

# Bitter Lake

## Site Description

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### 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	0.5 miles south of Waubay, SD

### Survey Dates and Netting Information

Survey dates	August 30-September 1, 2011 (FN, GN) September 27, 2011 (EF-WAE)
Gill net sets (n)	8
Electrofishing-WAE (min)	60

### Morphometry

Watershed area (acres)	71,248
Surface area (acres)	>15,000
Maximum depth (ft)	≈28
Mean depth (ft)	unknown

### Ownership and Public Access

Bitter Lake is a meandered lake owned by the State of South Dakota and the fishery is managed by SDGFP. Two public access sites maintained by SDGFP are located on Bitter Lake (Figure 2). One located on the east shore off Day Co. Highway 1 includes a large parking area, double-lane concrete boat ramp, and dock; while the other located on the west shore off 442<sup>nd</sup> Avenue includes a smaller gravel lot, concrete-plank boat ramp, and dock.

### Watershed and Land Use

Land use within the Bitter Lake watershed is primarily agricultural with a mix of pasture or grassland, cropland, and scattered shelterbelts.

### Water Level Observations

No Ordinary High Water Mark has been established by the South Dakota Water Management Board on Bitter Lake. The elevation of Bitter Lake on May 17, 2011 was 1802.4 fmsl and indicated an increase from the fall 2010 elevation of 1799.9 fmsl. By October 5, 2011 the water level had declined slightly to an elevation of 1801.9 fmsl.

### Aquatic Nuisance Species Monitoring

#### Plant Survey

Submersed vegetation is prevalent in most shallow areas of Bitter Lake. In 2011, no aquatic nuisance plant species were encountered.

#### Shoreline Survey

No shoreline survey was conducted in 2011.

#### Fish Community Survey

Common carp was the only aquatic nuisance fish species captured during the 2011 survey.

### 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	Walleye: minimum length 15"
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.

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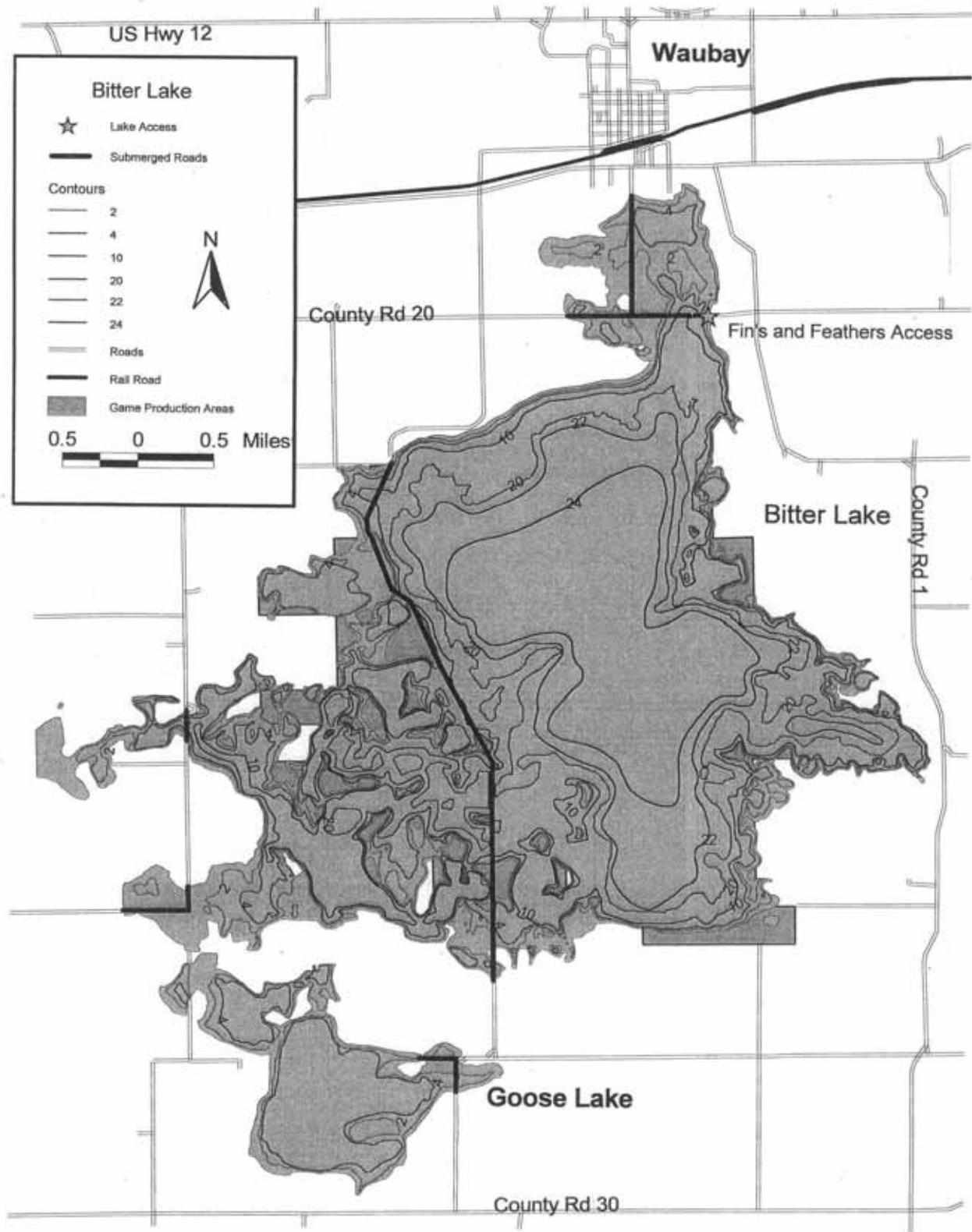


Figure 1. Bitter Lake, Day County, South Dakota contour map.



Figure 2. Map depicting geographic location of several Day County, South Dakota lakes including Bitter Lake. Also noted are public access locations 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  $\geq 10$ , a PSD of 30-60, and a PSD-P of 5-10.
- 2) Maintain a mean gill net CPUE of stock-length yellow perch  $\geq 30$ , 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 an approximate depth of 3 ft. High water conditions since the mid to late 1990's have increased the water depth and surface area of Bitter Lake. Currently, Bitter Lake covers in excess of 15,000 acres and is managed as a walleye and yellow perch fishery.

### *Primary Species*

Walleye: The mean gill net CPUE of stock-length walleye was 20.1 (Table 1) and above the minimum objective ( $\geq 10$  stock-length walleye/net night; Table 3). Since 2003, the mean gill net CPUE has ranged from a low of 9.1 (2008) to a high of 50.6 (2010; Table 2). The 2011 gill net CPUE represented a substantial decrease from the 50.6 observed in 2010 (Table 2), but still indicated high relative abundance.

Gill net captured walleye ranged in total length from 12 to 65 cm (4.7 to 25.6 in), had a PSD of 76 and a PSD-P of 4 (Table 1; Table 3; Figure 3). The PSD was above the management objective of 30-60; while the PSD-P was slightly below the objective range of 5-10 (Table 3). The majority of stock-length walleye in the gill net catch were from the strong 2009 year class and  $\geq$  quality-length (38 cm; 15 in) which resulted in the high PSD (Table 3; Table 4; Figure 3). At the time of sampling, approximately 45% of walleye in the gill net catch were above the 381-mm (15-inch) minimum length restriction and available for angler harvest (Figure 3).

Since 2005, otoliths have been collected from a sub-sample of gill net captured walleye. In 2011, nine year classes were present (2000-2002, 2005, and 2007-2011) with the 2009 and 2011 year classes, which were naturally produced, being the most represented (Table 4). The 2009 year class comprised 51% of walleye in the gill net catch; while the 2011 cohort accounted for an additional 40% (Table 4; Table 6). The 2011 (age-0) cohort was well represented in the gill net catch (Table 4) and had a mean fall night electrofishing CPUE of 377.0 (Table 1) which indicated strong reproduction; however, recruitment is currently unknown and will be assessed in future surveys (Table 1; Table 4).

Walleye in Bitter Lake generally exceed quality-length (38 cm; 15 in) by age-3 (Table 5). Since 2005, the weighted mean length at capture for age-3 walleye has ranged from 410 to 464 mm (16.1 to 18.3 in; Table 5). In 2011, the weighted mean total length at capture of age-3 walleye was 464 mm (18.3 in; Table 5). Gill net captured walleye had mean  $Wr$  values that ranged from 92 to 101 for all length categories (e.g., stock to quality) sampled with the mean  $Wr$  of stock-length walleye being 93 (Table 1). No length-related trends in walleye condition were apparent.

Yellow Perch: The mean gill net CPUE of stock-length yellow perch was 39.0 (Table 1) and the highest CPUE observed from 2003-2011 (Table 2). The gill net CPUE was above the minimum objective ( $\geq 30$  stock-length perch/net night) and indicated high relative abundance.

Gill net captured yellow perch ranged in total length from 8 to 33 cm (3.1 to 13.0 in; Figure 4). The majority of stock-length yellow perch in the gill net catch were  $\geq$  quality-length which resulted in high PSD and PSD-P values of 84 and 14, respectively (Table 1; Table 2; Figure 4). Both the PSD and PSD-P were above the management objectives of 30-60 and 5-10 (Table 3).

Otoliths were collected from a sub-sample of gill net captured yellow perch in 2011. Age structure information indicated the presence of five consecutive year classes (2007-2011). The 2009 year class was the most represented and comprised approximately 59% of yellow perch in the gill net catch; while the 2011 (age-0) cohort accounted for an additional 32% (Table 7). Recruitment of the 2011 year class is currently unknown and will be assessed in future surveys.

The weighted mean total length at capture of age-2 male yellow perch was 203 mm (8.0 in); while the weighted mean total length at capture of age-2 female yellow perch was 233 mm (9.2 in; Table 8). Gill net captured yellow perch had mean  $Wr$  values that exceeded 100 for all length categories (e.g., stock to quality) sampled and no length-related trends in condition were apparent. The mean  $Wr$  of stock-length yellow perch was 110 (Table 1).

### *Other Species*

Northern Pike: Northern pike typically are not sampled effectively during standardized mid-summer fish community surveys. As a result, mean gill net CPUE values are often low. Northern pike relative abundance in Bitter Lake has generally been considered low to moderate with mean gill net CPUE values that ranged from 0.3 to 1.5 from 2003-2011 (Table 2). In 2011, 12 stock-length northern pike that ranged in total length from 62 to 74 cm (24.4 to 39.1 in) were captured in the gill net catch which resulted in a mean gill net CPUE of 1.5 (Table 1). Few inferences can be made concerning the size structure, growth, and condition of northern pike due to low sample size.

Other: Black crappie, common carp, spottail shiner, and white sucker were other fish species captured in low numbers during the 2011 fish community survey on Bitter Lake (Table 1).

## Management Recommendations

- 1) Conduct fish population assessment surveys on an annual basis (next survey scheduled in summer 2012) 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 age-0 walleye relative abundance.
- 3) Collect otoliths from walleye and yellow perch to assess age structure and growth rates of each population.
- 4) Stock walleye fry ( $\approx 500$  fry/acre; 50% OTC marked) 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  $< 25$  cm (10 in) walleye and/or fall night electrofishing CPUE of age-0 walleye  $< 75$  fish/hour).
- 5) Maintain the 381-mm (15 in) minimum length limit on walleye to benefit the population and comply with tool box options (Lucchesi and Blackwell 2009).

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, 2011. Confidence intervals include 80 percent ( $\pm$  CI-80) or 90 percent ( $\pm$  CI-90). BLC= black crappie; COC= common carp; NOP= northern pike; SPS= spottail shiner; WAE= walleye; WHS=white sucker; 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>								
BLC	0.5	0.3	25	59	0	---	127	16
COC	1.4	1.3	64	28	0	---	127	7
NOP	1.5	0.8	100	0	33	26	89	3
SPS <sup>1</sup>	0.1	0.2	---	---	---	---	---	---
WAE	20.1	3.5	76	6	4	2	93	1
WHS	0.3	0.2	100	0	100	0	95	29
YEP	39.0	13.6	84	3	14	3	110	<1
<i>Electrofishing</i>								
WAE <sup>2</sup>	377.0	---	---	---	---	---	---	---

<sup>1</sup> All fish sizes.

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, 2003-2011. BLC= black crappie; COC= common carp; NOP= northern pike; SPS=spottail shiner; WAE= walleye; WHB= white bass; WHS=white sucker; YEP= yellow perch

Species	CPUE								
	2003	2004	2005	2006 <sup>3</sup>	2007 <sup>3</sup>	2008	2009	2010	2011
<i>Gill nets</i>									
BLC	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.5
COC	0.2	0.0	0.1	0.0	0.3	0.1	0.0	0.3	1.4
NOP	1.5	1.3	0.4	0.8	0.3	0.4	0.5	1.0	1.5
SPS <sup>1</sup>	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1
WAE	25.8	17.9	20.0	31.8	16.9	9.1	11.0	50.6	20.1
WHB	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0
WHS	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.3	0.3
YEP	2.2	2.9	2.6	11.8	2.6	4.1	20.8	25.9	39.0
<i>Electrofishing</i>									
WAE <sup>2</sup>	1.4	0.0	90.1	0.0	440.0	136.9	294.0	0.0	377.0

<sup>1</sup> All fish sizes.

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

<sup>3</sup> Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")

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 from Bitter Lake, 2003-2011. NOP= northern pike; WAE= walleye; YEP= yellow perch

Species	2003	2004	2005	2006 <sup>1</sup>	2007 <sup>1</sup>	2008	2009	2010	2011	Objective
<i>Gill nets</i>										
NOP										
CPUE	2	1	< 1	1	<1	<1	1	1	2	---
PSD	100	100	100	100	100	100	100	63	100	---
PSD-P	33	10	100	17	100	100	25	13	33	---
Wr	80	84	74	102	84	75	88	93	89	---
WAE										
CPUE	26	18	20	32	17	9	11	51	20	≥ 10
PSD	51	76	96	50	91	81	24	19	76	30-60
PSD-P	2	1	1	8	10	8	2	3	4	5-10
Wr	90	94	89	96	90	92	94	102	93	---
YEP										
CPUE	2	3	3	12	3	4	21	26	39	≥ 30
PSD	77	96	76	64	86	42	34	29	84	30-60
PSD-P	23	61	43	49	29	24	13	22	14	5-10
Wr	114	112	113	97	114	114	116	106	110	---

<sup>1</sup> Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")

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, 2007-2011.

Survey Year	Year Class												
	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
2011 <sup>1</sup>	108	6	137	11	1		2			1	1	1	
2010 <sup>1</sup>	---	5	326	42	16		15		1	3	1		1
2009 <sup>1</sup>	---	---	123	53	15	3	13			1		1	1
2008 <sup>1</sup>	---	---	---	28	19	1	50			4	2	1	1
2007 <sup>1,2</sup>	---	---	---	---	1		97		3	14	6	4	1
# stocked													
fry					10000		9050					8015	5322
sm. fingerling													404
lg. fingerling													

<sup>1</sup> Older walleye were sampled, but are not reported in this table.

<sup>2</sup> Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")

Table 5. Weighted mean total length (mm) at capture for walleye age-0 through age-10 sampled in experimental gill nets (expanded sample size) from Bitter Lake, 2005-2011. 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
2011 <sup>1</sup>	155(108)	312(6)	397(137)	464(11)	473(1)	---	545(2)	---	---	653(1)	626(1)
2010 <sup>1</sup>	185(5)	307(326)	406(42)	443(16)	---	513(15)	---	561(1)	543(3)	635(1)	---
2009 <sup>1</sup>	133(123)	287(53)	358(15)	458(3)	474(13)	---	---	484(1)	---	496(1)	652(1)
2008 <sup>1</sup>	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)	---	---

<sup>1</sup> Older walleye were sampled, but are not reported in this table.

Table 6. Stocking history including size and number for fishes stocked into Bitter Lake, 1999-2011. WAE= walleye

Year	Species	Size	Number
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 7. Year class distribution based on the age/length summary for yellow perch sampled in gill nets from Bitter Lake, 2009-2011.

Survey Year	Year Class						
	2011	2010	2009	2008	2007	2006	2005
2011	145	28	268	11	6		
2010	---		152	48	8		
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, 2009-2011.

Year	Age				
	0	1	2	3	4
2011					
Male	100(116)	163(10)	203(55)	---	---
Female	97(14)	174(15)	233(213)	292(11)	323(6)
Combined	98(145)	172(28)	227(268)	292(11)	323(6)
2010					
Male	---	161(31)	238(1)	231(1)	---
Female	---	175(117)	258(47)	294(7)	---
Combined	---	172(152)	257(48)	286(8)	
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)

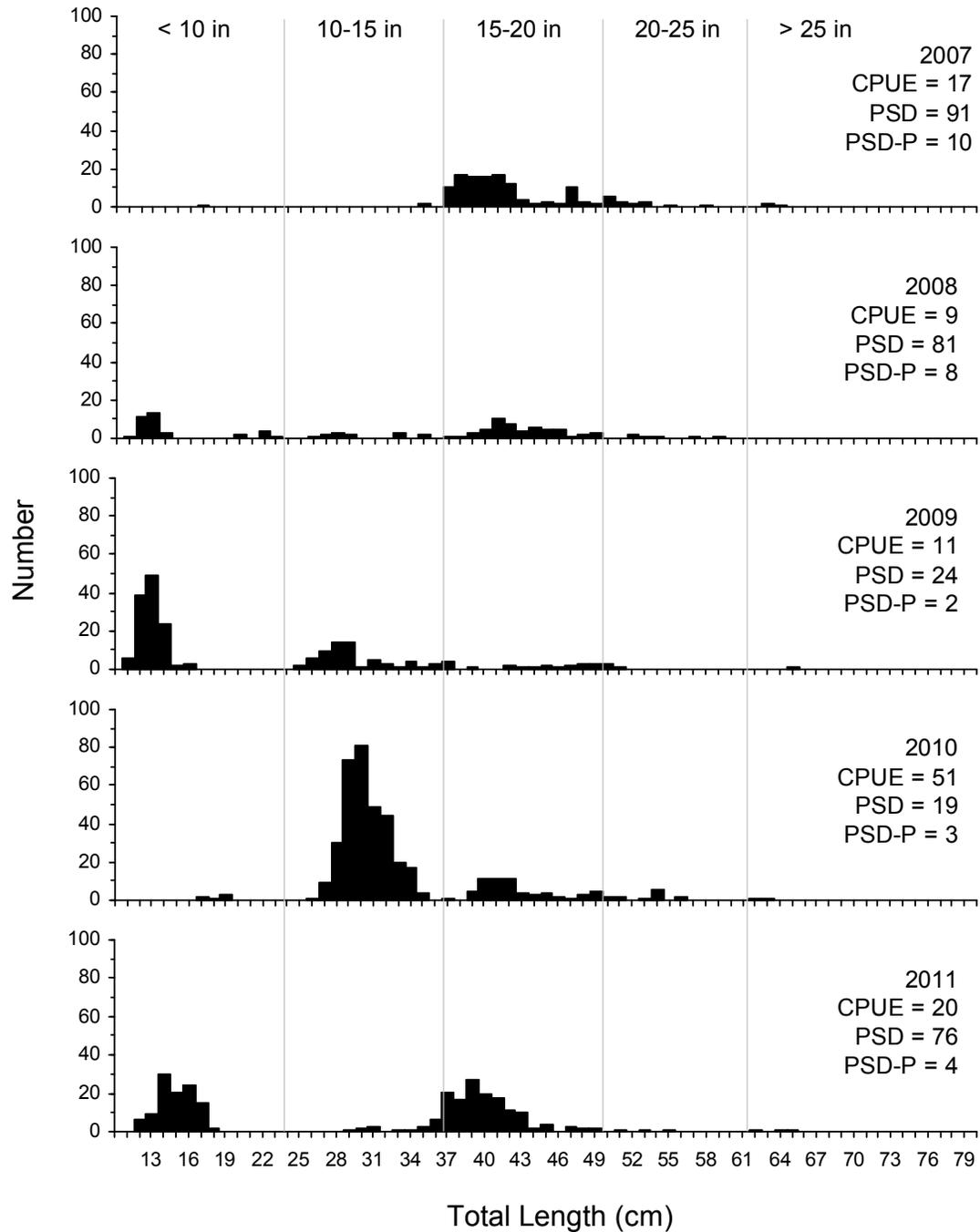


Figure 3. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for walleye captured using experimental gill nets in Bitter Lake, 2007-2011.

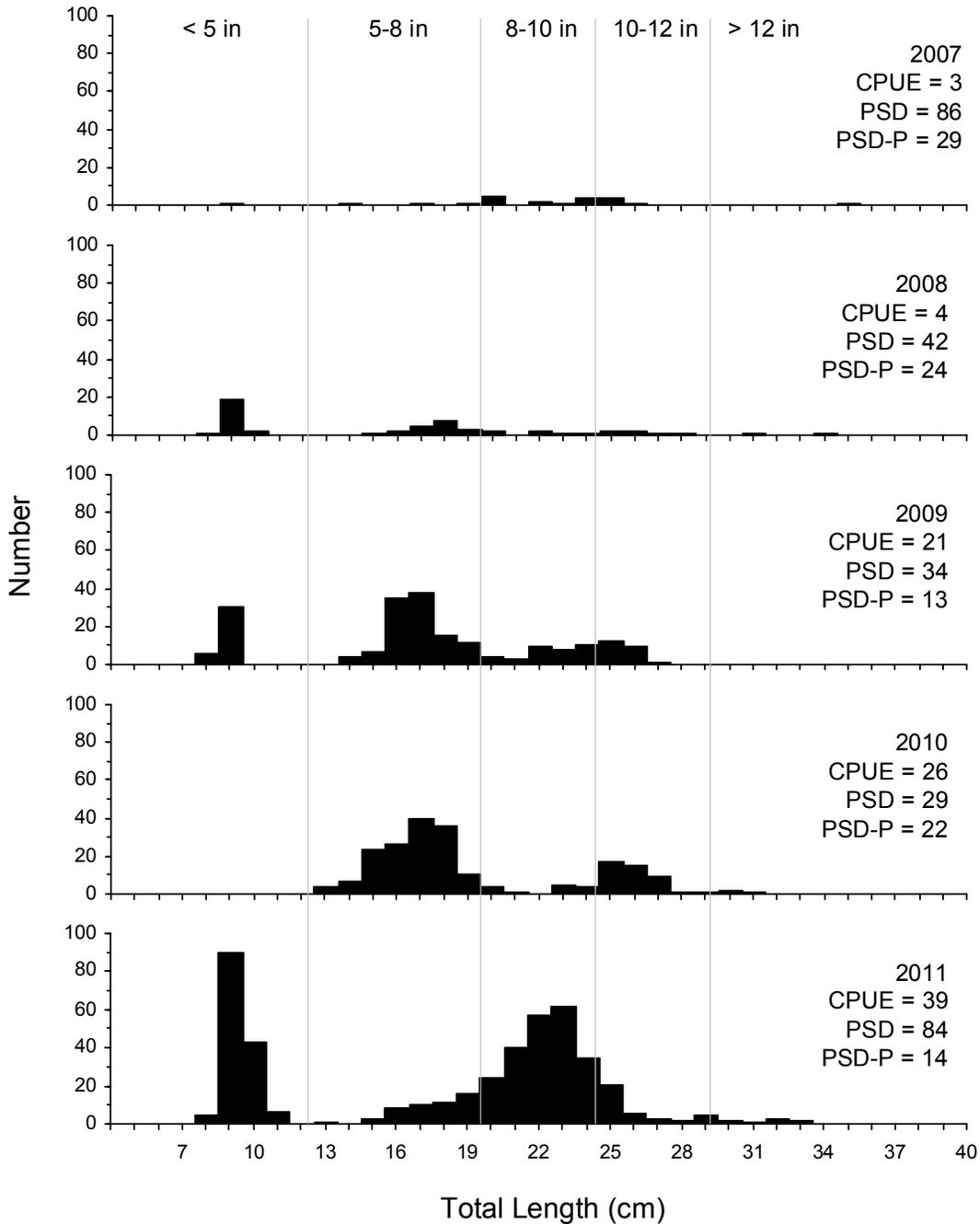


Figure 4. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for yellow perch captured using experimental gill nets in Bitter Lake, 2007-2011.