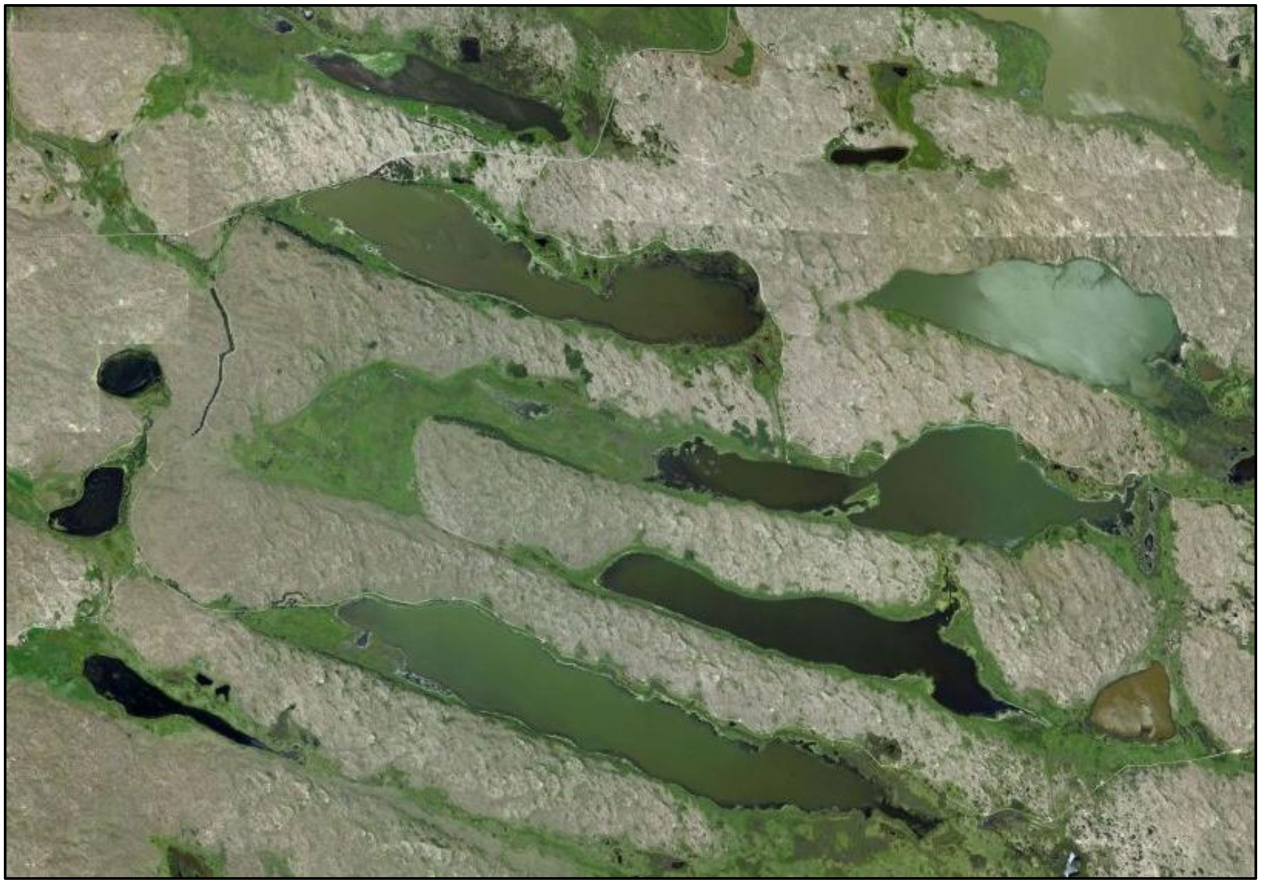
2012 FISHERIES SURVEY REPORT

VALENTINE NATIONAL WILDLIFE REFUGE, NEBRASKA



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INTRODUCTION

The Valentine National Wildlife Refuge (NWR) is located in the Sandhills region of north-central Nebraska, located about 40 km (25 miles) south of Valentine, Nebraska. The refuge was established in 1935 to provide feeding and resting areas for migrating waterfowl, but recreational activities such as hunting and fishing are permissible when not infringing on the refuge's primary objectives. Management responsibilities of fisheries on the refuge are shared by the U. S. Fish and Wildlife Service (USFWS) and the Nebraska Game and Parks Commission (NGPC) as declared in a 1978 Cooperative Agreement.

The Valentine NWR contains 39 lakes (Figure 1), nine of which support recreational fisheries and are open to fishing; these include Clear, Dewey, Duck, Hackberry, Pelican, Rice, Watts, West Long, and Willow (Figure 2). Environmental conditions in the Sandhills region fluctuate over a wide range of precipitation (i.e., wet, dry) and temperature (i.e., cold and hot) regimes. Thus, refuge lakes experience periodic winterkill, variable water levels (i.e., affecting reproduction and recruitment variability, fish movement among flooded lakes), and variable water temperatures that influences fish growth and survival.

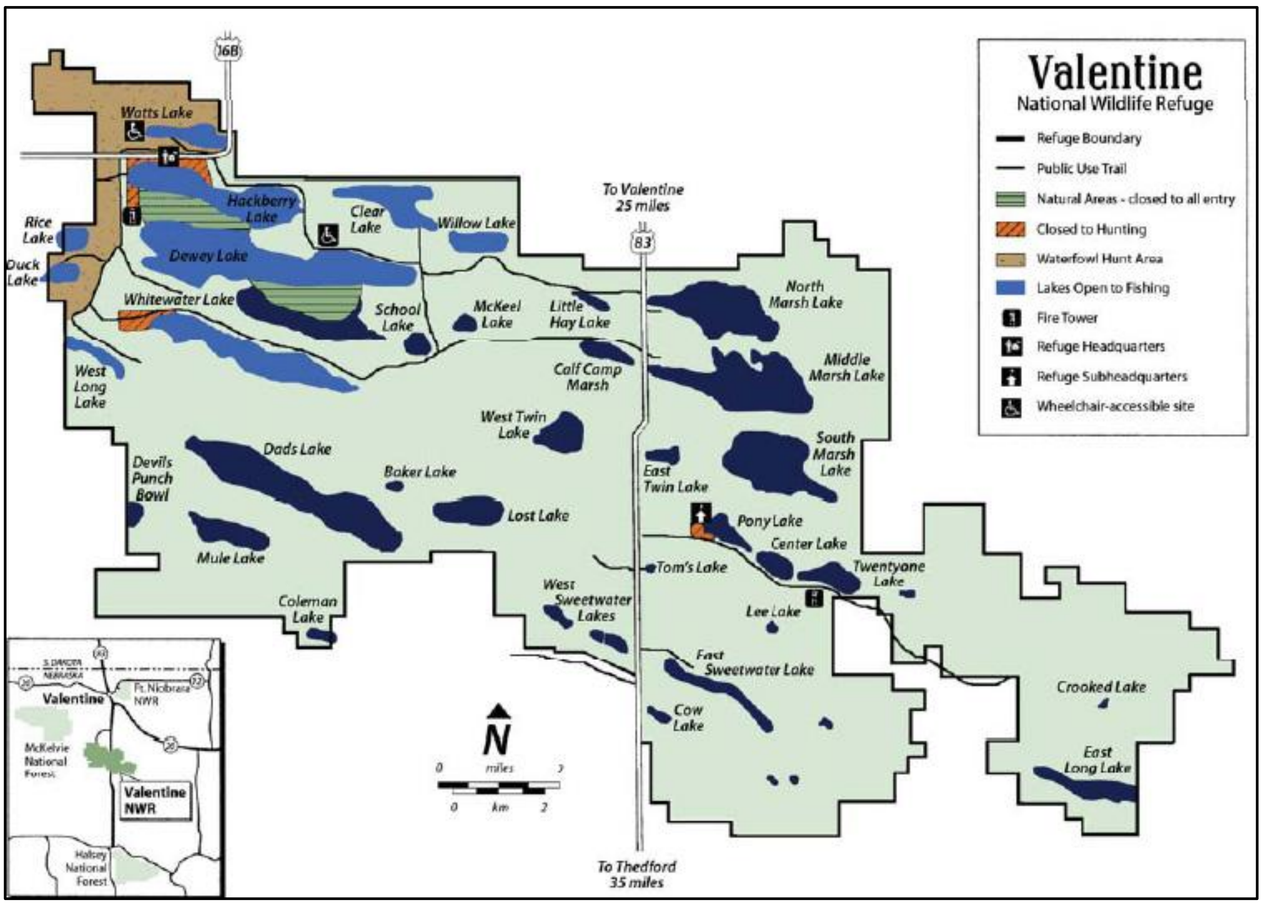


Figure Introduction-1. Map of the Valentine National Wildlife Refuge south of Valentine, Nebraska (image credit: http://www.visitvalentine.com/Attractions/VRefuge.aspx).

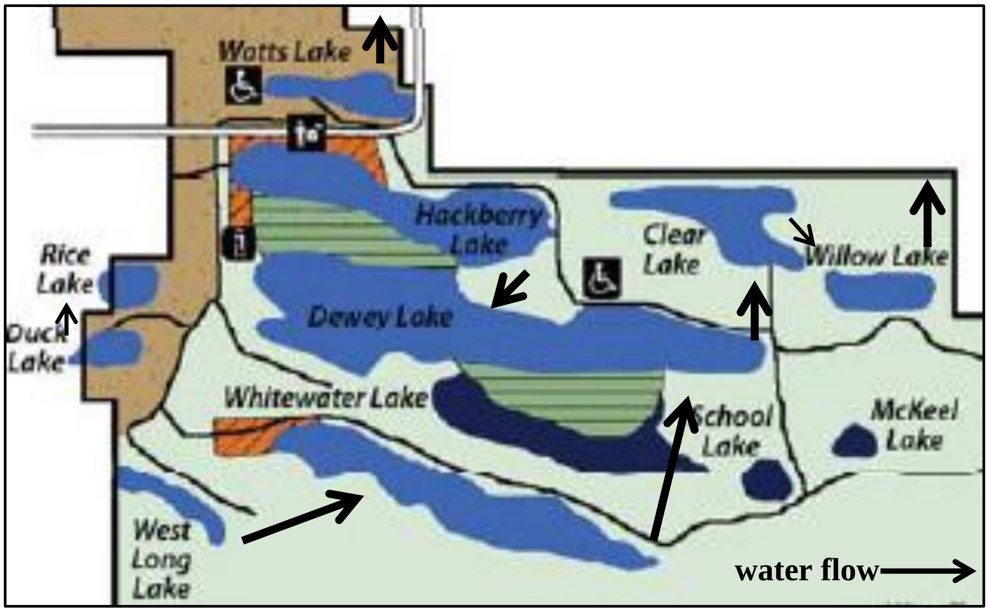


Figure Introduction-2. Map of lakes open to fishing (bright blue) in the Valentine NWR. The direction of water flow corresponds to the direction of the arrows.

Recreational fisheries at the refuge are primarily managed for largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), black crappie, (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), and northern pike (*Esox lucius*). Management of these species has been difficult due to the introduction and establishment of common carp (*Cyprinus carpio*), which gained access to the lake system through Gordon Ditch, created during the 1930's. The shallow, densely-vegetated refuge lakes provide ideal spawning habitat for carp and within 10 years of introduction, carp generally dominate the fishery.

Carp are known to degrade aquatic habitat for waterfowl (Chamberlain 1948, Robel 1961) and fish (Cahn 1929). Because of this, numerous chemical renovations have been conducted on refuge lakes with limited success. Game fish populations generally increased in quality after restocking, angling was excellent, and waterfowl use increased post-renovation, but only for about five years. Carp typically reinvaded after this time period and habitat degradation resumed.

Biological control of carp has also been attempted using northern pike. Preliminary efforts were deemed unsuccessful because the carp size structure was too large for northern pike to be effective predators. In 1988, northern pike and largemouth bass minimum length limits were enacted to increase abundance and size structure of common carp predators. Carp numbers initially stabilized in lakes where the restrictions were enacted, but periodic strong year classes have led to highly variable common carp abundance (i.e., large at times) in refuge lakes. Although northern pike management has had limited success on carp-control, northern pike have also been associated with altered abundance and size structure of largemouth bass, yellow perch, and bluegill (Paukert and Willis 2003, Paukert et al. 2003, Jolley et al. 2008).

This report summarizes the updated results (i.e., 2012 data) of fisheries lake surveys on the recreational fishing lakes on the Valentine NWR conducted by U.S. Fish and Wildlife Service fisheries biologists from the Great Plains Fish and Wildlife Conservation Office in Pierre, South Dakota.

GENERAL METHODS

Sampling

Standard gears used during annual sampling since 1992 include gill nets, trap nets, and night-electrofishing. Gill net surveys have been conducted during the late summer/early fall (August/September) since 1992. Trap net surveys had been conducted from late summer/early fall (August/September) from 1992 to 2005 but since 2006 have been completed during the late spring/early summer (May/June). From 1992 to 2004, electrofishing was completed in Clear, Dewey, Hackberry, and Pelican lakes in the fall, but has since been conducted in the late spring/early summer (May/June). In Duck and Watts lakes, electrofishing and trap net surveys have been done in the spring since 2001.

Experimental, monofilament gill nets were used that measure 38.1 m (125 ft) long and 1.8 m (6 ft) high. Each net had five, 7.6 m (25 ft) long panels including 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) bar measure (i.e., in order). Float lines were 13 mm (0.5 in) poly-foam-core and lead lines were 2.27 kg (5 pound) lead-core. Gill nets were typically set near shore with the smallest mesh closest to shore. Trap nets used during surveys were modified-fyke nets, built with two, 1.2 m (4 ft) wide, 0.9 m (3 ft) high rectangular steel frames, two, 0.9 m (3 ft) diameter circular hoops, and a 15.2 m (50 ft) long, 0.9 m (3 ft) high lead. The mesh used was 13 mm (0.5 in) bar measure green-coated, nylon mesh. Nets were set with the lead anchored perpendicular to shore for a maximum time of 24 hr. Electrofishing was conducted at night from a boat using a Smith Root model 5.0 GPP electrofishing system rated at 5,000 watts of output power and 4–6 amps pulsed DC (60 pulses per second). Electrofishing was typically conducted in 15 minute transects along the shoreline.

Select species were targeted for each gear (Bonar et al. 2009). Common carp, northern pike, yellow perch, and other fish (i.e., non-managed fish species) were targeted in gill nets; bluegill, black crappie, and other fish were targeted in trap nets; largemouth bass and bluegill were targeted during electrofishing. Beginning in 2012, all captured fish were measured for total length (TL, mm) and weighed (g). Captured fish were identified separately for each gear replicate.

Turtles are often captured in trap nets, thus monitoring of painted (*Chrysemys picta*), snapping (*Chelydra serpentina*), and blanding's (*Emydoidea blandingii*) turtles began in 2008. Turtle data is presented in Appendix 5.

Effort

Clear, Dewey, Duck, Hackberry, Pelican, and West Long lakes were surveyed in 2012 (Table 1). Trap net and electrofishing surveys were conducted from 20–23 May and gill netting was completed from 20–21 September. Due to very low water levels and boat ramp construction in September, boat access to Clear, Pelican, and West Long lakes was not possible, thus gill netting was not conducted in those lakes. Gill net surveys were conducted in Dewey, Duck, and Hackberry lakes.

Table Introduction-1. Total effort by gear in lakes sampled on the Valentine National Wildlife Refuge during 2012.

Lake	Electrofishing (minutes)	Spring trap nets (net nights)	Fall gill nets (net nights)
Clear	120	10	0*
Dewey	120	10	5
Duck	45	5	3
Hackberry	97.5	12	7
Pelican	105	12	0*
West Long	45	4	0*

* Low water level and boat ramp construction prevented boat access.

Analyses

Catch per unit effort (*C*/*f*) was assessed with number of fish (by species) per trap net night, number of fish per gill net night, and number of fish per electrofishing hour. Size structure was assessed using stock indices (i.e., proportional size distribution) and length frequency histograms. Length categories and references used for stock indices are reported in Appendix 3, Table Appendix 3-1. Condition of fish was assessed using relative weight (W_r). Standard weight (Ws) parameters and sources are reported in Appendix 3, Table Appendix 3-2. Statistical analyses were completed using Microsoft Excel and the statistics program R 2.15.2.

Water Quality

Surface water quality was measured at one site in each lake in both spring and fall. Water temperature (^{o}C), dissolved oxygen (mg/L), pH, and conductivity (µS/cm) were measured with a HACH HQ40d multi-parameter meter (HACH, Loveland, CO, USA). Phenolphthalein alkalinity (mg/L) and total alkalinity (mg/L) were measured with a HACH water quality test kit. Turbidity was quantified using a HACH 2100P Turbidometer and relative water clarity was assessed using a Secchi disk (cm). Water surface elevations were recorded and provided by U.S. FWS Refuge biologists (M. Nenneman, personal communication).

CLEAR LAKE

Lake Description

At full pool, Clear Lake has 172 surface ha (425 ac), a maximum depth of 3.1 m (10.2 ft), and a mean depth of 1.8 m (6 ft). The east end of the lake has a dike that allows for storage of about 1.2 m additional water. The additional area is primarily composed of flooded sand dunes and provides little fisheries habitat. The lake bottom is generally flat and sandy, but a small bay on the east end of the lake contains an expanse of highly organic benthos. The lake’s littoral area is limited and contains only sparse aquatic vegetation. Less than 2% of the lake area has emergent vegetation (primarily cattail *Typha* spp.) and submerged vegetation is nearly absent. Periods of high water are needed to inundate the limited shoreline vegetation to facilitate spring spawning and rearing sites for fish. The shoreline is predominately grass with few willow (*Salix spp.*) and cottonwood (*Populus deltoids*) trees.

Clear Lake is situated within a series of four lakes on the refuge connected by both natural and constructed drainages. Dewey Lake drains into Clear Lake via a constructed ditch and Clear Lake drains into Willow Lake during periods of high water. These pathways have allowed fish to move between lakes and have resulted in problems with fish management in the past.

In 1983, the lake was chemically renovated with rotenone and initially stocked with largemouth bass and black crappie beginning in 1985 and 1987, respectively (see Appendix 1). Just three years post renovation (1986), common carp were observed during lake surveys. Yellow perch were stocked in 1989, bluegills were stocked in 1991 and 1996, and northern pike were stocked from 2005 to 2009.

Primary sport fish in Clear Lake are black crappie, bluegill, largemouth bass, northern pike, and yellow perch. Black bullhead (*Ameiurus melas*) and common carp are also present. Ice fishing is popular on Clear Lake when ice conditions allow. During spring and fall months, northern pike fishing is popular. Clear Lake is easily accessible by anglers via gravel roads from County Highway 16B or U.S. Highway 83. A new, concrete boat ramp was built in 2012.

Fishing regulations in Clear Lake currently exist for northern pike, largemouth bass, and panfish (see Appendix 2). A maximum size limit of 711 mm (28 in) for northern pike (implemented in 1993) and a 381 mm (15 in) minimum for largemouth bass (since 1997) is in place. Panfish do not have a length restriction. Daily bag limits are three, four (1 > 533 mm [21 in]), and 15 for pike, bass, and sunfish, respectively.

Results and Discussion

Water quality and surface elevation

Water quality was measured (Table Clear-1) in late May, but not during the fall (September) because the boat ramp was under construction and water levels were too low to launch a boat. Generally, spring lake-surface elevation is higher than fall elevation in Clear Lake ($F_{1, 27}$=4.73; p=0.05; Figure Clear-1, top panel) and mean lake-surface elevation in the spring for 2012 was similar to past years of record. However the fall elevation reading was the second lowest on record (Figure Clear-1, top panel). The relative change in lake-surface elevation from spring to fall was the largest observed to date (Figure Clear-1, bottom panel). Clear Lake's water surface dropped >1 m over the summer, largely due to the extreme drought conditions in 2012. Overall, lake-surface elevation has been decreasing since 1992 in both the spring ($F_{1, 13}$=5.03; p=0.04; r^2=0.28) and fall ($F_{1, 11}$=9.53; p=0.01; r^2=0.46; Figure Clear-1, top panel), but the overall change in elevation from spring to fall has remained consistent ($F_{1, 11}$=0.25; p=0.62; r^2=0.02; Figure Clear-1, bottom panel).

Table Clear-1. Surface water quality values from Clear Lake, Valentine NWR from 1999 to 2012. The spring time period is denoted by 'S', fall by 'F', '.' indicates no sample, and "*" indicates water levels were too low to collect a sample.

	Temp. (°C)		Dissolved oxygen (mg/L)		Secchi depth (cm)		pH		Pheno. alkal. (mg/L)		Total alkal. (mg/L)		Conduc-tivity (µS/cm)		Tur-bidity (NTU)	
Year	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
2012	19	.*	9.0	.*	26	.*	.	.*	0	.*	171	.*	424	.*	48	.*
2011	20	25	7.9	8.8	.	61	8.8	9.1	17	0	171	291	471	492	.	.
2010	12	24	9.7	10.8	.	.	8.5	9.3	0	0	257	188	429	509	.	.
2009	19	23	8.3	8.4	119	.	8.7	8.9	26	0	220	239	535	558	.	.
2008	.	19	11.3	9.7	.	.	.	8.9	17	0	222	308	466	615	.	.
2007	19	.	8.7	.	91	.	7.0	.	17	.	308	.	666	.	.	.
2006	.	21	.	8.1	.	.	.	7.1	.	0	.	257	.	649	.	.
2005	.	22	.	.	.	.	.	7.2	.	0	.	290	.	.	.	.
2004	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2003	.	.	.	9.2	.	.	.	.	.	.	.	.	.	.	.	.
2002	.	21	.	6	.	.	.	8.1	.	0	.	513	.	500	.	.
2001	25	18	10.2	.	.	60	9	7.2	30	0	196	205	.	486	.	.
2000	.	17	.	.	.	30	.	8.4	.	0	.	308	.	590	.	.
1999	.	16	.	.	.	.	.	8.2	.	.	.	.	.	.	.	.

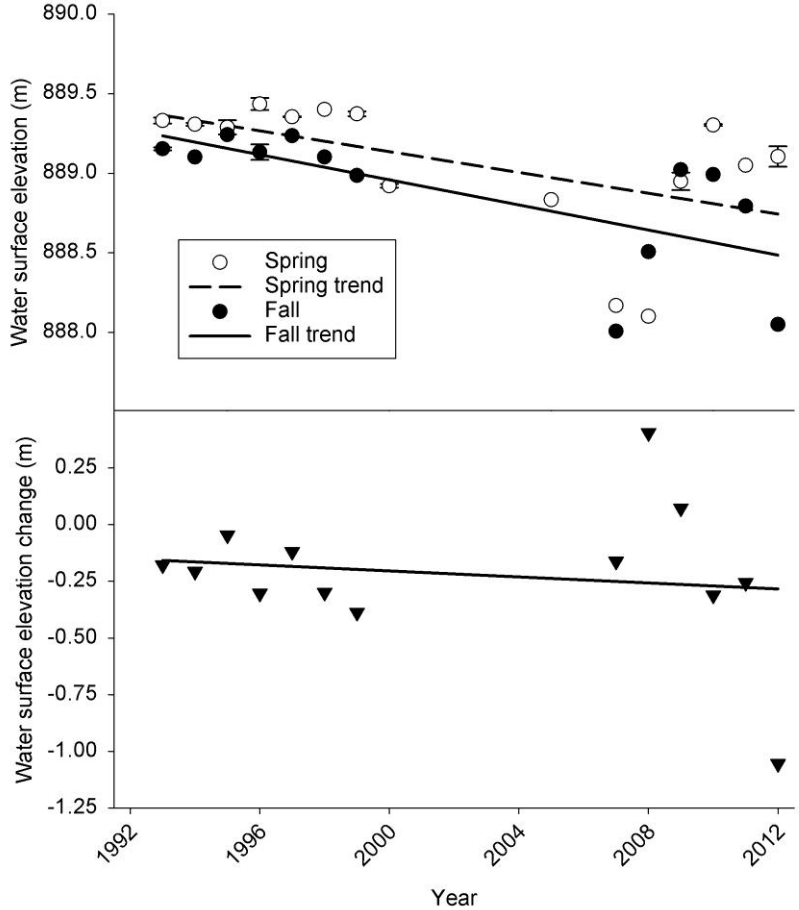


Figure Clear-1. Water surface elevation (m above mean sea level; top panel) and relative change in water surface elevation from spring to fall (bottom panel) at Clear Lake from 1992 to 2012. Mean elevation was calculated for spring (March–April) and fall (September–October) time periods. Linear regression lines are represented by solid and dashed lines. Error bars (if present) represent one standard error.

Common carp

Gill net surveys in Clear Lake were not completed because water levels were extremely low, which prevented boat access. Additionally, a new boat ramp was under construction at the time of the scheduled survey. The results from the 2011 surveys are reported here.

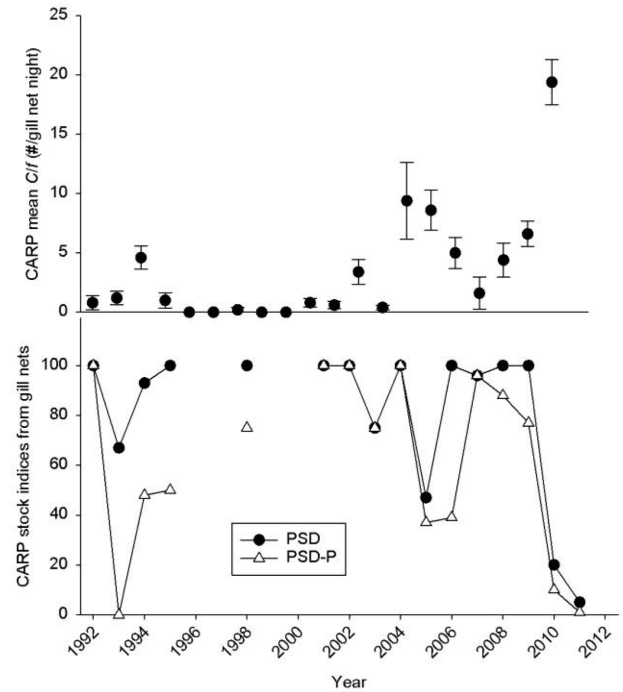


Figure Clear-2. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of common carp caught by gill nets set in Clear Lake from 1992 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

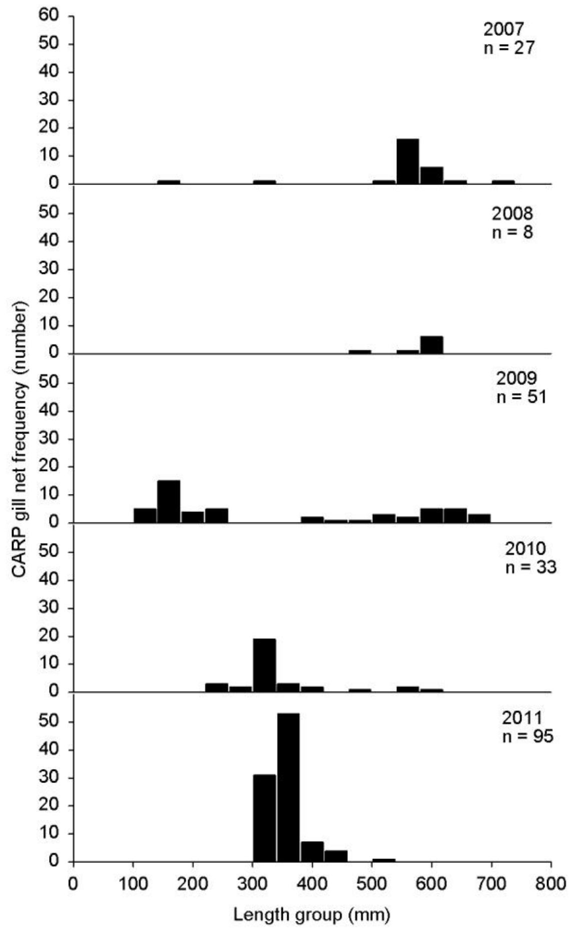


Figure Clear-3. Length frequency histograms (40 mm groups) of common carp caught by gill nets set in Clear Lake from 2007 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

Northern Pike

Gill net surveys in Clear Lake were not completed because water levels were extremely low, which prevented boat access. Additionally, a new boat ramp was under construction at the time of the scheduled survey. The results from the 2011 surveys are reported here. Also, analyses of relative abundance, stock indices, and condition trends from 1992–2011 are reported here.

Overall mean relative abundance of northern pike has not significantly changed since 1992 ($F_{1, 18}$=0.42; p=0.53; r^2=0.02; Figure Clear-4). Size structure has also remained similar to past years of record (Figure Clear-5). However, northern pike stock indices have changed since implementation of the 711 mm (28 in) maximum size limit in 1993. A significant increase in both PSD ($F_{1, 18}$=5.39; p=0.03; r^2=0.23) and PSD≥M ($F_{1, 18}$=6.08; p=0.02; r^2=0.25), but not PSD-

P ($F_{1, 18}$=2.11; p=0.16; r^2=0.10) was observed (Figure Clear-6), suggesting that the proportion of stock size northern pike in Clear Lake greater than >860 mm (34 in) has increased. Condition of northern pike has not changed for smaller ($F_{1, 18}$=0.30; p=0.59; r^2=0.02) or larger ($F_{1, 18}$=0.39; p=0.54; r^2=0.02) length fish (Figure Clear-7).

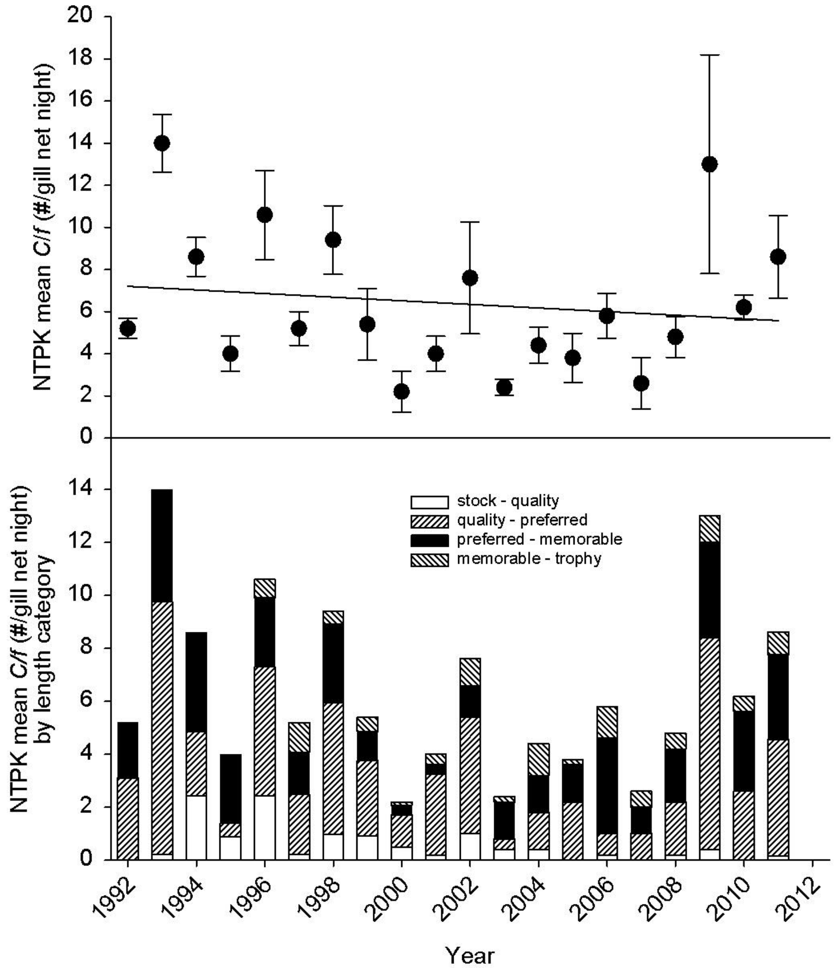


Figure Clear-4. Mean relative abundance (C/f ± 1 SE; top panel) and relative abundance by length category (bottom panel) of northern pike caught by gill nets set in Clear Lake from 1992 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

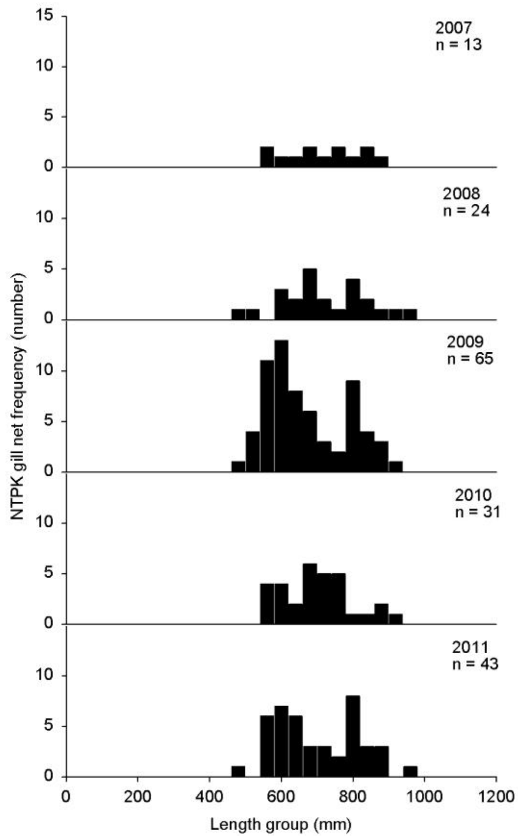


Figure Clear-5. Length frequency histograms (40 mm groups) of northern pike caught by gill nets set in Clear Lake from 2007 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

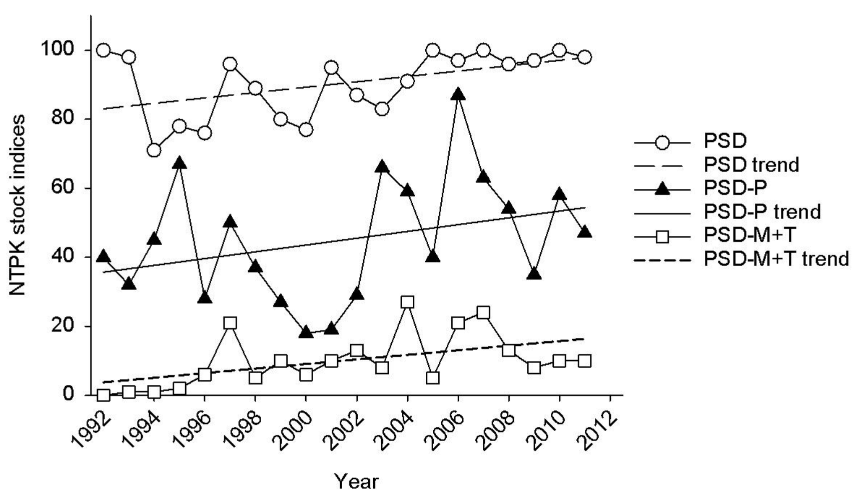


Figure Clear-6. Stock indices of northern pike caught from Clear Lake from 1992 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012. NOTE: data are pooled (trap+gill nets) from 1992 to 2005; data are from gill nets only from 2006 to present. Trends are regression lines.

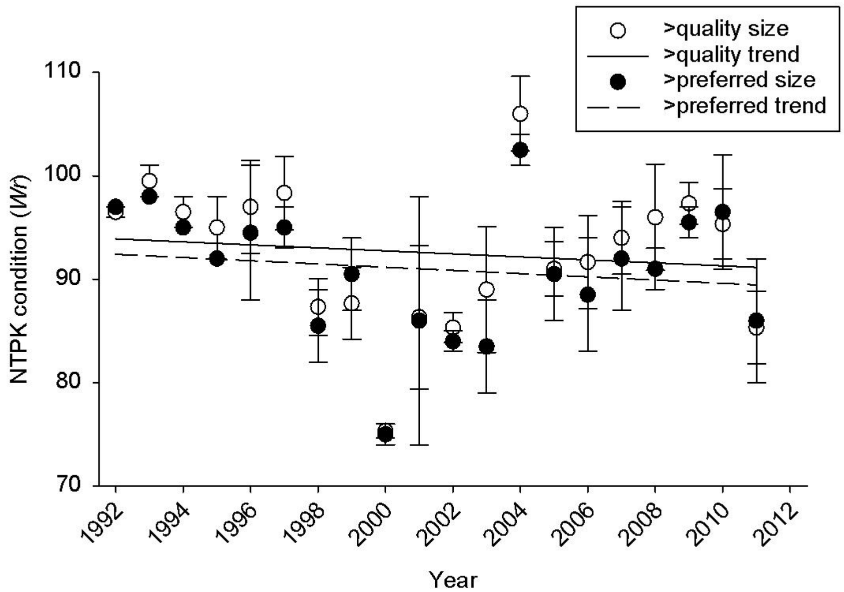


Figure Clear-7. Mean condition (W_r) of northern pike caught from Clear Lake from 1992 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012. NOTE: data are pooled (trap+gill nets) from 1992 to 2005; data from gill nets only from 2006 to present. Error bars represent ±1 SE; trends are regression lines.

Black crappie

Over 365,000 black crappie (i.e., mostly fry and fingerling) were stocked in Clear Lake from 2004 to 2006. Stock length (≥130 mm) fish were not observed until 2009 and relative abundance has remained low (Figure Clear-8). However, based on black crappie length frequencies (Figure Clear-9), natural reproduction is apparently occurring. While abundance is low, size structure is improving (Figures Clear-8 and Clear-9). Condition is satisfactory (Figure Clear-10).

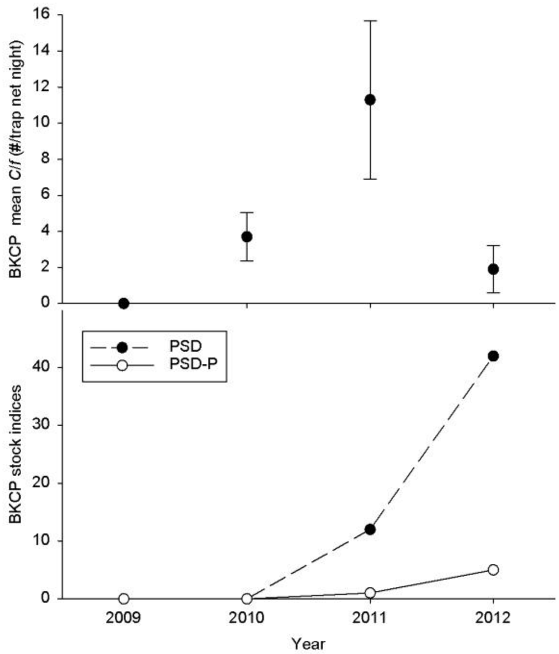


Figure Clear-8. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of black crappie caught by trap nets set in Clear Lake from 2009 to 2012.

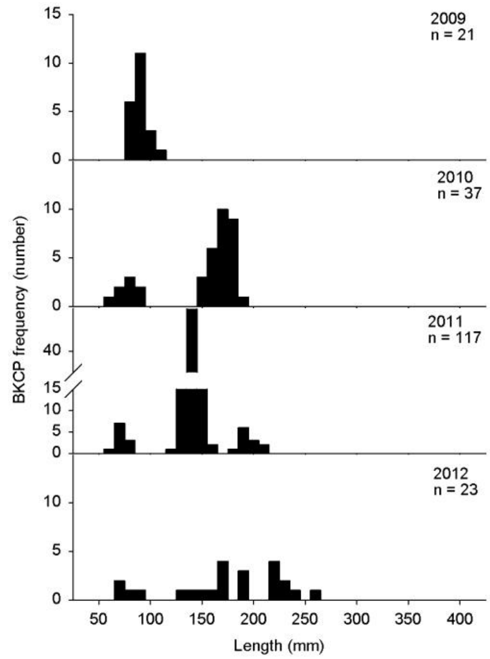


Figure Clear-9. Length frequency histograms (10 mm groups) of black crappie caught by trap nets set in Clear Lake from 2009 to 2012.

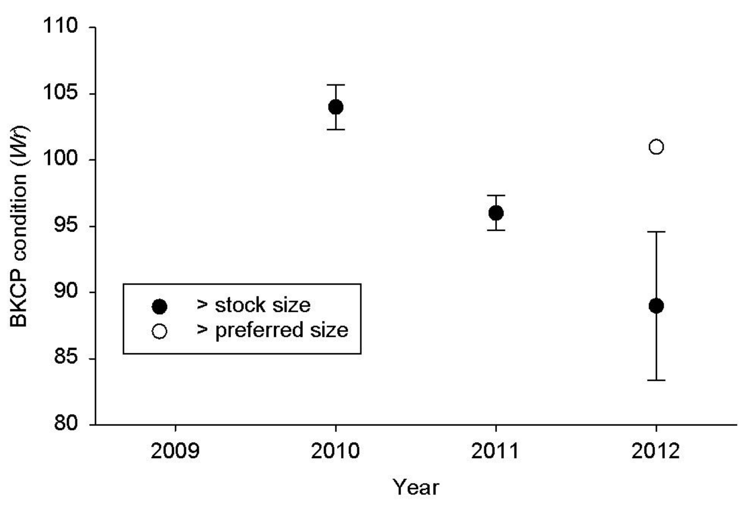


Figure Clear-10. Condition (W_r) of black crappie caught by trap nets set in Clear Lake from 2009 to 2012. Error bars represent ±1 SE.

Bluegill

Relative abundance of bluegill in Clear Lake was average (mean=29; SE=14) during 2012 (Figure Clear-11) and the size structure has increased since 2009 (Figures Clear-11 and -12). Bluegill condition was excellent (~100; Figure Clear-13).

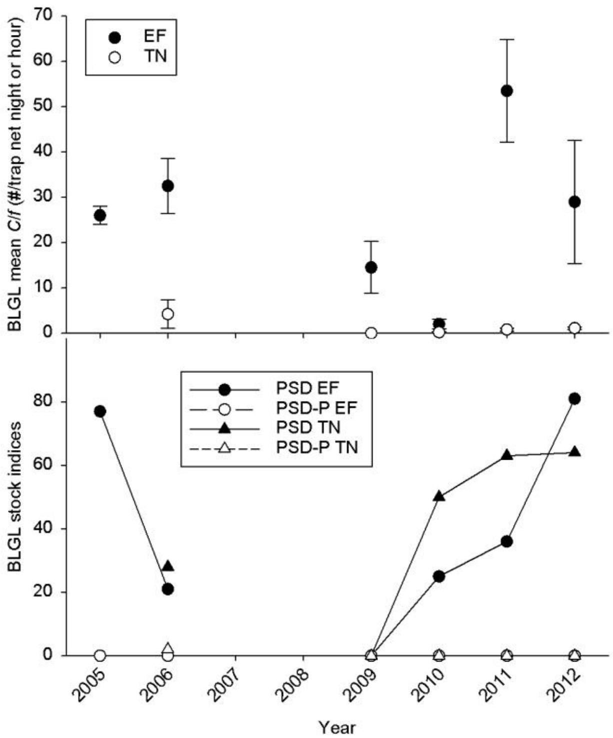


Figure Clear-11. Mean relative abundance ($C/f \pm 1$ SE; top panel) and stock indices (bottom panel) of bluegill caught by electrofishing (EF) or trap nets (TN) set in Clear Lake from 2005 to 2012. Sampling was not completed in 2007 or 2008 because of low water levels.

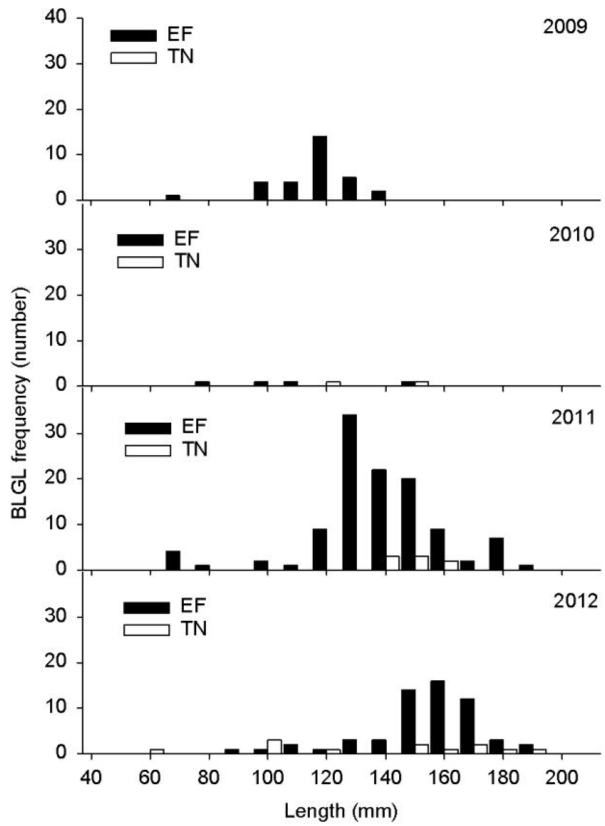


Figure Clear-12. Length frequency histograms (10 mm groups) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Clear Lake from 2009 to 2012.

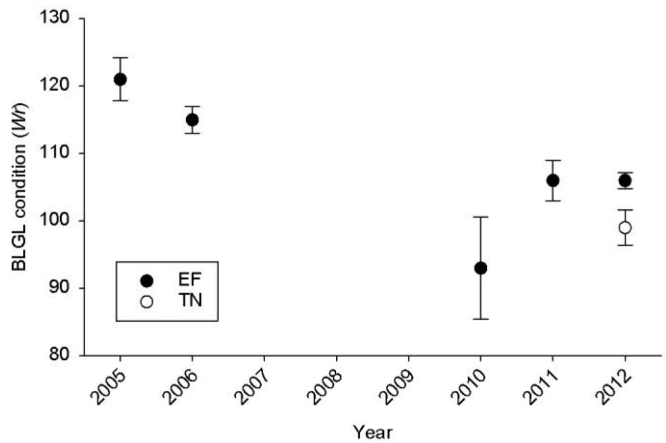


Figure Clear-13. Condition (W_r) of bluegill caught from electrofishing (EF) and trap nets (TN) set in Clear Lake from 2005 to 2012. Error bars represent ±1 SE.

Largemouth bass

Relative abundance of largemouth bass in 2012 (mean=20.0; SE=4.9) was similar to that in 2009 and 2010 (mean=14.3; SE=0.8) after decreasing from an abnormally large value in 2011 (mean=51.0; SE=8.6; Figure Clear-14). Larger fish were present in 2012 as indicated by stock indices (Figure Clear-14) and the number of fish between 300 and 400 mm (Figure Clear-15). Condition remained excellent (*Wr*>100; Figure Clear-16).

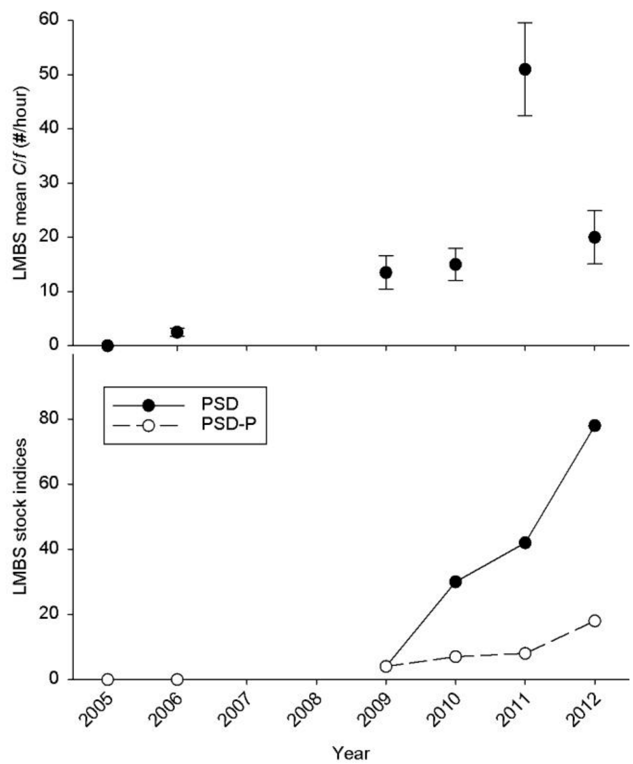


Figure Clear-14. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of largemouth bass caught by electrofishing in Clear Lake from 2005 to 2012.

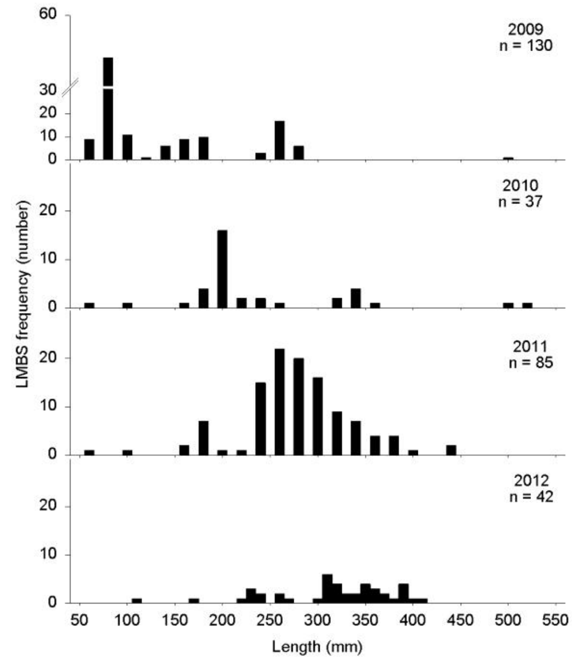


Figure Clear-15. Length frequency histograms (10 mm groups beginning 2012) of largemouth bass caught by electrofishing in Clear Lake from 2009 to 2012.

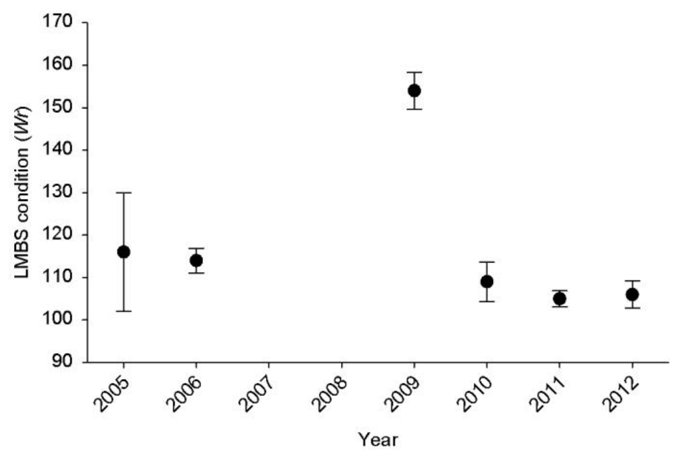


Figure Clear-16. Condition (W_r) of largemouth bass caught by electrofishing in Clear Lake from 2005 to 2012. Sampling was not completed in 2007 or 2008 because of low water levels. Error bars represent ±1 SE.

Yellow perch

Because of new boat ramp construction and very low water levels in the fall, gill net surveys were not completed. Presented are data previous to 2012.

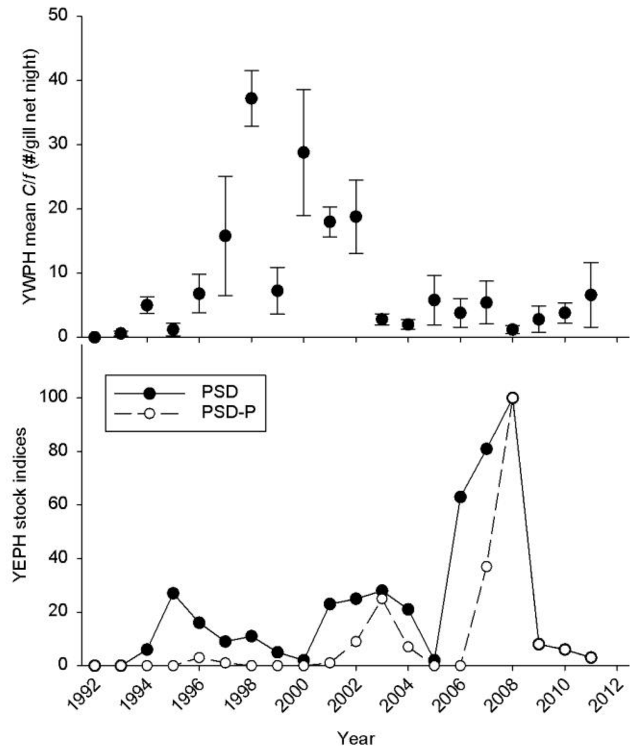


Figure Clear-17. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of yellow perch caught by gill nets set in Clear Lake from 1992 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

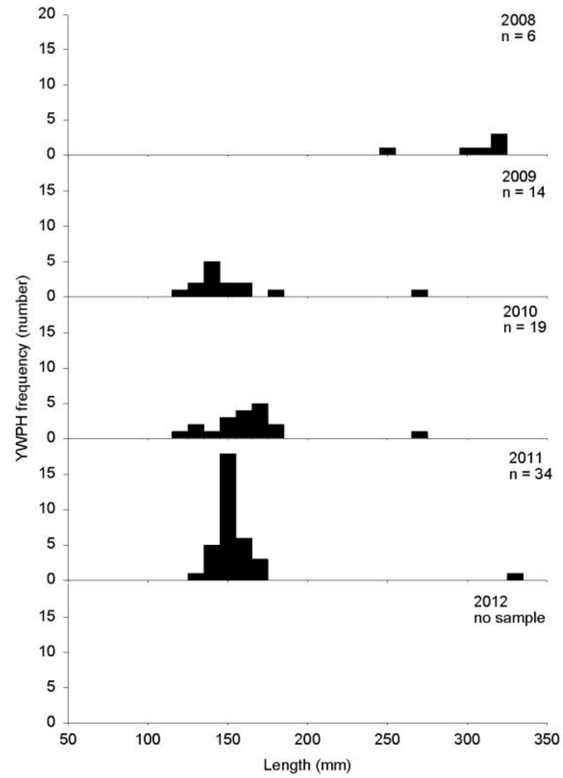


Figure Clear-18. Length frequency histograms (10 mm groups) of yellow perch caught in gill nets set in Clear Lake from 2008 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

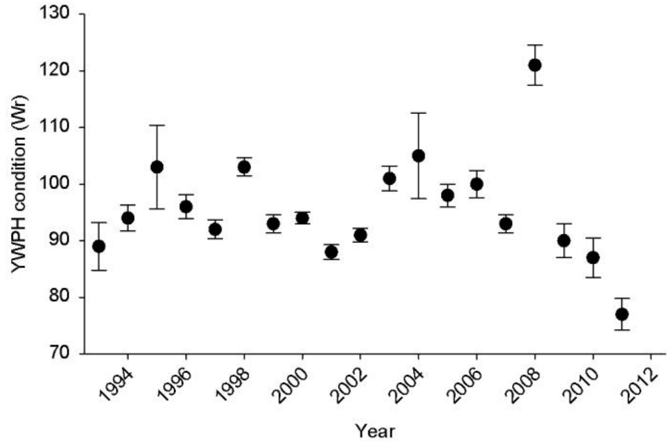


Figure Clear-19. Condition indices (W_r) of yellow perch caught by gill nets set in Clear Lake from 1992 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012. Error bars represent ±1 SE.

Management Recommendations

1. Monitor conditions for winterkill because of extremely low water levels preceding winter. Develop plan for renovation and (or) stocking should winterkill occur.

2. Maintain 28 inch maximum size limit for northern pike. Although relative abundance has not significantly changed since implementation of the regulation, size structure has significantly increased, suggesting that the regulation has had an effect.

3. Conduct fisheries surveys in 2013, particularly gill net surveys if access permits.

DEWEY LAKE

Lake Description

At full pool, Dewey Lake has 223 surface ha (551 ac), a maximum depth of 2.4 m (8 ft), and a mean depth of 1.2 m (4 ft). The east end of the lake has a dike that allows for storage of about 1.3 m additional water. Overall, the bottom is generally flat. The lake bottom on its north-east side is sandy and sparsely vegetated, but the bottom on the south-east side has an organic bottom, which contains much emergent vegetation (primarily cattail and bulrush *Scirpus* spp.). The west side of the lake has only small areas of open water. During summer, shoreline macrophytes (submerged and emergent) are abundant. Water temperatures can exceed 30 °C (86 °F) and dense algae blooms occasionally occur. The surrounding shoreline is predominately grassland with few willow and cottonwood trees.

Dewey Lake is situated within a series of four lakes on the refuge connected by natural and constructed drainages. Upstream of Dewey Lake is Hackberry Lake, which drains into Dewey Lake via a constructed ditch. Dewey Lake drains into Clear Lake through another constructed ditch. These pathways allow fish to move between lakes and have resulted in problems with fish management.

Dewey Lake was chemically renovated (rotenone) in 1981 and then periodically stocked with bluegill, largemouth bass, northern pike, and yellow perch (see Appendix 1). In 1984, an angler reported catching a common carp. During the spring of 1993, large numbers of common carp were observed in a ditch between Dewey and White Water lakes. Several tons (estimated) were removed from the ditch at that time. Large numbers of carp were also physically removed in 2008.

Primary sport fish in Dewey Lake are bluegill, largemouth bass, northern pike, and yellow perch. Black bullhead and common carp are also present. The lake receives ice fishing pressure when conditions are favorable. Angling pressure is sometimes great in the spring and fall, but declines when dense vegetation covers much of the lake. Dewey Lake is accessible by anglers from County Highway 16B or U.S. Highway 83.

Fishing regulations are in place for largemouth bass, northern pike, and panfish (see Appendix 2). Northern pike size restrictions have changed four times since 1987 in attempts to improve abundance and size structure and to predate on common carp. The current size restrictions in Dewey Lake are a maximum size limit of 711 mm (28 in) for northern pike (implemented in 1993) and a 381 mm (15 in) minimum for largemouth bass (since 2007). Panfish do not have a length restriction. Daily bag limits are three, four (1>533 mm [21 in]), and 15 for pike, bass, and sunfish, respectively.

Results and Discussion

Water quality and surface elevation

Water quality was measured in late May and September (Table Dewey-1). Generally, spring lake-surface elevation is higher than fall elevation in Dewey Lake ($F_{1, 31}$=39.32; p<0.0001; Figure Dewey-1, top panel). Mean lake-surface elevation in both the spring and fall 2012 were the lowest on record (Figure Dewey-1, top panel). The relative change in lake-surface elevation from spring to fall was the largest observed to date (Figure Dewey-1, bottom panel). Dewey Lake's water surface dropped 0.61 m over the summer, largely due to the extreme drought conditions in 2012. Overall, lake-surface elevation has been decreasing since 1992 in both the spring ($F_{1, 16}$=15.57; p=0.001; r^2=0.49) and fall ($F_{1, 12}$=15.39; p=0.002; r^2=0.56; Figure Dewey-1, top panel); the overall change in elevation from spring to fall is increasing ($F_{1, 12}$=8.47; p=0.01; r^2=0.41; Figure Dewey-1, bottom panel), suggesting that fall water levels relative to spring water levels in in Dewey Lake are increasingly lower.

Table Dewey-1. Surface water quality values at Dewey Lake from 1999 to 2012. The spring time period is denoted by 'S', fall by 'F', and '.' indicates no sample.

	Temp. (°C)		Dissolved oxygen (mg/L)		Secchi depth (cm)		pH		Pheno. alkal. (mg/L)		Total alkal. (mg/L)		Conduc-tivity (µS/cm)		Tur-bidity (NTU)	
Year	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
2012	17	17	6.3	10.2	152	20	.	9.8	0	0	120	51	308	283	6	79
2011	22	26	9.2	15.3	.	47	8.6	9.5	0	17	154	120	336	290	.	.
2010	12	22	10.4	11.3	.	.	8.5	9.7	0	34	120	86	265	274	.	.
2009	22	22	8.0	15.0	45	.	8.7	9.8	0	34	170	86	323	272	.	.
2008	13	21	10.6	20.4	.	.	.	10.0	17	51	154	120	296	315	.	.
2007	20	.	7.4	.	.	.	7.4	.	0	.	205	.	304	.	.	.
2006	.	21	.	11.7	.	.	.	8.1	.	0	.	188	.	395	.	.
2005	.	23	.	.	.	.	.	8.5	.	0	.	240	.	320	.	.
2004	.	20	.	.	.	42	.	8.7	.	0	.	139	.	.	.	.
2003	.	21	.	9.2	.	.	.	.	.	.	.	.	.	.	.	.
2002	.	21	.	9.5	.	.	.	.	.	0	.	410	.	320	.	.
2001	25	18	9.2	.	.	66	7.8	7.0	0	0	163	145	.	346	.	.
2000	.	18	.	.	.	60	.	9.5	.	0	.	308	.	344	.	.
1999	.	15	.	.	.	.	.	11.5	.	.	.	.	.	.	.	.

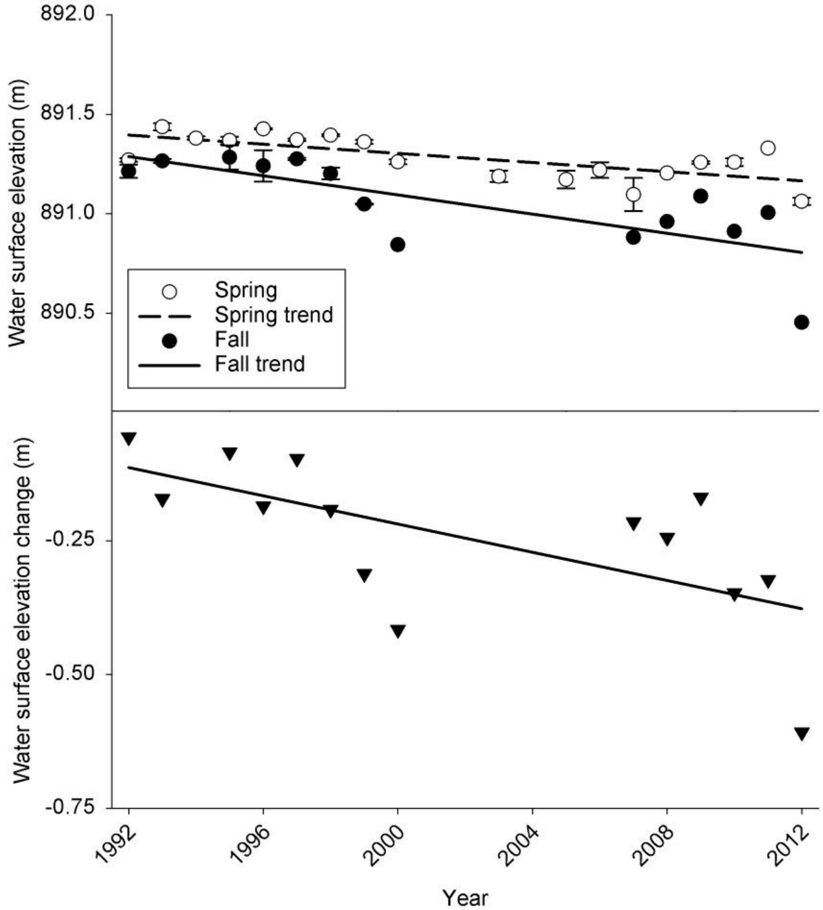


Figure Dewey-1. Water surface elevation (m above mean sea level; top panel) and relative change in water surface elevation from spring to fall (bottom panel) at Dewey Lake from 1992 to 2012. Mean elevation was calculated for spring (March–April) and fall (September–October) time periods. Solid and dashed lines represent regression lines. Error bars (if present) represent one standard error.

Common carp

Relative abundance of common carp in 2012 (mean=1.4; SE=0.4) is similar to the past four years (mean=1.4; SE=0.2; Figure Dewey-2). Unlike the past three years of sampling, a smaller year class (~200 mm TL) of common carp was observed, suggesting new recruitment of adults into the population (Figure Dewey-3).

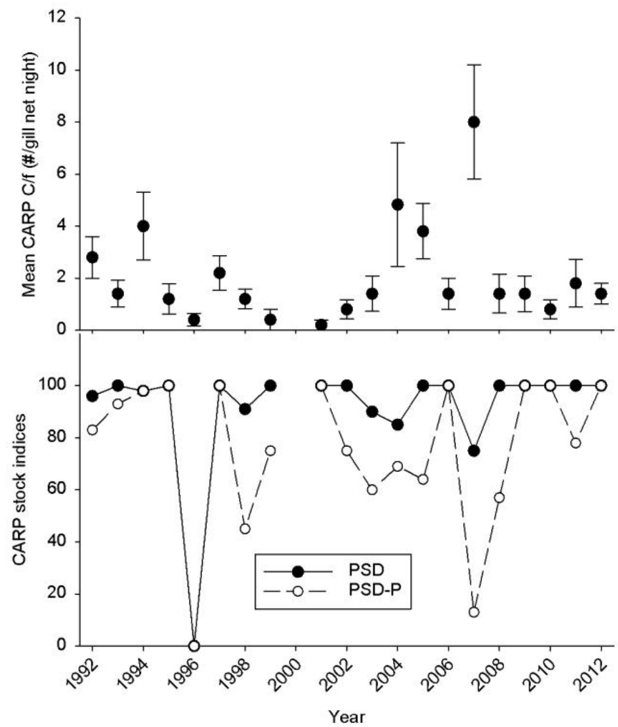


Figure Dewey-2. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of common carp caught by gill nets set in Dewey Lake from 1992 to 2012.

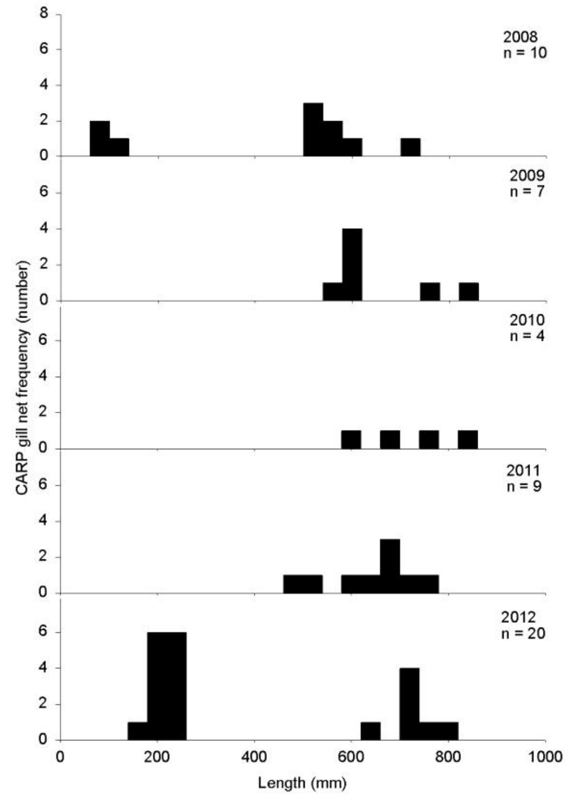


Figure Dewey-3. Length frequency histograms (40 mm groups) of common carp caught by gill nets set in Dewey Lake from 2008 to 2012.

Northern pike

Overall mean relative abundance of northern pike has not changed since 1992 ($F_{1, 19}$=0.42; p=0.53; r^2=0.02; Figure Dewey-4). Size structure has also remained similar to past years of record (Figure Dewey-5). Northern pike stock indices have remained largely unchanged since implementation of the 711 mm (28 in) maximum size limit in 1993, except for fish > memorable length (i.e., 860 mm; 34 in). Both PSD ($F_{1, 19}$=0.13; p=0.72; r^2=0.01) and PSD-P ($F_{1, 19}$=0.88; p=0.36; r^2=0.04) has not changed, but PSD≥M has increased ($F_{1, 19}$=18.83; p<0.01; r^2=0.50; Figure Dewey-6), suggesting that the regulation may have contributed to an increase in the proportion of larger northern pike in Dewey Lake. Condition of northern pike has not changed for smaller ($F_{1, 19}$=0.66; p=0.43; r^2=0.03) or larger ($F_{1, 19}$=2.38; p=0.14; r^2=0.11) length fish (Figure Dewey-7).

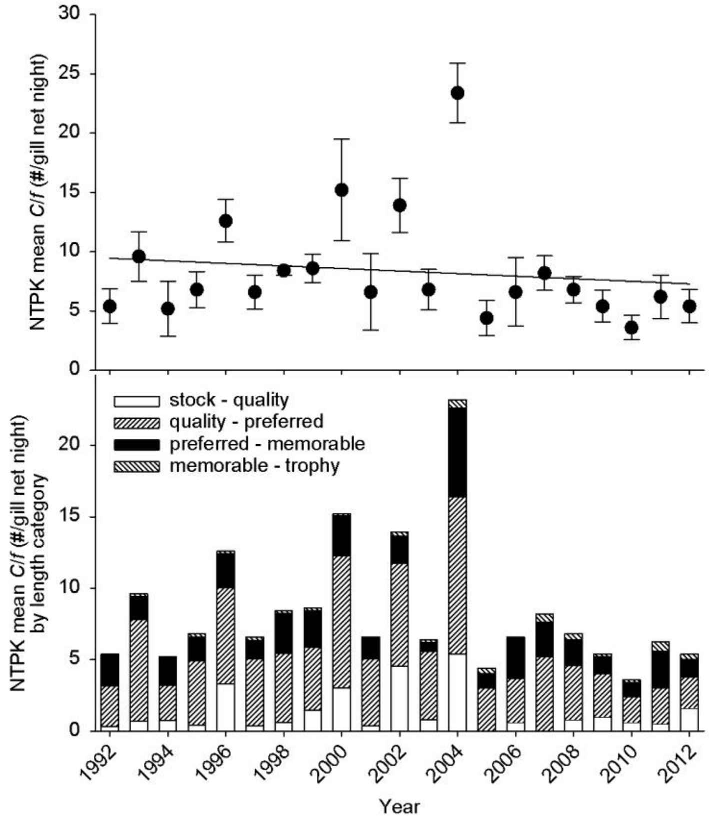


Figure Dewey-4. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and relative abundance by length category (bottom panel) of northern pike caught by gill nets set in Dewey Lake from 1992 to 2012.

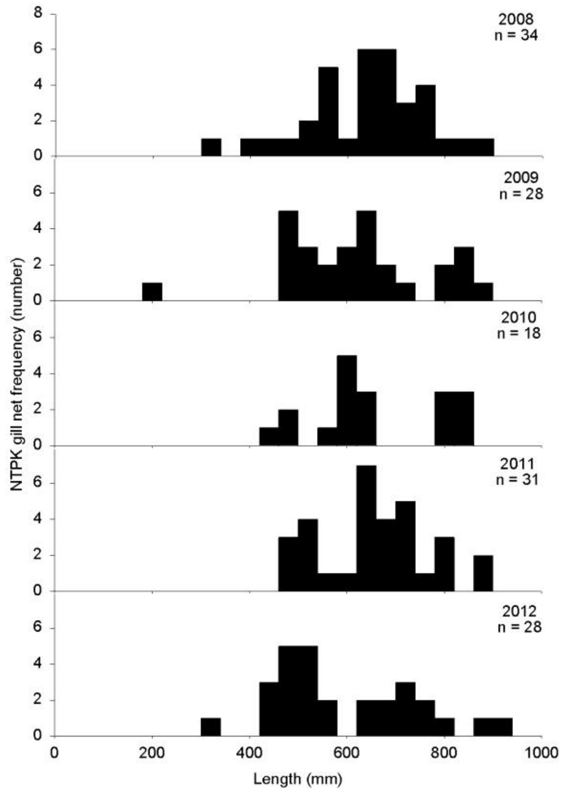


Figure Dewey-5. Length frequency histograms (40 mm groups) of northern pike caught by gill nets set in Dewey Lake from 2008 to 2012.

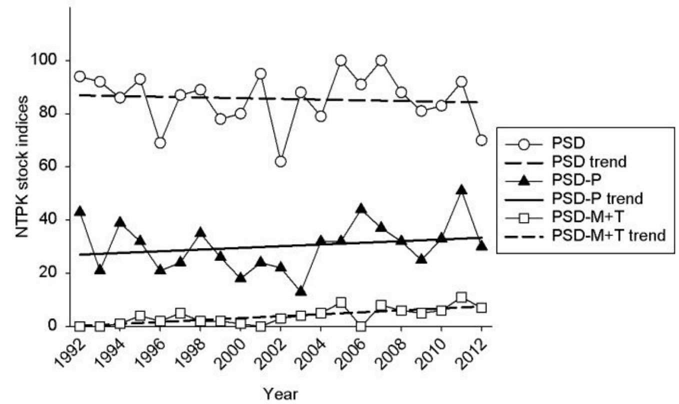


Figure Dewey-6. Stock indices of northern pike caught in Dewey Lake from 1992 to 2012. NOTE: data are pooled (trap+gill nets) from 1992 to 2005; data are from gill nets only from 2006 to present. Trends are regression lines.

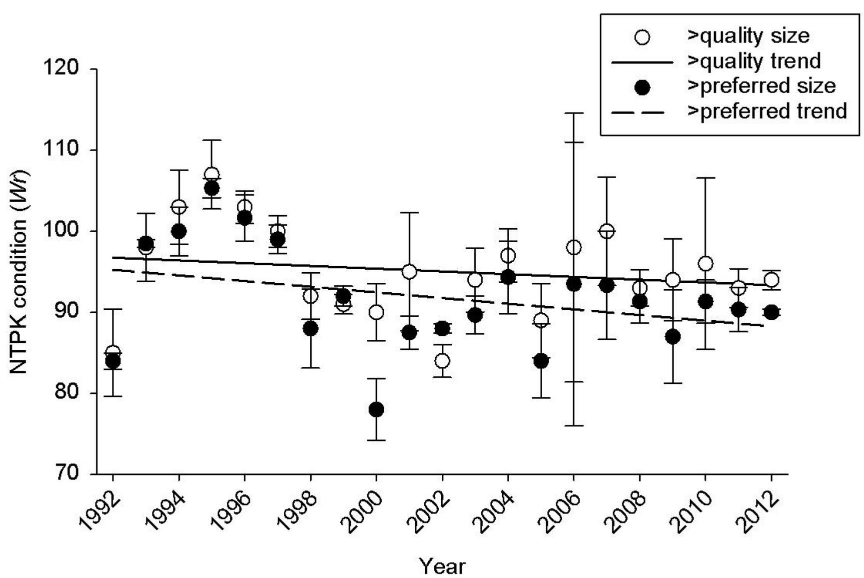


Figure Dewey-7. Condition (*Wr*) of northern pike caught in Dewey Lake from 1992 to 2012. NOTE: data are pooled (trap+gill nets) from 1992 to 2005; data are from gill nets only from 2006 to present. Error bars represent ±1 SE; trends are regression lines.

Black bullhead

A single black bullhead was caught in both a gill net (182 mm TL) and trap net (210 mm TL) in 2012. None were caught in 2011. During 2010 a single black bullhead was captured in a trap net (224 mm) and one in a gill net (222 mm). Seven black bullhead that ranged in length from 79 to 181 mm (mean=143 mm; SD=35.5) were captured in trap nets during spring 2009. During 2008, three were caught in trap nets, which was the first year black bullheads were detected in Dewey Lake since 1997.

Bluegill

Excluding an unusually large relative abundance in 2011, mean relative abundance of bluegill in 2012 (electrofishing mean=71.5; SE=23.1) was similar to the long term average from 2005–2010 (electrofishing mean=70.2; SE=19.5; Figure Dewey-8). Size structure and stock indices suggest that bluegill in Dewey Lake overall are similar or slightly larger compared with past years (Figure Dewey-8 and -9). Condition in 2012 was lower than past years, but remains satisfactory (*Wr*>90; Figure Dewey-10).

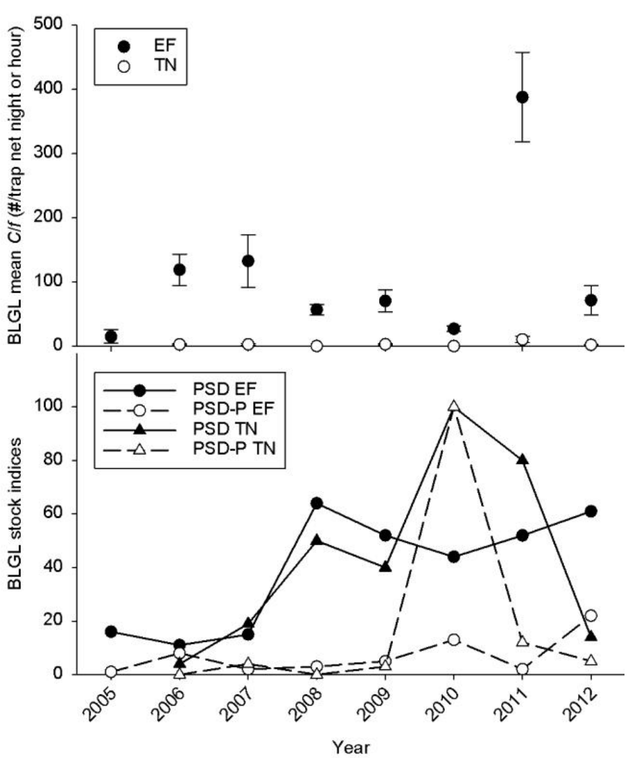


Figure Dewey-8. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Dewey Lake from 2005 to 2012.

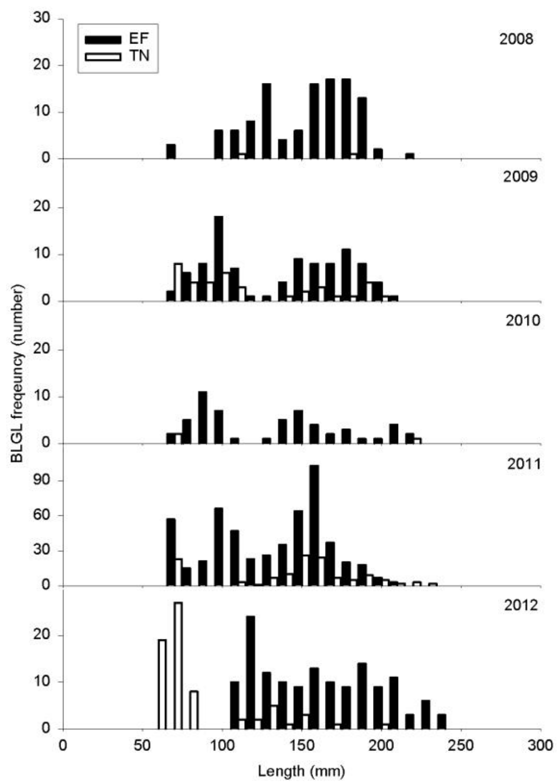


Figure Dewey-9. Length frequency histograms (10 mm groups) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Dewey Lake from 2008 to 2012. NOTE: scale for frequency in 2011 is larger.

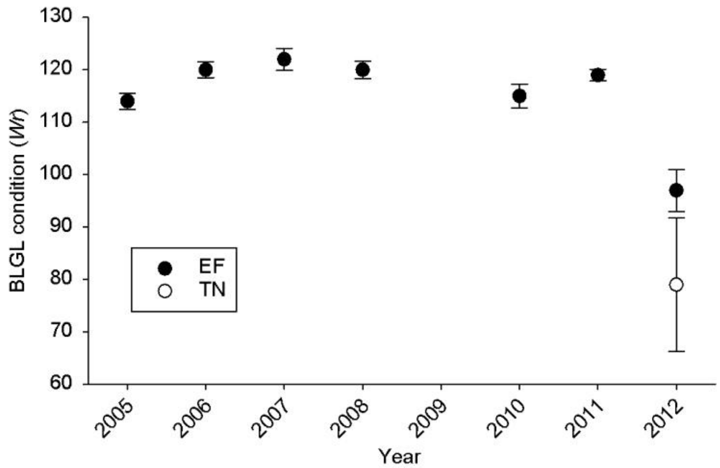


Figure Dewey-10. Condition (W_r) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Dewey Lake from 2005 to 2012. Error bars represent ±1 SE.

Largemouth bass

Mean relative abundance of largemouth bass (mean=22.5; SE=4.4) in Dewey Lake was again high, similar to 2011 (Figure Dewey-11). The size structure and stock indices also indicated that the population was increasing in length (Figures Dewey-11 and -12). However, mean condition of largemouth bass was lower in 2012 (*Wr*=83; SE=7.2) compared with values previously observed (2008–2011 mean=121.6; SE=3.8; Figure Dewey-13).

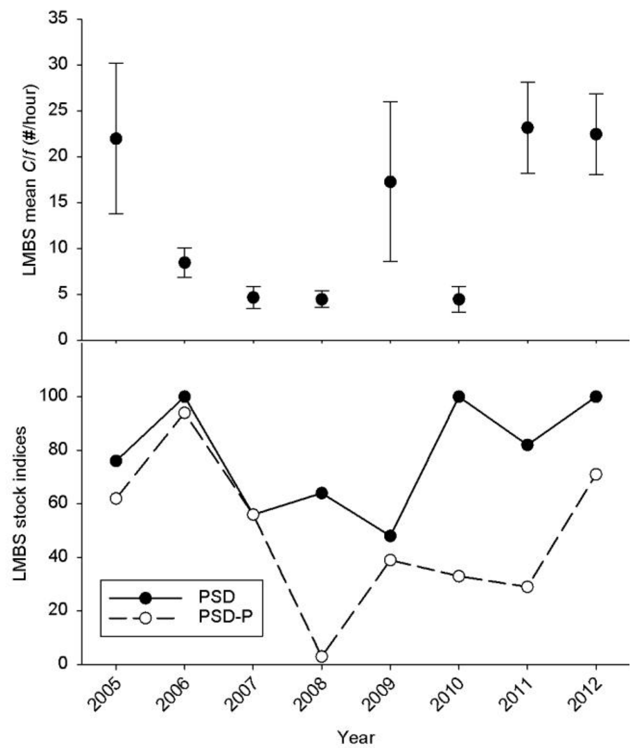


Figure Dewey-11. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of largemouth bass caught by electrofishing in Dewey Lake from 2005 to 2012.

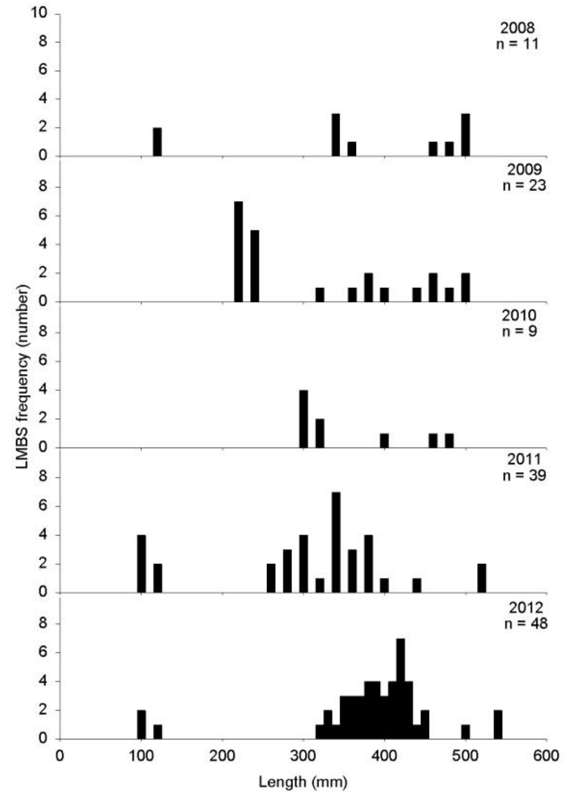


Figure Dewey-12. Length frequency histograms (10 mm groups beginning 2012) of largemouth bass caught by electrofishing in Dewey Lake from 2008 to 2012.

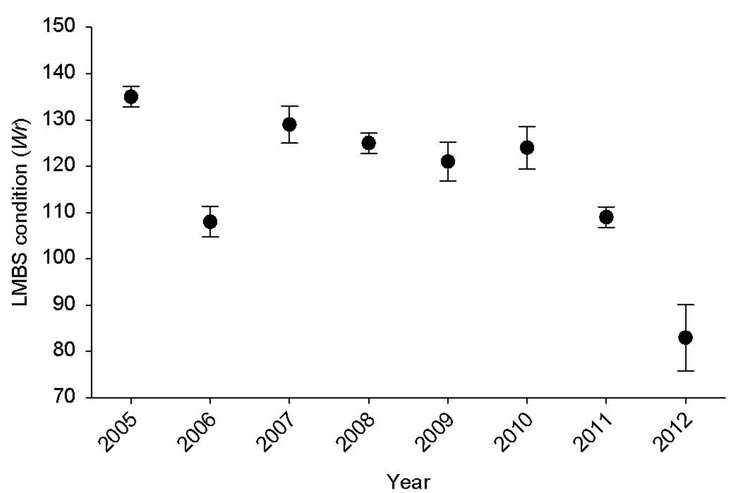


Figure Dewey-13. Condition (W_r) of largemouth bass caught by electrofishing in Dewey Lake from 2005 to 2012. Error bars represent ±1 SE.

Yellow perch

Mean relative abundance of yellow perch in 2012 (13.4; SE=5.2) was similar to the previous 7-year mean of 11.4 (SE=1.7; Figure Dewey-14). Previous to 2005, the mean relative abundance was 31.6 (SE=4.0). Reasons for this sustained decrease in yellow perch relative abundance are unknown. Stock indices display a gradual increase since 1992 (Figure Dewey-14), but size structure is similar to those from 2008 (Figure Dewey-15). Condition remained good (*Wr*>90; Figure Dewey-16).

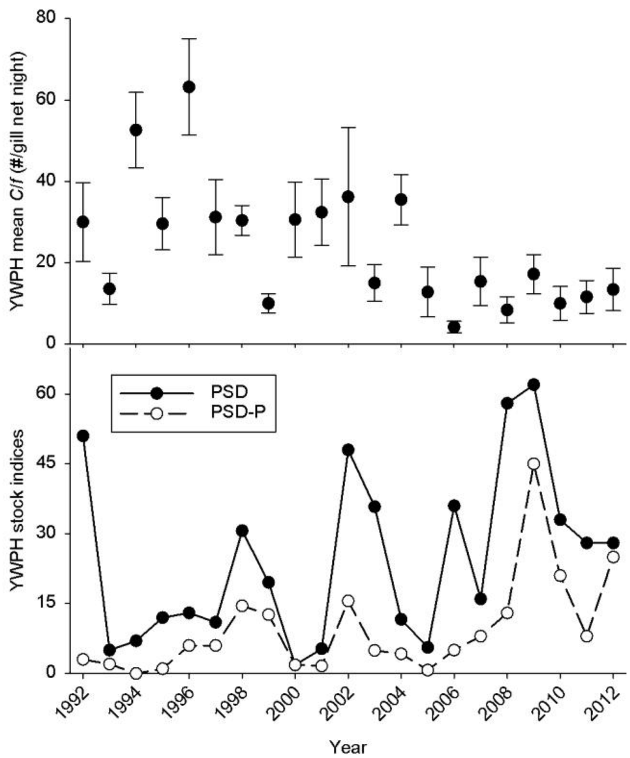


Figure Dewey-14. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of yellow perch caught by gill nets set in Dewey Lake from 1992 to 2012.

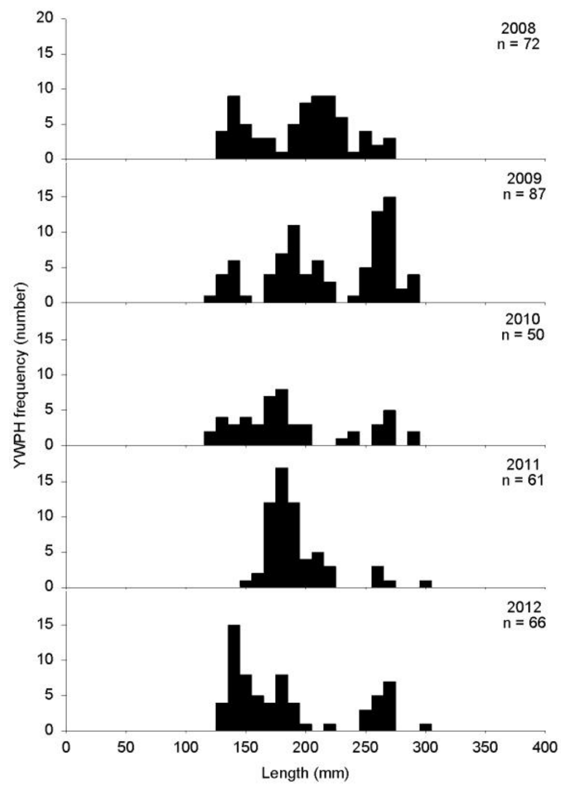


Figure Dewey-15. Length frequency histograms (10 mm groups) of yellow perch caught by gill nets set in Dewey Lake from 2008 to 2012.

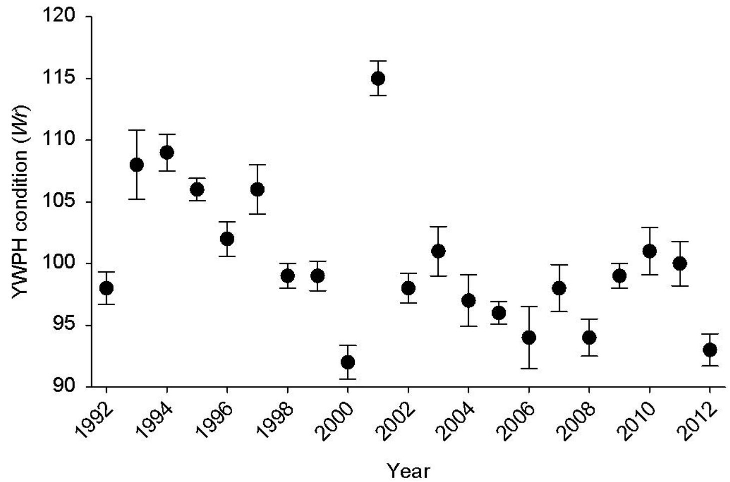


Figure Dewey-16. Condition (W_r) of yellow perch caught by gill nets set in Dewey Lake from 1992 to 2012. Error bars represent ±1 SE.

Management Recommendations

1. Monitor conditions for winterkill because of extremely low water levels preceding winter. Develop plan for renovation and (or) stocking should winterkill occur.

2. Maintain 28 inch maximum size limit for northern pike. Although relative abundance has not significantly changed since implementation of the regulation, the proportion of larger northern pike has significantly increased, suggesting that the regulation has had an effect.

3. Investigate potential reasons for decline in yellow perch relative abundance that began in 2005.

4. Conduct fisheries surveys in 2013.

DUCK LAKE

Lake Description

At full pool, Duck Lake has 27 surface ha (67 ac), a maximum depth of 2.4 m (8 ft), and a mean depth of 1.2 m (4 ft). The lake bottom is generally flat and composed of about 90% sand and 10% organic silt. Rocky substrates are also present in the lake, located in the south side and northeast corner. During summer, submerged vegetation such as narrow-leaf pondweed *Potamogeton strictifolius* and curly-leaf pondweed *P. crispus*, coontail *Ceratophyllum* spp., and duck weed *Lemna* spp.cover about 99% of the lake. Emergent vegetation, predominately cattail, bulrush, and some *Phragmites* form a ring around most of the lake. The shoreline has cottonwood and willow trees with a dense understory of brush and short grasses.

The lake is a closed system and has no water control structures, but a constructed ditch connects Duck and Rice Lakes. The lake is susceptible to winterkill, but springs seem to moderate those.

Duck Lake has never been chemically renovated because common carp have never been observed or reported.

Primary sport fish in Duck Lake are bluegill, largemouth bass, orangespotted sunfish (*Lepomis humilis*), pumpkinseed (*Lepomis gibbosus*), and yellow perch. Black bullheads have also been observed.

The lake receives moderate fishing pressure during spring and fall, but heavy submerged vegetation restricts fishing during the summer. Ice fishing is popular when access to the other lakes is hampered by inaccessible roads.

Fishing regulations are in place for largemouth bass, northern pike, and panfish (see Appendix 2). The current size restrictions in Duck Lake are a maximum size limit of 711 mm (28 in) for northern pike (implemented in 1993) and a 381 mm (15 in) minimum for largemouth bass (since 2007). Panfish do not have a length restriction. Daily bag limits are three, four (1>533 mm [21 in]), and 15 for pike, bass, and sunfish, respectively.

Results and Discussion

Water quality

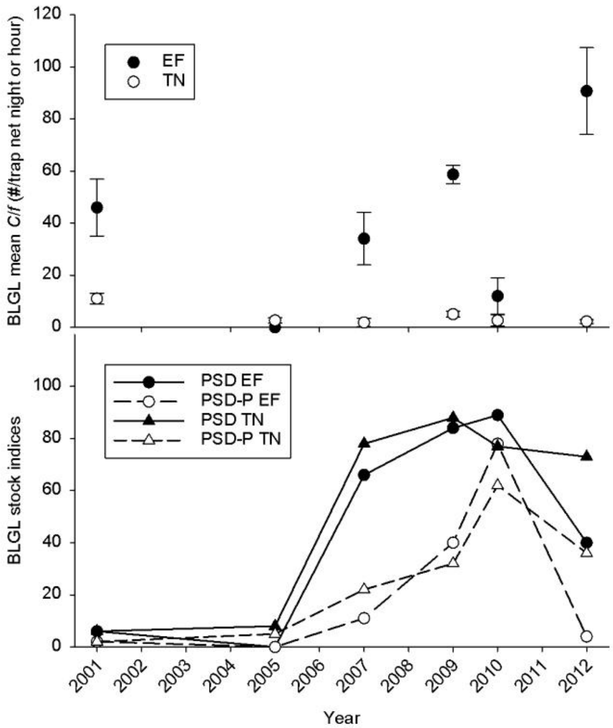
Water quality was measured in May and September (Table Duck-1).

Table Duck-1. Surface water quality values at Duck Lake from 2001 to 2012. The spring time period is denoted by ‘S’, fall by ‘F’, and ‘.’ indicates no sample.

	Temp. (°C)		Dissolved oxygen (mg/L)		Secchi depth (cm)		pH		Pheno. alkal. (mg/L)		Total alkal. (mg/L)		Conduc-tivity (µS/cm)		Tur-bidity (NTU)	
Year	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
2012	19	17	9.0	12.0	63	40	.	9.7	17	0	102	51	201	224	18	17
2010	14	23	8.9	10.3	.	.	8.3	8.9	0	0	128	102	225	262	.	.
2009	15	22	8.7	9.8	68	.	9.3	8.8	0	0	119	120	290	257	.	.
2007	22	.	10.8	.	154	.	6.7	.	51	.	154	.	333	.	.	.
2005	19	.	.	.	.	.	7.1	.	0	.	290	.	260	.	.	.
2001	26	16	11.7	.	.	90	8.9	10.1	51	0	154	120	.	284	.	.

Bluegill

Mean relative abundance of bluegill (mean=90.7; SE=16.7) was elevated in 2012 (Figure Duck-1). Both stock indices (Figure Duck-1) and size structure (Figure Duck-2) data suggest that the population is considerably smaller as few bluegill >200 mm were present in either electrofishing or trap net surveys. Condition was also low compared to the past several years (Figure Duck-3).



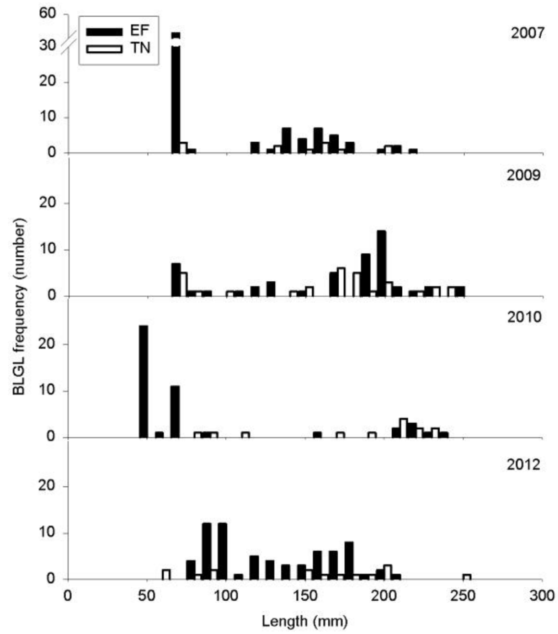


Figure Duck-2. Length frequency histograms (10 mm groups) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Duck Lake from 2007 to 2012.

Figure Duck-1. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Duck Lake from 2001 to 2012.

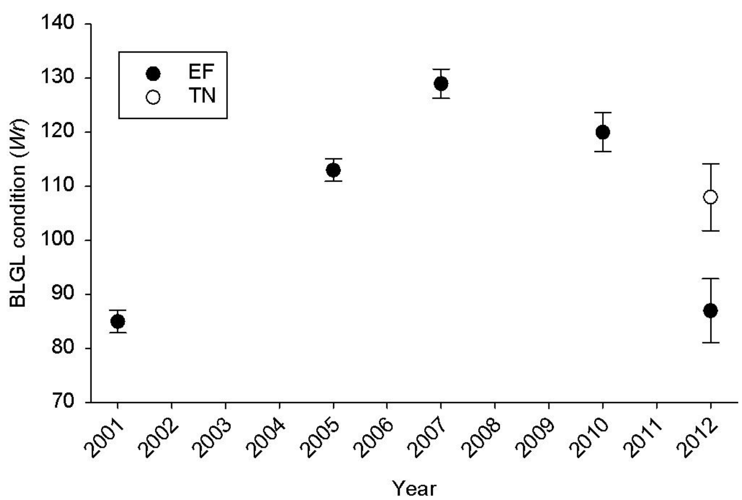


Figure Duck-3. Condition (W_r) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Duck Lake from 2001 to 2012. Error bars represent ±1 SE.

Largemouth bass

Mean relative abundance of largemouth bass (mean=116; SE=24) remained relatively high in 2012 (Figure Duck-4). The population is composed of larger fish compared to data since 2007 (Figure Duck-4 and -5). Largemouth bass condition in 2012 (mean=87; SE=2.4) was considerably smaller than values since 2001 (mean=107; SE=4.2; Figure Duck-6).

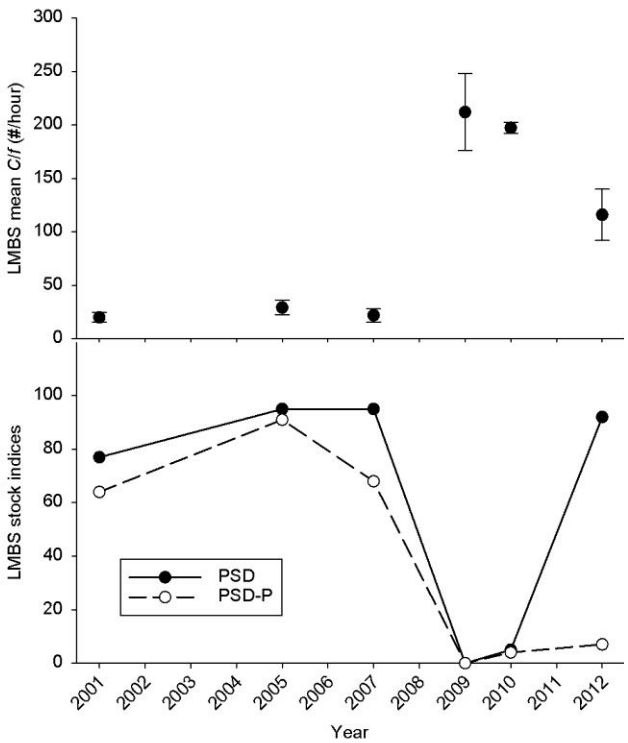


Figure Duck-4. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of largemouth bass caught by electrofishing in Duck Lake from 2001 to 2012.

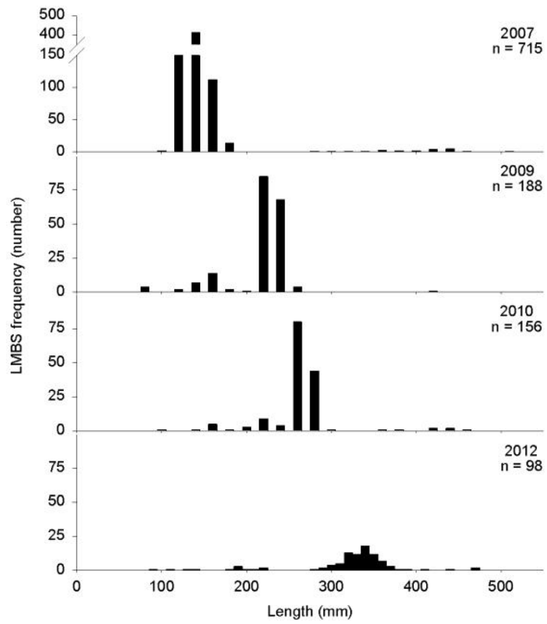


Figure Duck-5. Length frequency histograms (10 mm groups beginning 2012) of largemouth bass caught by electrofishing in Duck Lake from 2007 to 2012.

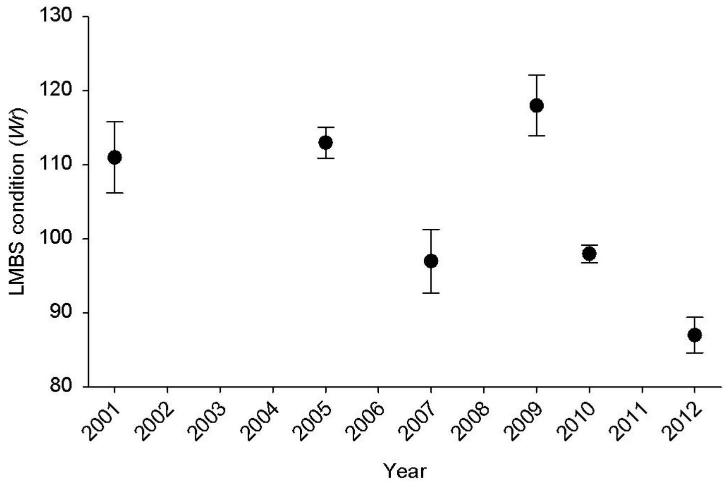


Figure Duck-6. Condition (W_r) of largemouth bass caught by electrofishing in Duck Lake from 2001 to 2012. Error bars represent ±1 SE.

Pumpkinseed

The relative abundance of pumpkinseed sunfish in Duck Lake remains low. Two pumpkinseed sunfish (140 and 187 mm TL) were caught in trap nets during 2012 surveys. Only one pumpkinseed (77 mm) was caught in 2010 and four (122–134 mm) were caught in 2009. Pumpkinseeds were first observed in Duck Lake in 2005.

Yellow perch

Because only four yellow perch were caught in 2012, relative abundance in 2012 (mean=1.3; SE=1.3) was small compared with the average since 2001 (mean=5.0; SE=1.1; Figure Duck-7). Of the four fish caught, two were >preferred length (250 mm; 10 in). Mean condition was good (*Wr*>90; Figure Duck-9).

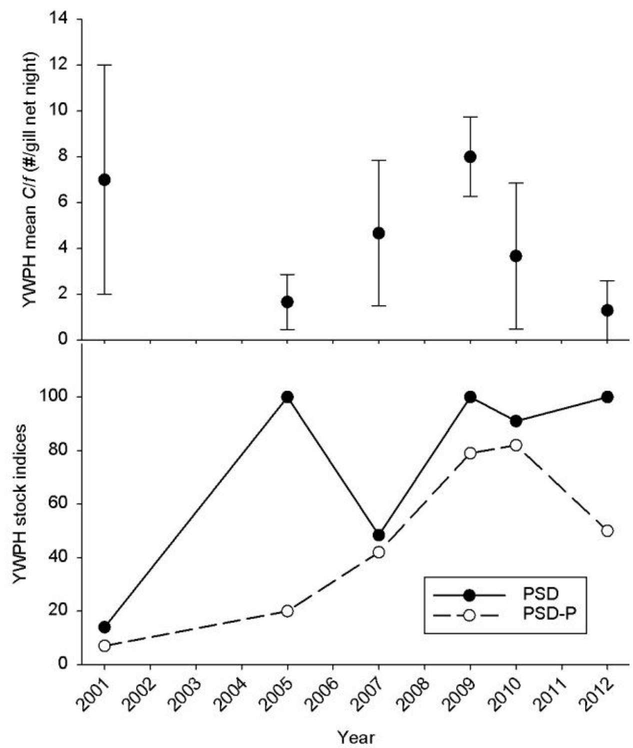


Figure Duck-7. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of yellow perch caught by gill nets set in Duck Lake from 2001 to 2012.

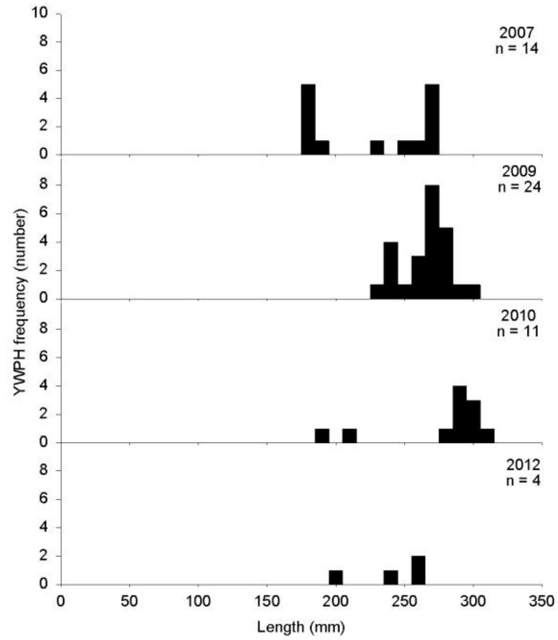


Figure Duck-8. Length frequency histograms (10 mm groups) of yellow perch caught by gill nets set in Duck Lake from 2007 to 2012.

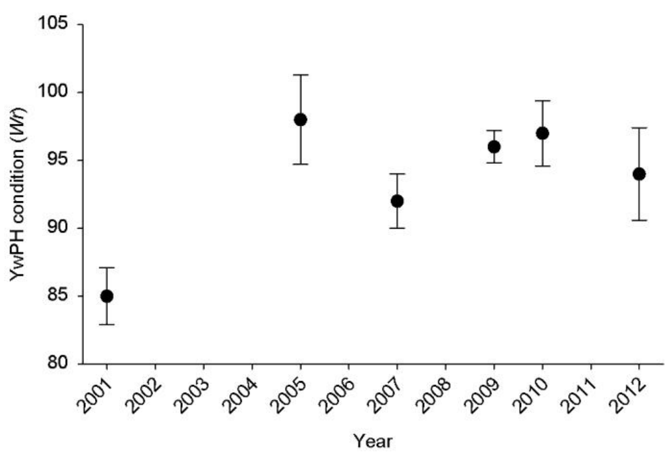


Figure Duck-9. Condition (W_r) of yellow perch caught in gill nets set in Duck Lake from 2001 to 2012. Error bars represent ±1 SE.

Management Recommendations

1. Conduct fisheries survey in 2014.

2. Consider stocking yellow perch if they are a desired species in Duck Lake because abundance is low.

HACKBERRY LAKE

Lake Description

At full pool, Hackberry Lake has 275 surface ha (680 ac), a maximum depth of 1.5 m (5 ft), and a mean depth of 0.9 m (3 ft). The lake bottom is generally flat and composed of organic material. Nearly the entire lake has submerged macrophytes during the summer and emergent vegetation (cattail and bulrush) along the entire shoreline. Hackberry is prone to periodic winterkill, occasional summerkill, and dense algae blooms. The surrounding watershed consists of mixed-grass sandhills, which are lightly grazed by cattle.

Hackberry Lake is the most upstream of a series of four lakes on the refuge connected by natural and constructed drainages. A water control structure between Hackberry and Dewey (downstream of Hackberry) lakes can be used to manipulate water levels in Hackberry during high-water years. Fish movement between lakes has occurred during periods of high water.

In 1975, the lake was chemically renovated (rotenone) and presumed to be free of carp for ~12 years after which carp were observed during surveys in 1988. Hackberry was then used as a control lake from 1988 to 1992 to evaluate the potential for northern pike to control carp recruitment in other refuge lakes. In 2004, refuge managers and NGPC cooperated to chemically renovate the lake once again. Water levels were drawn down in August 2004 and the lake was subsequently rotenoned. By October 2004, Hackberry Lake was declared carp free and fish have been stocked periodically since then (see Appendix 1). Carp were again observed in Hackberry during the 2008 surveys.

Primary sport fish in Hackberry Lake are bluegill, largemouth bass, northern pike, and yellow perch. Common carp are also present. The lake receives heavy fishing pressure during winters when refuge trails and the other fishing lakes are not easily accessible. Angling pressure is largest from the ice fishing season through late spring/early summer and declines as vegetation grows in the lake. Hackberry Lake is adjacent to the Refuge headquarters and easily accessible from State Highway 16B. A new, concrete boat ramp was constructed in 2012.

Fishing regulations at Hackberry Lake are in place for largemouth bass, northern pike, and panfish (see Appendix 2). Northern pike size restrictions have changed four times since 1987. The current size restrictions in Hackberry Lake are a maximum size limit of 711 mm (28 in) for northern pike (implemented in 1993) and a 381 mm (15 in) minimum for largemouth bass (since 2007). Panfish do not have a length restriction. Daily bag limits are three, four (1>533 mm [21 in]), and 15 for pike, bass, and sunfish, respectively.

Results and Discussion

Water quality and surface elevation

Water quality was measured in May and September (Table Hackberry-1). Generally, spring lake-surface elevation is higher than fall elevation in Hackberry Lake ($F_{1, 23}$=8.79; p=0.02; Figure Hackberry-1, top panel); mean lake-surface elevation in the spring for 2012 was fourth highest on record. However, the fall elevation reading was the third lowest on record (Figure Hackberry-1, top panel). The relative change in lake-surface elevation from spring to fall was the largest observed to date (Figure Hackberry-1, bottom panel). Hackberry Lake's water surface dropped >0.5 m over the summer, largely due to the extreme drought conditions in 2012. Overall, lake-surface elevation has been decreasing since 1992 in both the spring ($F_{1, 13}$=5.53; p=0.04; r^2=0.30) and fall ($F_{1, 7}$=5.41; p=0.05; r^2=0.44; Figure Hackberry-1, top panel); the overall change in elevation from spring to fall is increasing ($F_{1, 7}$=4.81; p=0.06; r^2=0.41; Figure Hackberry-1, bottom panel), suggesting that fall water levels relative to spring water levels in Hackberry Lake are increasingly lower.

Table Hackberry-1. Surface water quality values at Hackberry Lake from 1999 to 2012. The spring time period is denoted by 'S', fall by 'F', and '.' indicates no sample.

	Temp. (°C)		Dissolved oxygen (mg/L)		Secchi depth (cm)		pH		Pheno. alkal. (mg/L)		Total alkal. (mg/L)		Conduc-tivity (µS/cm)		Tur-bidity (NTU)	
Year	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
2012	20	14	8.2	9.3	51	43	.	9.3	0	0	137	34	375	322	34	23
2011	19	22	9.5	6.8	.	78	9.0	8.9	0	0	171	171	369	388	.	.
2010	12	23	9.3	11.3	.	.	8.6	9.1	0	0	171	154	351	370	.	.
2009	22	22	11.8	6.0	120	.	9.1	8.2	34	0	153	171	403	392	.	.
2008	.	19	7.7	11.9	.	.	.	8.8	0	0	205	222	345	402	.	.
2007	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2006	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2005	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2004	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2003	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2002	.	20	.	11.0	.	.	.	9.7	.	137	.	393	.	430	.	.
2001	26	18	8.0	.	.	75	7.6	7.2	17	8	137	154	.	368	.	.
2000	.	18	.	.	.	30	.	8.5	.	10	.	200	.	425	.	.
1999	.	16	.	.	.	.	.	7.1	.	.	.	.	.	.	.	.

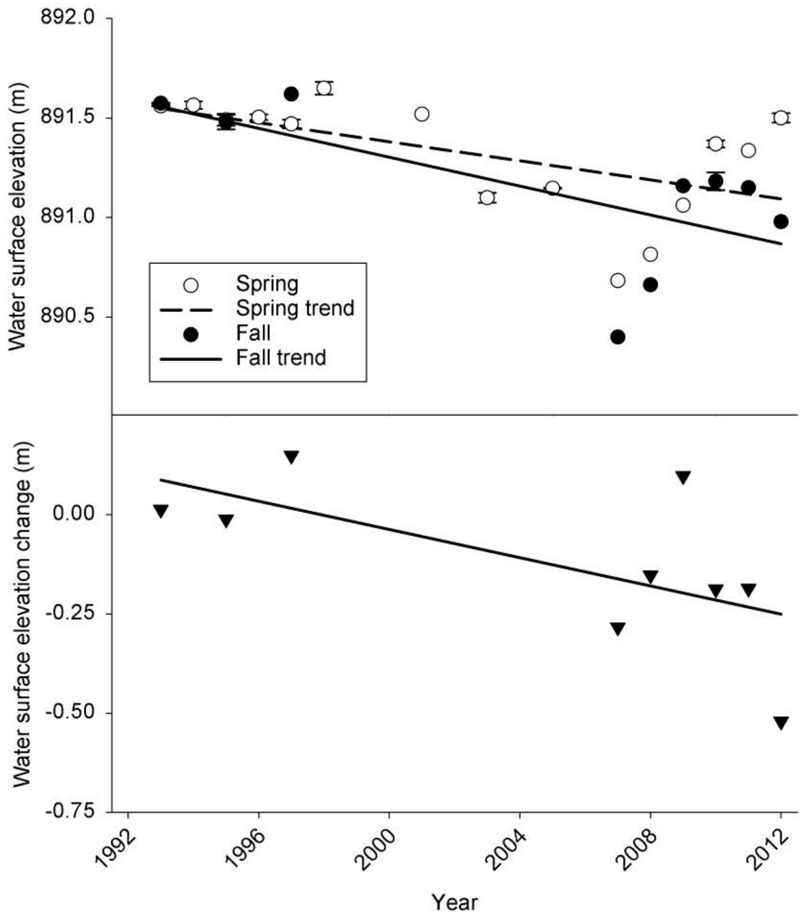


Figure Hackberry-1. Water surface elevation (m above mean sea level; top panel) and relative change in water surface elevation from spring to fall (bottom panel) at Hackberry Lake from 1992 to 2012. Mean elevation was calculated for spring (March–April) and fall (September–October) time periods. Solid and dashed lines represent regression lines. Error bars (if present) represent one standard error.

Common carp

Mean relative abundance of common carp continued to show a decreasing trend from when they were first observed in 2008 after the 2004 chemical renovation. Only one common carp was caught in 12 trap net nights. Mean gill net relative abundance in 2012 was 1.7 (SE=0.5; Figure Hackberry-2). Length frequency histograms suggest that the current population consists of few, large individuals with no observed recruitment (Figure Hackberry-3).

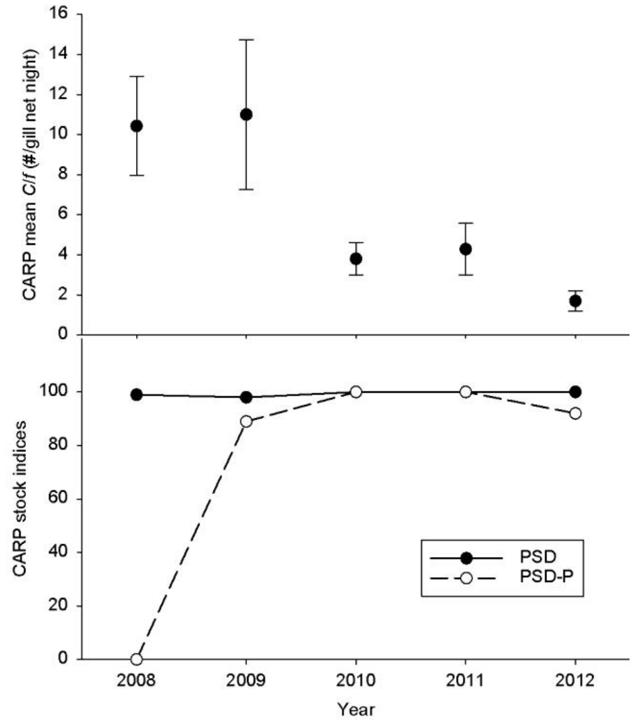


Figure Hackberry-2. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of common carp caught by gill nets set in Hackberry Lake from 2008 to 2012.

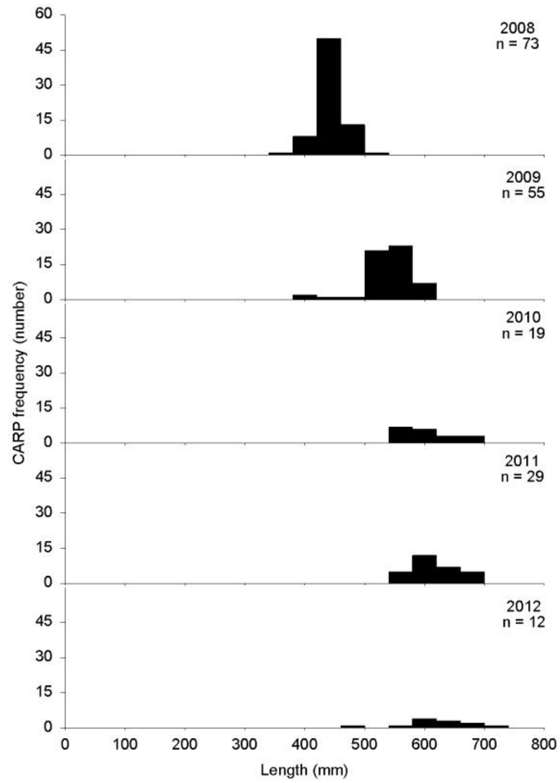


Figure Hackberry-3. Length frequency histograms (40 mm groups) of common carp caught by gill nets set in Hackberry Lake from 2008 to 2012.

Northern pike

Mean relative abundance of northern pike in 2012 (2.1; SE=0.7) was similar to that in 2011 (2.6; SE=0.8; Figure Hackberry-4). After a chemical renovation in 2004, northern pike were first observed in 2008 surveys. Stock indices (Figure Hackberry-4) and multiple age classes (Figure Hackberry-5) suggest that after an initial introduction of adult-sized northern pike into Hackberry Lake, the fish are reproducing and recruiting. Condition has continually decreased since the first observation in 2008 (Figure Hackberry-6).

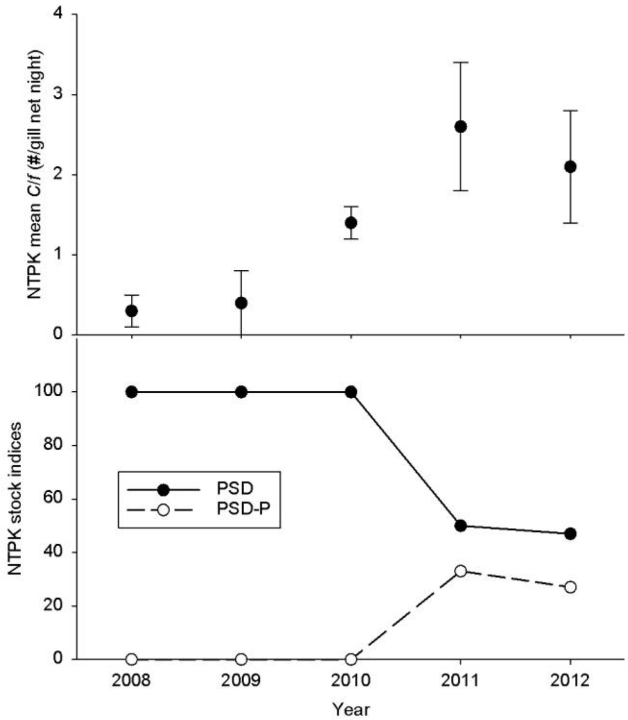


Figure Hackberry-4. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of northern pike caught by gill nets set in Hackberry Lake from 2008 to 2012.

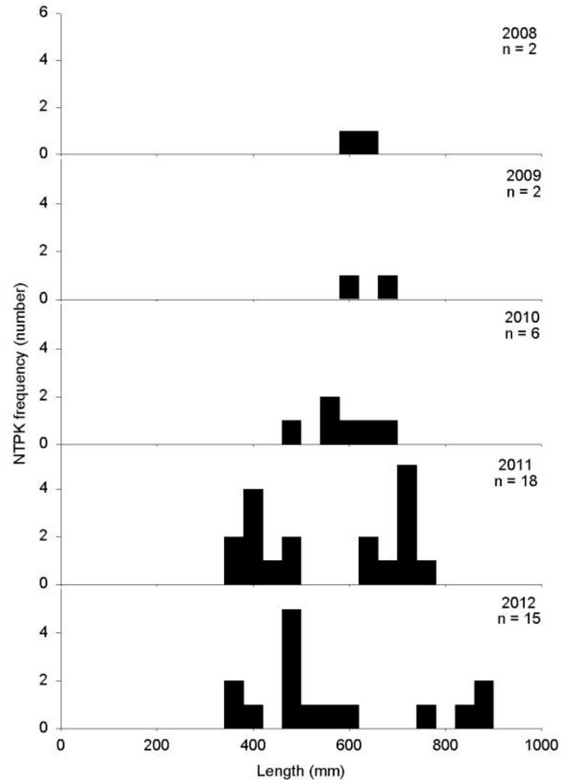


Figure Hackberry-5. Length frequency histograms (40 mm groups) of northern pike caught by gill nets set in Hackberry Lake from 2008 to 2012.

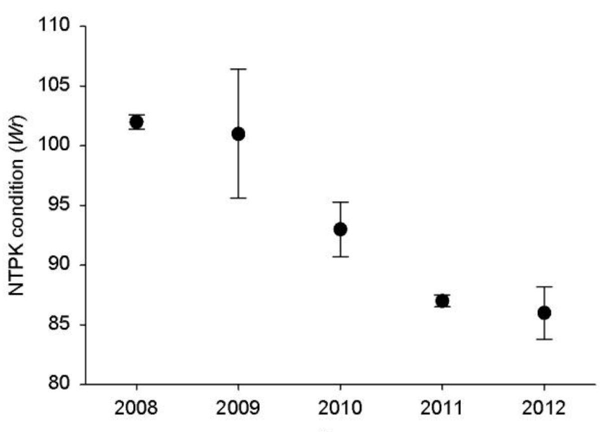


Figure Hackberry-6. Condition (W_r) of northern pike caught by gill nets set in Hackberry Lake from 2008 to 2012. Error bars represent ±1 SE.

Bluegill

After stocking >232,000 bluegill into Hackberry Lake in 2007 and 2008, relative abundance has remained high, suggesting that the stockings succeeded in establishing a population. Mean relative abundance (103; SE=23), stock indices, size structure, and condition (Figures Hackberry-7–9) all indicate a good population of bluegill in Hackberry Lake.

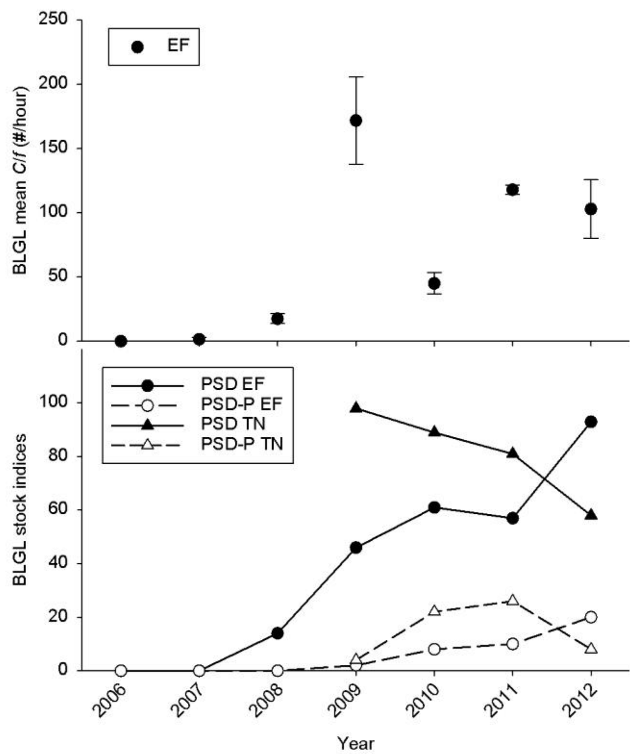


Figure Hackberry-7. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Hackberry Lake from 2006 to 2012.

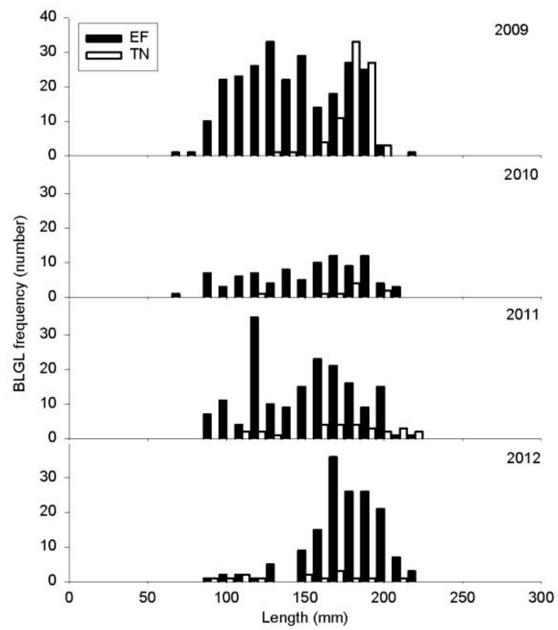


Figure Hackberry-8. Length frequency histograms (10 mm groups) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Hackberry Lake from 2009 to 2012.

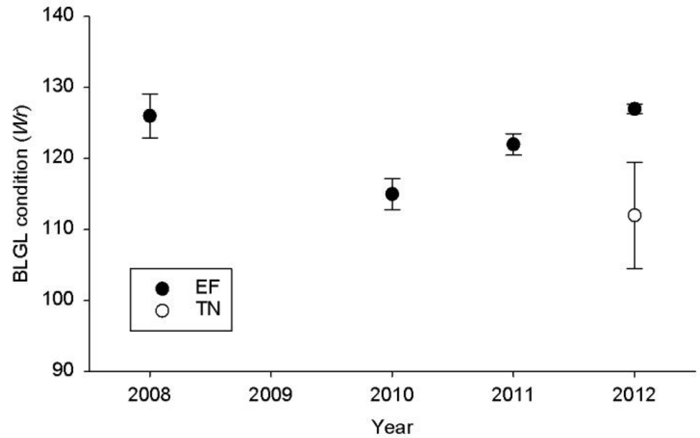


Figure Hackberry-9. Condition (W_r) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Hackberry Lake from 2008 to 2012. Error bars represent ±1 SE.

Largemouth bass

After stocking >40,000 fingerling largemouth bass into Hackberry Lake in 2007, relative abundance has remained high (Figure Hackberry-10), suggesting that the stockings succeeded in establishing a population. Stock indices in 2012 are similar to those since 2009 (Figure Hackberry-10). Size structure histograms suggest a population consisting of moderate (~300 mm) to large (>400 mm) largemouth bass, but fish <150 mm were not observed in 2012 (Figure Hackberry-11). Condition has shown a decreasing trend since 2008, but remains good (mean *Wr*=94; SE=1.7; Figure Hackberry-12).

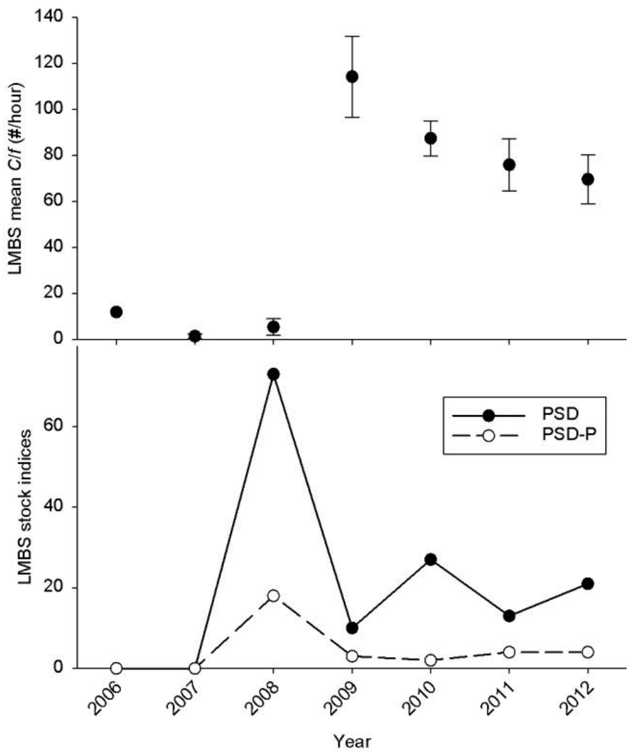


Figure Hackberry-10. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of largemouth bass caught by electrofishing in Hackberry Lake from 2006 to 2012.

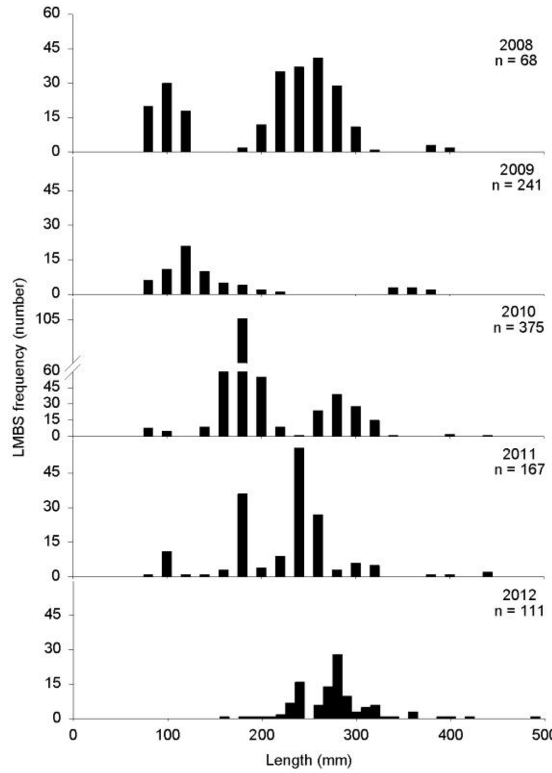


Figure Hackberry-11. Length frequency histograms (10 mm groups beginning 2012) of largemouth bass caught by electrofishing in Hackberry Lake from 2008 to 2012.

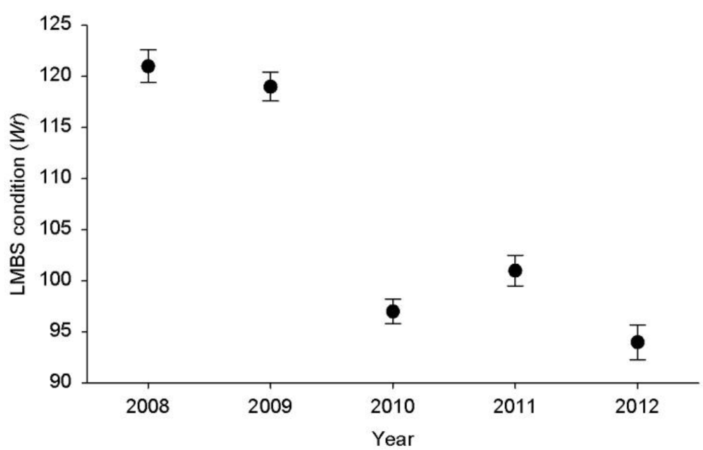


Figure Hackberry-12. Condition (W_r) of largemouth bass caught by electrofishing in Hackberry Lake from 2008 to 2012. Error bars represent ±1 SE.

Yellow perch

Mean relative abundance in 2012 (mean=8.9; SE=1.4) is about 50% of the average since 2008 (mean=20.9; SE=5.4; Figure Hackberry-13). Stock indices and size structure information suggest that relatively large yellow perch are present in Hackberry Lake (Figure Hackberry-14). However, for the 5th consecutive year, virtually zero yellow perch <150 mm were observed. Condition remains satisfactory (Figure Hackberry-15).

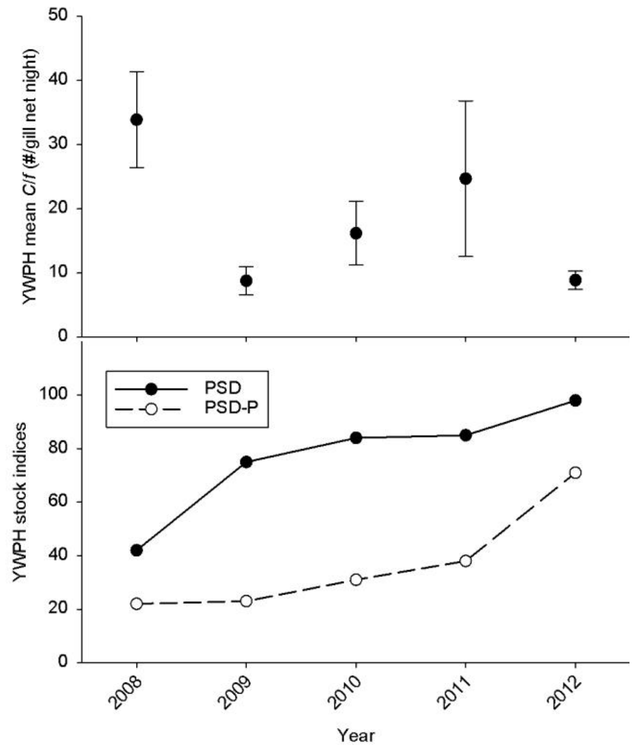


Figure Hackberry-13. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of yellow perch caught by gill nets set in Hackberry Lake from 2008 to 2012.

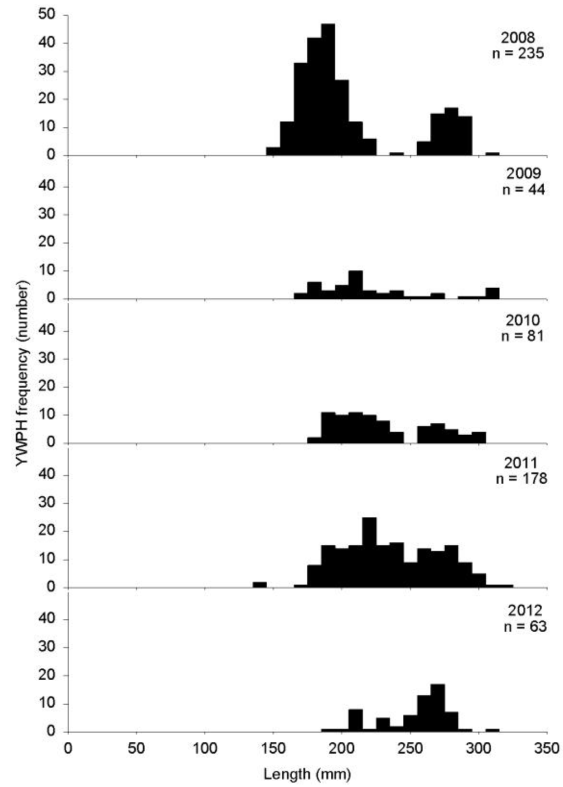


Figure Hackberry-14. Length frequency histograms (10 mm groups) of yellow perch caught by gill nets set in Hackberry Lake from 2008 to 2012.

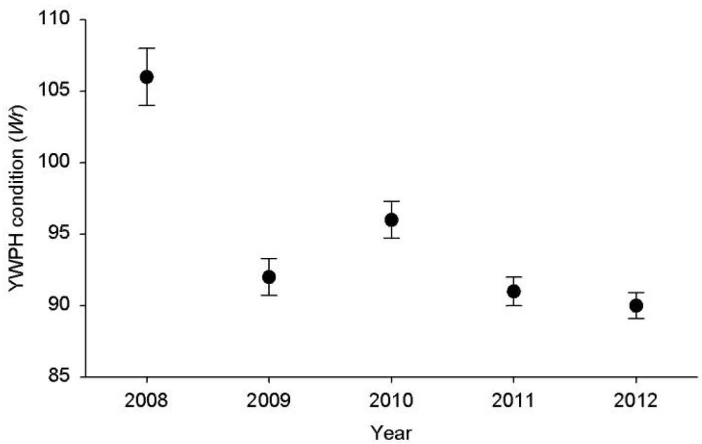
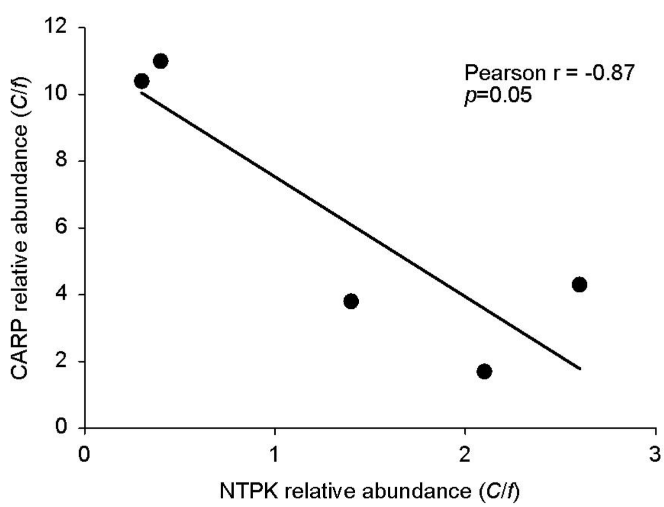


Figure Hackberry-15. Condition (W_r) of yellow perch caught by gill nets set in Hackberry Lake from 2008 to 2012. Error bars represent ±1 SE.

Management Recommendations

1. Monitor conditions for winterkill because of extremely low water levels preceding winter. Develop plan for renovation and (or) stocking should winterkill occur.

2. Evaluate the influence of northern pike on common carp numbers in Hackberry Lake. A preliminary correlation analysis indicates that northern pike abundance may be associated with reduced common carp numbers because of a significant negative correlation (see figure).



3. Conduct fisheries surveys in 2013 to monitor the common carp and northern pike abundance association as well as other species.

4. Consider stocking yellow perch because evidence of recruitment has not been observed since 2008.

PELICAN LAKE

Lake Description

At full pool, Pelican Lake has 331 surface ha (818 ac), a maximum depth of 3.0 m (10 ft), and a mean depth of 1.2 m (4 ft). The lake bottom is generally flat and composed of organic material. Submerged vegetation present in Pelican includes milfoil *Myriophyllum* spp., curly-leaf pondweed *Potamogeton crispus*, and some coontail. Emergent vegetation is scattered throughout the lake and is primarily cattail, bulrush, and *Phragmites*. Sporadic stands of wild rice *Zizania* spp. are also present. The surrounding watershed is composed of rolling sandhills containing mixed-grasses and cottonwood and willow trees along the shoreline.

Pelican is a closed system except during periods of large rainfall when sheet flow occurs. The lake is situated in the lowlands of the surrounding sandhills, which creates conditions for springs within the lake. These springs provide thermal refuge for fish when water temperature is high (>30 °C) during some summer months and can alleviate winterkill severity.

Pelican Lake was chemically renovated (rotenone) in 1979, but common carp were observed during surveys one year later in 1980. A winterkill was noted during in the 1987–1988 winter. Large amounts of precipitation in the spring and summer of 1995 and 1997 increased water levels refuge-wide and allowed for fish movement between lakes. Periodic fish stockings have occurred since 1989 (see Appendix 1).

Primary sport fish in Pelican Lake are bluegill, largemouth bass, northern pike, and yellow perch. Other fish species in the lake are black bullhead, common carp, and golden shiner. Pelican receives large fishing pressure during the spring and winter ice-fishing months. The lake has been known by anglers as the best fishery on the refuge and is noted for producing trophy bluegill. Pelican is easily accessible, located three miles south of Highway 16B (west of Valentine NWR headquarters), and two miles east along the Pelican Lake sub-headquarters road. A new, concrete boat ramp was built in 2012.

Fishing regulations are in place for largemouth bass, northern pike, and panfish. Northern pike size restrictions have changed four times since 1987 (see Appendix 2) in attempts to improve abundance and size structure and to predate on common carp. The current size restrictions in Pelican Lake are a maximum size limit of 711 mm (28 in) for northern pike (implemented in 1993) and a 381 mm (15 in) minimum for largemouth bass (since 2007). Sunfish do not have a length restriction. Daily bag limits are three, four (1>533 mm [21 in]), and 15 for pike, bass, and sunfish, respectively.

Results and Discussion

Water quality and surface elevation

Water quality was measured (Table Pelican-1) in late May, but not during the fall (September) because the boat ramp was under construction and water levels were too low to launch a boat. Generally, spring lake-surface elevation is higher than fall elevation in Pelican Lake ($F_{1, 24}$=4.06; p=0.08; Figure Pelican-1, top panel). Mean lake-surface elevation in the spring for 2012 was similar to past years of record, but the fall elevation reading was the second lowest on record (Figure Pelican-1, top panel). The relative change in lake-surface elevation from spring to fall was the largest observed to date (Figure Pelican-1, bottom panel). Pelican Lake's water surface dropped >0.5 m over the summer, largely due to the extreme drought conditions in 2012. Overall, lake-surface elevation since 1992 has remained consistent in both the spring ($F_{1, 13}$=2.59; p=0.13; r^2=0.17) and fall ($F_{1, 8}$=2.55; p=0.15; r^2=0.24; Figure Pelican-1, top panel); the overall change in elevation from spring to fall has also remained consistent ($F_{1, 7}$=0.24; p=0.64; r^2=0.03; Figure Pelican-1, bottom panel).

Table Pelican-1. Surface water quality values at Pelican Lake from 1999 to 2012. The spring time period is denoted by 'S', fall by 'F', '.' indicates no sample, and "*" indicates water levels were too low to collect a sample.

	Temp. (°C)		Dissolved oxygen (mg/L)		Secchi depth (cm)		pH		Pheno. alkal. (mg/L)		Total alkal. (mg/L)		Conduc-tivity (µS/cm)		Tur-bidity (NTU)	
Year	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
2012	19	.*	7.6	. *	54	. *	.	. *	0	. *	103	. *	277	. *	33	. *
2011	18	23	6.0	13.3	.	48	8.7	9.6	0	17	129	171	320	275	.	.
2010	17	.	6.2	.	.	.	8.2	.	0	.	171	.	171	.	.	.
2009	23	20	8.5	8.4	40	.	8.5	8.9	0	0	153	120	369	317	.	.
2008	16	20	11.3	15.4	.	.	.	9.4	0	34	171	120	298	308	.	.
2007	20	.	7.4	.	.	.	6.8	.	17	.	137	.	351	.	.	.
2006	24	.	8.1	.	129	.	6.9	.	0	.	137	.	378	.	.	.
2005	.	21	.	.	.	.	.	8.5	.	.	.	240	.	320	.	.
2004	.	23	.	.	.	30	.	.	.	0	.	205	.	375	.	.
2003	.	23	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2002	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2001	26	18	9.4	.	.	36	8.2	7.5	21	8	118	120	.	318	.	.
2000	.	18	.	.	.	30	.	8.0	.	0	.	205	.	.	.	.
1999	.	14	.	.	.	.	.	10.0	.	.	.	.	.	.	.	.

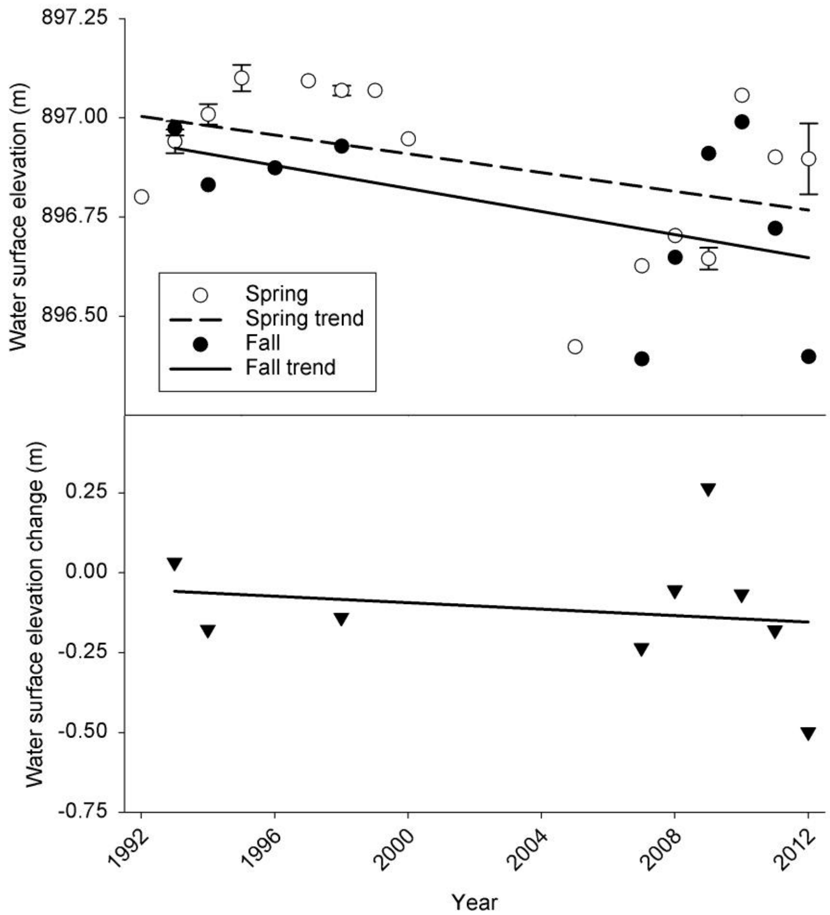


Figure Pelican-1. Water surface elevation (m above mean sea level; top panel) and relative change in water surface elevation from spring to fall (bottom panel) at Pelican Lake from 1992 to 2012. Mean elevation was calculated for spring (March–April) and fall (September–October) time periods. Solid and dashed lines represent regression lines. Error bars (if present) represent one standard error.

Common carp

Gill net surveys in Pelican Lake were not completed because water levels were extremely low, which prevented boat access. Additionally, a new boat ramp was under construction at the time of the scheduled survey. The results from the 2011 surveys are reported here.

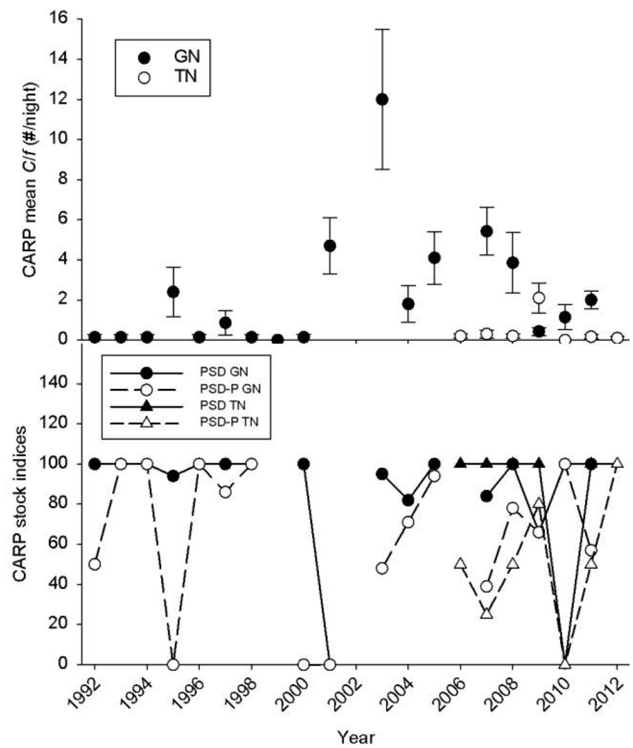


Figure Pelican-2. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of common carp caught by gill nets (GN) and trap nets (TN) set in Pelican Lake from 1992 to 2012. Due to boat ramp construction and low water levels, gill net data were not collected in 2012.

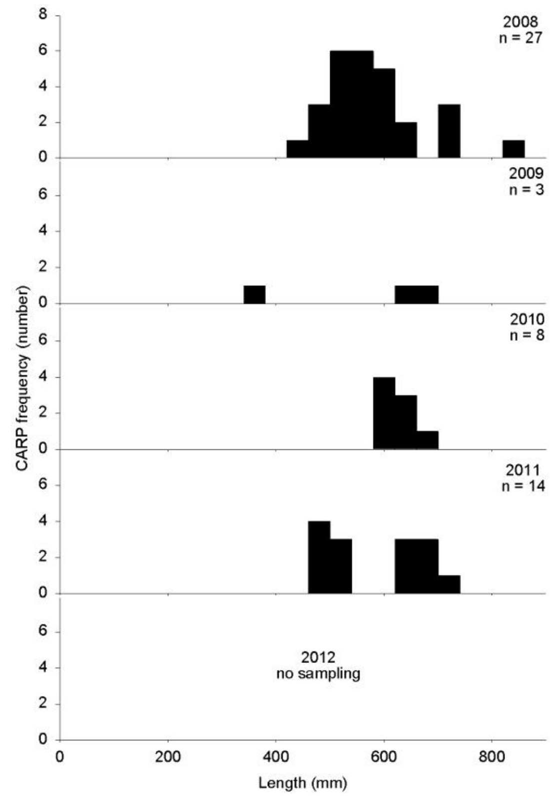


Figure Pelican-3. Length frequency histograms (40 mm groups) of common carp caught by gill nets set in Pelican Lake from 2008 to 2011. Due to boat ramp construction and low water levels, gill net data were not collected in 2012.

Northern Pike

Gill net surveys in Pelican Lake were not completed because water levels were extremely low, which prevented boat access. Additionally, a new boat ramp was under construction at the time of the scheduled survey. The results from the 2011 surveys are reported here. Also, analyses of relative abundance, stock indices, and condition trends from 1992–2011 are reported here.

Overall mean relative abundance of northern pike has slightly decreased since 1992 ($F_{1, 16}$=3.62; p=0.08; r^2=0.18; Figure Pelican-4). Generally, northern pike stock indices have not changed since implementation of the 711 mm (28 in) maximum size limit in 1993. No change in PSD ($F_{1, 16}$=0.10; p=0.76; r^2=0.01) or PSD-P ($F_{1, 16}$=0.30; p=0.59; r^2=0.02) was observed (Figure Pelican-5), but PSD≥M has slightly increased ($F_{1, 16}$=1.01; p=0.06; r^2=0.25). Size structure has also remained similar to past years of record (Figure Pelican-7). These data suggest that the regulation has had little effect on the proportional size distribution of northern pike in Pelican Lake. Condition of northern pike has not changed for smaller northern pike ($F_{1, 15}$=0.45; p=0.51;

r^2=0.03), but condition has decreased for larger northern pike ($F_{1, 15}$=4.60; p=0.05; r^2=0.23) in the lake (Figure Pelican-6).

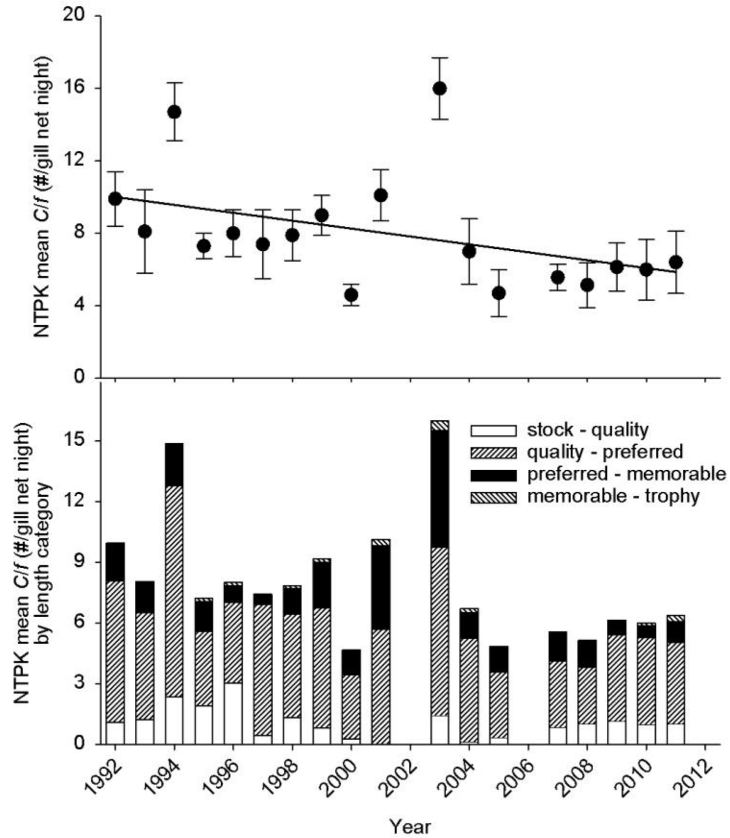


Figure Pelican-4. Mean relative abundance (C/f ± 1 SE; top panel) and relative abundance by length category (bottom panel) of northern pike caught by gill nets set in Pelican Lake from 1992 to 2011. Due to boat ramp construction and low water levels, gill net data were not collected in 2012.

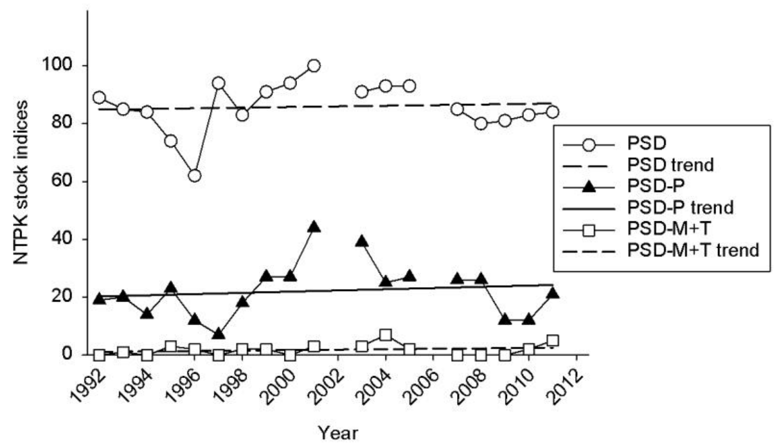


Figure Pelican-5. Stock indices of northern pike caught by gill nets set in Pelican Lake from 1992 to 2011. Trends are regression lines. Due to boat ramp construction and low water levels, data were not collected in 2012.

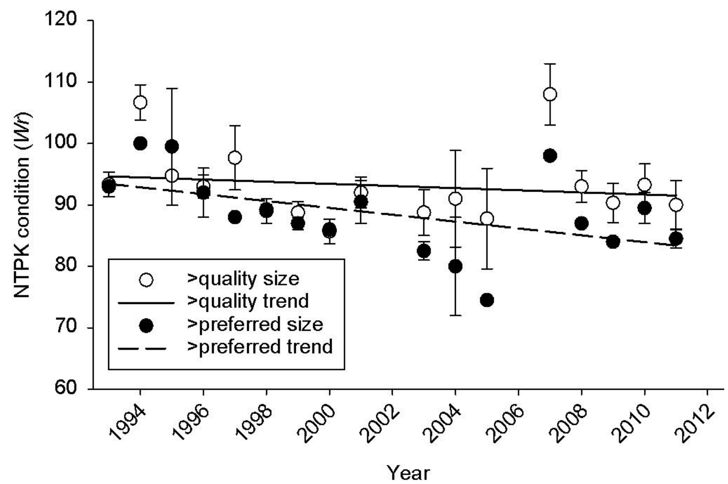


Figure Pelican-6. Condition (*Wr*) of northern pike caught by gill nets set in Pelican Lake from 1993 to 2011. Error bars represent ±1 SE; trends are regression lines. Due to boat ramp construction and low water levels, data were not collected in 2012.

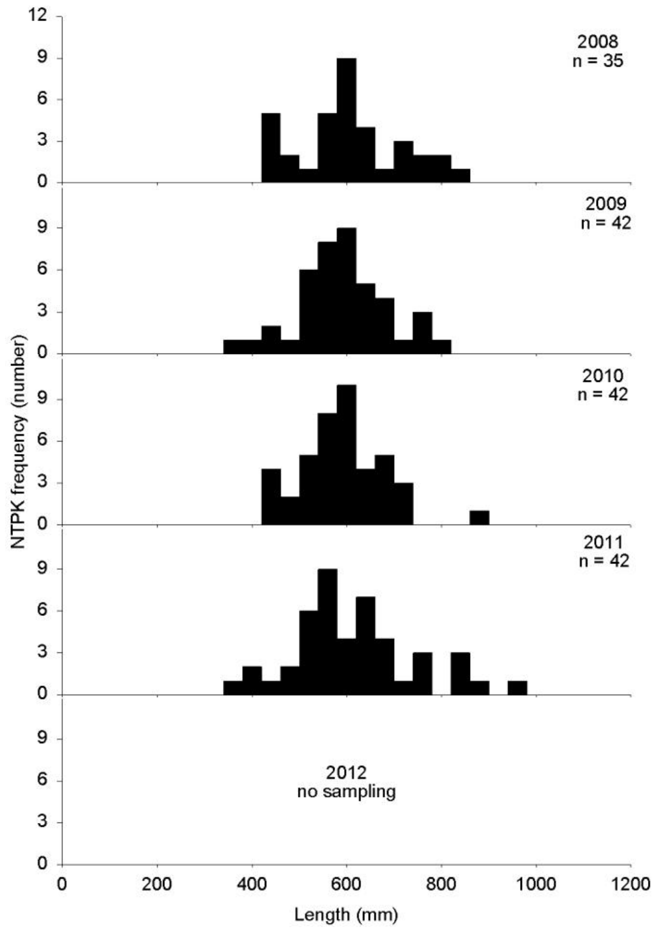


Figure Pelican-7. Length frequency histograms (40 mm groups) of northern pike caught by gill nets set in Pelican Lake from 2008 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

Bluegill

Relative abundance of bluegill in 2012 (mean=155; SE=28) was similar to the past three years (mean=151; SE=60; Figure Pelican-8). Stock indices (Figure Pelican-8) and size distribution (Figure Pelican-9) both suggest that the population consists of a large range of bluegill lengths (~50–250 mm). Mean condition was satisfactory (*Wr*>90; Figure Pelican-10).

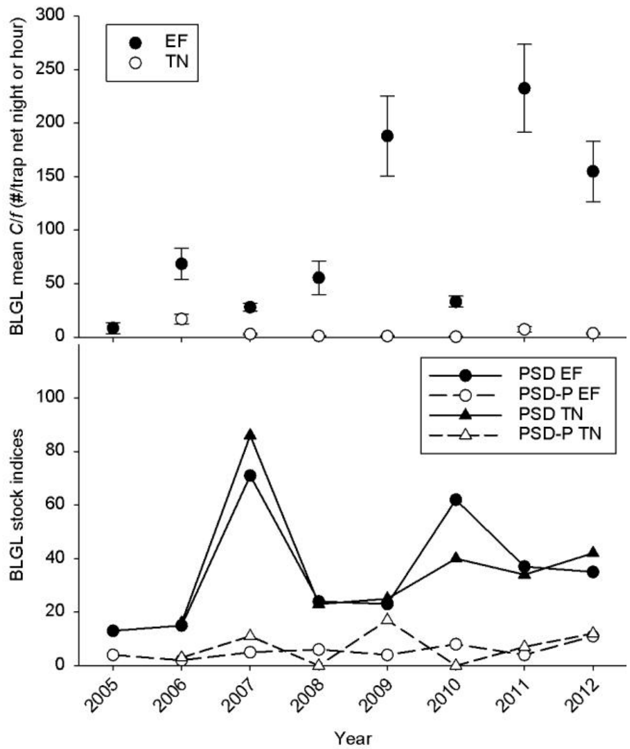


Figure Pelican-8. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Pelican Lake from 2005 to 2012.

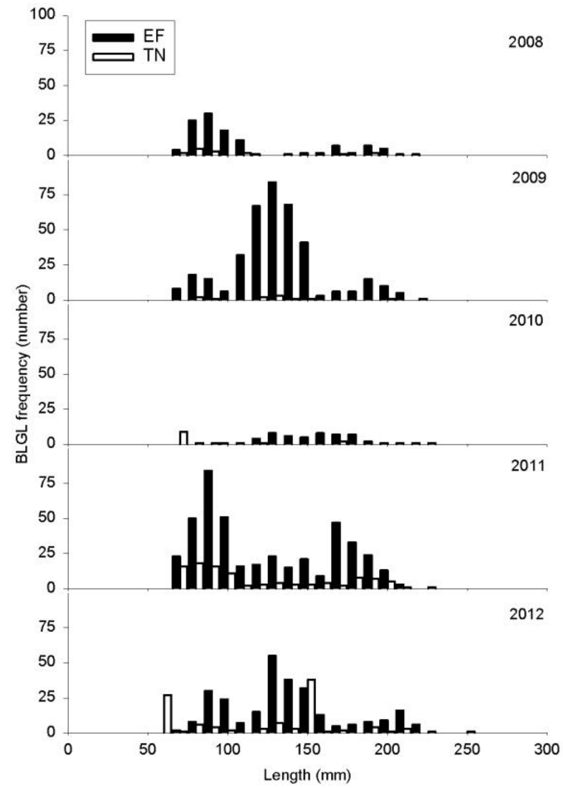


Figure Pelican-9. Length frequency histograms (10 mm groups) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Pelican Lake from 2008 to 2012.

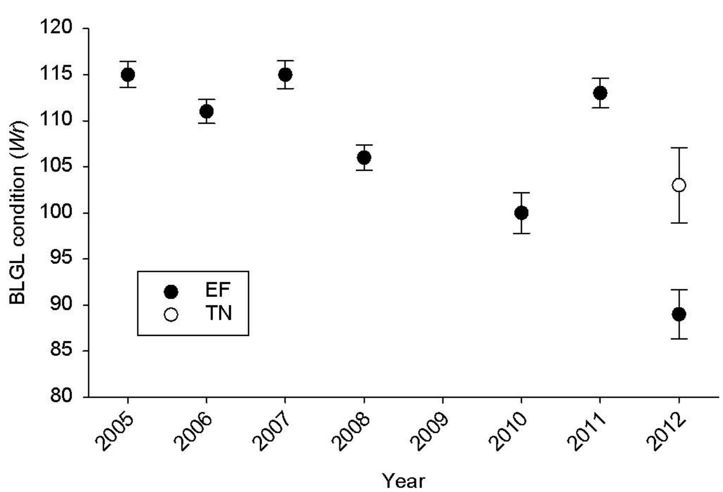


Figure Pelican-10. Condition (W_r) of bluegill caught by electrofishing (EF) and trap nets (TN) set in Pelican Lake from 2005 to 2012. Error bars represent ±1 SE.

Golden shiner

Relative abundance of golden shiners in Pelican Lake remains low. In 2012, one golden shiner (138 mm) was caught in a trap net. No golden shiners were caught during the 2011 sampling season; four golden shiners were caught during 2010, six in 2009, and two in 2008.

Largemouth bass

Relative abundance of largemouth bass in 2012 (mean=17.7; SE=4.5) was low compared to the average *C*/*f* since 2005 (mean=25.8; SE=4.2; Figure Pelican-11). But, stock indices and size structure information suggests the population is composed of a good number of larger (>400 mm) fish (Figures Pelican-11 and -12). Also, a young age class was present, suggesting successful reproduction (Figure Pelican-12). Condition is excellent (*Wr*>100; Figure Pelican-13).

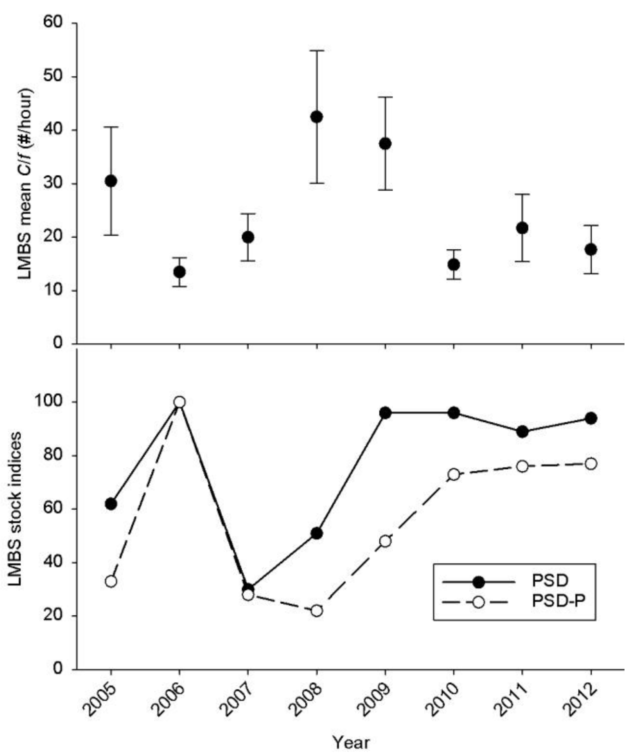


Figure Pelican-11. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of largemouth bass caught by electrofishing in Pelican Lake from 2005 to 2012.

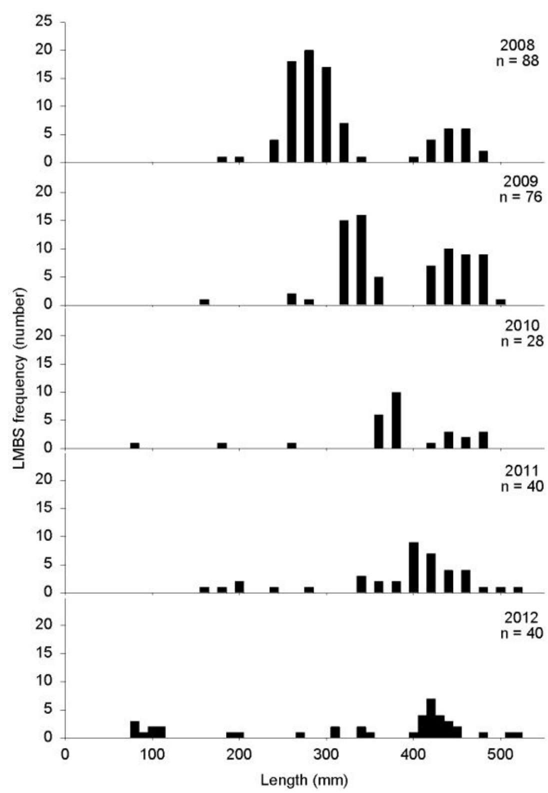


Figure Pelican-12. Length frequency histograms (10 mm groups beginning 2012) of largemouth bass caught by electrofishing in Pelican Lake from 2008 to 2012.

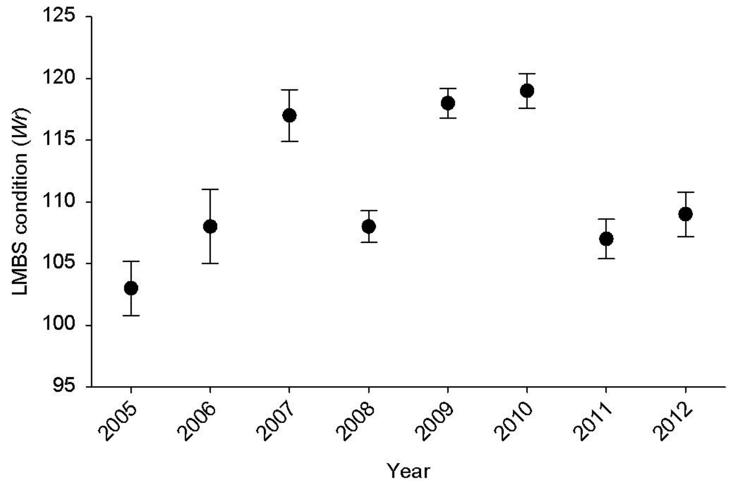


Figure Pelican-13. Condition (W_r) of largemouth bass caught by electrofishing in Pelican Lake from 2005 to 2012. Error bars represent ±1 SE.

Yellow perch

Gill net surveys in Pelican Lake were not completed because water levels were extremely low, which prevented boat access. Additionally, a new boat ramp was under construction at the time of the scheduled survey. The results from the 2011 surveys for yellow perch are reported here.

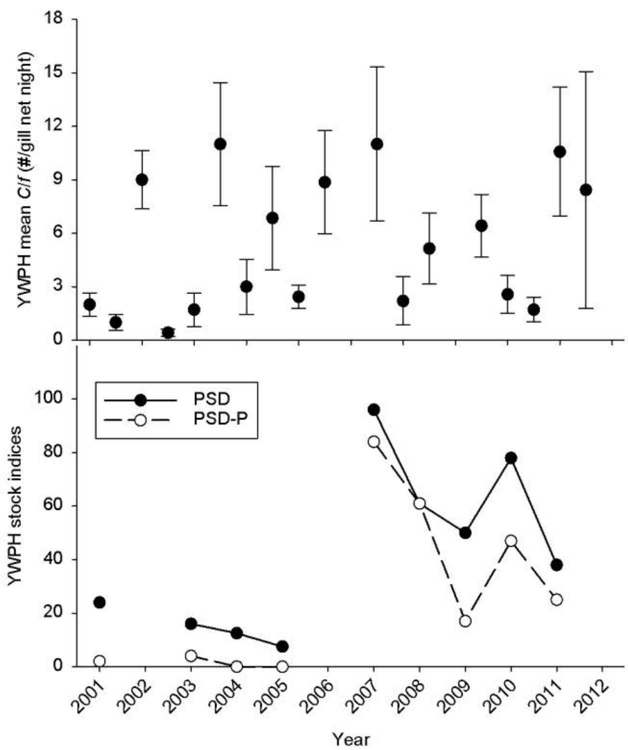


Figure Pelican-14. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of yellow perch caught by gill nets set in Pelican Lake from 2001 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

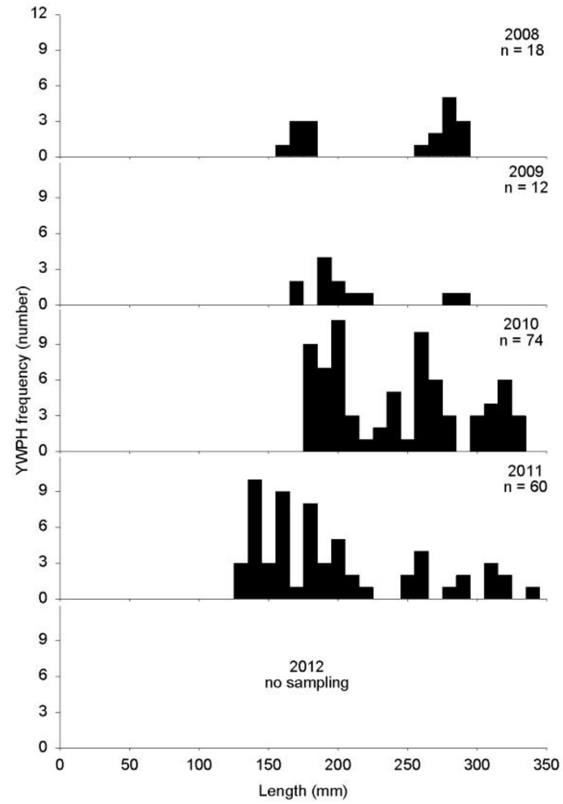


Figure Pelican-15. Length frequency histograms (10 mm groups) of yellow perch caught by gill nets set in Pelican Lake from 2008 to 2011. Due to boat ramp construction and low water levels, data were not collected in 2012.

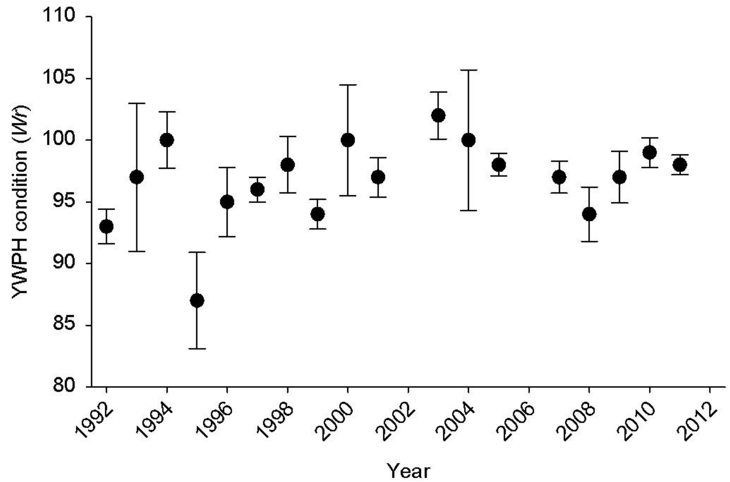


Figure Pelican-16. Condition (W_r) of yellow perch caught by gill nets set in Pelican Lake from 1992 to 2011. Error bars represent ±1 SE. Due to boat ramp construction and low water levels, data were not collected in 2012.

Management Recommendations

1. Monitor conditions for winterkill because of extremely low water levels preceding winter. Develop plan for renovation and (or) stocking should winterkill occur.

2. Because relative abundance of northern pike has slightly decreased, size structure has not changed, and condition of larger northern pike has decreased, the 28 inch maximum size limit for northern pike should be evaluated to determine if the regulation is satisfying management goals.

3. Conduct fisheries surveys in 2013.

WATTS LAKE

Notes

Standard fisheries surveys in Watts Lake occur during odd years (i.e., every other year), so survey results do not exist for 2012. However, anecdotal observations were made by refuge biologist M. Lindvall and NGPC biologists. A small number of dead fish (~20 fish; small and large; largemouth bass, common carp, yellow perch, northern pike) along ~500 yards of shoreline were noted on the east side of the lake around October 29, 2012 leading to concerns of a possible fish kill. NGPC and refuge biologists electroshocked the lake on November 20. Good numbers of live largemouth bass, bluegill, yellow perch, some common carp, and northern pike were observed.

Lake-surface elevation data was available for 2012 and presented here.

Water surface elevation

Generally, spring lake-surface elevation is higher than fall elevation in Watts Lake ($F_{1, 28}$=13.33; p=0.004; Figure Watts-1, top panel); mean lake-surface elevation in the spring for 2012 was similar to past years of record, but the fall elevation reading was the lowest on record (Figure Watts-1, top panel). The relative change in lake-surface elevation from spring to fall was the largest observed to date (Figure Watts-1, bottom panel). Watts Lake's water surface dropped 1 m over the summer, largely due to the extreme drought conditions in 2012. Overall, lake-surface elevation has been decreasing since 1992 in both the spring ($F_{1, 14}$=4.72; p=0.05; r^2=0.25) and fall ($F_{1, 11}$=9.42; p=0.01; r^2=0.46; Figure Watts-1, top panel), but the overall change in elevation from spring to fall has remained consistent ($F_{1, 9}$=1.20; p=0.30; r^2=0.12; Figure Watts-1, bottom panel).

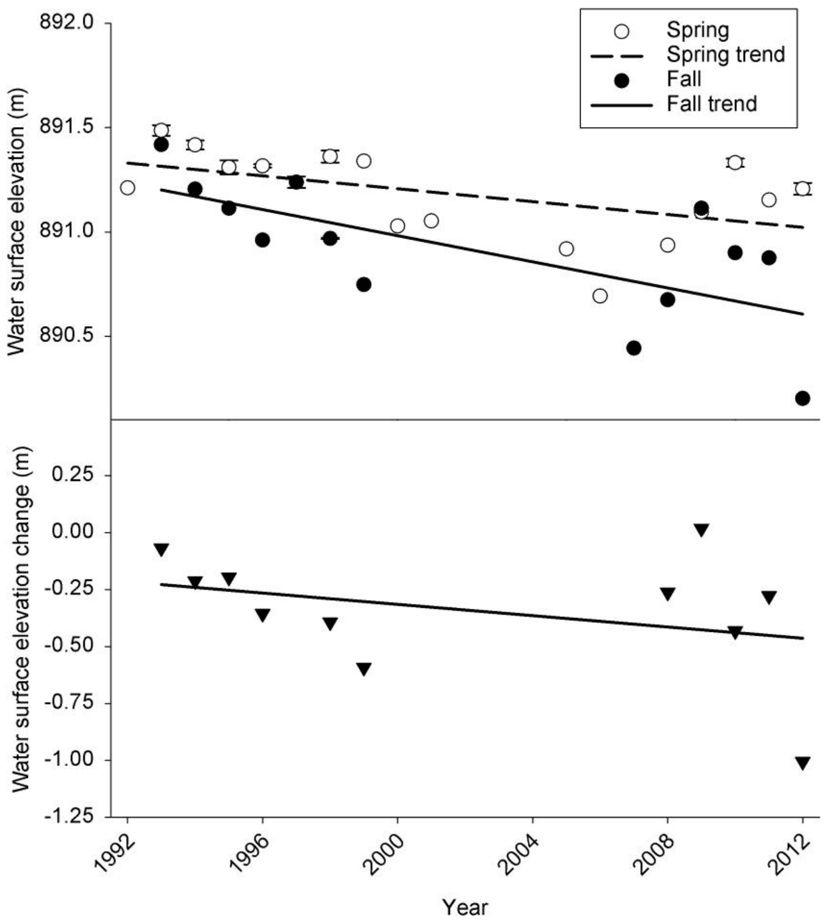


Figure Watts-1. Water surface elevation (m above mean sea level; top panel) and relative change in water surface elevation from spring to fall (bottom panel) at Watts Lake from 1992 to 2012. Mean elevation was calculated for spring (March–April) and fall (September–October) time periods. Solid and dashed lines represent regression lines. Error bars (if present) represent one standard error.

WEST LONG LAKE

Lake description

At full pool, West Long Lake has 25 surface ha (62 ac), a maximum depth of 1.8 m (6 ft), and a mean depth of 1.2 m (4 ft). The lake bottom is generally flat and sandy with an organic substrate around the edges. Submerged vegetation, including narrow and curly-leaf pondweed, milfoil, coontail, and duck weed is spread over almost 100% of the lake. Emergent vegetation, predominately cattail, bulrush, and scattered areas of *Phragmites* nearly surround the entire perimeter of the lake and also forms "islands" within the lake.

The lake is a semi-closed system and has no water control structures. During periods of high precipitation, water can connect West Long and Pelican lakes via a meadow on the northwest side of West Long and allow fish movement between lakes.

West Long Lake was chemically renovated sometime during the 1980s, but details are limited about this renovation. To date, common carp have not been observed in the lake.

Primary sport fish are bluegill, largemouth bass, and yellow perch. Black bullhead and northern pike are also present.

The lake receives moderate fishing pressure during the spring and fall, but decreases in the summer due to dense submerged vegetation. Fishing pressure during the winter is less than the other refuge lakes unless accessibility to the other lakes is hampered by heavy snow. 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. A new, concrete boat ramp was constructed in 2012.

Fishing regulations are in place for largemouth bass, northern pike, and panfish (see Appendix 2). The current size restrictions in West Long Lake are a maximum size limit of 711 mm (28 in) for northern pike (implemented in 1993) and a 381 mm (15 in) minimum for largemouth bass (since 2007). Panfish do not have a length restriction. Daily bag limits are three, four (1>533 mm [21 in]), and 15 for pike, bass, and sunfish, respectively.

Results and Discussion

Water quality

Water quality was measured (Table West Long-1) in May, but not during the fall (September) because the boat ramp was under construction.

Table West Long-1. Surface water quality values at West Long Lake from 1999 to 2012. The spring time period is denoted by ‘S’, fall by ‘F’, ‘.’ indicates no sample, and “*” indicates water levels were too low to collect a sample.

	Temp. (°C)		Dissolved oxygen (mg/L)		Secchi depth (cm)		pH		Pheno. alkal. (mg/L)		Total alkal. (mg/L)		Conduc-tivity (µS/cm)		Tur-bidity (NTU)	
Year	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
2012	20	.*	9.7	. *	43	. *	.	. *	17	. *	103	. *	268	. *	12	. *
2010	14	24	7.6	10.3	.	.	8.2	8.7	0	0	103	103	251	323	.	.
2008	.	16	11.1	8.2	.	.	.	.	0	17	171	120	270	292	.	.

Common carp

Common carp were not observed during sampling in 2012.

Northern pike

Due to low water levels and boat ramp construction, gill net surveys were not conducted in 2012. Northern pike were not observed in trap nets. In 2010, one northern pike (601 mm) was caught during gill net surveys.

Black bullhead

In 2012, zero black bullheads were observed in trap nets. Four black bullheads (246–330 mm) were caught in gill nets and one (82 mm) in a trap net in 2010. During fall gill net surveys in 2008, nine black bullheads were caught (255–380 mm).

Bluegill

Mean relative abundance of bluegill in 2012 (mean=82.7; SE=2.7) was lower than values from 2010, but similar to 2006 and 2008 (Figure West Long-1). Stock indices (Figure West Long-1) and size structure (Figure West Long-2) suggest that bluegill in West Long are reaching longer lengths compared with past years. Condition is excellent as mean *Wr* values exceed 120 (Figure West Long-3).

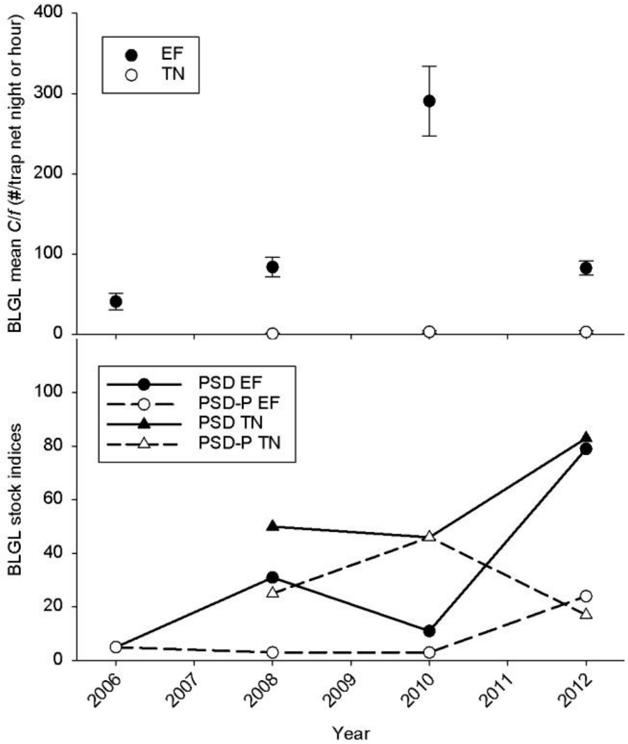


Figure West Long-1. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of bluegill caught by electrofishing and in trap nets set in West Long Lake from 2006 to 2012.

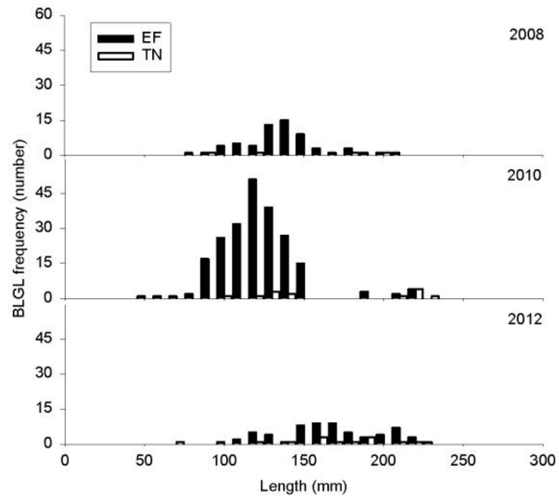


Figure West Long-2. Length frequency histograms (10 mm groups) of bluegill caught by electrofishing and trap nets set in West Long Lake from 2008 to 2012.

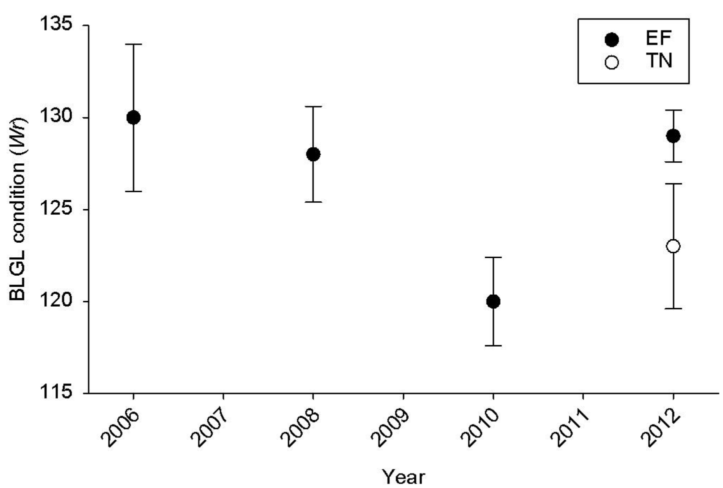


Figure West Long-3. Condition (W_r) of bluegill caught by electrofishing and trap nets set in West Long Lake from 2006 to 2012. Error bars represent ±1 SE.

Largemouth bass

Mean relative abundance of largemouth bass in 2012 (mean=116; SE=21) was similar to the average since 2006 (mean=131; SE=73; Figure West Long-4). A larger number of longer fish were present in 2012 (Figure West Long-5). Condition is low relative to the past several years, but mean *Wr* is still >90 (Figure West Long-6).

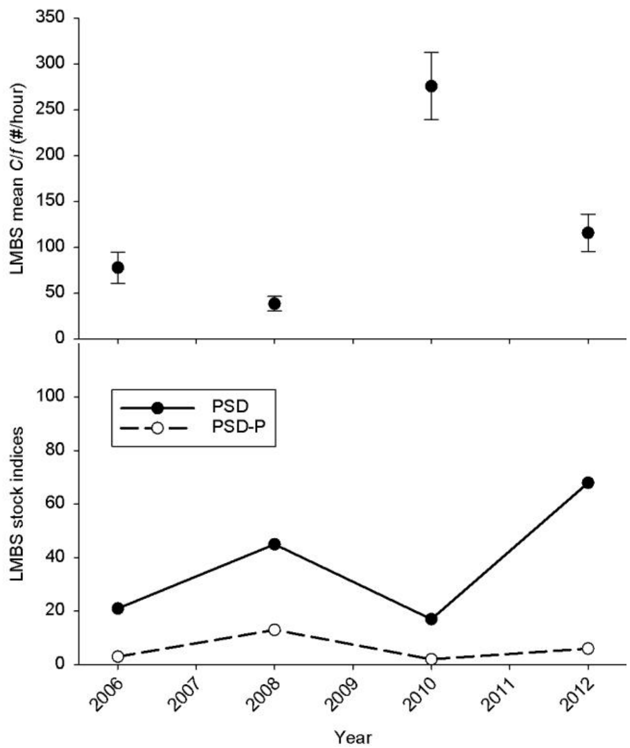


Figure West Long-4. Mean relative abundance (C/f ± 1 SE; top panel) and stock indices (bottom panel) of largemouth bass caught by electrofishing in West Long Lake from 2006 to 2012.

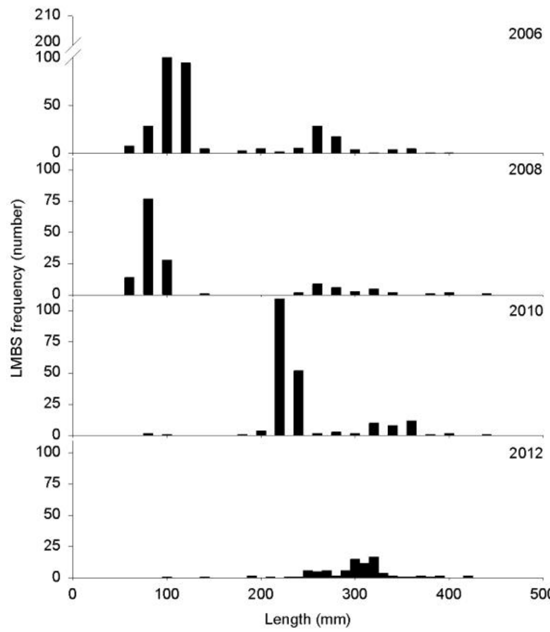


Figure West Long-5. Length frequency histograms (10 mm groups beginning 2012) of largemouth bass caught by electrofishing in West Long Lake from 2006 to 2012.

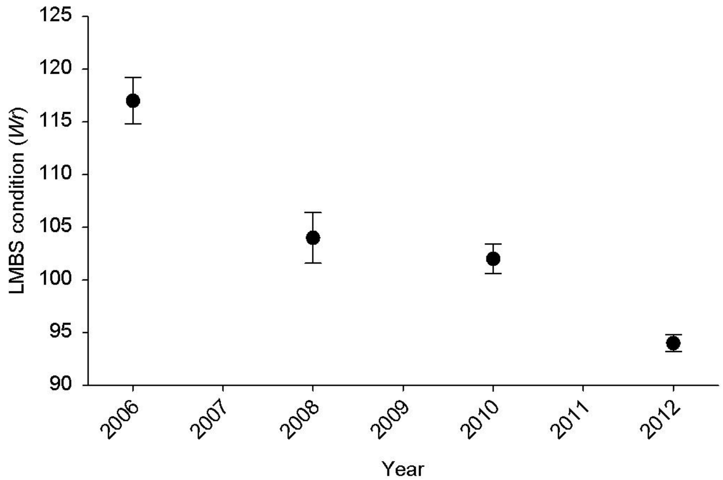


Figure West Long-6. Condition (W_r) of largemouth bass caught by electrofishing in West Long Lake from 2006 to 2012. Error bars represent ±1 SE.

Yellow perch

Gill net surveys in West Long Lake were not completed because water levels were extremely low, which prevented boat access. Additionally, a new boat ramp was under construction at the time of the scheduled survey. The results from the 2011 surveys for yellow perch are reported here.

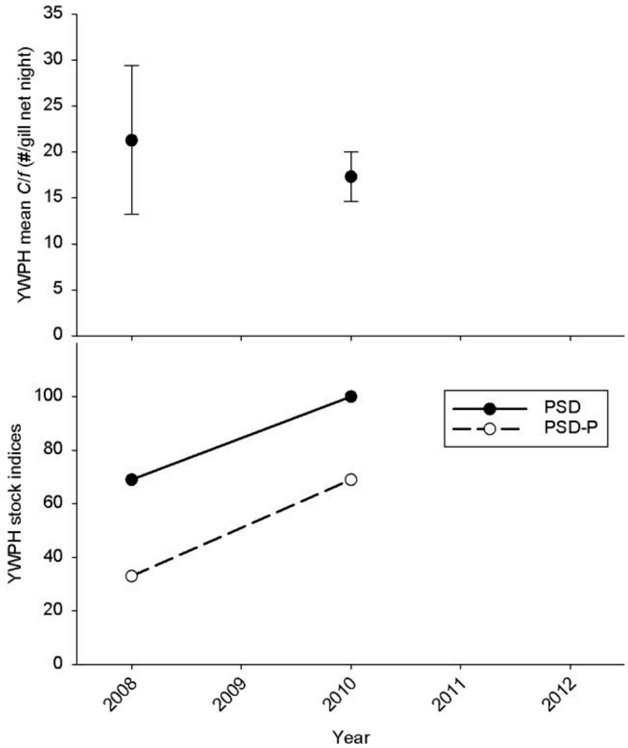


Figure West Long-7. Mean relative abundance (*C*/*f* ± 1 SE; top panel) and stock indices (bottom panel) of yellow perch caught by gill nets set in West Long Lake from 2008 to 2012. Due to boat ramp construction and low water levels, gill net data were not collected in 2012.

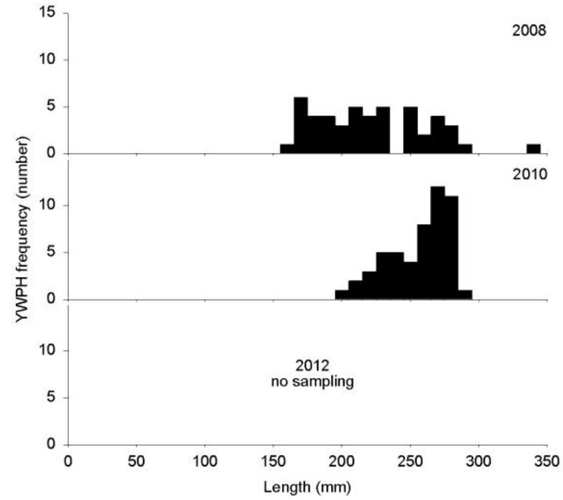


Figure West Long-8. Length frequency histograms (10 mm groups) of yellow perch caught by gill nets set in West Long Lake from 2008 to 2012. Due to boat ramp construction and low water levels, gill net data were not collected in 2012.

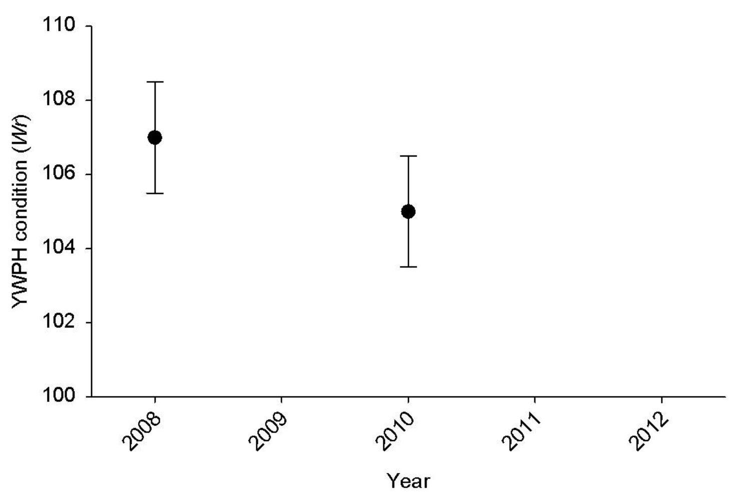


Figure West Long-9. Condition (W_r) of yellow perch caught by gill nets set in West Long Lake from 2008 to 2012. Error bars represent ±1 SE. Due to boat ramp construction and low water levels, gill net data were not collected in 2012.

Management Recommendations

1. Monitor conditions for winterkill because of extremely low water levels preceding winter. Develop plan for renovation and (or) stocking should winterkill occur.

2. Conduct full fisheries surveys in 2014. Consider conducting gill net surveys in 2013 because surveys were not possible in 2012.

ACKNOWLEDGEMENTS

I thank Rob Klumb, Dane Shuman, and Kristen Grohs (USFWS, Great Plains Fish and Wildlife Conservation Office) for field assistance and reviewing drafts of this report. I also thank technicians Jake Billings, Kirstyn Larsen, Jake Lindgren, and Zach Pawlowski (USFWS, GPFWCO) for field assistance. Mark Lindvall and Melvin Nennemen (USFWS, Valentine NWR) provided housing accommodations, water elevation data, and other miscellaneous information used in this report. Funding was provided by the Valentine NWR.

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APPENDICES

Appendix 1. Fish stocking history at lakes on the Valentine National Wildlife Refuge. Size designations are: FY = fry (hatch to 1.49 in); FG = fingerling (1.5 to 5.49 in); AD = adult (sexually mature, regardless of size); MX = mixed (trap and transfer).

	Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
Year	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Clear Lake																					
2009							Mar	6	AD												
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																					
Dad's Lake																					
1987							Apr	150,000	FY												
Dewey Lake																					
2004	Aug	43	AD				Aug	195	AD	Aug	150	AD									
1992																					
1991	Jul	28,000	FG	Aug	50,000	FY															
1989							Mar	1,010	AD												
1987							Mar & Apr	1,256	AD												
1985				Sep	50,000	FY															
1981[a]																					
Duck Lake																					
1995																Jun	4,000	FY			
1994																Apr	4,000	FG			
1991	Jul	10,000	FY	Aug	30,000	FY				Jun	20,000	FY									
1986				Aug	25,000	FY															
1985				Sep	38,000	FY															

Appendix 1 continued.

	Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
Year	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Hackberry Lake																					
2008				Sep	52,445	FG															
2007	Jun	40,865	FG	Mar & Sep	179,194	FG															
2006				Oct	364,315	FG															
2005	Aug	31	AD	Oct	148,070	FG				Jun	136,000	FY									
	May& Aug	68,200	FG	Feb & Mar	128,000	FG				Apr	1,400,000	Egg									
										Feb	19,068	FG									
2004[a]				Oct	86,250	FG															
1996				Oct	75,000	FG															
1992							Apr	1,200	MX												
1991	Aug	35,000	FG																		
1990	Jul	35,000	FG																		
1989	Aug	37,000	SA																		
1986	Jul	30,000	FG	Aug	25,000	FY	Mar	203	AD												
	May	107	AD																		
1985				Sep	50,000	FY															
Pelican Lake																					
2010							Apr	5	AD												
1996				Oct	102,800	FG															
1995										Apr	2,000	AD									
1994							Mar	651	AD	Apr	59,981	MX									
1993										Apr	5,651	MX									
1992	Jun	136,000	FY							Apr	1,100	AD									
1991	Jul	40,000	FG																		
1990	Jul	40,000	FG																		
1989	Jul	32,000	FG																		
1986							Mar	207	AD												
1985				Sep	50,000	FY				Apr	7,660	AD									
Rice Lake																					
2010	Jun	81	AD	Jun	42	AD															
2004				Mar	26,048	FY				Mar	3,326	FG									
2011				Sep	24,440	FG															

Appendix 1 continued.

	Largemouth bass			Bluegill			Northern pike			Yellow perch			Black crappie			Sauger X walleye			Muskellunge		
Year	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size	Month	N	Size
Watts Lake																					
2005	Sep	15,525	FG	Oct	148,070	FG				Aug	19,261	FG									
1997																			Sep	100	SA
1996				Oct	30,000	FG										Jun	10,000	FG	Sep	50	SA
1995																Jun	5,000	FG			
1994																Apr	5,000	FG			
1992	Jun	50,000	FY																		
1991	Jul	5,000	FG																		
1990	Jul	5,000	FG				May	77	AD												
1989	Jul	5,000	FG																		
1988																			Jun & Sep	47	AD
1987																			Aug	347	AD
																			May	6,500	FY
1986																			Jun	75	FG
1985																			Aug	1,152	SA
West Long Lake																					
1986				Aug	25,000	FY															
1985																					
1998	Apr	124	AD																		
1996	Sep	70	AD																		
1994										Apr	2,241	AD									
1992										Apr	1,100	AD									
1991	Jul	10,000	FG	Aug	20,000	FG				Jun	30,000	FG									
1986	Jul	15,000	FG	Aug	25,000	FY															
Willow Lake																					
2009										Sep	35,750	FG									
1988				Aug & Sep	116,000	FG	Apr	180,000	FY	Apr	4,000	AD									
2011				Sep	149,400	FY															

[a] Year of chemical renovation.

Appendix 2. Summary of fishing regulations at lakes on the Valentine NWR. Panfish species include black crappie, bluegill, green sunfish, orange-spotted sunfish, pumpkinseed, sunfish hybrids, and yellow perch. The bag limit for panfish is an aggregate.

Lake	Species	Time period (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	2011 – present		15
		1988 – 2010		30
		1987		No limit
Dewey, 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	2011 – present		15
		1988 – 2010		30
		1987		No limit

Appendix 2 continued.

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	2011 – present		15
		1988 – 2010		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	2011 – present		15
		1988 – 2010		30
		1987		No limit
	Saugeye	2007 – present	15 in min and 1 > 22 in	4
Other refuge lakes	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	2011 – present		15
		1988 – 2010		30
		1987		No limit

Appendix 3. Parameters and references used to calculate stock indices and condition factors.

Table Appendix 3-1. Proposed length categories for fish species commonly found in Valentine NWR lakes.

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

Note: all measurements are total length: E = English units (inches); M = metric units (cm).

Table Appendix 3-2. Intercept (a) and slope (b) parameters for standard weight (Ws) equations and the minimum total length (mm) recommended for use.

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

Note: The Ws equation is log10*(Ws) = a + b*(log10 total length). Metric (M) values are millimeters and grams; English (E) values are inches and pounds.

Appendix 4. Glossary of fisheries terms.

Alkalinity: a measure of the resistance of water to change in pH, expressed in mg/L or ppm. Because alkalinity is dependent on minerals such as calcium (Ca) and is related to aquatic vegetation production, alkalinity is an indicator of a water body's potential to produce biomass. An alkalinity value less than 40 mg/L is considered soft water while a value greater than 40 mg/L is considered hard water.

Catch per unit effort (C/f): an index of abundance used to document relative changes over time (also known as relative abundance), calculated as,

$$C/f = \frac{\text{number of fish (per length group, category, or sample)}}{\text{effort in unit of time (e.g., hour or net night)}}$$

Conductivity: a measure of water's ability to conduct electrical current, which is dependent on the amount of ions in the water. Total dissolved solids (TDS) are equal to ~0.5*conductivity. Conductivity is an approximate measure of a water body's productivity due to a relationship between minerals and productivity.

Effort: the amount of time expended in collecting a sample (e.g., hours, minutes, or net nights). Effort is used to calculate C/f.

Memorable length: the length of a fish (unique to each species) considered as the length that most anglers remember catching, quantified as 59–64% of the world record length for that species.

Net-night: a unit of time (i.e., overnight, <24 hr.) describing the effort expended for a sampling gear, such as a gill net or trap net. For example, if five gill nets were left in the water overnight, five gill net nights of effort were expended.

pH: a measure of how basic or acidic water is. Pure water is considered neutral with a pH of 7. Because pH is on a log10 scale, a change of 1 pH unit equates to a 10-fold increase in H^+ (hydrogen ions).

Preferred length: the length of a fish (unique to each species) that is considered the preferred length that most anglers want to catch, quantified as 45–55% of the world record length for that species.

Proportional size distribution (PSD): the percentage of a sample of stock length fish that are also greater than the number of fish ≥ a fish's length category (i.e., quality, preferred, memorable, trophy), calculated as,

$$\text{PSD} = \frac{\text{number of fish} \geq \text{quality length}}{\text{number of fish} \geq \text{stock length}} \text{ X } 100$$

$$\text{PSD} - \text{P} = \frac{\text{number of fish} \geq \text{preferred length}}{\text{number of fish} \geq \text{stock length}} \text{ X } 100$$

$$\text{PSD} - \text{M} = \frac{\text{number of fish} \geq \text{memorable length}}{\text{number of fish} \geq \text{stock length}} \text{ X } 100$$

$$\text{PSD} - \text{T} = \frac{\text{number of fish} \geq \text{trophy length}}{\text{number of fish} \geq \text{stock length}} \text{ X } 100$$

Relative weight (W_r): an index of the condition, or general well-being, of a fish, calculated as,

$$W_r = \frac{\text{weight (W)}}{\text{standard weight (Ws)}} \times 100$$

where W is the weight (g) of an individual fish and Ws is a length specific standard weight.

Quality length: the length of a fish (unique to each species) that is considered the minimum length most anglers would keep, quantified as 36–41% of the world record length for that species.

Standard error (SE): the standard deviation of the sampling distribution of a statistic, calculated as,

$$\frac{\text{standard deviation}}{\sqrt{\text{n}}}$$

or,

$$\sqrt{\frac{\text{variance}}{\text{n}}}$$

where n is the sample number.

Standard weight: weight of a fish standardized by regression of weight on length for a particular species, often determined by the 75th percentile weight rather than average weight in a length-class.

Stock length: the length of a fish (unique for each species) considered as the length that a fish reaches sexual maturity, quantified as 20–26% of the world record length for that species.

Trophy length: the length of a fish (unique to each species) considered to be a length worthy of acknowledgement, quantified as 74–80% of the world record length for that species.

Variance: a measure of the dispersion around the average of the sample, calculated as,

$$(\text{observed value} - \text{sample mean})^2$$

Appendix 5. Turtle catch Valentine NWR lakes.

Table Appendix 5-1. Incidental catch of turtle species caught in trap nets during fisheries surveys in either spring (S) or fall (F). Number (N) and mean catch per unit effort (*C*/*f*; turtles/net-night ± 1 SE) are reported for painted *Chrysemys picta*, snapping *Chelydra serpentina*, and Blanding's *Emydoidea blandingii* turtles.

	Painted		Snapping		Blanding's	
Sample period	N	Mean *C*/*f*;	N	Mean *C*/*f*;	N	Mean *C*/*f*;
Clear Lake						
2012 (S)	4	0.4 (0.2)	0		0	
2011 (S)	3	0.3 (0.2)	0		0	
2010 (S)	1	0.1 (0.1)	0		0	
2009 (S)	17	1.7 (0.4)	0		0	
Dewey Lake						
2012 (S)	12	1.2 (0.6)	3	0.3 (0.2)	0	
2011 (S)	33	3.3 (1.3)	2	0.2 (0.1)	1	0.1 (0.1)
2010 (S)	22	2.2 (1.0)	0		0	
2009 (S)	52	5.2 (3.0)	0		0	
2008 (S)	11	1.1 (0.6)	0		0	
2008 (F)	38	3.8 (1.4)	0		0	
Hackberry Lake						
2012 (S)	54	4.5 (1.3)	1	0.1 (0.1)	0	
2011 (S)	10	0.9 (0.4)	1	0.9 (0.9)	0	
2010 (S)	11	1.1 (0.5)	0		0	
2009 (S)	13	1.3 (0.8)	1	0.1 (0.1)	0	
Pelican Lake						
2012 (S)	47	3.9 (1.2)	3	0.3 (0.1)	0	
2011 (S)	22	1.8 (1.2)	6	0.5 (0.2)	0	
2010 (S)	41	3.4 (1.6)	0		0	
2009 (S)	64	5.3 (1.4)	3	0.3 (0.3)	0	
2008 (S)	6	0.5 (0.3)	0		0	
Duck Lake						
2012 (S)	7	1.4 (0.9)	0		1	0.2 (0.2)
2010 (S)	11	2.2 (0.7)	0		0	
2009 (S)	59	11.8 (3.9)	2	0.4 (0.2)	0	
Watts Lake						
2011 (S)	81	11.6 (4.2)	12	1.7 (0.8)	0	
2009 (S)	20	2.9 (1.3)	0		0	
West Long Lake						
2012 (S)	3	0.8 (0.5)	0		0	
2010 (S)	4	1.0 (0.4)	0		0	
2008 (F)	1	0.3 (0.3)	0		2	0.5 (0.3)

Appendix 6. Water chemistry results for Valentine NWR during 2011.

Table Appendix 6-1. Results from water chemistry analysis for nitrate, nitrite, total nitrogen, orthophosphorous, total phosphorous, and ammonia from Clear, Dewey, Hackberry, Pelican, and Watts lakes sampled during the fall of 2011. Analysis was performed using a Hach DR–2800 spectrophotometer.

Date	Sub-sample	Date	Nitrate (mg/l)	Nitrite (mg/l)	Total Nitrogen (mg/l)	Othro-Phosphorous (mg/l)	Total Phosphorous (mg/l)	Ammonia (mg/l)
Clear	1	8/30/2011	0.316	0.017		10.3	8.32	0.005
Clear	2	8/30/2011	0.247	0.012		56.8	30.6	0.064
Dewey	1	8/30/2011	0.312	0.024	3.26	17.6	12.3	0.064
Dewey	2	8/30/2011	0.314	0.018		4.87	2.48	0.095
Hackberry	1	8/29/2011	0.298	0.02	3.55	2.63	15.6	0.096
Hackberry	2	8/29/2011	0.305	0.025		3.61	3.99	0.106
Pelican	1	8/29/2011	0.306	0.015	2.71	2.92	4.77	0.184
Pelican	2	8/29/2011	0.297	0.021		2.27	12	0.107
Watts	1	8/30/2011	0.322	0.024	3.65	3.99	1.31	0.088