2008 FISHERIES SURVEYS CONDUCTED ON THE VALENTINE NATIONAL WILDLIFE REFUGE, NEBRASKA

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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.

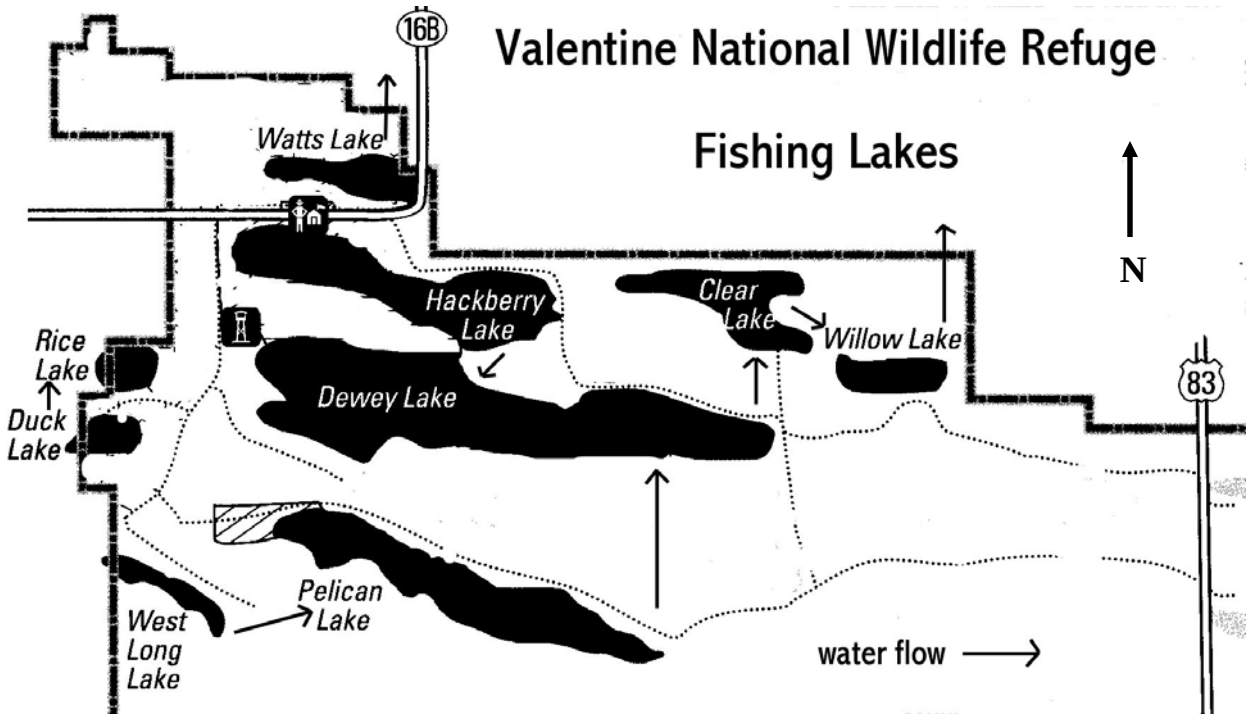

Figure A-1. Map of the lakes that are open to fishing on the Valentine NWR. Direction of water flow is depicted by arrows and refuge trails are depicted by dotted lines.

Common carp (*Cyprinus carpio*) gained access to the Valentine NWR lake system through Gordon Ditch, which was dug during the 1930's. 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 and 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 game of 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 carp numbers stabilized in lakes where the restrictions were enacted. However, strong year classes of carp during years where northern pike populations were down have led to recruitment and higher 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/summer (< 21^{o}C) during 1992, 1993, and 2008. The springs of 1994-97 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. 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.

METHODS

Electrofishing and trap netting surveys were conducted during the spring from 26-29 May 2008 and gill and trap netting surveys were conducted from 2-4 September 2008.

Night-time electrofishing was conducted with a Smith and Root 5.0 GPP electrofishing system rated at 5,000 watts of output power, using pulsed DC at 7-9 amps and 60 pulses per second. Electrofishing was conducted in 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. A comparison between spring and fall trap netting is summarized in Appendix E. A summary of turtle catches in trap nets are summarized in Appendix F.

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.

Effort for each gear in each lake is presented in Table A-1.

Table A-1. Effort for each gear in each lake sampled on the Valentine NWR during 2008.

Lake	Electrofishing (hr)	Spring trap nets (N)	Fall trap net (N)	Gill nets (N)
Clear[a]	0	4	0	5
Dewey	2.0	10	10	5
Hackberry	2.0	0	0	7
Pelican	2.0	12	12	7
West Long	0.75	4	4	3

[a] Could not sample properly with all gears due to low water levels in May.

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 a infertile sandy bottom and high turbidity. Surface water quality parameters measured in Clear Lake during each survey (Table B-1) are specific conductivity, which averages 567 μS/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. However, a trend has developed as overall relative abundance has declined since then. 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, 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 2008.

Date	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
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 dusk	26	13.0		7.7		60	196	
07/2001 dawn	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 spring 2008. Therefore, no further data analyses were conducted for bluegill, black crappie, or largemouth bass.

Common carp

On 2 May 2008, water was released from Dewey Lake into Clear Lake by the water control structure. A large number of carp were observed moving upstream in the drainage canal that flows from Dewey into Clear Lake. On 16 May, a temporary fence, constructed with steel posts and 2" X 4" welded wire mesh, was built across the canal near the outlet into Clear Lake. Once the fence was in place, water was then stopped from being released at the water control structure. Water temperature was measured at 58 °F. Most carp were found dead a few days later and rotenone was applied to the pockets of water where carp were found alive. A total of 2,735 carp were killed with a lower and upper 95% confidence interval of 1,734 to 3,736. Most carp were of similar size, estimated to be 8-10 pounds (3.6 – 4.5 kg) each. The largest carp were estimated to be from 25 to 30 pounds (11.3 – 13.6 kg). No scale was available during the treatment to measure check weights of carp. Non-target fish killed was minimal, as only four northern pike, one largemouth bass, and one yellow perch were found dead in the canal (M. Nenneman, USFWS, personal communication).

The relative abundance of carp has substantially declined since 2005 and PSD remains near 100 (Figure B-1). The carp removal efforts in May 2008 likely contributed to the substantial decline in relative abundance seen in gill nets during fall 2008. The length frequency distribution indicates an aging population (Figure B-2). In 2002 and 2004, a large number of sub-stock carp were captured in gill nets. It appears that those carp have recruited to the population as mean CPUE of stock length (≥ 280 mm) fish substantially increased in 2005 and 2006 (Figure B-1). Although sub-stock length carp were not detected in gill nets in 2008, sub-stock length carp were found in the stomachs of northern pike in the fall each year from 2006 to 2008 (Table B-2; Wanner 2007).

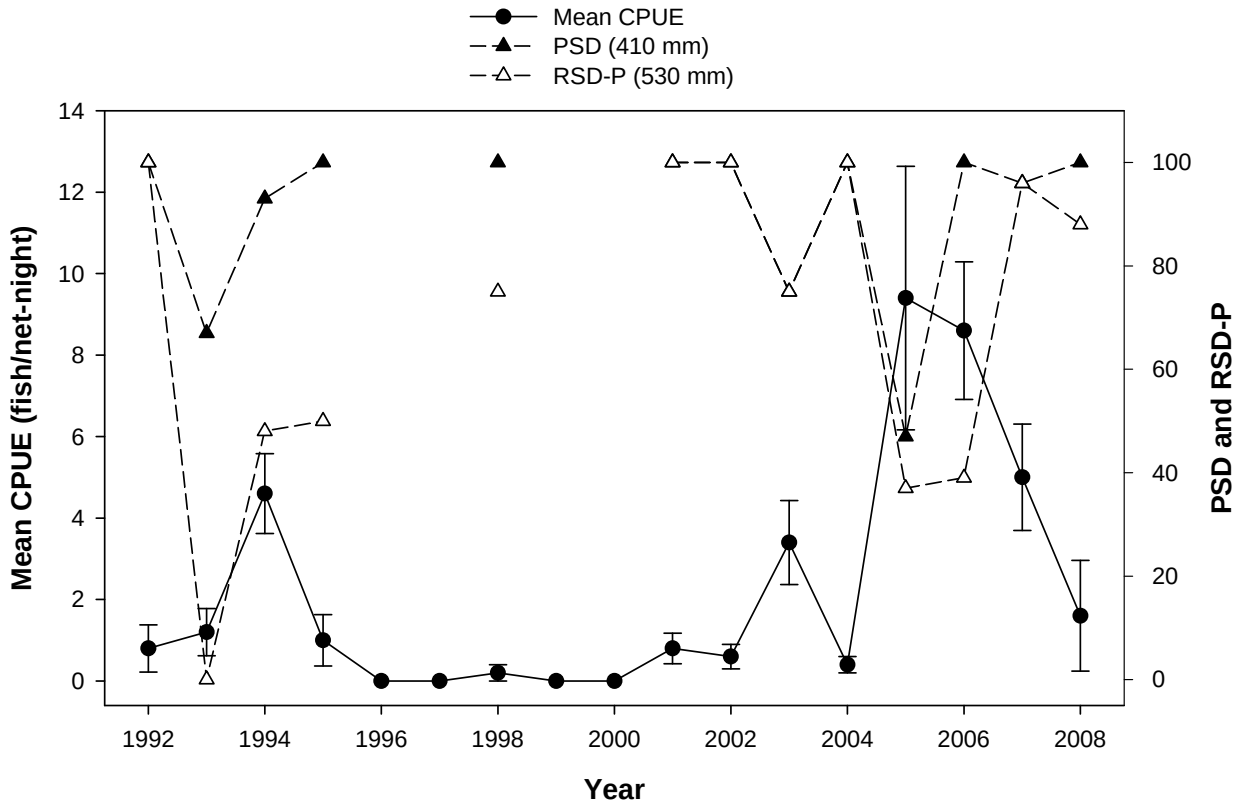

Figure B-1. Annual relative abundance (carp/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp captured by gill nets in Clear Lake from 1992 to 2008. Mean catch per unit effort (CPUE) calculated for carp ≥ stock length (280 mm) only.

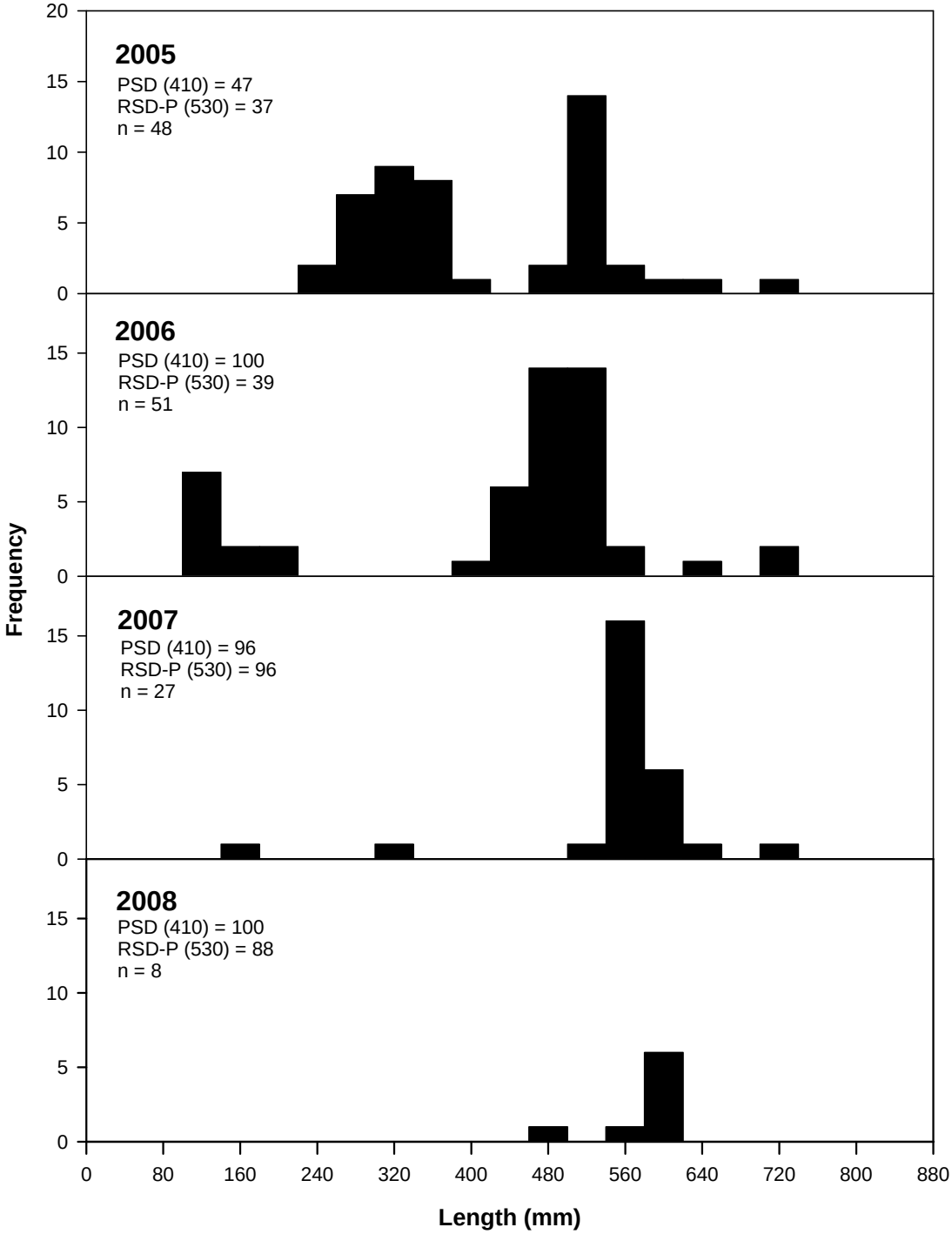

Figure B-2. Length frequency distribution (40-mm length groups) of common carp captured in gill nets in Clear Lake, Valentine NWR, from 2005 to 2008.

Table B-2. Clear Lake northern pike diet summary by length group during September 2008. 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
Stock – quality (350 – 530 mm)	0					
Quality – preferred (530 – 710 mm)	8	38	Common carp	71 (1.3)	100	100
Preferred – memorable (710 – 860 mm)	7	57	Common carp	68 (4.8)	100	57
			Yellow perch	90 (2.9)	33	43
Memorable – trophy (860 – 1120 mm)	0					

Northern Pike

The northern pike population in Clear Lake continues to be dominated by quality to preferred and preferred to memorable length fish. Since 2005, there is evidence of some reproduction, with low recruitment (Figure B-3). Relative abundance was not significantly different since 1996 (Figure B-4). However, a trend has developed as overall relative abundance has declined since 1992 (Figure B-5). Northern pike relative abundance in Clear Lake oscillates up and down in 2-3 year cycles. Changes in relative abundance may be due to fishing mortality. Ice fishing occurred almost exclusively in the month of December during the unusually warm winter of 2005-2006, while fishing pressure was high during December through February during the winters of 2006-2007 and 2007-2008. Cannibalism is also likely regulating the abundance and size structure of northern pike (Craig 1996) in Clear Lake. This is even more likely as yellow perch abundance has remained low since 2002 (Figure B-6) and the last strong year class of carp was produced in 2004. Stock to quality length northern pike, RSD-S has remained below 10 since 2003 (Table B-3) further providing evidence of pike controlling their own size structure and abundance. Mean W_r is stable (Table B-3) and was similar to other Sandhill lakes (Paukert and Willis 2003). Since the 28 in. 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-3).

Although sample size was small (N = 5), the diet of quality to preferred length northern pike had less empty stomachs and preyed on exclusively carp, while the protected preferred length fish had more empty stomachs and preyed on yellow perch and carp (Table B-2).

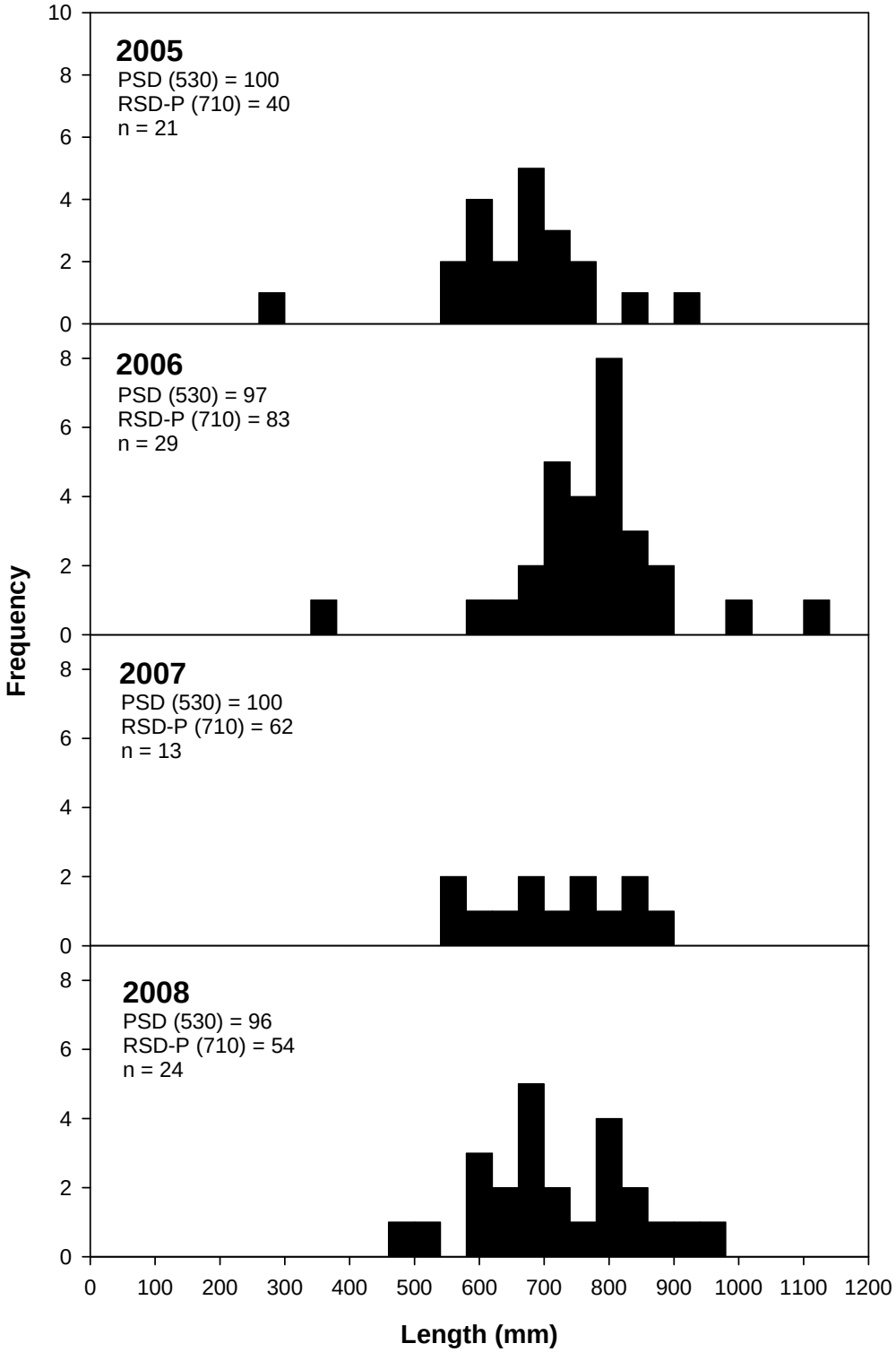

Figure B-3. Length frequency distribution (40-mm length groups) of northern pike captured by gill nets during the fall in Clear Lake from 2005 to 2008.

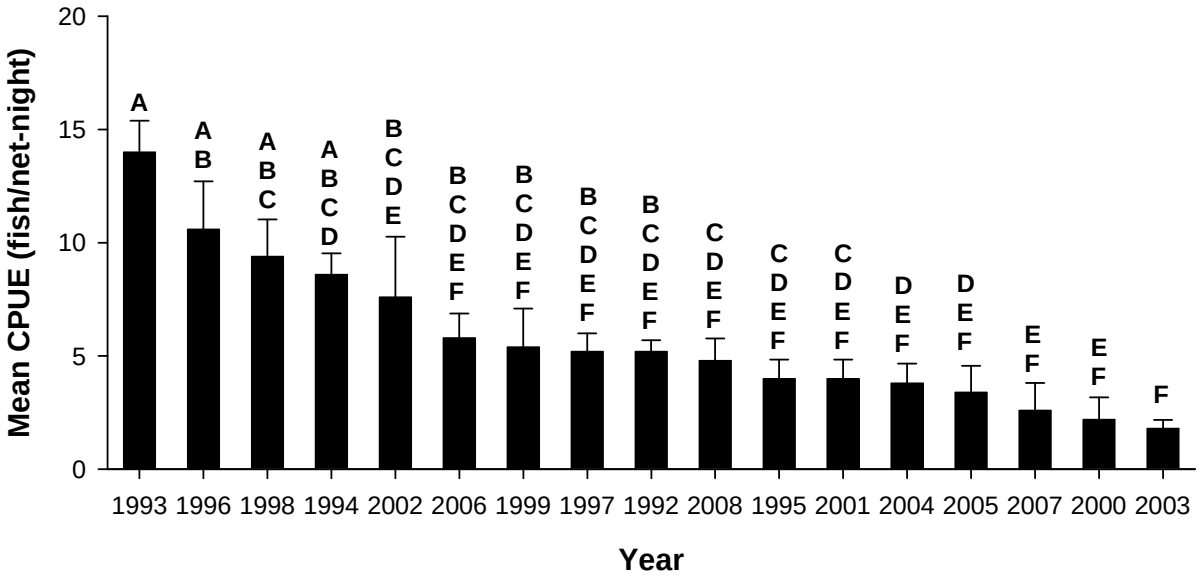

Figure B-4. Northern pike gill net mean catch per unit effort (CPUE) in Clear Lake from 1992 to 2008. Years with the same letter are not significantly different (P > 0.20) using ANOVA with Tukey-Kramer multiple comparison tests.

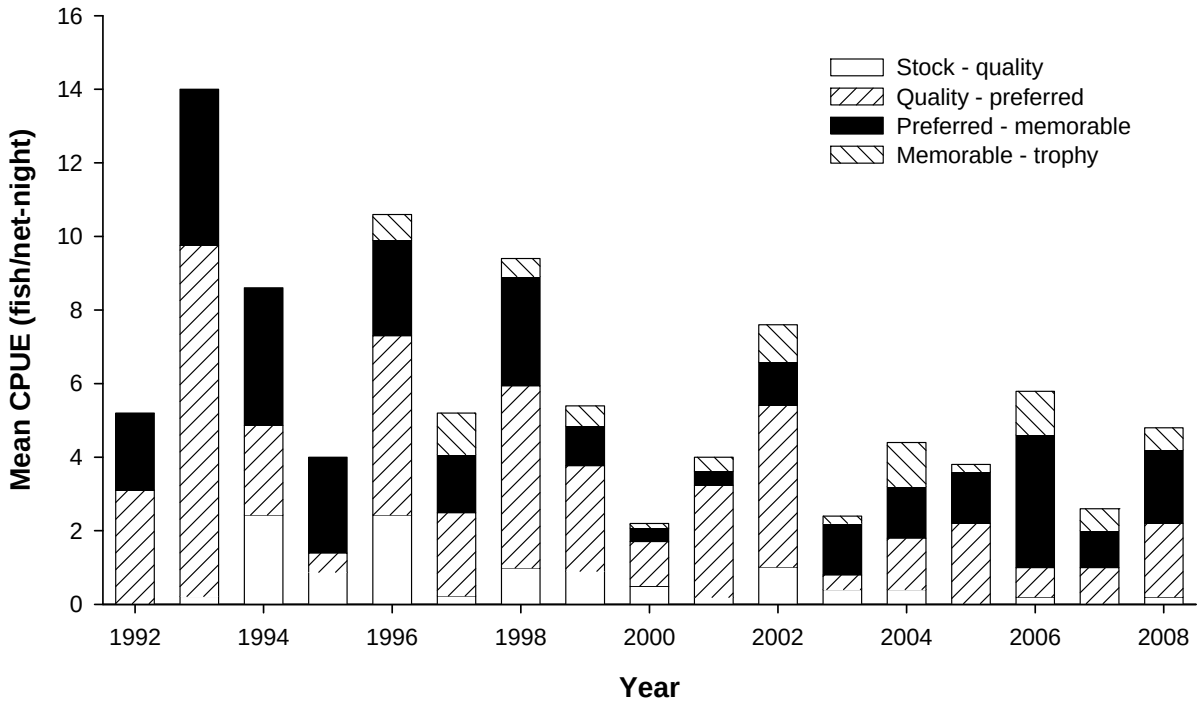

Figure B-5. Gill net mean catch per unit effort (CPUE) for northern pike by length category in Clear Lake from 1992 to 2008.

Table B-3. 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 – 2008 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	% ≥ Quality		S-Q (350-530mm) (14-21 in)			Q-P (530-710mm) (21-28 in)			P-M (710-860mm) (28-34 in)			M-T (860-1120mm) (34-44 in)		
	PSD	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r
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	

Golden shiner

One 85 mm golden shiner *Notemigonus crysoleucas* was captured in a trap net during the spring in 2008.

Yellow perch

Relative abundance of stock length perch (≥ 130 mm) has remained low every year since 2003, while PSD and RSD have substantially increased from 2005 to 2008. Currently, the population is dominated by preferred length perch (Figure B-6). There is no evidence of reproduction in the last few years and it appears that one or two year classes have recruited to the preferred length group (Figure B-7). Almost identical trends are occurring concurrently in the Dewey and Pelican Lake yellow perch populations. There appears to be low recruitment of yellow perch in Clear Lake, either due to environmental conditions or an abundance of predators, including bluegill, crappie, and adult yellow perch that prey on yellow perch fry. Mean W_r increased in 2008 (Table B-4) and was substantially higher compared to other Sandhill lakes (Paukert and Willis 2001).

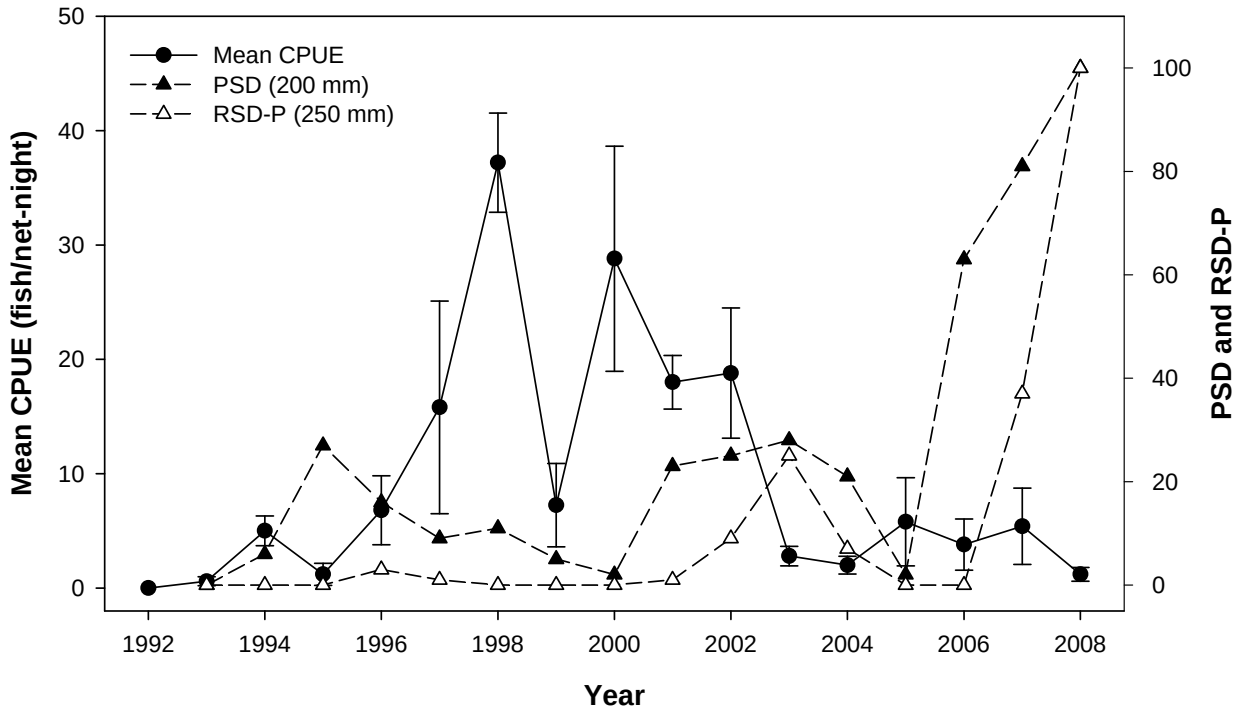

Figure B-6. Annual relative abundance (perch/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch caught by gill nets in Clear Lake from 1992 to 2008. Mean catch per unit effort (CPUE) calculated for perch ≥ stock length (130 mm) only.

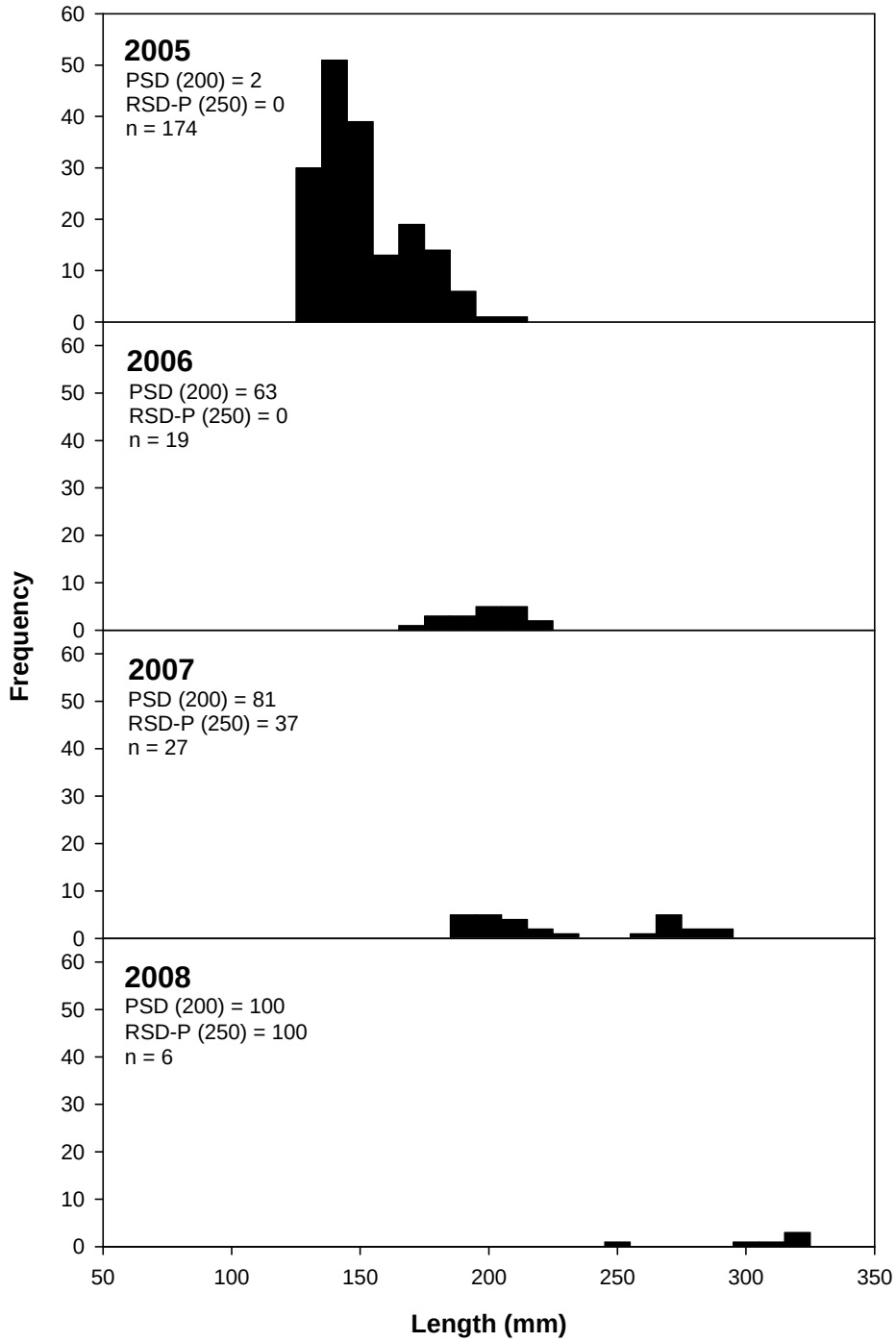

Figure B-7. Length frequency distribution (10-mm length groups) for yellow perch captured in gill nets during the fall in Clear Lake from 2005 to 2008.

Table B-4. 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 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)
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, but may have been calculated in overall W_r.

Summary

Common carp – Relative abundance of carp has been declining since 2005. The removal of 2,735 carp in the ditch between Clear and Dewey Lake additionally contributed to the decline in 2008. During fisheries surveys in the spring and fall, turbidity was drastically reduced and the lake bottom could be observed in > 3 m of water. This was likely a direct result of lower carp abundance in Clear Lake. No young of the year carp were collected in gill nets; however, they were found in the stomachs of northern pike. This indicates that a year class was produced in 2008 and that gill nets may not always be effective at detecting carp reproduction in any given year or low detectability by gill nets due to low abundance and that northern pike are effectively controlling carp recruitment.

Northern pike – Relative abundance of pike remained similar to previous years. However, the overall trend has been a decline in abundance since 1993, the same year the 28 in. maximum length limit began. The northern pike population in Clear Lake was dominated by large individuals with minimal evidence of reproduction, recruitment, and/or increased harvest of pike (< 28 in.). Northern pike are likely controlling their own abundance and size structure as yellow perch abundances remain low and variable spawning success of carp limit prey availability. Northern pike mean W_r was average compared to other Sandhill lakes. Quality to preferred length northern pike preyed exclusively on carp, while preferred length fish preyed on both yellow perch and carp.

Bluegill – Low water levels did not allow for sampling bluegill since 2006.

Golden shiner – Golden shiners provide additional forage for predators.

Largemouth bass – Low water levels did not allow for sampling largemouth bass since 2006.

Yellow perch – There is no evidence of reproduction since 2004. One or two year classes have recruited to the preferred length in 2008 providing good angling opportunities for large 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 use Clear – Dewey ditch as a means for trapping and removing carp when water conditions exist. This effort needs to be set up in a systematic fashion and evaluated for success and cost efficiency. Prior to May 2009, floy tag/fin clip carp in Clear Lake prior to trapping fish in Dewey ditch to estimate effectiveness of treatment.

3. Continue moving northern pike from West Long Lake to Clear Lake to supplement the adult population.

4. Extend boat ramp out to deeper water to improve access.

5. Build a handicap accessible fishing dock off the point just east of the boat ramp.

6. 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.

7. Record water levels in a consistent standardized manner to evaluate effects on spawning success.

8. Add turbidity as a water quality measurement.

9. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

10. 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, but this 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 ditch was dug to connect Hackberry (the first in the series) to Dewey. A ditch was also dug from Dewey to Clear (downstream from Dewey), and Dewey now feeds into Clear. 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.

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 carp migrated into Dewey from other lakes as a fisherman reported catching a carp in 1984. In the spring of 1993, large numbers of 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. Northern pike size restrictions changed four times from 1987 to 1993 (Appendix B) to improve the abundance and size structure of northern pike in an effort to biologically control the carp population. Northern pike greater than 28 in. have been protected since 1993. The long-term trend for the northern pike population appears to be stable when considering relative abundance, size structure, and condition since enactment of these regulations.

Primary fish species include: yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and carp.

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 2008.

Date	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
09/2008	21.3	20.4		10.0	0.16	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 dusk	27	11.2		7.3		0	171	
07/2001 dawn	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

On 7 May 2008, water was released from the control structure at Whitewater Lake into Dewey Lake. Refuge staff trapped and removed approximately 1,300 very large (25 to 30 pound) carp in the ditch flowing between the lakes. It was estimated that 16.25 tons of carp were removed (M. Lindvall, USFWS, personal communication). This likely contributed to the substantial decrease in gill net mean CPUE from 8 fish/net-night (SE = 2.2) in 2007 to 1.4 fish/net-night (SE = 0.7) in 2008 with a subsequent increase in PSD and RSD-P values (Figure C-1). A similar trend was seen in 1993 with a decrease in mean CPUE following carp removal in the same ditch between Dewey and White Water lakes.

Mean CPUE was low from 1992 to 2006 and PSD and RSD-P remained high during the same time period indicating low recruitment until 2007. In 2008, the carp population was dominated by preferred length fish with a few sub-stock length fish captured in gill nets indicating that spawning was successful in 2008 (Figure C-2).

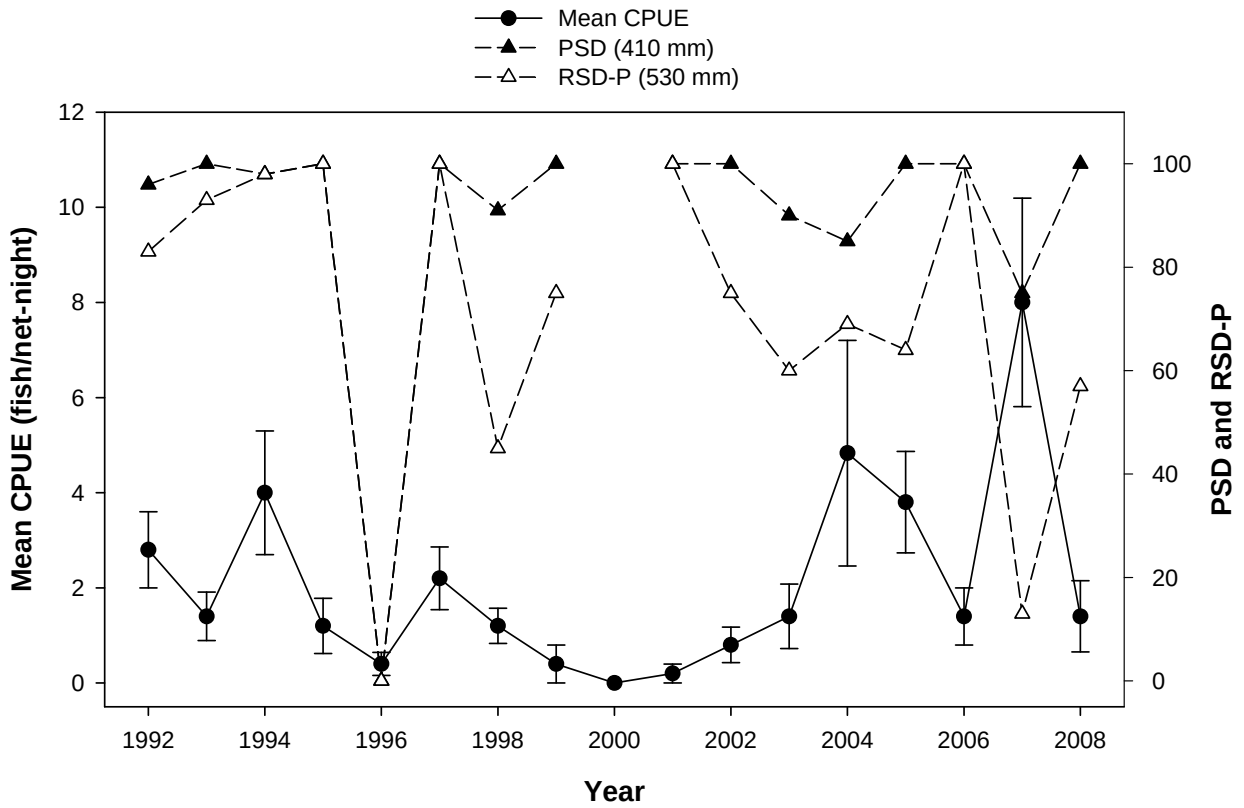

Figure C-1. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp caught by gill nets during the fall in Dewey Lake from 1992 to 2008. Mean catch per unit effort (CPUE) calculated for carp ≥ stock length (280 mm) only.

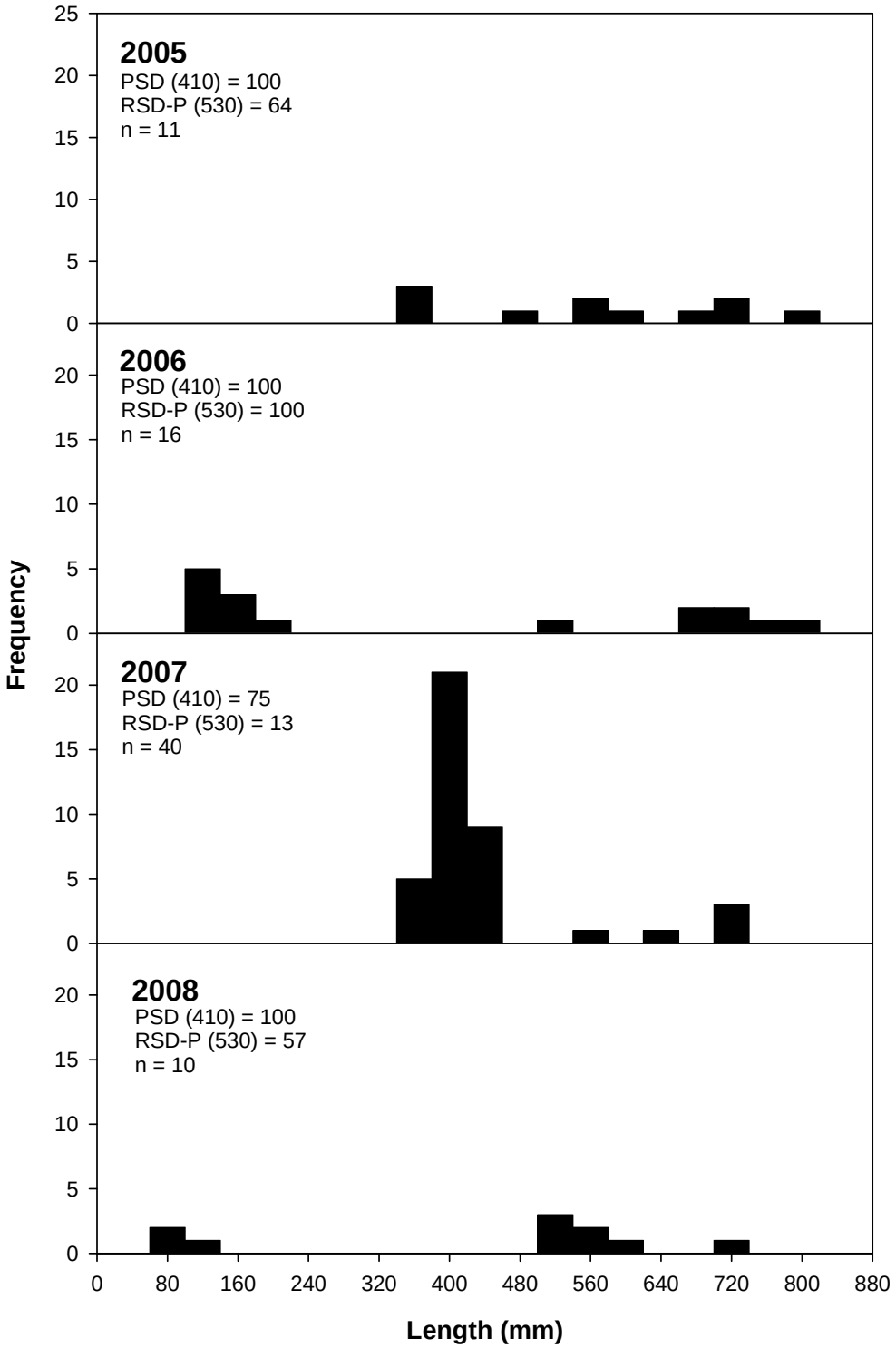

Figure C-2. Length frequency distribution (40-mm length groups) of common carp captured in gill nets during the fall in Dewey Lake from 2005 to 2008.

Northern pike

The size structure of northern pike in Dewey Lake has remained nearly constant from 2005 to 2008 (Figure C-3). The relative abundance of pike in 2008 (gill net mean CPUE = 6.8; SE = 1.2) was not significantly different from all years since standardized sampling began in 1992, except for 2004 (Figure C-4). There has been little change in relative abundance among length categories from 2005 to 2008 with all years consistently dominated by quality to preferred length fish (Figure C-5). Overall mean W_r substantially decreased from a high of 100 in 2007 to 93 in 2008. The largest decrease in condition was found in the quality to preferred length northern pike (Table C-2). However, mean W_r remained average compared to other Sandhill lakes.

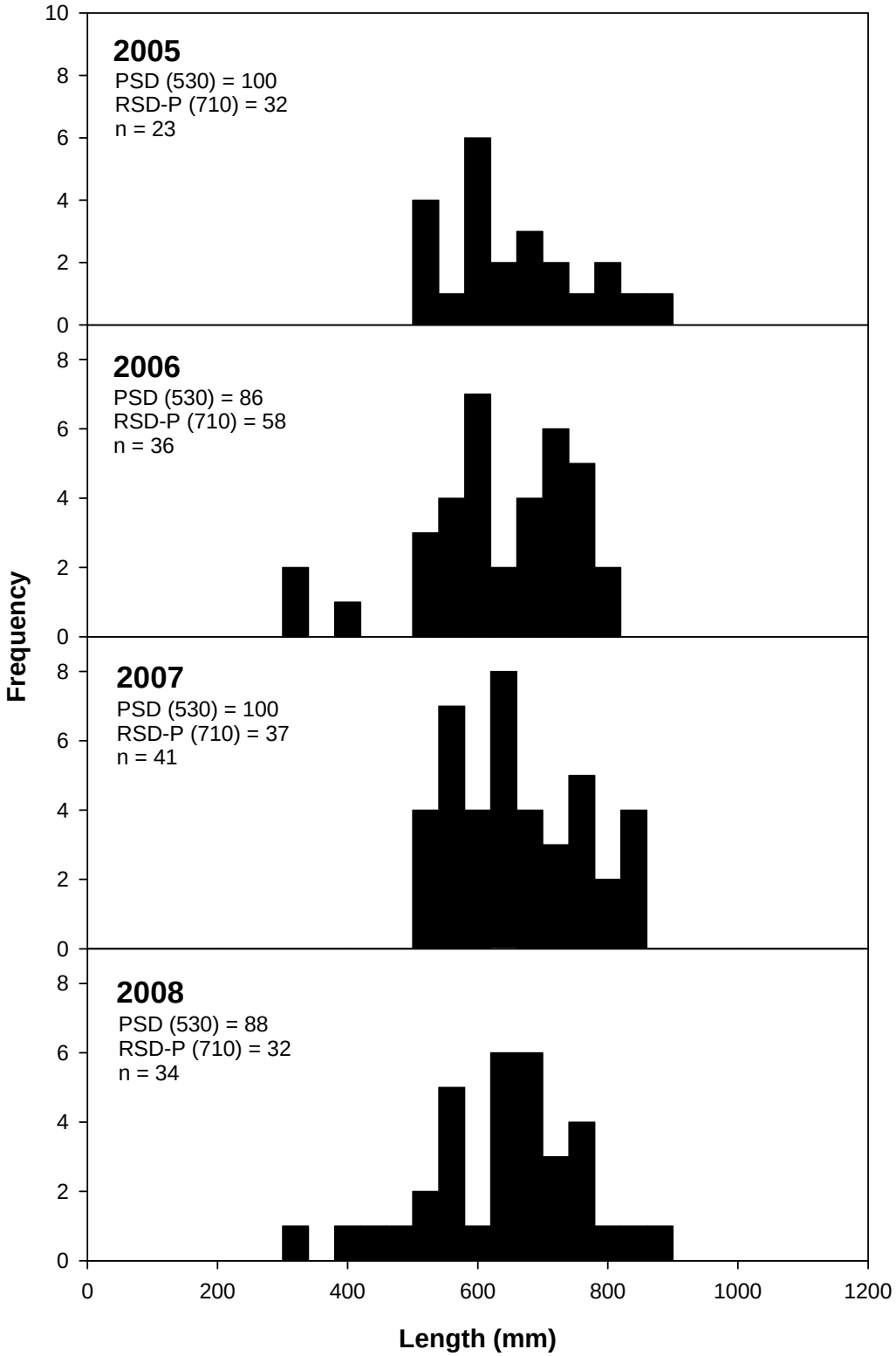

Figure C-3. Length frequency distribution (40-mm length groups) for northern pike captured in gill nets during the fall in Dewey Lake from 2005 to 2008.

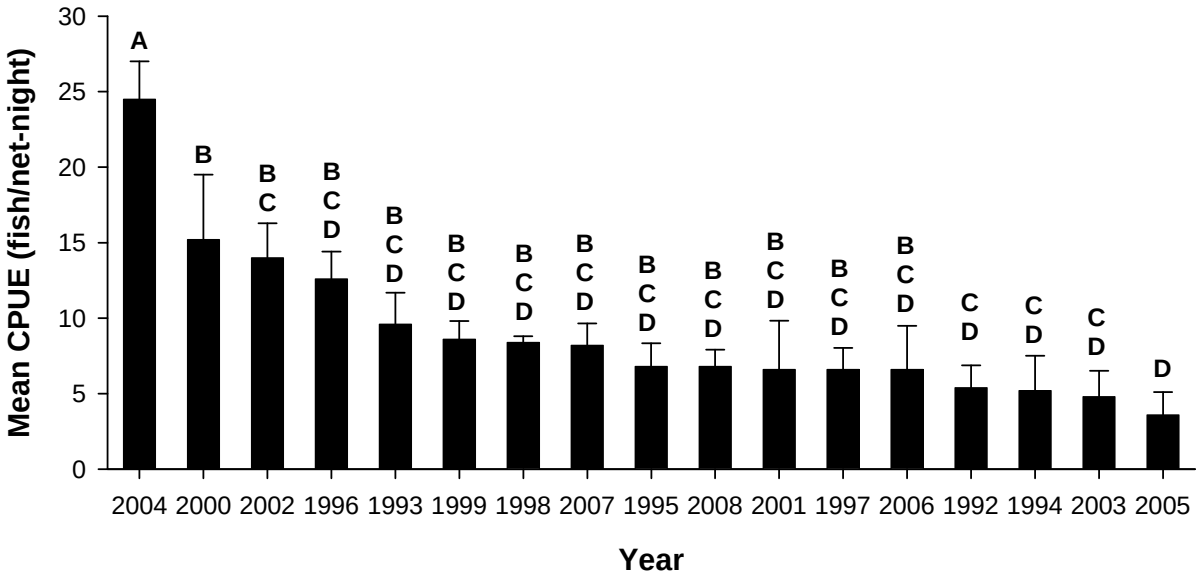

Figure C-4. Northern pike gill net mean catch per unit effort (CPUE) with SE bars for Dewey Lake from 1992 to 2008. Years with the same letter are not significantly different (P > 0.20) using ANOVA with Tukey-Kramer multiple comparison tests.

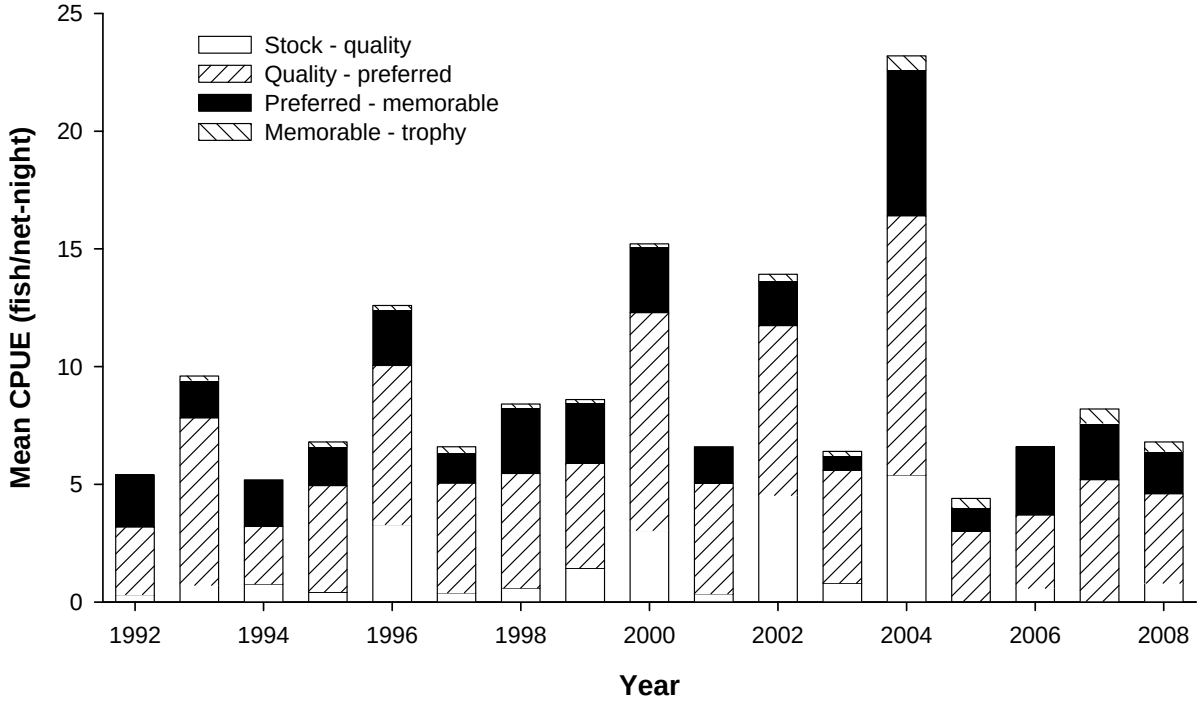

Figure C-5. Gill net mean catch per unit effort (CPUE) for northern pike by length category in Dewey Lake from 1992 to 2008.

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 and 2007 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	% ≥ Quality		S-Q (350-530mm) (14-21 in)			Q-P (530-710mm) (21-28 in)			P-M (710-860mm) (28-34 in)			M-T (860-1120mm) (34-44 in)		
	PSD	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r	RSD	+/-	W_r
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

In 2008, three bullheads were captured during spring trap nets (89, 94, and 194 mm), one fish in fall gill nets (150 mm), and one fish in fall trap netting (173 mm). This was the first detection of bullheads in Dewey Lake since 1997.

Bluegill

Relative abundance of stock length bluegill substantially decreased to 57 fish/hr (SE = 7.9) in 2008 from a high of 133 fish/hr (SE = 40.9) in 2007 (Figure C-6). Size structure improved as PSD = 64 while RSD-P remained low at 3. The bluegill population in Dewey Lake was dominated by quality to preferred length fish likely from a strong year class in 2005 (Figure C-7). Bluegill mean W_r remains high, was similar to other Sandhill lakes, and also continued to have low variation among years and length categories (Table C-3).

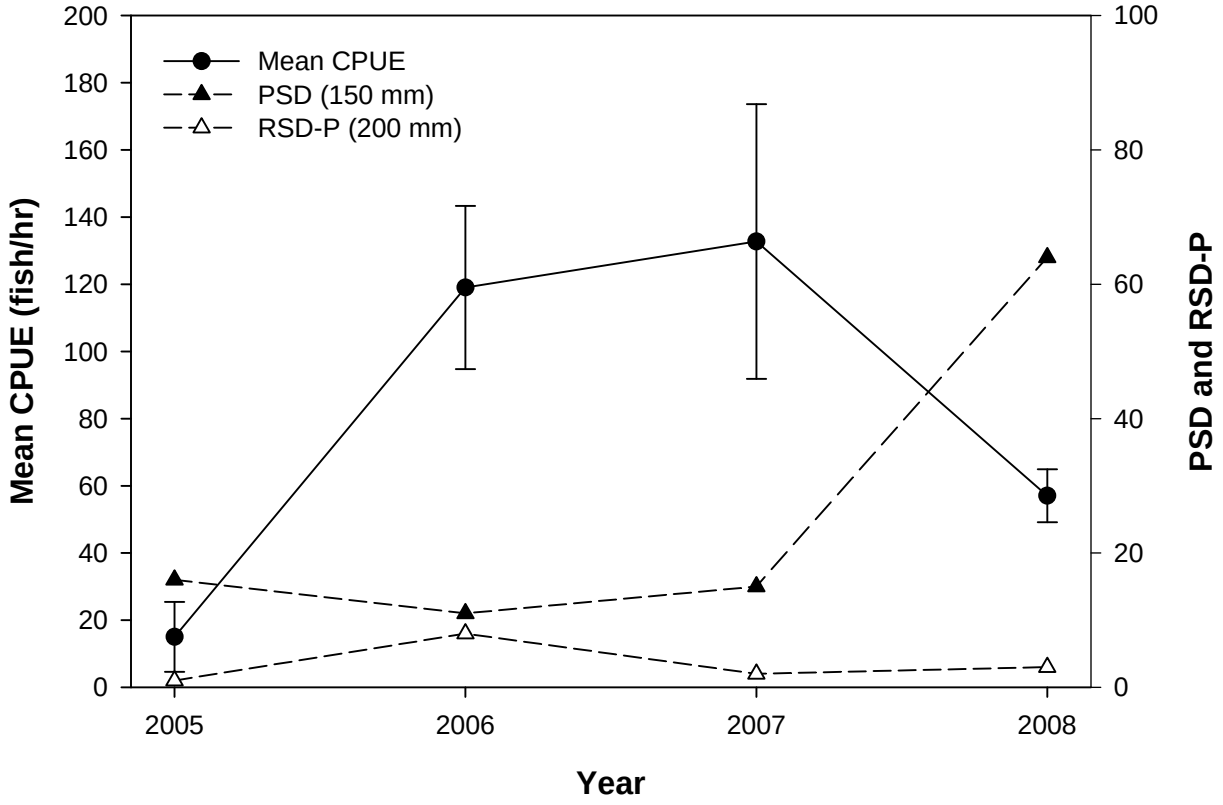

Figure C-6. Annual relative abundance (fish/hr), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing during the spring in Dewey Lake from 2005 to 2008. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

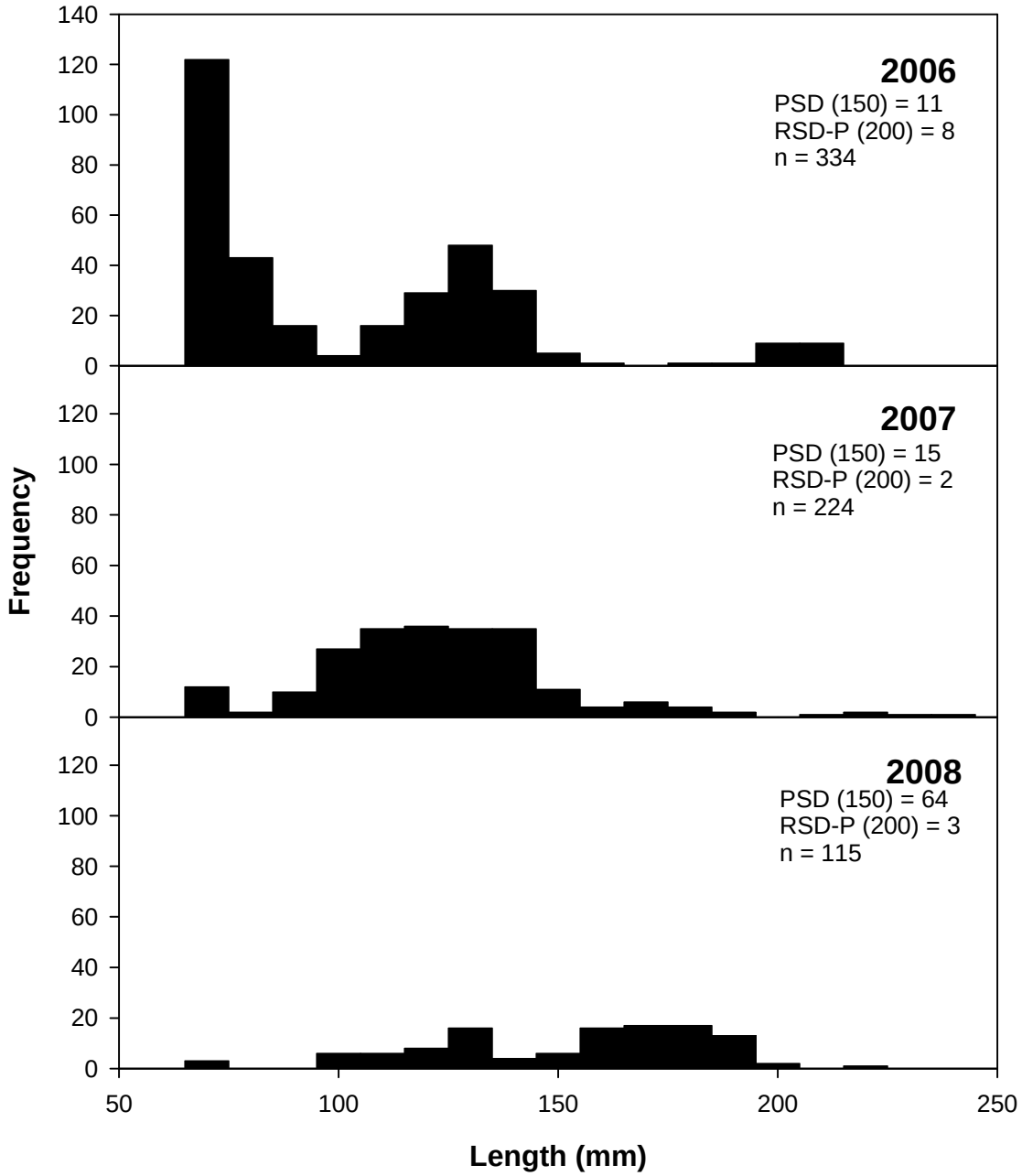

Figure C-7. Length frequency distribution (10-mm length groups) for bluegill captured by electrofishing during the spring in Dewey Lake from 2006 to 2008.

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 2008. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2008.

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

Largemouth bass

Relative abundance remained low at 4.5 fish/hr (SE = 0.9) in 2008 compared from a high of 22 fish/hr (SE = 8.2) in 2005 (Figure C-8). The population in Dewey Lake went from a somewhat "balanced" population in 2005, to a population dominated by sub-stock length fish and few preferred length fish (Figure C-9). A strong year class that was likely produced in 2005 and detected in 2006 (Figure C-9), had low recruitment past age 1. Prior to 2005, length frequency data indicated strong year classes but few of these fish recruited to larger sizes in subsequent years. Mean W_r has increased since 2007 and is above average compared to other Sandhill lakes (Table C-4).

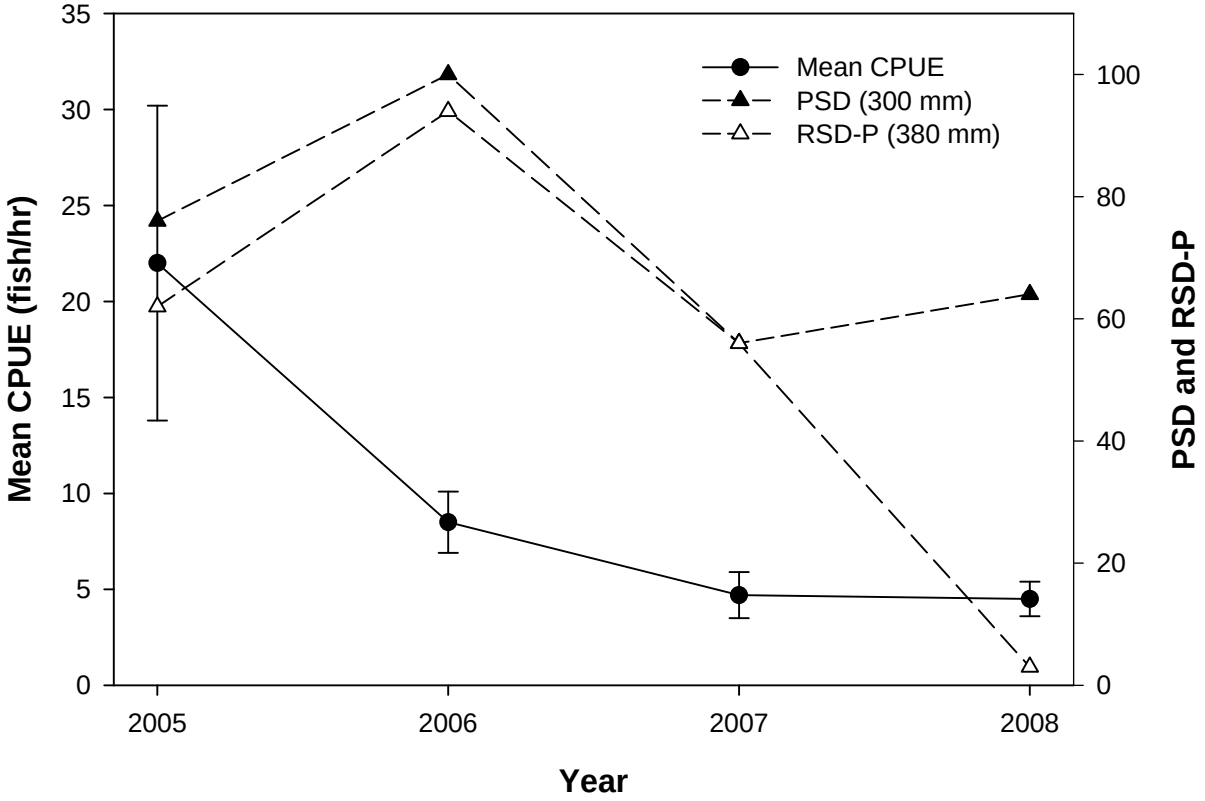

Figure C-8. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing during the spring in Dewey Lake from 2005 to 2008. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

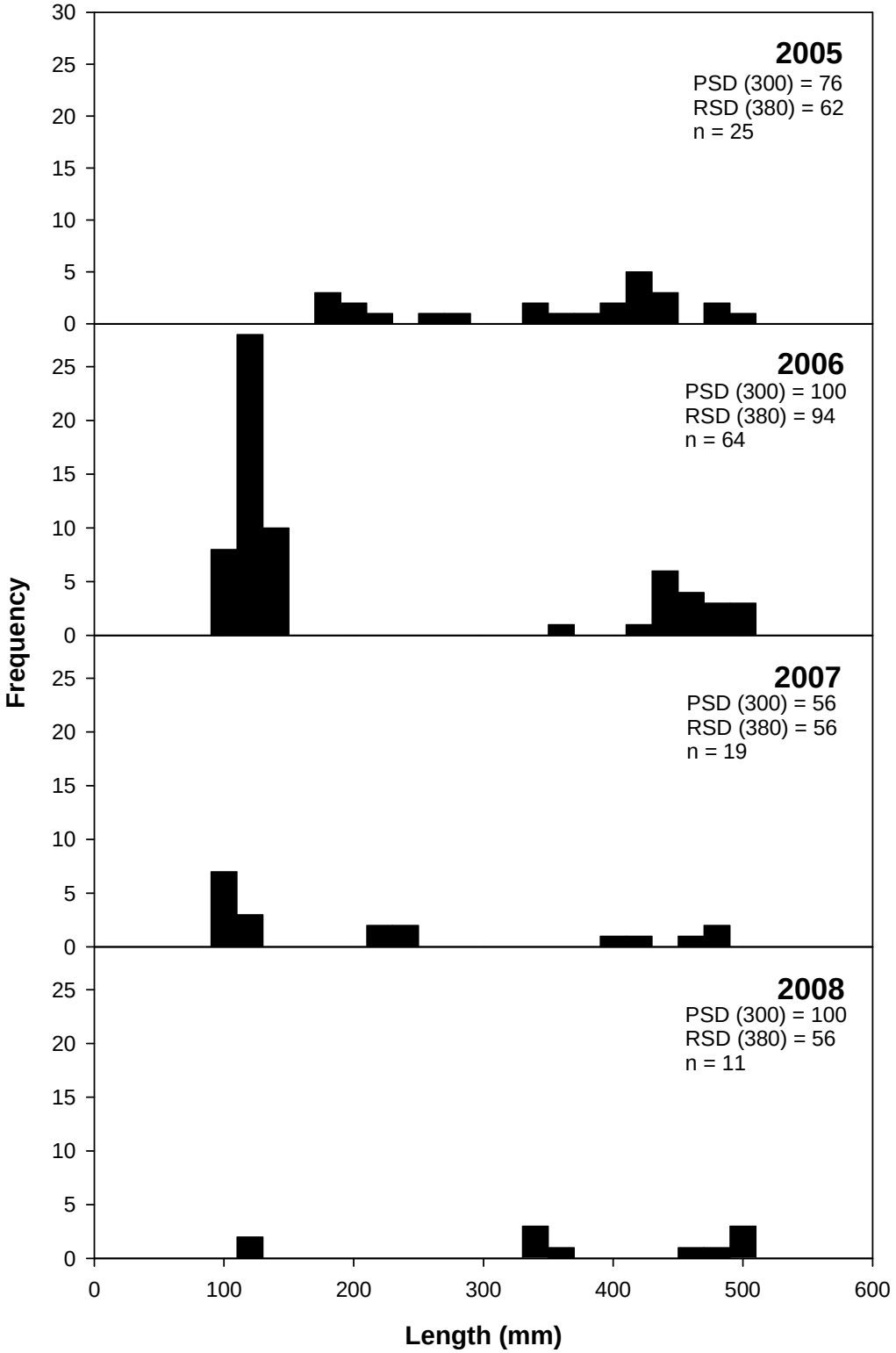

Figure C-9. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing during the spring in Dewey Lake from 2005 to 2008.

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 2008. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2008.

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)
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, but may have been calculated in overall W_r.

Yellow perch

Relative abundance of yellow perch remained low in 2008 (gill net mean CPUE = 8.4; SE = 3.2) when compared to the mid-90's (Figure C-10). The PSD/RSD values declined during the years with strong year classes but this was usually a reflection of the increased abundance of smaller fish. Size structure has been improving since a low in 2005 (Figure C-10). The yellow perch population is dominated by stock to quality length fish with few preferred length fish (Figure C-11). Overall mean W_r in 2008 was similar to other Sandhill lakes, but remained below the highs seen in the mid-90's (Table C-5).

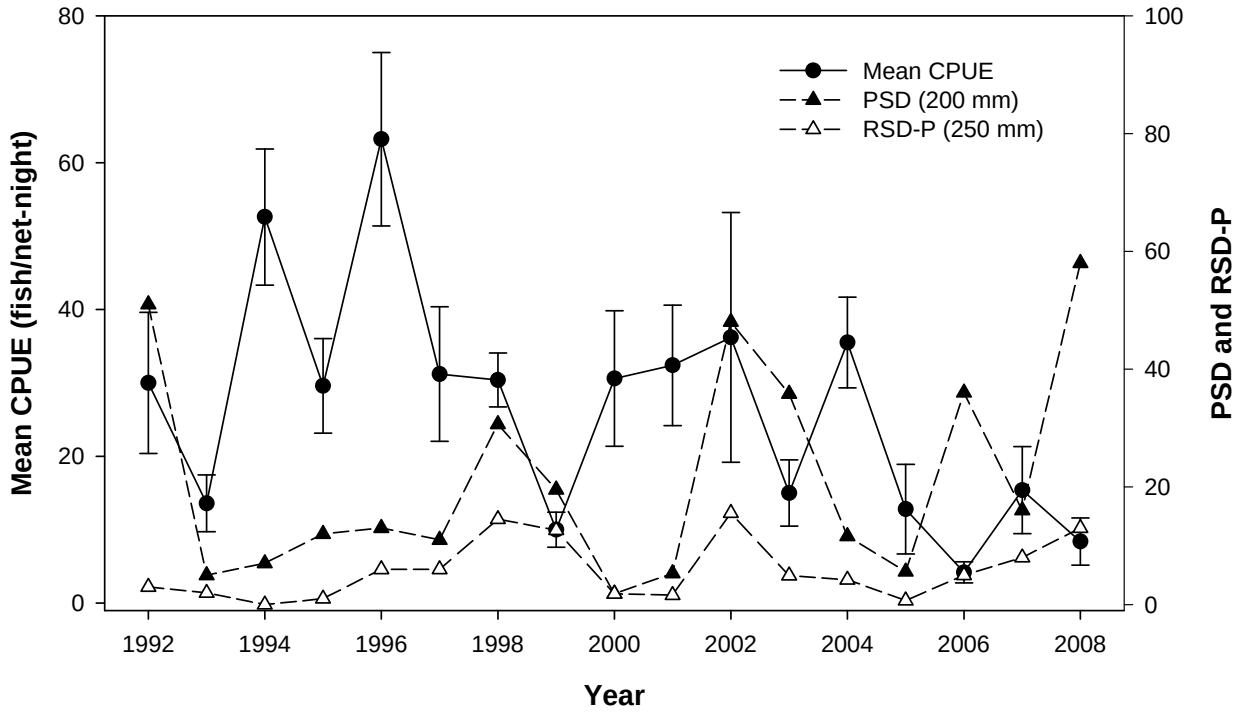

Figure C-10. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets during the fall in Dewey Lake from 1992 to 2008. Mean catch per unit effort (CPUE) calculated for perch ≥ stock length (130 mm) only.

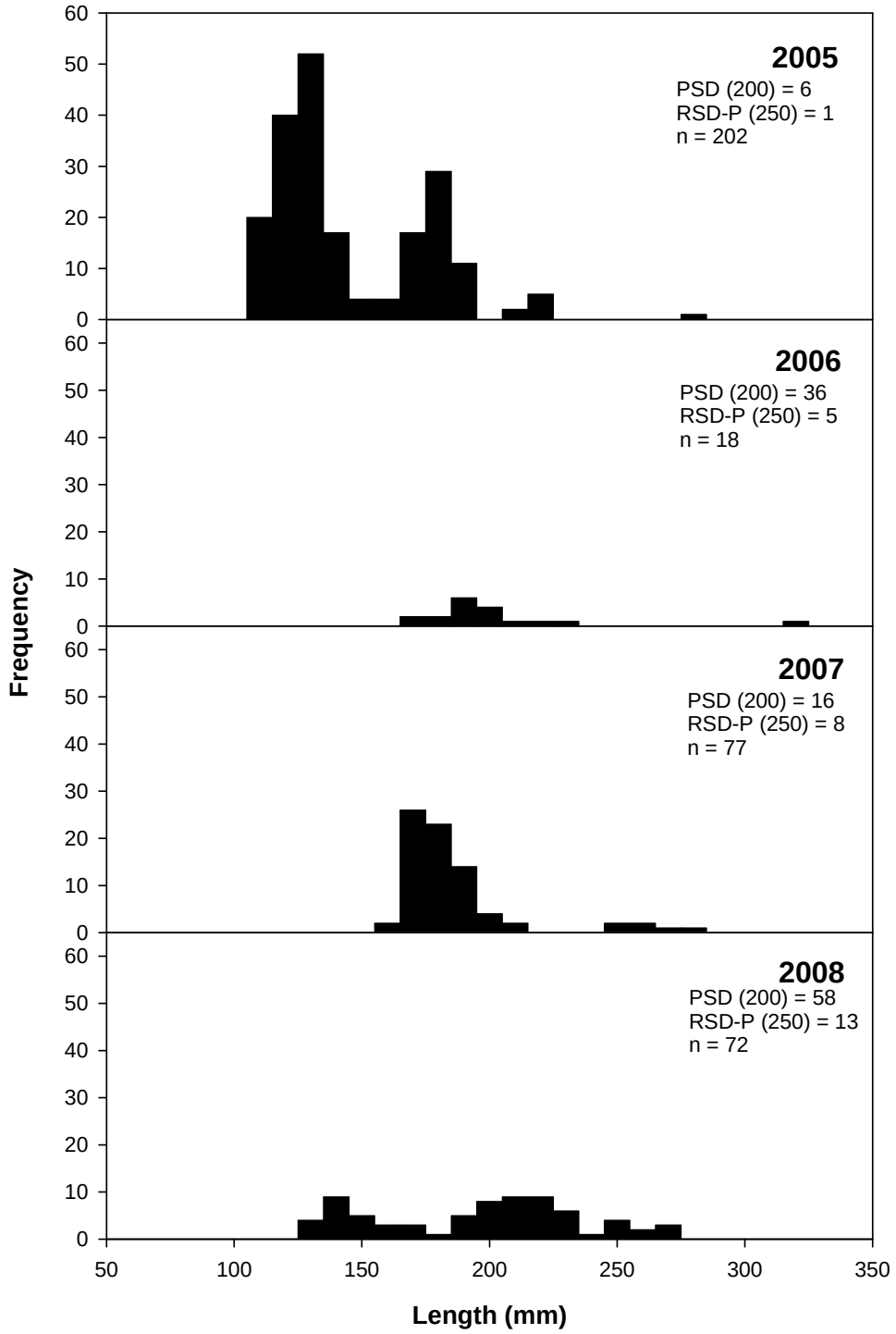

Figure C-11. Length frequency distribution (10-mm length groups) of yellow perch captured in gill nets during the fall in Dewey Lake from 2005 to 2008.

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 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)
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, but may have been calculated in overall W_r.

Summary

Common carp – The removal of 1,300 carp in the ditch between Dewey and Whitewater Lake likely contributed to the decline in relative abundance in 2008 compared to the all time high in 2007. Mean CPUE was low from 1992 to 2006 and PSD and RSD-P remained high during that same time period indicating low or no recruitment until 2007. The carp population was dominated by stock to quality length fish as the sub-stock length (< 280 mm) carp in 2006 recruited to the population. Carp successfully spawned in 2008 as young of the year were captured in gill nets during the fall.

Northern pike – The long-term trends for the northern pike population appears to be stable when considering relative abundance, size structure, and condition. However, it does appear that a strong year class of carp did recruit to the population during the same time of lower than normal northern pike abundances from 2005 to 2007. Northern pike are also likely controlling abundance and size structure of other important game species in Dewey Lake.

Bluegill – Relative abundance of bluegills declined in 2008 with a corresponding improvement in size structure providing good angling opportunities. Mean W_r remained high.

Largemouth bass – Relative abundance of largemouth bass continued to decline in Dewey Lake from a high of 22 fish/hr (SE = 8.2) in 2005. The population is out of balance as was dominated by sub-stock length fish and few preferred length fish.

Yellow perch – Relative abundance remained low, while size structure has improved, but remained below the highs of the mid-90's. Angling opportunities do exist for preferred length 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 use Dewey - Whitewater ditch as a means for trapping and removing carp when water conditions exist. This effort needs to be set up in a systematic fashion and evaluated for success and cost efficiency. Prior to May 2009, floy tag/fin clip carp in Clear Lake prior to trapping fish in Dewey ditch to estimate effectiveness of treatment.

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 turbidity as a water quality measurement.

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.

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 Lake (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 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 µS/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 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" 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, and bluegill.

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

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

Date	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
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 dusk	28	12.0		7.1		17	137	
07/2001 dawn	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

A total of 15 carp ranging from 230 to 343 mm were captured while conducting post-renovation electrofishing in May 2008. This was the first detection of carp in Hackberry Lake since the renovation was conducted in 2004 as no carp were detected while electrofishing in 2006 or 2007. During fall gill netting in 2008, mean CPUE was 10.4 fish/net-night (SE = 2.5) for stock length (≥ 280 mm) fish. This was the highest carp gill net mean CPUE for stock length fish ever recorded in any Refuge lakes since standardized surveys began in 1992.

The carp population appeared to be dominated by one year class of fish in the quality to preferred length group (Figure D-1).

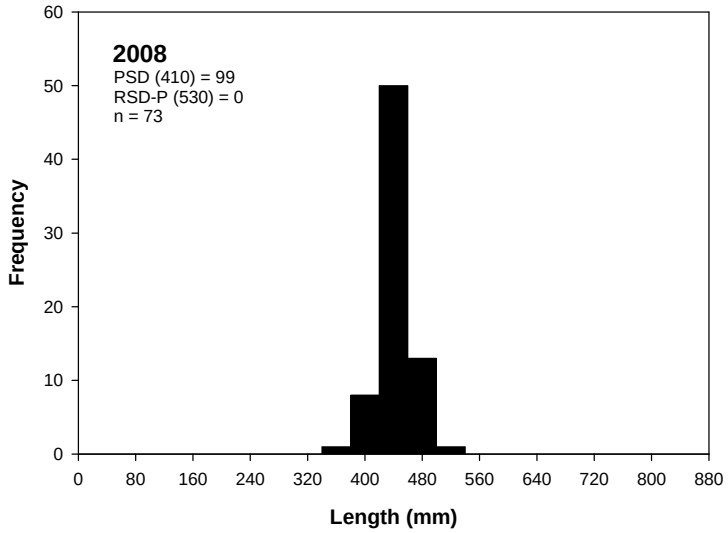

Figure D-1. Length frequency distribution (40-mm length groups) of common carp captured in gill nets in Hackberry Lake in September 2008.

Northern pike

One northern pike (690 mm and 1.7 kg) was captured while electrofishing in May 2008. This fish was moved to Dewey Lake after being captured. This was the first detection of northern pike in Hackberry Lake since the renovation in 2004. Two northern pike (613 and 672 mm) were captured while gill netting in September 2008. Both fish were moved to Dewey Lake.

Bluegill

Stocking of nearly 180,000 fingerling bluegills in 2007 appears to have been successful as mean CPUE increased from 1.5 fish/hr (SE = 1.5) in 2007 to 17.5 fish/hr (SE =3.8) in 2008 (Figure D-2). The bluegill population was dominated by sub-stock and stock to quality length fish (Figure D-3). Large numbers of dead bluegill were observed during the spring of 2007 after ice out indicating a possible winter-kill. In 2008, mean Wr was 126 (SE = 3.0) and the second highest among Refuge lakes.

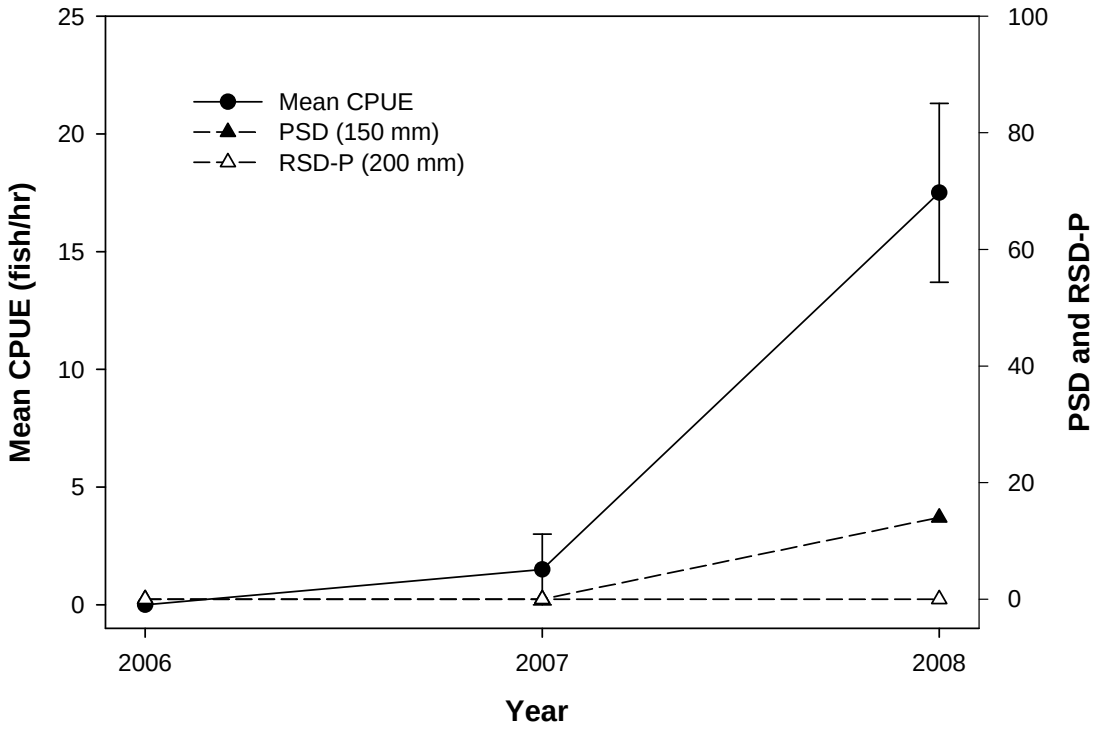

Figure D-2. Annual relative abundance (fish/hr), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing during the spring in Hackberry Lake from 2006 to 2008. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

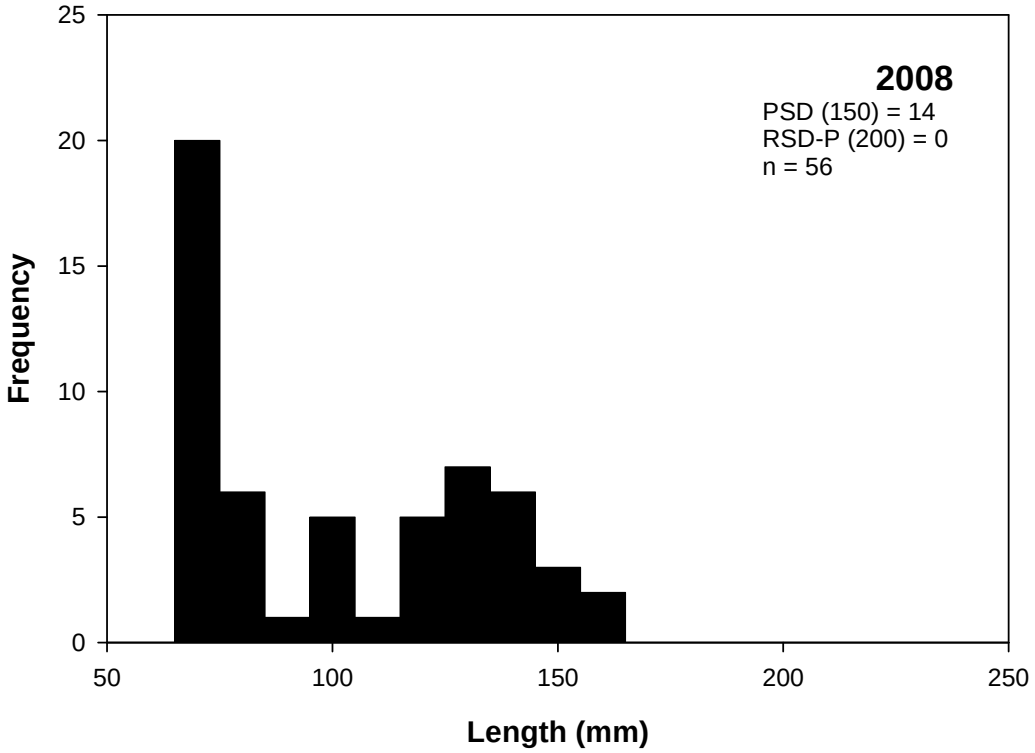

Figure D-3. Length frequency distribution (10-mm length groups) for bluegill captured by electrofishing in Hackberry Lake in May 2008.

Largemouth bass

With high variability in the electrofishing sampling, mean CPUE of stock length largemouth bass increased in 2008 (Figure D-4). Relative abundance decreased from 12.0 LMB/hr (SE = 0) in 2006 to 1.5 LMB/hr (SE = 1.1) in 2007. Large numbers of dead largemouth bass were observed during the spring of 2007 indicating a possible winter-kill.

It appears that the stocking of > 40,000 fingerling bass in 2007 was successful as the population was dominated by sub-stock length fish with a few quality length fish from previous stockings (Figure D-5). However, we can not exclude the possibility that a few adult bass may have naturally produced a strong year-class in 2007.

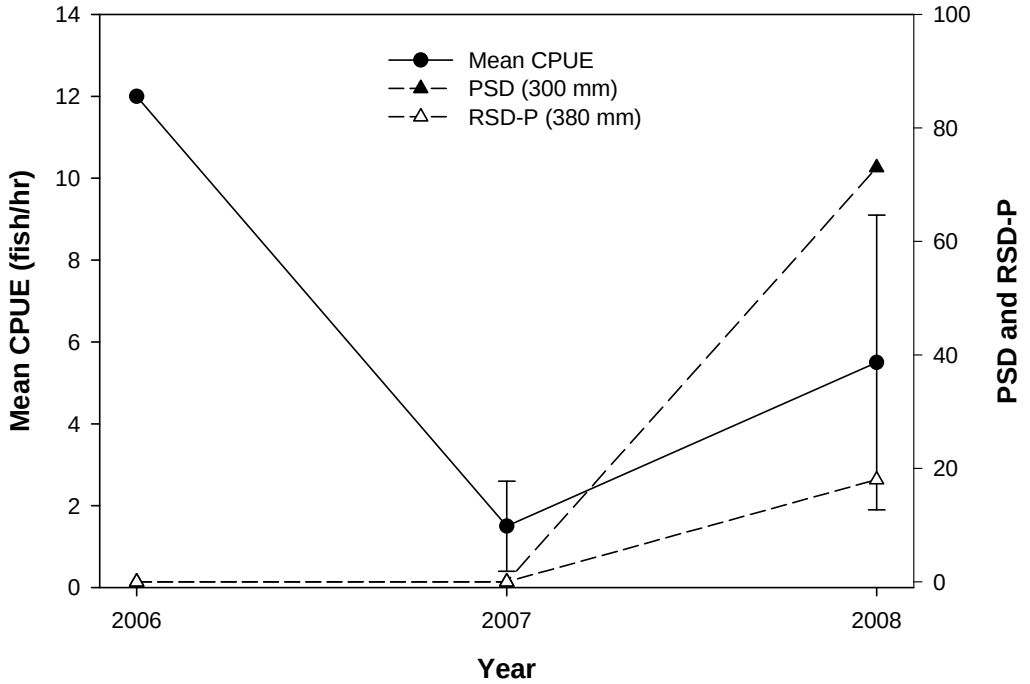

Figure D-4. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by electrofishing during the spring in Hackberry Lake from 2006 to 2008. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

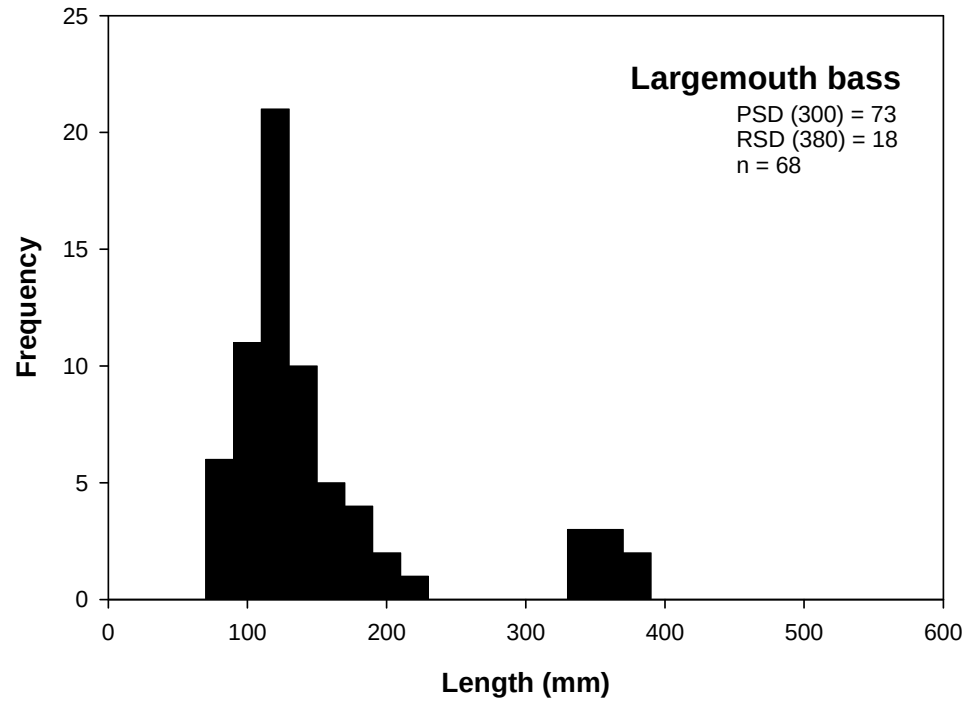

Figure D-5. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing in Hackberry Lake in May 2008.

Yellow perch

Although electrofishing is not typically used in standard surveys for yellow perch, we attempted to capture all fish we encountered in our post-renovation survey of Hackberry Lake.

The relative abundance of stock length yellow perch in Hackberry substantially decreased as did PSD values from 2007 to 2008 (Figure D-6). However, the overall size structure has improved with an increase in preferred length fish in 2008 (Figures D-7 and D-8). Length frequency histograms indicated three year classes and that a strong year-class of perch was produced in 2007. Gill netting may be a more effective gear at capturing preferred length perch than electrofishing, but did not detect fish < 150 mm (Figures D-7 and D-8). Mean W_r of yellow perch in Hackberry Lake improved in 2008 after a substantial decline from 2006 to 2007 (Table D-2). The condition of yellow perch in Hackberry Lake is one of the highest among the Refuge lakes and is above average for Sandhill lakes.

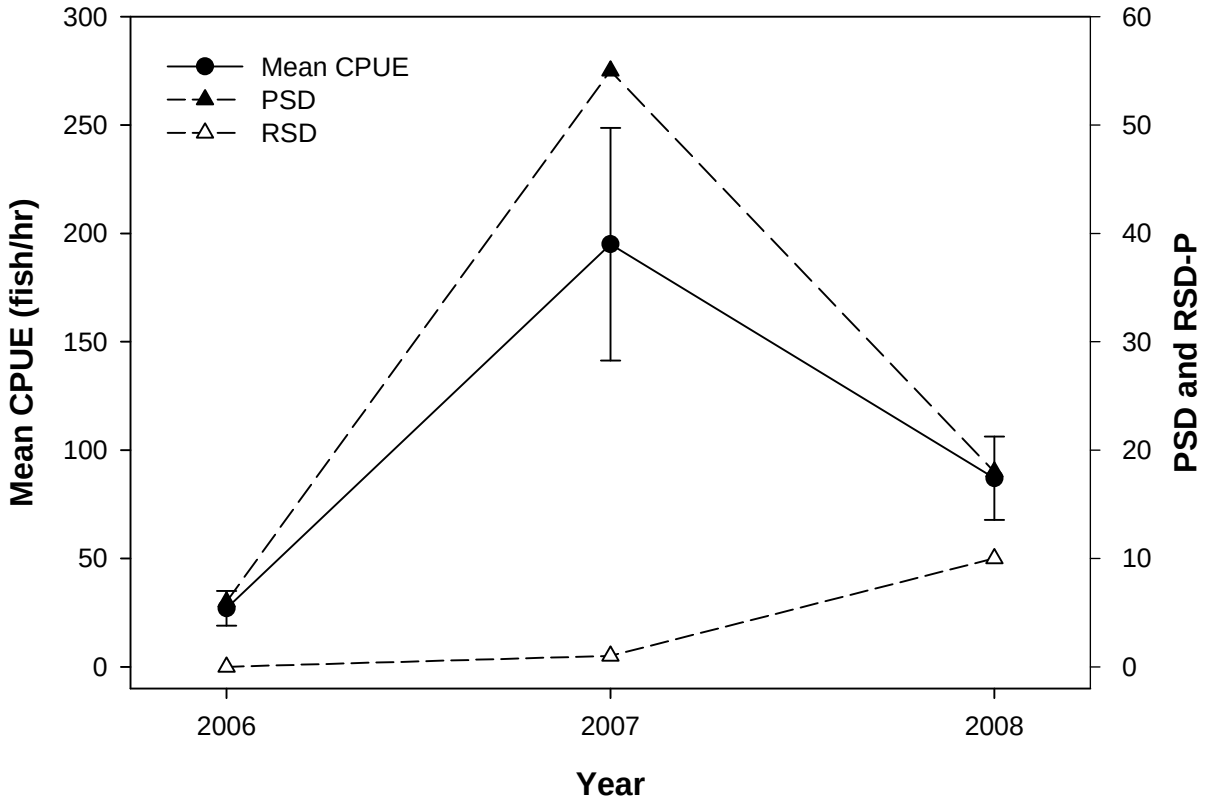

Figure D-6. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by electrofishing during spring in Hackberry Lake from 2006 to 2008. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

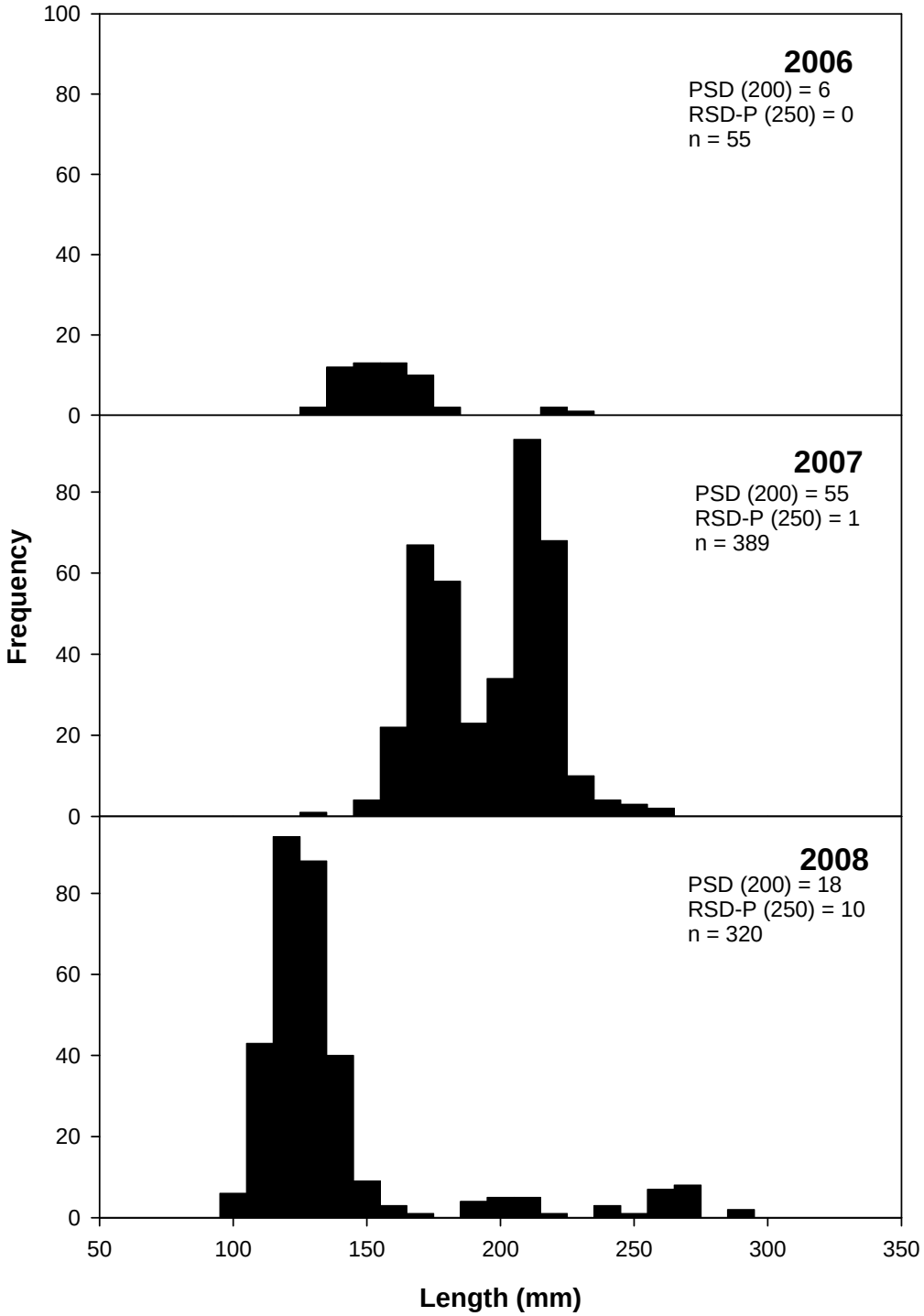

Figure D-7. Length frequency distribution (10-mm length groups) of yellow perch captured by electrofishing during spring in Hackberry Lake from 2006 to 2008.

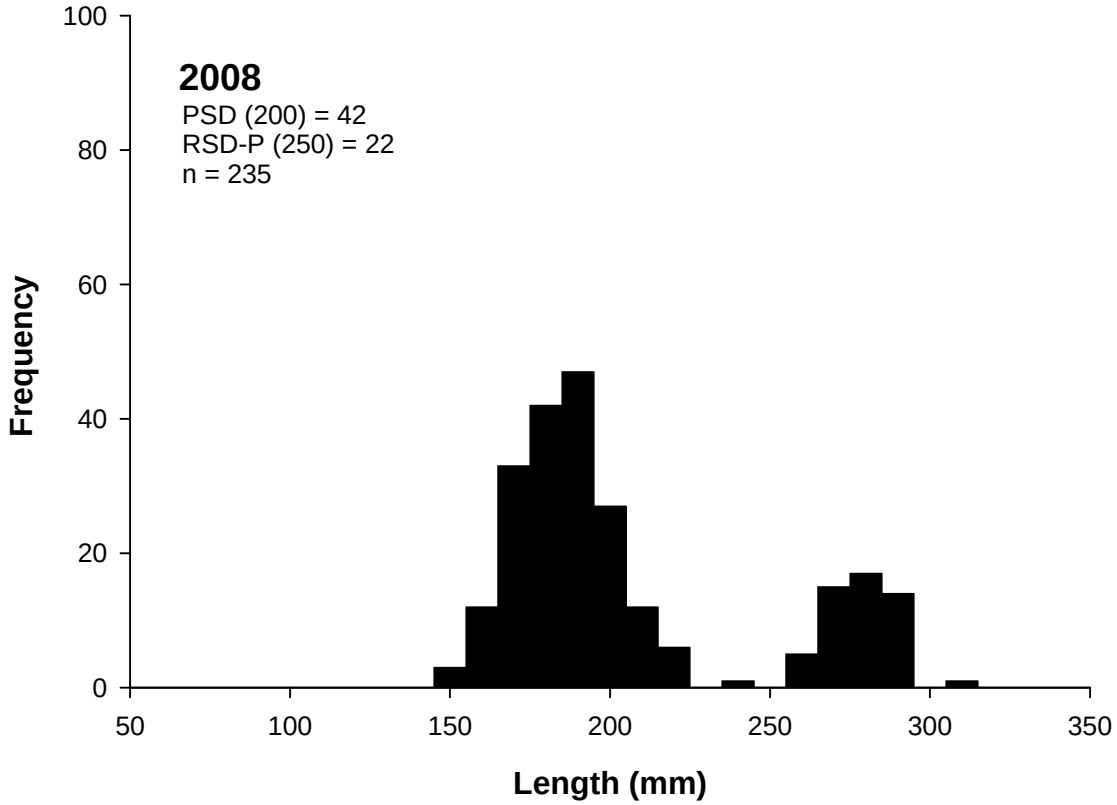

Figure D-8. Length frequency distribution (10-mm length groups) of yellow perch captured by gill netting in Hackberry Lake in September 2008.

Table D-2. 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 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)
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 during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall W_r.

Summary

Common carp – Carp were first detected by electrofishing in May 2008 since the renovation was conducted in 2004. Carp gill net mean CPUE for stock length fish in Hackberry Lake in 2008 was the highest ever recorded in any Refuge lakes since standardized surveys began in 1992. The carp population appeared to be dominated by one year class of fish in the quality to preferred length group.

Northern pike – In addition to common carp, northern pike were observed in 2008 for the first time since the renovation in 2004.

Bluegill – Stocking of nearly 180,000 fingerling bluegills in 2007 appeared to be successful as mean CPUE substantially increased in 2008 after large numbers of dead bluegill were observed during the spring of 2007 after ice out indicating a winter-kill. Bluegill condition in Hackberry Lake is one of the highest among the Refuge lakes and is above average for Sandhill lakes.

Largemouth bass – A significant winter-kill during the winter of 2006-2007 likely reduced the largemouth bass population in Hackberry Lake. The stocking of > 40,000 fingerling bass in 2007 was successful as the population in 2008 was dominated by sub-stock length fish with a few quality length fish from previous stockings.

Yellow perch – The relative abundance of perch decreased in 2008; however, the overall size structure improved with an increase in preferred length fish available to anglers. Gill netting appears to be a more effective gear at capturing preferred length perch compared to electrofishing. The condition of yellow perch in Hackberry Lake is one of the highest among the Refuge lakes and is above average for Sandhill lakes.

Management Recommendations

1. Since the introduction of common carp and northern pike, begin 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 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 turbidity as a water quality measurement.

7. 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 μS/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 ^{0}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.

Pelican Lake has had a similar history of 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 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 flowing over. 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 carp populations. Northern pike greater than 28 in have been protected since 1993. The carp population in Pelican Lake appears to have stabilized since an increase was observed in 2003. It does appear that carp are successful at spawning nearly every year with some recruitment. Northern pike are likely having an affect on the carp population; however, current low pike numbers may allow a strong carp year class to recruit to the population.

The fishery includes yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and common carp.

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 2008.

Date	Water temp. (°C)	D.O. (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
09/2008	20.2	15.4		9.4	0.16	34	120	308
05/2008	15.7	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 dusk	28	11.7		7.7		25	110	
07/2001 dawn	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

Annual relative abundance of stock length carp appears to be stable since an initial increase between 2001 and 2003 (Figure E-1). Since 2001, gill net mean CPUE has ranged from 4.1 carp/net-night (SE = 1.4) to 12 carp/net-night (SE = 3.5). Spawning by carp appears to be successful in Pelican Lake with a few sub-stock fish (< 280 mm) captured in 2005 and 2007 (Figure E-2). Although we were unable to gill net due to low water levels in 2006, the number of stock to quality length (280 – 410 mm) carp captured in 2007 suggests high numbers of sub-stock length carp comprised the population during 2006 (Figure E-2).

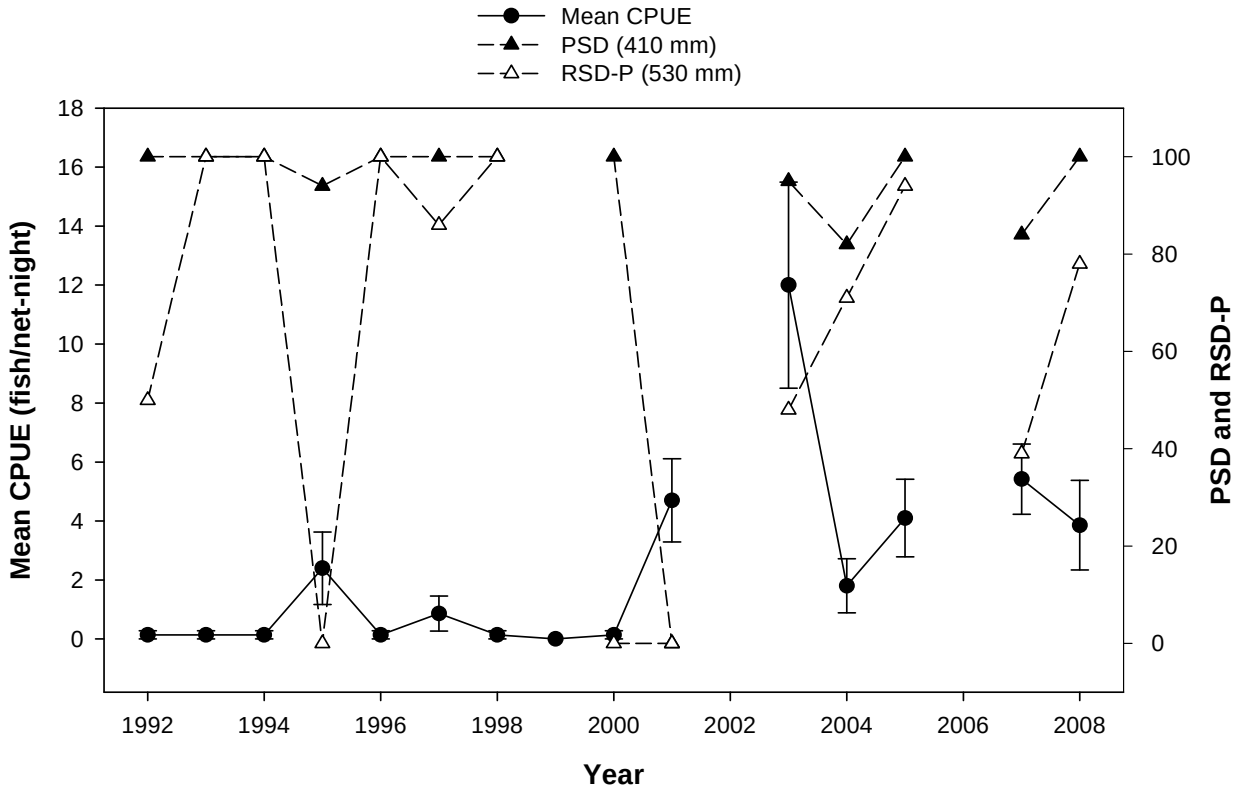

Figure E-1. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of common carp captured gill nets during the fall in Pelican Lake from 1992 to 2008. Mean catch per unit effort (CPUE) calculated for carp ≥ stock length (280 mm) only.

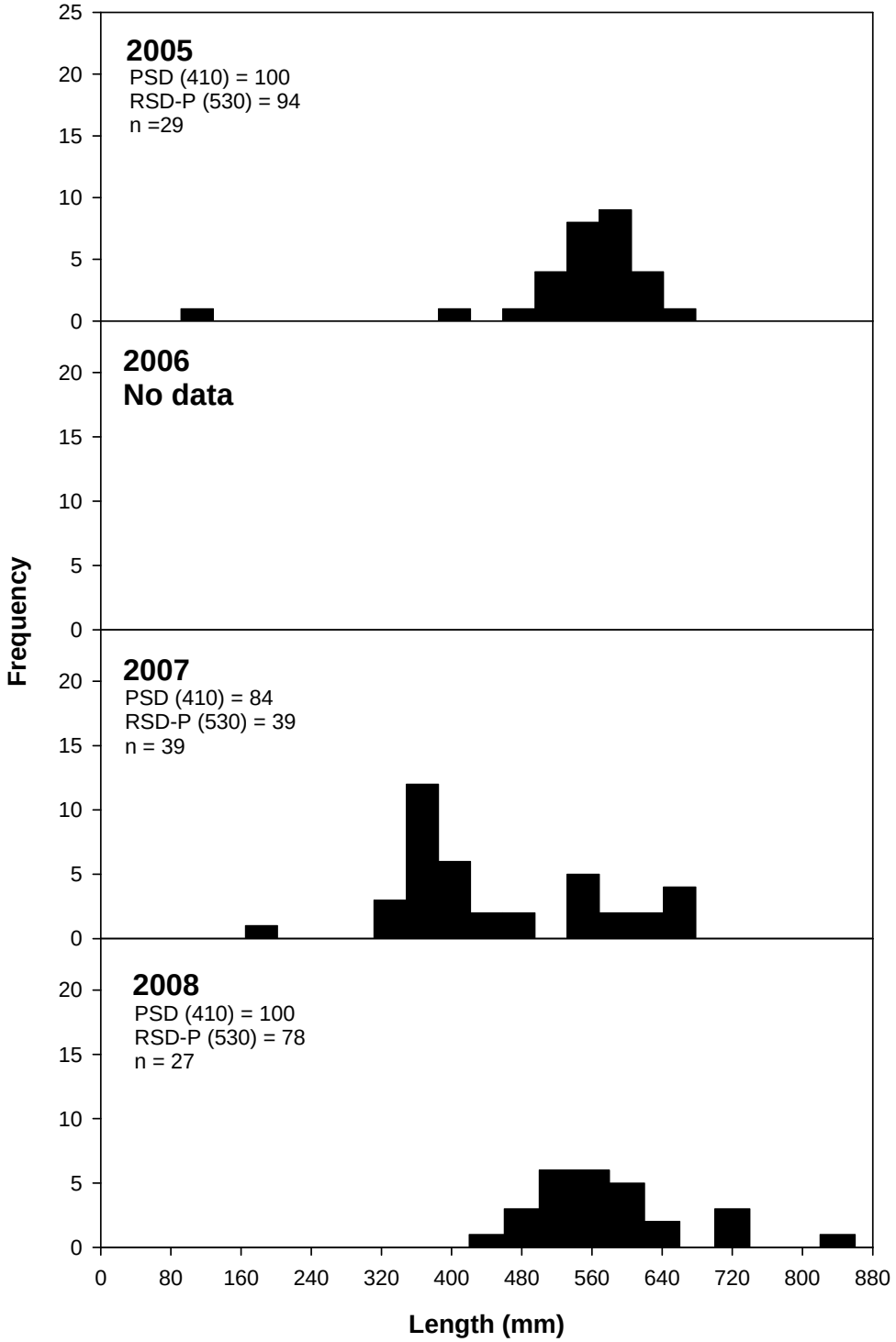

Figure E-2. Length frequency distribution of carp captured in gill nets during the fall in Pelican Lake from 2005 to 2008. Gill nets were not deployed in 2006 due to inaccessibility during low water.

Northern Pike

The size structure of northern pike in Pelican Lake has remained consistent from 2005 to 2008 (Figure E-3). Relative abundance has not significantly changed since a decrease occurred after 2003 (16 fish/gill net night; SE = 1.7) (Figure E-4). Gill net mean CPUE for northern pike by length category has remained constant and dominated by quality to preferred length fish since 2004 (Figure E-5). Overall mean W_r substantially declined in 2008 from an all-time high in 2007 (Table E-2). However, mean W_r was average compared to other Sandhill lakes.

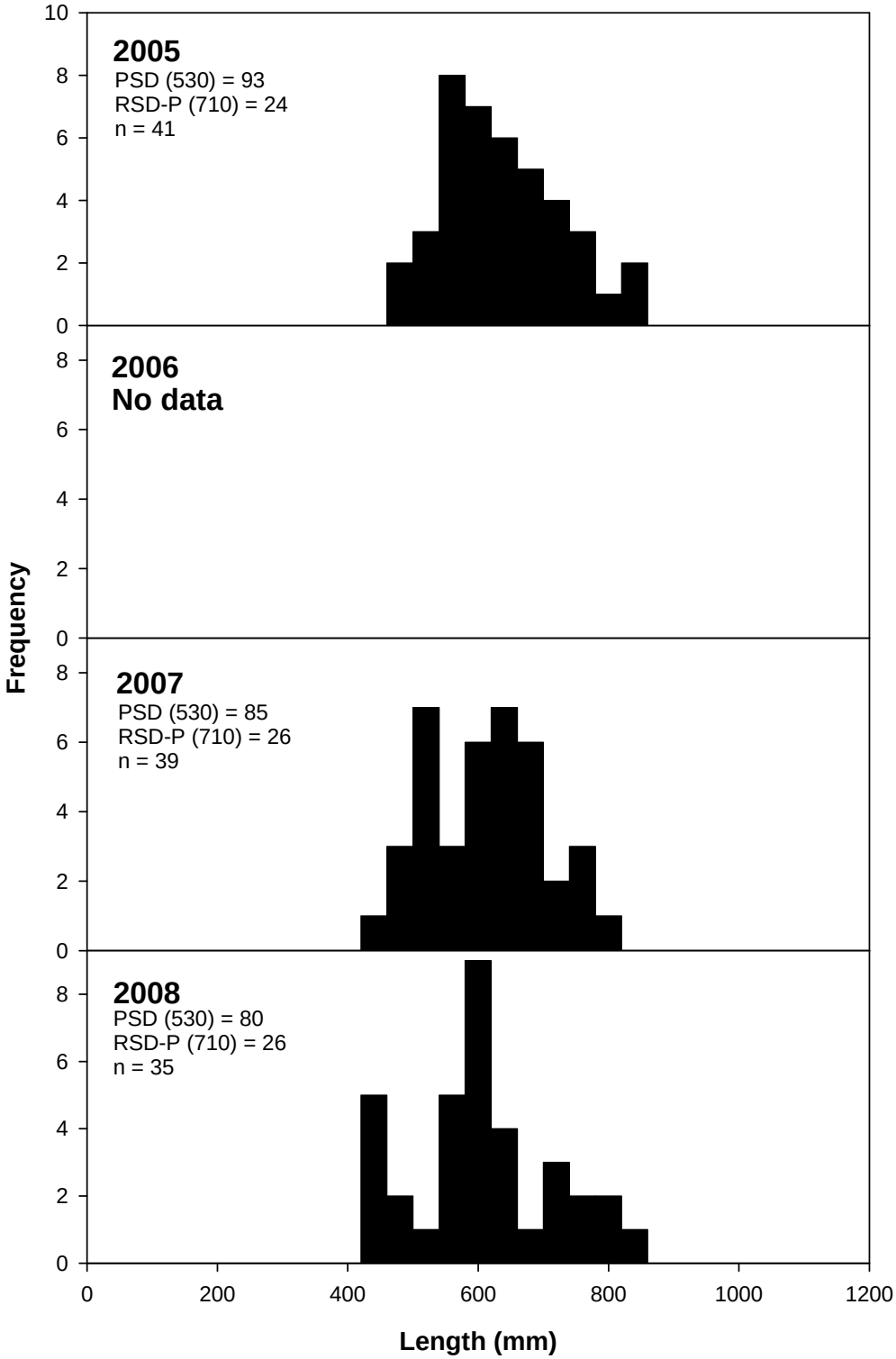

Figure E-3. Length frequency distribution (40-mm length groups) for northern pike captured with gill nets during the fall in Pelican Lake from 2005 to 2008. Gill nets were not deployed in 2006 due to inaccessibility during low water.

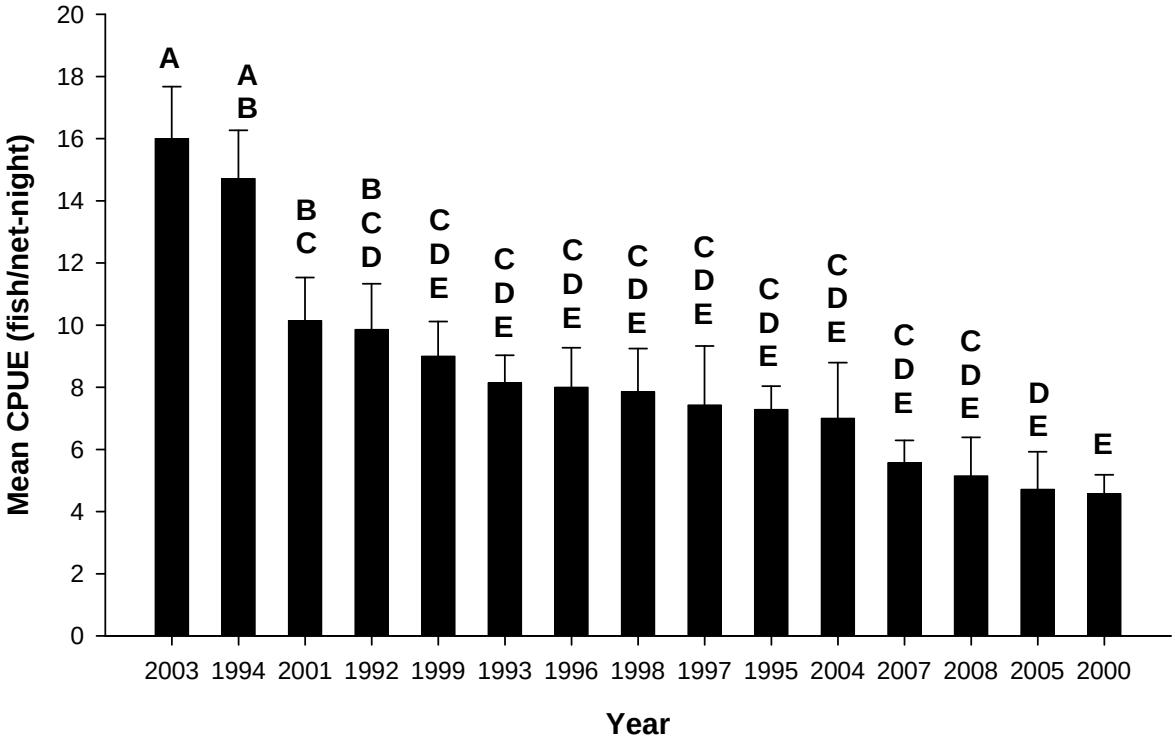

Figure E-4. Northern pike gill net mean catch per unit effort (CPUE) in Pelican Lake from 1992 to 2008. Years with the same letter are not significantly different ($P > 0.20$) using ANOVA with Tukey-Kramer multiple comparison tests.

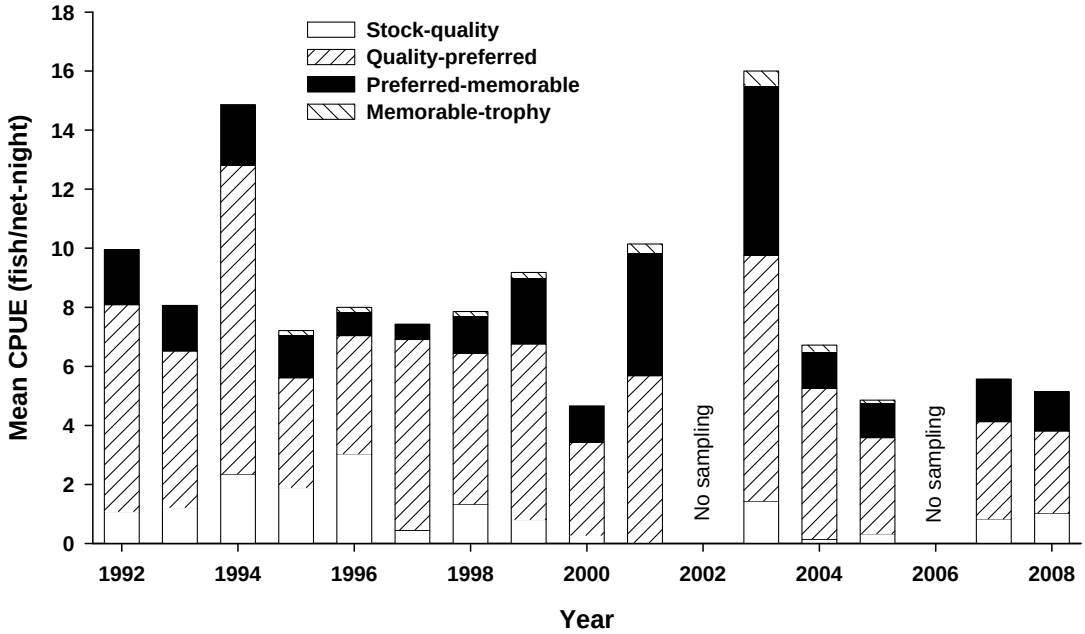

Figure E-5. Gill net mean catch per unit effort (CPUE) for northern pike by length category in Pelican Lake from 1992 to 2008.

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 2008 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	% ≥ Quality		S–Q (350 – 529mm) (14-21 in)			Q-P (530-709mm) (21-28 in)			P-M (710-859mm) (28-34 in)			M-T (860-1120mm) (34-44 in)		
	PSD	W_r	RSD	±	W_r	RSD	±	W_r	RSD	±	W_r	RSD	±	W_r
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

Bluegill relative abundance appears to be highly variable from year to year as mean CPUE has bounced from a low of 8.5 fish/hr (SE = 5.2) to a high of 68.5 fish/hr (SE = 14.5) from 2005 to 2008 (Figure E-6). A corresponding increase and decrease in PSD has also occurred as stock to quality length fish in 2006 recruited to the quality to preferred length group in 2007 and a new year class of stock to quality length fish appeared in 2008 (Figure E-7). Bluegill mean W_r declined below 110 for the first time since 1998 (Table E-3). Bluegill mean W_r was below average when compared to other Sandhill lakes.

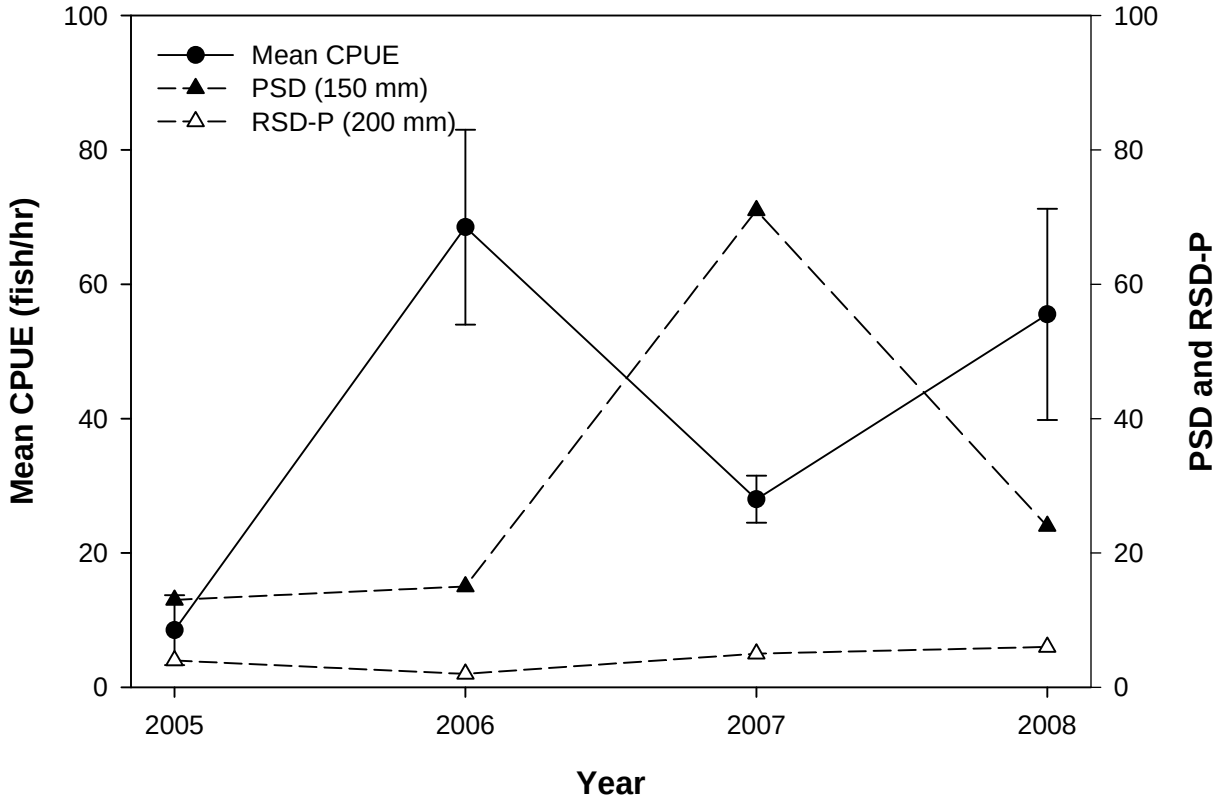

Figure E-6. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing in Pelican Lake from 2005 to 2008. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

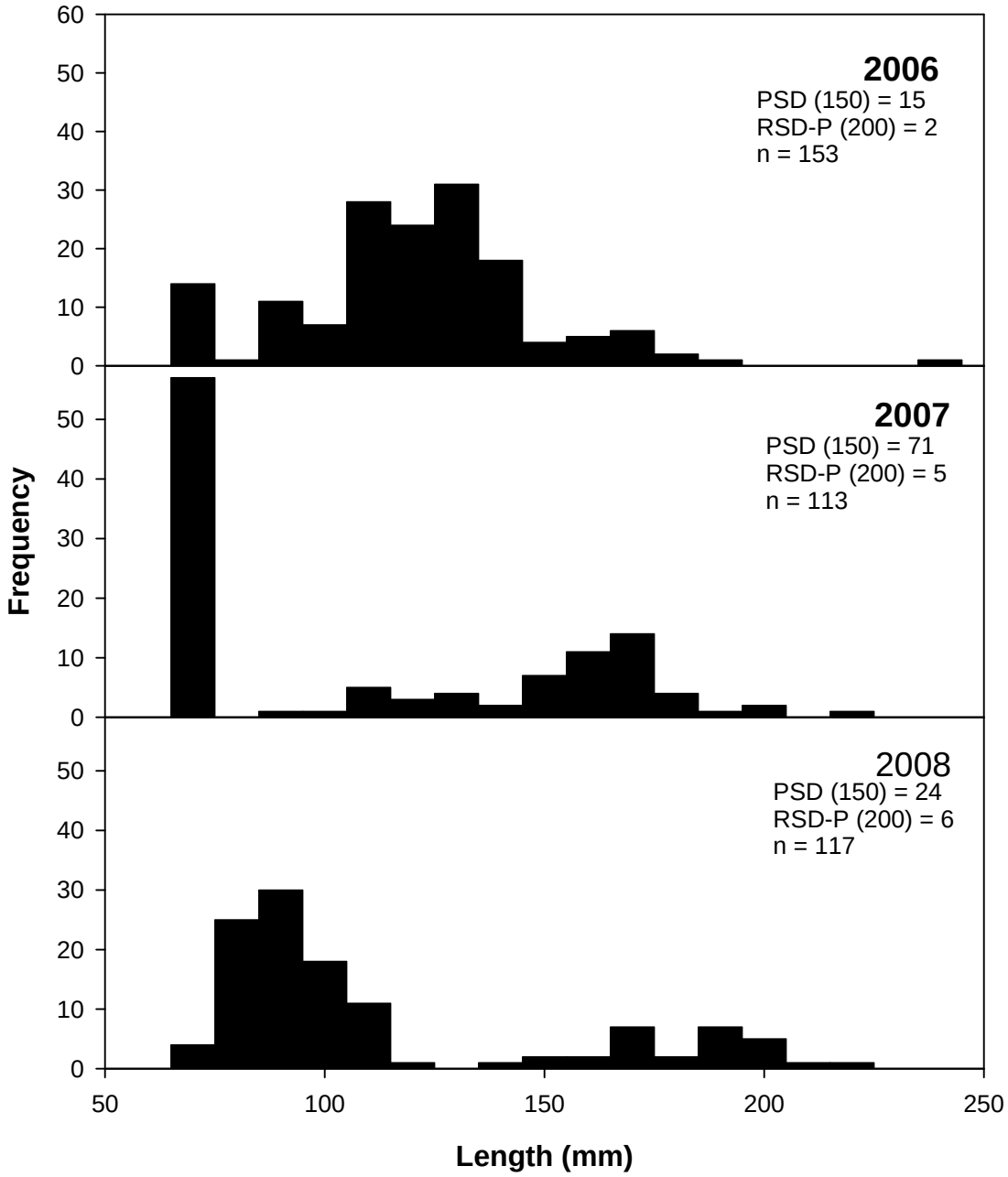

Figure E-7. Length frequency distribution (10-mm length groups) for bluegill captured by electrofishing during the spring in Pelican Lake from 2006 to 2008.

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 2008. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2008.

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)
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 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

Two golden shiners (83 and 141 mm) were captured during spring trap netting in 2008.

Largemouth bass

In 2008, with a mean CPUE of 42.5 fish/hr (SE = 12.4), relative abundance of stock length largemouth bass (≥ 200 mm) was the highest it has been in the last four years (Figure E-8). Size structure improved with an increase in PSD since 2007 (Figure E-8). Based on length frequency distributions, it appears that a strong 2005 year class recruited to the population (Figure E-9). The largemouth bass population has good numbers of preferred length fish providing excellent angling opportunities. Mean W_r remained average in 2008 when compared to other Sandhill Lakes but was substantially lower when compared to mean W_r throughout the 1990's (Table E-4).

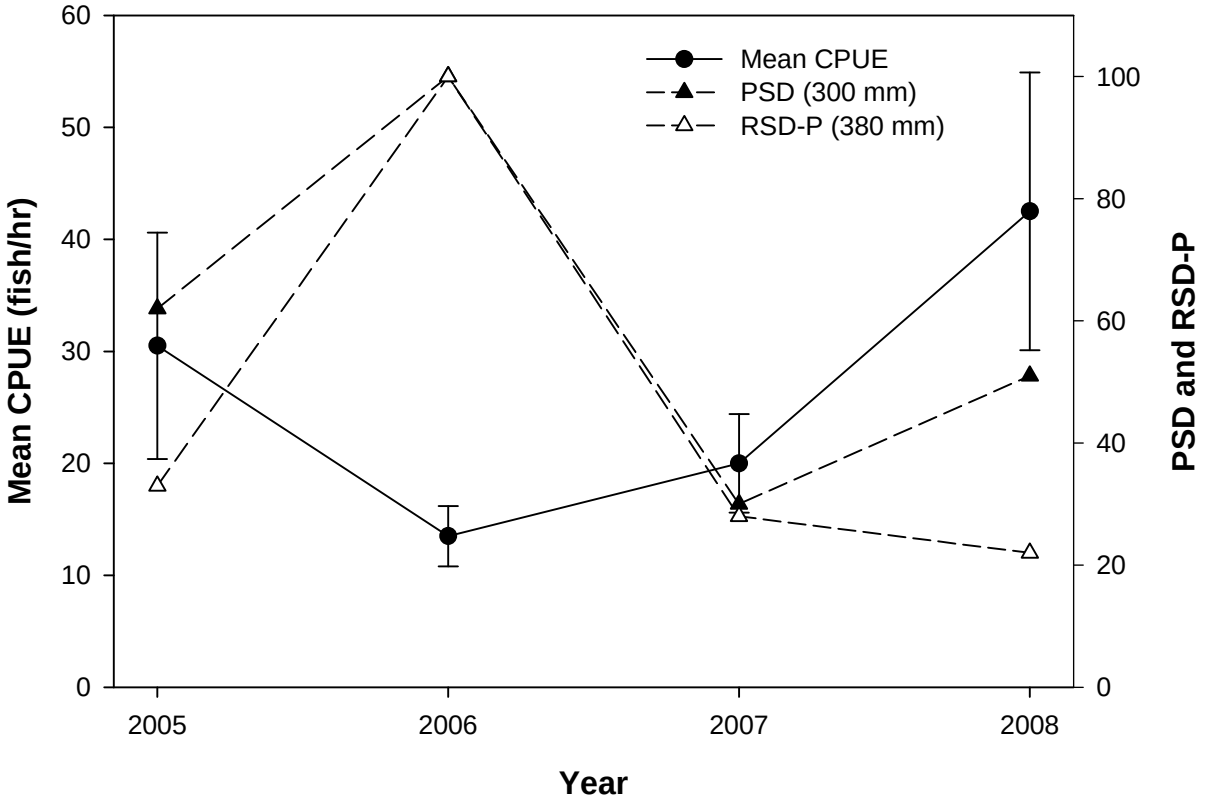

Figure E-8. Annual relative abundance (largemouth bass/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by spring time electrofishing in Pelican Lake from 2005 to 2008. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

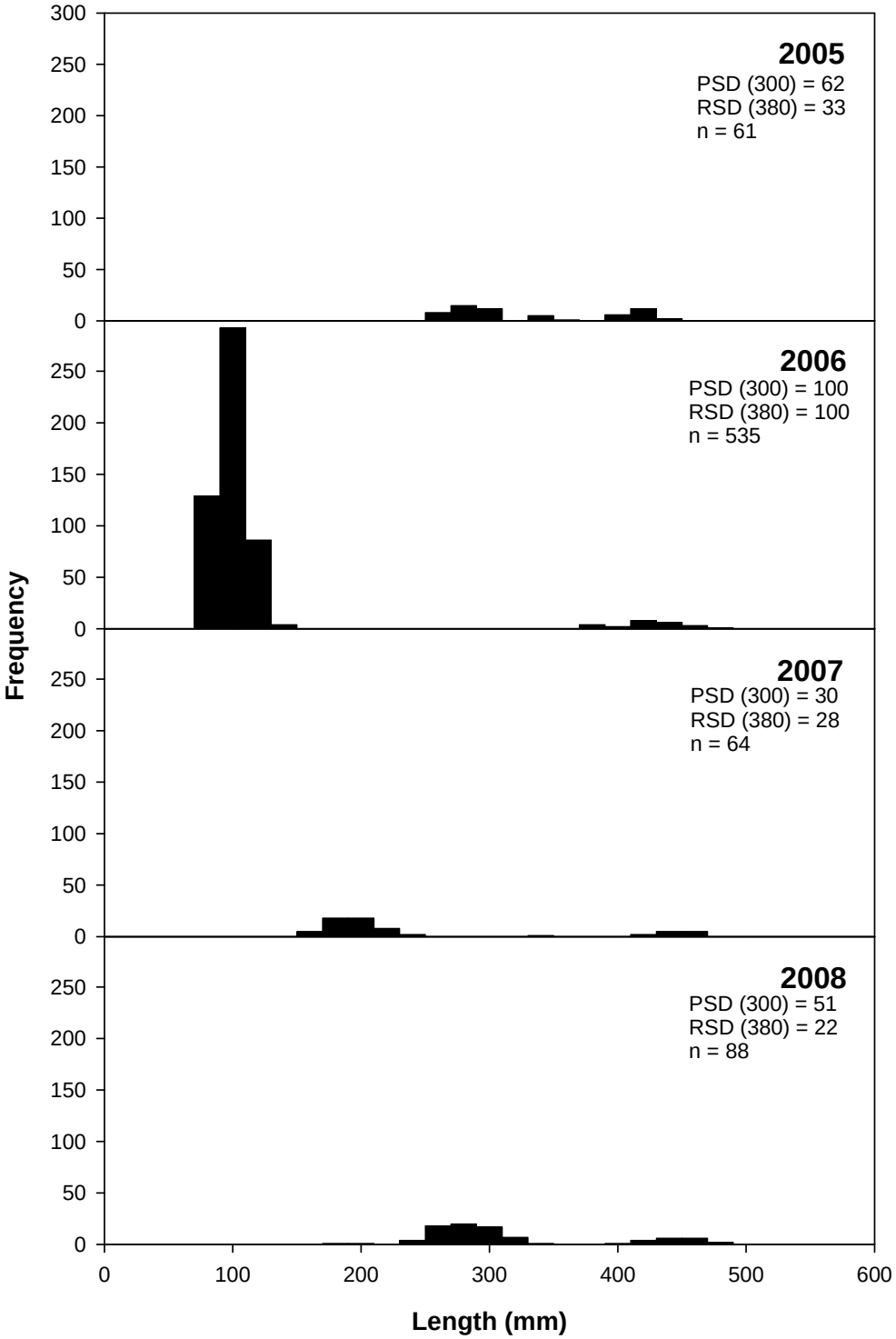

Figure E-9. Largemouth bass length frequency distribution (20-mm length groups) captured by electrofishing during the spring in Pelican Lake from 2005 to 2008.

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 2008.

Year	Overall *Wr*	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)
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, but may have been calculated in overall W_r.

Yellow perch

As with bluegills in Pelican Lake, relative abundance of stock length yellow perch (≥ 130 mm) continued to oscillate up and down from one year to the next (Figure E-10). Since 2005, years with higher bluegill relative abundance (Figure E-6) are the same years of low yellow perch abundance and vice versa (Figure E-10). Both PSD and RSD-P declined from a high in 2007 (Figure E-10). Based on length frequency distributions (mean lengths at age; Paukert and Willis 2001; Jolley et al. 2008), it appears that strong year classes from 2001 to 2004 have recruited to preferred length category in 2007 and 2008. Another year class (2005) appeared in the stock to quality length category in 2008 (Figure E-11). Mean W_r was average for all length categories compared to other Sandhill lakes (Table E-5).

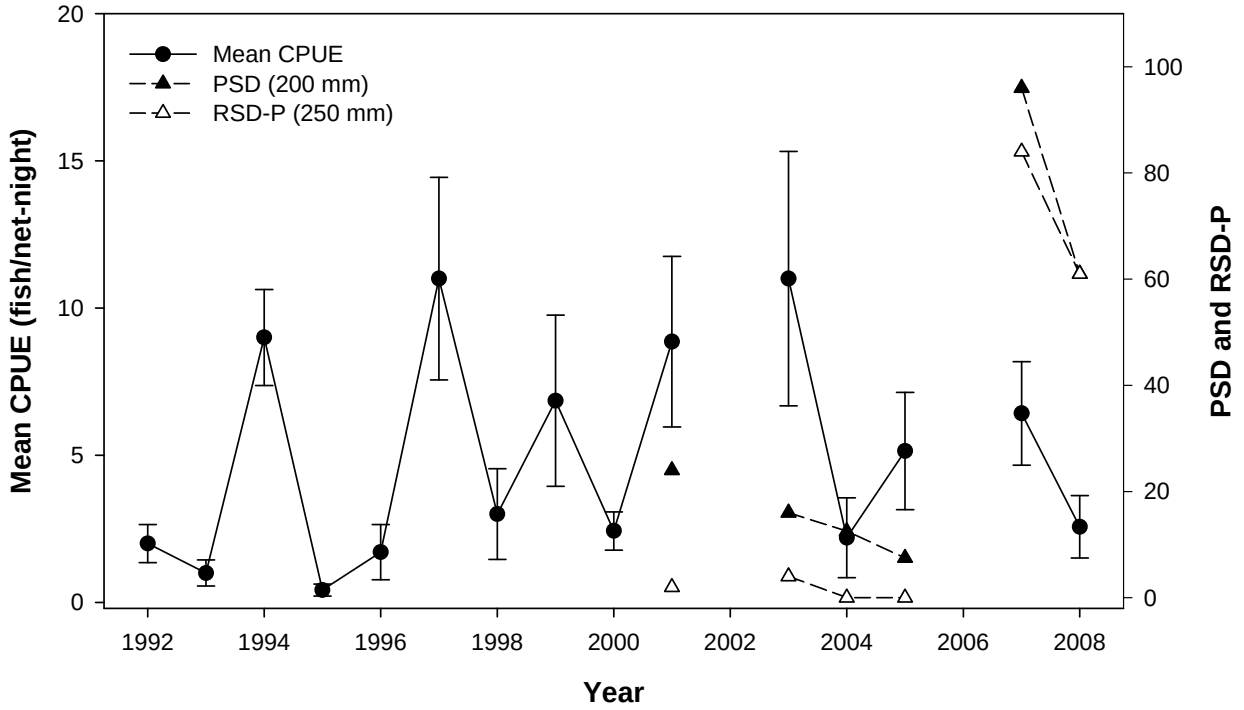

Figure E-10. Annual relative abundance (fish/net-night with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of yellow perch captured by gill nets during the fall in Pelican Lake from 1992 to 2008. Mean catch per unit effort (CPUE) calculated for perch ≥ stock length (130 mm) only.

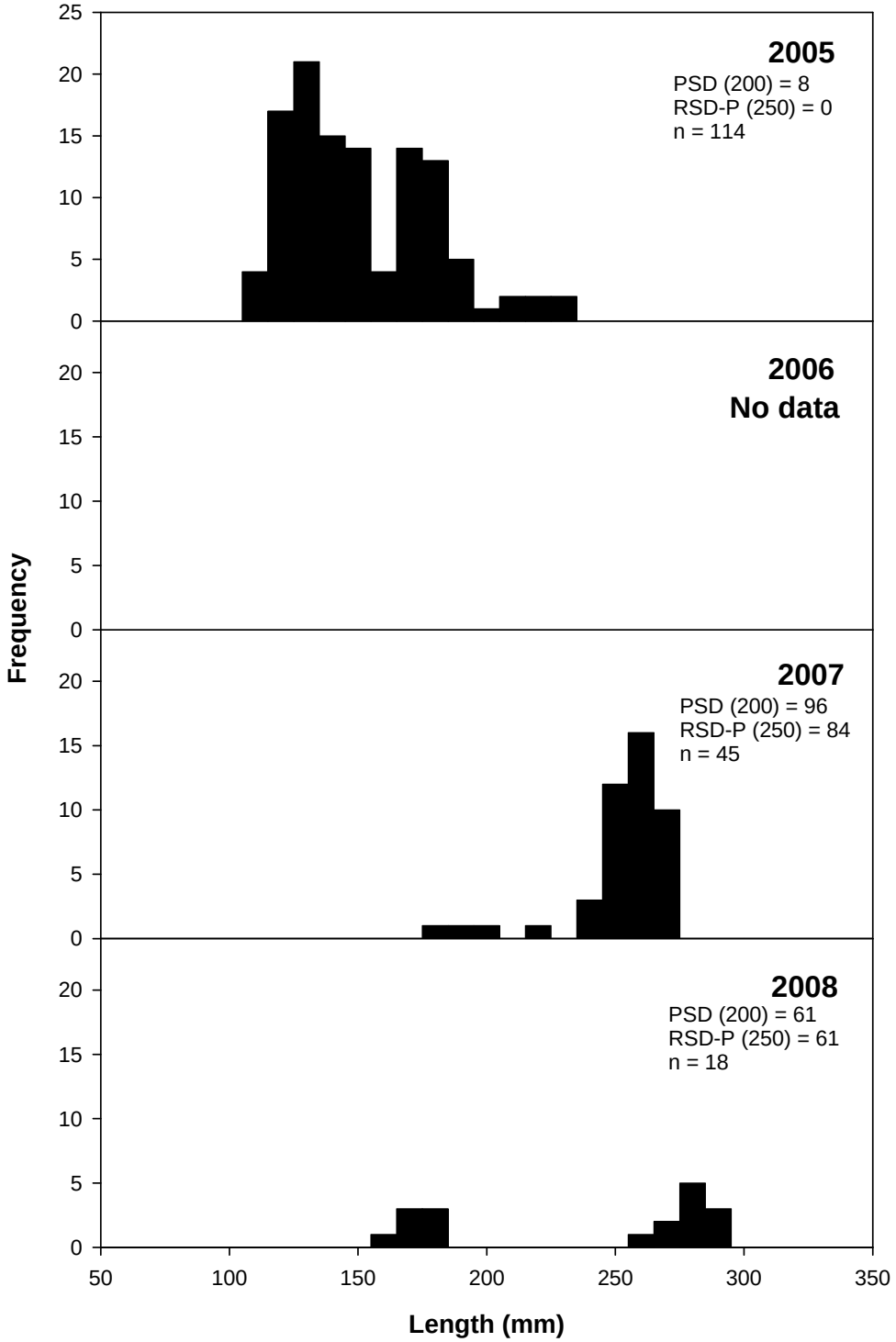

Figure E-11. Length frequency distribution (10-cm length groups) of yellow perch captured by gill nets during the fall in Pelican Lake from 2005 to 2008. Gill nets were not deployed in 2006 due to inaccessibility during low water.

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)
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, but may have been calculated in overall W_r.

Summary

Common carp – The carp population in Pelican Lake appears to have stabilized since 2003. Carp are successful at spawning nearly every year with some recruitment. Northern pike predation is likely having some affect on the carp population; however, current low pike numbers may allow a strong carp year class to recruit to the population.

Northern pike – Relative abundance and size structure has remained constant from 2004 to 2008. The good condition of northern pike shows evidence of abundant prey in Pelican Lake.

Bluegill – Relative abundance was highly variable from year to year from 2005 to 2008 and opposite of yellow perch relative abundance. A corresponding increase and decrease in PSD has also occurred as stock to quality length fish in 2006 recruited to the quality to preferred length group in 2007 and a new year class of stock to quality length appeared in 2008. Mean W_r declined below 110 for the first time since. Bluegill mean W_r is below average when compared to other Sandhill lakes indicating that prey may not be readily available compared to earlier years.

Largemouth bass – Relative abundance was the highest observed since 2005. Based on length frequency distributions, a strong 2005 year class has recruited to the population. The largemouth bass population does have good numbers of preferred length fish providing excellent angling opportunities. Mean W_r remains average in 2008 when compared to other Sandhill Lakes.

Yellow perch – Relative abundance of stock length yellow perch continues to oscillate up and down from one year to the next. It appears that strong year classes from 2001 to 2004 have recruited to the preferred length group in 2007 and 2008. Condition of yellow perch was average in 2008 when compared to other Sandhill lakes.

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.

3. Record water levels in a consistent standardized manner to evaluate effects on spawning success.

4. Add turbidity as a water quality measurement.

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.

WEST LONG LAKE

Lake description

West Long Lake is approximately 2.5 miles south of Highway 16B on an unnamed county highway and about 0.5 miles south of the Pelican Lake access road. The lake receives moderate fishing pressure during the spring and fall, but dense submergent vegetation accumulates during summer and most anglers avoid the lake until the vegetation dies back in late fall. During most winters this lake receives less fishing pressure than the larger refuge lakes, but during winters with heavy snow this lake remains accessible and use increases dramatically.

The lake has a relatively flat sandy bottom with a highly organic substrate around the edges. Emergent vegetation, predominately cattail, bulrush, and scattered areas of phragmites form a band around most of the lake and has scattered "island like areas" of vegetation throughout the interior. During summer, submergent vegetation, including narrow *Potamogeton strictifolius* and curly leaf pondweed *P. crispus*, milfoil, coontail, and duck weed *Lemna sp.* cover almost 100% of the lake's surface. The lake has no water control structures or draw down capabilities.

Conductivity averages 380 at 25 °C; total alkalinity averages 150 and phenolphthalein alkalinity is 70 ppm. The lake's pH ranges from 9.1 during the winter through early spring to 10 by mid summer. Secchi disc readings average 2.0 m but turbidity reaches 3.2 NTU on windy days. The lake is too shallow to develop a thermocline and summer surface water temperatures reach 30 °C. Maximum lake depth is 6 ft and average depth is 4.2 ft.

The fishery includes yellow perch, largemouth bass, and bluegill. Northern pike were purposely excluded from this lake because of its relatively small size and the absence of carp, but northern pike were collected by anglers in 1999 and during spring 2000 surveys. Bullheads have also become established in the lake as they were first collected during the 2000 survey. Length and bag limits are summarized in Appendix A and the history of fish stockings are summarized in Appendix B.

Common carp were identified in West Long Lake and the lake was chemically renovated during the 1980's, but details are limited. No carp have been located in the lake since the last renovation likely because this lake is a semi-closed system. The chance that carp will become re-established is less than any of the other refuge lakes. Still, the lake is accessible to carp during high water years such as 1995-1997 as water runs between Pelican and West Long lakes through a wet meadow on the northwest side.

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

Table F-1. West Long Lake surface water quality parameters from 2008.

Date	Water temp. (°C)	DO (mg/L)	Secchi depth (cm)	pH	Salinity (ppt)	Phenolphthalein alkalinity (mg/L)	Total alkalinity (mg/L)	Conductivity (µS/cm)
09/2008	16	8.2				17	120	292
05/2008		11.1				0	171	270

Results and Discussion

Common carp

No carp were detected during trap and gill netting or electrofishing in 2008.

Northern pike

No northern pike were detected during trap and gill netting or electrofishing in 2008. During brood stock collection by the NGPC in April 2008, 59 northern pike were removed. Of those fish, 51 were stocked in Clear Lake and the other 8 were moved to the AKSARBEN aquarium.

Black bullhead

During fall gill netting in 2008, nine black bullheads were captured and ranged from 255 to 380 mm.

Bluegill

The relative abundance of bluegill in West Long Lake increased to 84 fish/hr (SE = 12.2) from 41/hr (SE = 10) in 2006 (Figure F-1). Multiple length groups of bluegill were found in West Long Lake (Figure F-2) indicating good spawning conditions in recent years. Mean W_r for bluegill in West Long Lake was the highest among the refuge lakes in 2008 (Table F-2).

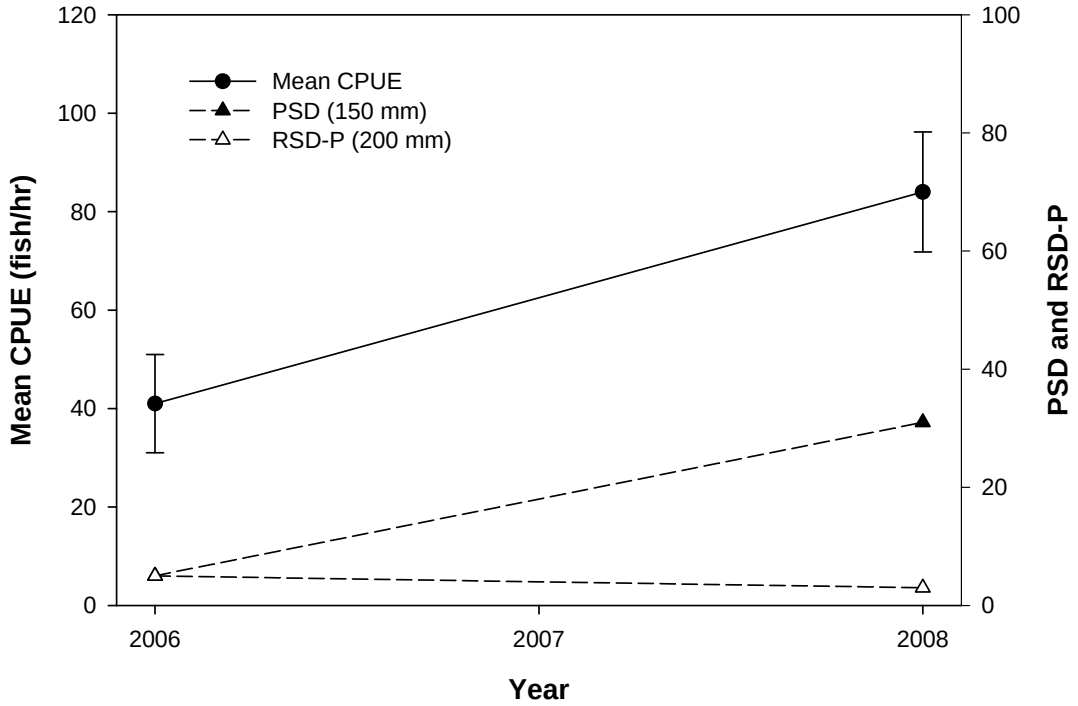

Figure F-1. Annual relative abundance (fish/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of bluegills captured by electrofishing in West Long Lake in 2006 and 2008. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

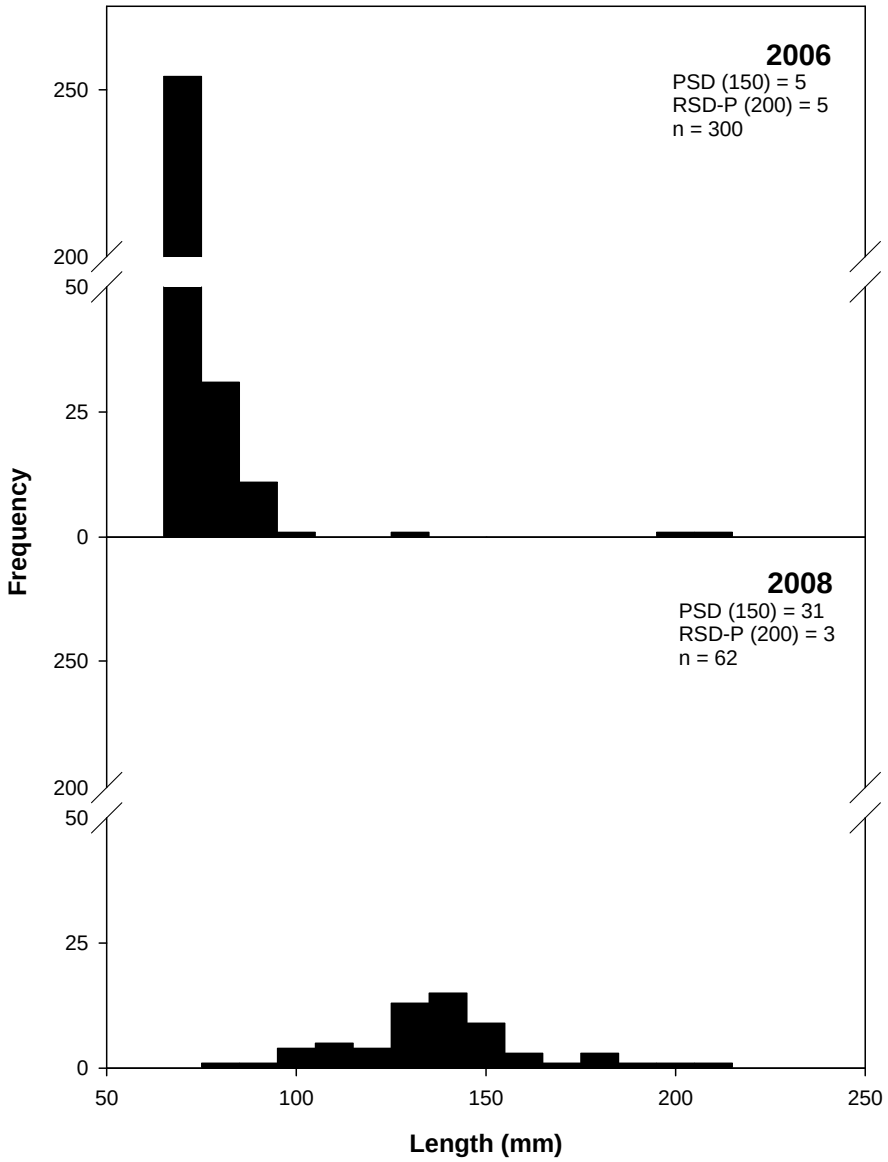

Figure F-2. Length frequency distribution (10-mm length groups) of bluegill captured by electrofishing in West Long Lake, Valentine NWR, during the spring in 2006 and 2008.

Table F-2. Bluegill mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing in West Long Lake during the spring from 2006 to 2008.

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)
2008	128 (2.6)	126 (3.8)	130 (3.5)	141 (3.0)	b
2007	a	a	a	a	a
2006	130 (4.0)	133 (3.9)	b	116 (13.3)	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.

Largemouth bass

The relative abundance of stock length largemouth bass continued to be the highest among the Refuge lakes, but has declined to 39 fish/hr (SE = 9.1) in 2008 from 78 fish/hr (SE = 17.2) in 2006 (Figure F-3). The population continues to be represented by multiple length categories (Figure F-4) providing evidence of successful spawning each year. The overall mean *Wr* was 104 (Table F-3) and similar to other Sandhill lakes.

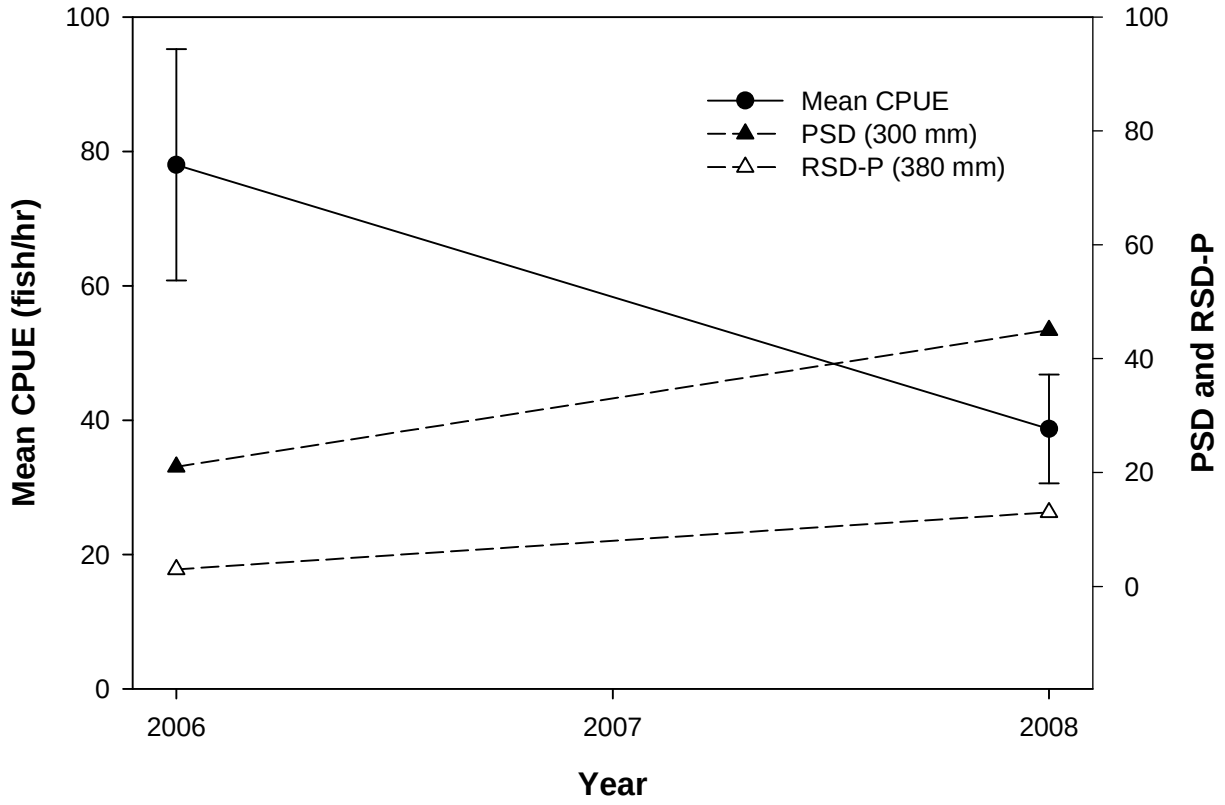

Figure F-3. Annual relative abundance (largemouth bass/hr with SE bars), proportional stock density (PSD), and relative stock density (RSD-P) of largemouth bass captured by spring time electrofishing in West Long Lake, Valentine NWR in 2006 and 2008. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

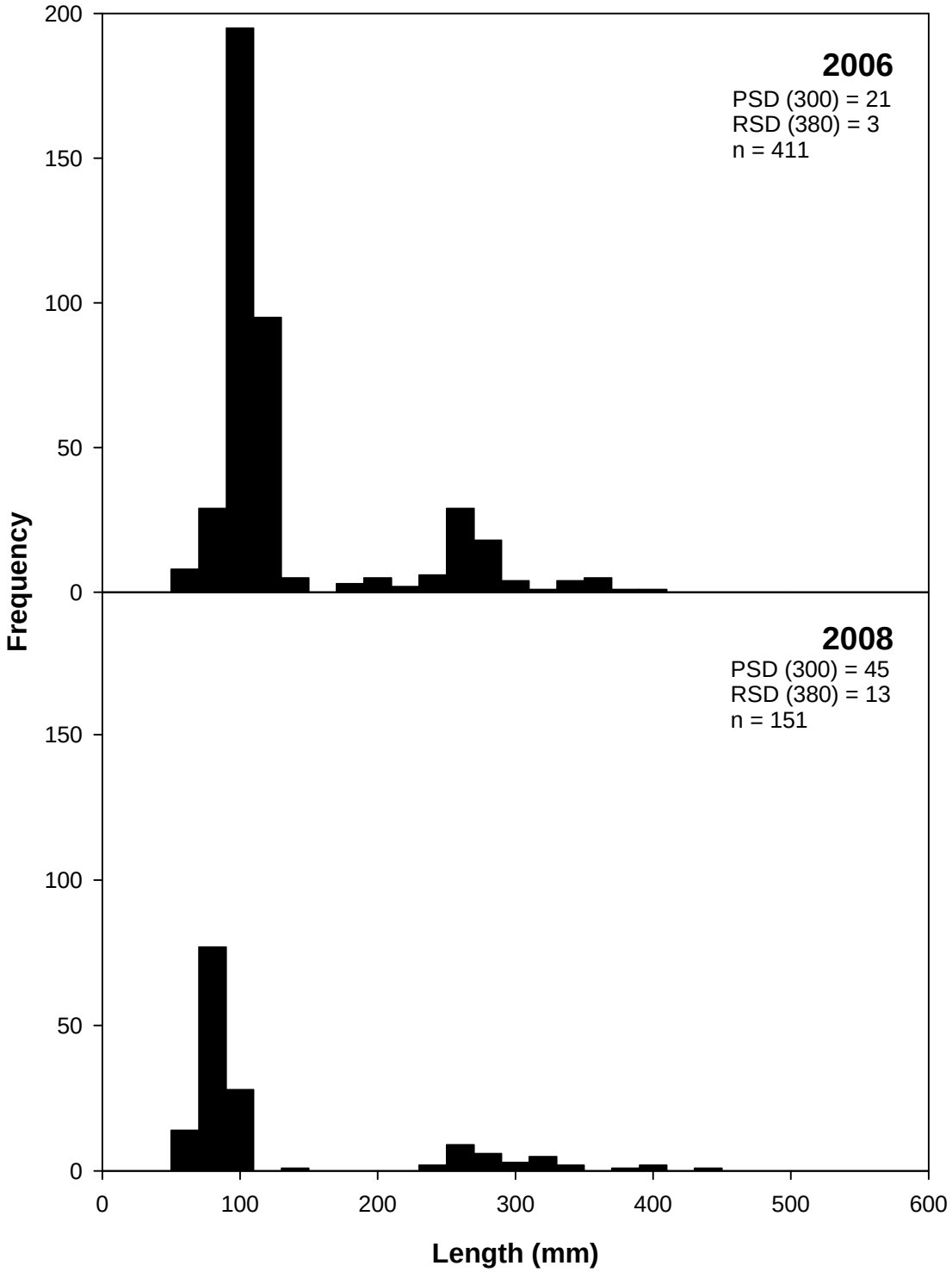

Figure F-4. Length frequency distribution (20-mm length groups) of largemouth bass captured by electrofishing in West Long Lake during the spring in 2006 and 2008.

Table F-3. Largemouth bass mean relative weight (W_r) with standard error (SE) in parenthesis by length category captured by electrofishing in West Long Lake during the spring from 2006 to 2008.

Year	Overall *Wr*	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)
2008	104 (2.4)	97 (4.7)	95 (2.8)	90 (7.0)	b
2007	a	a	a	a	a
2006	117 (2.2)	103 (2.1)	114 (6.9)	114 (11.5)	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

Mean CPUE of yellow perch in West Long Lake was 21.3 fish/gill net-night (SE = 8.1). This was the second highest relative abundance among the Refuge lakes in 2008 only behind Hackberry Lake. The size structure of the yellow perch population was balanced with PSD = 69 and RSD-P = 33 (Figure F-5). One of the highest mean *Wr* for yellow perch at the Refuge was found in West Long Lake (Table F-4).

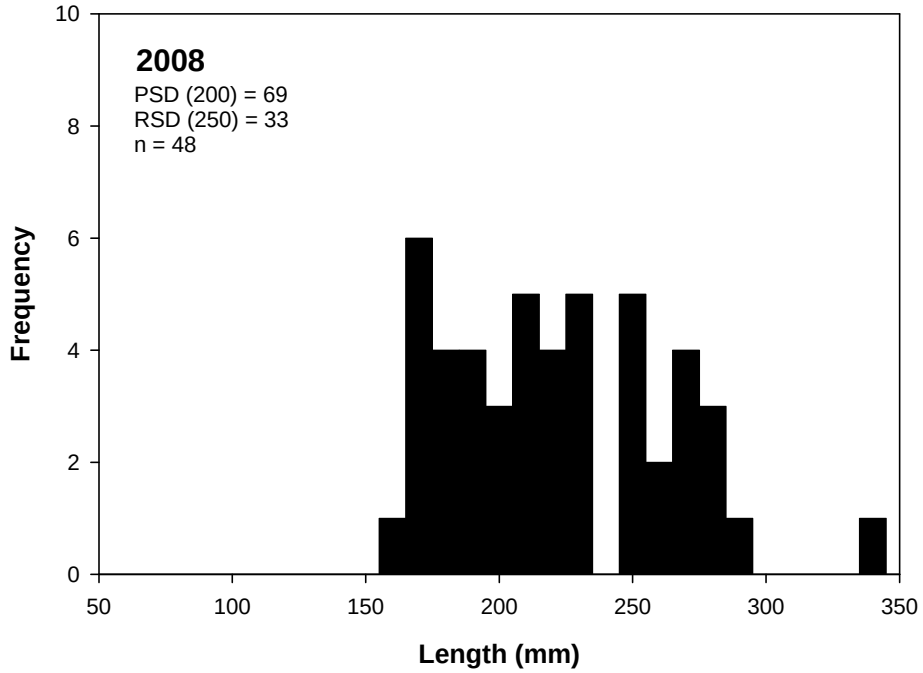

Figure F-5. Length frequency distribution (10-cm length groups) of yellow perch captured by gill nets during the fall in West Long Lake in 2008.

Table F-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 West Long Lake during 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)
2008	107 (1.5)	112 (2.1)	104 (2.6)	103 (2.2)	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.

Summary

Northern pike – No northern pike were observed during spring electrofishing, spring and fall trap netting, or fall gill netting.

Bluegill – The relative abundance of bluegill doubled since 2006 with multiple lengths available for anglers. The removal of northern pike (Jolley et al. 2008) and half the abundance of largemouth bass has directly improved abundance and size structure of bluegill in West Long Lake. Mean W_r was the highest among the refuge lakes indicating an abundance of prey.

Largemouth bass – Even though abundance of largemouth bass was half the amount in 2008 compared to 2006, abundance continued to be the highest among the Refuge lakes. The population was represented by multiple length categories with evidence of successful spawning each year. Mean W_r levels indicated an abundance of prey for largemouth bass in West Long Lake.

Yellow perch – Relative abundance was the second highest among the Refuge lakes only behind Hackberry Lake. The size structure of the yellow perch population was balanced with one of the highest mean *Wr* for yellow perch found among Refuge Lakes.

Management Recommendations

1. Continue biannual surveys.

2. Continue to remove northern pike to enhance size structure and abundance of bluegill, yellow perch, and largemouth bass.

3. High numbers of bluegill, largemouth bass, and yellow perch would allow for West Long Lake being a source for translocation stockings to other Refuge lakes by Refuge or hatchery personnel. Fish could be collected through electrofishing or trap netting.

4. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

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Appendix A. Fish stocking history.

Appendix A. Fish stocking history for Valentine National Wildlife Refuge lakes. 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).

		Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
Lake	Year	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Clear	2008							Apr	51	AD												
	2007							Mar	48	AD												
	2006													Jun	211,385	FY						
	2005							Mar	50	AD				Jul	140,727	FY						
														Mar	514	FG						
	2004													Aug & Sep	12,698	FG						
														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	1987							Apr	150,000	FY												
Dewey	2004	Aug	43	AD				Aug	195	AD	Aug	150	AD									
	1992[a]																					
	1991	Jul	28,000	FG	Aug	50,000	FY															
	1989							Mar	1,010	AD												
	1987							Mar & Apr	1,256	AD												
	1985				Sep	50,000	FY															
	1981[b]																					
Duck	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] 1,100 channel catfish (6 – 9 in. in TL) stocked on 25 August 1992.

[b] Lake renovation occurred during that year.

Appendix A continued. Fish stocking history for Valentine National Wildlife Refuge lakes. 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).

		Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
Lake	Year	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Hackberry	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[b]				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	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	2004				Mar	26,048	FY				Mar	3,326	FG									

[b] Lake renovation occurred during that year.

Appendix A continued. Fish stocking history for Valentine National Wildlife Refuge lakes. 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).

		Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
Lake	Year	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Watts	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
																				May	6,500	FY
	1986				Aug	25,000	FY													Jun	75	FG
	1985																			Aug	1,152	SA
West Long	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	1988				Aug & Sep	116,000	FG	Apr	180,000	FY	Apr	4,000	AD									

Appendix B. Summary of fishing regulations.

Table B-1. 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 waters 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 bodies 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 ≥ "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:

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

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:

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

where "W" is the weight of an individual and "Ws" 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, 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 D-1).

3) Calculating relative weight (W_r) assessed condition of fish by size groups (Table D-2).

Table D-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, 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 D-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	Source
	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.
Green sunfish	-4.915	-3.216	3.101	100	Bister et al.
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 Log10(Ws) = a + b(Log10 total length). Metric (M) equations are in millimeters and grams; English (E) equations are in inches and pounds.

Appendix E. A comparison between spring and fall trap netting.

Introduction

Trap nets are a commonly used tool in recreational fisheries assessments. From 1992 to 2005, trap nets have been sampled only during the fall. Beginning in 2006, trap nets were sampled during the spring in an effort to make comparisons to statewide fishery surveys in Nebraska. Since then, trap net capture rates have declined, either because of real decreases in fish abundances or that spring trap netting is not as successful at capturing fish compared to fall netting and thus reducing our ability to describe a fish population. Our objective was to compare spring and fall trap net catches for all fish species in each Refuge lake.

Methods

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. Effort for each lake is presented in Table E-1. Mean CPUE was calculated as stock length fish/trap net-night. A two-sample *t*-test was used to determine differences between spring and fall mean CPUE for each species in each lake.

Table E-1. Trap net effort for each lake sampled on the Valentine NWR during 2008.

Lake	Spring trap nets (n)	Fall trap net (n)
Clear[a]	4	0
Dewey	10	10
Hackberry	0	0
Pelican	12	12
West Long	4	4

[a] Could not sample properly due to low water levels in May. No spring and fall analysis conducted for this lake.

Results and Discussion

For every species in each lake sampled, a trend was observed as trap nets that were set in the fall had a higher mean CPUE than spring trap nets except for common carp in Pelican Lake (Figure E-1). Additionally, yellow perch in Dewey Lake had significantly higher mean CPUE in fall trap nets compared to spring. Fish behavior due to environmental factors is likely influencing catch rates and fish may be offshore while spring trap netting is being conducted. Spawning behavior during the spring would likely affect fish behavior and movement patterns. Spring water temperatures may be more variable increasing the variability of CPUE data.

Spring and fall trap net evaluations will continue in 2009.

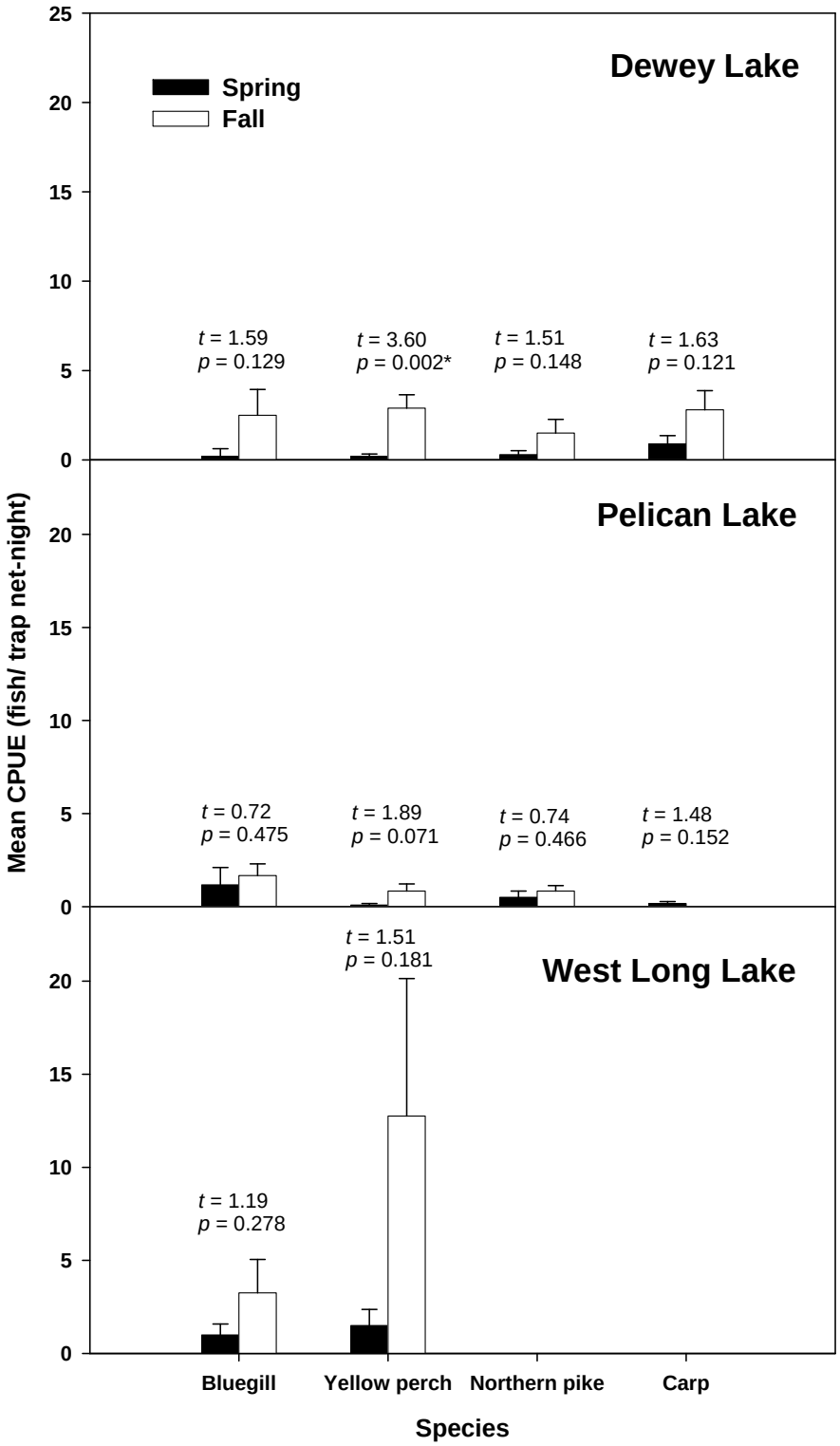

Figure E-1. Mean catch per unit effort (CPUE) for four species of fish comparing spring and fall trap netting. A two-sample *t*-test was used to compare Mean CPUE for each species in each lake.

Appendix F. Turtle catches on Valentine NWR.

To reduce turtle mortality, all efforts are made to set trap nets so that the top of the cab was 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 F-1).

Very low incidence of turtle mortality was observed in 2008. Turtle mortality data was not recorded in 2008, but will be done in future fishery surveys.

Table F-1. 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).

		Painted		Snapping		Blanding's	
Lake	Sample period	N	Mean CPUE	N	Mean CPUE	N	Mean CPUE
Clear	2008 (S)	b		b		b	
	2008 (F)	a		a		a	
Dewey	2008 (S)	11	1.1 (0.64)	0		0	
	2008 (F)	38	3.8 (1.36)	0		0	
Hackberry	2008	a		a		a	
Pelican	2008 (S)	6	0.5 (0.26)	0		0	
	2008 (F)	b		b		b	
West Long	2008 (S)	b		b		b	
	2008 (F)	1	0.25 (0.25)	0		2	0.5 (0.29)

a = Sampling did not occur during that year.
b = Sampling occurred; however, turtle data was not recorded.