

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

Survey dates	August 25-27, 2009 (GN) September 14, 2009 (EF-WAE)
Gill net sets (n)	8
Fall electrofishing (min)	60

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 21, 2008 was 1793.9 fmsl, but by April 29, 2009 the elevation had increased to 1797.2 fmsl. On September 30, 2009 the elevation remained at 1797.2 fmsl.

Aquatic Nuisance Species Monitoring

Plant Survey

Submersed vegetation is prevalent in most shallow areas of Bitter Lake. Aquatic plant species identified during the 2009 survey include sago pondweed and common duckweed. No aquatic nuisance plant species were encountered.

Macro-Invertebrate/Mussel Survey

No aquatic nuisance macro-invertebrate or mussel species were sampled in 2009.

Fish Community Survey

No aquatic nuisance fish species were captured during the 2009 survey, but common carp are well established in Bitter Lake and have been sampled in past surveys (Table 2).

Fish Management Information

Primary species	walleye, yellow perch
Other species	black crappie, common carp, northern pike, spottail shiner, white bass, white sucker
Lake-Specific regulations	NE Panfish Management Area: 10 daily; 50 possession Walleye: minimum length 16"
Management classification	warm-water permanent
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.

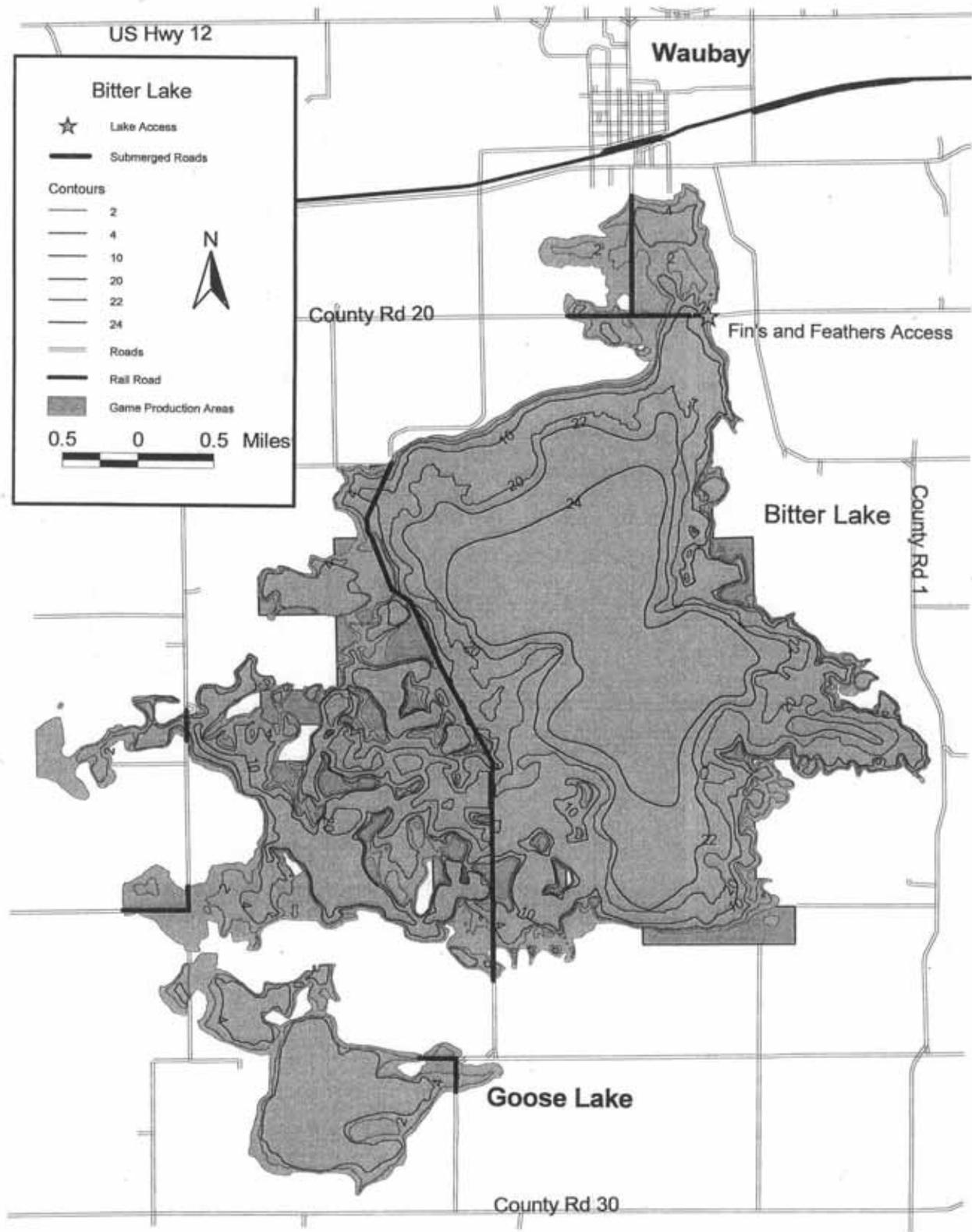


Figure 1. Bitter Lake contour map.

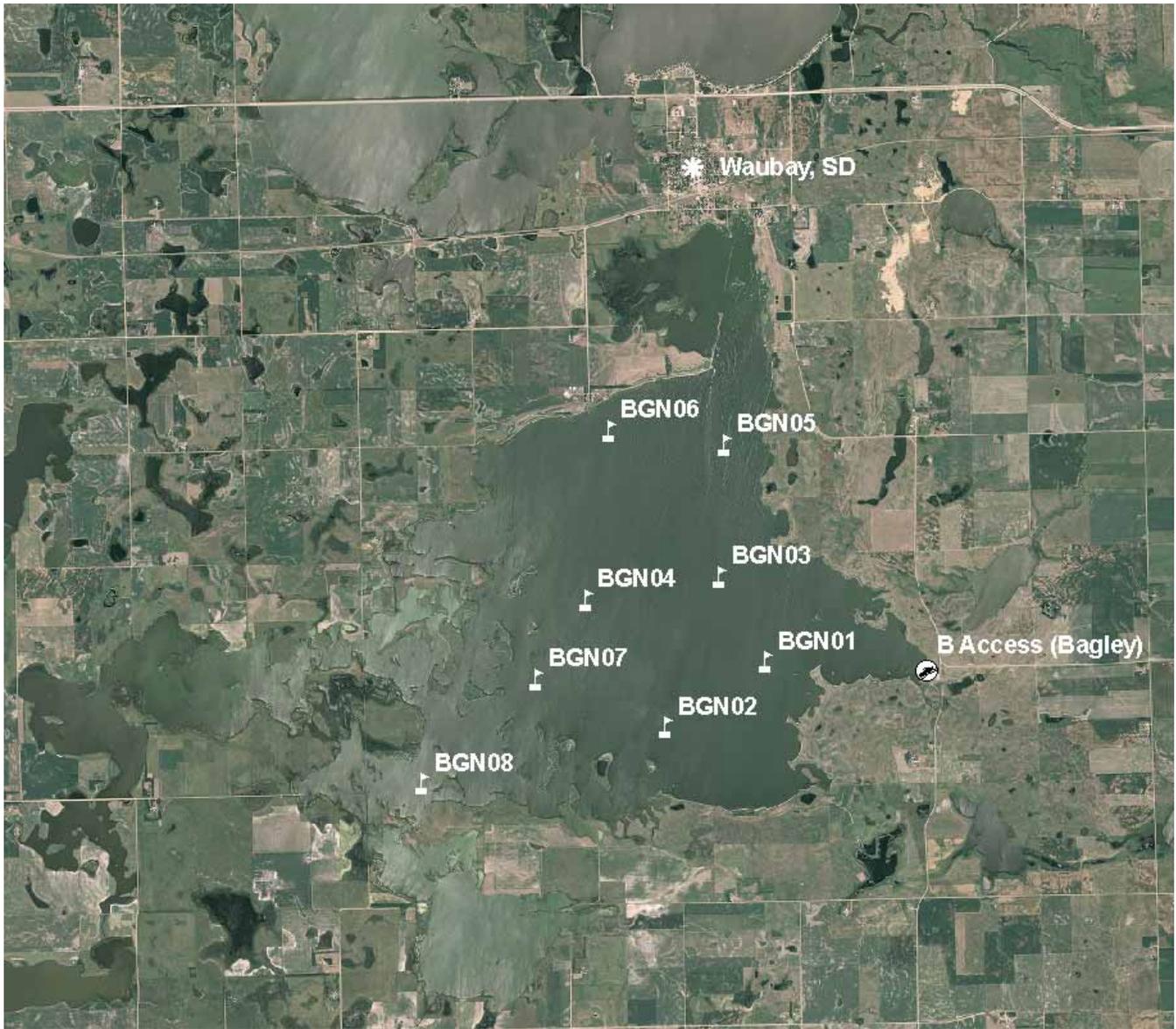


Figure 2. Map depicting public access location and standardized net locations for Bitter lake, Day County, South Dakota. BGN=gill nets

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 ≥ 30 , 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 mean gill net CPUE of stock-length walleye during 2009 was 11.0 (Table 1) and slightly above the minimum objective (≥ 10 stock-length walleye/net night; Table 3). Since 2002, the mean gill net CPUE has ranged from a low of 9.1 (2008) to a high of 31.8 (2006), with the 2002-2009 average being 18.3 (Table 2). The 2009 gill net CPUE represented a slight increase from the 9.1 observed in 2008 (Table 2) and indicated moderate to high relative abundance.

Walleye captured in the 2009 gill net catch ranged in total length from 11 to 65 cm (4.3 to 25.6 inches), had a PSD of 24 and a PSD-P of 2 (Figure 5). Both the 2009 PSD and PSD-P were below the management objectives of 30-60 and 5-10 (Table 3) indicating a population skewed towards smaller individuals. The low PSD and PSD-P likely result from the abundant 2008 year-class obtaining stock-length and fewer larger walleye being captured (Table 4; Figure 3). In 2009, approximately 23% of stock-length walleye captured in the gill net catch were above the 406-mm (16-inch) minimum length restriction enforced on Bitter Lake (Figure 3).

Otoliths were collected from a sub-sample of gill net captured walleye. Eight walleye year classes were present, with the 2005 and 2007-2009 cohorts being the most represented (Table 4). Year classes produced in 2005 and 2007 coincide with fry stockings; while the 2008 and 2009 cohorts are the result of natural reproduction (Table 4). The contribution of stocked or naturally-produced walleye to the 2005 and 2007 year-classes is unknown, as fry stockings were unmarked. Walleye from the 2009 year class were well represented in both the 2009 gill net catch (15.4/gill net) and during fall night electrofishing (294.0/hour); however, the recruitment of this cohort to the adult population is currently unknown and will be assessed in future surveys.

Walleye in Bitter Lake generally exceed quality-length (38 cm; 15 in) by age-3 (Table 6). Since 2005, the weighted mean length at capture for age-3 walleye has ranged from 410 to 461 mm (16.1 to 18.1 in) with the 2009 weighted mean length at capture for age-3 walleye being 458 mm (17.7 in; Table 6). Condition of stock-length walleye captured in the 2009 gill net catch was good with a mean Wr of 94 (Table 1). Mean Wr values ranged from 87 to 108 for all length categories sampled and a slight decreasing trend in Wr values was observed as total length increased in 2009.

Yellow Perch: The 2009 mean gill net CPUE of stock-length yellow perch was 20.8 (Table 1) and below the minimum objective (≥ 30 stock-length perch/net night). Since 2002, the gill net CPUE of stock-length yellow perch has fluctuated from a low of 2.2 (2003) to a high of 20.8 (2009), with the 2002-2009 average being 7.4 (Table 2). The 2009 gill net CPUE represented a substantial increase from past years and indicated moderate relative abundance.

Yellow perch captured in the 2009 gill net catch ranged in total length from 8 to 27 cm (3.1 to 10.6 in), had a PSD of 34, and a PSD-P of 13. The 2009 PSD was within the objective range of 30-60; while the PSD-P was above the objective range of 5-10 indicating a relatively-high proportion of yellow perch larger than 25 cm (10 in) in the population (Table 3).

Otoliths were collected from a sub-sample of gill net captured yellow perch in 2009. Age structure information indicated that year classes produced in 2005-2009 comprised the entire sample, with the 2008 year class being the most represented (Table 7; Figure 4). The increased relative abundance in 2009 (Table 2) can be attributed to the abundant 2008 year class attaining stock-length (Table 7; Figure 4).

The weighted mean total length at capture for age-1 and age-2 male yellow perch was 165 and 223 mm (6.3 and 8.7 in), respectively (Table 8). The weighted mean total length at capture for age-1 and age-2 female yellow perch was 173 and 239 mm (6.8 and 9.4 in; Table 8). Mean Wr values of gill net captured yellow perch in 2009 ranged from 111 to 119 for all length categories sampled with the mean Wr of stock-length yellow perch being 116 (Table 1).

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.

Five northern pike ranging in total length from 31 to 84 cm (12.2 to 33.1 in) were captured by gill nets in Bitter Lake during 2009, resulting in a CPUE of 0.5 (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 2002-2009 average being 0.9 (Table 2). Recent high water levels in Bitter Lake should benefit the northern pike population, as 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: White sucker were captured in low numbers during the 2009 survey and likely contribute little to the fishery (Table 1).

Management Recommendations

- 1) Conduct fish population assessment surveys on an annual basis (next survey scheduled in summer 2010) 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) 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, 2009. 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>								
NOP	0.5	0.5	100	0	25	59	88	9
WAE	11.0	4.9	24	7	2	3	94	1
WHS	0.3	0.2	50	50	0	---	101	<1
YEP	20.8	4.3	34	6	13	5	116	1

Table 2. Historic mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish for various fish species captured using experimental gill nets and electrofishing in Bitter Lake, 2002-2009. BLC= black crappie; COC= common carp; NOP= northern pike; SPS=spottail shiner; WHS=white sucker; WAE= walleye; YEP= yellow perch

Species	CPUE								Mean
	2002	2003	2004	2005	2006 ³	2007 ³	2008	2009	
<i>Gill nets</i>									
BLC	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
COC	0.0	0.2	0.0	0.1	0.0	0.3	0.1	0.0	0.1
NOP	2.0	1.5	1.3	0.4	0.8	0.3	0.4	0.5	0.9
SPS ¹	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.1
WAE	13.7	25.8	17.9	20.0	31.8	16.9	9.1	11.0	18.3
WHB	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0
WHS	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.1
YEP	12.3	2.2	2.9	2.6	11.8	2.6	4.1	20.8	7.4
<i>Electrofishing</i>									
WAE ² (age-0)	104.4	1.4	0.0	90.1	0.0	440.0	136.9	294.0	133.4

¹ All fish sizes.

² Fall night electrofishing-WAE; catch rate (CPUE) represents age-0 walleye/hour

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) 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, 2002-2009. NOP= northern pike; WAE= walleye; YEP= yellow perch

Species	2002	2003	2004	2005	2006 ¹	2007 ¹	2008	2009	Average	Objective
<i>Gill nets</i>										
NOP										
CPUE	2	2	1	< 1	1	<1	<1	1	1	---
PSD	92	100	100	100	100	100	100	100	99	---
PSD-P	8	33	10	100	17	100	100	25	53	---
Wr	81	80	84	74	102	84	75	88	83	---
WAE										
CPUE	14	26	18	20	32	17	9	11	19	≥ 10
PSD	49	51	76	96	50	91	81	24	71	30-60
PSD-P	2	2	1	1	8	10	8	2	5	5-10
Wr	88	90	94	89	96	90	92	94	91	---
YEP										
CPUE	12	2	3	3	12	3	4	21	6	≥ 30
PSD	30	77	96	76	64	86	42	34	67	30-60
PSD-P	20	23	61	43	49	29	24	13	36	5-10
Wr	113	114	112	113	97	114	114	116	111	---

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

Table 4. Year class distribution based on the expanded age/length summary for walleye sampled in gill nets and associated stocking history (Number stocked x 1,000) from Bitter Lake, 2005-2009.

Survey Year	Year Class												
	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
2009 ¹	123	53	15	3	13			1		1	1		
2008 ¹	---	28	19	1	50			4	2	1	1		
2007 ²	---	---	1		97		3	14	6	4	1	3	6
2006 ²	---	---	---	1	131	5	9	66		31	5	3	4
2005	---	---	---	---	64	2	7	52	47	15	14	16	2
# stocked													
fry			10000		9050					8015	5322	9228	
sm. fingerling											404		96
lg. fingerling													

¹ Older walleye were sampled, but are not reported in this table.

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

Table 5. Stocking history including size and number for fishes stocked into Bitter Lake, 1997-2009. 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. Weighted mean total length at capture (mm) for walleye age-0 through age-10 sampled in experimental gill nets (expanded sample size) from Bitter Lake, 2005-2009. Note: sampling was conducted at approximately the same time during each year allowing comparisons among years to monitor growth trends.

Year	Age										
	0	1	2	3	4	5	6	7	8	9	10
2009 [†]	133(123)	287(53)	358(15)	458(3)	474(13)	---	---	484(1)	---	496(1)	652(1)
2008 [†]	130(28)	271(19)	357(1)	431(50)	---	---	509(4)	510(2)	495(1)	598(1)	---
2007	170(1)	---	402(97)	---	466(3)	497(14)	484(6)	504(4)	455(1)	599(3)	544(6)
2006	191(1)	326(131)	413(5)	461(9)	468(66)	---	490(31)	509(5)	584(3)	442(4)	---
2005	165(64)	295(2)	383(7)	410(52)	429(47)	440(15)	455(14)	438(16)	478(2)	---	---

[†] Older walleye were sampled, but are not reported in this table.

Table 7. Year class distribution based on the age/length summary for yellow perch sampled in gill nets from Bitter Lake, 2009.

Survey Year	Year Class					
	2009	2008	2007	2006	2005	2004
2009	36	108	55	2	2	

Table 8. Weighted mean total length (mm) at capture by gender for yellow perch captured in experimental gill nets (expanded sample size) from Bitter Lake, 2009.

Year	Age					
	0	1	2	3	4	5
2009						
Male	92 (26)	165 (7)	223 (2)	---	266 (1)	---
Female	92 (10)	173 (101)	239 (53)	264 (2)	---	---
Combined	92 (36)	172 (108)	238 (55)	264 (2)	266 (2)	

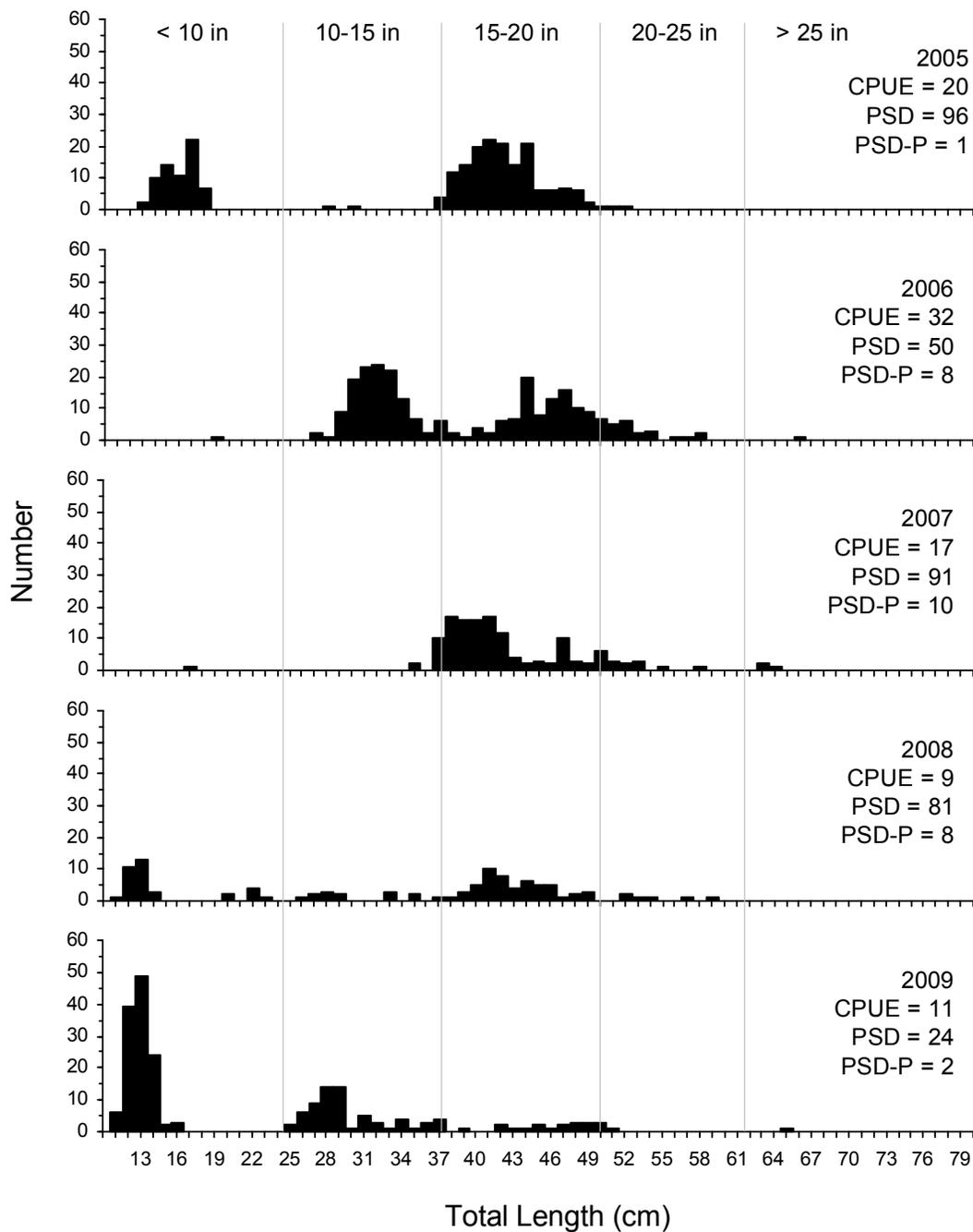


Figure 3. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for walleye captured using experimental gill nets in Bitter Lake, 2005-2009.

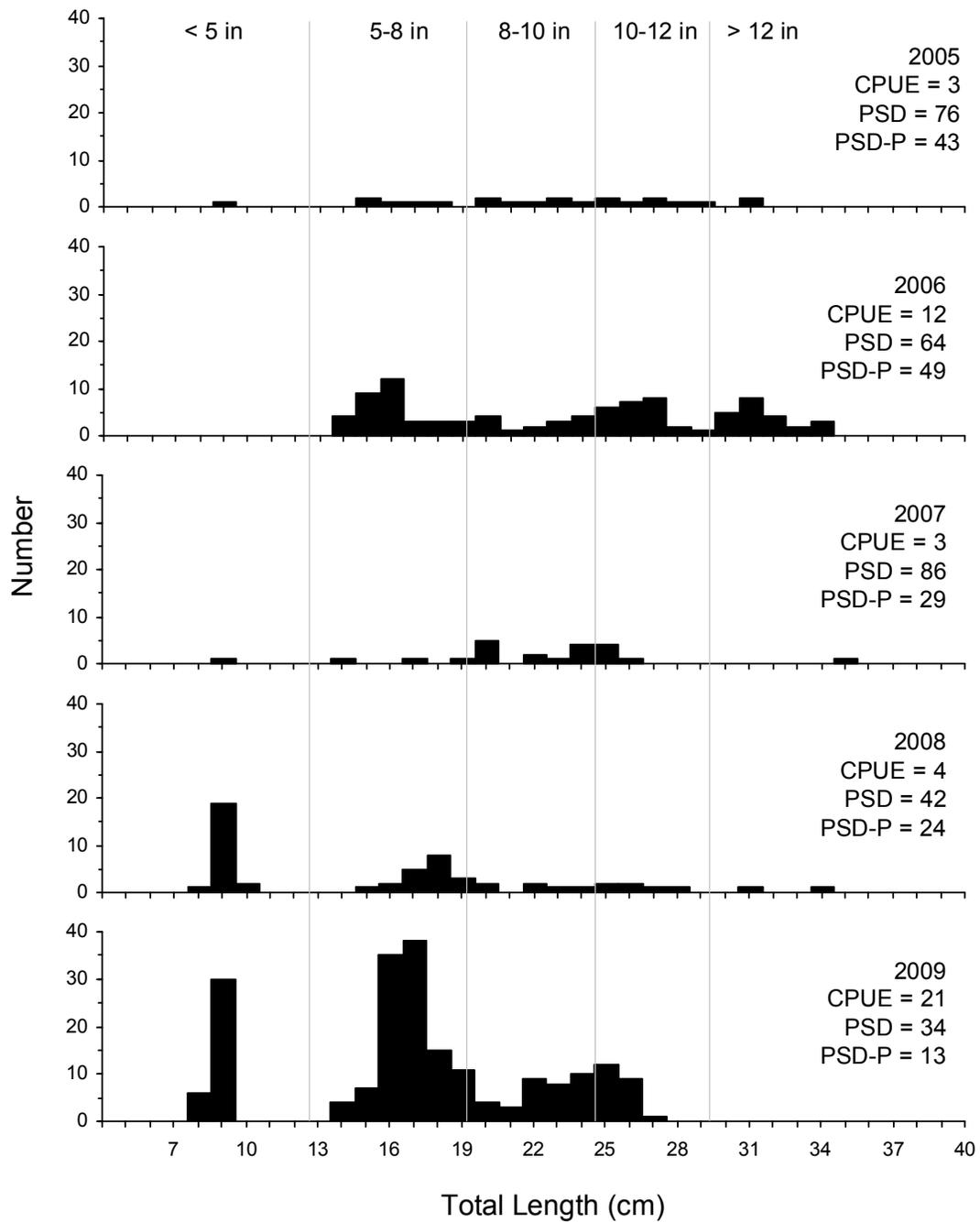


Figure 4. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for yellow perch captured using experimental gill nets in Bitter Lake, 2005-2009.