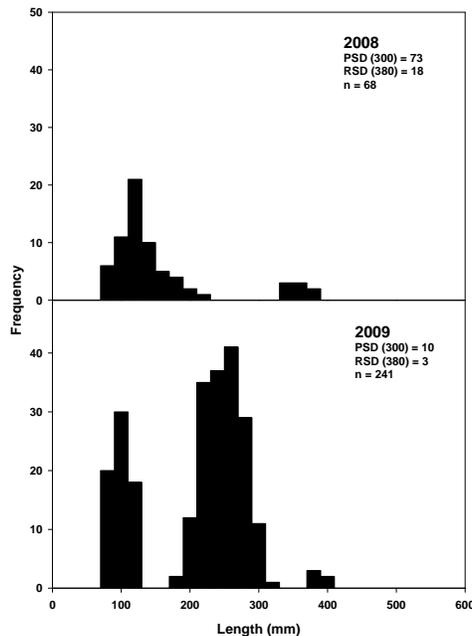


Figure D-5. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing in Hackberry Lake in May 2009.

Table D-3. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing in Hackberry Lake from 2008 to 2009.

Year	Overall W_r	Stock - Quality (200-300 mm) (8-12 in)	Quality - Preferred (300-380 mm) (12-15 in)	Preferred - Memorable (380-510 mm) (15-20 in)	Memorable - Trophy (510-630 mm) (20-25 in)
2009	119 (1.4)	118 (1.6)	121 (3.5)	118 (4.0)	b
2008	121 (1.6)	120 (1.5)	120 (5.6)	148 (2.0)	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall W_r .

Yellow perch

According to the electrofishing data, there was no change in relative abundance from spring 2008 to spring 2009 (Figure D-6). However, fall gill net mean CPUE declined substantially from 2008 to 2009 (Figure D-7) as did the fall mean W_r (Table D-4). Size structure of the yellow perch population is excellent (Figure D-8 and D-9) and one of the most balanced among the Refuge lakes. Excellent angling opportunities exist for yellow perch in Hackberry Lake.

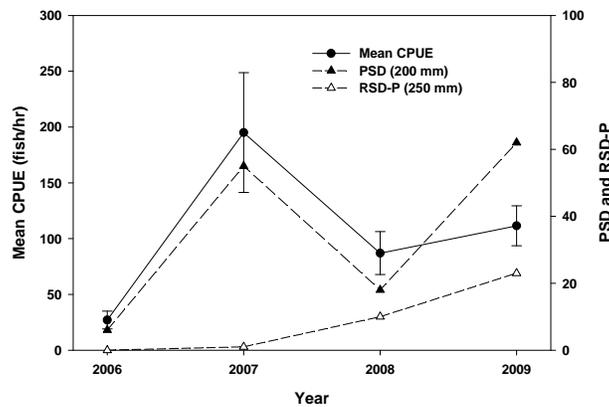


Figure D-6. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by electrofishing during spring in Hackberry Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

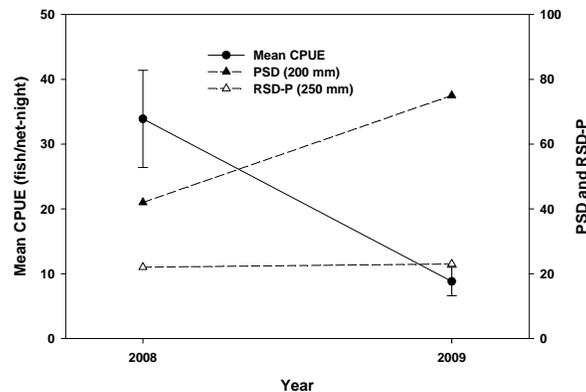


Figure D-7. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets during fall in Hackberry Lake from 2008 to 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

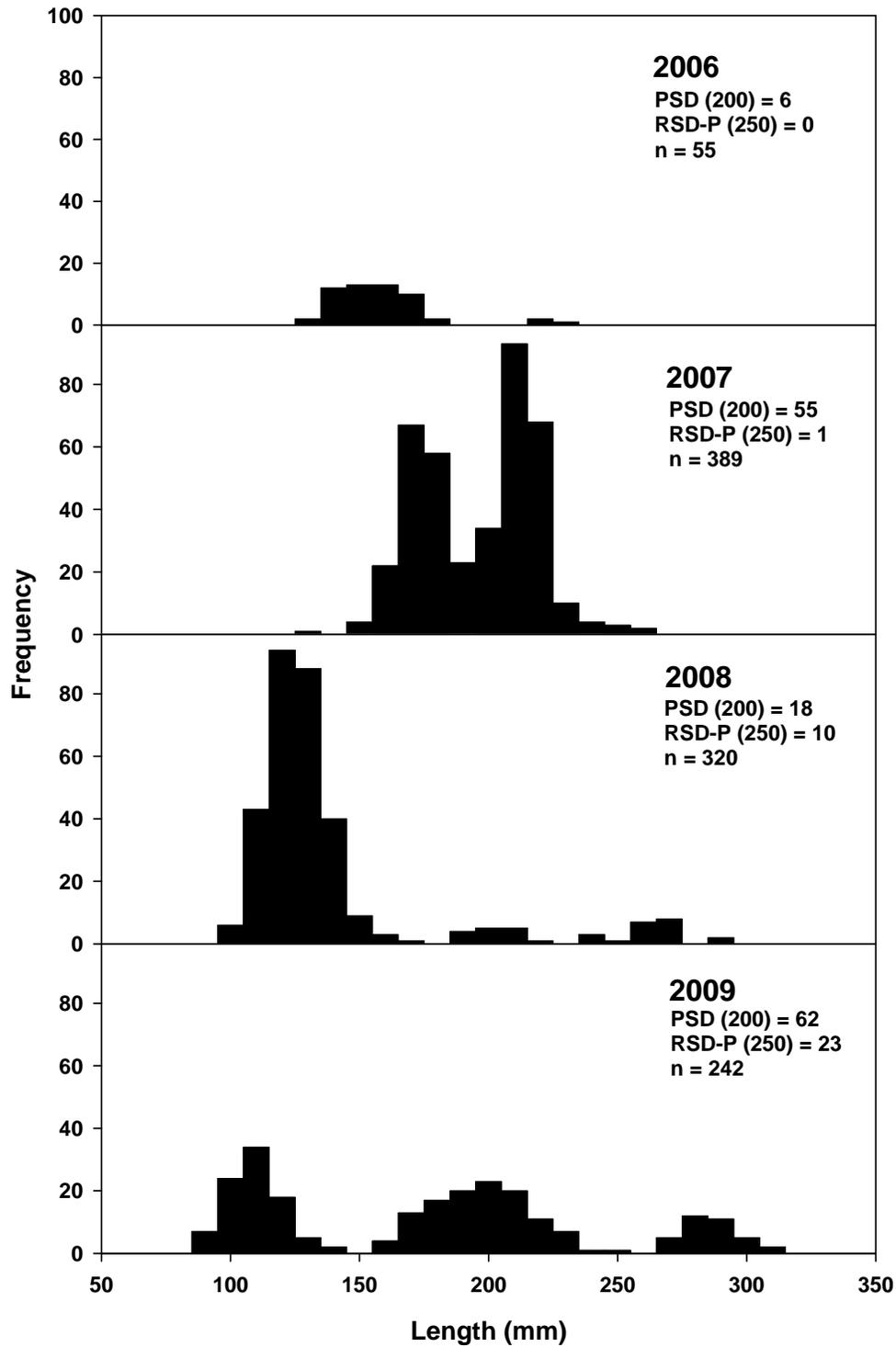


Figure D-8. Length frequency distribution (10-mm length groups) of yellow perch captured by electrofishing during spring in Hackberry Lake from 2006 to 2009.

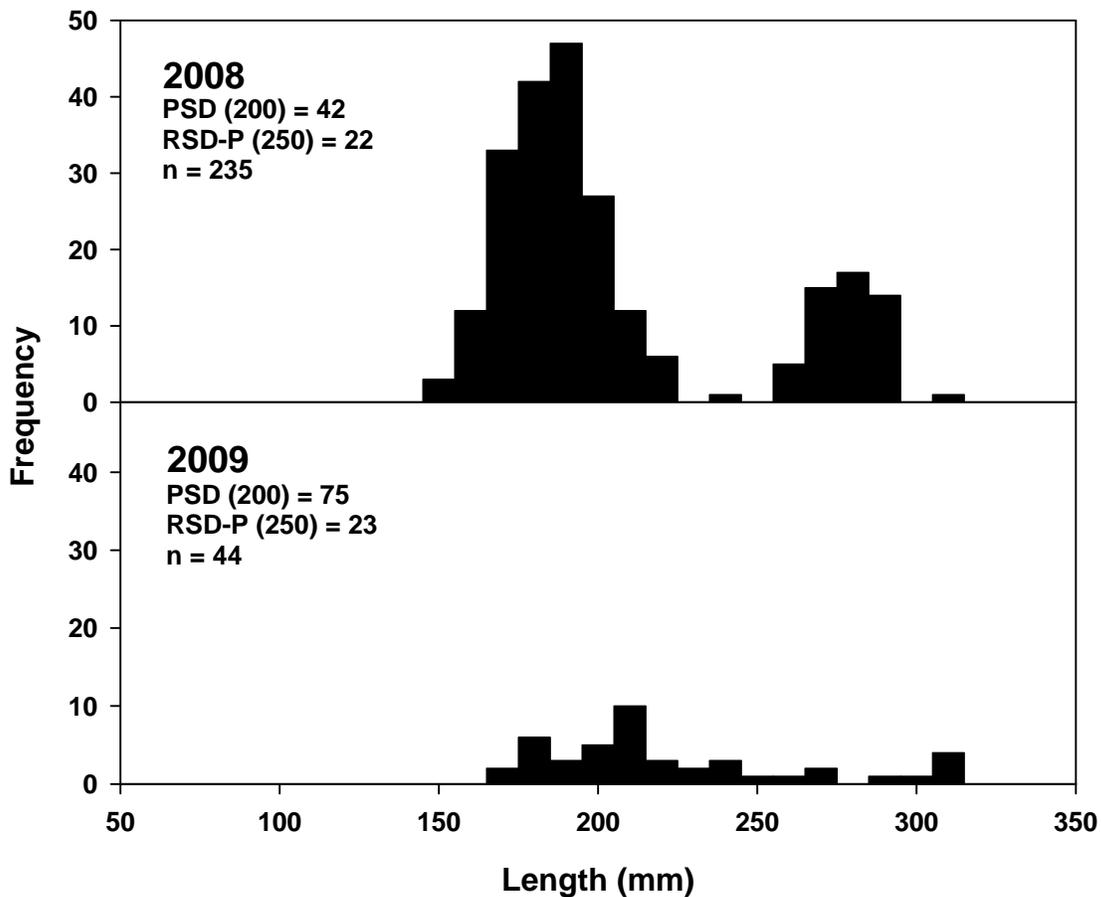


Figure D-9. Length frequency distribution (10-mm length groups) of yellow perch captured by gill netting in Hackberry Lake during the fall in 2008 and 2009.

Table D-4. Yellow perch mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by spring (S) electrofishing or fall (F) gill netting in Hackberry Lake from 2006 to 2009.

Year	Overall W_r	Stock - Quality (130-200 mm) (5-8 in)	Quality - Preferred (200-250 mm) (8-10 in)	Preferred - Memorable (250-300 mm) (10-12 in)	Memorable - Trophy (300-380 mm) (12-15 in)
2009 (F)	92 (1.3)	95 (2.5)	89 (2.0)	95 (3.1)	95 (1.8)
2009 (S)	a	a	a	a	a
2008 (F)	106 (2.0)	114 (2.4)	103 (5.6)	100 (1.4)	b
2008 (S)	104 (1.2)	109 (1.6)	97 (2.3)	102 (2.3)	b
2007 (S)	95 (1.0)	93 (1.2)	97 (1.7)	95 (1.7)	b
2006 (S)	108 (3.4)	107 (3.7)	115 (8.1)	b	b

a = Sampling did not occur or weights were not recorded during that year.

b = Category had less than two samples for mean and SE calculations.

Summary

Common carp – The highest gill net mean CPUE of stock length common carp for Valentine NWR lake was recorded in Hackberry Lake in 2009. All common carp are likely from the same year class.

Northern pike – The population remains at a low abundance.

Bluegill – Relative abundance and size structure continued to improve in Hackberry Lake where angling should be excellent within the next year.

Largemouth bass – Relative abundance and size structure continued to improve in Hackberry Lake where angling should be excellent within the next year.

Yellow perch – Relative abundance did decrease; however, improved size structure will provide excellent angling opportunities.

Management Recommendations

1. Since the introduction of common carp and northern pike, continue annual surveys of electrofishing, trap, and gill netting.
2. Continue to improve boat ramps including handicap accessibility.
3. Identify how common carp and northern pike entered Hackberry Lake.
4. Discuss plans to remove common carp in Hackberry Lake including complete renovation, establish an abundant population of large northern pike, or other carp removal projects.
5. Record water levels in a consistent standardized manner to evaluate effects on spawning success.
6. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

PELICAN LAKE

Lake Description

Pelican Lake is located three miles south of Highway 16B just west of Valentine NWR headquarters then two miles east along the Pelican Lake sub-headquarters road. The roads are black topped most of the way to the lake, and the west boat ramp is usually accessible. The lake receives heavy angling pressure during the spring and again during the winter ice-fishing season. Pelican Lake has been known as the best fishery on the Refuge and is noted for producing trophy bluegill. The excellent fishery is related to the lake depth, the ratio of open water to submergent vegetation during summer, and the abundance of emergent vegetation.

Pelican Lake is 331 surface ha (817 acres). Maximum depth is 3.3 m (10 ft) with a mean depth of 1.3 m (4 ft). Specific conductivity averages 328 $\mu\text{S}/\text{cm}$, total alkalinity averages 160 mg/L, phenolphthalein alkalinity averages 10 mg/L, pH ranges from 8 during winter through spring to 9 during summer and secchi disc readings average 0.3 m. The lake does not develop a thermocline and is a closed system except during periods of excessive rainfall when sheet flow occurs. The lake is situated in the lowlands of the surrounding sandhills, and these conditions create many springs within the lake. The springs provide summer thermal refuge for cool-water species (e.g., northern pike) and are important because surface water temperatures can exceed 30 °C. The bottom is relatively flat and highly organic. These conditions coupled with the shallow depth make the lake susceptible to winter kills when the ice remains snow covered for extended periods. However, the presence of springs likely reduces the occurrence and severity of winter-kills. Emergent vegetation is primarily cattail, bulrush, and *Phragmites*, but scattered stands of wild rice (*Zizania spp.*) occur. Submergent vegetation includes milfoil (*Myriophyllum spp.*), curly-leaf pondweed (*Potamogeton spp.*), and scattered areas of coontail (*Ceratophyllum spp.*). The surrounding watershed is rolling sandhills with mixed grasses with a few cottonwoods and willows along the shoreline. The fishery includes yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and common carp.

Pelican Lake has had a similar history of common carp infestation as the other refuge lakes but to a lesser degree. Pelican Lake was chemically renovated during 1979, but a complete kill did not occur as common carp were captured in 1980 surveys. A limited winter-kill was noted during 1987-88. The spring and summer of 1995-1997 were years with excessive run-off and high water. Many of the refuge lakes, including Pelican, were full and overflowing. The high water resulted in many of the lakes becoming inter-connected and fish movement was observed.

Northern pike size restrictions changed four times from 1987 to 1993 (Appendix B) to improve the size structure and abundance of this species to biologically control common carp populations. Northern pike greater than 28 in have been protected since 1993. The common carp population in Pelican Lake appears to have stabilized since an increase was observed in 2003. It appears that common carp successfully spawn nearly every year and there is some recruitment. Northern pike are likely having an affect on the common carp population; however, current low northern pike numbers may allow a strong common carp year class to establish.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table E-1).

Table E-1. Pelican Lake surface water quality parameters from 1999 to 2009.

Date	Time	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
08/2009	0930	20	8.4		8.9		0	120	317
05/2009	1820	23	8.5	40	8.5		0	153	369
09/2008		20	15.4		9.4	0.2	34	120	308
05/2008		16	11.3			0.2	0	171	298
05/2007		20	7.4		6.8	0.2	17	137	351
06/2006		24	8.1	129	6.9	0.20	0	137	378
08/2005		21			8.5			240	320
09/2004		23		30			0	205	375
09/2003		23							
09/2001		18		36	7.5		8	120	318
07/2001	2000	28	11.7		7.7		25	110	
07/2001	0845	24	7.0		8.7		17	127	
09/2000		18		30	8.0		0	205	
09/1999		14			10.0				

Results and Discussion

Common carp

Gill net mean CPUE substantially decreased from 2007 to 2009 (Figure E-1), while the trap net mean CPUE substantially increased in 2009, but was highly variable (Figure E-2). Overall, the common carp relative abundance appears to be substantially lower compared to the all-time high found in 2003. Even though only three fish were captured in gill nets in 2009, two of the fish were likely from the strong 2006 year class (Figure E-3). Pelican Lake had the lowest gill net mean CPUE for common carp among the large Refuge lakes (Clear, Dewey, and Hackberry).

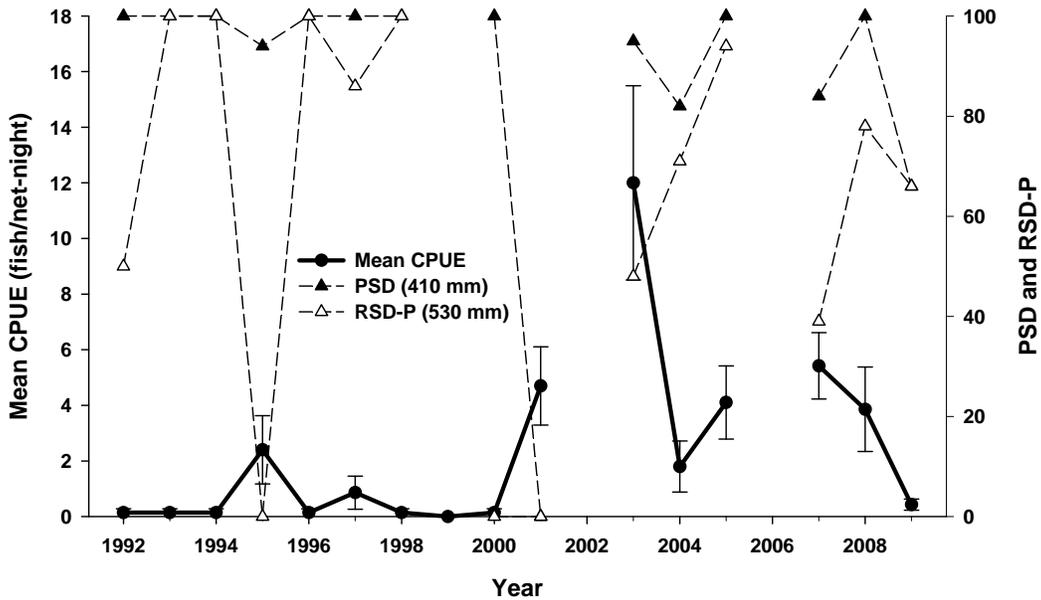


Figure E-1. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp captured gill nets during the fall in Pelican Lake from 1992 to 2009. Mean catch per unit effort (CPUE) calculated for carp \geq stock length (280 mm) only.

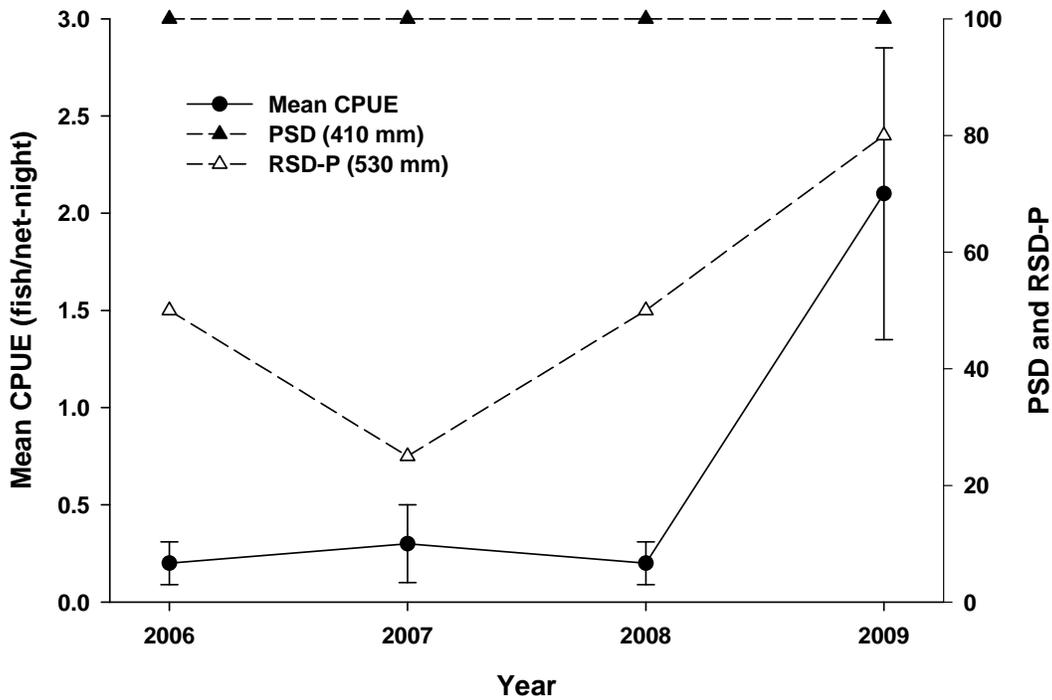


Figure E-2. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp captured by trap nets during the spring in Pelican Lake from 2006-2009. Mean catch per unit effort (CPUE) calculated for common carp \geq stock length (280 mm) only.

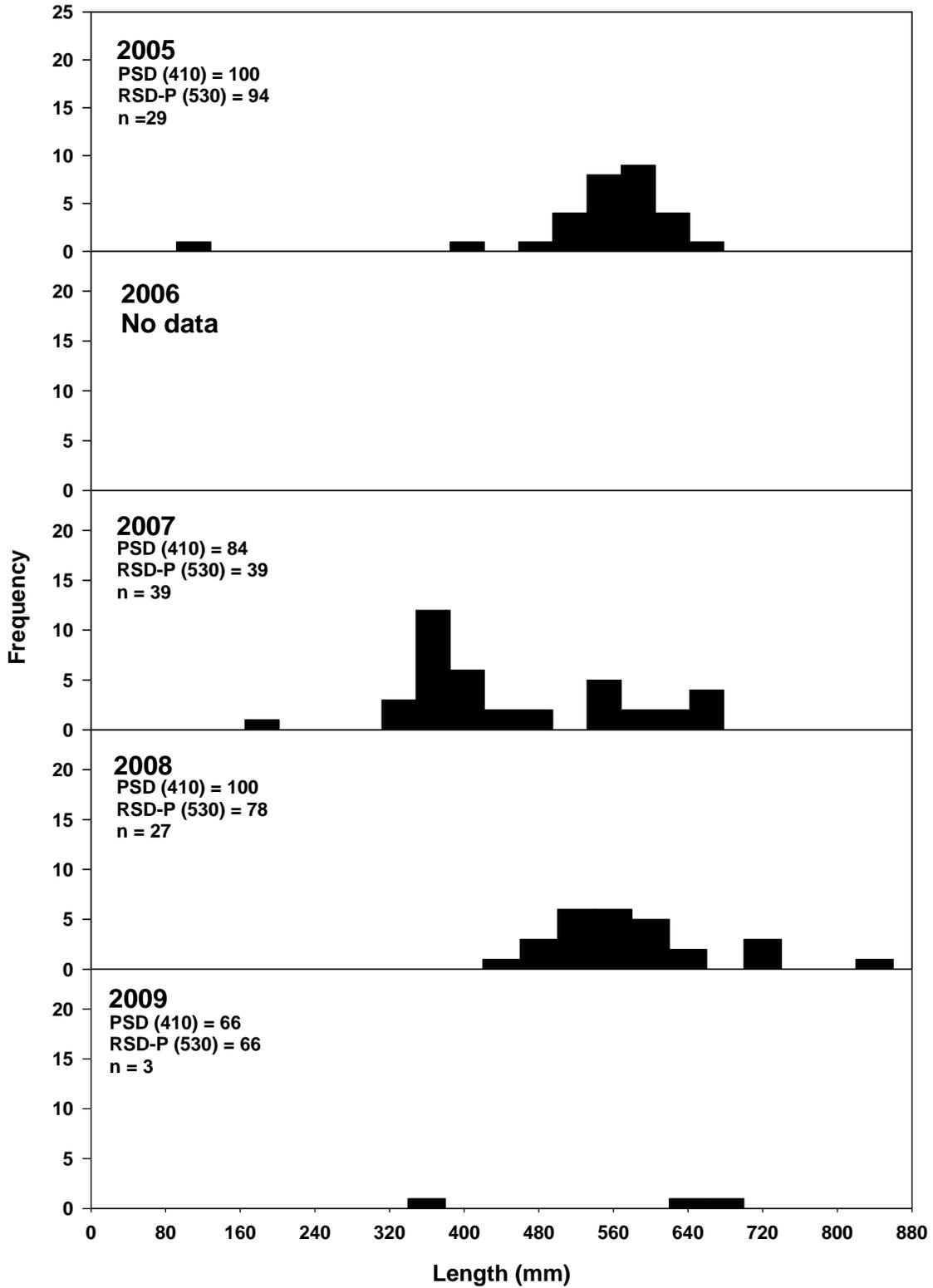


Figure E-3. Length frequency distribution (40-mm length groups) of carp captured in gill nets during the fall in Pelican Lake from 2005 to 2009. Gill nets were not deployed in 2006 due to inaccessibility during low water.

Northern Pike

Although not substantial, a trend has emerged as the northern pike mean length and size structure decreased each year from 2005 to 2009 (Figure E-4). Trap net relative abundance has remained low since 2007 (Figure E-5) and gill net indices also indicate no change in abundance since 2004 (Figure E-6). Pelican Lake rarely produces large (memorable length; ≥ 860 mm) northern pike compared to other Refuge lakes (Clear, Dewey, and Hackberry). The last year that a memorable northern pike was collected in Pelican Lake was 2005 (Figure E-7), while both Clear and Dewey lakes consistently produce large northern pike. Relative weights were normal (Table E-2).

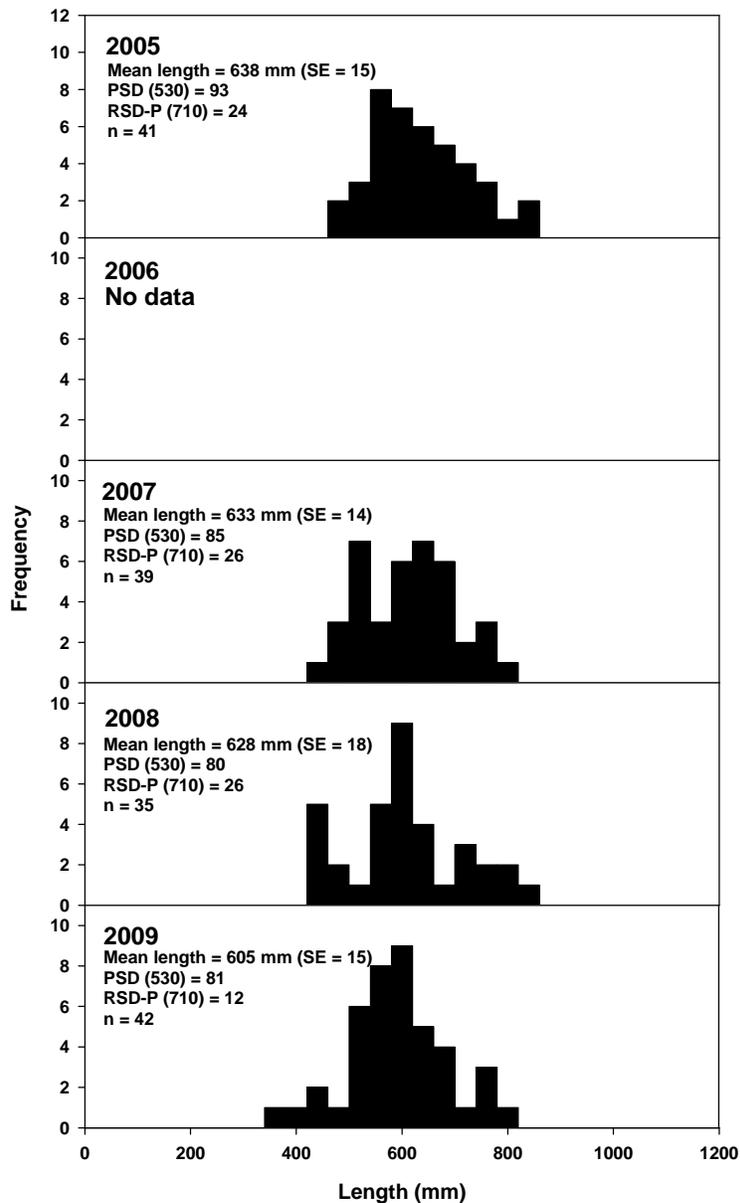


Figure E-4. Length frequency distribution (40-mm length groups) for northern pike captured with gill nets during the fall in Pelican Lake from 2005 to 2009. Gill nets were not deployed in 2006 due to inaccessibility during low water.

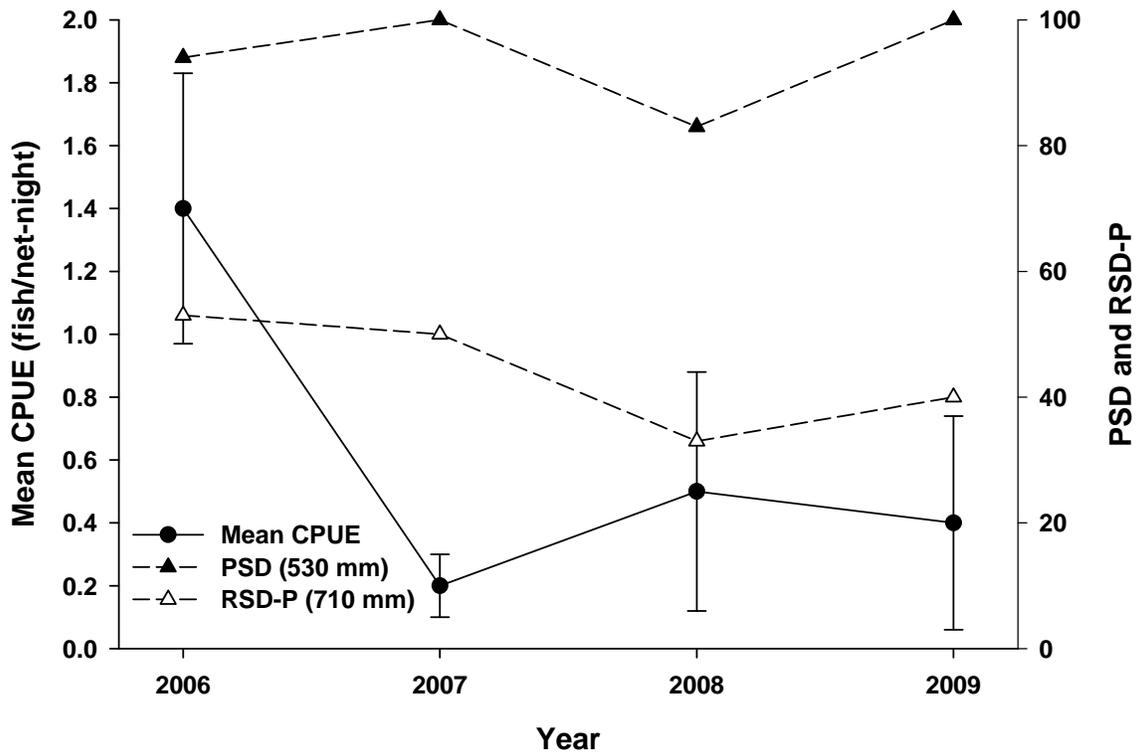


Figure E-5. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of northern pike captured by trap nets during the spring in Pelican Lake from 2006-2009. Mean catch per unit effort (CPUE) calculated for northern pike \geq stock length (350 mm) only.

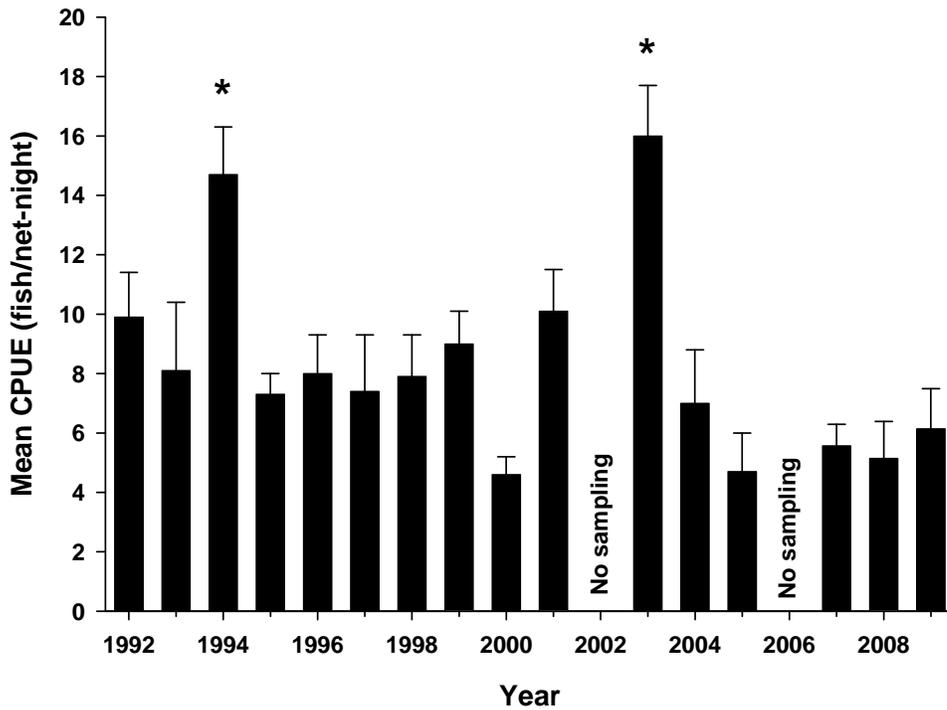


Figure E-6. Northern pike gill net mean catch per unit effort (CPUE) in Pelican Lake from 1992 to 2009. Years with an asterisk were significantly different ($P > 0.20$) from 2009 using ANOVA with Tukey-Kramer multiple comparison tests.

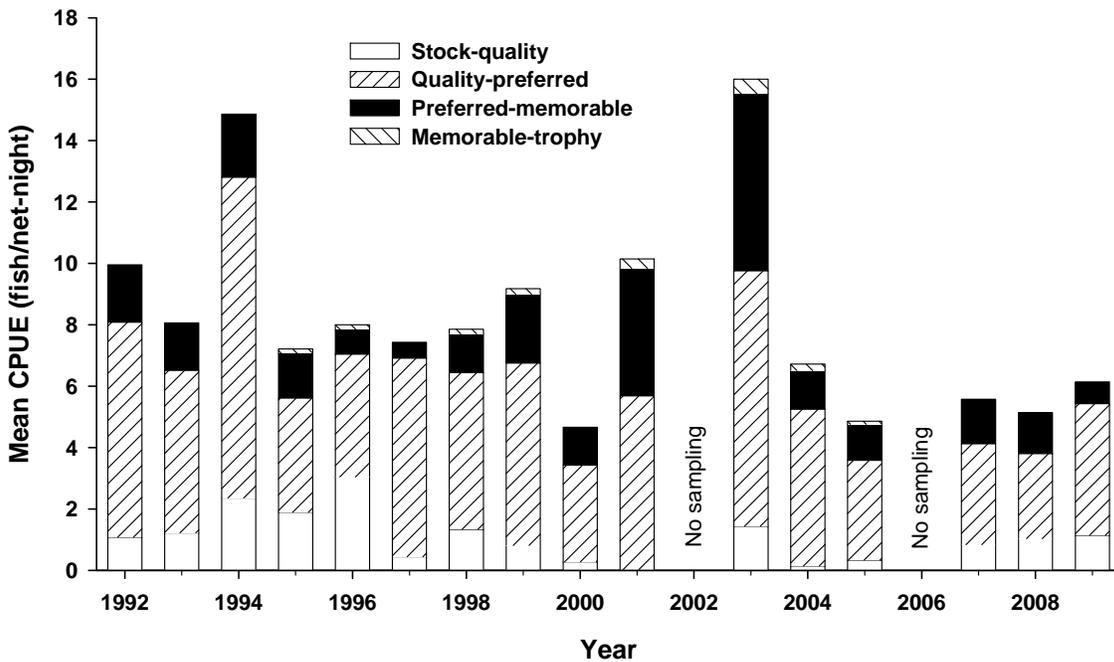


Figure E-7. Gill net mean catch per unit effort (CPUE) for northern pike by length category in Pelican Lake from 1992 to 2009.

Table E-2. Northern pike population size structure, traditional proportional stock density (PSD), and incremental relative stock density (RSD) with mean relative weights (W_r) in Pelican Lake during the fall from 1989 to 2008. Data are pooled for trap and gill nets from 1989 to 2005. Data from 2006 to 2009 are for fall gill nets only. Data are summarized by length categories with 80% confidence intervals (+/-) and “a” denotes small sample size, confidence intervals could not be calculated (Gustafson 1988).

Year	% \geq Quality		Stock - Quality (350-530mm) (14-21 in)			Quality to Preferred (530-710mm) (21-28 in)			Preferred to memorable (710-860mm) (28-34 in)			Memorable to trophy (860-1120mm) (34-44 in)		
	PSD	W_r	RSD	\pm	W_r	RSD	\pm	W_r	RSD	\pm	W_r	RSD	\pm	W_r
2009	81	92	19	9	94	70	10	93	12	a	84	0	a	
2008	80	93	20	11	96	54	13	96	26	12	87	0	a	
2007	85	109	15	a	113	59	18	113	26	a	98	0	a	
2006	No fall gill net sampling in 2006 due to low water levels													
2005	93	90	7	a	108	69	15	94	25	a	74	2	a	75
2004	93	105	2	a	110	73	11	94	18	a	72	3	a	88
2003	91	89	9	14	97	52	10	93	36	12	81	3	a	84
2002	No fall trap or gill netting conducted in 2002 due to low water levels													
2001	100	93	0	a	0	56	9	95	41	9	87	3	a	94
2000	94	88	6	a	82	69	2	89	27	3	86			
1999	91	88	9	6	94	66	9	87	25	8	88	2	a	86
1998	83	89	17	7	90	65	9	89	16	7	87	2	a	91
1997	94	98	6	5	106	87	7	99	7	6	88			
1996	62	93	38	8	96	50	12	92	10	7	88	2	8	96
1995	74	90	26	9	92	51	12	88	20	11	90	2	9	109
1994	84	106	16	5	110	71	6	110	14	5	100	0		
1993	85	90	15	6	90	65	9	97	19	6	93	0		
1992	89	68	11		45	71		72	19		58	0		
1991	94	86	6	5	100	81	7	84	13	6	89	0		
1990	96	91	4	6	95	83	9	92	11	6	91	2		89
1989	86	98	14		101	72		93	8		101	6		102

Bluegill

The relative abundance of bluegill substantially increased in 2009 based on electrofishing surveys (Figure E-8); however, trap net data showed no change in abundance from 2007 to 2009 (Figure E-9). Both gears have tracked the size structure similarly with the bluegill population being dominated by stock to quality length fish since 2008 (Figure E-10). Relative weight data was not calculated in 2009 (Table E-3).

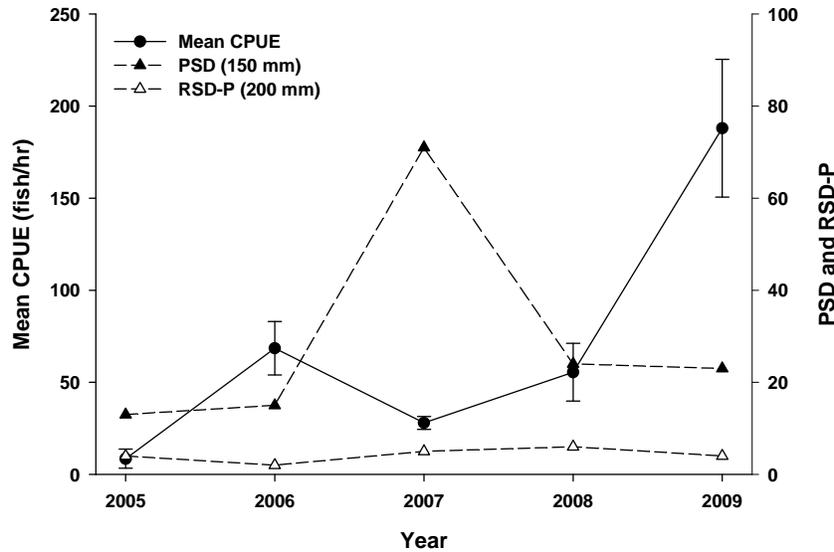


Figure E-8. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing in Pelican Lake from 2005 to 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

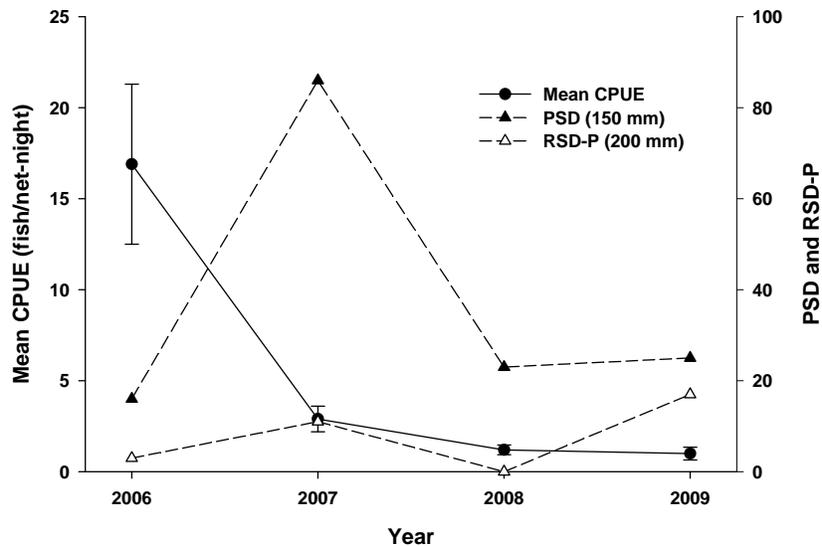


Figure E-9. Annual relative abundance (fish/net-night), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by trap nets during the spring in Pelican Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

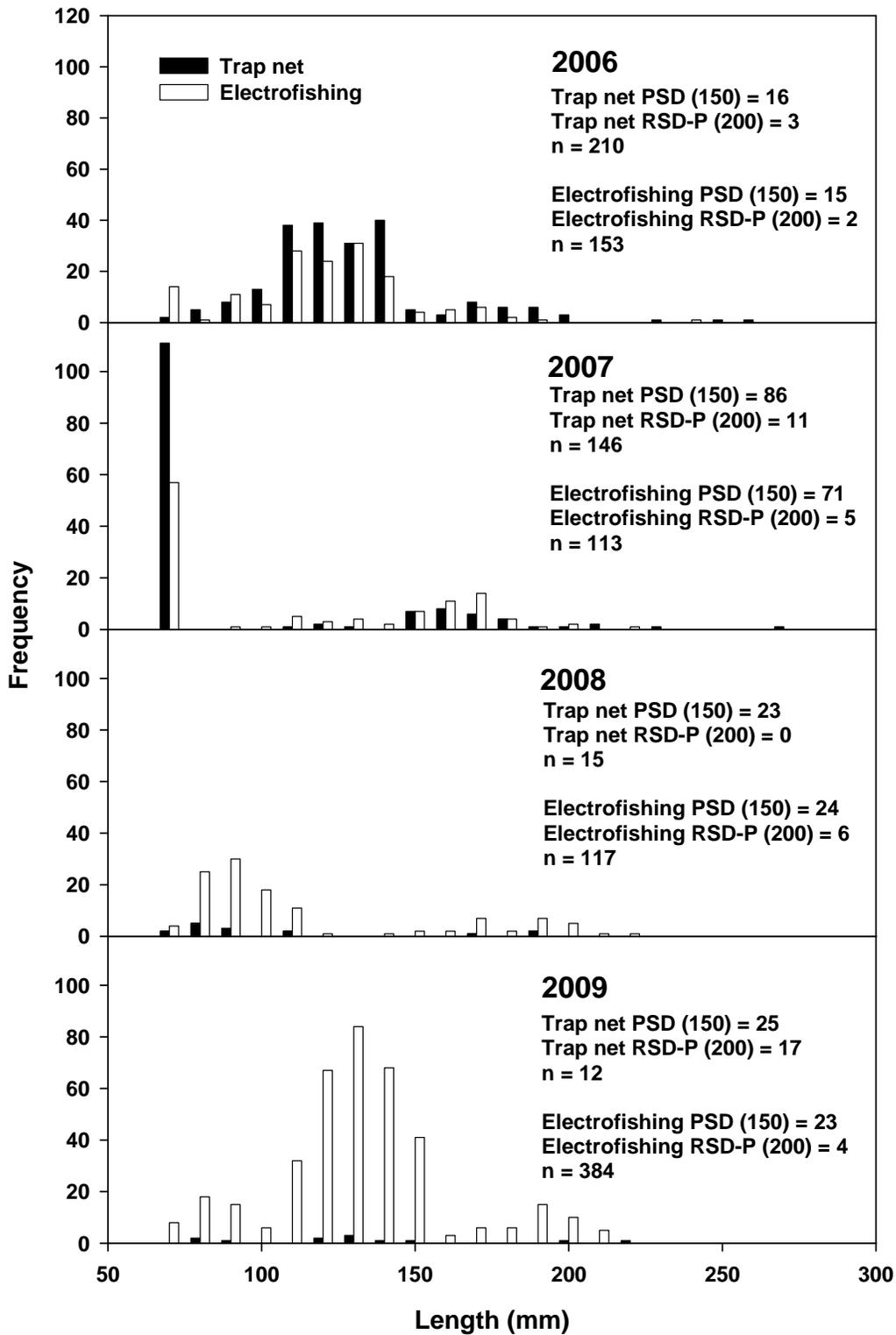


Figure E-10. Length frequency distribution (10-mm length groups) for bluegill captured by trap nets (black bars) and electrofishing (white bars) during the spring in Pelican Lake from 2006 to 2009.

Table E-3. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Pelican Lake from 1992 to 2009. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2009.

Year	Overall W_r	Stock - Quality (80-150 mm) (3-6 in)	Quality - Preferred (150-200 mm) (6-8 in)	Preferred - Memorable (200-250 mm) (8-10 in)	Memorable - Trophy (250-300 mm) (10-12 in)
2009	a	a	a	a	a
2008	106 (1.4)	102 (1.8)	113 (2.1)	107 (3.8)	b
2007	115 (1.5)	113 (2.0)	115 (2.0)	116 (4.6)	b
2006	111 (1.3)	111 (2.0)	113 (1.4)	113 (5.5)	113 (3.8)
2005	115 (1.4)	114 (1.7)	113 (3.5)	126 (2.3)	b
2004	114 (2.3)	109 (2.7)	125 (2.8)	121 (0.1)	b
2003	111 (1.6)	112 (2.4)	111 (3.0)	108 (3.4)	b
2002	a	a	a	a	a
2001	114 (1.9)	105 (2.2)	120 (4.0)	124 (2.4)	b
2000	113 (1.8)	108 (2.9)	115 (2.2)	123 (2.6)	105 (15.6)
1999	121 (1.4)	115 (3.3)	124 (1.2)	123 (3.7)	b
1998	105 (1.4)	100 (2.1)	108 (2.0)	116 (2.7)	109 (2.6)
1997	109 (1.3)	102 (1.6)	109 (2.0)	120 (2.2)	120 (2.4)
1996	118 (1.5)	114 (1.6)	121 (3.4)	126 (4.0)	125 (3.7)
1995	124 (2.0)	113 (1.6)	121 (1.7)	136 (1.6)	142 (3.8)
1994	b	b	b	b	b
1993	119 (3.2)	100 (6.6)	116 (3.9)	132 (3.9)	135 (9.7)
1992	122 (1.8)	113 (2.3)	129 (3.4)	125 (2.3)	b

a = Sampling did not occur or weights were not recorded during that year.

b = Category had less than two samples for mean and SE calculations.

Golden shiner

Six golden shiners were captured in trap nets in 2009 providing an additional prey source.

Largemouth bass

There was no change in the relative abundance of largemouth bass from 2008 to 2009 (Figure E-11). The 2009 largemouth bass population had a high proportion of quality and preferred length fish providing excellent angling opportunities for large fish (Figure E-12). Mean W_r was excellent, indicating an abundance of prey (Table E-4).

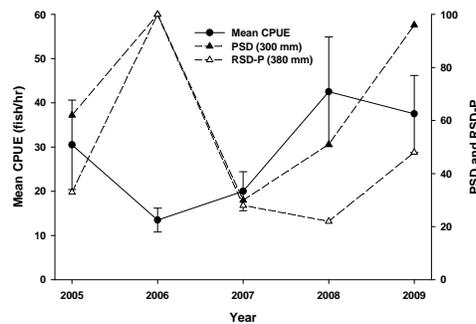


Figure E-11. Annual relative abundance (largemouth bass/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by spring time electrofishing in Pelican Lake from 2005 to 2009. Mean catch per unit effort (CPUE) calculated for largemouth bass \geq stock length (200 mm) only.

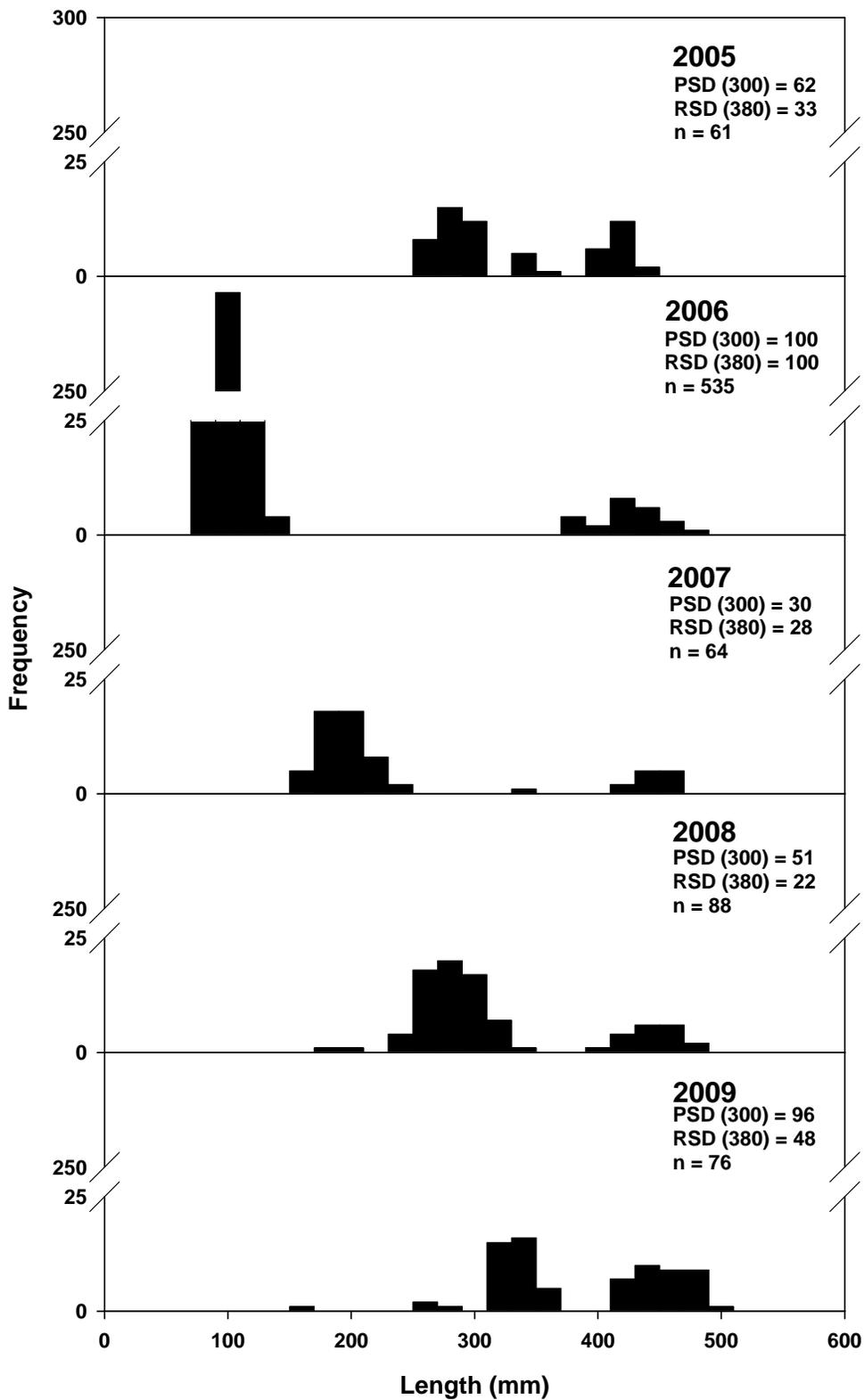


Figure E-12. Largemouth bass length frequency distribution (20-mm length groups) captured by electrofishing during the spring in Pelican Lake from 2005 to 2009.

Table E-4. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing in Pelican Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (200-300 mm) (8-12 in)	Quality - Preferred (300-380 mm) (12-15 in)	Preferred - Memorable (380-510 mm) (15-20 in)	Memorable - Trophy (510-630 mm) (20-25 in)
2009	118 (1.2)	116 (7.8)	118 (2.2)	118 (1.4)	b
2008	108 (1.3)	107 (1.7)	107 (1.7)	111 (3.2)	b
2007	117 (2.1)	111 (2.0)	130 (5.0)	123 (4.0)	b
2006	108 (3.0)	b	b	108 (3.0)	b
2005	103 (2.2)	103 (3.3)	92 (4.8)	113 (1.8)	b
2004	120 (4.0)	136 (6.6)	b	114 (4.1)	b
2003	124 (2.4)	b	b	125 (2.5)	b
2002	a	a	a	a	a
2001	123 (5.2)	138 (0.4)	b	120 (3.3)	b
2000	118 (1.2)	131 (6.1)	115 (1.3)	120 (1.7)	b
1999	124 (1.4)	125 (2.2)	125 (2.1)	122 (3.6)	b
1998	128 (1.4)	126 (1.9)	126 (2.1)	133 (3.2)	b
1997	125 (2.4)	124 (2.7)	119 (7.2)	131 (5.7)	b
1996	133 (2.0)	135 (1.8)	b	125 (8.7)	b
1995	128 (5.2)	139 (16.6)	125 (3.1)	122 (5.2)	b
1994	135 (1.9)	128 (6.1)	141 (2.3)	131 (2.9)	126 (0.8)
1993	125 (6.2)	128 (6.4)	b	123 (11.1)	b
1992	129 (2.0)	131 (1.9)	b	122 (0.1)	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Yellow perch

Yellow perch gill net mean CPUE has declined the past two years (Figure E-13) and no yellow perch were collected in trap nets in 2009 (Figure E-14). Few preferred length fish exist in Pelican Lake (Figure E-15). Mean W_r was normal (Table E-5).

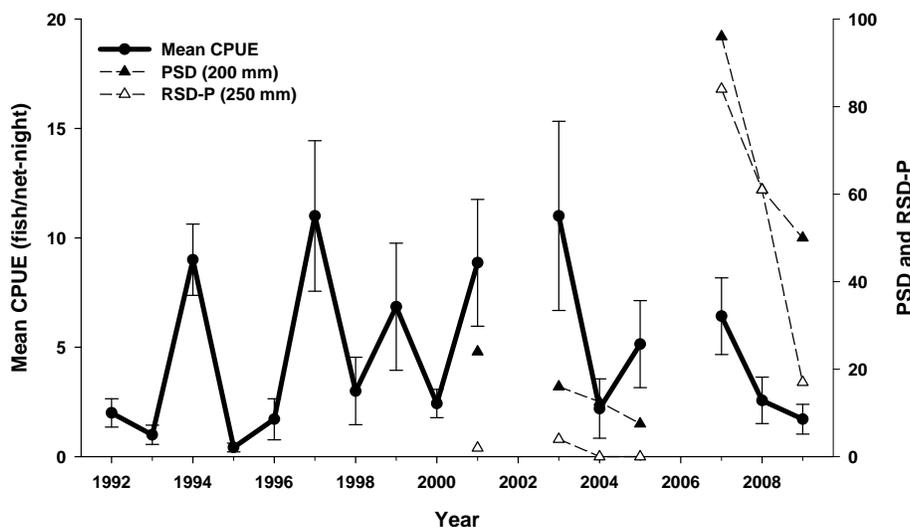


Figure E-13. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets during the fall in Pelican Lake from 1992 to 2009. Mean catch per unit effort (CPUE) calculated for perch \geq stock length (130 mm) only.

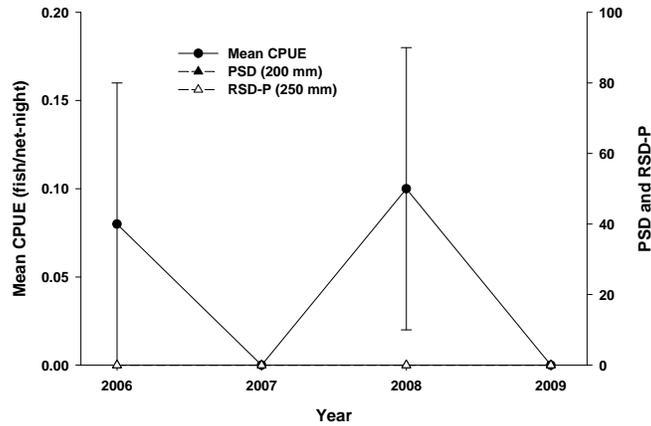


Figure E-14. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by trap nets during the spring in Pelican Lake from 2006 to 2009. Mean catch per unit effort (CPUE) calculated for perch \geq stock length (130 mm) only.

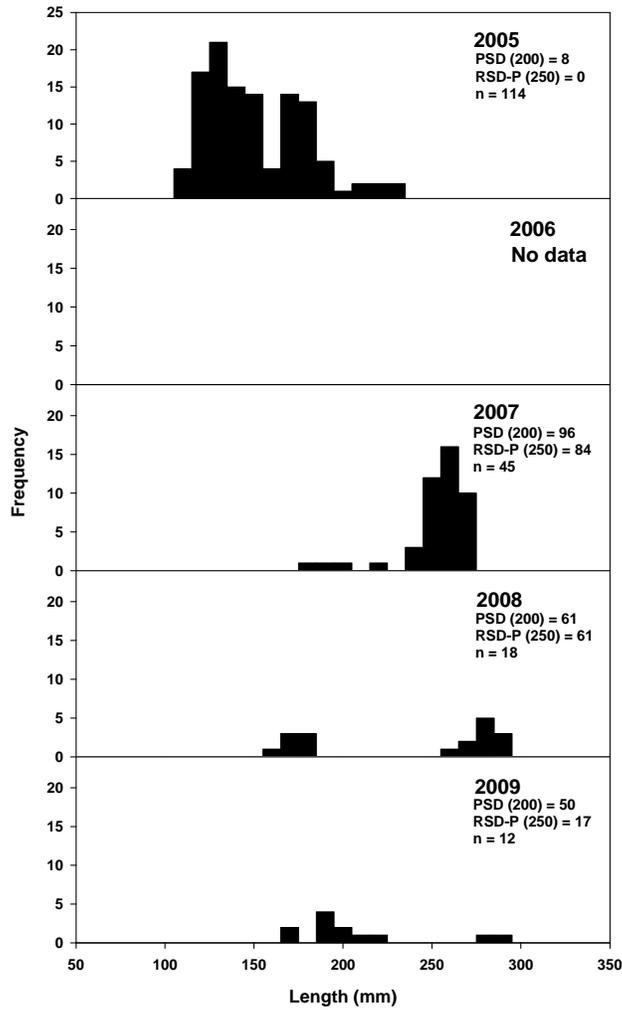


Figure E-15. Length frequency distribution (10-cm length groups) of yellow perch captured by gill nets during the fall in Pelican Lake from 2005 to 2008. Gill nets were not deployed in 2006 due to inaccessibility during low water.

Table E-5. Yellow perch mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by gill nets during the fall in Pelican Lake from 1992 to 2008.

Year	Overall W_r	Stock - Quality (130-200 mm) (5-8 in)	Quality - Preferred (200-250 mm) (8-10 in)	Preferred - Memorable (250-300 mm) (10-12 in)	Memorable - Trophy (300-380 mm) (12-15 in)
2009	97 (2.1)	99 (1.4)	95 (5.4)	93 (7.8)	b
2008	94 (2.2)	94 (2.5)	86 (3.9)	103 (2.2)	b
2007	97 (1.3)	92 (2.5)	102 (4.9)	97 (0.9)	b
2006	a	a	a	a	a
2005	98 (0.9)	99 (1.0)	97 (2.3)	b	b
2004	100 (5.7)	92 (1.7)	109 (11.6)	b	b
2003	102 (1.9)	103 (2.6)	97 (2.4)	109 (8.7)	b
2002	a	a	a	a	a
2001	97 (1.6)	99 (2.0)	92 (2.3)	b	b
2000	100 (4.5)	98 (2.8)	118 (32.4)	b	96 (5.5)
1999	94 (1.2)	94 (1.3)	b	90 (3.6)	b
1998	98 (2.3)	97 (3.4)	b	99 (4.0)	97 (2.8)
1997	96 (1.0)	96 (1.3)	95 (1.7)	99 (3.3)	99 (7.0)
1996	95 (2.8)	91 (1.6)	b	112 (8.7)	b
1995	87 (3.9)	91 (2.8)	b	b	b
1994	100 (2.3)	95 (2.3)	112 (3.7)	b	121 (0.4)
1993	97 (6.0)	96 (9.5)	97 (3.2)	b	b
1992	93 (1.4)	92 (1.4)	b	b	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Summary

Common carp – Pelican Lake has one of the lowest relative abundance of common carp among the Refuge lakes. Mean CPUE has remained low since an all-time high observed in 2003.

Northern pike – Relative abundance and size structure has remained unchanged since 2004. No memorable length fish have been collected since 2005.

Bluegill – Relative abundance of bluegill increased but there were few preferred length fish.

Largemouth bass – Stable numbers of quality and preferred length largemouth bass exist in Pelican Lake providing excellent angling opportunities.

Yellow perch – Pelican Lake continues to have a low abundance of yellow perch.

Management Recommendations

1. Continue the 28 in maximum size limit for northern pike. Encourage catch and release for northern pike to maintain and increase the adult population.
2. Continue to improve boat ramp accessibility. Turn pole holders around on dock to open water side. Extend dock past vegetation or remove vegetation to improve fishing opportunities from the new dock.
3. Record water levels in a consistent standardized manner to evaluate effects on spawning success.
4. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.
5. Continue annual surveys.

DUCK LAKE

Lake Description

Duck Lake is 1.5 miles south of Highway 16B on an unnamed County Highway. The lake receives moderate fishing during spring and fall, but heavy submergent vegetation during summer precludes fishing during this period. Winter ice-fishing is popular when access to the bigger lakes is restricted by inaccessible roads.

Common carp have never been identified in Duck Lake; therefore, chemical renovations have not been necessary. A ditch connects Duck and Rice Lakes, but otherwise the lake is a closed system with no water control structures or draw down capabilities.

The fishery includes yellow perch, largemouth bass, bluegill, pumpkinseed (*Lepomis gibbosus*), orangespotted sunfish (*Lepomis humilis*), and bullheads. The lake is 27 surface hectares (66 ac); maximum depth is 3.3 m (8 ft) and the average depth is 1.3 m (4 ft). The shoreline is surrounded by cottonwoods and willows with a dense understory of brush and short grasses.

The bottom is relatively flat and highly organic around the edge. About 90% of the bottom is sand and 10% organic silt. Rocky areas are located on the south side and north east corner and during the spring largemouth bass generally congregate in these areas to spawn. The lake's shallow depth makes it susceptible to winter-kills, but underground springs appear to moderate the kill occurrences. Emergent vegetation, predominately cattail, bulrush, and scattered areas of phragmites form a ring around most of the lake. During summer, submergent vegetation, narrow & curly-leaf pond weed, coontail, and duck weed cover about 99% of the lake.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table F-1). Specific conductivity averages 292 $\mu\text{S}/\text{cm}$, total alkalinity averages 174 mg/L, phenolphthalein alkalinity averages 31 mg/L, pH ranges from 8.5 during winter/spring to 10 during summer, and secchi disc readings average 2.0 m. The lake is too shallow to develop a thermocline and summer surface water temperatures reach 30 °C.

Table F-1. Duck Lake surface water quality parameters from 2001 to 2009.

Date	Time	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)
08/2009	1045	22	9.8		8.8		0	120	257
06/2009	0220	15	8.7	68	9.3		0	119	290
05/2007		22	10.8	154	6.7	0.1	51	154	333
06/2005		19			7.1		0	290	260
09/2001		16		> 90	10.1		0	120	284
07/2001	0940	25	10.8		9.6		51	154	
07/2001	2100	28	12.5		8.1		51	154	

Results and Discussion

Bluegill

Both electrofishing (Figure F-1) and trap net (Figure F-2) data indicated that the relative abundance of stock length bluegill increased from 2007 to 2009. The size structure also increased (Figure F-3) with the abundant stock to quality length largemouth bass controlling the bluegill population in Duck Lake. Duck Lake had the highest number of preferred length bluegills among Refuge lakes. Relative weight data was not calculated in 2009 (Table F-2).

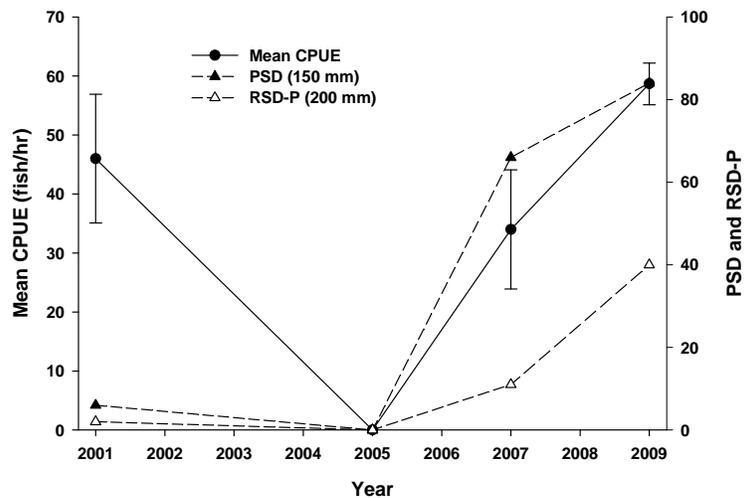


Figure F-1. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills sampled by electrofishing during the spring in Duck Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

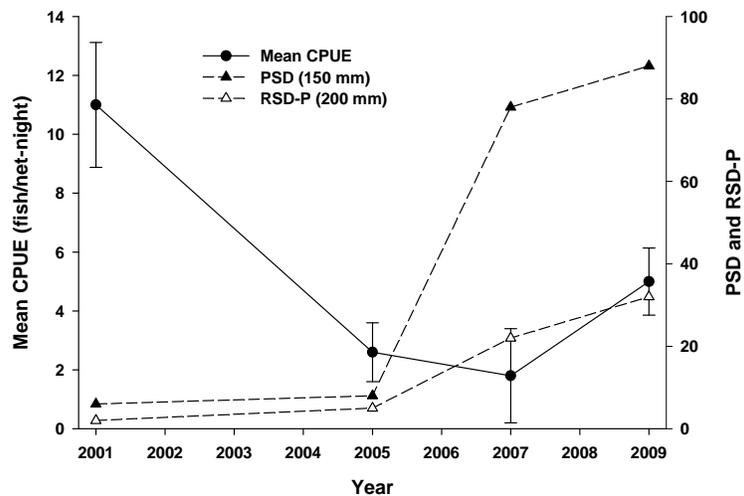


Figure F-2. Annual relative abundance (fish/net-night), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by trap nets during the spring in Duck Lake during 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

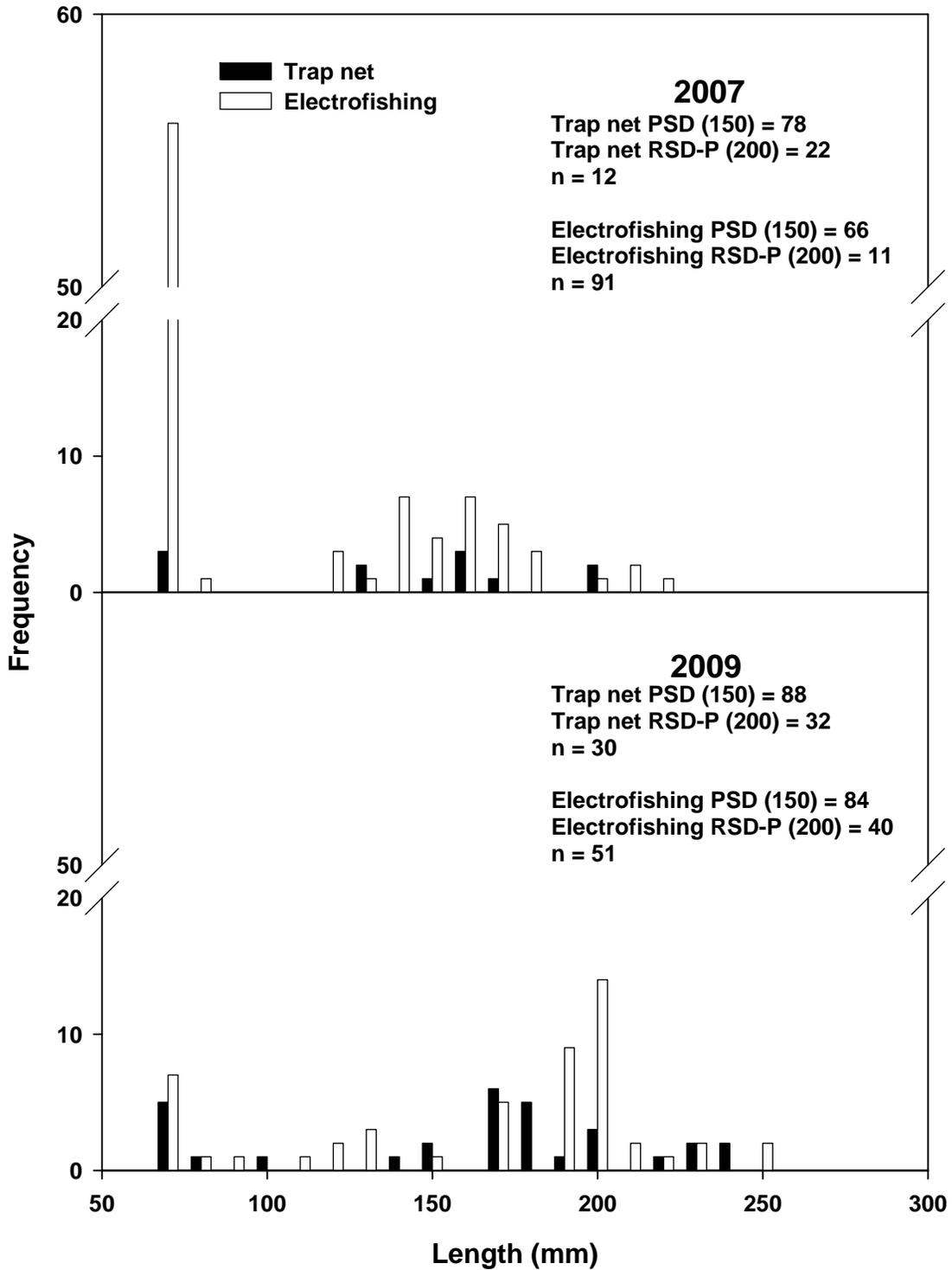


Figure F-3. Length frequency distribution (10-mm length groups) for bluegill captured by trap nets (black bars) and electrofishing (white bars) during the spring in Duck Lake in 2007 and 2009.

Table F-2. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by trap nets and electrofishing during the spring in Duck Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (80-150 mm) (3-6 in)	Quality - Preferred (150-200 mm) (6-8 in)	Preferred - Memorable (200-250 mm) (8-10 in)	Memorable - Trophy (250-300 mm) (10-12 in)
2009	a	a	a	a	a
2008	a	a	a	a	a
2007	129 (2.7)	119 (2.8)	129 (3.8)	142 (114)	b
2006	a	a	a	a	a
2005	113 (2.1)	112 (1.6)	b	b	b
2004	a	a	a	a	a
2003	a	a	a	a	a
2002	a	a	a	a	a
2001	85 (2.1)	111 (2.9)	111 (3.7)	b	b
2000	a	a	a	a	a
1999	a	a	a	a	a
1998	a	a	a	a	a
1997	a	a	a	a	a
1996	a	a	a	a	a
1995	106 (1.4)	110 (2.2)	129 (1.7)	134 (2.2)	b
1994	a	a	a	a	a
1993	117 (1.8)	114 (3.3)	119 (2.4)	118 (4.1)	b
1992	122 (3.7)	118 (6.2)	128 (5.0)	120 (9.4)	b

a = Sampling did not occur or weights were not recorded during that year.
 b = Category had less than two samples for mean and SE calculations.

Largemouth bass

The relative abundance of stock length largemouth bass substantially increased in 2009 (Figure F-4) as the 2006 year class did recruit to the population (Figure F-5). Relative weights were good for stock to quality length fish, while preferred length fish had low relative weights (Table F-3).

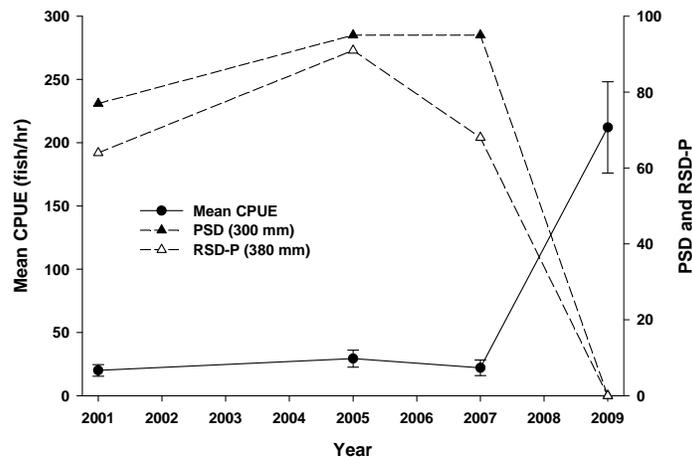


Figure F-4. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing during the spring in Duck Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for largemouth bass \geq stock length (200 mm) only.

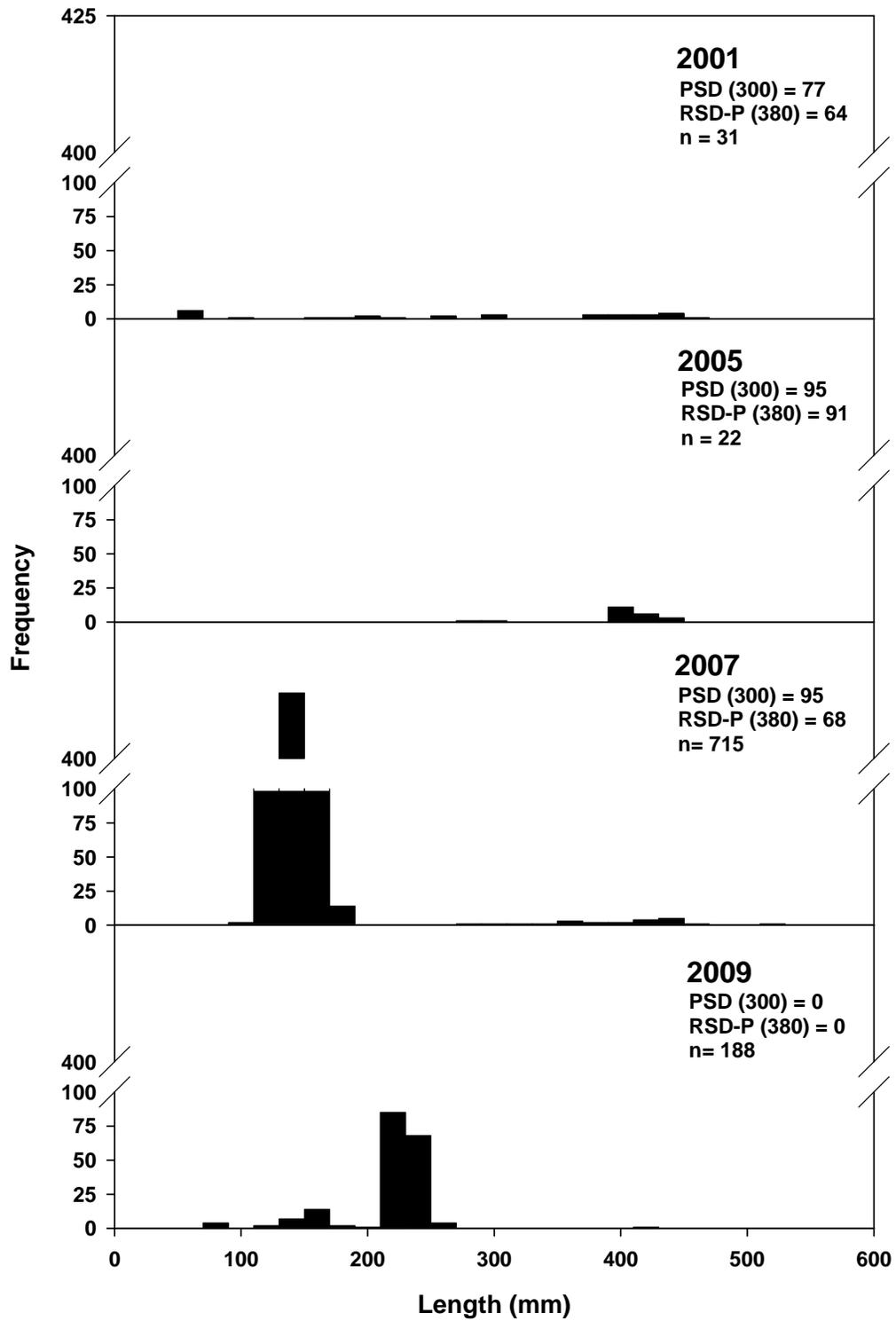


Figure F-5. Largemouth bass length frequency distribution (20-mm length groups) captured by electrofishing in Duck Lake during the spring in 2001, 2005, 2007, and 2009.

Table F-3. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing during the spring in Duck Lake, Valentine NWR from 1992 to 2009.

Year	Overall W_r	Stock - Quality (200-300 mm) (8-12 in)	Quality - Preferred (300-380 mm) (12-15 in)	Preferred - Memorable (380-510 mm) (15-20 in)	Memorable - Trophy (510-630 mm) (20-25 in)
2009	118 (4.1)	105 (2.1)	b	91 (2.8)	b
2008	a	a	a	a	a
2007	97 (4.3)	109 (12.4)	98 (2.6)	91 (5.1)	b
2006	a	a	a	a	a
2005	113 (2.1)	118 (7.3)	113 (8.9)	111 (2.1)	b
2004	a	a	a	a	a
2003	a	a	a	a	a
2002	a	a	a	a	a
2001	111 (4.8)	122 (19.7)	113 (1.8)	106 (3.3)	b
2000	a	a	a	a	a
1999	a	a	a	a	a
1998	a	a	a	a	a
1997	a	a	a	a	a
1996	a	a	a	a	a
1995	106 (1.4)	104 (2.5)	106 (1.5)	108 (5.4)	b
1994	a	a	a	a	a
1993	104 (2.4)	102 (2.5)	118 (1.2)	103 (8.3)	b
1992	102 (1.3)	102 (1.0)	b	101 (1.9)	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Pumpkinseed

Three pumpkinseed (122 - 134 mm) were collected in trap nets and one fish (122 mm) was collected while electrofishing in 2009. Pumpkinseeds were first detected in Duck Lake in 2005. No pumpkinseeds were collected in 2007. Pumpkinseed will likely remain at low abundances and have little recreational angler value.

Yellow perch

The relative abundance of yellow perch remains low in Duck Lake (Figures F-6 and F-7), especially when compared to other Refuge lakes. The population is dominated by larger, preferred length fish (Figure F-8). Relative weights were normal (Table F-4).

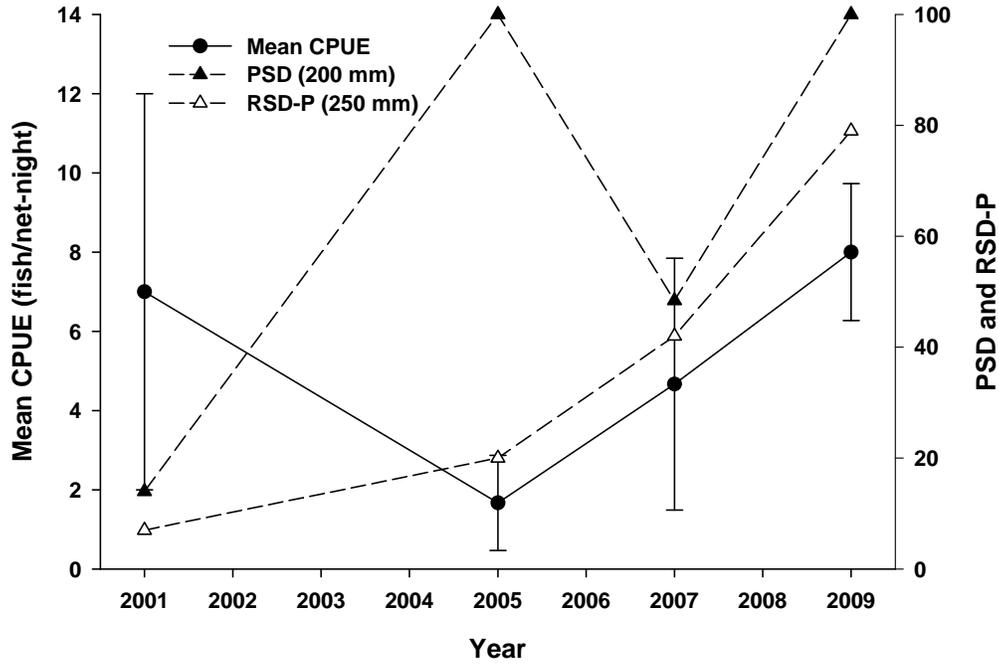


Figure F-6. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets during the fall in Duck Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

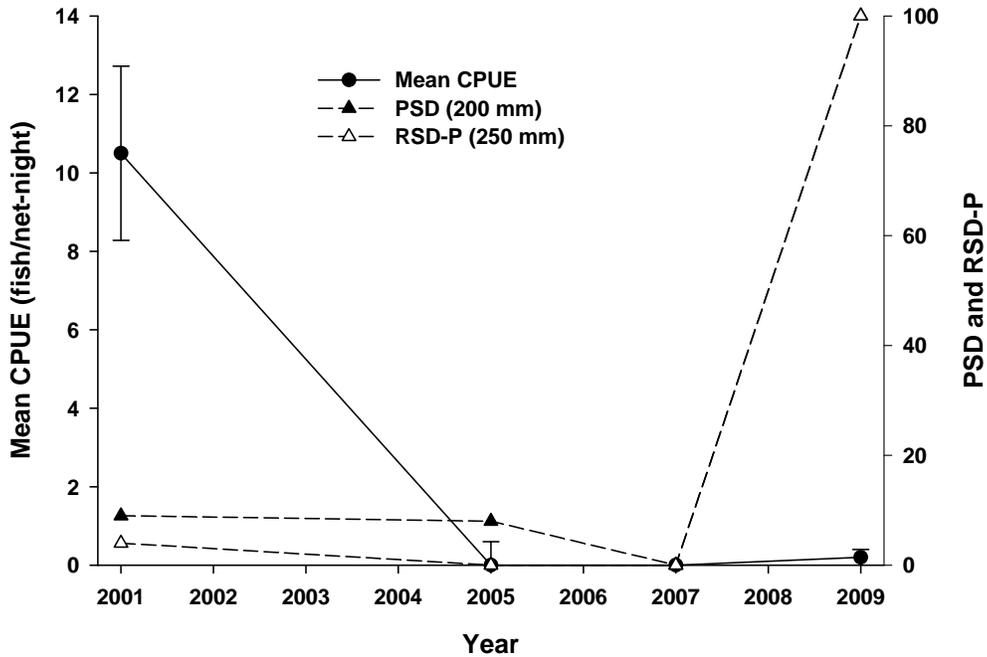


Figure F-7. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by trap nets during the spring in Duck Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

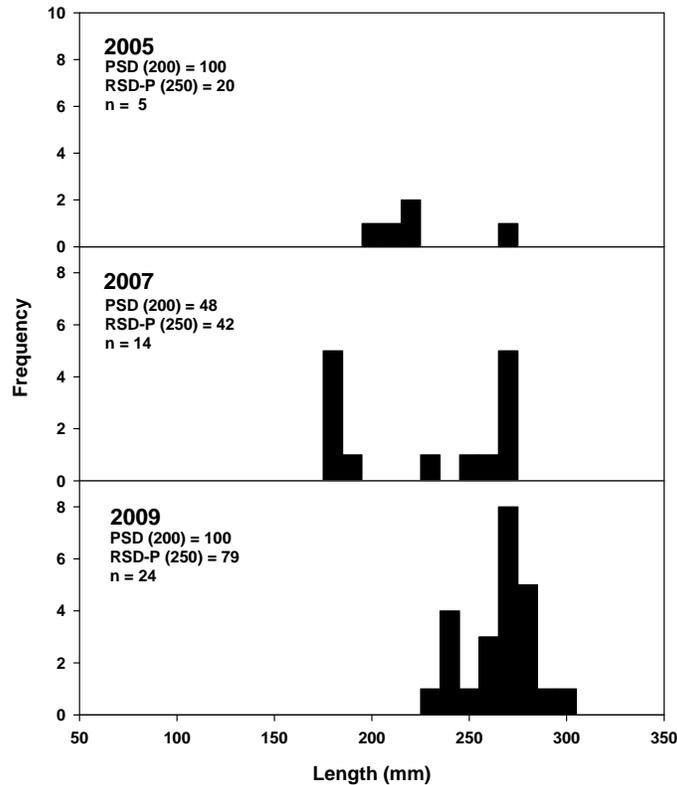


Figure F-8. Length frequency distribution of yellow perch captured in gill nets during the fall in Duck Lake in 2005, 2007, and 2009.

Table F-4. Yellow perch mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by trap and gill nets during the spring in Duck Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (130-200 mm) (5-8 in)	Quality - Preferred (200-250 mm) (8-10 in)	Preferred - Memorable (250-300 mm) (10-12 in)	Memorable - Trophy (300-380 mm) (12-15 in)
2009	96 (1.2)	b	100 (1.5)	95 (1.4)	b
2008	a	a	a	a	a
2007	92 (2.0)	98 (2.0)	b	89 (1.4)	b
2006	a	a	a	a	a
2005	98 (3.3)	88 (3.1)	103 (2.2)	b	b
2004	a	a	a	a	a
2003	a	a	a	a	a
2002	a	a	a	a	a
2001	85 (2.1)	86 (2.1)	b	b	b
2000	a	a	a	a	a
1999	a	a	a	a	a
1998	a	a	a	a	a
1997	a	a	a	a	a
1996	a	a	a	a	a
1995	104 (2.0)	102 (1.4)	107 (3.7)	b	b
1994	a	a	a	a	a
1993	93 (1.2)	93 (2.2)	93 (2.2)	91 (3.7)	b
1992	90 (1.8)	89 (2.4)	90 (2.6)	b	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Summary

Bluegill – Duck Lake should provide the best angling opportunities for bluegill among the Refuge lakes with the highest number of preferred length fish.

Largemouth bass – The relative abundance of stock length fish substantially increased in 2009. Most fish were < 300 mm.

Pumpkinseed – Low in abundance and will likely provide low angler value.

Yellow perch – Although low in abundance, the population is dominated by preferred length (\geq 250 mm) fish.

Management Recommendations

1. Continue fishery surveys every odd year (i.e., 2011).

WATTS LAKE

Lake Description

Watts Lake is adjacent to Highway 16B and about 0.3 miles east of the Hackberry Lake headquarters. The lake is easily accessible from the highway and receives considerable fishing pressure, especially during the times that the other refuge lakes are inaccessible. The lake develops dense submergent vegetation during late spring through fall and this curtails fishing during this time. Watts Lake has no inlet and the lake is held artificially high by a water control structure on the east end.

Watts Lake was last renovated during 1976 and re-stocked the following year (Appendix A). No common carp were detected since the renovation until one was captured in 2005. During 1987, the lake was opened to musky and largemouth bass harvest. Musky were more susceptible to harvest than predicted and many were harvested. Watts Lake was then designated as a brood stock lake for musky and largemouth bass and managed as a catch-and-release fishery until 2007 (Appendix B). An over abundance of slow growing yellow perch were noted during 1989 surveys and 80 male northern pike were transplanted in an attempt to control yellow perch recruitment for improved growth rates and size class distribution. The 1992 surveys did not indicate that the northern pike had controlled yellow perch recruitment, therefore saugeye (i.e., sauger *Sander canadense* X walleye *S. vitreum* hybrids) were stocked during 1994, 1995, and 1996 (Appendix A) to add additional predators. The fishery includes yellow perch, largemouth bass, bluegill, orangespotted sunfish, green sunfish (*Lepomis cyanellus*), grass pickerel (*Esox americanus*), northern pike, saugeye, black bullhead, and common carp.

Watts Lake is 93 surface ha (230 ac); maximum depth is 2 m (6 ft.) with an average depth of 1.3 m (4 ft.) (Figure A-1). The lake is subject to winter-kills during winters that heavy snow occurs early and remains for extended periods. Winter-kills would occur more often if not for the many springs that occur in the lake. The bottom is relatively flat and about 60% silt and 40% sand. Much of the bottom is flocculent and nest builders such as bluegill and largemouth bass have limited spawning habitat. Emergent vegetation (e.g. cattail, bulrush, phragmites) dominate much of the shoreline making access difficult. The lake is essentially a large littoral area and submergent vegetation is dense during summer. Submergent vegetation includes sago pondweed, curly-leaf pondweed, coontail, and water milfoil. The surrounding watershed is sandy rolling grasslands and the primary land use is livestock grazing. The uplands adjacent to the lake are dominated by short grasses with a few cottonwoods and willows.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table 1). Specific conductivity averages 241 $\mu\text{S}/\text{cm}$, total alkalinity averages 149 mg/L, phenolphthalein alkalinity averages 12 mg/L, pH ranges from 8.5 during spring to 10.5 during late summer, and secchi disk reading average 1 m with water clarity limited more by phytoplankton blooms than turbidity. The lake is too shallow to develop a summer thermocline.

Table G-1. Watts Lake surface water quality parameters from 2001 to 2009.

Date	Time	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
08/2009	1645	24	10.9		9.1		17	86	227
5/2009	1710	22	9.2	65	8.5		0	119	277
05/2007		17	9.2	110	7.7	0.1	17	103	229
06/2005		20			7.1		0	290	260
09/2001		17		40	7.2		42	111	235
07/2001	0615	23	5.8		8.8		0	120	
07/2001	1910	26	12.9		8.0		0	120	

Results and Discussion

Common carp

Remarkably, no common carp were collected in the 2009 spring trap or fall gill net surveys. Although common carp are not as susceptible to being captured as other fish species, the zero catches still indicate that the population maybe extirpated or at such low densities that they were not detected. The first observation of common carp in Watts Lake was one sub-stock length fish captured in a gill net in 2005. In 2007, mean CPUE was 7 carp/gill net-night (SE = 2.5) and the size structure of the population was of adult fish that were all preferred length.

Northern pike

Northern pike were first detected in Watts Lake in 2005. Since then, gill net mean CPUE substantially increased (Figure G-1) and trap net mean CPUE increased in 2007 and has remained unchanged since (Figure G-2). Mean W_r was normal and similar to other Refuge lakes (fall mean $W_r = 96$ [SE = 2.5]).

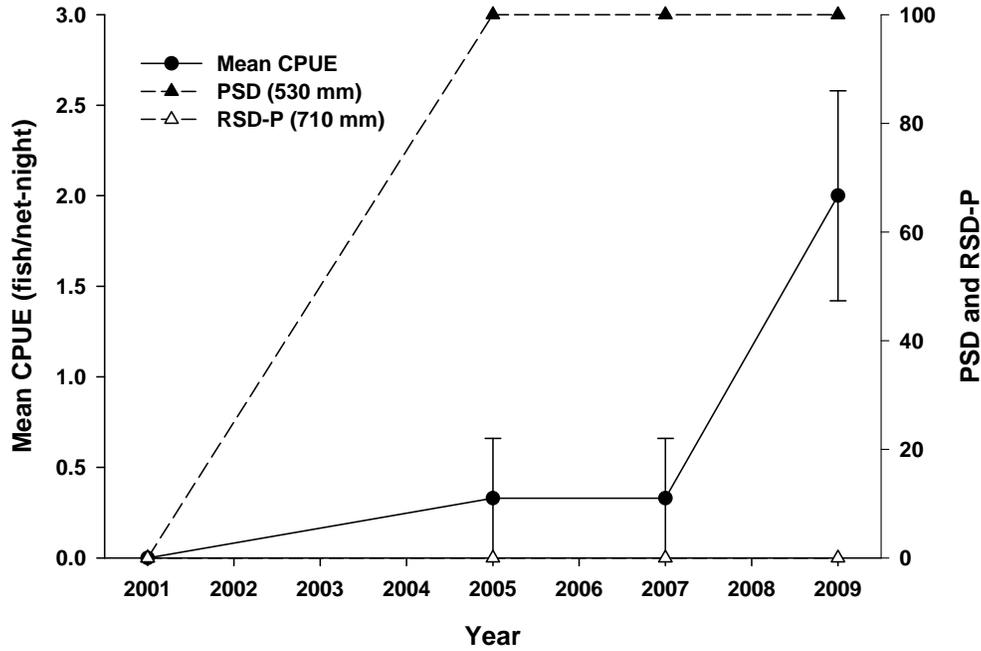


Figure G-1. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of northern pike captured by gill nets during the spring in 2001 and during the fall in 2005, 2007, and 2009 in Watts Lake. Mean catch per unit effort (CPUE) calculated for northern pike \geq stock length (350 mm) only.

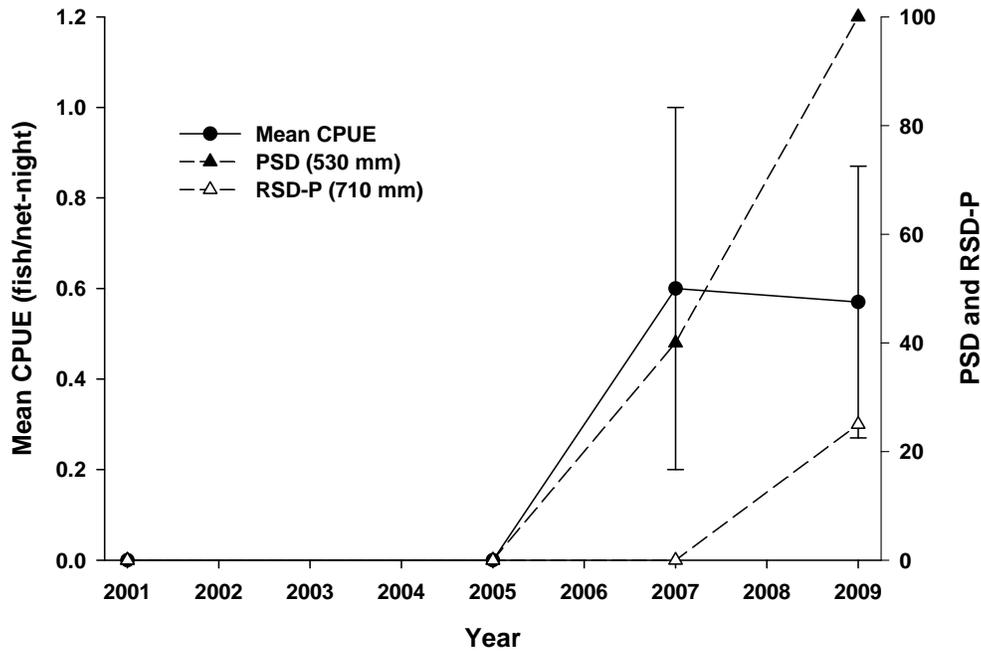


Figure G-2. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of northern pike captured by trap nets during the spring in Watts Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for northern pike \geq stock length (350 mm) only.

Black bullhead

Nine black bullheads were collected in gill nets that ranged from 254 to 320 mm (mean = 296 mm; SD = 21.1). Two bullheads were collected in 2007 (179 and 265 mm), which was the first detection of the this species in Watts Lake.

Bluegill

Bluegill relative abundance has substantially increased since 2005 after a suspected major winter-kill (Figures G-3 and G-4). Watts Lake had the highest density of bluegill in 2009 among the Refuge lakes. Bluegill size structure has also improved from 2007 to 2009 (Figure G-5). Relative weights were not calculated in 2009 (Table G-2).

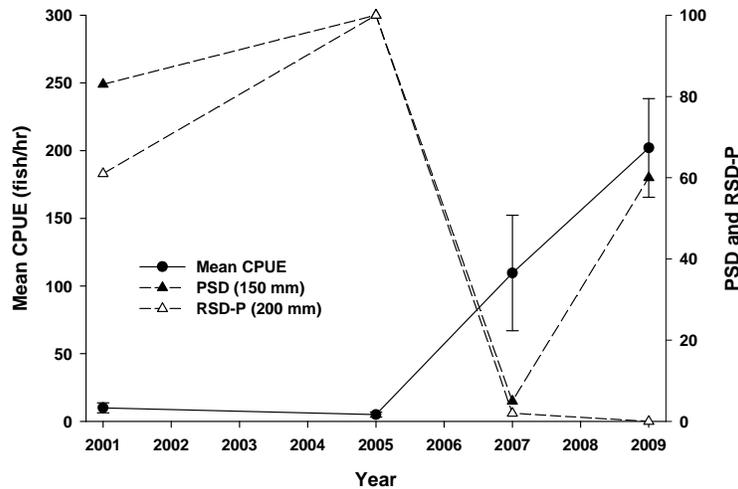


Figure G-3. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills sampled by electrofishing during the spring in Watts Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

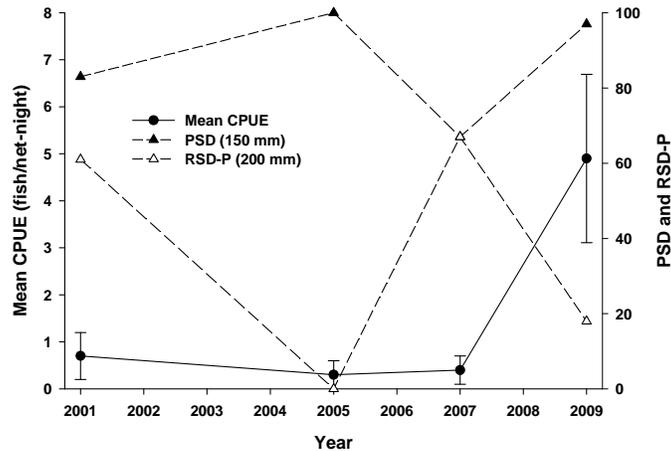


Figure G-4. Annual relative abundance (fish/net-night), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by trap nets during the spring in Watts Lake during 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for bluegill \geq stock length (80 mm) only.

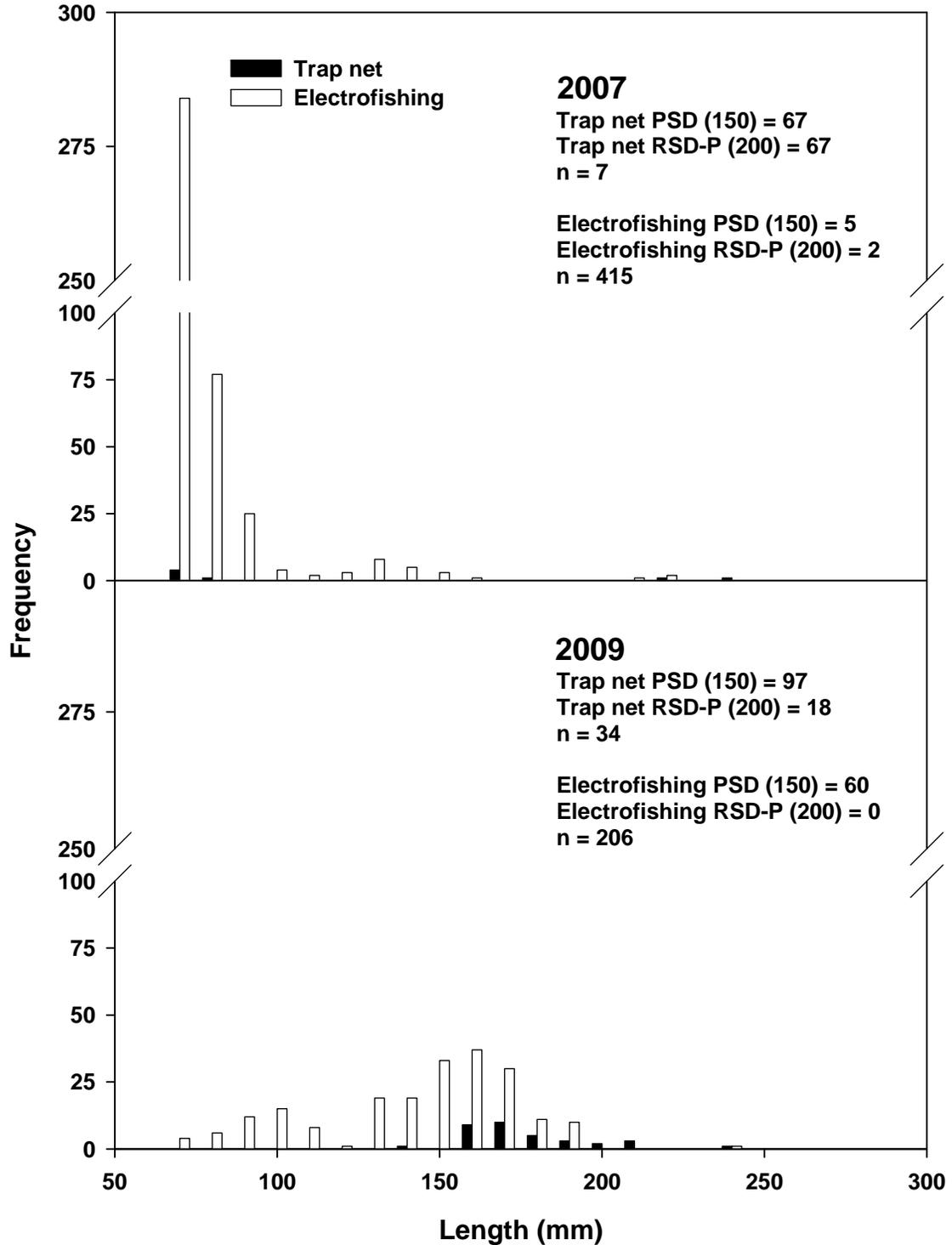


Figure G-5. Length frequency distribution (10-mm length groups) for bluegill captured by trap nets (black bars) and electrofishing (white bars) during the spring in Watts Lake in 2007 and 2009.

Table G-2. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category that were captured by trap nets and electrofishing during the spring in Watts Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (80-150 mm) (3-6 in)	Quality - Preferred (150-200 mm) (6-8 in)	Preferred - Memorable (200-250 mm) (8-10 in)	Memorable - Trophy (250-300 mm) (10-12 in)
2009	a	a	a	a	a
2008	a	a	a	a	a
2007	127 (1.9)	127 (2.2)	123 (2.8)	137 (6.7)	b
2006	a	a	a	a	a
2005	b	b	b	b	b
2004	a	a	a	a	a
2003	a	a	a	a	a
2002	a	a	a	a	a
2001	116 (3.4)	113 (4.6)	104 (9.6)	121 (3.4)	b
2000	a	a	a	a	a
1999	a	a	a	a	a
1998	119 (3.9)	136 (3.3)	106 (4.9)	104 (7.1)	b
1997	a	a	a	a	a
1996	130 (3.1)	118 (6.4)	133 (4.8)	136 (2.6)	b
1995	a	a	a	a	a
1994	a	a	a	a	a
1993	a	a	a	a	a
1992	113 (3.7)	111 (4.7)	123 (2.6)	111 (11.5)	b

a = Sampling did not occur or weights were not recorded during that year.

b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall W_r .

Golden shiner

In 2009, 23 golden shiners were captured in trap nets and nine fish were captured in gill nets. Sizes of golden shiners ranged from 140 to 170 mm.

Largemouth bass

Largemouth relative abundance and size structure (Figure G-6) has improved each year since Watts Lake had a major winter-kill in 2005. Based on multiple modes in length frequency histogram, strong year classes with consistent recruitment is occurring (Figure G-7). Mean W_r was excellent (Table G-3) indicating an abundance of prey.

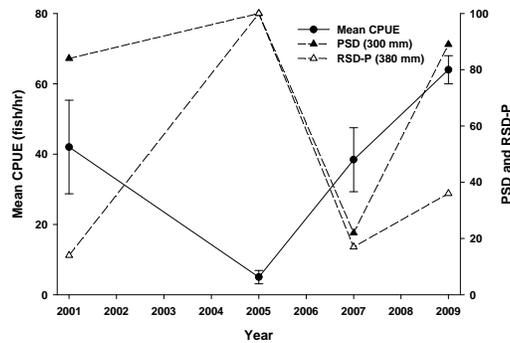


Figure G-6. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing in Watts Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for largemouth bass \geq stock length (200 mm) only.

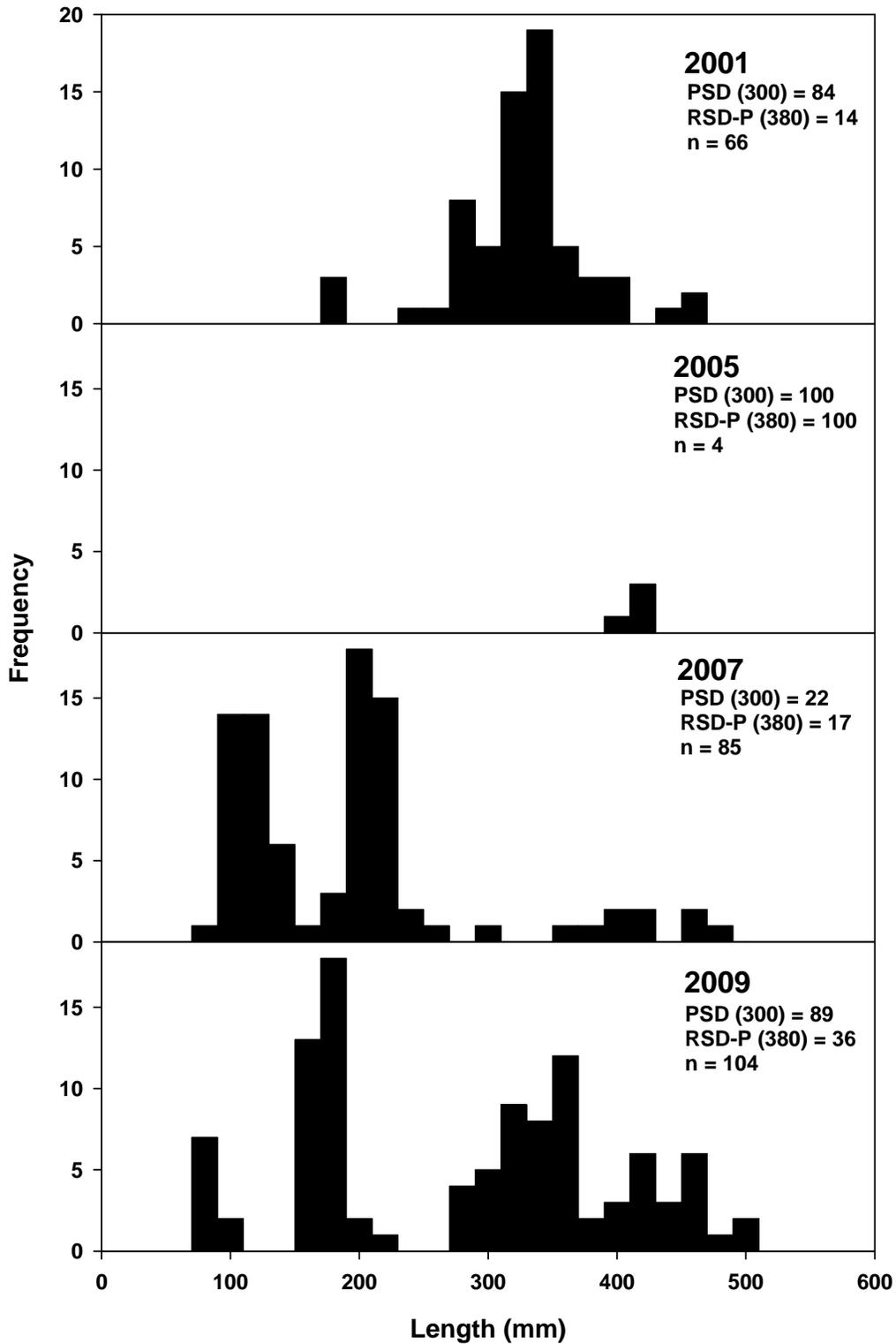


Figure G-7. Largemouth bass length frequency distribution (10-mm length groups) captured by electrofishing during the spring in Watts Lake in 2001, 2005, 2007, and 2009.

Table G-3. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing during the spring in Watts Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (200-300 mm) (8-12 in)	Quality - Preferred (300-380 mm) (12-15 in)	Preferred - Memorable (380-510 mm) (15-20 in)	Memorable - Trophy (510-630 mm) (20-25 in)
2009	120 (1.5)	118 (6.4)	120 (1.6)	119 (2.5)	b
2008	a	a	a	a	a
2007	119 (1.4)	116 (1.6)	120 (2.5)	122 (3.2)	b
2006	a	a	a	a	a
2005	129 (3.2)	b	136 (12.3)	128 (3.4)	b
2004	a	a	a	a	a
2003	a	a	a	a	a
2002	a	a	a	a	a
2001	101 (1.6)	103 (1.8)	101 (2.4)	100 (2.4)	b
2000	a	a	a	a	a
1999	a	a	a	a	a
1998	a	a	a	a	a
1997	a	a	a	a	a
1996	113 (2.6)	112 (2.8)	107 (2.8)	127 (4.3)	b
1995	a	a	a	a	a
1994	a	a	a	a	a
1993	a	a	a	a	a
1992	108 (2.0)	120 (3.2)	112 (6.8)	105 (2.1)	b

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Saugeye

No saugeye were captured in Watts Lake in 2009. The saugeye population is either extirpated or at such low levels that they were not detected. About 20,000 saugeye were stocked in Watts Lake from 1994 to 1996 to control the overabundant yellow perch population. Gill net data for Watts Lake in 1996, 2001, 2005, and 2007 all indicated a declining and aging population since the last stocking.

Yellow perch

In 2005 and 2007, the yellow perch population appeared to have recovered from being nearly extirpated in 2001. In 2009, both gill and trap net data indicates a substantial decrease in relative abundance (Figures G-8 and G-9). The length frequency distribution indicates that spawning and recruitment has been successful for multiple years (Figure G-10). The last strong year class was likely in 2003 or 2004. Mean W_r in Watts Lake were normal; however, lower than other Refuge lakes. Watts Lake has historically had low mean W_r for yellow perch (Table G-4).

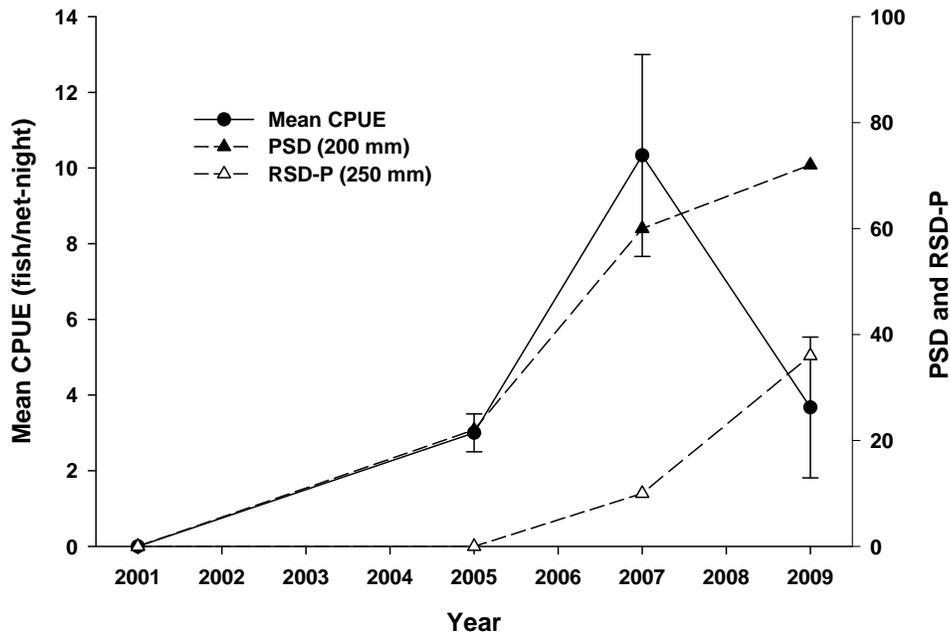


Figure G-8. Annual relative abundance (fish/net with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets in Watts Lake in 2001, 2005, 2007, and 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

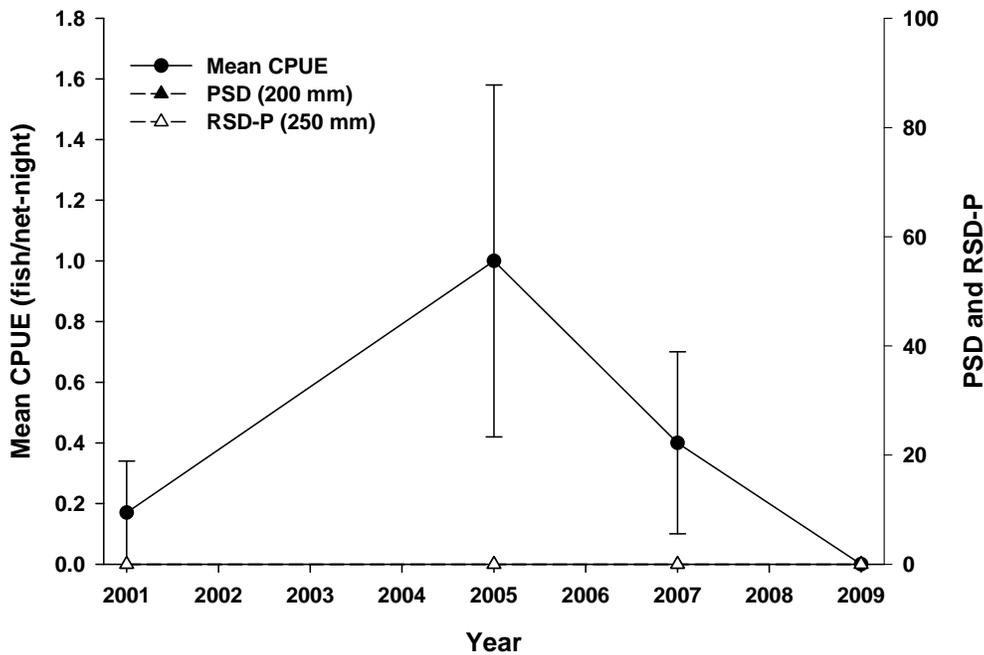


Figure G-9. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by trap nets during the spring in Watts Lake from 2001 to 2009. Mean catch per unit effort (CPUE) calculated for yellow perch \geq stock length (130 mm) only.

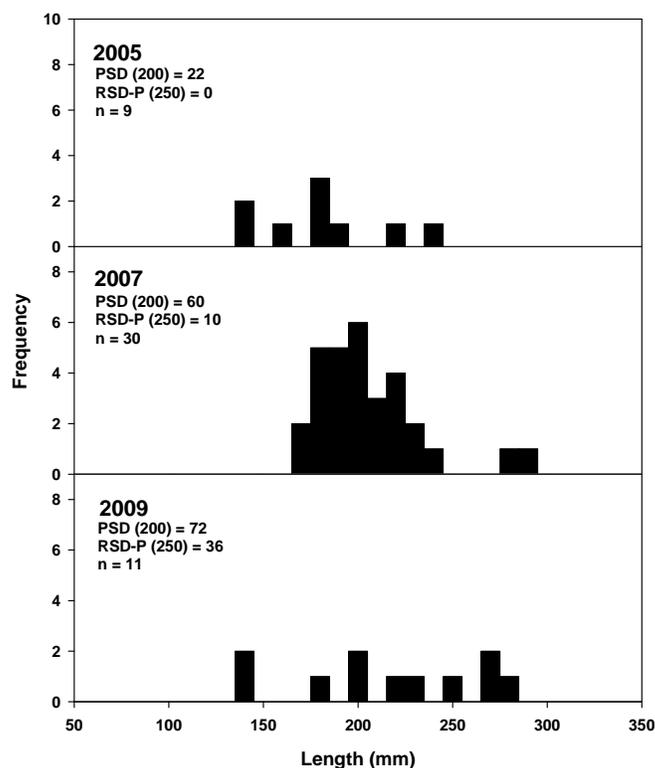


Figure G-10. Length frequency distribution (10-mm length group) for yellow perch captured in gill nets during the fall in Watts Lake in 2005 to 2009.

Table G-4. Yellow perch mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by gill nets during the fall in Watts Lake from 1992 to 2009.

Year	Overall W_r	Stock - Quality (130-200 mm) (5-8 in)	Quality - Preferred (200-250 mm) (8-10 in)	Preferred - Memorable (250-300 mm) (10-12 in)	Memorable - Trophy (300-380 mm) (12-15 in)
2009	92 (2.0)	95 (5.9)	92 (3.0)	89 (2.11)	b
2008	a	a	a	a	a
2007	92 (1.2)	95 (1.6)	90 (1.7)	88 (6.5)	b
2006	a	a	a	a	a
2005	95 (2.0)	97 (2.1)	90 (0.1)	b	b
2004	a	a	a	a	a
2003	a	a	a	a	a
2002	a	a	a	a	a
2001	b	b	b	b	b
2000	a	a	a	a	a
1999	a	a	a	a	a
1998	91 (1.4)	93 (2.0)	90 (1.8)	85 (5.1)	b
1997	a	a	a	a	a
1996	103 (2.7)	104 (3.9)	104 (3.7)	84 (2.2)	b
1995	a	a	a	a	a
1994	a	a	a	a	a
1993	a	a	a	a	a
1992	86 (1.6)	89 (2.7)	84 (1.3)	80 (1.9)	69 (0.7)

a = Sampling did not occur during that year.

b = Category had less than two samples for mean and SE calculations.

Summary

Common carp – The common carp population appears to be at such low densities that they were not detected during the 2009 surveys.

Northern pike – Relative abundance of northern pike is likely still increasing but starting to stabilize.

Black bullhead – The black bullhead population appears to be increasing in abundance after first being detected in 2007.

Bluegill – In 2009, Watts Lake had the highest density of bluegill among Refuge lakes with few fish of preferred length.

Golden shiners – Trap nets and gill nets detected golden shiners indicating a high abundance this alternative prey species.

Largemouth bass – Relative abundance and size structure has continued to improve after the major winter-kill in 2005. Consistent spawning and recruitment was also occurring in Watts Lake.

Saugeye – No saugeye were collected in 2009 indicating that the population is either extirpated or at such low levels that they were not detected.

Yellow perch – There was a substantial decrease in the relative abundance of yellow perch from 2007 to 2009. Multiple year classes of perch were collected with some fish being of preferred length.

Management Recommendations

1. Consider supplemental stocking of saugeye as an additional game fish species.
3. Consider collecting northern pike and moving these fish to Clear or Dewey lakes.
4. Continue fishery surveys every odd year (i.e., 2009).
5. Improve handicap fishing access. Include a large concrete pad for parking and wheel chair access. Extend handicap accessible ramp to deep waters. Construct a new, roomier dock for handicap access.

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Appendix A. Fish stocking history for Valentine National Wildlife Refuge lakes. Multiple life stages (sizes) were stocked: FY = fry (Hatch to 1.49 in.); FG = fingerlings (1.5 to 5.49 in.); AD = adult (sexually mature, regardless of size); MX = mixed (transplanted from natural sources).

Year	Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Clear Lake																					
2008							Apr	51	AD												
2007							Mar	48	AD												
2006													Jun	211,385	FY						
2005							Mar	50	AD				Jul	140,727	FY						
2004													Mar	514	FG						
													Aug	12,698	FG						
													& Sep								
													Oct	48	AD						
1996				Oct	45,000	FG															
1991	Jul	6,000	FG	Aug	50,000	FY															
1990	Jul	17,000	FG																		
1989	Jul	15,000	FG							Sep	3,000	FG	Sep	2,448	FG						
1988													Sep	5,750	FG						
1987													Sep	4,086	FG						
1985	Jul	35,541	FG																		
1983 ^b																					
Dad's Lake																					
1987							Apr	150,000	FY												
Dewey Lake																					
2004	Aug	43	AD				Aug	195	AD	Aug	150	AD									
1992																					
1991	Jul	28,000	FG	Aug	50,000	FY															
1989							Mar	1,010	AD												
1987							Mar	1,256	AD												
							& Apr														
1985				Sep	50,000	FY															
1981 ^a																					
Duck Lake																					
1995																Jun	4,000	FY			
1994																Apr	4,000	FG			
1991	Jul	10,000	FY	Aug	30,000	FY				Jun	20,000	FY									
1986				Aug	25,000	FY															
1985				Sep	38,000	FY															

^a Lake renovation occurred during that year.

Appendix A continued.

Year	Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Hackberry Lake																					
2008				Sep	52,445	FG															
2007	Jun	40,865	FG	Mar & Sep	179,194	FG															
2006				Oct	364,315	FG															
2005	Aug	31	AD	Oct	148,070	FG				Jun	136,000	FY									
	May & Aug	68,200	FG	Feb & Mar	128,000	FG				Apr	1,400,000	Egg									
										Feb	19,068	FG									
2004 ^a				Oct	86,250	FG															
1996				Oct	75,000	FG															
1992							Apr	1,200	MX												
1991	Aug	35,000	FG																		
1990	Jul	35,000	FG																		
1989	Aug	37,000	SA																		
1986	Jul	30,000	FG	Aug	25,000	FY	Mar	203	AD												
	May	107	AD																		
1985				Sep	50,000	FY															
Pelican Lake																					
1996				Oct	102,800	FG															
1995										Apr	2,000	AD									
1994							Mar	651	AD	Apr	59,981	MX									
1993										Apr	5,651	MX									
1992	Jun	136,000	FY							Apr	1,100	AD									
1991	Jul	40,000	FG																		
1990	Jul	40,000	FG																		
1989	Jul	32,000	FG																		
1986							Mar	207	AD												
1985				Sep	50,000	FY				Apr	7,660	AD									
Rice Lake																					
2004				Mar	26,048	FY				Mar	3,326	FG									

^a Lake renovation occurred during that year.

Appendix A continued.

Year	Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Watts Lake																					
2005	Sep	15,525	FG	Oct	148,070	FG				Aug	19,261	FG									
1997																			Sep	100	SA
1996				Oct	30,000	FG										Jun	10,000	FG	Sep	50	SA
1995																Jun	5,000	FG			
1994																Apr	5,000	FG			
1992	Jun	50,000	FY																		
1991	Jul	5,000	FG																		
1990	Jul	5,000	FG				May	77	AD												
1989	Jul	5,000	FG																		
1988																			Jun & Sep	47	AD
1987																			Aug	347	AD
1986																			May	6,500	FY
1985																			Jun	75	FG
																			Aug	1,152	SA
West Long Lake																					
1986				Aug	25,000	FY															
1985																					
1998	Apr	124	AD																		
1996	Sep	70	AD																		
1994										Apr	2,241	AD									
1992										Apr	1,100	AD									
1991	Jul	10,000	FG	Aug	20,000	FG				Jun	30,000	FG									
1986	Jul	15,000	FG	Aug	25,000	FY															
Willow Lake																					
2009										Sep	35,750	FG									
1988				Aug & Sep	116,000	FG	Apr	180,000	FY	Apr	4,000	AD									

Appendix B. Summary of fishing regulations.

Fishing regulations on the Valentine National Wildlife Refuge. *Panfish species include bluegill, yellow perch, black crappie, green sunfish, orangespotted sunfish, pumpkinseed, and all sunfish hybrids. **Panfish bag limit is in aggregate.

Lake	Species	Year	Size limit	Bag limit**
Clear	Northern pike	1993 – present	28 in. max.	3
		1991 – 1992	36 in. min.	3
		1990	30 in. min.	6
		1988 – 1989	36 in. min.	6
		1987	24 in. min.	6
	Largemouth bass	2007 – present	15 in. min. and 1 > 21 in.	4
		1988 – 2006	15 in. min. and 1 > 24 in.	4
		1987	12 in. min.	8
	Panfish*	1988 – present		30
1987			No limit	
Dewey and Pelican	Northern Pike	1993 – present	28 in. max.	3
		1990 – 1992	36 in. min.	3
		1988 – 1989	36 in. min.	6
		1987	24 in. min.	6
	Largemouth bass	2007 – present	15 in. min. and 1 > 21 in.	4
		1988 – 2006	15 in. min. and 1 > 24 in.	4
		1987	12 in. min.	8
	Panfish*	1988 – present		30
		1987		No limit
Hackberry	Northern pike	1993 – present	28 in. max.	3
		1992	36 in. min.	3
		1990 – 1991	24 in. min.	3
		1987 – 1989	24 in. min.	6
	Largemouth bass	2007 – present	15 in. min. and 1 > 21 in.	4
		1988 – 2006	15 in. min. and 1 > 24 in.	4
		1987	12 in. min.	8
	Panfish*	1988 – present		30
		1987		No limit
Watts	Muskellunge	2007 – present	40 in. min.	1
		1988 – 2006	Catch and release	
		1987	36 in. min.	3
	Largemouth bass	2007 – present	15 in. min. and 1 > 21 in.	4
		1988 – 2006	Catch and release	
		1987	12 in. min.	8
	Panfish*	1988 – present		30
1987			No limit	
Saugeye	2007 – present	15 in. min. and 1 > 22 in.	4	
All refuge lakes not previously identified	Northern pike	1993 – present	28 in. max.	3
		1990 – 1992	24 in. min.	3
		1987 – 1989	24 in. min.	6
	Largemouth bass	2007 – present	15 in. min. and 1 > 21 in.	4
		1988 – 2006	15 in. min. and 1 > 24 in.	4
		1987	12 in. min.	8
	Panfish*	1988 – present		30
1987			No limit	

Appendix C. Glossary of fishery terms.

Alkalinity: Alkalinity is a measure of a water's ability to resist a change in pH expressed in mg/l or ppm. Because alkalinity is dependent on minerals such as calcium (Ca), and this relates to aquatic vegetation production, alkalinity is a good indicator of a water body's potential to produce fish. Less than 40 mg/l is considered soft water; greater than 40 mg/l is hard water.

Catch per Unit Effort (CPUE): CPUE is the catch per unit of sampling effort that is used as an index of abundance or to document population changes over time. This is also known as relative abundance. The formula is:

$$\text{CPUE} = \frac{\text{number of fish in a length class, length category, or sample}}{\text{Hour for electrofishing or net night}}$$

Conductivity: Conductivity is a measure of a water body's ability to conduct electricity, which is dependent on the amount of ions in the water. Total dissolved solids (TDS) is equal to 0.5 X conductivity. Conductivity is a good measure of a water body's productivity because of the relation between minerals and productivity.

Effort: The effort is the total amount of time expended in collecting a sample. The time may be in hours, minutes, or net days. The effort is used to calculate CPUE.

Memorable length: The memorable length is a standard category unique for each species. The memorable length is the length that most anglers remember catching and is 59 to 64% of the world record length.

Net-nights: A unit of time used to describe the effort required to collect a sample using gill nets or trap nets. For example, if five gill nets were left for a 24 hour period, then five gill net-nights worth of effort were expended.

pH: a measure of how basic or acidic a body of water is. Pure water is considered neutral with a pH = 7. pH is on a Log10 scale, therefore a change of 1 pH unit equates to a 10 fold increase in H⁺ (hydrogen ions). This information is important as many species of game fish have narrow pH tolerances.

Preferred length: The preferred length is a standard category unique for each species. The preferred length is the length that most anglers prefer to catch and is usually within a range of 45 to 55% of the world record length.

Proportional Stock Density (PSD): PSD is the number of fish greater than or equal to a minimum quality length in a sample divided by the number of fish greater than or equal to a minimum stock length. The formula is:

$$\text{PSD} = \frac{\text{number of fish} \geq \text{"quality" length}}{\text{number of fish} \geq \text{"stock" length}}$$

Quality length: The quality length is a standard length category unique for each species of fish. The Quality length is usually within a range of 36 to 41% of the world record length and generally the minimum size that most anglers will keep.

Relative Stock Density (RSD): The RSD is the number of fish greater than a minimum preferred length in a stock divided by the number of fish greater than or equal to a minimum stock size. The formula is:

$$\text{RSD} = \frac{\text{number of fish} \geq \text{"preferred" length}}{\text{number of fish} \geq \text{"stock" length}}$$

Relative weight (W_r): The relative weight of a fish or group of fish is referred to as a " W_r " value. The relative weight is a comparison of the condition of the fish in a sample and the condition of a theoretical optimum sample. The formula is:

$$W_r = (W/W_s) \times 100$$

where "W" is the weight of an individual and "W_s" is a length specific standard weight.

Stock length: The stock length is the smallest of the standard length categories and is unique for each species of fish. The stock length is usually within a range of 20 to 26% of the world record length and at or near which a species reaches sexual maturity.

Trophy length: Trophy length is a standard length category unique for each species of fish. The Trophy length is size worthy of acknowledgment and is greater than 74% of the world record length.

Appendix D. Data collection and analysis protocol.

For each species, five fish per 10 mm (0.4 inch) for fish > 80 mm (3.2 inches) TL were weighed to the nearest gram (g) and measured to the nearest millimeter (mm). Fish smaller than 80 mm were tallied for length frequency analysis only. Once five fish were recorded for a 10 mm group, additional fish in that group were tallied for length frequency analysis only. Panfish, largemouth bass, and saugeye should use the 10-mm data sheet. Northern pike and common carp should use the 20-mm data sheet (Figures in this Appendix).

Catch per unit effort (CPUE) was recorded separately for each net and each electrofishing transect to enable calculating CPUE confidence intervals (CI) at the 80% CI level. CPUE and confidence intervals were analyzed using the one or two gears that are appropriate for each species of fish.

Analysis of Data Collected

- 1) Trends in relative abundance were assessed as catch-per-unit-effort (CPUE) as fish/trap net night, fish/gill net night, and for electrofishing fish/hr.
- 2) Size structure will be assessed with PSD and RSD. Length categories have been proposed for various fish species (Table J-1).
- 3) Calculating relative weight (W_r) assessed condition of fish by size groups (Table J-2).

Table J-1. Length Categories that have been proposed for various fish species.

Species	Stock		Quality		Preferred		Memorable		Trophy		Reference
	E	M	E	M	E	M	E	M	E	M	
Saugeye	9	23	14	35	18	46	22	56	56	69	Flammang et al. 1993
Yellow perch	5	130	8	20	10	25	12	30	15	38	Gabelhouse 1984
Largemouth bass	8	20	12	30	15	38	20	51	25	63	Gabelhouse 1984
White and black crappie	5	13	8	20	10	25	12	30	15	38	Gabelhouse 1984
Bluegill, green sunfish, and pumpkinseed	3	8	6	15	8	20	10	25	12	30	Gabelhouse 1984
Black bullhead	6	15	9	23	12	30	15	38	18	46	Gabelhouse 1984
Common carp	11	28	16	41	21	53	26	66	33	84	Gabelhouse 1984
Northern pike	14	35	21	53	28	71	34	86	44	112	Gabelhouse 1984

Note: All measurements are total length. E = English units (inches). M = Metric units (cm).

Table J-2. Intercept (a) and slope (b) parameters for standard weight (Ws) equations that have been proposed and the minimum total lengths (mm) recommended for application.

Species	Intercept (a)		Slope (b)	Minimum total length	Reference
	M	E			
Black bullhead	-4.974	-3.297	3.085	130	Bister et al. 2000
Black crappie	-5.618	-3.576	3.345	100	Neumann and Murphy 1991
Bluegill	-5.374	-3.371	3.316	80	Hillman 1982
Common carp	-4.639	-3.194	2.920	200	Bister et al. 2000
Green sunfish	-4.915	-3.216	3.101	100	Bister et al. 2000
Largemouth bass	-5.528	-3.587	3.273	150	Henson 1991
Northern pike	-5.437	-3.745	3.096	100	Willis 1989
Yellow perch	-5.386	-3.506	3.230	100	Willis et al. 1991

Note: The standard equation format is $\text{Log}_{10}(Ws) = a + b(\text{Log}_{10} \text{ total length})$. Metric (M) equations are in millimeters and grams; English (E) equations are in inches and pounds.

Appendix E. Mean lake levels (feet above mean sea level), for Clear, Dewey, Hackberry, Pelican, and Watts lakes from 1992 to 2009 (Figures I-1 to I-5). Mean lake levels were calculated twice each year as spring (March - June) and summer (July - October) levels. Stars indicate the highest and lowest recorded lake level since 1992.

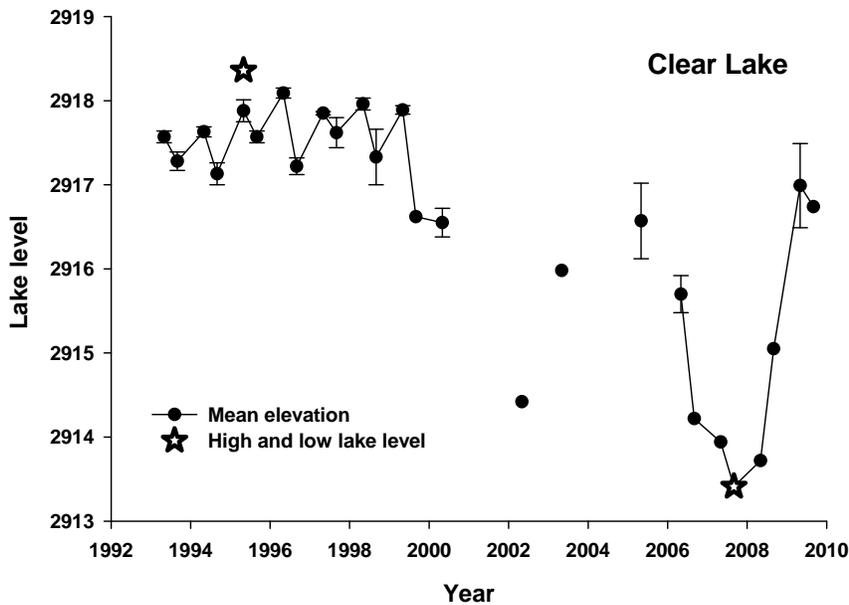


Figure J-1. Clear Lake mean lake levels from 1992 to 2009.

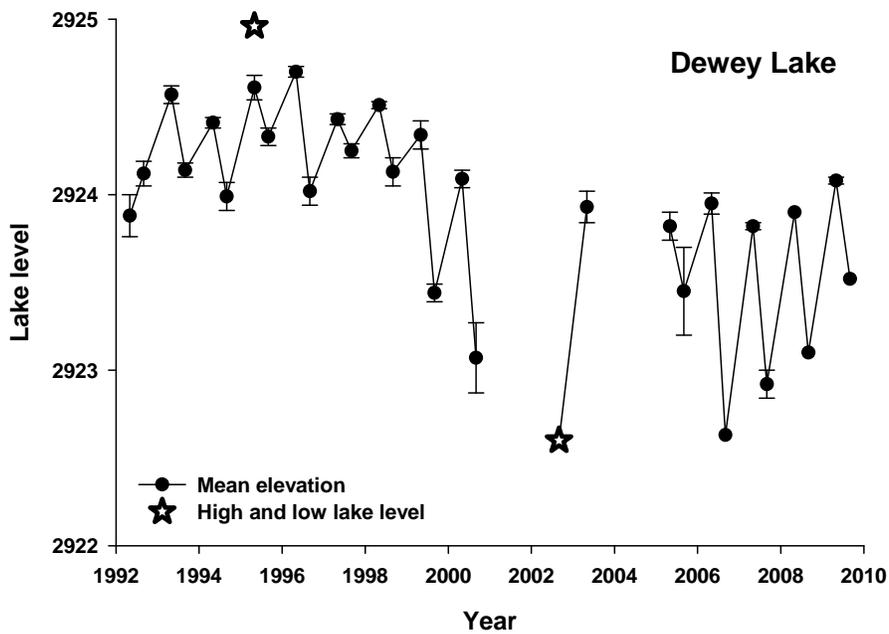


Figure J-2. Dewey Lake mean lake levels from 1992 to 2009.

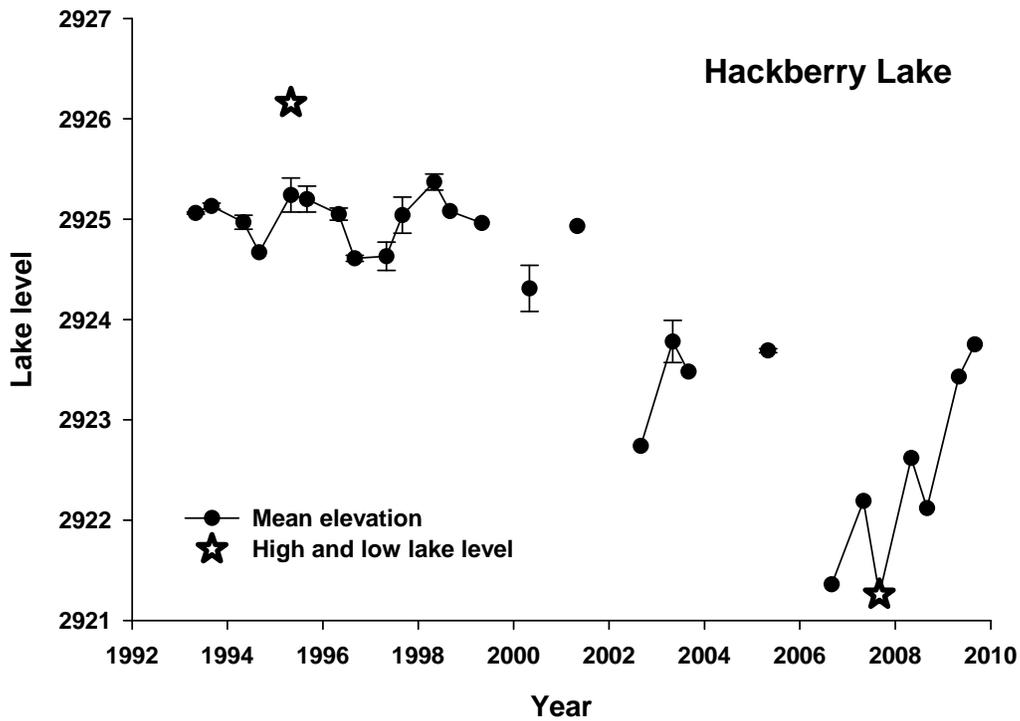


Figure J-3. Hackberry Lake mean lake levels from 1992 to 2009.

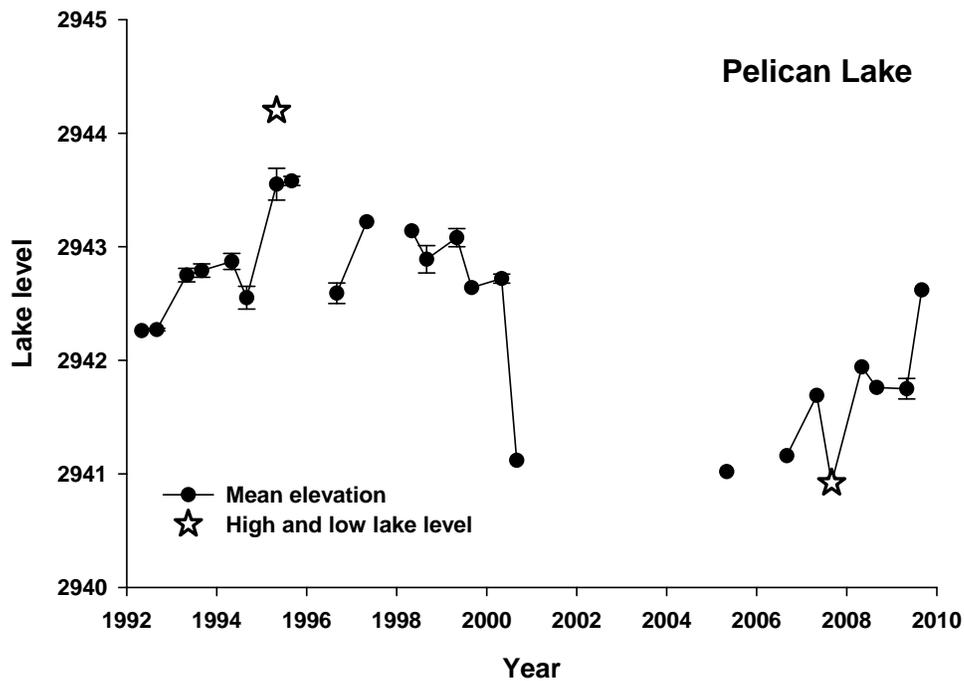


Figure J-4. Pelican Lake mean lake levels from 1992 to 2009.

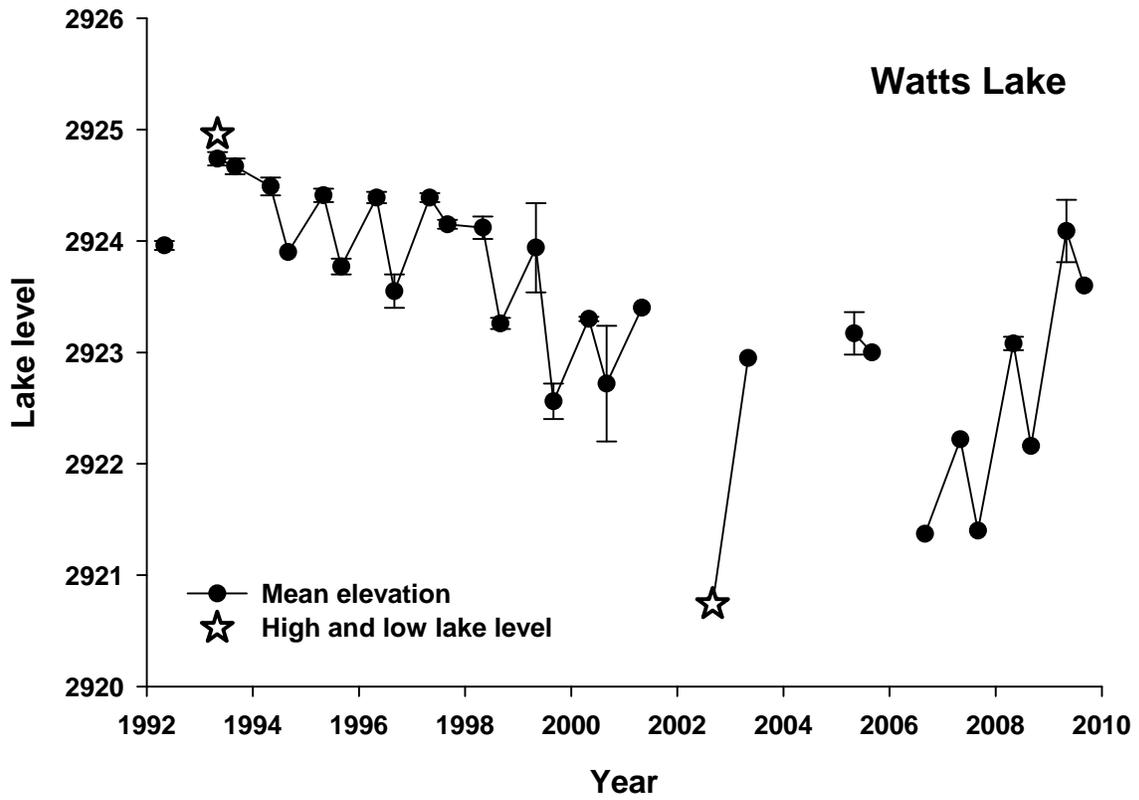


Figure J-5. Watts Lake mean lake levels from 1992 to 2009.

Appendix F. Northern pike food habit data.

Table J-3. Northern pike diet summary by length group during August 2009 in Clear, Dewey, and Pelican lakes. Number of stomachs examined (N), percent of empty stomachs (% E), prey item, mean length of prey with SE in parenthesis, frequency of occurrence (% O), and percent of total number (% N).

Length group	N	% E	Prey item	Prey mean length	% O	% N
Clear Lake						
Stock – quality (350 – 530 mm)	1	100				
Quality – preferred (530 – 710 mm)	31	60	Common carp Yellow perch Unidentified	200 134 (3)	8 75 17	8 69 23
Preferred – memorable (710 – 860 mm)	16	69	Common carp Yellow perch Unidentified	207 (13) 132	40 20 40	40 20 40
Memorable – trophy (860 – 1120 mm)	3	67	Common carp	245	100	100
Dewey Lake						
Stock – quality (350 – 530 mm)	4	50	Yellow perch	109 (9)	100	100
Quality – preferred (530 – 710 mm)	7	71	Yellow perch	148 (28)	100	100
Preferred – memorable (710 – 860 mm)	6	83	Yellow perch	76	100	100
Memorable – trophy (860 – 1120 mm)	0					
Pelican Lake						
Stock – quality (350 – 530 mm)	5	60	Unidentified		100	100
Quality – preferred (530 – 710 mm)	23	70	Yellow perch Unidentified	120	14 86	14 86
Preferred – memorable (710 – 860 mm)	3	100				
Memorable – trophy (860 – 1120 mm)	0					

Appendix G. Turtle catches on Valentine NWR.

To reduce turtle mortality, all efforts are made to set trap nets so that the top of the cab remains just out of the water. Trap nets consisted of a lead set at the shoreline that is 15.2 m (50 ft) in length by 1 m (3 ft) in height, two 1.2 m (4 ft) wide and 1 m (3 ft) high rectangular steel frames, and two 1 m (3 ft) diameter circular hoops with 13 mm (0.5 in) nylon mesh. A green protective coat was applied to the nylon mesh. Trap nets were set overnight for a maximum of 24 h with leads set perpendicular to the shore. Mean CPUE was calculated as turtles/trap net-night (Table J-4).

Table J-4. Number (N) and mean catch per unit effort (CPUE; turtles/net-night) with SE in parenthesis for painted *Chrysemys picta*, snapping *Macrochelys temminckii*, and Blanding's *Emydoidea blandingii* turtles captured in trap nets during the spring (S) and fall (F).

Lake	Sample period	Painted		Snapping		Blanding's	
		N	Mean CPUE	N	Mean CPUE	N	Mean CPUE
Clear	2009 (S)	17	1.7 (0.42)	0		0	
Dewey	2009 (S)	52	5.2 (3.03)				
	2008 (S)	11	1.1 (0.64)	0		0	
	2008 (F)	38	3.8 (1.36)	0		0	
Hackberry	2009 (S)	13	1.3 (0.80)	1	0.1 (0.10)	0	
Pelican	2009 (S)	64	5.3 (1.44)	3	0.3 (0.30)	0	
	2008 (S)	6	0.5 (0.26)	0		0	
Duck	2009 (S)	59	11.8 (3.9)	2	0.4 (0.24)	0	
Watts	2009 (S)	20	2.9 (1.3)	0		0	
West Long	2008 (F)	1	0.25 (0.25)	0		2	0.5 (0.29)