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	0.5 miles south of Waubay, SD

Survey Dates and Netting Information

Survey dates	August 27-29, 2013 (FN, GN) October 7, 2013 (EF-WAE)
Frame net sets (n)	18
Gill net sets (n)	8
Electrofishing-WAE (min)	60

Morphometry (Figure 1)

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 1; 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 442nd Avenue includes a smaller gravel parking 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 OHWM has been established by the South Dakota Water Management Board on Bitter Lake. On May 21, 2013 the elevation was 1802.5 fmsl; 0.9 ft above the fall 2012 elevation of 1801.6 fmsl. The water level had declined to an elevation of 1802.1 fmsl on October 8, 2013.

Fish Management Information

Primary species	Walleye, Yellow Perch
Other species	Black Bullhead, Black Crappie, Common Carp, Northern Pike, Rock Bass, 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. Also see Department of Health website: http://doh.sd.gov/Fish/Default.aspx for more information.

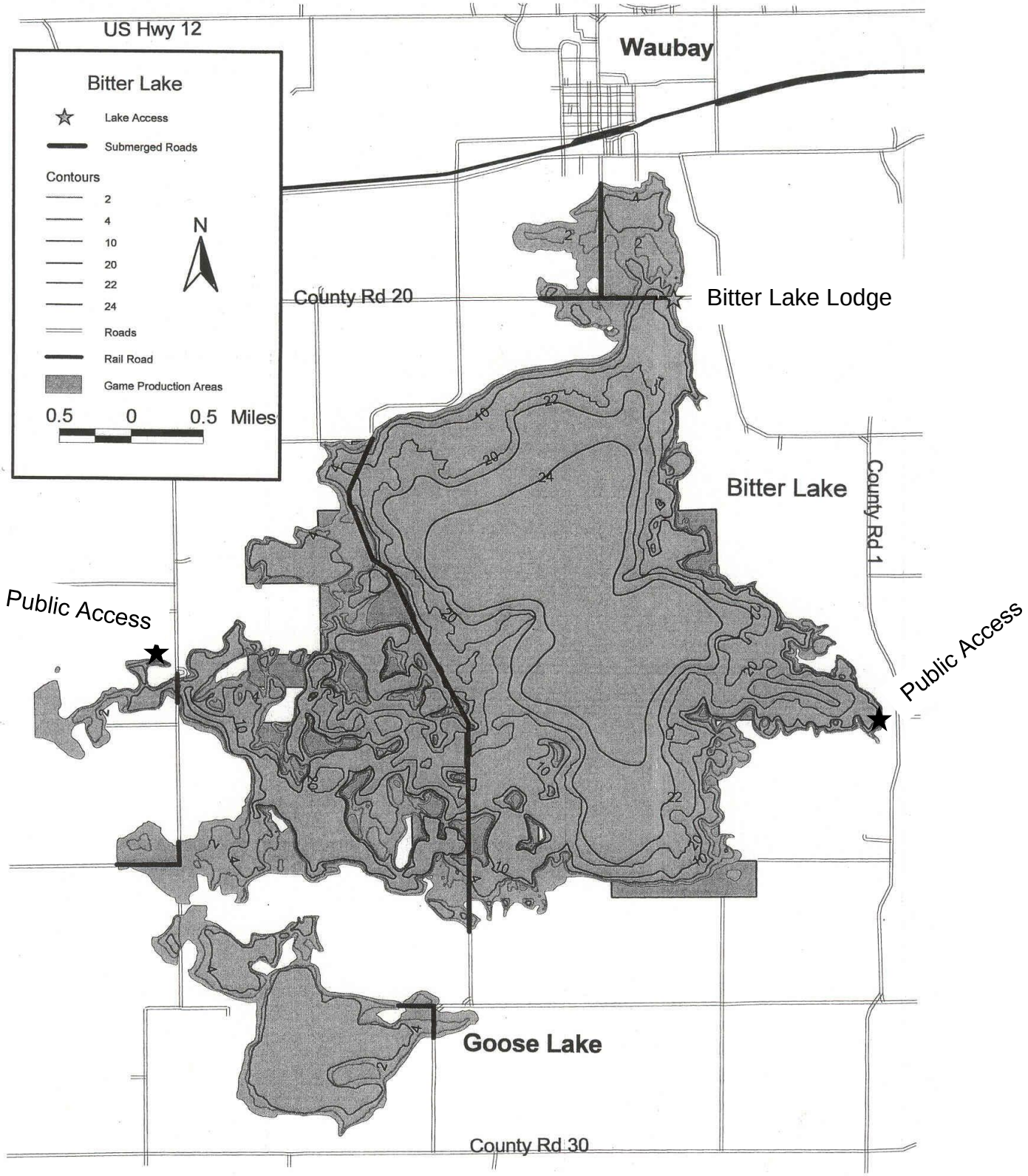

Figure 1. Bitter Lake, Day County, South Dakota contour map.

Figure 2. Map depicting geographic location of Bitter Lake from Waubay, Day County, South Dakota. Also noted are public access and standardized net locations for Bitter Lake. BFN=frame nets; 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 northeast 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 18.0 (Table 1) and above the minimum objective (≥ 10 stock-length Walleye/net night; Table 3). Since 2004, the mean gill net CPUE has ranged from a low of 9.1 (2008) to a high of 50.6 (2010; Table 2). The 2013 gill net CPUE was lower than the 2012 CPUE of 19.8 (Table 2), but relative abundance was still considered high.

Gill net captured Walleye ranged in TL from 13 to 59 cm (5.1 to 23.2 in), had a PSD of 30 and a PSD-P of 6 (Table 1; Figure 3). The PSD and PSD-P were within management objectives (Table 3) and point toward a relatively balanced population (defined as PSD of 30-60 and a PSD-P of 5-10; Table 3; Figure 3). At the time of sampling, approximately 28% of Walleye in the gill net catch were above the 381-mm (15-in) minimum length restriction (Figure 3).

Otoliths collected from a sub-sample of gill net captured Walleye revealed the presence of 10 year classes (2002, 2003, 2005, and 2007-2013), with the 2009 and 2011 year classes, which were naturally produced, being the most represented (Table 4; Table 6). The 2011 year class comprised 67% of walleye in the gill net catch; while the 2009 cohort accounted for an additional 22% (Table 4). The decline in PSD values in 2012 and 2013 can be attributed to growth of the strong 2011 cohort into the stock-quality length category coupled with a decrease in the number of individuals being sampled from the strong 2009 year class that has dominated the population in recent years (Table 4; Table 5; Figure 3). In 2013, the mean fall night electrofishing CPUE of age-0 Walleye was 34.0 (Table 1) and only three age-0 Walleye were captured in the gill net catch (Table 4). The low fall night electrofishing CPUE coupled with the capture of few age-0 Walleye in the gill net catch suggested that a weak cohort was produced, despite the spring stocking of 7,500,000 Walleye fry (Table 2; Table 4; Table 6).

Walleye in Bitter Lake exceed quality length and the minimum length limit (38 cm; 15 in) by age-3 (Table 5). Since 2005, the weighted mean length at capture for age-2

Walleye has ranged from 275 to 413 mm (10.8 to 16.3 in); while the weighted mean TL at capture for age-3 fish ranged from 387 to 464 mm (15.2 to 18.3 in; Table 5). In 2013, the weighted mean TL at capture of age-2 Walleye was 275 mm (10.8 in) and lowest recorded since 2005 (Table 5). Few age-3 Walleye were sampled (Table 4; Table 5). Gill net captured Walleye had mean Wr values that ranged from 80 to 83 for all length categories (e.g., stock to quality) sampled. The mean Wr of stock-length Walleye was 83 (Table 1) and no length-related trends in condition were apparent.

Yellow Perch: The mean gill net CPUE of stock-length Yellow Perch was 21.4 (Table 1) and below the minimum objective (≥ 30 stock-length perch/net night; Table 3). Since 2004, mean gill net CPUE values have ranged from a low of 2.6 (2005, 2007) to a high of 67.3 (2012; Table 2). Based on the 2013 gill net CPUE, relative abundance appears to be moderate.

Gill net captured Yellow Perch ranged in TL from 14 to 33 cm (5.5 to 13.0 in; Figure 4). The PSD was 78 and the PSD-P was 49, both exceeded management objectives of 30-60 and 5-10, indicating a population comprised of larger (i.e., ≥20 cm; 8 in) individuals (Table 1; Table 3; Figure 4).

Otoliths were collected from a sub-sample of gill net captured Yellow Perch. Age structure information suggested the presence of five consecutive year classes (2008-2012; Table 7). Year classes produced in 2009 and 2011 were the most abundant and collectively comprised 86% of Yellow Perch in the gill net catch (Table 4). Limited recruitment of Yellow Perch in 2012 coupled with growth of individuals from the 2009-2012 cohorts resulted in size structure changes (i.e., increased PSD and PSD-P) observed from 2012 to 2013 (Table 3; Figure 4).

Yellow perch in Bitter Lake display fast growth and attain quality-length (20 cm; 8 in) by age 2 (Table 8). Since 2009, weighted mean TL at capture values for age-2 Yellow Perch have ranged from 200 to 257 mm (8.0 to 10.1 in); while the weighted mean TL at capture for age-3 fish has ranged from 264 to 292 mm (10.4 to 11.5 in), when both males and females were combined (Table 8). In 2013, the weighted mean TL at capture for age-2 and age-3 Yellow Perch was 200 and 267 mm (7.9 and 10.5 in), respectively (Table 8). As with most populations, males tend to be smaller at a given age than females, particularly at older ages (Table 8). Condition of gill net captured Yellow Perch was high with mean Wr values > 100 for all length categories (e.g., stock to quality) sampled.

Other Species

Northern Pike: The mean gill net CPUE of stock-length Northern Pike was 4.1 (Table 1). The 2013 gill net CPUE represented a decrease from the 2012 CPUE of 5.0 (Table 2), but still indicated high relative abundance.

Northern Pike captured in the gill net sample ranged in TL from 53 to 97 cm (20.9 to 38.2 in), had a PSD of 100 and a PSD-P of 18 (Table 1; Figure 5). No age or growth information was collected. The majority of Northern Pike in the gill net catch were in the quality-preferred length category, which had a mean Wr of 75.

Other: Black Bullhead, Common Carp, White Bass, and White Sucker were other fish species captured in low numbers during the 2013 fish community survey on Bitter Lake (Table 1).

Management Recommendations

1) Conduct fish population assessment surveys utilizing frame nets and gill nets on an annual basis (next survey scheduled in summer 2014) 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 (≈500 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 sub-stock (< 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. The regulation is designed to protect smaller fish from harvest and increase average fish size (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, 2013. Confidence intervals include 80 percent (± CI-80) or 90 percent (± CI-90). BLB= Black Bullhead; COC= common carp; NOP= northern pike; WAE= walleye; WHB= white bass; WHS= White Sucker; YEP= yellow perch

	Abundance		Stock Density Indices				Condition	
Species	CPUE	CI-80	PSD	CI-90	PSD-P	CI-90	Wr	CI-90
Frame nets								
BLB	0.2	0.2	100	0	100	0	99	5
COC	1.4	0.8	100	0	56	17	107	1
NOP	2.3	0.7	76	12	17	10	78	<1
WAE	5.7	3.2	11	5	3	3	85	<1
WHB	0.2	0.1	100	0	100	0	102	4
YEP	0.2	0.1	33	67	0	---	110	11
Gill nets								
NOP	4.1	2.2	100	0	18	12	76	1
WAE	18.0	8.0	30	6	6	4	83	<1
WHS	0.4	0.3	100	0	100	0	103	8
YEP	21.4	13.6	78	5	49	6	110	1
Electrofishing								
WAE[1]	34.0	41.7	---	---	---	---	---	---

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

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, 2004-2013. BLB= Black Bullhead; BLC= black crappie; COC= common carp; NOP= northern pike; ROB= rock bass; SPS=spottail shiner; WAE= walleye; WHB= white bass; WHS=white sucker; YEP= yellow perch

	CPUE									
Species	2004	2005	2006[3]	2007[3]	2008	2009	2010	2011	2012	2013
Frame nets										
BLB	---	---	---	---	---	---	---	---	---	0.2
COC	---	---	---	---	---	---	---	---	---	1.4
NOP	---	---	---	---	---	---	---	---	---	2.3
WAE	---	---	---	---	---	---	---	---	---	5.7
WHB	---	---	---	---	---	---	---	---	---	0.2
YEP	---	---	---	---	---	---	---	---	---	0.2
Gill nets										
BLC	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.5	0.0	0.0
COC	0.0	0.1	0.0	0.3	0.1	0.0	0.3	1.4	0.1	0.0
NOP	1.3	0.4	0.8	0.3	0.4	0.5	1.0	1.5	5.0	4.1
ROB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
SPS [1]	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
WAE	17.9	20.0	31.8	16.9	9.1	11.0	50.6	20.1	19.8	18.0
WHB	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0
WHS	0.0	0.3	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.4
YEP	2.9	2.6	11.8	2.6	4.1	20.8	25.9	39.0	67.3	21.4
Electrofishing										
WAE[2]	0.0	90.1	0.0	440.0	136.9	294.0	0.0	377.0	36.0	34.0

[1] All fish sizes.
[2] Fall night electrofishing-WAE; catch rate (CPUE) represents age-0 walleye/hour
[3] 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, 2004-2013. WAE= walleye; YEP= yellow perch

Species	2004	2005	2006[1]	2007[1]	2008	2009	2010	2011	2012	2013	Objective
Gill nets											
WAE											
CPUE	18	20	32	17	9	11	51	20	20	18	≥ 10
PSD	76	96	50	91	81	24	19	76	58	30	30-60
PSD-P	1	1	8	10	8	2	3	4	4	6	5-10
Wr	94	89	96	90	92	94	102	93	86	83	---
YEP											
CPUE	3	3	12	3	4	21	26	39	67	21	≥ 30
PSD	96	76	64	86	42	34	29	84	59	78	30-60
PSD-P	61	43	49	29	24	13	22	14	40	49	5-10
Wr	112	113	97	114	114	116	106	110	105	110	---

[1] 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 (# stocked x 10,000) from Bitter Lake, 2009-2013.

	Year Class													
Survey Year	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
2013	3	3	102	3	33	3	1		2		1	1		
2012[1]	---	8	107	15	73	4			2				1	
2011[1]	---	---	108	6	137	11	1		2			1	1	1
2010[1]	---	---	---	5	326	42	16		15		1	3	1	
2009[1]	---	---	---	---	123	53	15	3	13			1		1
# stocked														
fry	750						1000		905					802
sm. fingerling														
lg. fingerling														

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

Table 5. Weighted mean TL (mm) at capture for walleye age-0 through age-10 sampled in experimental gill nets (expanded sample size) from Bitter Lake, 2005-2013. Note: sampling was conducted at approximately the same time during each year allowing comparisons among years to monitor growth trends.

	Age										
Year	0	1	2	3	4	5	6	7	8	9	10
2013[1]	184(3)	211(3)	275(102)	387(3)	471(33)	498(3)	500(1)	---	529(2)	---	592(1)
2012[1]	139(8)	252(107)	387(15)	446(73)	527(4)	---	---	592(2)	---	---	---
2011[1]	155(108)	312(6)	397(137)	464(11)	473(1)	---	545(2)	---	---	653(1)	626(1)
2010[1]	185(5)	307(326)	406(42)	443(16)	---	513(15)	---	561(1)	543(3)	635(1)	---
2009[1]	133(123)	287(53)	358(15)	458(3)	474(13)	---	---	484(1)	---	496(1)	652(1)
2008[1]	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)	---	---

[1] 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, 2000-2013. WAE= walleye

Year	Species	Size	Number
2000	WAE	fry	8,015,200
2005	WAE	fry	9,050,000
2007	WAE	fry	10,000,000
2013	WAE	fry	7,500,000

Table 7. Year class distribution based on the age/length summary for yellow perch sampled in gill nets from Bitter Lake, 2009-2013.

	Year Class								
Survey Year	2013	2012	2011	2010	2009	2008	2007	2006	2005
2013		1	65	20	82	3			
2012	---	9	240	53	251	12	2		
2011	---	---	145	28	268	11	6		
2010	---	---	---		152	48	8		
2009	---	---	---	---	36	108	55	2	2

Table 8. Weighted mean TL (mm) at capture by gender for yellow perch captured in experimental gill nets (expanded sample size) from Bitter Lake, 2009-2013.

	Age					
Year	0	1	2	3	4	5
2013						
Male	---	---	186(13)	219(2)	241(26)	---
Female	---	147(1)	203(52)	273(20)	280(53)	289(4)
Combined	---	147(1)	200(65)	267(20)	268(82)	289(3)
2012						
Male	126(10)	144(65)	223(28)	232(41)	---	---
Female	---	157(163)	232(22)	270(209)	303(12)	338(2)
Combined	126(9)	153(240)	226(53)	264(251)	303(12)	338(2)
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)	---

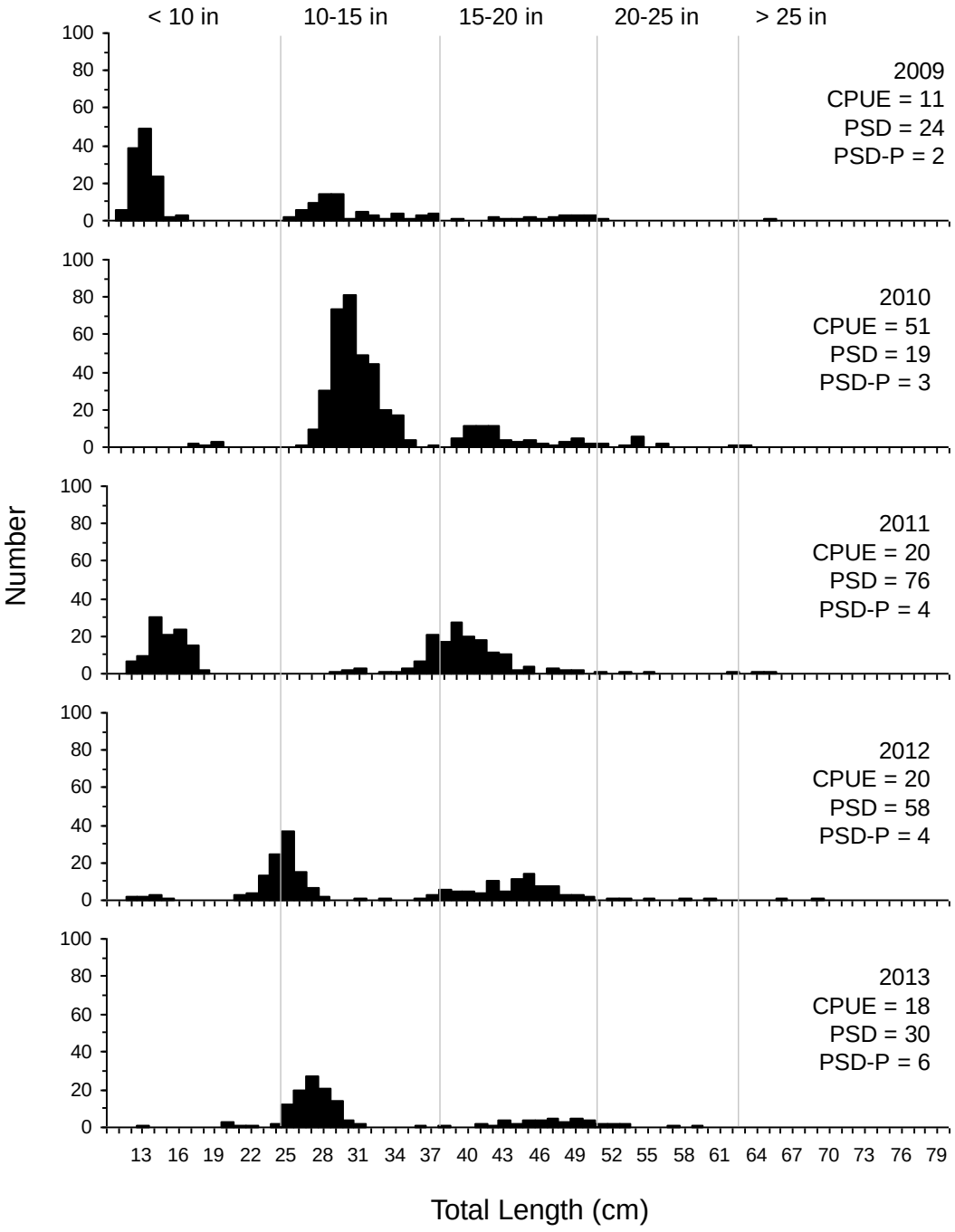

Figure 3. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for Walleye captured using experimental gill nets in Bitter Lake, 2009-2013.

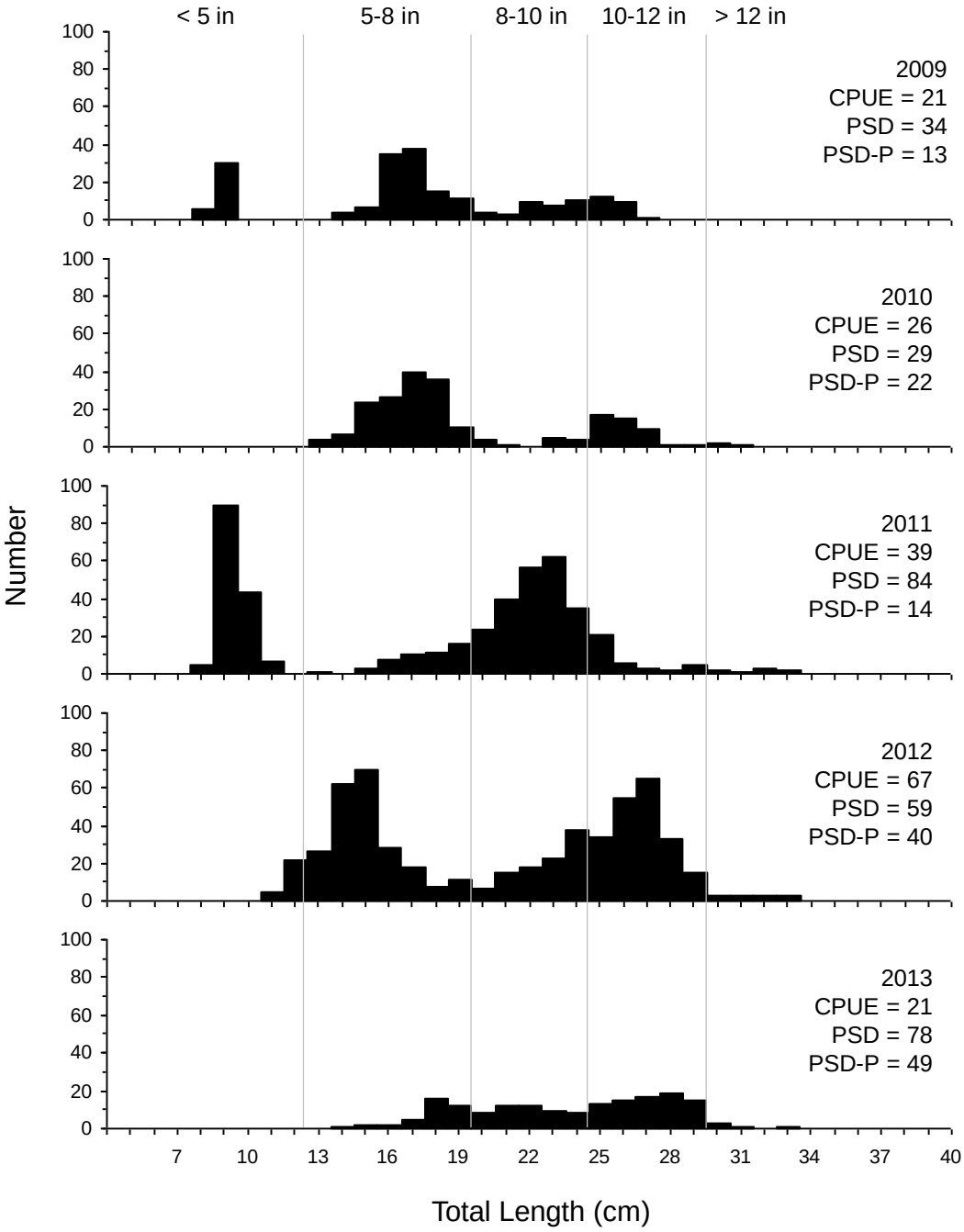

Figure 4. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for Yellow Perch captured using experimental gill nets in Bitter Lake, 2009-2013.

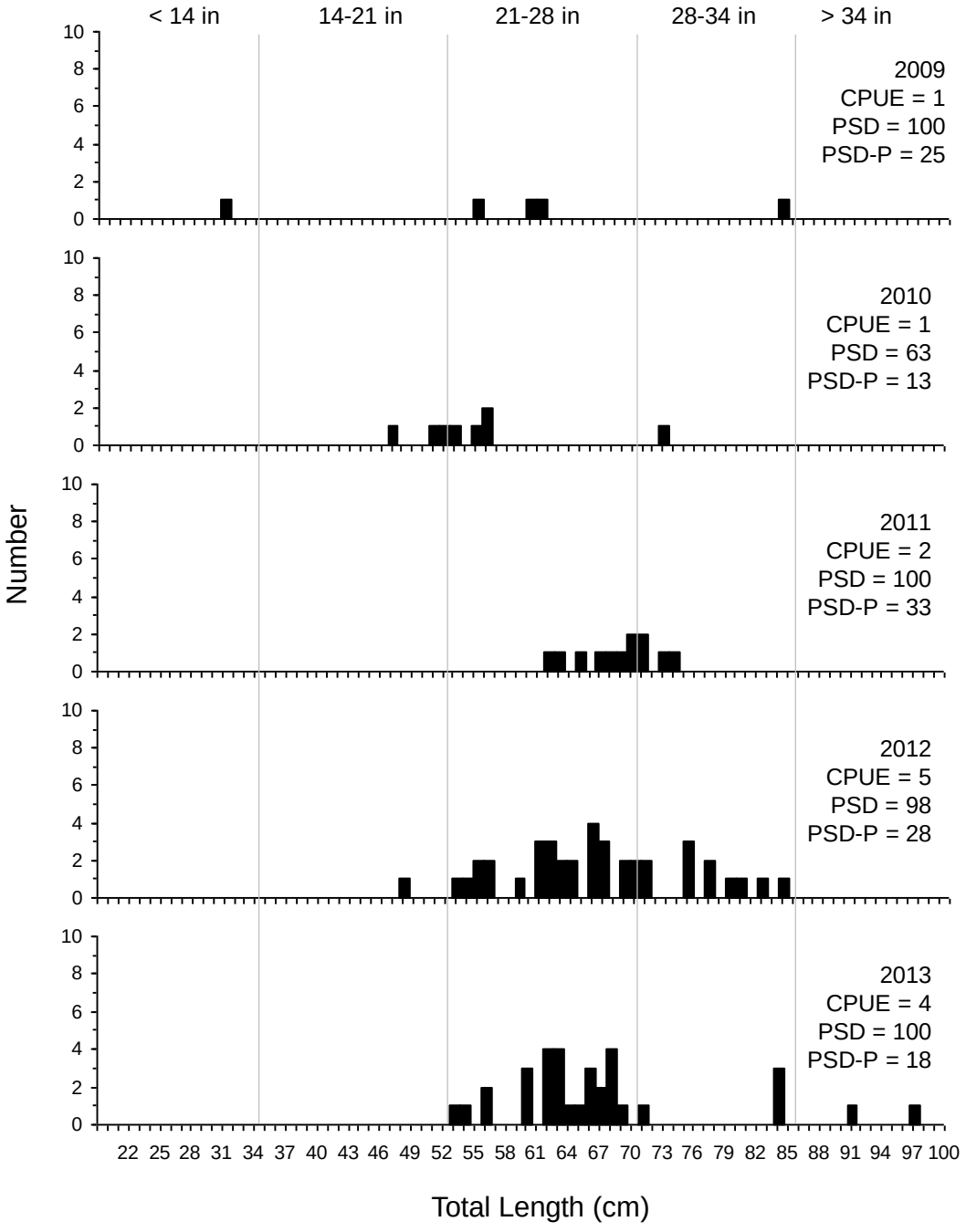

Figure 5. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for Northern Pike captured using experimental gill nets in Bitter Lake, 2009-2013.