RESULTS FROM THE 2005 FISHERY ASSESSMENT SURVEYS CONDUCTED ON THE VALENTINE NATIONAL WILDLIFE REFUGE

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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 (Service) and Nebraska Game and Parks Commission (NG&P).

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. These lakes have varying degrees of potential for fisheries management. All of the designated fishing lakes, except Rice Lake, are accessible by vehicles.

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 high numbers of carp are detrimental to waterfowl and game fish habitat. These refuge lakes have a long history of renovation to remove carp. Historically, for about five years following a renovation, fishing is excellent, duck use is high, and then both decline due to carp-induced habitat degradation. Fisheries biologists from the Service and NG&P have experimented with the use of northern pike (*Esox lucius*) as a biological carp-control. The first attempts were unsuccessful because northern pike were introduced after carp were well established.

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. The size restrictions appear to be successful as carp numbers have stabilized in lakes where the restrictions were enacted. The success has not been without perceived drawbacks. Predation by northern pike reduces the abundance of small largemouth bass and all sizes of yellow perch (*Perca flavescens)*, and bluegills (*Lepomis macrochirus)*, and alters the relationship between largemouth bass and panfish (Paukert and Willis 2003). Although large numbers of northern pike have probably impacted game fish populations, environmental conditions such as a 1987-88 winter-kill, low reproduction/ recruitment due to drought conditions during the summers of 1989 – 1990 and 2002-2003, and an extremely cool spring/summer ($<21^{o}$ C) during 1992 and 1993 probably had equal impact. The springs of 1994-97 were exceptionally wet, and these conditions provided good habitat and conditions for strong year classes. However, high water levels also connect lakes that are usually isolated, which allows fish movement. Of special concern during high water years are the inter-lake movement of carp as observed during 1996 and 1997.

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 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 inches, and 3) evaluating the impacts of the special northern pike regulations on other game fish species with special emphasis on the bluegill and yellow perch populations.

CLEAR LAKE

Clear Lake is accessed by dirt trails from County Highway 16B or U.S. Highway 83. Ice fishing is popular during winter with good ice, although the roads are often closed during winters with heavy snow. 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. Clear Lake historically received water from Willow Lake (the most downstream lake of the four). 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 between Clear and Willow Lakes for much of the spring and summer and inter-lake fish movement was observed. Beginning in 2002 and continuing to date, the refuge lakes have experienced lowered water levels due to below precipitation and low winter accumulations of snow.

The lake was chemically renovated with rotenone in 1983 and restocked with game fish, such as northern pike and largemouth bass. During the 1986 survey, sub-adult carp were collected for the first time since the 1983 renovation. A major winterkill occurred during 1987-1988 and poor recruitment of yellow perch and bluegill was seen in subsequent years. Beginning January 1988, a 36 in. minimum length limit for northern pike was implemented in an attempt to develop a predator population capable of controlling carp recruitment. The size limit was reduced to 30 in. during 1990 and returned to 36 in. during 1991. Beginning January 1993, regulations were enacted that protected only northern pike greater than 28 in. Since enactment of these regulations, fall surveys generally indicate strong northern pike year-classes, excellent size structure, and good condition. Length and bag limits are summarized in Appendix A.

Primary fish species include: northern pike, carp, largemouth bass, bluegill, black bullhead (*Ameiurus melas*), and yellow perch. Previous attempts to establish a black crappie (*Pomoxis nigromaculatus*) fishery have been unsuccessful. The lake has been described as having a boom or bust fishery.

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 high pool (Figure 1). A dike on the east end holds 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 and cottonwoods. 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), and submergent vegetation is absent. The lack of vegetation is related to the infertile sandy bottom and turbidity. Conductivity averages 590 µS/cm at 25 ^{0}C. Total alkalinity is 308 and phenolphthalein alkalinity is 0 ppm. The lake's pH averages about 8.5 through most of the year and Secchi disk averages about 0.3 m. The lake is too shallow to develop a thermocline.

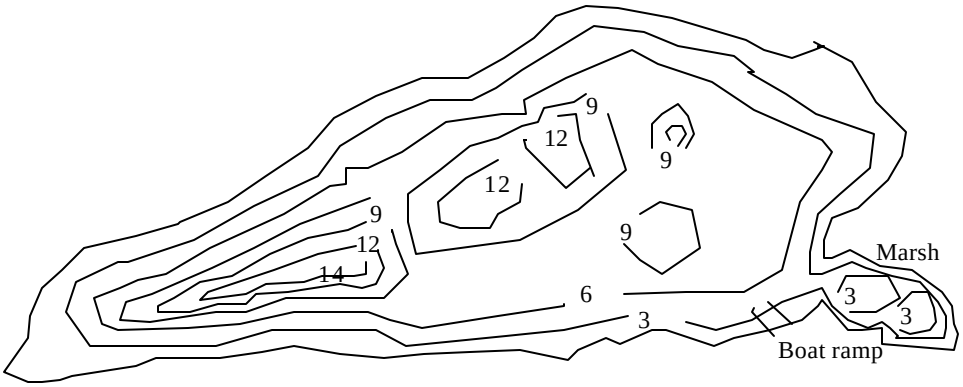

Figure 1. Contour map (in feet) of Clear Lake (Full pool).

Methods

In 2005, electrofishing was conducted in Clear Lake on 16 June and trap and gill nets were set overnight on 23 August. Electrofishing is ineffective on Clear Lake during low lake levels and was not conducted from 2002 to 2004 with only two electrofishing stations conducted in 2005. During our assessments, water temperatures were 21° C during electrofishing and 22° C during netting. The lake's pH was measured at 7.2, total alkalinity was measured at 290 ppm, and phenolphthalein alkalinity was 0 ppm

Electrofishing was conducted for 0.5 hours after dusk with a Smith and Root 5.0 GPP electrofishing system using 200 volts pulsed DC, 8-9 amps, and a pulse frequency of 120 cycles per second (cps). Electrofishing was conducted in 15 minute transects along the shoreline. Ten trap nets and five gill nets were set perpendicular to the shore for 24 hours (Figure 2). Trap nets had 13-mm (0.5 in.) mesh, single throats, and 15.2-m (50 ft.) leads. Gill nets were 38.1 m (125 ft.) long by 1.8 m (6 ft.) high monofilament experimental nets consisting of five 25 ft. panels (19 mm, 25 mm, 38 mm, 51 mm, and 76 mm) (0.75 in., 1.0 in., 1.5 in., 2.0 in., and 3.0 in.) bar mesh.

Data collation and analysis techniques are summarized in Appendix C.

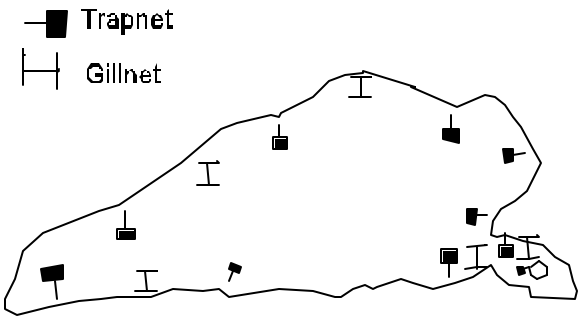

Figure 2. Net locations for Clear Lake.

Results and Discussion

Black bullhead

No black bullhead were collected in 2005. Black bullhead gill net mean CPUE declined from a high of 55 fish/net in 1987 to less than 1 fish/net, where it has remained since 1993. Black bullheads now make up an minor part of the Clear Lake fishery.

Largemouth bass

Due to low water levels, electrofishing equipment would not effectively sample the desired vegetated habitats, thus largemouth bass have not been sampled with electrofishing since 2001. Forty Largemouth bass were captured in trap and gill nets. Reproduction is evident with 36 sub-stock fish captured, however recruitment maybe low. Adult (= Stock, 200 mm) largemouth bass was N = 4, Wr = 115, S.D. = 27.7

Largemouth bass mean CPUE declined from 17 fish/hr of electrofishing (= stock length) during 1989 to about 1 fish/hr (= stock length) by 1991. Largemouth bass electrofishing mean CPUE has ranged between 60 during 1996 to 6.3 during 2000. Few fish have been longer than stock length. In 2001, largemouth bass electrofishing mean CPUE was 71 fish/hr and all were sub-stock length. Relative weights for size classes captured in 2001 were all above average with a mean of 130.6, similar to 2000 relative weights.

Black crappie

Ten sub-stock crappie were collected in trap nets in Clear Lake in 2005.

Bluegill

Only 20 bluegills were captured in 2005 between electrofishing and trap nets. Bluegills were not sampled using electrofishing gear during either 2003 or 2004 due to low water conditions.

Between 1987 and 1988, bluegill mean CPUE declined substantially and remained low until two strong year classes were produced during 1995 and 1996 (Figure 3) but these fish failed to recruit to stock length and longer fish. Strong year classes were produced in 1999 and 2001, but also failed to recruit to longer sizes and the 2005 surveys indicated a bluegill fishery comprised of few angler preferred length fish (Figure 4) with relative weights indicating above average growth rates for those fish sampled (Table 1). Because of the ineffectiveness of electrofishing due to low water levels, too few bluegill have been collected since 2001 to make reliable population inferences.

Table 1. Bluegill weights and relative weights by length class for Clear Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<80.0	0	0	0.0	0.0
Stock - Quality	80 - 149	11	45	124	17.7
Quality - Preferred	150 - 199	9	112	118	8.5
Preferred - Memorable	200 - 249	0	0	0.0	0.0
Memorable - Trophy	250 - 299	0	0	0.0	0.0
Trophy	≥300	0	0	0.0	0.0

Mean W_r = 121, SE = 3.2
N = 20

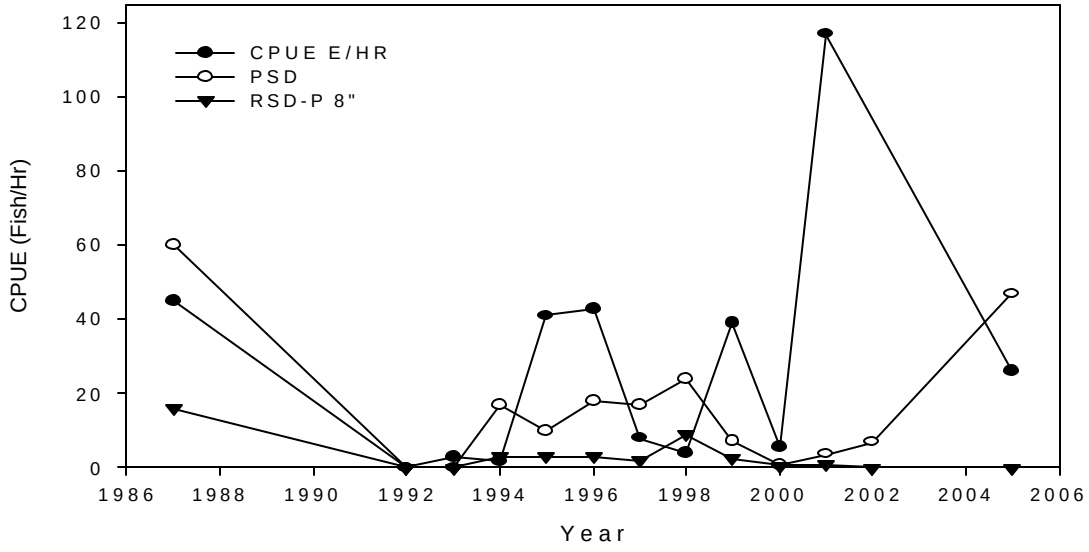

Figure 3. Annual relative abundance of bluegills caught by electrofishing (E) in Clear Lake, Valentine NWR. Mean catch per unit effort (CPUE) for all length groups, proportional stock density (PSD) and relative stock density (RSD-P).

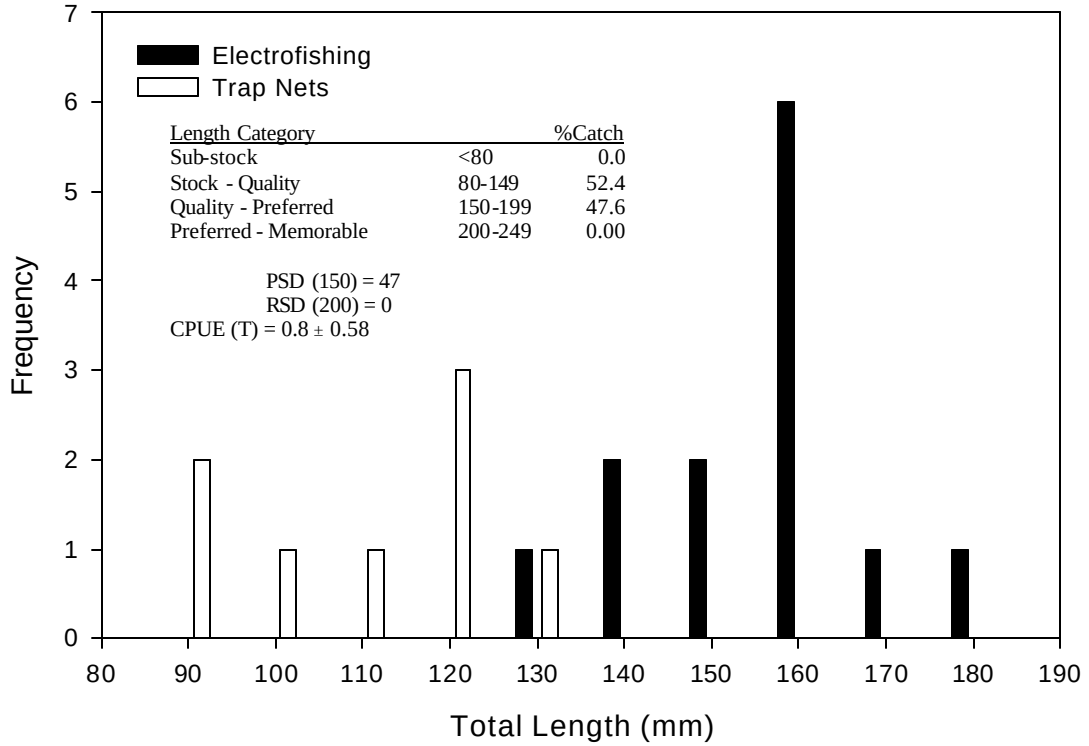

Figure 4. Bluegill length frequency distribution by gear type for Clear Lake, Valentine NWR, 2005.

Yellow Perch

The 2005 survey did show a substantial decline in size structure from previous years. PSD levels from 2003 (PSD = 29) and 2004 (PSD = 21) were higher than 2005 (PSD = 1). However, mean CPUE for trap and gill nets were similar to previous years (Figure 5). There appears to be low recruitment, most likely due to low water levels. There are also very few fish recruiting to larger size classes. Relative weights (Table 2) for all size classes were similar to other Sandhill lakes.

Yellow perch mean CPUE declined from 90 fish/gill net during 1987 to 0 fish/gill net by 1989 and perch remained a negligible part of the Clear Lake fishery until 1997 surveys. The 1998 mean CPUE was substantially higher than 1997 surveys with indications of successful multiple year classes and recruitment into sizes preferred by anglers. However, mean CPUE declined from 91 fish/gill net and 37 fish/trap net in 1998 to 7 fish/gill net and 16 fish/trap net in 1999. Gill and trap net mean CPUE has been low since 1999.

Table 2. Yellow perch weights and relative weights by length class for Clear Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<130	0	0	0.0	0.0
Stock - Quality	130 - 199	59	59	98	15.5
Quality - Preferred	200 - 249	2	114	93	3.8
Preferred – Memorable	250 - 299	0	0	0.0	0.0
Memorable - Trophy	300 - 379	0	0	0.0	0.0
Trophy	≥380	0	0	0.0	0.0

Mean W_r = 98, SE = 1.96
N = 61

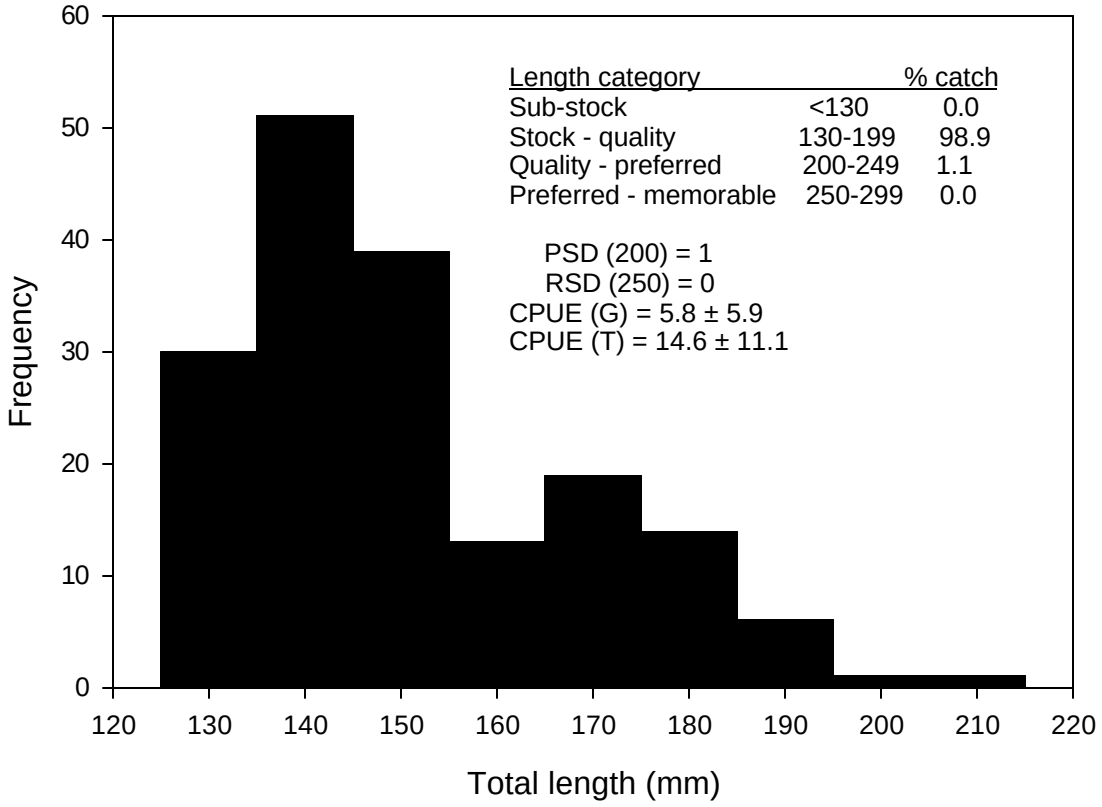

Figure 5. Length frequency distribution for yellow perch in Clear Lake, Valentine NWR, 2005.

Northern Pike (*Esox lucius*)

In 2005, PSD/RSD levels did increase as little or no recruitment has occurred in the last couple of years (Figure 6). Gill net mean CPUE has not significantly changed since 1998 (Figure 7 and 8). The condition of northern pike is above average compared to other Sandhill lakes (Paukert and Willis 2003) (Table 3).

During 1988, a 36 in. minimum size limit for northern pike was implemented. The minimum size regulation was reduced to 30 in. beginning 1990 and returned to a 36 in. minimum during 1991. In 1993, the regulations were changed to allow only harvest of northern pike less than 28 in. It is difficult to interpret how these changes have impacted the northern pike population, but the northern pike appeared to respond poorly to 36 in. minimum size limit, which was reflected in declining abundance and condition. The new regulation allowed harvest of northern pike less than 28 in. and protected larger individuals, which was enacted to increase the number of larger northern pike thought to be necessary for controlling carp recruitment. Northern pike mean CPUE for size classes preferred and larger (i.e., >28 inches) individuals has generally increased since this regulation was imposed, but the increase has not been linear. Since the 28 in. size limit, the most notable differences in RSD values have occurred for memorable to trophy length fish. Fish in this length category have usually been collected every year since 1996 (except 2000) with incremental RSD values ranging from 21 in 1997 to five in 1998. However, before 1996, northern pike in this size class were only collected once in 1989 with a RSD value of two (Table 4).

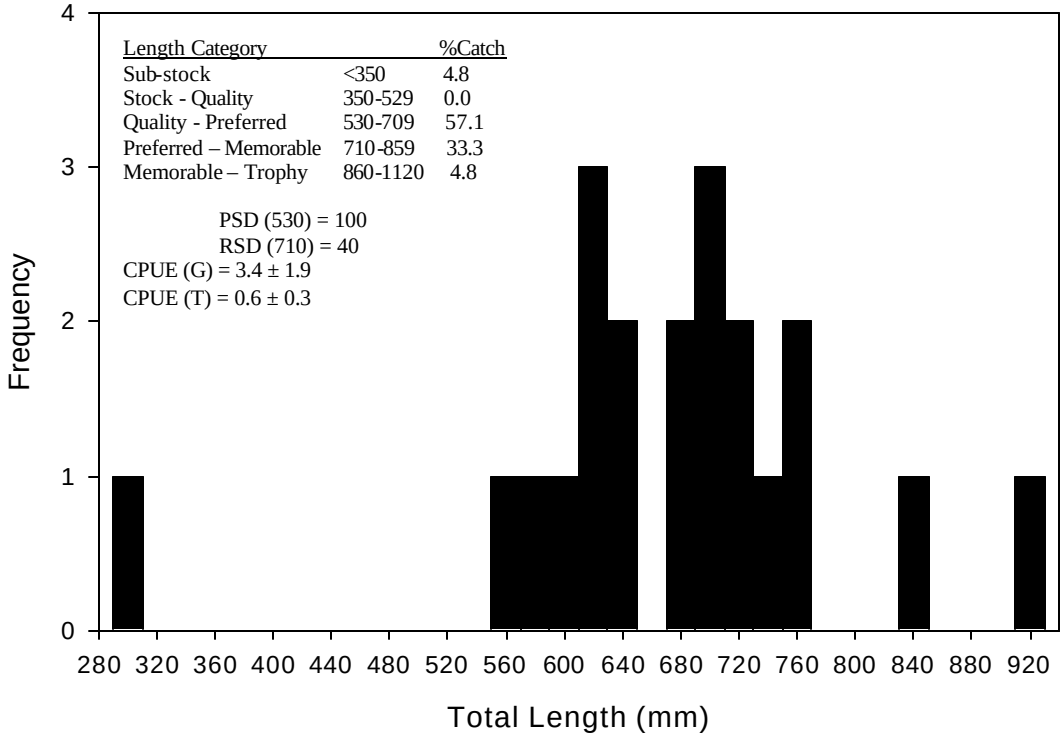

Figure 6. Northern pike length frequency distribution for Clear Lake, Valentine NWR, 2005.

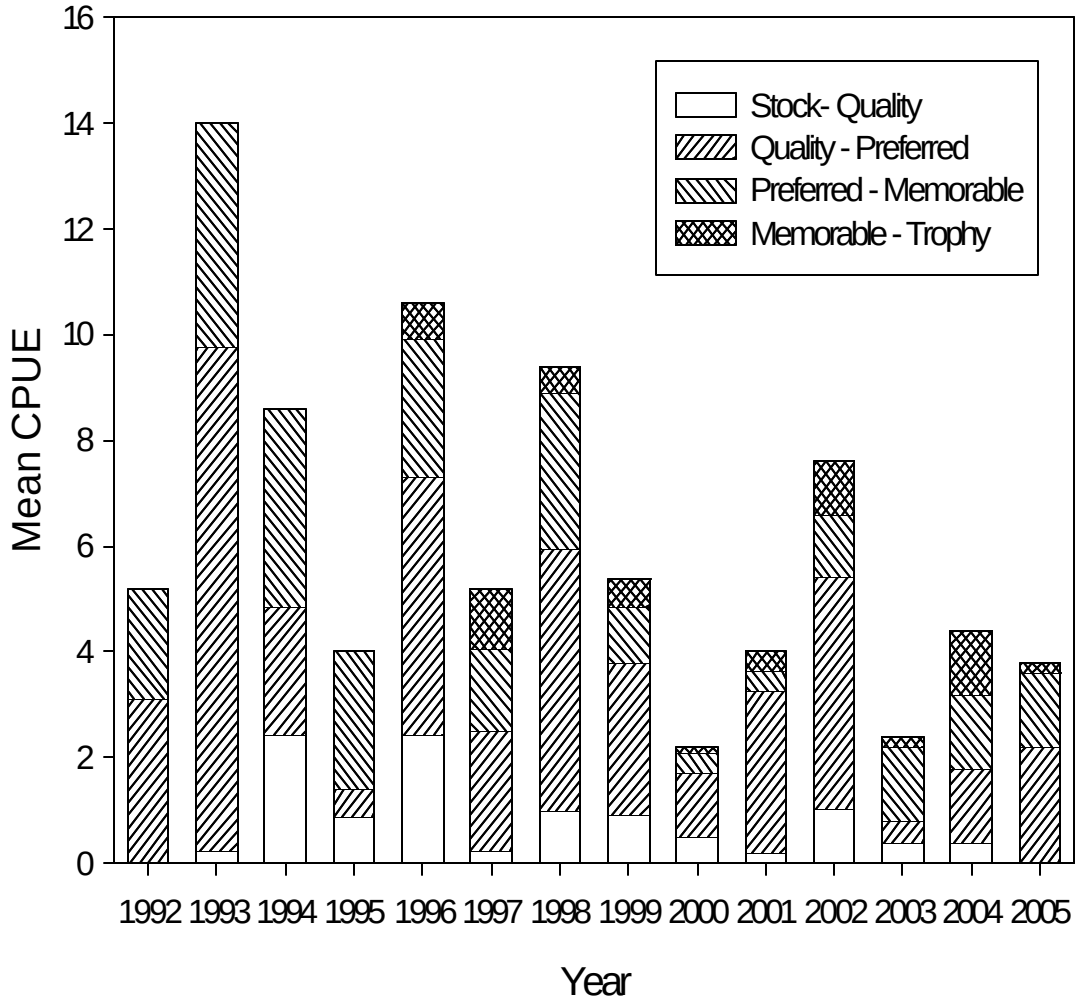

Figure 7. Gill net mean catch per unit effort for northern pike by size category in Clear Lake, Valentine NWR for years 1992-2002.

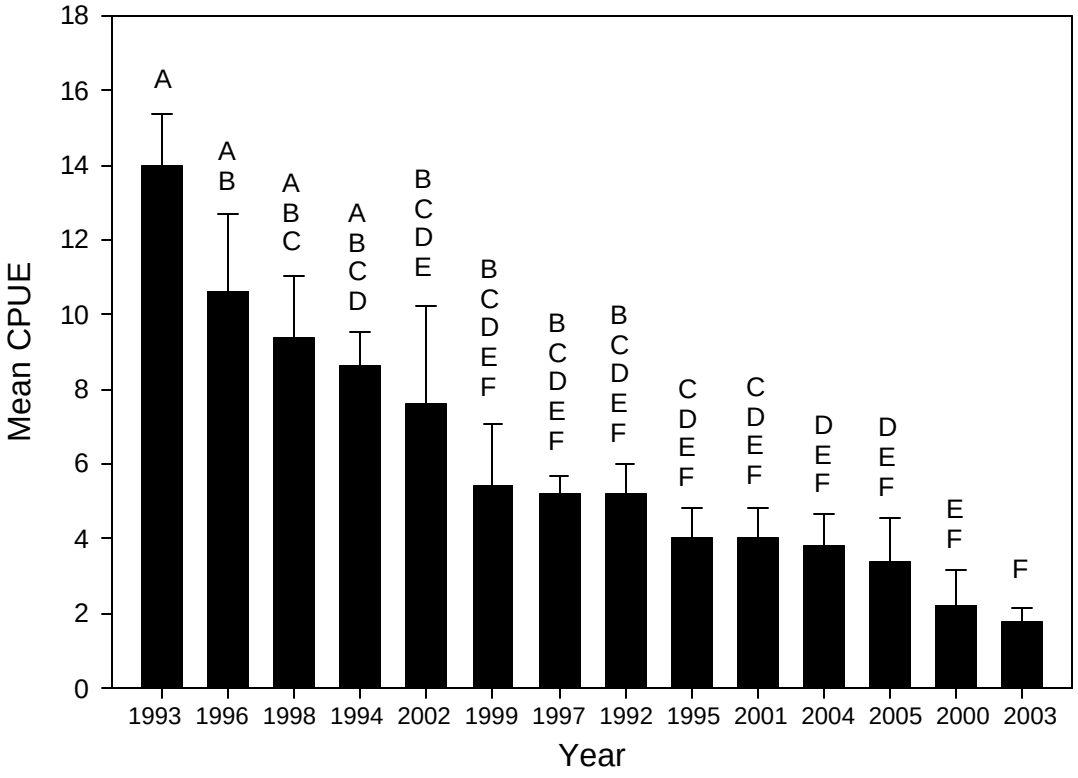

Figure 8. Northern pike gill net mean CPUE by year in Clear Lake, Valentine NWR. Years with the same letter are not different (P > 0.20) using ANOVA with Tukey-Kramer multiple comparison test.

Table 3. Northern pike weights and relative weights by length class for Clear Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<350	1	225	103	0.0
Stock - Quality	350 - 529	0	0	0.0	0.0
Quality - Preferred	530 - 709	12	1679	92	8.1
Preferred - Memorable	710 - 859	7	2918	95	5.3
Memorable - Trophy	860 - 1119	1	4900	86	0.0
Trophy	≥1120	0	0	0.0	0.0

Mean W_r = 93
N = 21

Table 4. Population size structure, traditional proportional stock density (PSD) and incremental relative stock density (RSD) with relative weights (*Wr*) of northern pike in Clear Lake, Valentine NWR. Data are pooled for trap and gill nets and summarized by size categories with 80 % confidence intervals (+/-). "a" denotes small sample size, confidence intervals could not be calculated.

Year	% = Quality X 100		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	*Wr*	RSD	+/-	*Wr*	RSD	+/-	*Wr*	RSD	+/-	*Wr*	RSD	+/-	*Wr*
2005	100	93	0			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	0		
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		
1994	71	105	28	9	115	28	9	98	43	11	95	0		
1993	98	97	1	a	97	68	11	101	30	9	98	0		
1992	100	96	0			60	9	96	40	9	97	0		
1991	100	92	0			87	a	94	13	a	90	0		
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		

* Indicates small sample size.

Common carp

In 2002 and 2004, the gill net mean CPUE had substantial increases of sub-stock carp. Recruitment of carp has occurred as PSD = 44 and RSD-P = 30 in 2005. Common carp gill net mean CPUE has ranged from 0 in 1999 and 2000 to 31 in 2004 (Figure 9).

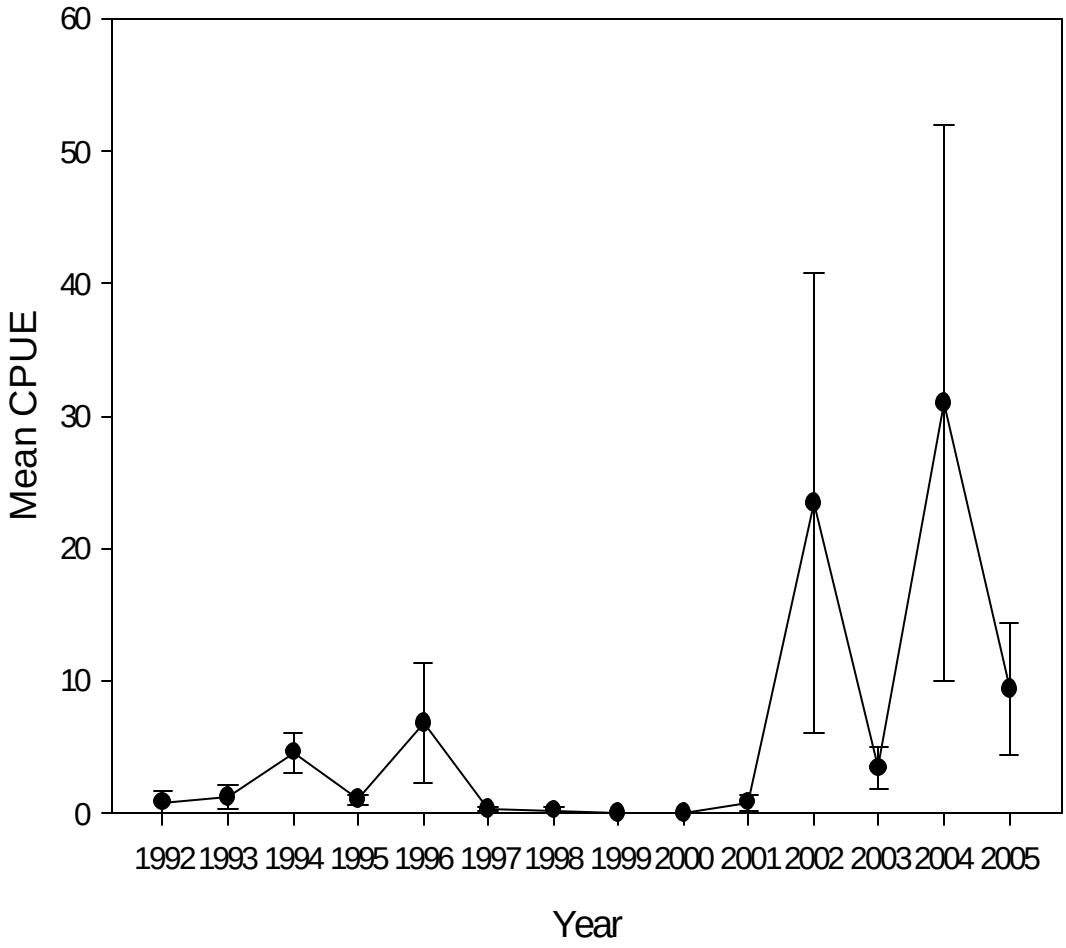

Figure 9. Carp gill net mean CPUE with standard error bars for Clear Lake, Valentine NWR for 1992-2005.

Summary

Common carp - In previous years it appeared that northern pike predation did not allow common carp to recruit to adult sizes in Clear Lake as the population of common carp was dominated by sub-stock fish. However, an increase in carp PSD indicates that carp recruitment did occur after the large increase in gill net CPUE in 2004.

Northern pike - Gill net CPUE remained similar to previous years. The northern pike population in Clear Lake is dominated by larger older individuals as little to no recruitment has occurred in recent years. Northern pike mean Wr is above average compared to other sandhill lakes.

Largemouth bass - Although electrofishing has not been effective on Clear Lake since 2001, largemouth bass were collected in trap and gill nets indicating fishery potential.

Yellow perch - Few preferred length yellow perch were captured in 2005.

Bluegill – Few preferred length bluegill were captured in 2005.

Black crappie – Although only sub-stock size, black crappie were captured in trap nets for the first time. A population may develop in this lake, assuming that young black crappies can survive predation by northern pike.

Management Recommendations

1. Continue the 28" maximum size limit for northern pike and evaluate its impact on northern pike abundance and size structure.

2. Conduct electrofishing surveys during the spring when water levels are more likely to be higher allowing more effective electrofishing.

3. Continue annual surveys.

3. Evaluate the use of black crappie as an additional game species.

DEWEY LAKE

Dewey Lake is accessible by dirt trails 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 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') and a mean depth of 1.4 m (4') (Figure 1). A dike on the east end of Dewey maintains the water about 1.3 m above natural pool. The surrounding shoreline is predominately grassland with few willows (*Salix spp.*) and cottonwoods (*Populus spp.*). The west end of the lake has a muck 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 a muck bottom and is heavily vegetated with emergent vegetation such as cattails (*Typha spp.*) and bulrush (*Scirpus spp.*). During summer, submergent and emergent vegetation is abundant in a band around the edge and is often referred to as "weed choked". The bottom of Dewey Lake is relatively flat with few drop-offs or depressions. Conductivity averages 344 µS/cm at 25^0C. Total alkalinity is 308 ppm, and phenolphthalein alkalinity is 0 ppm. The lake's pH averages between 9 during summer and 8 during fall/spring. Secchi disk averages 0.6 m. The lake is too shallow to develop a summer thermocline. Summer surface water temperatures often exceed 30 ^{0}C (80 ^{0}F), and dense algae blooms are noted.

Dewey Lake was chemically renovated with rotenone in 1981 and restocked with game fish the following year. However, the renovation was either not 100% successful or carp migrated into Dewey from other lakes. A fisherman reported the first post-renovation carp in 1984. Beginning in January 1988, a 36 in. minimum length limit for northern pike was implemented in an attempt to develop a predator population capable of controlling carp recruitment. Beginning in 1993, size regulations were enacted that protected only northern pike greater than 28 in. in length. In the spring of 1993, large numbers of carp were noted in the ditch between Dewey and White Water, likely making their upstream spawning migration. These carp were removed with an estimate of several tons of carp removed. Extremely high lake levels during spring (and through much of the summer) provided opportunities for inter-lake movement of fish. Size and bag limits for fishing are summarized in Appendix B.

Primary fish species include: yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and carp. In 1987 and 1988, adult flathead catfish (*Pylodictis olivaris*) were stocked to control an expanding slow growing population of black bullhead. Dewey Lake is considered one of the better fishing lakes on the Refuge but also has a history of becoming dominated by carp shortly after chemical renovations.

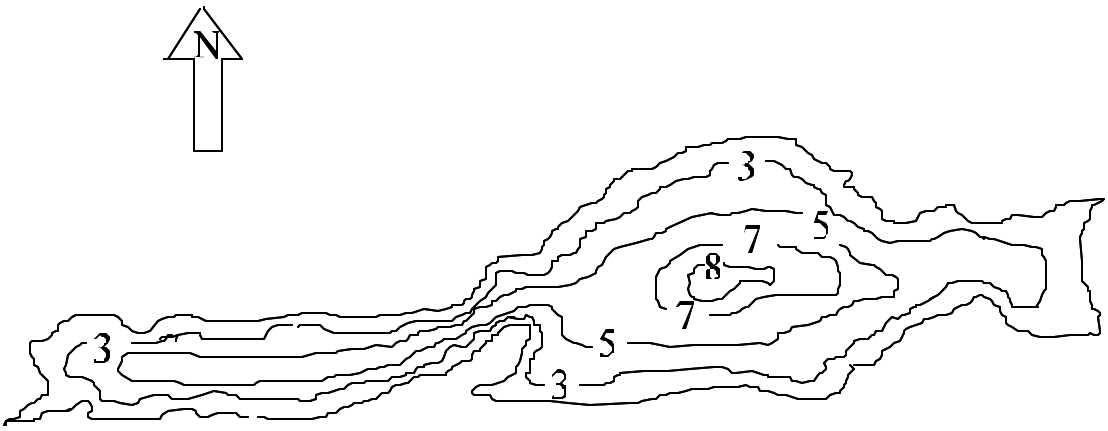

Figure 1. Bottom profile of Dewey Lake, Valentine NWR, contour intervals are measured in feet.

Methods

Night time electrofishing was conducted 16 June 2005 and trap and gill nets were set overnight on 22 August 2005. Water temperature was 21 ^{o}C while electrofishing and temperatures were 23 ^{o}C during the netting operation.

Electrofishing was conducted for one hour after dusk with a Smith and Root 5.0 GPP electrofishing system using 200 volts pulsed DC, 9 amps, and a pulse frequency of 120 cycles per second (cps). Electrofishing was conducted in 15 minute transects along the shoreline. Ten trap nets and 5 gill nets were set perpendicular to the shore for 24 hours (Figure 2). Trap nets had 13-mm (0.5 in.) mesh, single throats, with 15.2-m (50 ft.) leads. Gill nets were 38.1 m (125 ft.) long by 1.8 m (6 ft.) high monofilament experimental nets consisting of five 25 ft. panels (19 mm, 25 mm, 38 mm, 51 mm, and 76 mm) (0.75", 1.0", 1.5", 2", and 3") mesh. The pH was 8.5 Total alkalinity was 240 ppm and phenolphthalein was 0.00 ppm. Conductivity was measured at 320 μS/cm.

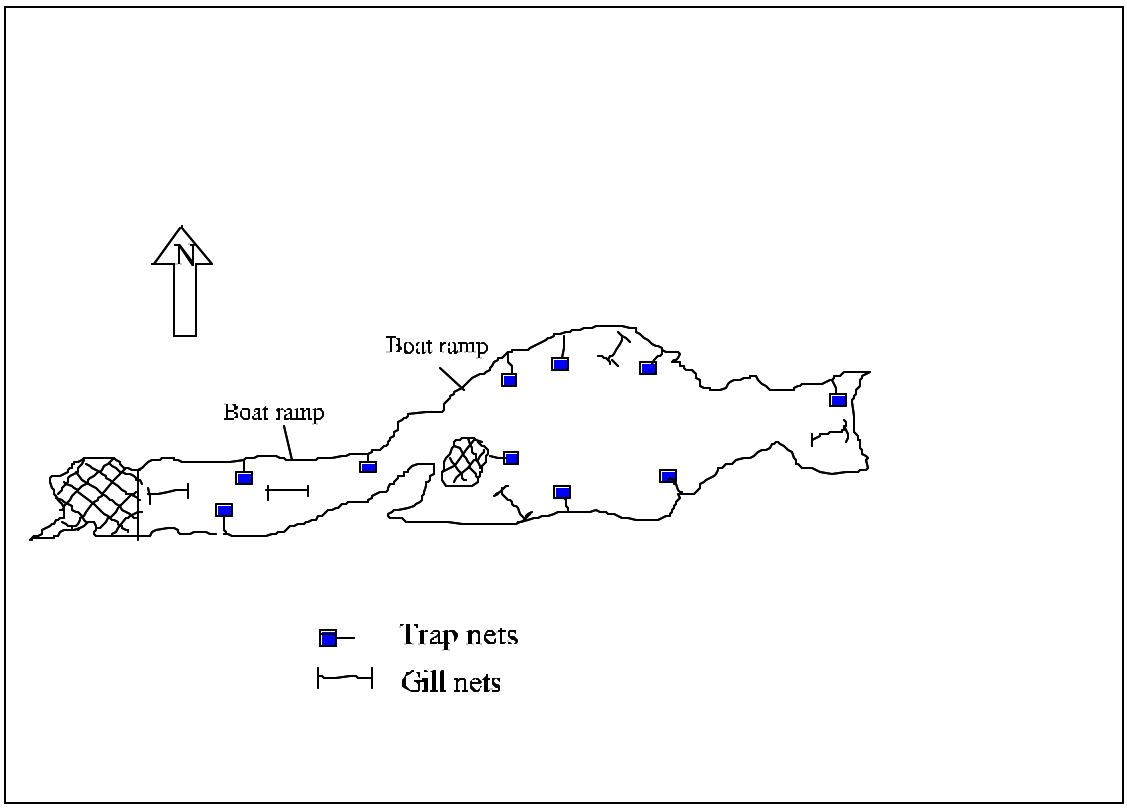

Figure 2. Net locations for Dewey Lake.

Results and Discussion

Bluegill

In 2005, bluegill mean CPUE for electrofishing was 15 fish/hr and mean CPUE for trap nets was 13 fish/net, which was similar from 2003 to 2004. PSD/RSD values decreased from recent years (Figure 3 and 4). Strong bluegill year classes were observed in 1996 and 2001; however, it appears that only a few of these fish have recruited to larger lengths. The bluegill fishery has limited numbers of preferred length class and larger fish. A cyclic pattern is developing in our CPUE indices (Figure 3). Bluegill Wr values for all size classes were good (Table 1).

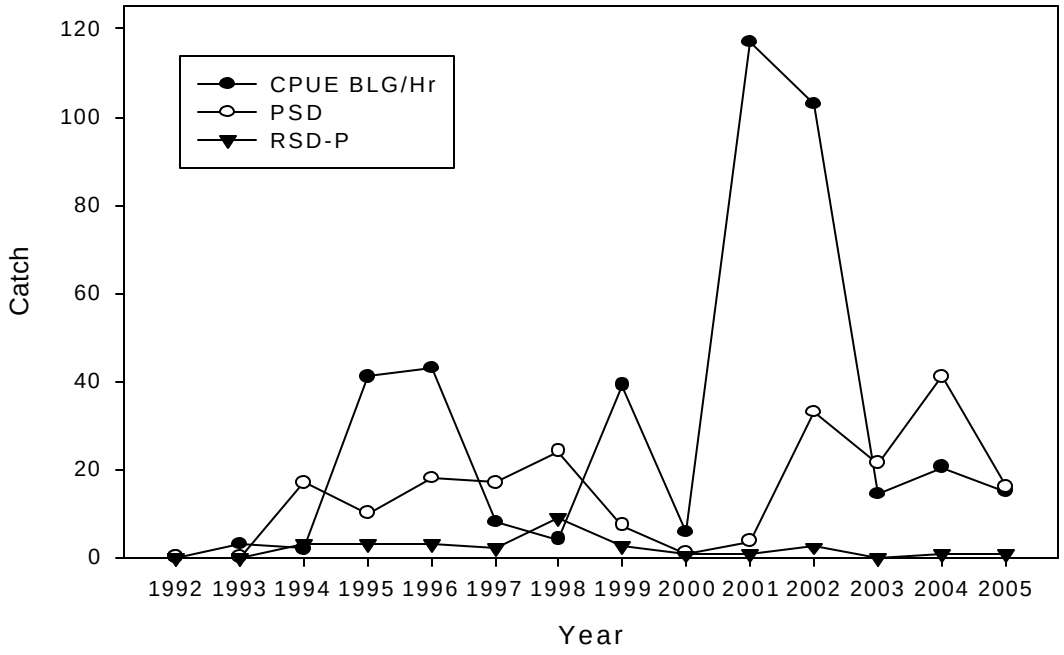

Figure 3. Annual relative abundance of bluegills caught by electrofishing in Dewey Lake, Valentine NWR. Mean catch-per-unit-effort (CPUE) for all length groups, proportional stock density (PSD), and relative stock density (RSD-P) for preferred length bluegills.

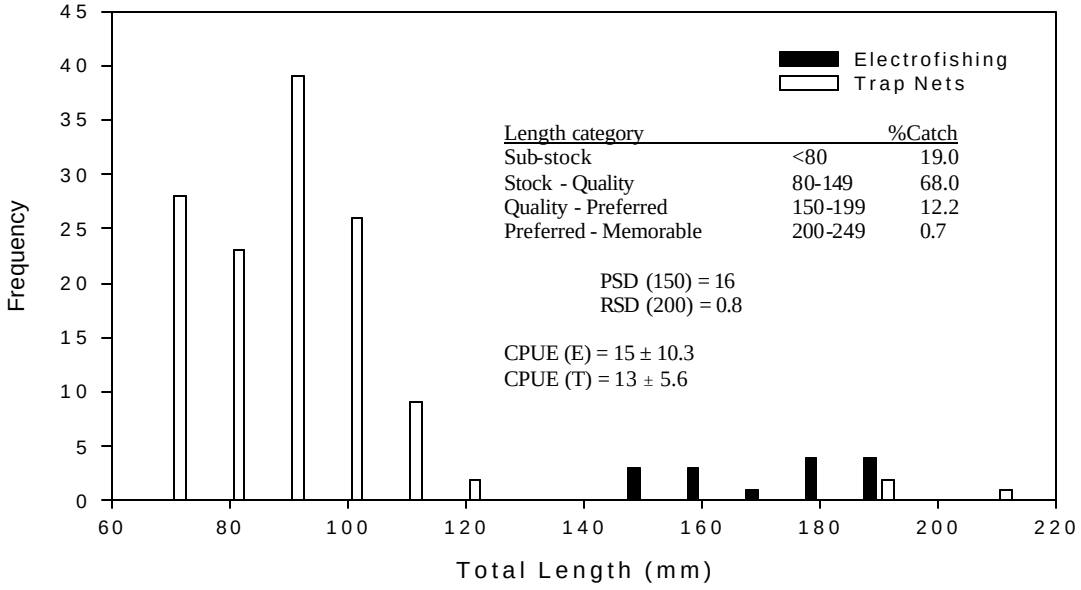

Figure 4. Bluegill length frequency distribution for Dewey Lake, Valentine NWR, 2005.

Table 1. Bluegill weights and relative weights by length class for Dewey Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<80	0	0	0	0.0
Stock - Quality	80 - 149	22	23	115	8.3
Quality - Preferred	150 - 199	18	144	113	11.0
Preferred - Memorable	200 - 249	1	265	121	0.0
Memorable - Trophy	250 - 299	0	0.0	0	0.0

Mean W_r = 115
N = 41

Black bullhead

During the 2005 survey, no bullheads were collected. Since the 1987 introduction of flathead catfish into Dewey Lake, the black bullhead gill net mean CPUE has declined from a high of 30 fish/gill net in 1987 to near 0 in 1997. Mean CPUE has remained at 0 since 1997.

Common carp

In 2005, common carp gill net mean CPUE (3.8 ± 1.64) which was similar to 2003 and 2004 in Dewey Lake (Figure 5). No sub-stock length carp were collected in 2005 indicating little or no recruitment.

Although gill net mean CPUE has oscillated up and down, these changes have not been substantial between years, and carp abundance appears to be stable (Figure 5). During the spring of 1993, refuge personnel trapped and killed large numbers of carp in the ditch between Dewey and White Water lakes, which may have contributed, to the decline noted in the fall 1993 surveys. In past surveys, length frequency and PSD/RSD data indicated poor recruitment of smaller length groups with a population comprised mainly of large old fish. However, young-of-the-year fish were caught in 1997, and these fish appeared to recruit successfully. Ten carp were caught in gill and trap nets during 1998 and ranged from 415 to 745 mm. In the 1999 survey, 12 of the 16 carp collected were sub-stock length. In general, carp spawning appears to be successful, but recruitment seems sporadic and only one carp was caught in a trap net during the 2000 surveys. In 2001, spawning was successful as 30 sub-stock length carp were caught in trap nets. In 2003, no sub-stock carp were collected and in 2004, almost all carp collected were sub-stock.

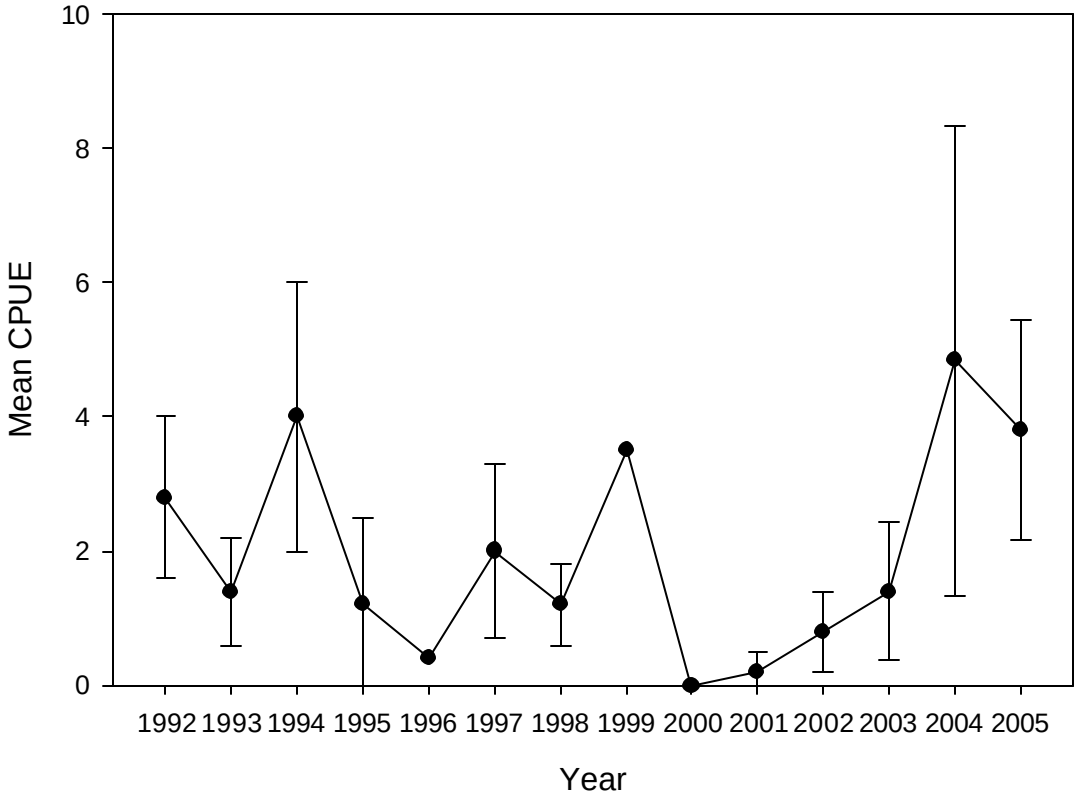

Figure 5. Common carp gill net mean CPUE with standard error bars for Dewey Lake, Valentine NWR, 1992-2005.

Yellow perch

The 2005 survey indicates the yellow perch gill net mean CPUE (12.8 ± 9.3) has declined since 2002, and PSD and RSD-P have also declined from the 2004 survey (Figure 6 and 7). The PSD/RSD values declined during the years with strong year classes but this is usually a reflection of the increased abundance of smaller fish. However, low mean CPUE and PSD values indicated little or no recruitment in Dewey Lake since 2003. The mean Wr is 97 (Table 2), which is similar to past years and other Sandhill lake.

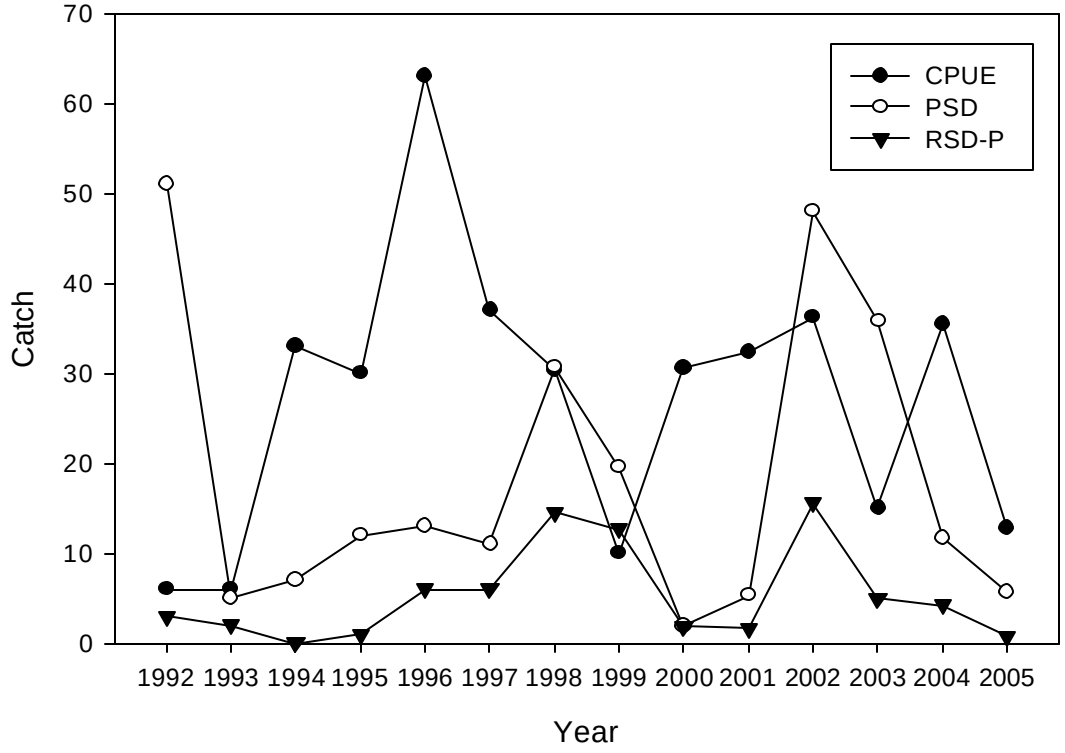

Figure 6. Annual relative abundance of yellow perch caught by gill nets in Dewey Lake, Valentine NWR. Mean catch-per-unit-effort (CPUE) presented for all length groups, proportional stock density (PSD), and relative stock density (RSD-P) for preferred length perch.

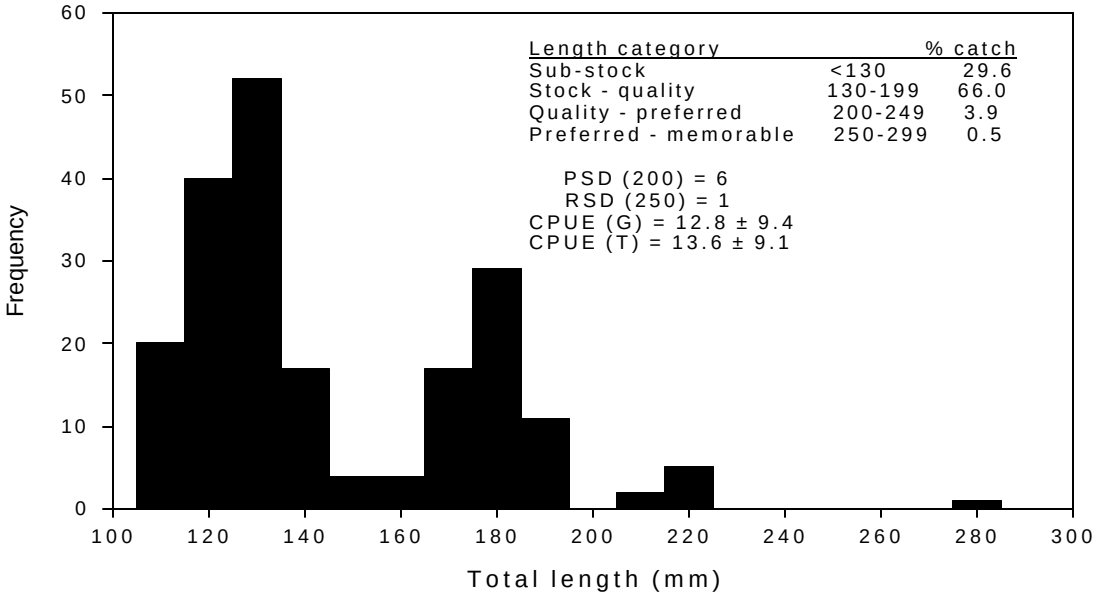

Figure 7. Yellow perch length frequency distribution for Dewey Lake, Valentine NWR, 2005.

Table 2. Yellow Perch weights and relative weights by length class for Dewey Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<130	10	22.5	100	14.5
Stock - Quality	130 - 199	33	62	97	5.6
Quality - Preferred	200 - 249	7	143	93	3.1
Preferred - Memorable	250 - 299	1	265	80	0.0
Memorable - Trophy	300 - 379	0	0	0	0.0

Mean W_r = 97
N = 51

Largemouth bass

In 2005, electrofishing mean CPUE was 24 ± 15.3 which is substantially higher than previous years (2004 mean CPUE = 3.7 and 2003 mean CPUE = 2.8). Angler opportunities were exceptional for Dewey Lake with PSD = 76 and RSD-P = 62.

Largemouth bass electrofishing CPUE for stock size and larger fish has been less than 10 fish/hour since 1989 until 2005. Prior to 2005, length frequency data indicated strong year classes but few of these fish recollected in subsequent years. Mean Wr were exceptional for largemouth bass in Dewey Lake (Table 3).

Table 3. Largemouth bass weights and relative weights by length class for Dewey Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<200	26	24	142	17.6
Stock - Quality	200 – 299	5	258	128	8.9
Quality - Preferred	300 – 379	3	967	142	4.7
Preferred - Memorable	380 – 509	12	1742	135	10.6
Memorable - Trophy	510 – 629	1	3000	139	0.0

Mean W_r = 139
N =47

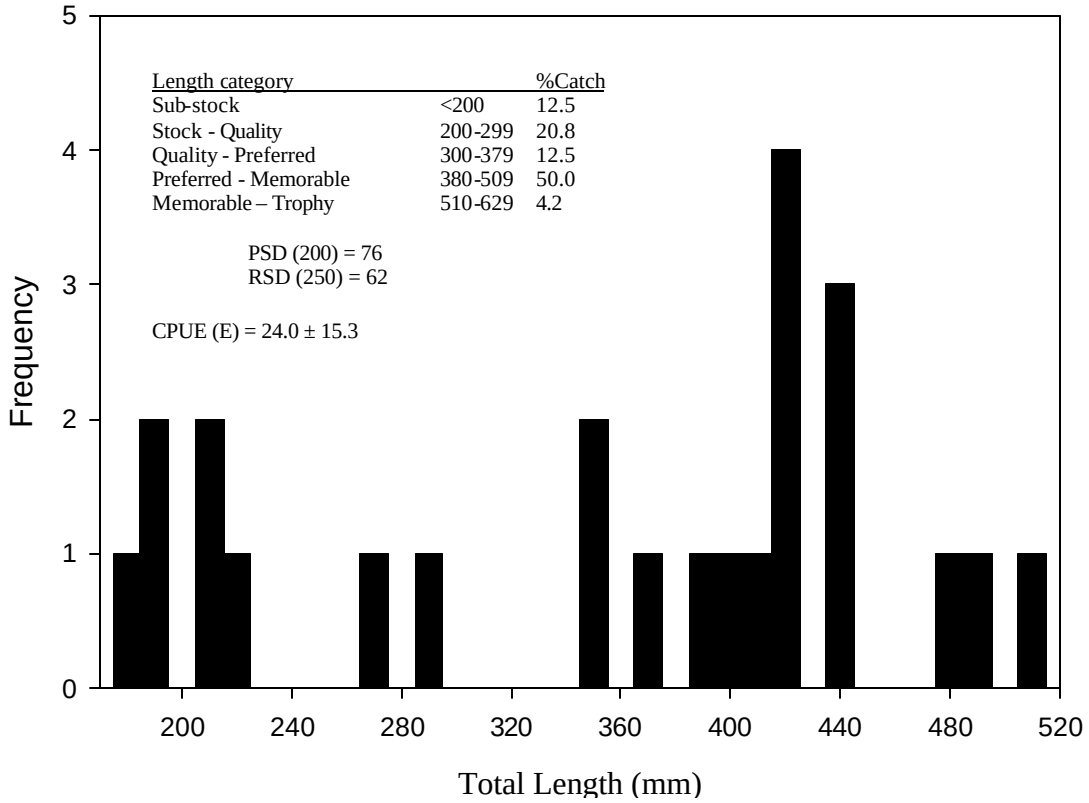

Figure 8. Length frequency for largemouth bass in Dewey Lake, Valentine NWR, 2005.

Northern pike

In 2005, northern Pike gill net mean CPUE was lowest since surveys began in 1992 (Figure 9 and 10). Only quality (= 530 mm) length fish were collected in 2005 (Figure 11). Low abundance and high PSD values indicate little or no recruitment of northern pike in Dewey Lake in recent years. Relative weights are low and have decreased from recent surveys (Table 8 and 9).

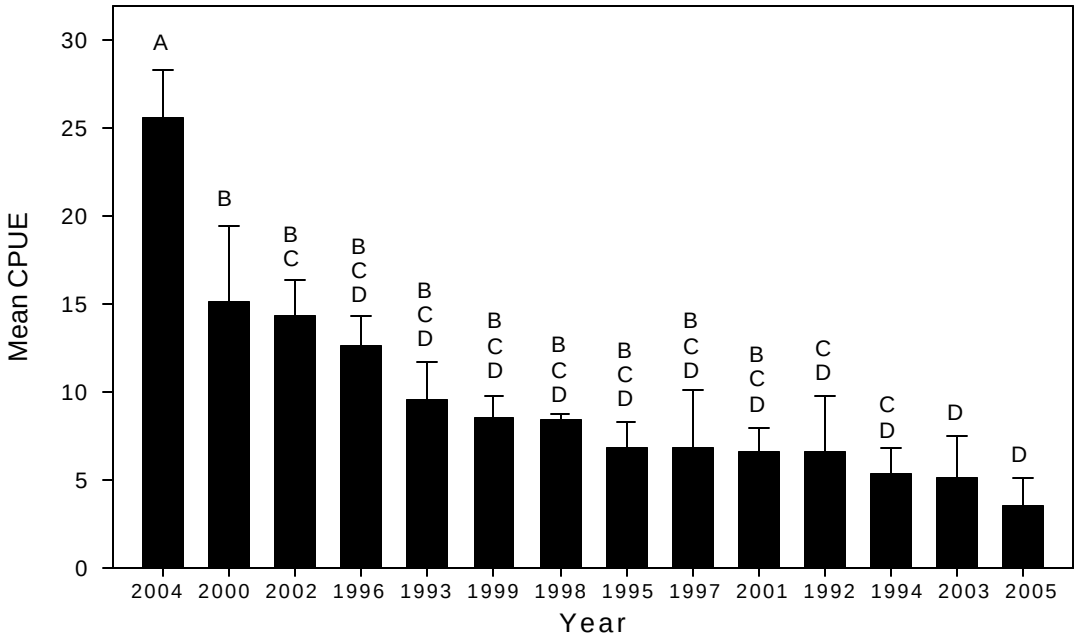

Figure 9. Northern pike gill net mean CPUE by year in Dewey Lake, Valentine NWR. Years with the same letter are not different (P > 0.20) using ANOVA with Tukey-Kramer multiple comparison test.

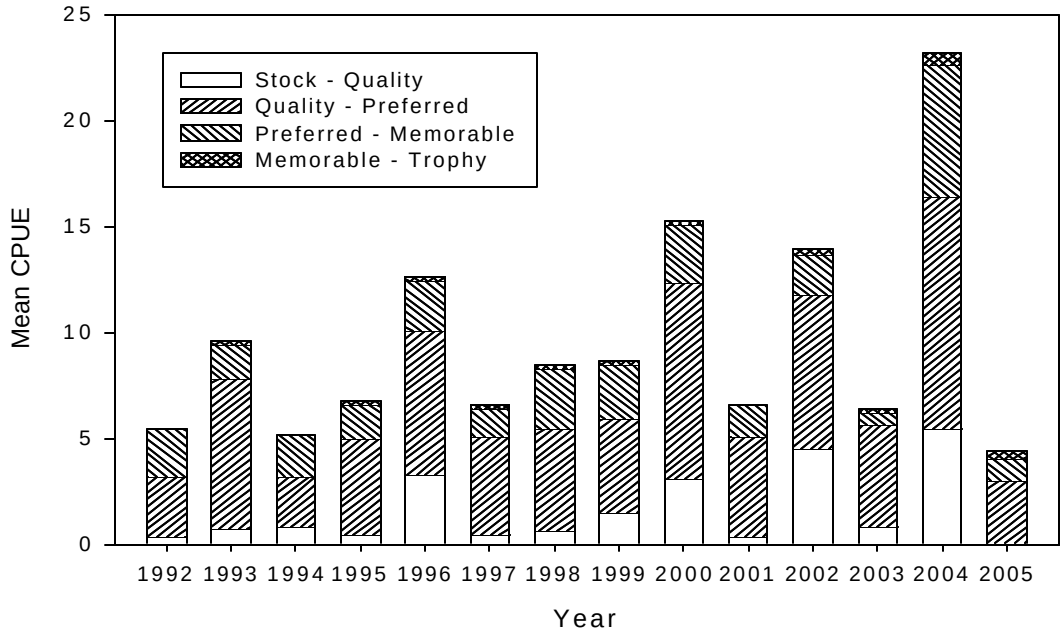

Figure 10. Gill net mean CPUE for northern pike by size category in Dewey Lake, Valentine NWR for years 1992-2005.

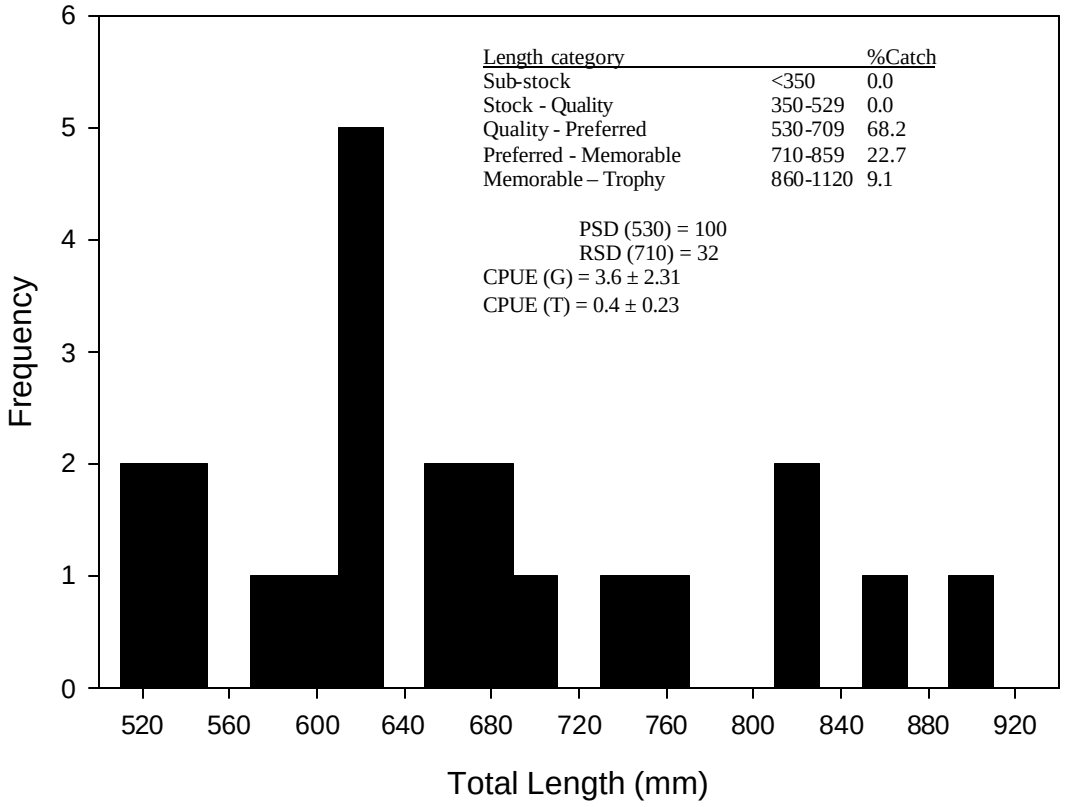

Figure 11. Length frequency distribution for northern pike in Dewey Lake, Valentine NWR, 2005.

Table 8. Northern pike W_r by length class for Dewey Lake, Valentine NWR 2005.

Length Class (mm)		Frequency	Mean Weight (g)	Average W_r	SD W_r
Sub-stock	<350.0	0	0	0	0.0
Stock	350.0 - 529.0	0	0	0	0.0
Quality	530.0 - 709.0	15	1470	93	7.0
Preferred	710.0 - 859.0	5	2560	81	18.3
Memorable	860.0 - 1119.0	2	3775	78	7.2
Trophy	≥1120.0	0	0	0.0	0.0

Mean W_r = 89
N = 22

Table 9. Population size structure, traditional proportional stock density (PSD) and incremental relative stock density (RSD) with relative weights (*Wr*) of northern pike in Dewey Lake, Valentine NWR. Data are pooled for trap and gill nets and summarized by size categories with 80% confidence intervals (+/-).(+/-). "a" denotes small sample size, confidence intervals could not be calculated.

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	*Wr*	RSD	+/-	*Wr*	RSD	+/-	*Wr*	RSD	+/-	*Wr*	RSD	+/-	*Wr*
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		
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		
1993	92	98	8	9	111	71	8	99	21	a	98	0		
1992	94	85	6	8	100	51	9	85	43	8	83	0		
1991	95	88	5	a	94	59	a	91	36	a	86	0		
1990	96	90	4	a	84	72	a	87	24	a	93	0		
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		
1987	17	110	83	a	95	12	a	90	5	a	96	0		

Summary

When Hackberry Lake was being renovated in August and September 2004, a large number of small common carp, yellow perch, and bluegills were observed being pumped from Hackberry Lake into Dewey Lake. The mean CPUE on all three fish species increased slightly in 2004. However, it appears that there was no recruitment into the population as the 2005 survey indicated a decrease in mean CPUE and PSD levels.

Common carp - Carp are spawning but few appear to recruit to stock length or larger. Carp mean CPUE did not substantially increase in 2005 from prior years. Carp mean CPUE oscillated between 1992 and 2000 but has since increased each year since 2000. During the spring of 1993, refuge personnel trapped and killed large numbers of carp in the ditch between Dewey and White Water Lakes, which may have contributed to the decline noted in the fall 1993 surveys.

Northern pike – It does appear that the northern pike regulations are helping to control common carp abundance but northern pike are likely controlling abundance and size of other important game species. The 28" maximum length harvest regulations for northern pike may have negatively impacted northern pike abundance as mean CPUE is at its lowest levels since the surveys began in 1992. However, PSD/RSD values indicated only large older northern pike in the population indicating poor recruitment during the low water years. Mean Wr were similar to other Sandhill lakes.

Bluegill - There were strong bluegill year classes in 2001 and 2002, and it appears that a few of these fish have recruited to quality and preferred lengths. Due to environmental conditions and an abundance of large predators, bluegill mean CPUE has decreased since 2001. PSD/RSD levels did increase in 2004, however there will likely be a decline in abundance and PSD until environmental conditions improve to provide strong year classes. Mean Wr were good for all size classes and similar to other Sandhill lakes.

Yellow perch - Indices indicate yellow perch are experiencing similar results as bluegill with a decline in abundance and size structure likely due to poor recruitment during the low water levels over the past four years. Mean Wr were similar to other Sandhill lakes.

Largemouth bass - Prior to 2005, largemouth bass length frequency data indicated strong year classes but few of these fish recollected in subsequent years. However, there are excellent angler opportunities for largemouth bass as fish have been collected in the preferred length group. Mean Wr were exceptional for largemouth bass in Dewey Lake.

Bullhead – In 1987, flathead catfish were introduced to Dewey Lake to control the bullhead population which was at a high of 30 bullheads/gill net. Since 1997, mean CPUE has remained at 0 bullheads/gill net.

Management Recommendations

1. Maintain the current size regulations and monitor abundance and size structure of northern pike.

2. Establish northern pike CPUE and PSD/RSD goals for this lake.

3. Evaluate the use of black crappie as an additional game species.

4. Continue to use Dewey – White Water ditch as a means for trapping and controlling carp. This effort needs to be set up in a systematic fashion and evaluated for success and cost efficiency.

5. Conduct electrofishing sampling during the spring when water levels are more likely to be higher allowing for more effective electrofishing.

6. Improve boat ramps for angler access.

HACKBERRY LAKE

Hackberry Lake is adjacent to the Refuge's Hackberry sub-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 4 lakes on the refuge that are connected by natural drainage or man-made ditches. 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') and 1.0 m (3'), respectively (Fig. 1). 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. Conductivity averages 425 µS/cm at 25^0 C. Total alkalinity averages 200 ppm, and phenolphthalein alkalinity averages 10 ppm. The lake's 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 short grass sandhills, which are lightly grazed by cattle.

Hackberry Lake has a history of high carp abundance. The lake was pumped and chemically renovated in August and September of 2004. The last chemical renovation prior to 2003 was conducted during 1975 and the lake was restocked the following year. With the 1975 renovation, 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" or less.

In 2004, refuge staff consulted with the Nebraska Game and Parks Commission and agreed to cooperate as a joint effort to lower Hackberry Lake and chemically renovate the fishery. Draw down began on the lake began in August of 2004 and the lake was chemically renovated using rotenone. By October 2004, Hackberry Lake was declared carp free. Fish stockings were initiated during the fall of 2004 with additional stockings in 2005 (Appendix B).

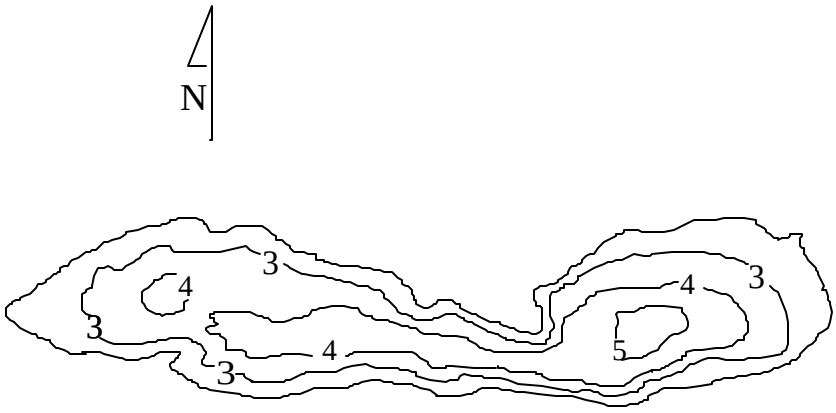

Figure 1. Contour map of Hackberry Lake, Valentine NWR.

Summary

In the fall of 2004, Hackberry Lake was chemically renovated due to the over abundance of common carp. Sampling has not occurred to date.

Common carp - Carp were first noted during 1988 surveys and abundance increased substantially soon after they were detected. The population appeared to have been remained low and stabilized from 1994 to 1998. We collected greater numbers of 200 mm carp during the 1999 and 2000 surveys but collected only five carp between 600-700 mm. Only two carp were collected in 2001. Only one young-of-the-year carp was collected in 2002. In 2003, carp gill net mean CPUE exceeded 30 fish/net.

Bluegill – based on mean CPUE, bluegill abundance increased from 2000 to 2003. The population was largely represented by stock length fish, indicating bluegill spawn and recruit through the first year but are gone before they reach lengths preferred by anglers.

Yellow perch - Yellow perch abundance and average size declined substantially after the 36" northern pike size regulations were implemented. Good numbers of young-of-the-year and stock size yellow perch have been noted during past surveys, but recruitment into larger size classes has been poor.

Largemouth bass - Long-term data indicates that Hackberry Lake never produced large numbers of bass. However, a few memorable to trophy length largemouth bass are captured each year. Largemouth bass supplemental stockings have not increased abundance. In 2002, there were 32 preferred length largemouth bass collected indicating good angling opportunities.

Northern pike – Extremely low mean Wr of northen pike were observed in 2002.

Management Recommendations

1. Begin electrofishing sampling in spring and netting in the fall of 2006 to evaluate the fish stocking.

2. Improve boat ramps.

3. Conduct creel surveys to gather information on angler harvest as soon as angling increases.

PELICAN LAKE

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 contains 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 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 noted. During the spring of 1995, it is likely that carp from the 1993 year class migrated into the lake.

Pelican Lake is one of three refuge lakes in which a 36 in. minimum length limit for northern pike was implemented during 1988 to develop an abundance of large predators. It was hypothesized that a population of large predators would be more effective at controlling carp recruitment. A 22-26 in. northern pike slot limit was implemented during 1991 to remove an over abundance of this size class. The slot limit was scheduled to be open until 4,000 northern pike were removed. This regulation continued into the spring because of weak ice and poor angling during the 1991-1992 winter ice-fishing season. The slot limit was continued through 1992 because spring surveys indicated a northern pike population with relative weights below 80 and some length groups below 60. Beginning January 1993, the northern pike regulations were changed to allow harvest of northern pike 28 in. and less. Size and bag-limits are summarized in Appendix A.

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

Pelican Lake is 331 surface ha (817 acres). Maximum depth is 3.3 m (10 ft), and mean depth is 1.3 m (4 ft) (Figure 1). Conductivity averages 375 at 25^0 C; total alkalinity averages 205 ppm and phenolphthalein alkalinity is 0 ppm. The lake's pH ranges from 8 during winter through spring to 9 during summer. Secchi disc reading averages 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 30^0C. 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 springs likely reduce the occurrence of winter kills. Emergent vegetation is primarily cattail, bulrush and *Phragmites*, but scattered stands of wild rice occur. Submergent vegetation includes milfoil (*Myriophyllum spp.)*, curly-leaf pondweed (*Potamogeton spp.)*, and scattered areas of coontail. The

surrounding watershed is rolling sandhills. The shoreline is dominated with short grasses with a few cottonwoods and willows.

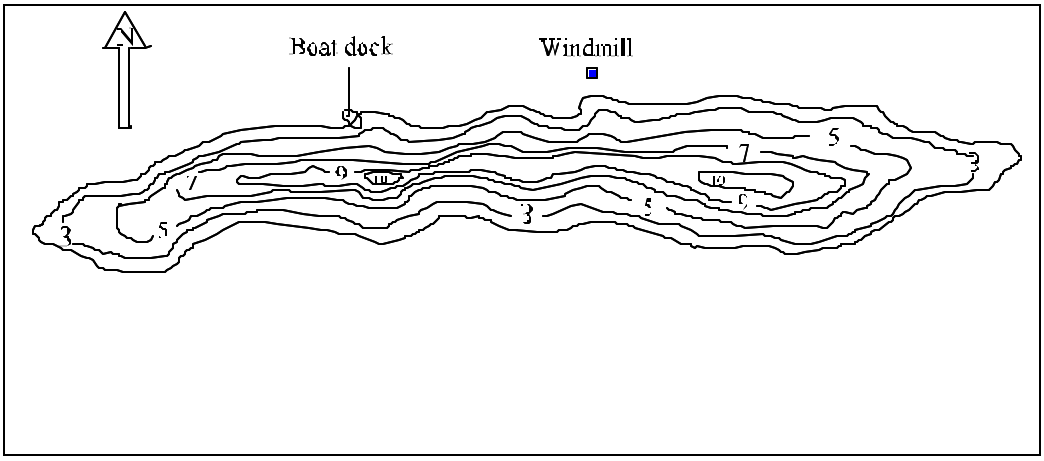

Figure 1. Contour map of Pelican Lake at full pool (depth in feet).

Methods

Night time electrofishing was conducted 15 June 2005 and trap and gill nets were set 25 August 2005. Water temperature was 21 ^{o}C while electrofishing and 22 ^{o}C during the netting operation.

Electrofishing was conducted for 2 hours after dusk with a Smith and Root 5.0 GPP electrofishing system using 200 volts pulsed DC, 9 amps, and a pulse frequency of 120 cycles per second (cps). Electrofishing was conducted in 15 minute transects along the shoreline. Twelve trap nets and seven gill nets were set perpendicular to the shore for 24 hours (Figure 2). Trap nets had 13-mm (0.5 in.) mesh, single throats, with 15.2-m (50 ft.) leads. Gill nets were 38.1 m (125 ft.) long by 1.8 m (6 ft.) high monofilament experimental nets consisting of five 25 ft. panels (19 mm, 25 mm, 38 mm, 51 mm, and 76 mm) (0.75 in., 1.0 in., 1.5 in., 2 in., and 3in.) mesh. The pH was 8.5. Total alkalinity was 240 ppm and phenolphthalein was 0 ppm. Conductivity was measured at 320 μS/cm.

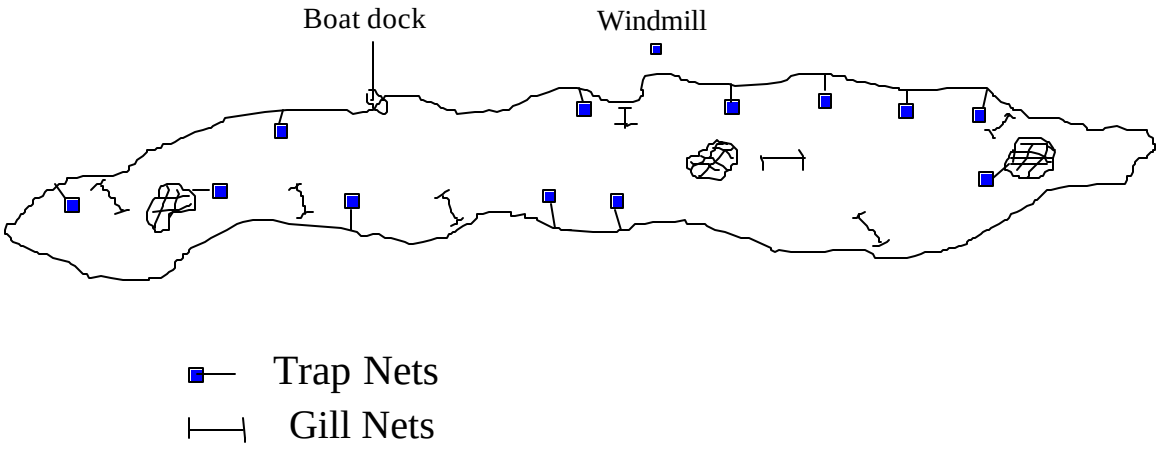

Figure 2. Trap and gill net locations on Pelican Lake, Valentine NWR in 2005.

Results and Discussion

Bluegill

Mean electrofishing mean CPUE declined in 2005 with 14.6 fish/hr compared to 83 fish/hr in 2004. However, PSD levels increased indicating recruitment into the larger length groups (Figure 3). The trend of declining mean CPUE since 2001 indicates the abundance of bluegill in Pelican Lake is declining most likely due to environmental conditions and an abundance of predators. Mean Wr were high (Table 1), similar to other Sandhill lakes.

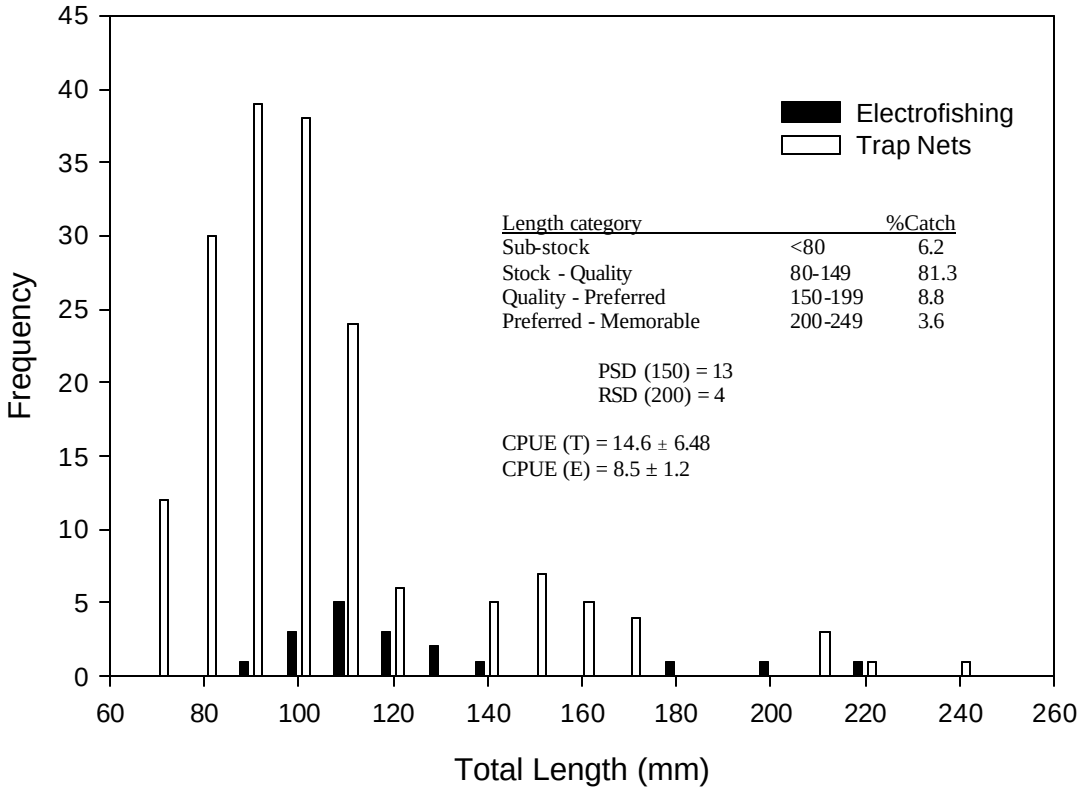

Figure 3. Bluegill length frequency distribution for Pelican Lake, Valentine NWR, 2005.

Table 1. Bluegill weights and relative weights by length group for Pelican Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<80.0	5	7	104	7.2
Stock - Quality	80.0 – 149.0	45	33	114	11.2
Quality - Preferred	150.0 – 199.0	15	106	112	13.4
Preferred - Memorable	200.0 – 249.0	7	312	126	6.1
Memorable - Trophy	250.0 – 299.0	0	0	0.0	0.0

Mean W_r = 115
N = 72

Largemouth bass

Largemouth bass mean CPUE for electrofishing declined from 48 fish/hr in 2004 to 30.5 fish/hr in 2005. PSD/RSD levels are at the appropriate levels for a largemouth bass population to be in balance (Figure 4). Mean Wr for largemouth bass is good (Table 2) and similar to other Sandhill lakes.

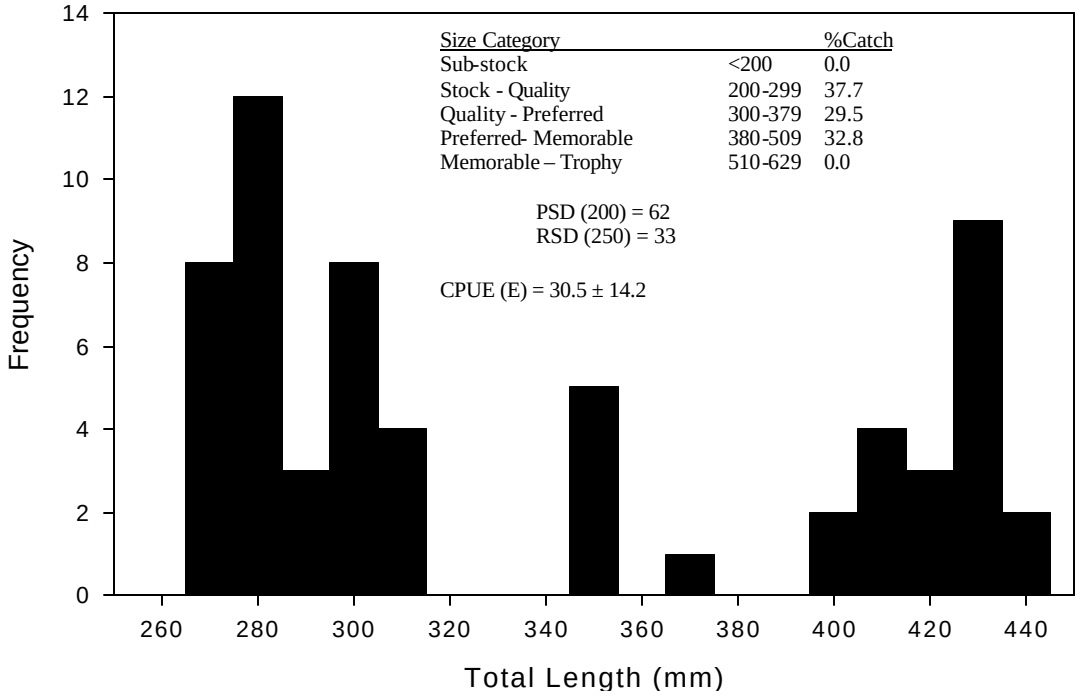

Figure 4. Largemouth bass length frequency distribution for Pelican Lake, Valentine NWR, 2005.

Table 2. Largemouth bass weights and relative weights by length class for Clear Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<200.0	24	15	138	19.0
Stock- Quality	200.0 – 299.0	15	322	102	12.7
Quality - Preferred	300.0 – 379.0	15	491	92	18.4
Preferred - Memorable	380.0 – 509.0	18	1317	113	7.5
Memorable - Trophy	510.0 – 629.0	0	0	0.0	0.0

Mean W_r = 114
N =72

Yellow perch

Yellow perch mean CPUE and PSD/RSD levels (Figure 5) are similar to previous years. An abundance of predators in Pelican Lake is probably controlling recruitment of yellow perch. Mean Wr of yellow perch (Table 3) are similar to other Sandhill lakes.

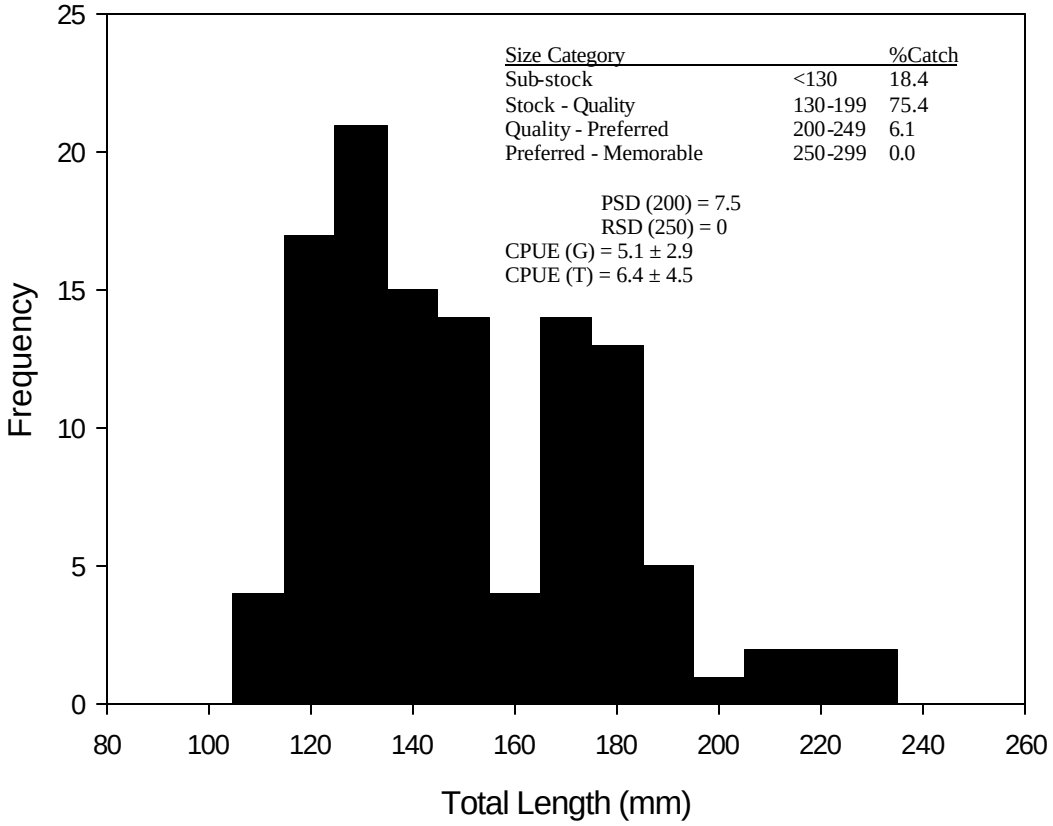

Figure 5. Yellow perch length frequency distribution for Pelican Lake, Valentine NWR, 2005.

Table 5. Yellow perch weights and relative weights by length class for Clear Lake, Valentine NWR 2003.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<130	9	22	99	6.7
Stock - Quality	130 – 199	39	61	99	6.4
Quality - Preferred	200 – 249	7	151	97	6.1
Preferred - Memorable	250 – 299	0	0	0	0.0

Mean W_r = 99
N =55

Common Carp

In 2005, carp gill net mean CPUE was 4.1 fish/net ± 1.9. In 2003, the mean CPUE was 12 fish/net which was dominated by young of the year fish. It appears that the 2003 year class did not recruit into the 2004 or 2005 fishery.

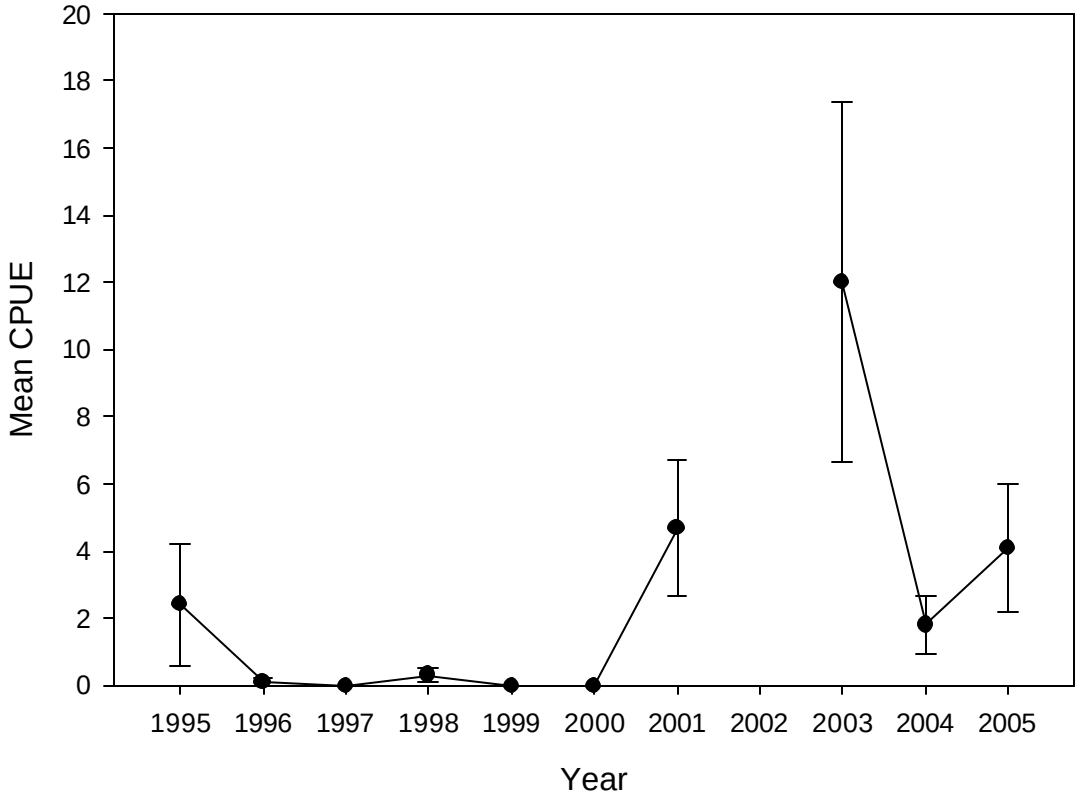

Figure 6. Common carp gill net mean CPUE with standard error bars for Pelican Lake, Valentine NWR, 1995 – 2005.

Northern Pike

Mean CPUE and PSD/RSD levels for 2005 are similar to the survey results in 2004 which are substantially lower than 2003 mean CPUE levels (Figure 7, 8, and 9). Mean Wr for the larger sized preferred and memorable length groups of northern pike were low, but similar to other Sandhill lakes (Table 6 and 7).

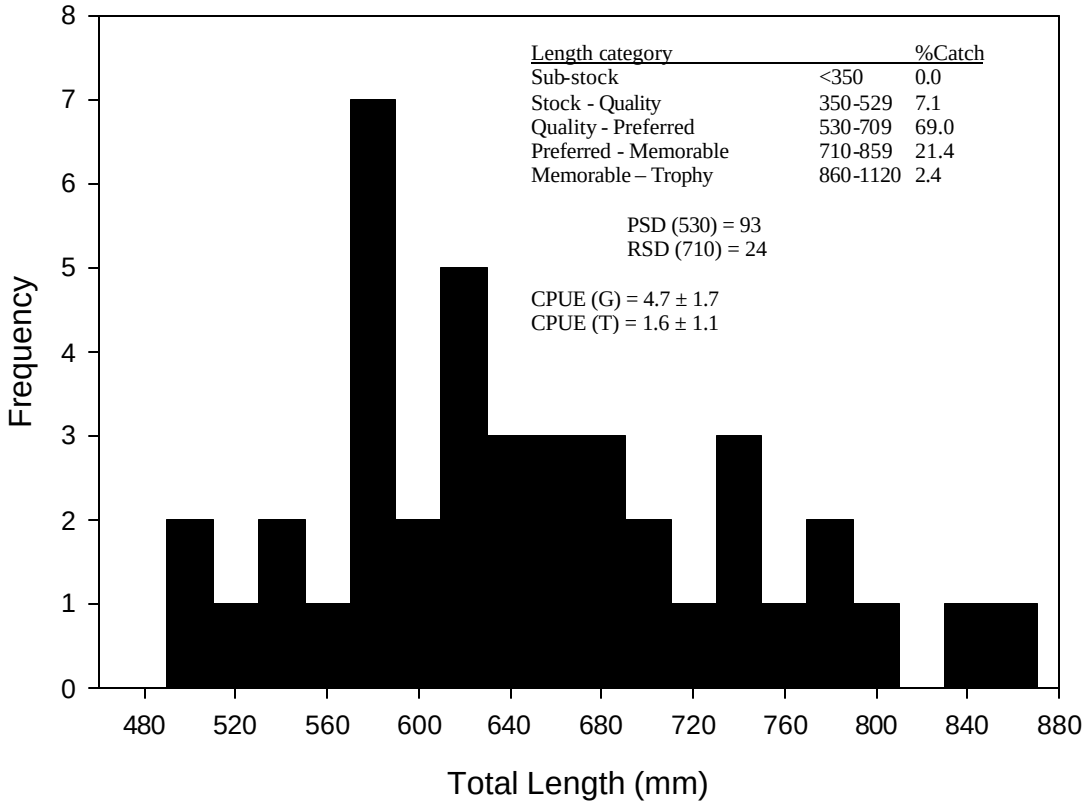

Figure 7. Northern pike length frequency distribution for Pelican Lake, Valentine NWR, 2005.

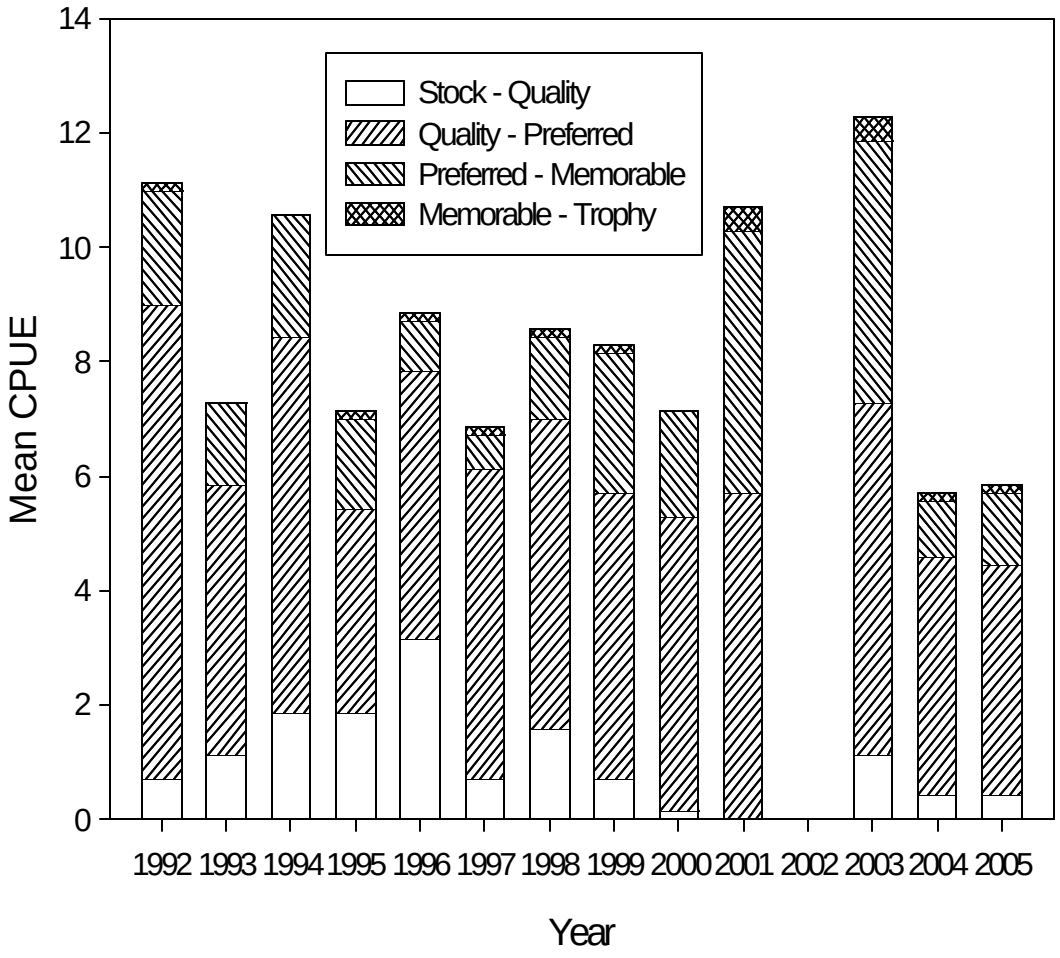

Figure 9. Gill net mean CPUE for northern pike by size category in Pelican Lake, Valentine NWR, 1992-2005. Sampling did not occur in 2002 due to low water levels.

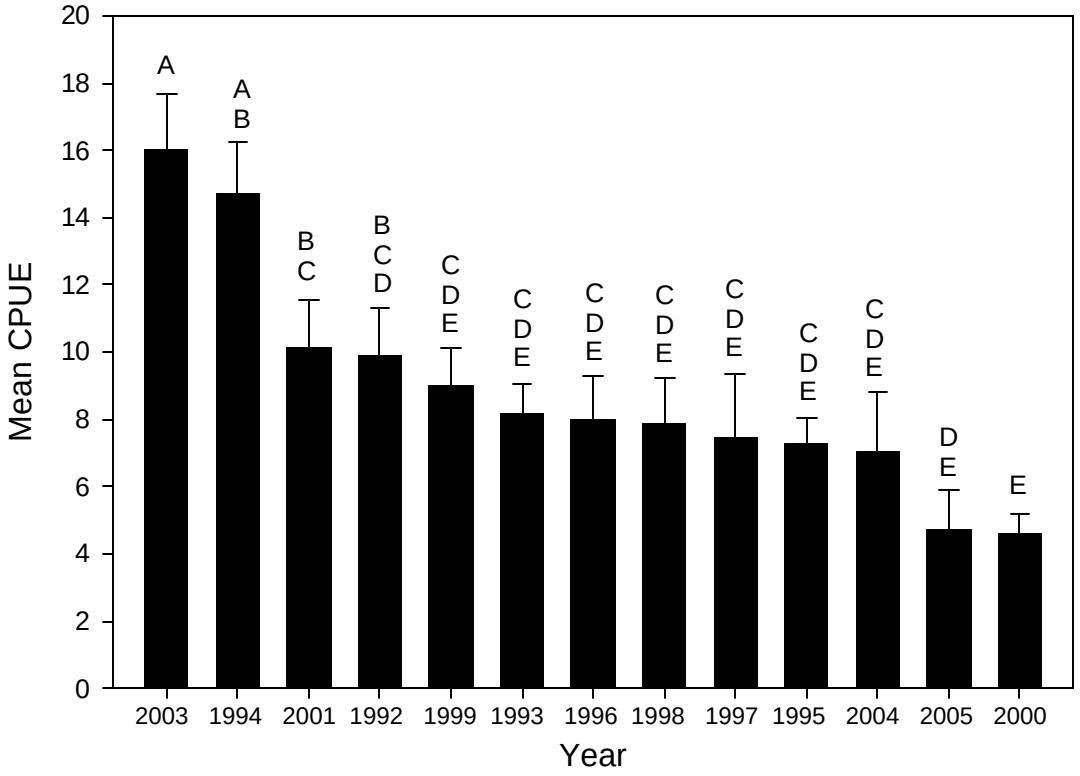

Figure 10. Northern pike gill net mean CPUE by year in Pelican Lake, Valentine NWR. Years with same letter are not different (p>20) using ANOVA with Tukey-Kramer multiple comparison test.

Table 6. Northern pike weights and relative weights by length class for Pelican Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	< 350	0	0	0	0.0
Stock - Quality	350 – 529	2	1000	108	6.9
Quality - Preferred	530 – 709	26	1639	94	5.4
Preferred - Memorable	710 – 859	9	2383	74	11.3
Memorable - Trophy	860 – 1129	1	3400	75	0.0

Mean W_r = 90
N =38

Table 7. Population size structure, traditional proportional stock density (PSD) and incremental relative stock density (RSD) with relative weights (*Wr*) of northern pike in Pelican Lake, Valentine NWR. Data are pooled for trap and gill nets and summarized by length groups with confidence intervals (±). a denotes small sample size confidences intervals could not be calculated.

Year	% > Stock		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	*Wr*	RSD	±	*Wr*	RSD	±	*Wr*	RSD	±	*Wr*	RSD	±	*Wr*
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
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

Summary

Bluegill – As with other lakes sampled on Valentine NWR, mean CPUE has declined compared to recent years most likely due to low water levels which is limiting spawning and recruitment success. An abundance of large predators has likely controlled bluegill abundance. Mean Wr levels were similar to other Sandhill lakes.

Yellow perch – Perch mean CPUE was similar to past years. Mean Wr levels were similar to other Sandhill lakes.

Largemouth bass – The largemouth bass population is in balance with PSD at 62 and RSP-P of 33. However, there was a substantial decline in mean CPUE electrofishing compared to 2004. Mean Wr levels indicate an abundance of prey for largemouth bass in Pelican Lake.

Common carp – After a substantial increase in gill net mean CPUE in 2003 consisting mainly of young of the year fish, mean CPUE has substantially declined in 2004 and 2005 indicating low carp recruitment. Large predators are most likely doing a good job of controlling carp recruitment even when carp successfully spawn.

Northern pike – The 2005 mean CPUE was similar to 2004 but still substantially lower than 2003. The 2005 mean CPUE is one of the lowest levels since surveys began in 1992 in Pelican Lake. Low water levels have probably reduced spawning success of northern pike. The northern pike population in Pelican Lake showed and incremental decline in mean Wr values as fish of attain greater lengths have substantially lower Wr values. However, this is a similar trend of most Sandhill lakes.

Management Recommendations

1. Conduct creel surveys to measure angler harvest of bluegill and northern pike.

2. Conduct public opinion polls to determine how best to manage the Pelican Lake bluegill fishery to maximize public satisfaction.

3. Continue to evaluate northern pike regulations.

4. Conduct electrofishing sampling in the spring when water levels are generally higher to effectively sample the shoreline.

5. Improve west boat ramp.

DUCK LAKE

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

Carp have not been identified in Duck Lake and chemical renovations have not been necessary. A ditch connects Duck and Rice Lakes, but other than this, the lake is a closed system with no water control structures or draw down capabilities. A small area on the west end of the lake is on private land, but the lake has none the less been managed by the U.S. Fish & Wildlife Service.

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

The bottom is relatively flat and highly organic around the edge. About 90% of the bottom is sand and 10% organic silt. Rocky areas are located on the south side and north east corner and during spring largemouth bass generally congregate in these areas to spawn. The lake's shallow depth makes it susceptible to winter-kills, but underground springs appear to moderate the kill occurrences. Emergent vegetation, predominately cattail, bulrush, and scattered areas of phragamites form a ring around most of the lake. During summer, submergent vegetation, narrow & curly leaf pond weed, millfoil, coontail, and duck weed cover about 100% of the lake.

Conductivity averages 350 μS/cm at 25^{0}C; total alkalinity averages 120 and phenolphthalein alkalinity is 0 ppm. The lake's pH ranges from 8.5 during winter/spring to 10 during summer. Secchi disc readings average 2.0 m and turbidity reaches 1.2 NTU on windy days. The lake is too shallow to develop a thermocline and summer surface water temperatures reach 30^{0}C.

METHODS

Night time electrofishing was conducted 14 June 2005 and trap and gill nets were set 23 August 2005. Water temperature was 19 ^{o}C while electrofishing and 23^{o}C during the netting operation.

Electrofishing was conducted for 0.75 hours after dusk with a Smith and Root 5.0 GPP electrofishing system using 200 volts pulsed DC, 9 amps, and a pulse frequency of 120 cycles per second (cps). Electrofishing was conducted in 15 minute transects along the shoreline. Five trap nets and 3 gill nets were set perpendicular to the shore for 24 hours (Figure 1). Trap nets had 13-mm (0.5 in.) mesh, single throats, with 15.2-m (50 ft.) leads. Gill nets were 38.1 m (125 ft.) long by 1.8 m (6 ft.) high monofilament experimental nets consisting of five 25 ft. panels (19 mm, 25 mm, 38 mm, 51 mm, and 76 mm) (0.75 in., 1.0 in, 1.5 in., 2 in., and 3 in.) mesh. The pH was 7.1. Total alkalinity was 290 ppm and phenolphthalein was 0 ppm. Conductivity was measured at 260 μS/cm.

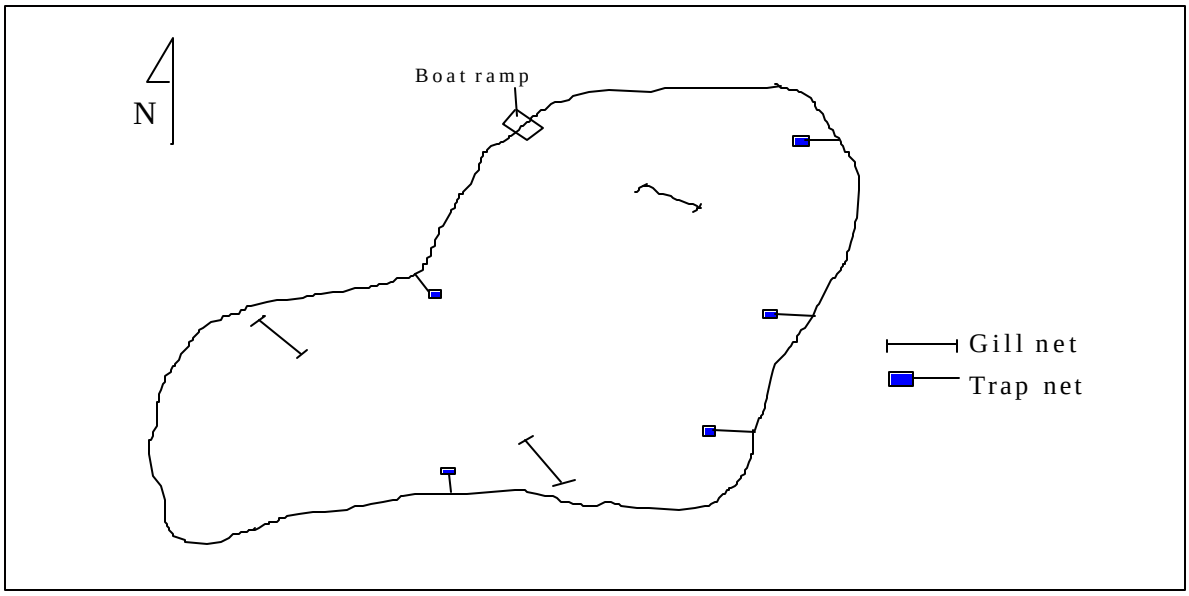

Figure 1. Net locations and electrofishing transects for Duck Lake.

RESULTS AND DISCUSSION

Largemouth bass

Mean CPUE was 29.3 fish/hr ± 6.6 which is not substantially different from the 2001 mean CPUE when the last survey was conducted. In 2001, the mean CPUE was 33 fish/hr. Largemouth bass mean CPUE for stock length bass was 18 fish/hr in 1993 and 19 fish/hr during the 1995 survey. The very high PSD/RSD-P values (Figure 2) indicate variable recruitment. Relative weights are at or above average (Table 1) for all length groups, which are typical for largemouth bass in Sandhill Lakes.

Table 1. Largemouth bass weights and relative weights by length class for Duck Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<200.0	17	9	136	18.1
Stock - Quality	200.0 – 299.0	4	404	119	14.6
Quality - Preferred	300.0 – 379.0	4	538	112	22.5
Preferred - Memorable	380.0 – 509.0	25	1181	104	26.7

Mean W_r = 117
N = 50

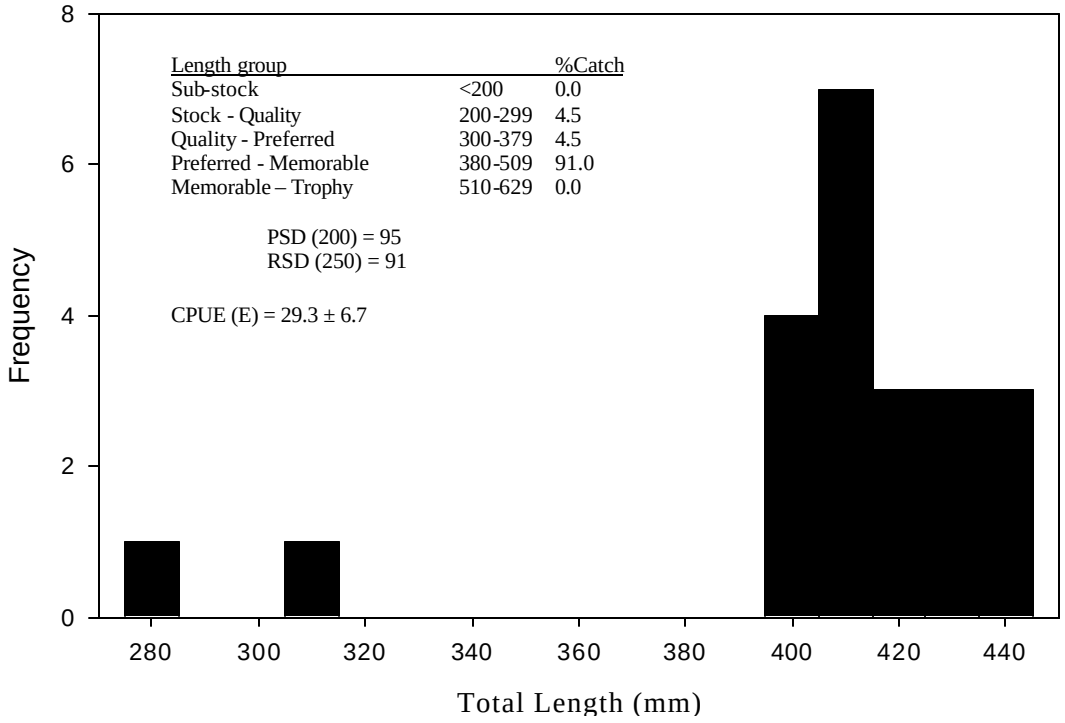

Figure 2. Largemouth bass length frequency for Duck Lake, Valentine NWR, 2005.

Bluegill

Mean CPUE in 2005 was 2.6 fish/trap net. In 2001, trap net mean CPUE was 11 fish/net. No bluegills were captured by electrofishing in 2005. Electrofishng mean CPUE in 2001 was high at 46 fish /hr, but most bluegills were of stock – quality length or smaller. This suggests that bluegill are spawning but are not recruiting to larger sizes due to predation or over harvest by anglers. Relative weights are high for all length groups (Table 2), which is typical for Sandhill lakes.

Table 2. Bluegill mean *Wr* by length class for Duck Lake, Valentine NWR 2005.

Length group (mm)		Frequency	Mean weight (g)	Mean W_r	SD W_r
Sub-stock	<80	0	0	0	0.0
Stock - Quality	80 – 149	11	29	112	5.3
Quality - Preferred	150 – 199	1	150	129	0.0

Mean W_r = 113
N = 12

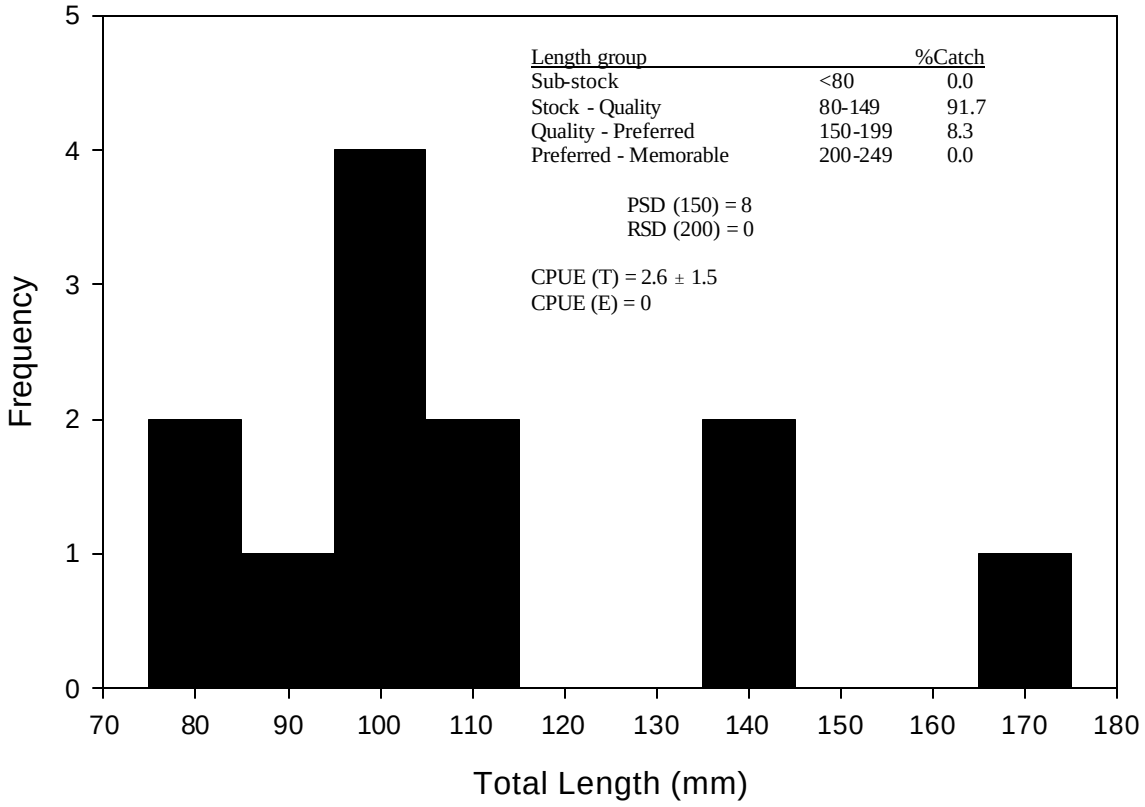

Figure 4. Bluegill length frequency for Duck Lake, Valentine NWR, 2005.

Yellow Perch

In 2005, only seven yellow perch were captured in gill nets. Mean CPUE in 2005 was 1.7 fish/gill net. Mean Wr was 97 which is similar to other sandhill lakes. Yellow perch gill net CPUE for 2001 was 7.0/net. PSD/RSD values in 2001 indicated the population was not balanced and the fish are not reaching lengths preferred by anglers.

Pumpkinseed Sunfish

Mean CPUE was 2.2 fish/trap net in 2005. This is the first year in our surveys that pumpkinseed were captured in Duck Lake. All fish captured were stock – quality length group or smaller.

Summary

Largemouth bass appear to have variable recruitment which makes them susceptible to over harvest. The variable recruitment is likely related to the limited spawning habitat. There is a low abundance of bluegills which may be the result of largemouth bass predation or more likely due to low water levels in recent years. Pumpkinseed sunfish were captured in trap nets for the first time in Duck Lake. All were in the stock – quality length group and smaller and do not provide angler opportunities at this time. Yellow perch are not abundant, but provides some recreational opportunities and produces fish of sizes acceptable to anglers. Sauger X walleye hybrids (saugeye) were stocked during 1994 and 1995, but survival appears low as no saugeye were captured in the 2001 or 2005 surveys.

MANAGEMENT RECOMMENDATIONS

1. Continue biannual surveys in the spring before lake is overgrown with vegetation.

2. Get your float tube and fish this lake in the spring.

WATTS LAKE

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

Watts Lake was last renovated during 1976 and restocked the following year. No carp have been detected since the renovation until one was captured in 2005. Watts Lake was designated as a brood stock lake for muskie and largemouth bass and they are managed as a catch-and-release fishery. During 1987, the lake was opened to musky and largemouth bass harvest. The muskie were more susceptible to harvest than predicted and many were harvested. The 1987 and 1988 winter was severe and a limited winter kill was noted. The following spring, nine muskie were reported dead by anglers and the regulations were rescinded. Watts Lake remains a catch-and-release muskie and largemouth bass fishery. An over abundance of slow growing yellow perch were noted during 1989 surveys and 80 male northern pike were transplanted in an attempt to control yellow perch recruitment for improved growth rates and size class distribution. The 1992 surveys did not indicate that the northern pike had controlled yellow perch recruitment so saugeye (i.e., sauger X walleye hybrids) were stocked during 1994, 1995, and 1996 (Appendix A) to add additional predators.

The fishery now includes yellow perch, largemouth bass, bluegill, muskie, grass pickerel, northern pike, saugeye, and common carp.

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

Conductivity averages 400 μS/cm at 25^0 C; total alkalinity averages 170, and phenolphthalein alkalinity is 0 ppm. The lakes pH ranges from 8.5 during spring to 10.5 during late summer. Secchi disk reading average 1 m and limited more by phytoplankton than turbidity. The lake is too shallow to develop a summer thermocline.

WATTS LAKE CONTOUR MAP

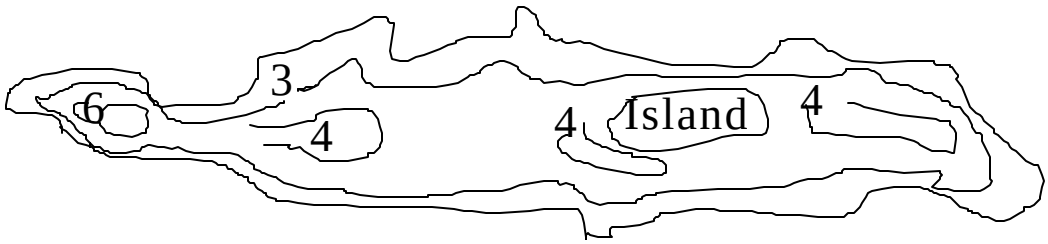

Figure 1. Contour map of Watts Lake at full pool.

METHODS

Night time electrofishing was conducted 14 June 2005 and trap and gill nets were set 22 August 2005. Water temperature was 20 ^{o}C while electrofishing and 22^{o}C during the netting operation.

Electrofishing was conducted for 1.0 hours after dusk with a Smith and Root 5.0 GPP electrofishing system using 200 volts pulsed DC, 9 amps, and a pulse frequency of 120 cycles per second (cps). Electrofishing was conducted in 15 minute transects along the shoreline. Three trap nets and 2 gill nets were set perpendicular to the shore for 24 hours. Trap nets had 13-mm (0.5 in.) mesh, single throats, with 15.2-m (50 ft.) leads. Gill nets were 38.1 m (125 ft.) long by 1.8 m (6 ft.) high monofilament experimental nets consisting of five 25 ft. panels (19 mm, 25 mm, 38 mm, 51 mm, and 76 mm) (0.75 in., 1.0 in., 1.5 in., 2 in., and 3 in.) mesh. The pH was 7.1. Total alkalinity was 290 ppm and phenolphthalein was 0 ppm. Conductivity was measured at 260 μS/cm.

Results and Discussion

Largemouth bass

In 2005, electrofishing mean CPUE was 5 fish/hr. In 2001, largemouth bass mean CPUE for electrofishing was 44/hr. Low water and possible winter/summer kills have most likely decreased largemouth bass abundance. However, four largemouth bass captured while electrofishing and eight fish captured in trap nets were in the preferred length group. Many sub-stock largemouth bass were observed in the clear water through the submergent vegetation. The mean Wr for largemouth bass was 129 for 14 fish which is above average for Sandhill lakes indicating an abundance of prey.

Bluegill

No bluegills were captured in one hour of electrofishing and one was captured in a trap net in the 2005 surveys. In 2001, mean CPUE for electrofishing was 10/hr. Bluegill abundance is low which is likely due to low water years. Possible winter/summer kills may have occurred since 2001.

Yellow Perch

In 2005, six perch were captured in gill nets and three in trap nets. All were stock length. Winter and summer kills have lowered abundance of yellow perch, but there is potential for future recruitment with higher water levels. In the whole survey conducted in 2001, only one perch was collected. This was likely due to the abundance of predators.

Saugeye (walleye X sauger hybrid)

Saugeye gill net mean CPUE was 2 fish/net indicating the stockings were successful but the population is not very abundant. This is similar to the 2 fish/gill net in the 2001 surveys. Saugeye ranged in length from 590 – 630 mm which is in the memorable size class.

Northern Pike

One northern pike 655 mm in length was captured in a gill net in 2005.

Common Carp

One sub-stock carp was captured in a gill net in 2005.

Muskie

No muskie were collected during the surveys in 2001 or 2005. Their absence from the surveys is related to their avoidance of traditional sampling gear (e.g., gill nets) and their low abundance.

Summary

Low water since 2001 has likely resulted in winter and summer kills with limited recruitment in all fish populations in Watts Lake. However, it appears that there is a low abundance of large saugeye and largemouth bass. With the low abundance of predators, panfish should recover with favorable environmental conditions next year.

MANAGEMENT RECOMMENDATIONS

1. Continue biannual surveys with electrofishing in the spring before lake is overgrown with vegetation and netting in the fall.

References

Anderson, R. O. 1978. New approaches to recreational fishery management. Pages 73-78 in G. D. Novinger and J. G. Dillard, editors. New approaches to the management of small impoundments. North Central Division, American Fisheries Society, Special Publication 5, Bethesda, Maryland.

Blackwell, B. G., M. L. Brown, D. W. Willis. 2000. Relative weight (Wr) status and current use in fisheries assessment and management. Reviews in Fisheries Science 8(1):1-44.

Gabelhouse, D. W., Jr. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Paukert, C. P. and D. W. Willis. 2003. Population characteristics and ecological role of northern pike in shallow natural lakes in Nebraska. North American Journal of Fisheries Management 23:313-322.

Wege G. J., and R. O. Anderson. 1978. Relative weight (Wr): a new index of condition for largemouth bass. Pages 79-91 in G. D. Novinger and J. G. Dillard, editors. New approaches to the management of small impoundments. North Central Division, American Fisheries Society, Special Publication 5, Bethesda, Maryland.

Appendix A. Summary of fishing regulations on the Valentine National Wildlife Refuge.

Clear Lake						
Year	Fish Species with minimum size and bag limits					
	Northern pike		Largemouth bass		Panfish*	
	Minimum size	Bag limit	Minimum size	Bag limit	Minimum size	Bag limit
1993 - present	Maximum 28 in	3	15 in & 1 > 24 in	4		30
1991-1992	36 in	3	15 in & 1 > 24 in	4		30
1990	30 in	6	15 in & 1 > 24 in	4		30
1988-1989	36 in	6	15 in & 1 > 24 in	4		30
1987	24 in	6	12"	8		No limit

Dewey and Pelican Lakes						
Year	Fish Species with minimum size and bag limits					
	Northern pike		Largemouth bass		Panfish*	
	Minimum size	Bag limit	Minimum size	Bag limit	Minimum size	Bag limit**
1993 - present	Maximum 28 in	3	15 in & 1 > 21 in	4		30
1990-1992	36 in	3	15 in & 1 > 21 in	4		30
1988-1989	36 in	6	15 in & 1 > 21 in	4		30
1987	24	6	12	8		No limit

* Panfish species include bluegill, yellow perch, black crappie, etc.
** Panfish bag limit is in aggregate.

Appendix A. Summary of fishing regulations on the Valentine National Wildlife Refuge.

Hackberry Lake						
Year	Fish Species with minimum size and bag limits					
	Northern pike		Largemouth bass		Panfish*	
	Minimum size	Bag limit	Minimum size	Bag limit	Minimum size	Bag limit**
1993 - present	Maximum 28 in	3	15 in & 1 > 21 in	4		30
1992	36 in	3	15 in & 1 > 21 in	4		30
1990-1991	24 in	3	15 in & 1 > 21 in	4		30
1988-1989	24 in	6	15 in & 1 > 21 in	4		30
1987	24 in	6	12	8		No limit

Watts Lake						
Year	Fish Species with minimum size and bag limits					
	Muskellunge		Largemouth bass		Panfish*	
	Minimum size	Bag limit	Minimum size	Bag limit	Minimum size	Bag limit**
1988 - present	Catch release		Catch release			30
1987	36 in	3	12 in	8		No limit

* Panfish species include bluegill, yellow perch, black crappie, etc.
** Panfish bag limit is in aggregate.

Appendix A. Summary of fishing regulations on the Valentine National Wildlife Refuge.

All Refuge Lakes not previously identified						
Year	Fish Species with minimum size and bag limits					
	Northern pike		Largemouth bass		Panfish*	
	Minimum size	Bag limit	Minimum size	Bag limit	Minimum size	Bag limit**
1993 - present	Maximum 28 in	3	15 in & 1 > 21 in	4		30
1990-1992	24 in	3	15 in & 1 > 21 in	4		30
1988-1989	24 in	6	15 in & 1 > 21 in	4		30
1987	24 in	6	12	8		No limit

* Panfish species include bluegill, yellow perch, black crappie, etc.
** Panfish bag limit is in aggregate.

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for Clear Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Bluegill			Black Crappie		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2005							7	140,727	FY
2004							10	4698	3.5 in
2004							10	48	AD
1996				10	45,000	1-2 in			
1991	07	6,000	FG	08	50,000	FY			
1990	07	17,000	FG						
1989	07	15,000	FG						
1988							09	750	MX

	Northern Pike								
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2005	3	50	AD						

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for Dewey Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Bluegill			Northern Pike		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2004	8	12	AD				8	195	AD
1991	07	28,000	FG	08	50,000	FY			
1990	07	28,000	FG						
1989	07	28,000	FG						

	Yellow Perch								
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2004	8	150	AD						

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for Hackberry Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Bluegill			Northern Pike		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2005				10	48,070	FG			
2005				8	100,000	FG			
2005	8	31	AD	3	128,000	FG			
2005	8	68,200	FG	2	12,780	FG			
2004				10	86,250	FG			
1996				10	75,000	1-2 in			
1992							04	1,200	MX
1991	08	35,000	FG	07	35,000	FG			
1990	07	35,000	FG						
1989	08	37,000	SA						

	Yellow Perch								
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2005	6	136,000	FY						
2005	2	19,068	FG						

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for Pelican Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Yellow perch			Bluegill		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
1996							9& 10	102,800	1-2 in
1994				04	7,000	MX			
1993				04	1,250	MX			
1991	07	40,000	FG						
1990	07	40,000	FG						
1989	07	32,000	FG						

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for Duck Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Bluegill			Yellow perch		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
1991	07	10,000	FY	08	30,000	FY	06	20,000	FY

	Sauger X Walleye Hybrid								
1995	06	4,000	1-2 in						
1994	04	4,000	FG						

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for Watts Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Muskellunge			Sauger X Walleye Hybrid		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2005	9	14,230	FG						
2005	9/28	1295	4-6 in						
1997				09	50	10 in			
1996				09	50	10 in	06	10,000	31pd 1-2
1995							06	5,000	1-2 in
1994							04	5,000	FG
1991	07	5,000	FG						
1990	07	5,000	FG						
1989	07	5,000	FG						
1988				09	29	AD			

	Bluegill			Yellow Perch					
	Month	Number	Size	Month	Number	Size	Month	Number	Size
2005	10	148,070	FG	8	19,261	FG			
1996	10	30,000	1-2 in						

Appendix B. Fish stocking history for Valentine National Wildlife Refuge Lakes. FY: Fry (Hatch to 1.49"); FG: Fingerlings (1.5" to 5.49"); SA: Sub adult (=>5.5", not sexually mature); AD: Adult (Sexually mature, regardless of size); MX: Mixed (transplanted from natural sources)

Stocking history for West Long Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Largemouth bass			Bluegill			Yellow perch		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
1996	09	70	AD brood						
1991	07	10,000	FG	08	20,000	FG	06	30,000	FG

Stocking history for Willow Lake, Valentine National Wildlife Refuge									
Year	Species stocked								
	Northern pike			Bluegill			Yellow perch		
	Month	Number	Size	Month	Number	Size	Month	Number	Size
1988	04	180,000	FY	09	116,000	FY	04	4,000	AD

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. 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 bodies ability to conduct electricity, which is dependent on the amount of ions in the water. Total dissolved solids is equal to 0.5 X Conductivity. Conductivity is a good measure of a water bodies 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.

Habitat Suitability Index (HSI): a numerical index (0 = poor, 1 = excellent) which is used to identify how well a fish species should perform in a lake or pond. The HSI value is computed using water quality and habitat conditions and evaluated how well a species can spawn, survive, and grown in a body of water.

Morphoedaphic Index (MEI): This index is used as a fish yield estimator based on average depth (X) and total dissolved solids (TDS). The formula is: MEI = X/TDS.

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 length.

Net days: A unit of time used to describe the effort required to collect a sample using Gill nets or Trap nets. For example, if 5 Gill nets were left for a 24 hour period, then 5 Gill nets days worth of effort were expended.

pH: a measure of how basic or acidic a body of water is. 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:

$$PSD = \frac{\text{number of fish greater than the minimum "quality" length}}{\text{number of fish greater than "stock" length}}$$

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 work record length and 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:

$$RSD = \frac{\text{number of fish greater than the minimum "preferred" length}}{\text{number of fish greater than the minimum "stock" length}}$$

Relative weight (*Wr*): The relative weight of a fish or group of fish is referred to as a "Wr" 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:

$$Wr = \frac{W}{Ws} \times 100$$

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 category 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 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) larger than 80 mm (3.2 inches) were weighted to the nearest gram 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.

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 two most appropriate gear for each species.

Data were pooled from nets and electrofishing to calculate proportional stock density (PSD) and incremental relative stock density (RSD) for substock, stock, quality, preferred, memorable, and trophy size categories.

Relative weight (*Wr*) values were calculated for each size category and by 10 mm length groups.

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) Calculating relative weight (Wr) assessed condition of fish by size groups.

Relative Weight (*Wr*): The relative weight of a fish or group of fish is referred to as a "Wr" value. The relative weight is a comparison of the condition of the fish in a sample and the condition of a theoretical optimum sample (Wege and Anderson 1978, Blackwell et al. 2000). The formula is:

$$Wr = \frac{W}{Ws} \times 100$$

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

3) Data were pooled from nets and electro fishing to calculate proportional stock density (PSD) and incremental relative stock density (RSD) for substock, stock, quality, preferred, memorable, and trophy size categories (Anderson 1978; Gabelhouse 1984).

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:

$$PSD = \frac{\text{number of fish greater than the minimum "quality" length}}{\text{number of fish greater than "stock" length}}$$

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:

$$RSD = \frac{\text{number of fish greater than the minimum "preferred" length}}{\text{number of fish greater than the minimum "stock" length}}$$