

Bitter Lake

Site Description

Location

Water designation number (WDN)	22-0016-00
Legal description	T121N-R54W-Sec. 8-10, 15-17, 20-23, 27-29, 33, 34
County (ies)	Day
Location from nearest town	1/2 mile south of Waubay

Survey Dates and Netting Information

Dates of current survey	August 26-28, 2008 (GN) October 2, 2008 (EF-WAE)
Dates of last survey	August 28-30, 2007 (GN) October 3, 2007 (EF-WAE)
Gill net sets (n)	8
Fall electrofishing (min)	61

Morphometry (Figure 1)

Watershed area (acres)	71,248
Surface area (acres)	9,900
Maximum depth (ft)	24
Mean depth (ft)	---

Ownership and Public Access

Bitter Lake (Figure 1) is a meandered lake owned by the State of South Dakota and managed by the SDGFP. Prior to 1990's, most of Bitter Lake was located on a 2,353 acre Game Production Area (GPA) managed by the South Dakota Game, Fish and Parks. Currently, much of the Bitter Lake GPA is under water and most of the lakeshore is privately owned. A public access site is located on the east shore off Day Co. Highway 1 and is maintained by the SDGFP (Figure 2). Private (fee) access is available on the northeast shore just outside the city limits of Waubay.

Watershed and Land Use

The Bitter Lake watershed is comprised of a mix of pasture (50%) and cropland (50%).

Water Level Observations

The elevation of Bitter Lake on October 17, 2007 was 1792.5 fmsl. On May 7, 2008 the elevation was 1793.2 fmsl and as of October 21, 2008 the elevation had increased to 1793.9 fmsl.

Aquatic Vegetation and Exotics

Localized regions of submersed vegetation (e.g., sago pondweed) can be found in Bitter Lake. Common carp has been the only exotic species reported in Bitter Lake.

Fish Management Information

Primary species	walleye, yellow perch
Other species	black crappie, common carp, northern pike, spottail shiner, white bass, white sucker
Management classification	unknown
Fish Consumption Advisories	Mercury: walleye (all sizes); northern pike (> 30"). See the South Dakota fishing handbook for more details on meal and portion size recommendations.

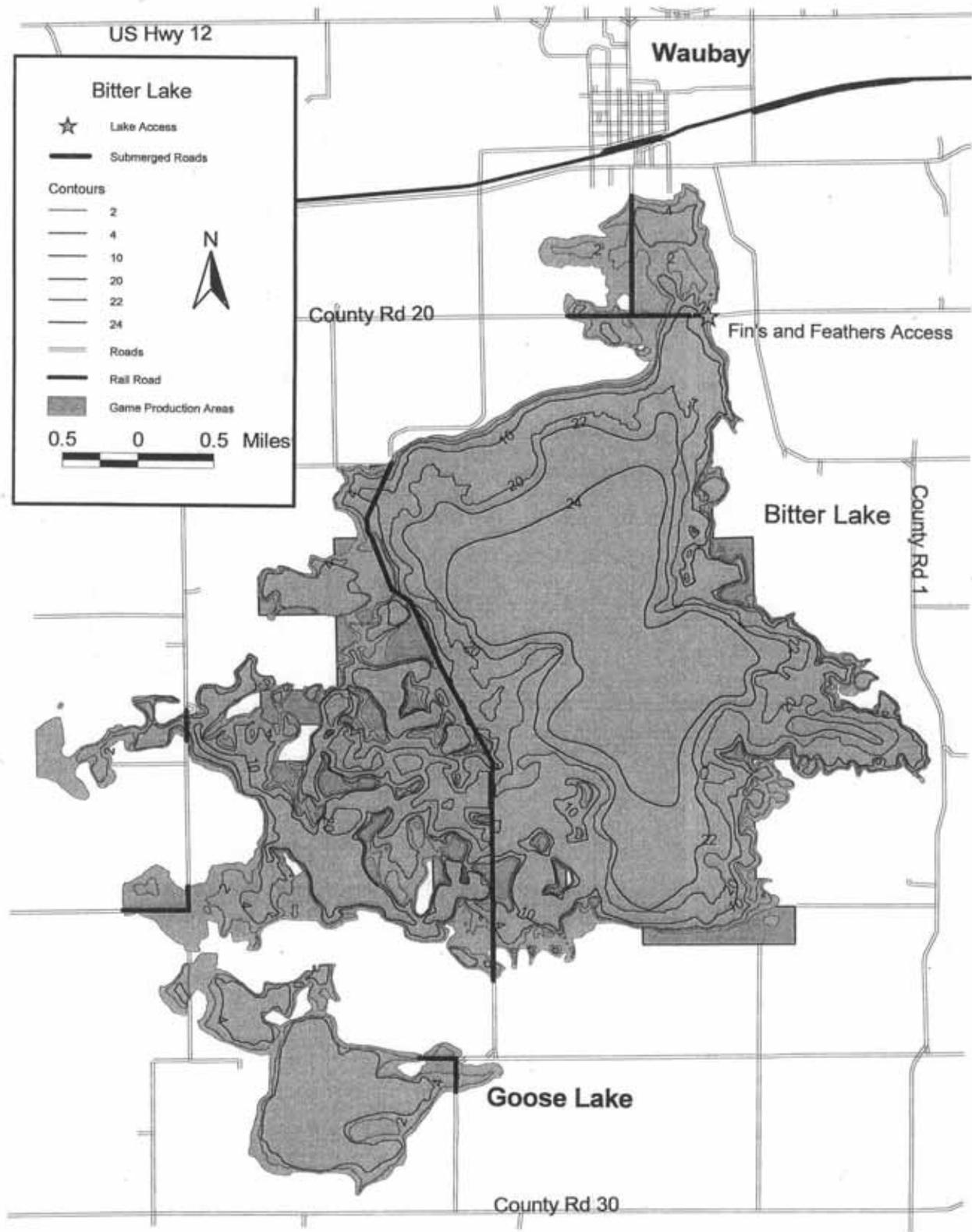


Figure 1. Bitter Lake contour map.

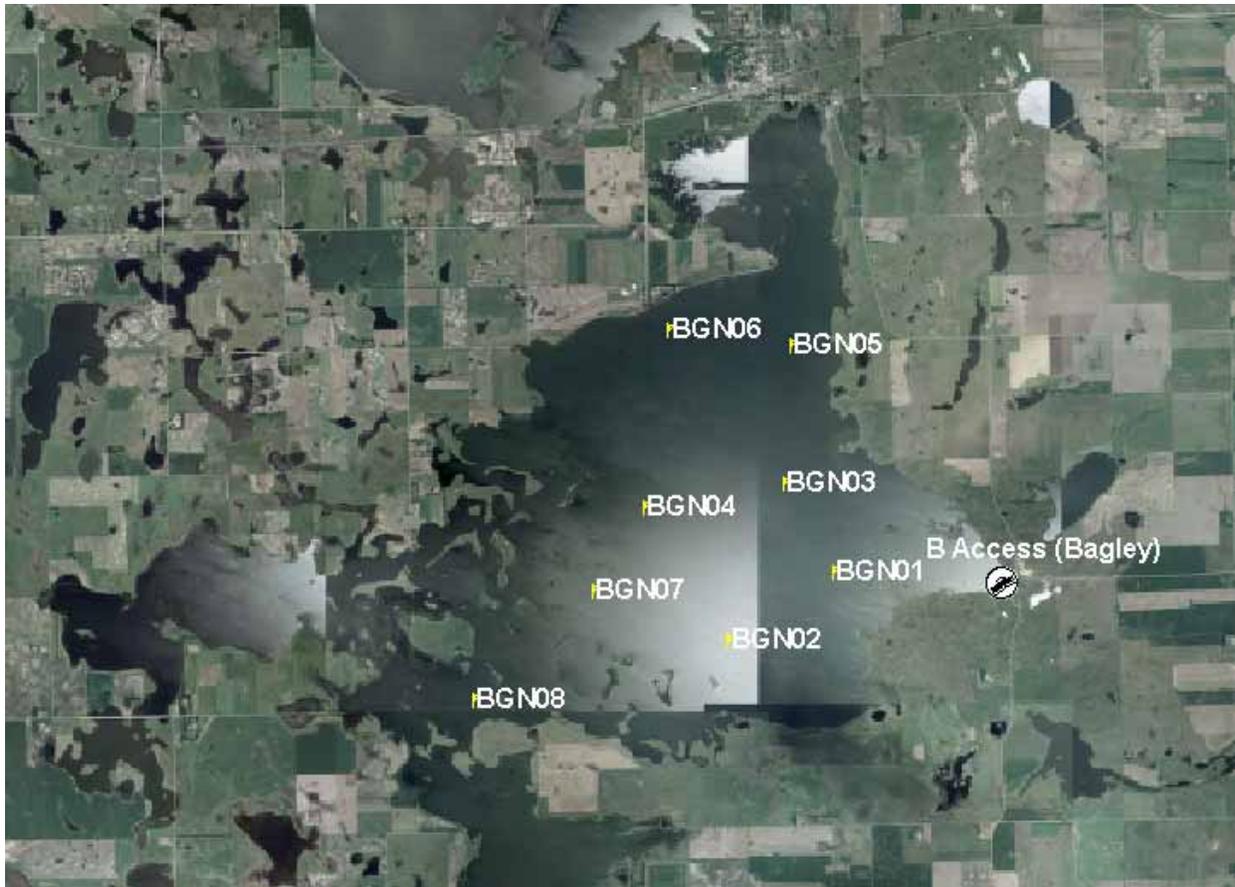


Figure 2. Map depicting public access location and standardized net locations for Bitter Lake, Day County, South Dakota. BGN=gill nets

Management Objectives

- 1) Maintain a mean gill net CPUE of stock-length walleye ≥ 10 , a PSD of 30-60, and a PSD-P of 5-10.
- 2) Maintain a mean gill net CPUE of stock-length yellow perch ≥ 25 , a PSD of 30-60, and a PSD-P of 5-10

Results and Discussion

Bitter Lake is a natural lake located south of Waubay, South Dakota in NE South Dakota. Prior to the 1990's Bitter Lake was a 3,000 acre alkaline slough with approximately 3 ft maximum depth. Above average precipitation during the 1990's, resulted in the chain of lakes leading into Bitter Lake filling and subsequently overflowing into Bitter Lake. Bitter Lake has tripled in size and now covers almost 10,000 acres. In addition, the depth of Bitter Lake has increased significantly and now depths of 24 feet are common. Currently, Bitter Lake is primarily managed as a walleye and yellow perch fishery.

Primary Species

Walleye: The 2008 mean gill net CPUE of stock-length walleye in Bitter Lake was 9.1 (Table 1) and slightly below the minimum objective (≥ 10 stock length fish/net night). Since 2001, the mean gill net CPUE of walleye has ranged from 9.1 (2008) to 31.8 (2006) stock-length walleye/net with the 2001-2008 average being 19.0 (Table 2). The 2008 gill net CPUE was indicative of moderate abundance (4-11 stock-length walleye/net).

Walleye year-classes produced in 2005, 2007 and 2008 comprised approximately 90% of all walleyes sampled by gill nets in Bitter Lake during 2008. Fall night electrofishing and gill net catches suggest limited natural recruitment of walleye in Bitter Lake from 2003-2007, as relatively strong year classes produced in 2005 and 2007 coincided with walleye fry stockings (Table 2; Table 5; Table 6). In 2008, both the gill net catch and fall night electrofishing indicated that a walleye year-class was naturally produced in Bitter Lake (Table 1; Table 6). The mean fall night electrofishing CPUE of age-0 walleye from Bitter Lake in 2008 was 136.9/hour and indicative of a strong year-class; however, recruitment is unknown at this time.

Walleye captured in gill nets during 2008 ranged in total length from 12 to 59 cm (4.7 to 23.2 in), had a PSD of 81 and a PSD-P of 8 (Figure 3). The 2008 PSD of 81 is above the objective range (30-60) indicating a population comprised of a high proportion of walleye exceeding quality-length (≥ 38 cm; 15 in). The increase in PSD is the result of poor recruitment of the 2006 walleye year-class coupled with growth of the abundant 2005 year-class into the quality- to preferred-length category (Table 3; Table 4; Figure 3). The 2008 PSD-P was within the objective range (5-10), and indicates a desired proportion of preferred-length fish (≥ 51 cm; 20 in) in the population (Figure 3). In 2008,

approximately 46% of the walleye captured in gill nets were above the 406-mm (16-inch) minimum length restriction enforced on Bitter Lake (Figure 3).

Walleye in Bitter Lake typically reach the 406-mm (16 in) minimum length restriction during their third growing season at age-2+. Since 2005, weighted mean length at capture data for age-3 walleye in Bitter Lake has ranged from 410 to 461 mm with the 2008 weighted mean length at capture of age-3 walleye being 431 mm (Table 4). Walleyes in the 2008 gill net catch from Bitter Lake had mean W_r values that ranged from 90 to 98 and no length-related trends were apparent. The mean W_r of stock-length walleye was 92 (Table 1).

Yellow Perch: The mean gill net CPUE of stock-length yellow perch in 2008 was 4.1 (Table 1), and below the minimum objective (> 25 stock-length yellow perch/net-night; Table 3). Since 2001, the gill net CPUE of stock-length yellow perch has fluctuated from a low of 2.2 (2003) to a high of 11.8 (2006), with an average of 5.0 (Table 2). Relative abundance of yellow perch in Bitter Lake appears to be low (< 8 stock-length yellow perch/net-night).

Although, relatively consistent the magnitude of yellow perch recruitment in Bitter Lake has generally been low resulting in a population that exhibits low relative abundance, fast growth and high size structure (Table 3; Figure 4). In 2008, collected yellow perch ranged in total length from 9 to 34 cm (3.5 to 13.4 in), had a PSD of 42, and a PSD-P of 24 (Figure 4). The 2008 PSD was within the objective range (30-60); while the PSD-P was above the objective range (5-10).

No growth information was available in 2008. Mean W_r values of yellow perch in the 2008 gill net catch ranged from 108-120 with the mean W_r for stock-length perch being 114 (Table 1). No length-related trends in W_r were apparent during 2008.

Other Species

Northern Pike: Northern pike typically are not sampled effectively using standard lake survey methods; therefore, reported values may not accurately represent the at-large population. Neumann and Willis (1995) reported the most reliable time to sample northern pike with gill nets was late spring following the spawn.

Three northern pike ranging in total length from 73 to 82 cm (28.7 to 32.3 in) were captured by gill nets in Bitter Lake during 2008, resulting in a CPUE of 0.4 (Table 1). Northern pike relative abundance, as indexed by mean gill net CPUE has varied from a high of 2.0 (2002) to a low of 0.3 (2007) with the 2001-2008 average being 0.9 (Table 2). Since 2001, it appears that abundance has declined from moderate to low levels likely the result of reduced northern pike recruitment caused by stable or receding water levels from 2002-2005 limiting available spawning habitat (i.e., flooded terrestrial vegetation) in Bitter Lake. Northern pike depend heavily on flooded vegetation for spawning and recruitment, and tend to have improved recruitment during springs that have rising water levels in northeastern South Dakota lakes.

Other: Common carp and white bass were also captured in low numbers during the 2008 survey (Table 1).

Management Recommendations

- 1) Conduct fish population assessment surveys on an annual basis (next survey scheduled in summer 2009) to monitor fish relative abundance, fish population size structures, fish growth, and stocking success.
- 2) Conduct fall night electrofishing on an annual basis to monitor walleye young-of-the-year abundance.
- 3) Evaluate walleye population dynamics and implement regulations to benefit the population and comply with tool box options.
- 4) Stock walleye fry (1,000 fry/acre) to establish additional year-classes if gill netting and/or fall night electrofishing CPUE of age-0 walleye results warrant (i.e., low gill net CPUE of < 250 mm (10 inch) walleye and/or fall night electrofishing CPUE of age-0 walleye < 75 fish/hour).
- 5) Collect otoliths from walleye and yellow perch (5/cm length group) to assess age structure and growth rates of each population.

Table 1. Mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish, proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish, and mean relative weight (Wr) of stock-length fish for various fish species captured in experimental gill nets and electrofishing in Bitter Lake, 2008. Confidence intervals include 80 percent (\pm CI-80) or 90 percent (\pm CI-90). COC= common carp; NOP= northern pike; WAE= walleye; WHB=white bass; YEP= yellow perch

Species	Abundance		Stock Density Indices				Condition	
	CPUE	CI-80	PSD	CI-90	PSD-P	CI-90	Wr	CI-90
<i>Gill nets</i>								
COC	0.1	0.2	100	---	0	---	109	---
NOP	0.4	0.3	100	0	100	0	75	17
WAE	9.1	3.4	81	8	8	6	92	1
WHB	0.1	0.2	100	---	100	---	110	---
YEP	4.1	3.0	42	15	24	13	114	1
<i>Electrofishing</i>								
WAE ¹ (age-0)	136.9	---	---	---	---	---	---	---

¹ Fall night electrofishing-WAE.

Table 2. Historic mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish for various fish species captured in experimental gill nets and electrofishing in Bitter Lake, 2001-2008. BLC= black crappie; COC= common carp; NOP= northern pike; SPS=spottail shiner; WHS=white sucker; WAE= walleye; YEP= yellow perch

Species	CPUE								Mean
	2001	2002	2003	2004	2005	2006 ³	2007 ³	2008	
<i>Gill nets</i>									
BLC	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
COC	0.2	0.0	0.2	0.0	0.1	0.0	0.3	0.1	0.1
NOP	1.5	2.0	1.5	1.3	0.4	0.8	0.3	0.4	1.0
SPS ¹	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.1
WAE	17.0	13.7	25.8	17.9	20.0	31.8	16.9	9.1	19.0
WHB	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0
WHS	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
YEP	6.8	12.3	2.2	2.9	2.6	11.8	2.6	4.1	5.7
<i>Electrofishing</i>									
WAE ² (age-0)	---	104.4	1.4	0.0	90.1	0.0	440.0	136.9	110.4

¹ All fish sizes.

² Fall night electrofishing-WAE.

³ Monofilament gill net mesh size change (.75", 1", 1.25", 1.5", 2" and 2.5")

Table 3. Mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish, proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish, and mean relative weight (Wr) of stock-length fish for selected species captured in experimental gill nets and electrofishing in Bitter Lake, 2001-2008. NOP= northern pike; WAE= walleye; YEP= yellow perch

Species	2001	2002	2003	2004	2005	2006 ²	2007 ²	2008	Average	Objective
<i>Gill nets</i>										
NOP										
CPUE	2	2	2	1	< 1	1	<1	<1	1	---
PSD	100	92	100	100	100	100	100	100	99	---
PSD-P	22	8	33	10	100	17	100	100	36	---
Wr	83	81	80	84	74	102	84	75	83	---
WAE										
CPUE	17	14	26	18	20	32	17	9	19	≥ 10
PSD	36	49	51	76	96	50	91	81	66	30-60
PSD-P	0	2	2	1	1	8	10	8	4	5-10
Wr	90	88	90	94	89	96	90	92	91	---
YEP										
CPUE	7	12	2	3	3	12	3	4	6	≥ 25
PSD	22	30	77	96	76	64	86	42	62	30-60
PSD-P	12	20	23	61	43	49	29	24	31	5-10
Wr	116	113	114	112	113	97	114	114	112	---
<i>Electrofishing</i>										
WAE ¹										
CPUE (age-0)	---	104	1	0	90	0	440	137	110	---

¹ Fall night electrofishing-WAE.

² Monofilament gill net mesh size change (.75", 1", 1.25", 1.5", 2" and 2.5")

Table 4. Weighted mean length at capture (mm) for walleye captured in experimental gill nets in Bitter Lake, 2001-2008. Note: sampling was conducted at approximately the same time during each year allowing comparisons among years to monitor growth trends.

Year	N	Age											
		0	1	2	3	4	5	6	7	8	9	10	11
2008 ¹	108	130	271	357	431	---	---	509	510	495	598	---	525
2007 ¹	135	170	---	402	---	466	497	484	504	455	599	544	---
2006 ¹	255	191	326	413	461	468	---	490	509	584	442	---	---
2005 ¹	155	---	295	383	410	429	440	455	438	478	---	---	---
2004	141	---	---	371	401	436	432	466	---	---	---	---	---
2003	156	---	279	345	382	411	455	552	---	---	---	---	---
2002	85	---	258	310	361	405	477	---	---	---	---	---	---
2001	97	---	263	342	372	413	403	---	---	---	---	---	---

¹Age assignments made using otoliths; scales were used in previous years

Table 5. Stocking history including size and number for fishes stocked into Bitter Lake, 1997-2008. WAE= walleye; YEP= yellow perch

Year	Species	Size	Number
1997	WAE	fingerling	95,650
	YEP	adult	8,000
1998	WAE	fry	9,228,000
	YEP	juvenile	1,875
	YEP	adult	5,340
1999	WAE	fry	5,322,000
	WAE	fingerling	404,100
2000	WAE	fry	8,015,200
2005	WAE	fry	9,050,000
2007	WAE	fry	10,000,000

Table 6. Numbers of walleye sampled (n) using gill nets, by year class and associated stocking history (Number stocked x 1,000) for walleye captured in Bitter Lake, 2001-2008.

Survey Year	Year Class											
	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
2008 ¹	28	19	1	50			4	2	1	1		2
2007 ^{1,2}	---	1		97		3	14	6	4	1	3	6
2006 ^{1,2}	---	---	1	131	5	9	66		31	5	3	4
2005 ¹	---	---	---		2	7	52	47	15	14	16	2
2004	---	---	---	---			38	45	21	29	8	
2003	---	---	---	---	---	2	26	22	55	38	14	1
2002	---	---	---	---	---	---	7	9	16	16	40	4
2001	---	---	---	---	---	---	---	33	8	24	43	19
Number stocked												
fry		10,000		9,050					8,015	5,322	9,228	
small fingerling										404		
large fingerling												96

¹ Age assignments made using otoliths; scales were used in previous years

² Monofilament gill net mesh size change (.75", 1", 1.25", 1.5", 2" and 2.5")

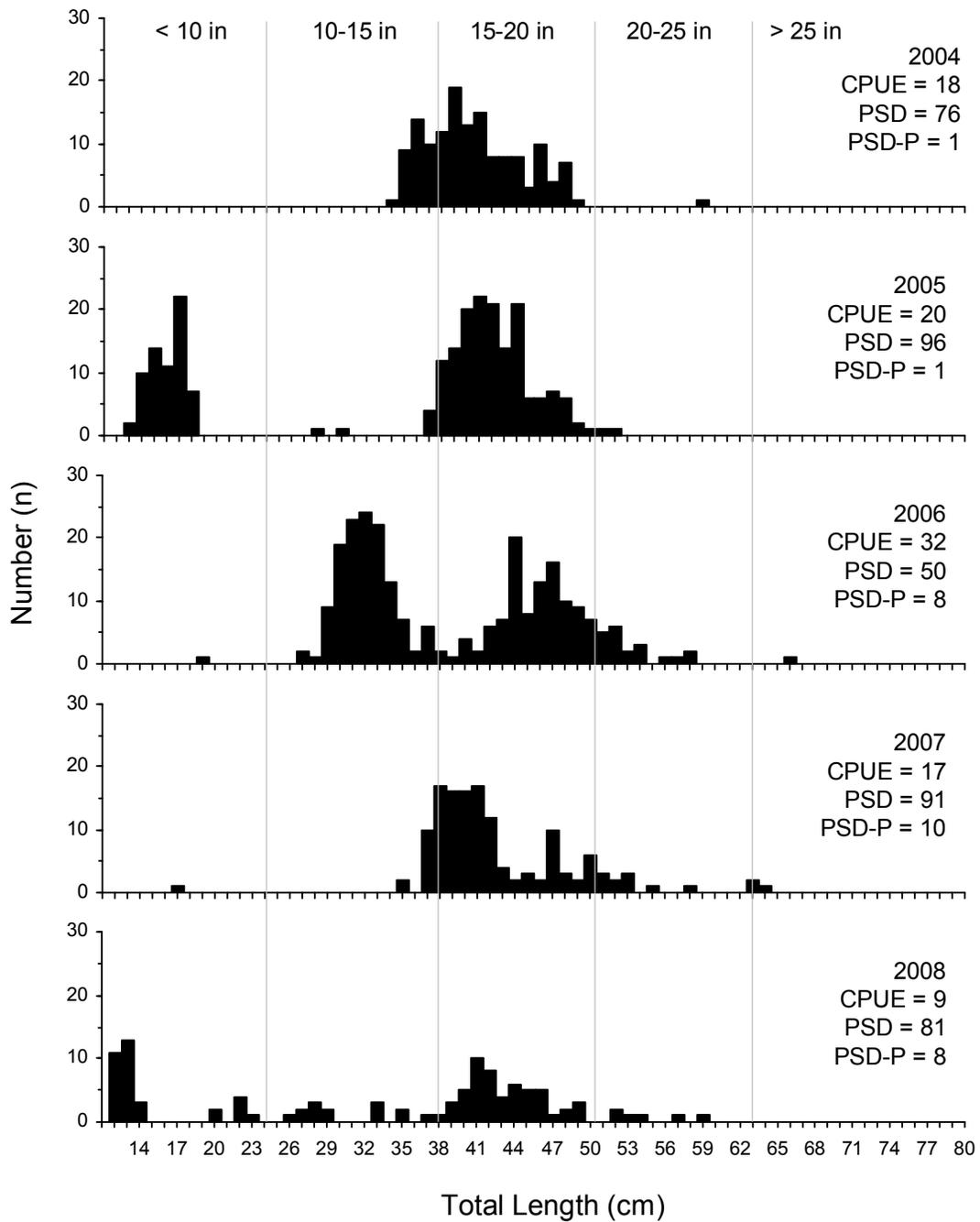


Figure 3. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for walleye captured using experimental gill nets in Bitter Lake, 2004-2008.

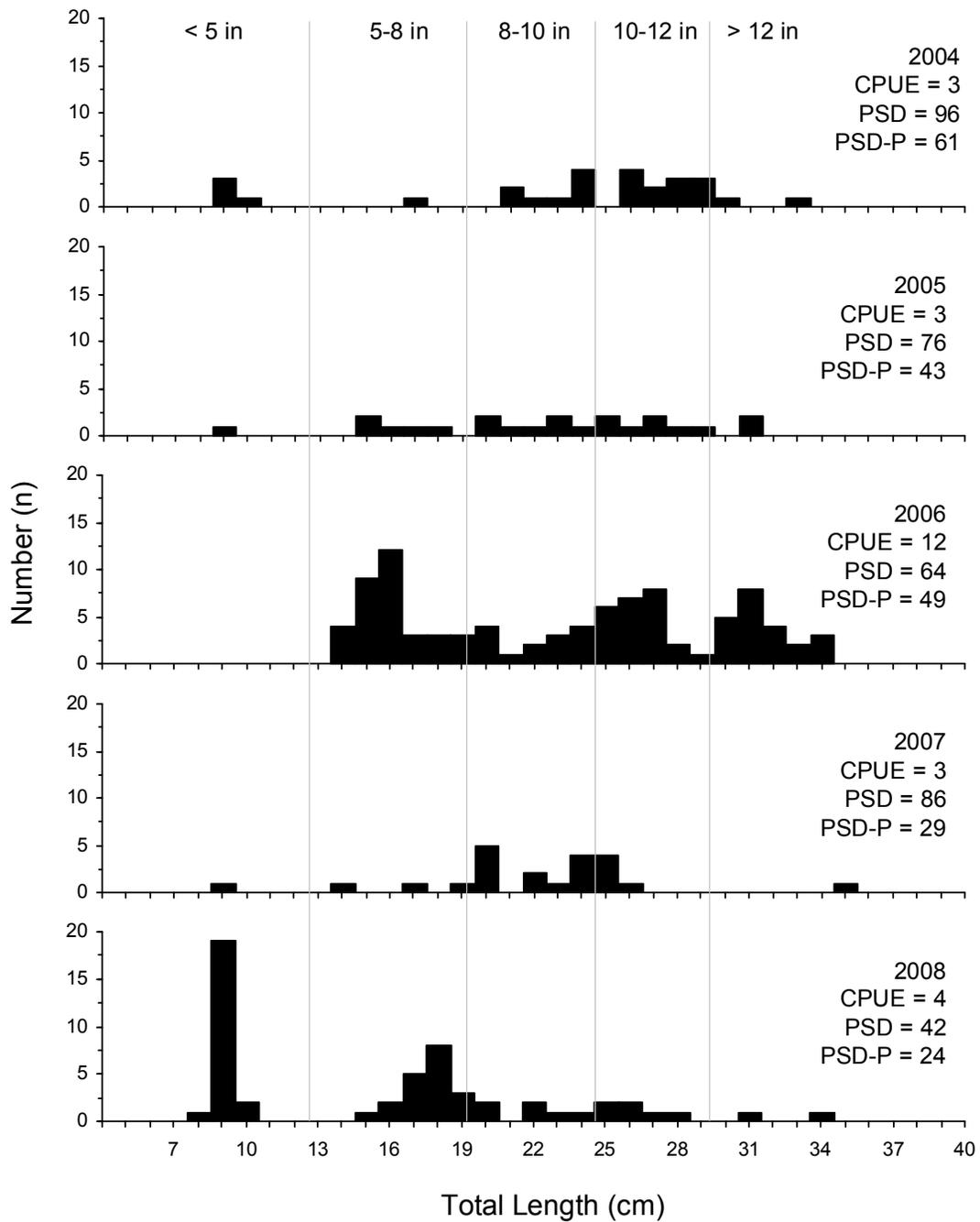


Figure 4. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for yellow perch captured using experimental gill nets in Bitter Lake, 2004-2008.