MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION
JOB PROGRESS REPORT

STATE: MONTANA PROJECT TITLE: STATEWIDE FISHERIES INVESTIGATIONS

PROJECT NO.: F-78-R-6 STUDY TITLE: SURVEY AND INVENTORY OF WARMWATER LAKES

JOB NO.: IV-C JOB TITLE: FORT PECK RESERVOIR STUDY

PROJECT PERIOD: JULY 1, 2021 THROUGH JUNE 30, 2022
REPORT PERIOD: MARCH 1, 2021 THROUGH FEBRUARY 29, 2022

ABSTRACT

Fort Peck Reservoir had a peak elevation on January 12th, 2021 at 2235.81 mean feet above sea level (MSL) to a minimum elevation on December 31st, 2021 at 2224.99 MSL, an decrease of 10.82 feet. Spawning walleye populations were sampled in the upper Big Dry Arm with modified fyke nets from April 2nd to April 17th, 2021. Walleye eggs were collected and the fertilized eggs were sent to Fort Peck and Miles City fish hatcheries. Trap netting (non-standardized) captured 2,176 walleye for a catch rate of 18.8 per net night which was up from the previous year of 16.3 per net night. Due to favorable spawning conditions, 74 million walleye eggs were collected. A total of 21.1 million fry and 2.1 million walleye fingerlings were stocked in various locations throughout Fort Peck Reservoir. One hundred gill nets were set in standard locations throughout the reservoir from July 13th to August 5th, 2021. Walleye, channel catfish, and goldeye were the most abundant species captured overall, with catch rates of 5.0, 3.1, and 2.5 per net night, respectively. Relative abundance of walleye in 2021 was up from the previous year at 5.0 per net night and above the long-term average of 3.9 per net for the period from (1992 to 2021). Gill-netted walleye averaged 16.2 inches and 2.2 pounds. In 2021, relative abundance increased for stock-size walleye while catch rates for all other length groups remained similar. Relative weights of walleye for all size groups decreased slightly in 2021 except for stock length fish. Northern pike relative abundance decreased slightly to 2.0 per net night which was near the long-term average of 2.1 per net night for the period of 1992 to 2021. Average size of gill-netted northern pike was 25.8 inches and 4.3 pounds. Overall, relative abundance of shoreline forage increased to 163 per haul in 2021 which was slightly below the long-term average of 174.8 per haul from 1990 to 2021. Spottail shiners were the most abundant species captured from shoreline seining in 2021 at 61.6 per seine haul. A total of 208,154 chinook salmon were stocked at Duck Creek, Marina, and Milk Coulee in June of 2021 at an average size of 26.9 fish/pound. Young-of-year cisco relative abundance decreased slightly to 152.7 per net night in 2021 but was above the long-term average of 82 per net night for the period of 1990 to 2021.

OBJECTIVES AND DEGREE OF ATTAINMENT

Activity 1 - Survey and Inventory

Objective: To survey and monitor the characteristics and trends of fish populations and to assess habitat conditions in Fort Peck Reservoir. This objective was met and is presented in the Results and Discussion section of this report.

Activity 2 - Fish Population Management

Objective: To implement fish stocking programs to maintain fish populations at levels consistent with habitat conditions and other limiting factors. This objective was met and results are presented in Results and Discussion of this report.

Activity 3 - Technical Guidance

Objective: To review projects by government agencies and private parties that have the potential to affect fisheries resources, provide technical advice or decisions to mitigate effects on these resources, and provide landowners and other private parties with technical advice and information to sustain and enhance fisheries resources. This objective was met by evaluating the impact of reservoir water levels on the Fort Peck Reservoir fishery and was presented to Corps of Engineers to make recommendations for Annual Operating Plan (AOP). Objectives of the Fort Peck Reservoir Fisheries Management Plan (FPRFMP) are presented in the Results and Discussion of this report. The FPRFMP will guide fisheries management activities on Fort Peck Reservoir for a ten-year period (2012-2022). Objective accomplished.

Activity 4 - Aquatic Education

Objective: To enhance the public's understanding, awareness and support of the state's fishery and aquatic resources and to assist young people to develop angling skills and to appreciate the aquatic environment. No volunteers assisted with the annual walleye egg-taking operation in the upper Big Dry Arm of Fort Peck Reservoir in 2021 due to COVID-19 restrictions still in place. This also resulted in no fishing clinics or public meetings. However, staff assisted the regional information and education officer with several press releases, interviews on the Montana Outdoor Radio Show (x2), and multiple Fisheries Friday posts for the R6 Facebook page. Objective accomplished.

STUDY AREA

Fort Peck Reservoir is a large earth-filled dam on the Missouri River located in northeastern Montana. Figure 1 depicts major roads around Fort Peck Reservoir, select locations and 5 sampling regions the reservoir is divided into: upper Big Dry Arm (UBD), lower Big Dry Arm (LBD), lower Missouri Arm (LMA), middle Missouri Arm (MMA), and upper Missouri Arm (UMA). The dam was closed in 1937 and is the largest water body in the state of Montana, with 240,000 surface acres at full multiple use pool. Full flood pool is reached at 2250 and multiple use pool is reached at 2246 mean feet above sea level (MSL). At full multiple use pool 1,500 miles of shoreline exists in 130 linear miles of the reservoir with a maximum depth of 220 feet. The bottom of the multiple use pool is 2234.19 MSL and the bottom of the multipurpose carryover zone is 2160 feet MSL. Fort Peck Reservoir had a peak elevation on January 12th, 2021, at 2235.81 mean feet above sea level (MSL) to a minimum elevation on December 31st, 2021 at 2224.99 MSL, an decrease of 10.82 feet. (Figure 2). Reservoir elevations are predicted to hold steady from March through June and fall beginning in June of 2021 based on the December median runoff forecast (USACE 2021).

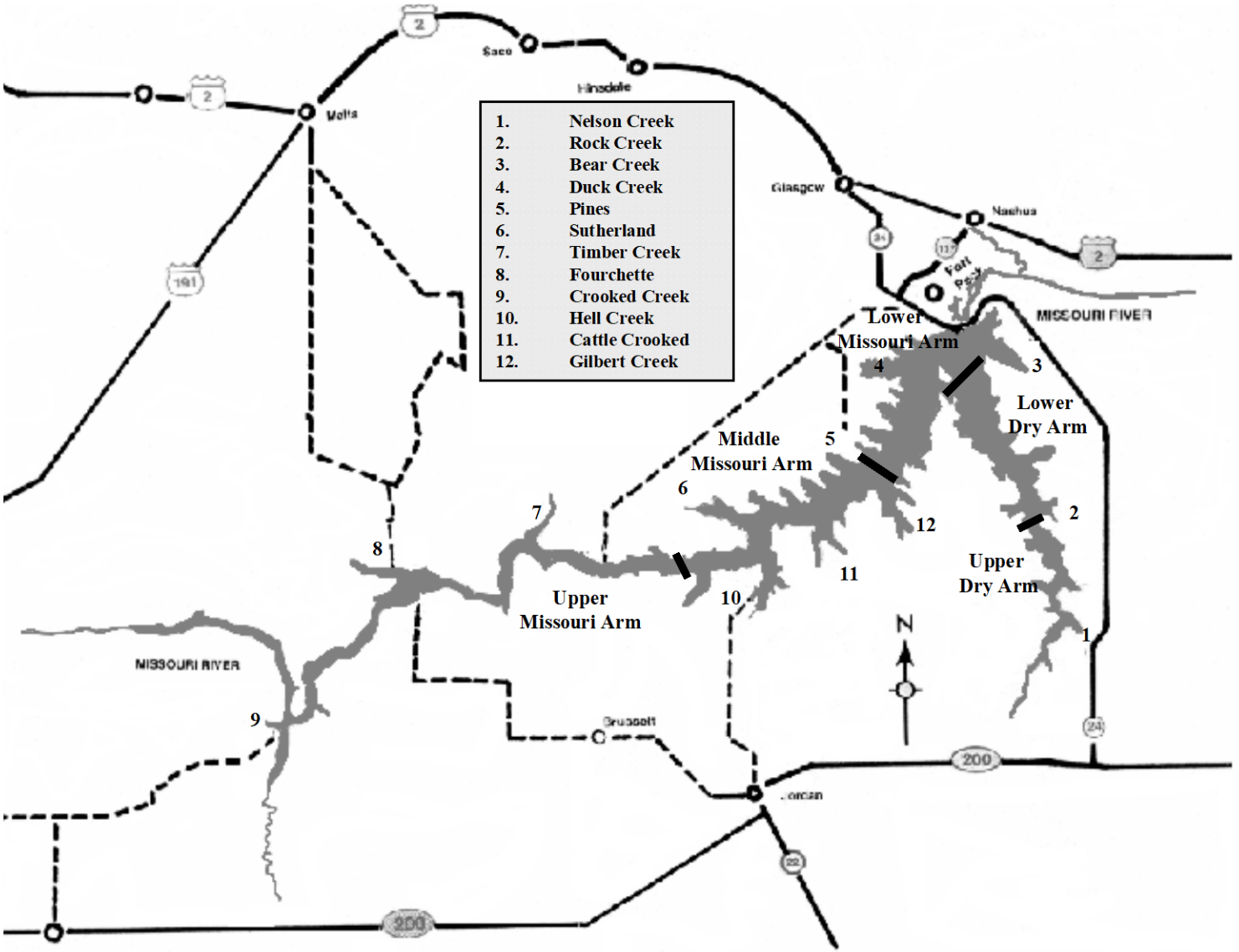


Figure 1. Fort Peck study area describing major sampling zones and select specific locations.

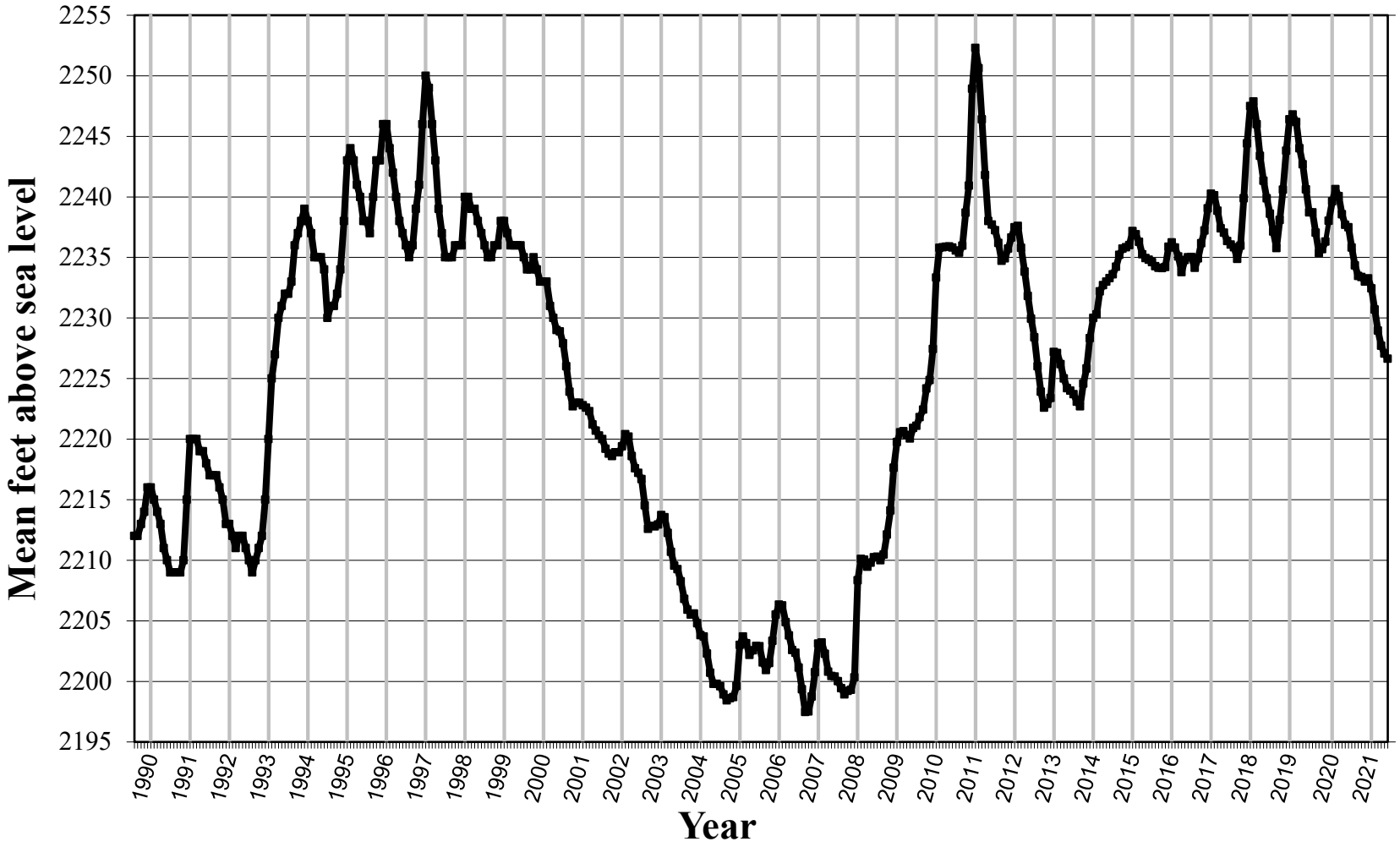


Figure 2. Peak monthly reservoir elevations on Fort Peck Reservoir from January 1990 to January 2021 (Data provided by the U.S. Army Corps of Engineers).

SAMPLING METHODS

Data Collection

- Spring trap netting efforts were conducted from April 2nd to April 17th, 2021 in the Big Dry Arm with 4-ft x 6-ft modified fyke nets of 1-in square mesh rigged and 30 to 50-ft leads. These sites are not standardized due to fluctuations in reservoir elevations. This netting effort is targeted for collection of walleye and northern pike to provide an egg source to meet stocking requests for Fort Peck Reservoir and other sport fisheries for the state of Montana. Not all fish are weighed and measured during the egg-taking effort due to time constraints, limited manpower, and rough conditions at times. Therefore, subsamples of fish are presented in the tables and length frequency distributions of this report. Vokoun et al. (2001) recommended using 300-400 individuals when constructing length frequency distributions with a given accuracy and precision.
- Limnological sampling was conducted at six sites (Bug Creek, Spring Creek, Haxby, Pines, Hell Creek, and Timber Creek) throughout the reservoir. Profile measurements were collected at 10-ft intervals using a Hydrolab equipped with a DS5 probe and Surveyor 4 data logger from May through September during the middle of each month. Profile measurements were recorded from the subsurface to the maximum depth at each site. Specific measurements included: temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L). A detailed table is located in Appendix 3 of the report.
- Zooplankton samples were collected using a 153 µ mesh net with a 12-in diameter opening and a 1:3 cone. Sampling was conducted at the same six sites listed above to address differences in general productivity and morphology of the reservoir. Fifty-foot vertical tows were performed monthly at each of the sampling stations from May through September. Two tows were conducted at each site and pooled into one sample. Zooplankton processing methods follow those described by Leathe and Graham (1982).
- One hundred sinking experimental multifilament gill nets 125-ft x 6-ft deep consisting of 25-ft panels of ¾, 1, 1 ¼, 1 ½, and 2-in square mesh were fished from 10 to 30-ft depths at standardized locations. Gill netting occurred from July 13th to August 5th, 2021 to monitor distribution, species composition, relative abundance, and population parameters for game and native species throughout the reservoir. A list of sampling dates by region, water surface temperature and reservoir elevation during time of sampling are presented in Appendix 3.
- Walleye otoliths were removed from all walleye collected during reservoir-wide gillnetting. Otoliths were mounted in epoxy and cut into thin sections on an Isomet saw and later mounted on glass slides. Walleye otoliths were used as an aging structure because of their higher precision when compared to scales and spines (Erickson 1983; Isermann et al. 2003). Growth was expressed as mean length-at-age at time of capture in July/August for walleye.
- Beach seining was conducted from August 2nd to September 25th, 2021 using a 100-ft x 9-ft beach seine of 3/16-in square mesh at 100 standardized locations throughout the reservoir, to determine relative abundance and reproductive success of game and forage fish.
- Twelve multifilament gill nets 100-ft x 6-ft with ½-in square mesh were fished vertically from the water's surface to sample young-of-year cisco from September 17th to September 29th, 2021. Additional mesh sizes of ¾, 1, 1 ¼, 1 ½-in mesh were incorporated in 2013 to sample adult cisco. Only the lower Big Dry, lower Missouri, and middle Missouri Arm regions were sampled because they contained sufficient depths of 100 ft. Lengths and weights were collected from the first 100 cisco captured per mesh, per site. Otoliths were removed for age estimation (10 per 10-mm length group per sampling region). Otoliths were mounted in epoxy and cut into thin sections on an Isomet saw and later mounted on glass slides (Secor et al. 1992). A total of 165 cisco otoliths were aged in 2021.
- Boat mounted electrofishing was used during September 29th to October 28th, 2021 to locate, sample, and collect chinook salmon as part of the annual egg-take effort.
- Chinook salmon otoliths were collected from all fish used in the egg taking process. Otolith preparation followed methods outlined by Secor et al. (1992). Otoliths were mounted in epoxy and cut into thin sections on an Isomet saw and later mounted on glass slides.

Data Analysis

Relative abundance of fish species was expressed as mean catch per unit effort (CPUE) for modified fyke nets (No./net night), gill net (No./net night), and seine catches (No./haul).

Proportional stock density (PSD; Anderson and Weithman 1978) and relative stock density (RSD) values were calculated for channel catfish, lake trout, northern pike, sauger, smallmouth bass, and walleye (Gablehouse 1984). However, the terminology to PSD has been changed to proportional size distribution and use of RSD was discontinued to assist in communication and name the index more correctly (Guy et al. 2007). Length categories used to calculate PSD values are listed in Table 1.

Table 1. Minimum lengths (in) of length-class designations used when calculating proportional size distribution values for fish population survey samples.

Species	Length Class				
	Stock	Quality	Preferred	Memorable	Trophy
Channel catfish	11	16	24	28	36
Lake trout	12	20	26	31	39
Northern pike	14	21	28	34	44
Sauger	8	12	15	20	25
Smallmouth bass	7	11	14	17	20
Walleye	10	15	20	25	30

Relative weights (*Wr*; Anderson 1980) were calculated using the standard weight (*Ws*) equations developed for channel catfish (Brown et al. 1995), cisco (Fisher and Fielder 1998), lake trout (Hubert et al. 1994) northern pike (Willis 1989), smallmouth bass (Kolander et al. 1993), and walleye (Murphy et al. 1990). Calculated values for channel catfish and northern pike are presented in Appendix 4, while values for walleye and cisco are presented in the results and discussion section of this report. Proportional size distribution, PSD-P, and *Wr* values were calculated using EXCEL.

RESULTS AND DISCUSSION

Spring Trap Netting

Spawning walleye and northern pike populations were sampled from Nelson Creek to McGuire Creek area of Fort Peck Reservoir from April 2nd to April 17th, 2021. A total of 116-trap days were committed to walleye spawning efforts in 2021. Netting effort was lower than previous years due to favorable water temperatures during trap netting efforts which led to increased catch rates of walleye and more eggs collected in a short amount of time. Ice cover typically recedes by the first week in April and the walleye spawning operation concludes in three to four weeks. Water surface temperatures were 45°F when trap netting efforts commenced and gradually increased to 51°F on April 8th. Walleye spawning activity peaks when water temperatures are 43°F to 50°F in the north-central United States (Becker 1983). FWP staff was limited in manpower efforts, which resulted in fewer trap nets set, as no public volunteers could assist with the trap netting and egg-taking operation due COVID-19 guidelines issued.

Because of normal ice-off conditions and gradually increasing water temperatures in 2021, the egg-take goal of 60 million was exceeded and 74 million total eggs were collected. Due to these favorable water temperatures and ice receding at a normal time, large numbers of ripe female walleye (46%) were captured during the operation. In addition, 50% of the female walleye captured were green and only 4% were spent female walleye during the 2021 trap netting effort. In contrast, higher than normal numbers of spent female walleye (61%) were captured in 2018 due to late ice cover followed by a rapid increase in water temperatures. It's possible some walleye ascended portions of the Big Dry Creek while there was still ice on the main portion of the reservoir and attempted to spawn in 2018. It should be noted that Liebelt (1979) observed natural reproduction of walleye during periods of higher reservoir elevations and higher inflows to the Big Dry Arm.

The fertilized walleye eggs were sent to Fort Peck and Miles City Fish Hatcheries. A total of 21.1 million fry and 2.1 million walleye fingerlings were stocked in various locations throughout Fort Peck Reservoir in 2021 (Appendix 2). Kerr (2011) recommended walleye release sites should be increased as size and basin complexity of the waterbody increases to distribute them over as wide an area as possible. The goal of 3 million fingerlings for Fort Peck Reservoir was not met (FPRFMP 2012). This was due to below average fingerling production at the Miles City and Fort Peck hatcheries. Water temperatures and plankton production were variable in the rearing ponds at Fort Peck and Miles City hatcheries during the time of fry stocking which likely decreased survival (Wade Geraets, personal communication).

Walleye

Relative abundance of walleye captured in spring trap nets was 18.8 per net in 2021 which increased from 16.3 per net the previous year. This was the highest on record and above the long-term average of 7.3 per net (1990-2021; Table 2). Length frequency distributions showed 54% of walleye were greater than 20 inches in 2020 compared to 49% in 2021 (Figure 3). The combination of more male walleye measured in 2021 and higher numbers of male walleye 15-18 inches influenced this trend (Figure 4). Typically, more male walleye are captured than females during trap netting. In general, length frequency distributions during the spring trap netting effort indicated male walleye were smaller when compared to female; however, male walleye up to 27 inches were captured during these efforts (Figure 4).

Table 2. Summary of mean CPUE (No./net-night), mean length (in), and mean weight (lb)walleye and northern pike captured during spring trap netting in the upper Big Dry Arm of Fort Peck Reservoir, 1990-2021. N is the total number of walleye and northern pike collected.

Year	Date	Net-Nights	Walleye N	Walleye CPUE	Northern pike N	Northern pike CPUE
1990	(4/05-5/04)	292	1,863	6.4	513	1.8
1991	(4/09-5/10)	375	793	2.1	491	1.3
1992	(4/07-4/29)	278	1,585	5.7	684	2.5
1993	(4/15-4/30)	172	1,945	11.3	201	1.2
1994	(4/12-4/26)	168	1,882	11.2	160	1
1995	(4/11-4/28)	473	3,284	6.9	648	1.4
1996	(4/15-5/02)	391	3,231	8.3	2,307	5.9
1997	(4/15-4/29)	307	3,937	12.8	2,652	8.6
1998	(4/04-4/29)	477	2,806	5.9	1,354	2.8
1999	(3/27-4/26)	434	5,673	13.1	2,573	5.9
2000	(4/04-4/28)	392	2,126	5.4	603	1.5
2001	(4/06-4/27)	328	3,362	10.3	1,922	5.9
2002	(4/17-5/09)	349	2,377	6.8	1,713	4.9
2003	(4/11-5/01)	426	2,366	5.6	1,579	3.7
2004	(4/09-4/26)	324	2,323	7.2	2,174	6.7
2005	(4/06-4/27)	537	2,030	3.8	1,327	2.5
2006	(4/12-5/01)	579	2,345	4.1	503	0.9
2007	(4/03-5/01)	617	2,478	4	1,425	2.3
2008	(4/18-5/07)	383	1,151	3	629	1.6
2009	(4/18-4/28)	176	1,740	9.9	813	4.6
2010	(4/13-4/30)	289	1,470	5.1	525	1.8
2011	(4/18-5/06)	399	1,341	2.8	911	2.3
2012	(3/27-5/01)	730	1,576	2.2	1,499	2.1
2013	(4/17-5/10)	484	2,176	4.5	5,082	10.5
2014	(4/18-5/05)	363	1,670	4.6	2,864	7.9
2015	(3/31-4/23)	405	1,740	4.3	1,147	2.8
2016	(3/29-4/21)	427	2,672	6.3	2,382	5.6
2017	(4/05-4/23)	277	2,261	8.2	1,040	3.8
2018	(4/23-5/08)	255	1,280	5.7	936	4.2
2019	(4/11-4/26)	205	2,058	10.0	1,301	6.3
2020	(4/08-4/18)	101	1,647	16.3	380	3.8
2021	(4/02-4/17)	116	2,176	18.8	700	6.0

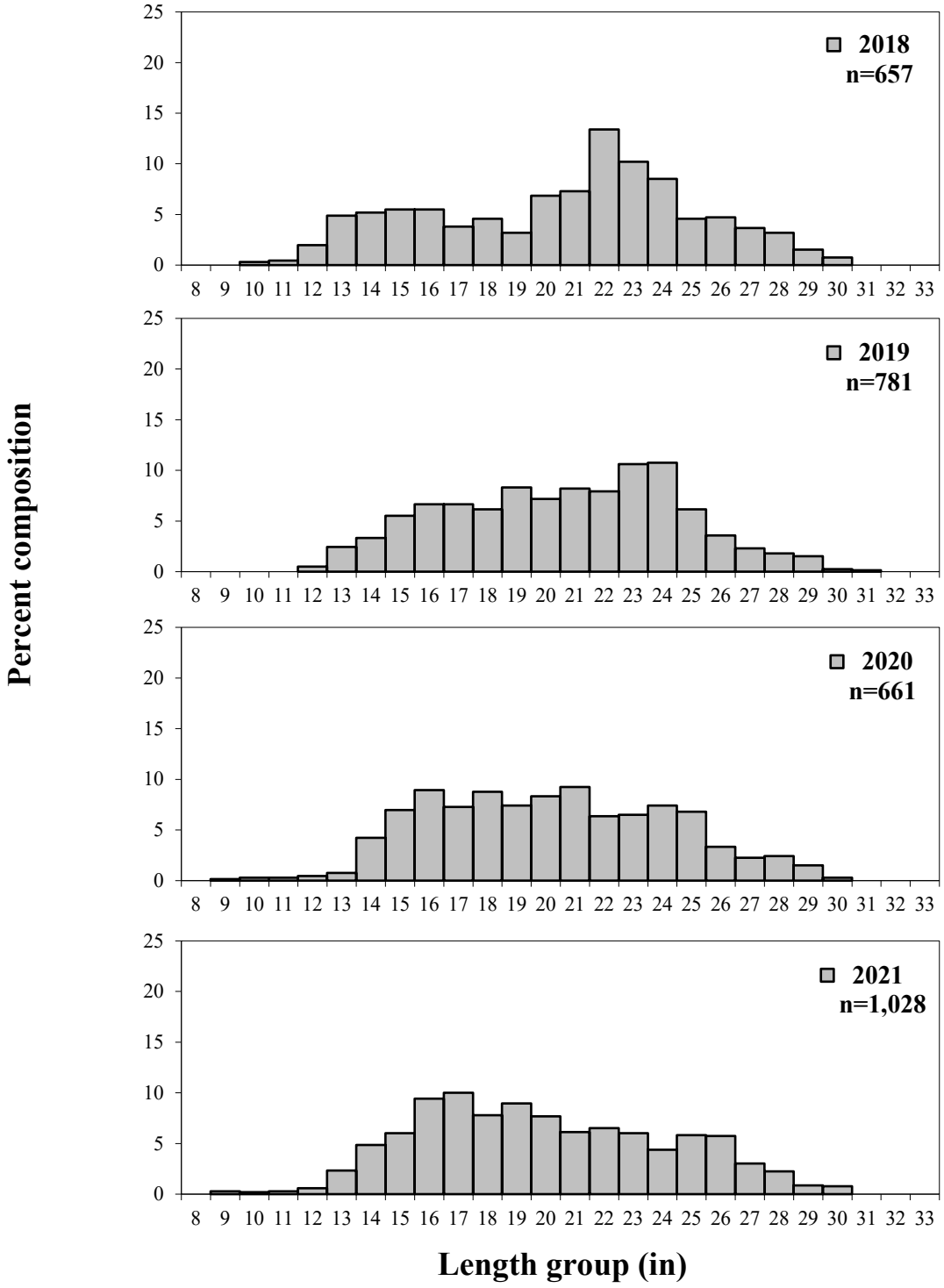


Figure 3. Length frequency of subsampled walleye collected during spring trap netting in the upper Big Dry Arm of Fort Peck Reservoir, 2018-2021.

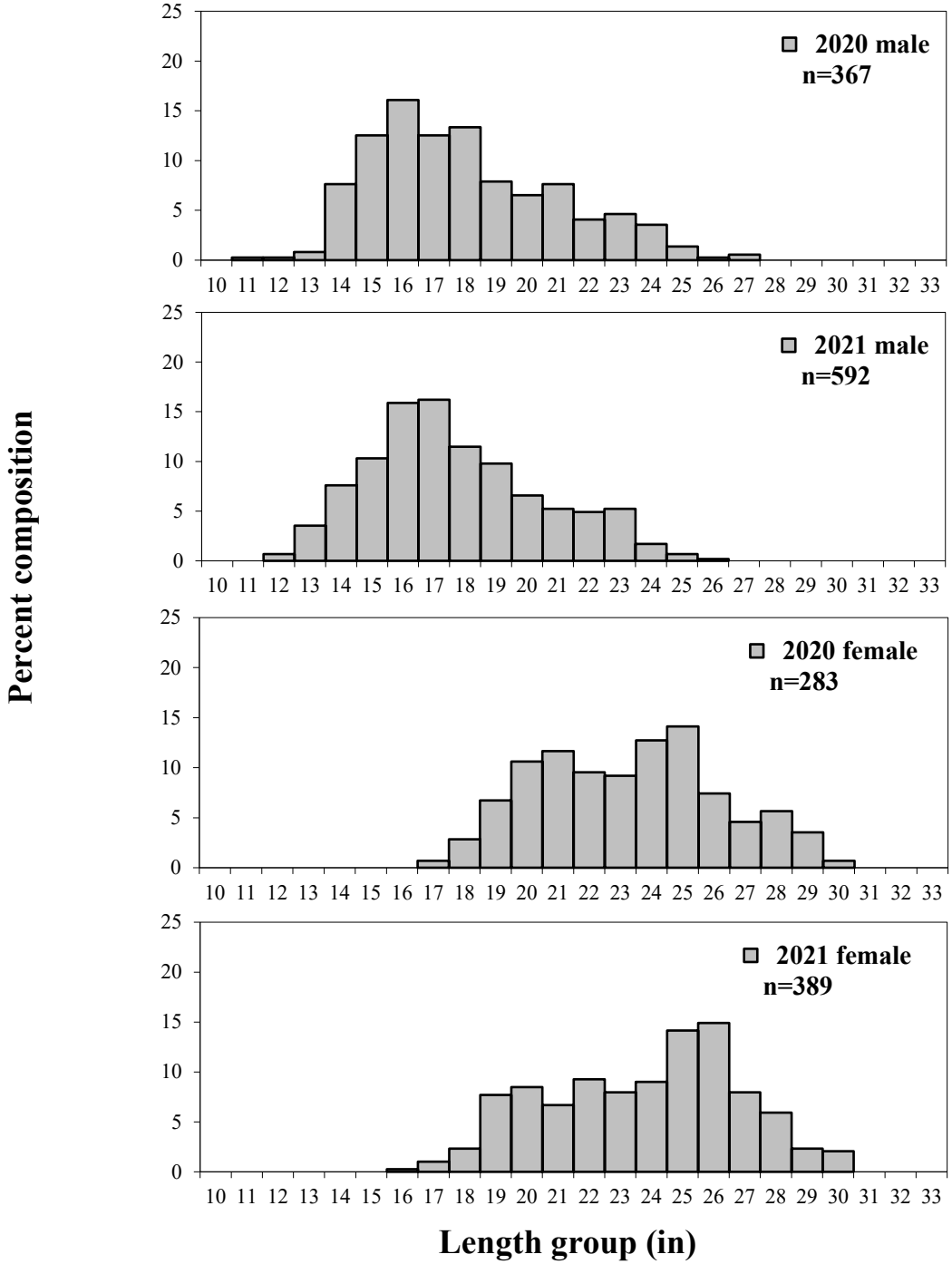


Figure 4. Length frequency of subsampled male and female walleye collected during spring trap netting in the upper Big Dry Arm of Fort Peck Reservoir, 2020-2021.

LIMNOLOGY AND ZOOPLANKTON MONITORING

Water temperature in Fort Peck Reservoir ranged from 24.3°C at the subsurface to 4.6°C at the bottom (Appendix 3). Temperatures throughout the water column were coolest during May and warmest during August. Water temperatures below the surface were warmest at the uppermost sites (Timber Creek and Bug Creek) during the sampling period but gradually decreased at each site moving downstream towards the dam area.

Thermal stratification of Fort Peck Reservoir was not observed until July and strong thermoclines were present in August and September (Appendix 3). Each site was thermally stratified during the month of August and continued into September with the exception of Timber Creek. Thermocline depth varied by month and site. The most pronounced thermocline was located at the Haxby site during July (Figure 5; Appendix 3).

Dissolved oxygen concentrations were highest (11.6 mg/L) during May when the reservoir was coolest. More uniform dissolved oxygen levels were also observed during this time when near isothermal conditions were present (Appendix 3). Dissolved oxygen concentrations decreased to their lowest levels during late summer/early fall. Dissolved oxygen levels fell below 5 mg/L near the bottom at Pines, Hell Creek, and Timber Creek during August and September. It should be noted that dissolved oxygen levels of less than 5 mg/L may limit some deep-water salmonid habitat (e.g., lake trout; Sellers et al. 1998). No anoxic conditions were observed at any of the locations in 2021.

The maximum estimated zooplankton density was 90.5/L which occurred in June of 2021 and was comprised largely of rotifers. Cyclopoids represented the zooplankton community throughout the sampling season and highest densities were observed during June at 28.9/L. *Daphnia* were the most abundant cladoceran sampled and were most abundant during July (Figure 6). Cladocerans, *Leptodora* and *Diaphanosoma*, were present in small numbers and were only collected periodically. These trends in seasonal abundance are similar to previous findings on Fort Peck Reservoir and other large mainstem Missouri River Reservoir systems (Wiedenheft 1985; Mullins 1991; Fielder 1992).

Comparison of total densities for all zooplankton from each station varied slightly by year and location (Figure 7). Wiedenheft (1985) noted a similar trend in zooplankton density. Mean densities of zooplankton by location in 2021 were similar to those observed in 2020. Increased inflows and increases in reservoir elevation have been shown to increase standing crops of zooplankton and diversity of the zooplankton community (Martin et al. 1981).

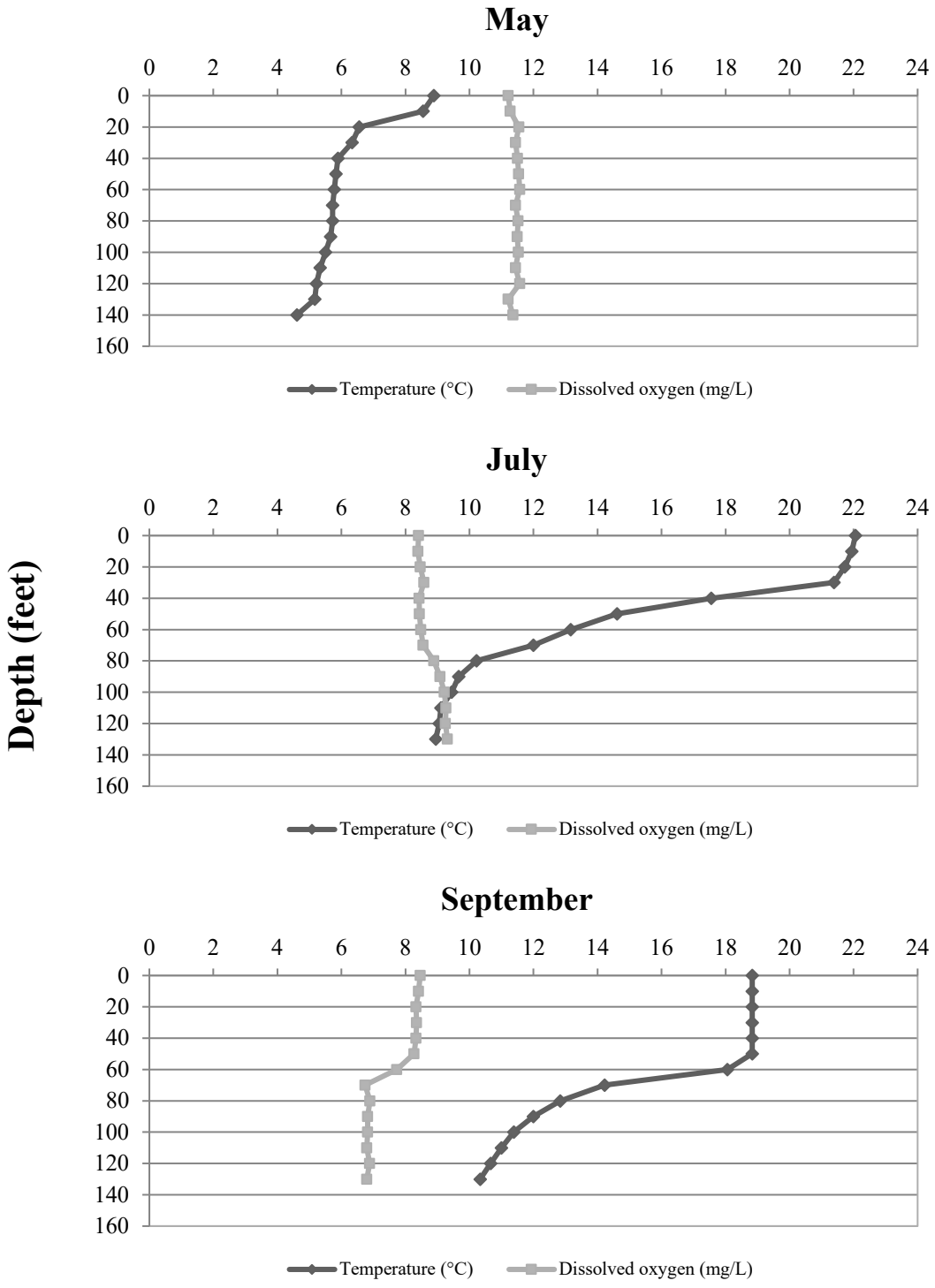


Figure 5. Depth profiles of temperature (°C) and oxygen (mg/L) located near Haxby Point on Fort Peck Reservoir, May, July, and September 2021.

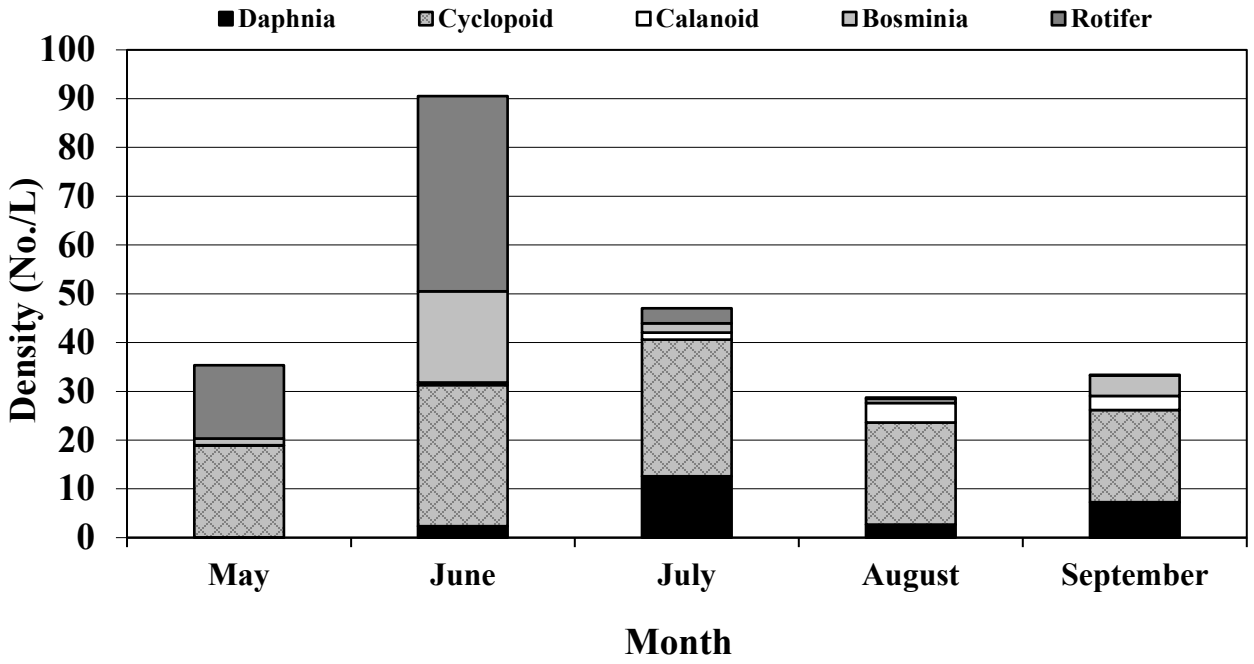


Figure 6. Mean zooplankton density (number of organisms/L) pooled from reservoir-wide samples by taxonomic group and month for Fort Peck Reservoir, 2021.

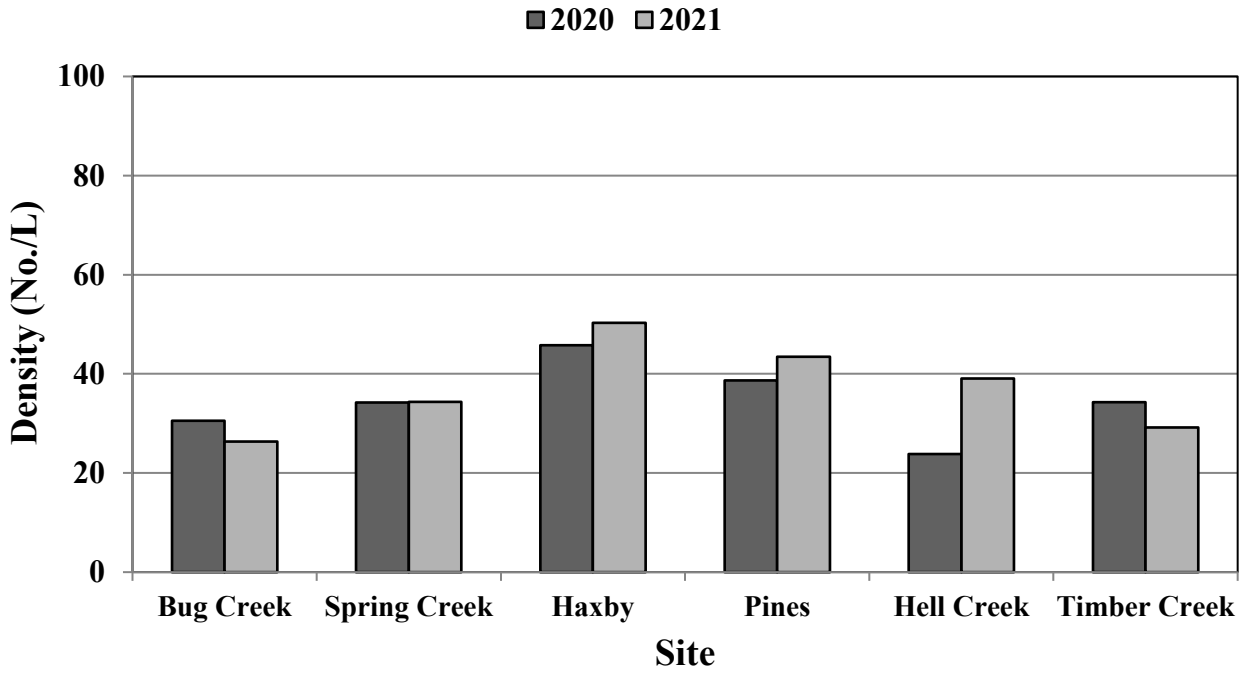


Figure 7. Mean zooplankton density (number of organisms/L) pooled for all months (May-September) for Fort Peck Reservoir, 2020-2021.

RESERVOIR-WIDE GILL NETTING

Standard experimental gill nets were set throughout the reservoir from July 13th to August 5th, 2021 when water surface temperatures ranged from 70.7°F to 80.5°F. Gill netting provides information on species distribution; composition, relative abundance, population parameters, and stomach contents of game species. Nineteen species were captured for a total of 2,375 fish (Table 2). Walleye, channel catfish, and goldeye were the most abundant species captured overall, with catch rates of 5.0, 3.1, and 2.5 per net night, respectively. Fish with catch rates equal to or greater than 1.0 per-net night include: common carp, northern pike, river carpsucker, shorthead redhorse, smallmouth bass, and smallmouth buffalo.

Walleye

Relative abundance of walleye in 2021 was 5.0 per net which was up from the previous year (Figure 8). This was above the long-term average of 3.9 per net from 1992 to 2021. The three-year running average goal of 3.6 per net was met (4.4 per net in 2019-2021) as outlined in the FPRFMP. Stock-length size groups comprised the largest group of walleye sampled in 2021 suggesting favorable growth and survival (Figure 8). Relative abundance of walleye was greatest in the lower Big Dry arm with a catch rate of 4.9 per net (Table 3).

Length frequency distributions of walleye in 2021 indicated a broad length distribution of fish a strong year class present 10 to 14-inch fish unlike 2020 (Figure 9). In 2019, there was a high abundance of 11 to 15-inch fish that comprised 49% of the walleye sampled and another group from 23 to 28 inches representing 18% of all walleye captured (Figure 9). In 2018, this group measured 21 to 25-inches and represented 25% of all walleye captured and 32% of all walleye gill netted in 2017 as 19 to 22-inch fish. Both years would suggest multiple, large year classes present. Based on length frequencies, walleye in Fort Peck Reservoir don't recruit to experimental gill nets until they are greater than 10 inches in length.

Mean length-at-age for walleye in 2021 tracked closely to the six-year average (Table 5). Mean lengths-at-age were higher when compared to the drought years (2006-2007) which were characterized by low reservoir elevations, low relative abundance of forage items, and low relative weights for all size groups of walleye (Headley 2012). A large group of age-3 and age-4 walleye were documented which comprised 48% of all walleye aged in 2021. The 2011-year class (10-year old fish) comprised 12% of all walleye sampled in 2021. This year class comprised 21% of all walleye aged in 2018. The oldest walleye sampled was aged at 20.

Overall, relative weights of walleye in 2021 decreased slightly compared to the previous year (Table 6). Relative weights decreased slightly for all length groups except stock length fish. Relative weights for all length groups of walleyes captured in 2021 were higher than the drought/low water years of 2005-2008 (Figure 10). Relative weights of preferred and memorable+ length groups remained over 90 which can be attributed to an abundance of young-of-year and adult cisco observed in 2021. Cisco have been found to be an important prey item for walleye greater than 18 inches in Fort Peck Reservoir (Mullins 1991).

Since 1992, walleye PSD would have fallen into the favorable category, with the exception of 1995 and 1996. The favorable trend resumed in 1998 and continued into 2015 with a value of 59 (Table 6). However, PSD of walleye in 2016 was 72 making it the highest on record and PSD-P was 34 indicating a greater abundance of preferred size walleye. A ratio between 10 and 20 is considered desirable as a PSD-P for a balanced population. High values of PSD-P indicate an abundance of larger fish with a small stock size available. PSD and PSD-P in 2021 decreased to 46 and 30, respectively. This would suggest more stock length fish in the population.

Table 3. Mean CPUE (No./net-night), mean length (in), and mean weight (lb) of fish collected by experimental gill nets in Fort Peck Reservoir during July-August, 2021. *N* is total number collected for length and weight measurements.

			Length		Weight	
Species	Number	CPUE	Inches	*N*	Pounds	*N*
Black crappie	22	0.2	9.6	22	0.5	22
Burbot	1	<0.1	13.8	1	0.5	1
Channel catfish	307	3.1	18.1	307	2.1	307
Cisco	1	<0.1	7.5	1	0.1	1
Common carp	201	2.0	21.9	201	5.0	201
Freshwater drum	52	0.5	14.3	52	1.4	52
Goldeye	254	2.5	13.3	252	0.8	250
Northern pike	201	2.0	25.8	201	4.3	201
Paddlefish	2	<0.1	0.0	2	62.5	2
Pallid sturgeon	1	<0.1	20.5	1	1.0	1
River carpsucker	242	2.4	20.6	242	5.0	241
Sauger	7	0.1	16.3	7	1.2	7
Shorthead redhorse	130	1.3	14.3	129	1.5	127
Smallmouth bass	171	1.7	12.9	170	1.4	169
Smallmouth buffalo	210	2.1	23.7	210	8.3	210
Walleye	503	5.0	16.2	503	2.2	501
White crappie	10	0.1	16.1	10	1.8	10
White sucker	4	<0.1	10.3	4	0.5	4
Yellow perch	56	0.6	7.0	56	0.2	54

Table 4. Number (*N*) and mean catch per unit effort (CPUE; No./net-night) of fish species collected by experimental gill nets in Fort Peck Reservoir during July-August, 2021.

	UBD[1]		LBD[2]		LMA[3]		MMA[4]		UMA[5]		Total	
Species	N	CPUE	N	CPUE	N	CPUE	N	CPUE	N	CPUE	N	CPUE
Black crappie	7	0.4	1	0.1	0	--	0	--	14	0.7	22	0.2
Burbot	0	--	0	--	0	--	0	--	1	0.1	1	<0.1
Channel catfish	85	4.3	34	1.7	17	0.9	31	1.6	140	7.0	307	3.1
Cisco	0	0.0	0	--	0	--	1	0.1	0	--	1	<0.1
Common carp	28	1.4	26	1.3	66	3.3	44	2.2	37	1.9	201	2.0
Freshwater drum	4	0.2	1	0.1	7	0.4	8	0.4	32	1.6	52	0.5
Goldeye	61	3.1	10	0.5	31	1.6	29	1.5	123	6.2	254	2.5
Northern pike	70	3.5	50	2.5	41	2.1	22	1.1	18	0.9	201	2.0
Paddlefish	0	--	0	--	1	0.1	1	0.1	0	--	2	<0.1
Pallid sturgeon	0	--	0	--	0	--	0	--	1	0.1	1	<0.1
River carpsucker	72	3.6	23	1.2	28	1.4	56	2.8	63	3.2	242	2.4
Sauger	1	0.1	0	--	0	--	3	0.2	3	0.2	7	0.1
Shorthead redhorse	45	2.3	21	1.1	2	0.1	11	0.6	51	2.6	130	1.3
Smallmouth bass	30	1.5	23	1.2	27	1.4	51	2.6	40	2.0	171	1.7
Smallmouth buffalo	68	3.4	56	2.8	25	1.3	21	1.1	40	2.0	210	2.1
Walleye	75	3.8	98	4.9	152	7.6	93	4.7	85	4.3	503	5.0
White crappie	1	0.1	7	0.4	2	0.1	0	--	0	--	10	0.1
White sucker	0	--	0	--	0	--	0	--	4	0.2	4	<0.1
Yellow perch	16	0.8	4	0.2	5	0.3	5	0.3	26	1.3	56	0.6
Total	563	28.2	354	17.7	404	20.2	376	18.8	678	33.9	2375	23.8

[1]Upper Big Dry (UBD): Nelson Creek., Lone Tree Creek, McGuire Creek, Bug Creek, Lost Creek
[2]Lower Big Dry (LBD): Box Creek, South Fork Rock Creek, North Fork Rock Creek, Box Elder Creek, Sand Arroyo, Spring Creek
[3]Lower Missouri Arm (LMA): Spillway Bay, Bear Creek, North Fork Duck Creek, South Fork Duck Creek, Main Duck Creek
[4]Middle Missouri Arm (MMA): Pines Bay, Gilbert Creek, Cattle/Crooked Creek, Hell Creek, Sutherland Creek, Snow Creek
[5]Upper Missouri Arm (UMA): Cabin Coulee, Wagon Coulee, Bone Trail, Timber Creek, Seven Blackfoot, Fourchette Bay, Devils Creek

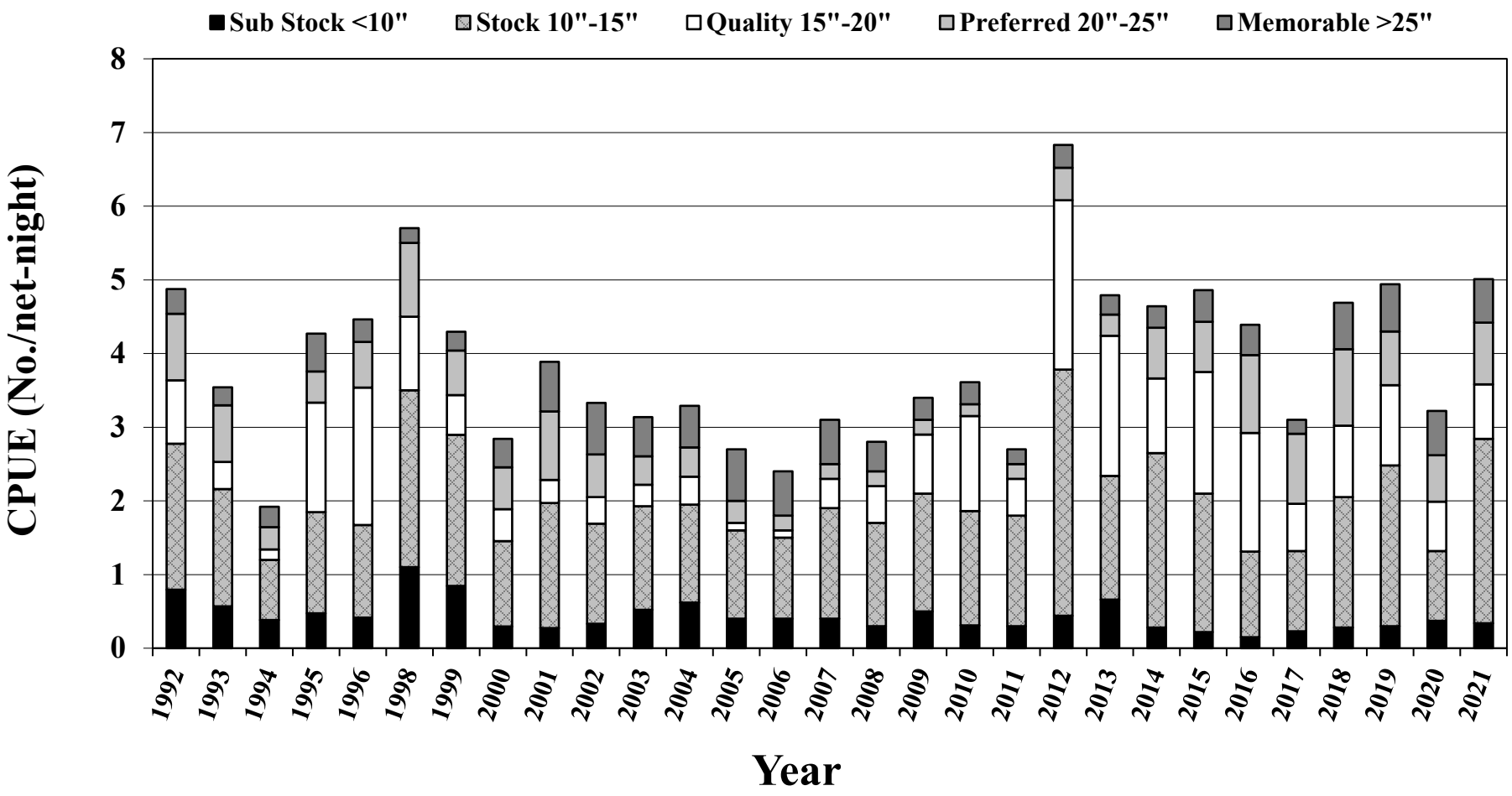


Figure 8. Catch per unit effort (CPUE) of PSD category of walleye collected by experimental gill nets throughout Fort Peck Reservoir during July-August, 1992-2021 (no data for 1997).

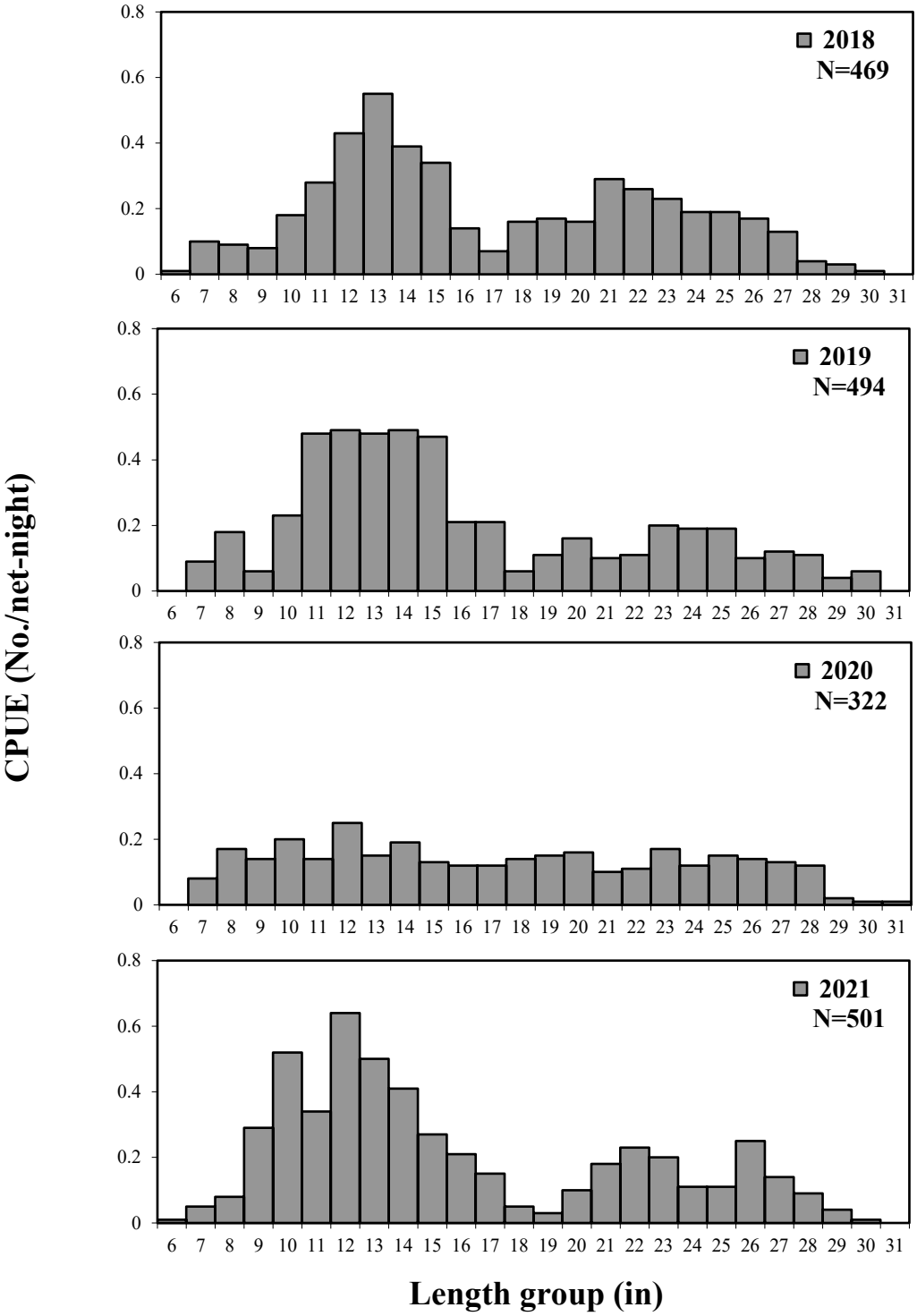


Figure 9. Length frequency, as catch per unit effort, of walleye collected by experimental gill nets in Fort Peck Reservoir during July-August, 2018-2021.

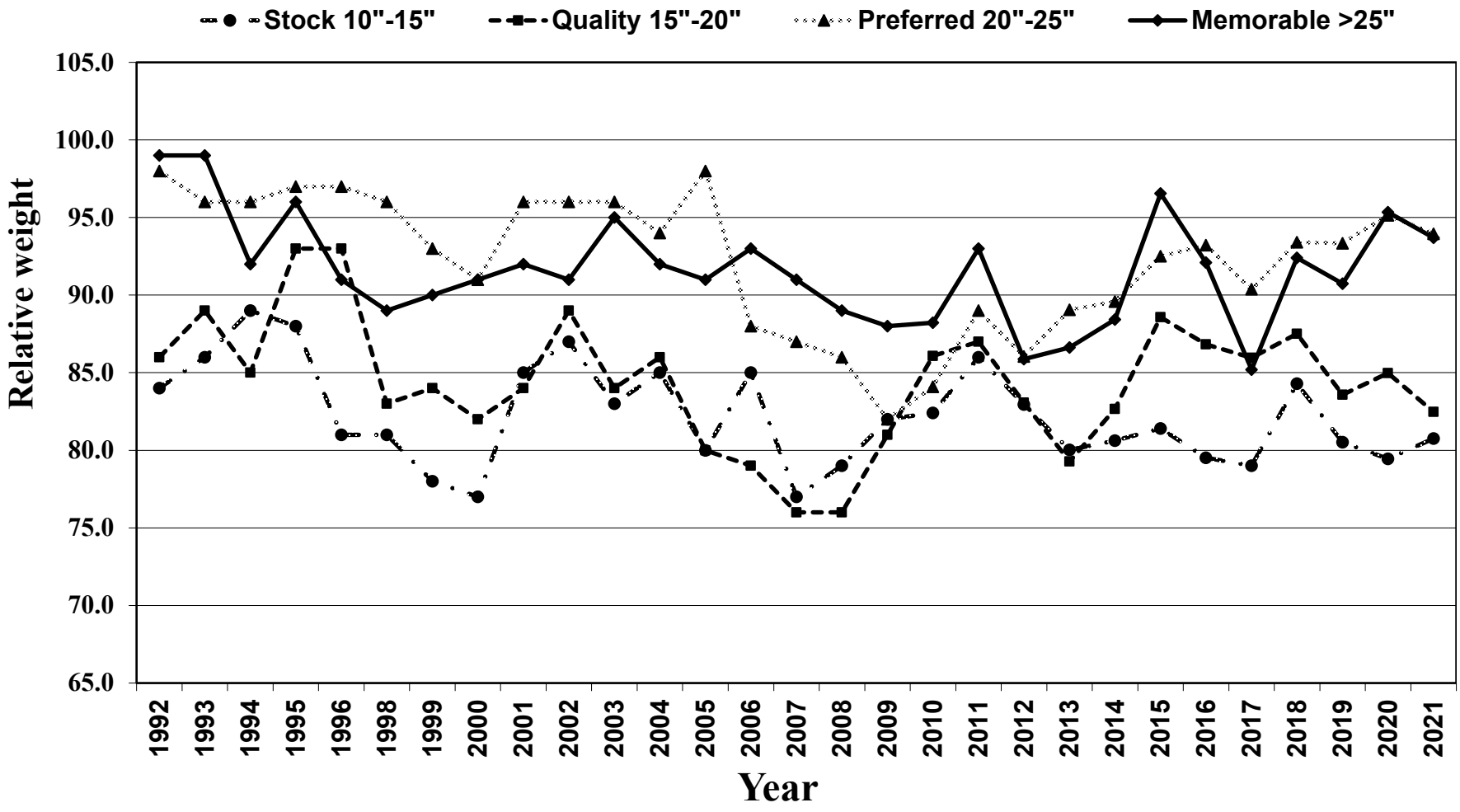


Figure 10. Relative weights for stock, quality, preferred, and memorable length groups of walleye collected by experimental gill nets in Fort Peck Reservoir, 1989-2021 (no data for 1990-1991 and 1997).

Table 5. Mean length-at-age at time of capture (in) for walleye collected in experimental gill nets, 2016-2021, on Fort Peck Reservoir, and aged from sectioned otoliths.

Year		Length at age at capture (in)													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
2016	Mean	--	9.5	12.1	15.4	16.8	19.0	21.5	23.0	24.1	19.6	24.0	24.9	23.8	18.2
	N	--	18	58	32	141	55	15	45	17	2	15	4	5	1
	SE	--	0.3	0.3	0.5	0.2	0.4	0.6	0.4	0.8	0.6	0.7	1.6	1.1	--
	Range	--	7.6-12.5	8.3-16.1	10.1-19.8	10.5-23.3	14.0-24.3	18.5-26.8	18.1-27.4	16.9-27.6	19.0-20.2	18.9-27.7	20.9-27.6	21.2-27.8	--
2017	Mean	7.4	9.1	10.6	13.0	16.6	18.4	19.8	23.5	23.6	23.5	23.3	28.3	--	23.4
	N	2	16	33	49	22	103	22	11	20	3	4	1	--	1
	SE	0.3	0.2	0.2	0.3	0.9	0.3	0.8	0.6	0.5	1.6	1.8	--	--	--
	Range	7.1-7.7	7.6-10.6	7.7-13.1	9.6-18.0	10.4-22.2	11.8-24.4	10.9-24.6	20.8-27.8	18.1-26.6	21.9-26.7	19.8-28.3	--	--	--
2018	Mean	8.4	9.8	11.7	13.6	14.6	17.2	18.9	21.8	23.4	24.3	25.9	25.6	26.9	23.1
	N	20	16	38	58	74	34	89	36	13	29	6	5	9	1
	SE	0.2	0.3	0.2	0.2	0.3	0.7	0.4	0.4	0.7	0.5	1.2	1.3	0.6	--
	Range	7.0-9.6	7.4-12.0	8.6-13.9	10.6-17.1	10.9-22.9	12.0-25.3	11.5-25.3	16.2-26.0	17.5-27.0	18.7-28.0	22.3-29.2	21.3-27.7	23.6-28.5	--
2019	Mean	8.3	11.4	13.1	13.8	15.3	16.4	18.7	20.3	22.2	24.0	26.0	27.9	27.6	28.0
	N	27	84	46	47	76	25	28	60	22	12	19	6	10	7
	SE	0.1	0.1	0.2	0.2	0.2	0.5	0.7	0.5	0.7	0.8	0.5	0.3	0.8	1.0
	Range	7.0-10.2	8.1-13.7	10.2-16.7	11.9-17.0	8.3-21.2	12.3-24.8	13.0-25.4	13.4-27.6	14.8-25.9	20.4-28.5	20.2-28.4	27.2-29.1	24.0-30.1	23.3-30.7
2020	Mean	8.1	9.4	12.4	14.6	16.6	17.0	19.1	20.8	22.9	24.1	24.3	26.8	24.5	28.1
	N	1	55	40	30	24	24	19	10	46	15	3	16	3	4
	SE	--	0.2	0.2	0.3	0.5	0.6	0.5	0.7	0.4	0.7	1.4	0.5	1.9	1.4
	Range	--	7.3-12.0	8.1-14.6	11.2-19.1	12.0-20.4	12.7-23.1	12.8-22.5	17.1-25.1	17.5-28.0	18.4-27.3	22.4-27.2	22.3-29.0	22.0-28.2	24.1-30.2
2021	Mean	7.5	10.3	11.7	13.9	15.0	16.5	18.7	20.0	22.1	23.7	25.1	25.3	26.2	27.1
	N	4	42	146	92	21	19	25	27	11	61	10	7	18	3
	SE	0.3	0.2	0.1	0.2	0.6	0.6	0.6	0.6	0.9	0.4	0.6	0.9	0.6	1.0
	Range	6.8-8.0	7.8-12.4	8.4-16.9	9.7-17.6	11.5-21.3	10.6-22.0	14.0-23.8	12.5-24.6	17.0-26.7	15.9-27.6	21.7-27.0	22.1-28.8	22.1-30.6	25.1-28.1
Mean of means		7.9	9.9	11.9	14.1	15.8	17.4	19.5	21.6	23.1	23.2	24.8	26.5	25.8	24.7

Northern Pike

Relative abundance of northern pike captured in gill nets was 2.0 per net in 2021 which was similar to the previous year (Table 3; Figure 11). The three-year running average goal of 2.0 northern pike per net was met (2.4 per net in 2021) as outlined in the FPRFMP. Average length and weight of northern pike in 2021 was 25.8 inches and 4.3 pounds which was similar compared to the previous year (Table 7). This was due to smaller-sized individuals growing and recruiting into the population as a result of limited natural reproduction. Northern pike less than 25 inches comprised 54% of the fish sampled in 2021 (Figure 12). In contrast, 80% of the northern pike captured in gill nets were greater than 25 inches during the low water years of 2005-2006 (Headley 2007).

In 2021, northern pike PSD was 89 and PSD-P was 27. During the drought years, PSD ranged from 93 to 98 and PSD-P ranged from 55-71 indicating a population comprised of larger fish. With stable to increasing water levels from 2017 to 2019, inundation of terrestrial vegetation became more prevalent throughout the reservoir which increased the amount of ideal spawning/rearing habitat. Relative abundance of shoreline forage also increased during that time and provided increased food items for juvenile northern pike. As a result, relative abundance of stock and quality length groups of northern pike has increased over the last two years. Relative weight of northern pike was 94 in 2021 which was slightly lower than the previous year.

Channel Catfish

Relative abundance of channel catfish captured by gill netting was 3.1 per net in 2021. This was nearly double compared to the previous year and above the 29-year average of 2.0 per net (Figure 13). Similar to previous years, highest abundance was observed in the Upper Missouri Arm at 7.0 per net (Table 4). In 2021, mean length and weight was 18.1 inches and 2.1 pounds, respectively. This was slightly higher than the long-term average of 16.9 inches and 1.9 pounds (Table 8). Relative weights of channel catfish were 85 in 2021 which were similar to the previous year. Catfish PSD and PSD-P were 45 and 7, respectively, indicating a population comprised of smaller fish.

Sauger

Sauger numbers have declined in Fort Peck Reservoir since 1985 and remained low since then (Figure 13). This decline has occurred in spite of restrictive angling regulations (i.e., 1 sauger daily and 2 in possession) implemented in 2002. However, fishing regulations changed in 2016 allowing anglers to keep 2 sauger daily and 4 in possession within the walleye/sauger combination of 5 daily and 10 in possession. Relative abundance in 2021 was less than 0.1 per net. Average size of sauger in 2021 was 16.3 inches and 1.2 pounds with a relative weight of 67. This population relies on natural reproduction from the Missouri River where more suitable spawning habitat is available (Bellgraph et al. 2008). Relative abundance for sauger was highest in the middle and upper Missouri arm with a catch rate of 0.2 per net (Table 4).

Table 6. Summary of mean catch per unit of effort (CPUE; No./net-night), standard error (SE), mean length (in), mean weight (lb), mean *Wr*, and stock density indices of walleye collected in experimental gill nets on Fort Peck Reservoir, 1998-2021.

Year	No. walleye	CPUE	SE	Length	Weight	*Wr*	Substock[1]	Stock[2]	Quality[3]	Preferred[4]	PSD[5]	PSD-P[6]
1998	418	5.6	0.4	14.8	1.6	86	79	339	159	89	47	26
1999	329	4.2	0.3	14.4	1.5	90	63	266	108	67	41	25
2000	250	2.8	0.2	16.6	2.3	83	26	224	122	84	54	38
2001	272	3.9	0.4	17.4	2.8	88	19	253	134	112	53	44
2002	324	3.3	0.2	17.4	2.8	90	32	291	159	124	55	43
2003	301	3.1	0.3	17.3	2.8	88	38	263	156	105	59	40
2004	250	3.3	0.3	15.9	2.3	88	47	203	102	73	50	36
2005	227	2.7	0.3	16.3	2.6	85	37	190	88	78	46	41
2006	207	2.4	0.2	16.2	2.6	87	38	168	78	66	46	39
2007	261	3.1	0.3	16.2	2.3	81	36	225	100	70	44	31
2008	234	2.8	0.3	15.5	1.9	81	21	212	89	45	42	21
2009	393	3.3	0.3	14.6	1.4	83	59	332	143	53	43	16
2010	361	3.6	0.3	15.4	1.7	84	31	330	175	46	53	13
2011	267	2.8	0.3	14.9	1.7	88	25	251	99	45	39	18
2012	683	6.8	0.4	15.1	1.4	83	44	639	305	75	47	12
2013	479	4.8	0.4	15.0	1.5	81	66	413	245	55	59	13
2014	466	4.7	0.3	15.5	1.7	84	28	436	199	98	46	22
2015	486	4.9	0.4	16.6	2.1	87	22	464	276	111	59	24
2016	440	4.4	0.3	17.8	2.5	87	15	424	308	147	72	34
2017	310	3.1	0.3	17.0	2.2	85	23	287	178	114	62	40
2018	471	4.7	0.3	17.4	2.5	88	28	441	263	167	60	38
2019	494	4.9	0.4	16.7	2.3	85	30	464	246	137	53	29
2020	323	3.2	0.2	17.7	2.9	87	37	285	190	123	67	43
2021	501	5.0	0.4	16.2	2.2	85	34	467	217	143	46	30

[1]Substock is the number of all walleye less than 10 inches, [2]Stock is the number of all walleye greater than 10 inches, [3]Quality is the number of all walleye greater than 15 inches, [4]Prefered is the number of all walleye greater than 20 inches, [5]PSD is the proportional size distribution (Quality/Stock), [6]PSD-P is the relative stock density, preferred (Preferred/Stock).

Table 7. Summary of mean catch per unit of effort (CPUE; No./net-night), mean length (in), mean weight (lb), and mean *Wr* of northern pike collected in experimental gill nets on Fort Peck Reservoir during July-August, 1992-2021 (no data for 1997).

Year	*N*	CPUE	Length	Weight	*Wr*
1992	35	0.6	26.6	5.5	112.3
1993	47	0.6	28.3	6.4	113.9
1994	104	1.4	22.6	4.4	107.3
1995	295	3.8	20.1	2.5	114.6
1996	321	3.9	23.3	3.7	112.8
1998	231	3.1	24.7	4.3	104.6
1999	151	1.9	26.5	5.1	103.2
2000	134	1.5	28	6	106.5
2001	73	1	28.6	6.5	110.6
2002	144	1.5	29.5	7.2	102
2003	126	1.3	28.1	6.2	101.1
2004	75	1	29.1	6.7	100.1
2005	86	1	28.4	6.5	100.3
2006	108	1.3	26.1	5.2	98.9
2007	147	1.7	24.8	4.6	101
2008	137	1.6	26.6	5.2	100
2009	176	1.5	24.5	4.3	93.1
2010	191	1.9	23.4	3.9	100
2011	293	2.9	23.2	3.6	100
2012	503	5.0	23.6	3.6	99.3
2013	324	3.2	24.6	3.9	93.0
2014	336	3.4	25.8	4.6	96.2
2015	264	2.6	26.3	5.0	97.5
2016	226	2.3	25.8	4.6	92.9
2017	184	1.8	26.0	4.4	90.2
2018	165	1.7	27.1	5.0	95.0
2019	302	3.0	24.7	4.0	96.1
2020	206	2.1	25.2	4.3	96.5
2021	201	2.0	25.8	4.3	94.2

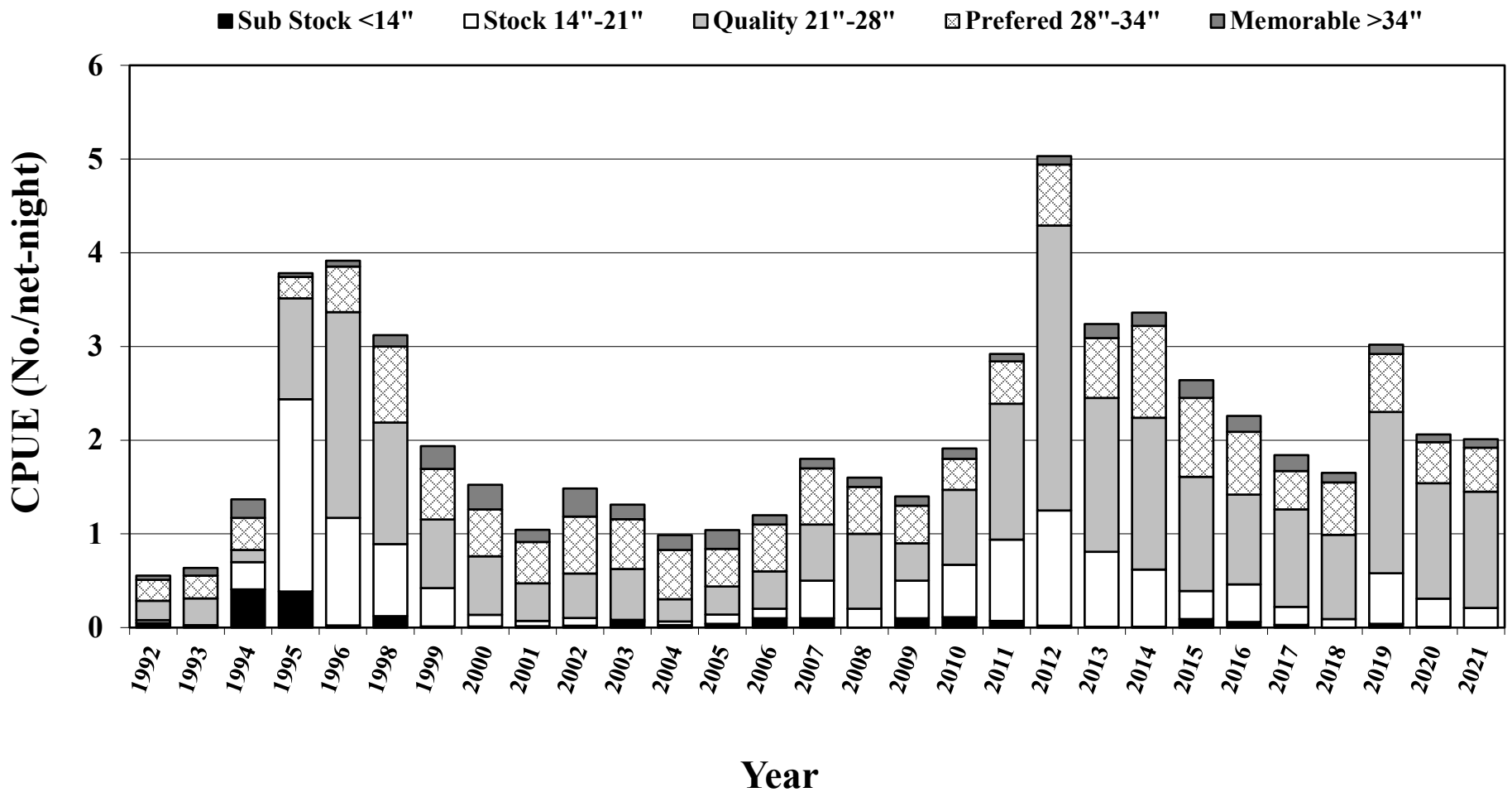


Figure 11. Catch per unit effort (CPUE) of PSD category of northern pike collected by experimental gill nets throughout Fort Peck Reservoir during, July-August, 1992-2021, (no data for 1997).

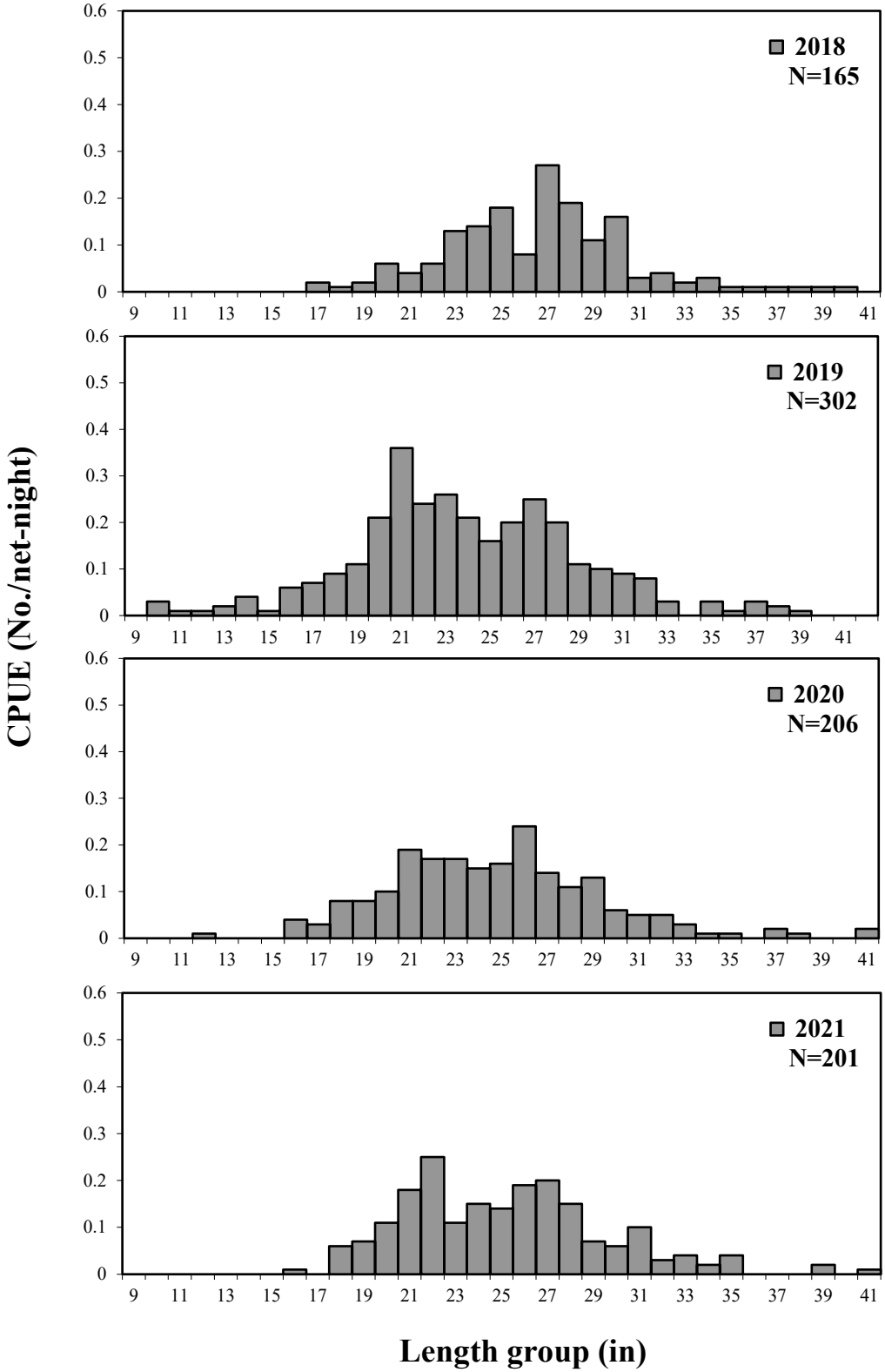
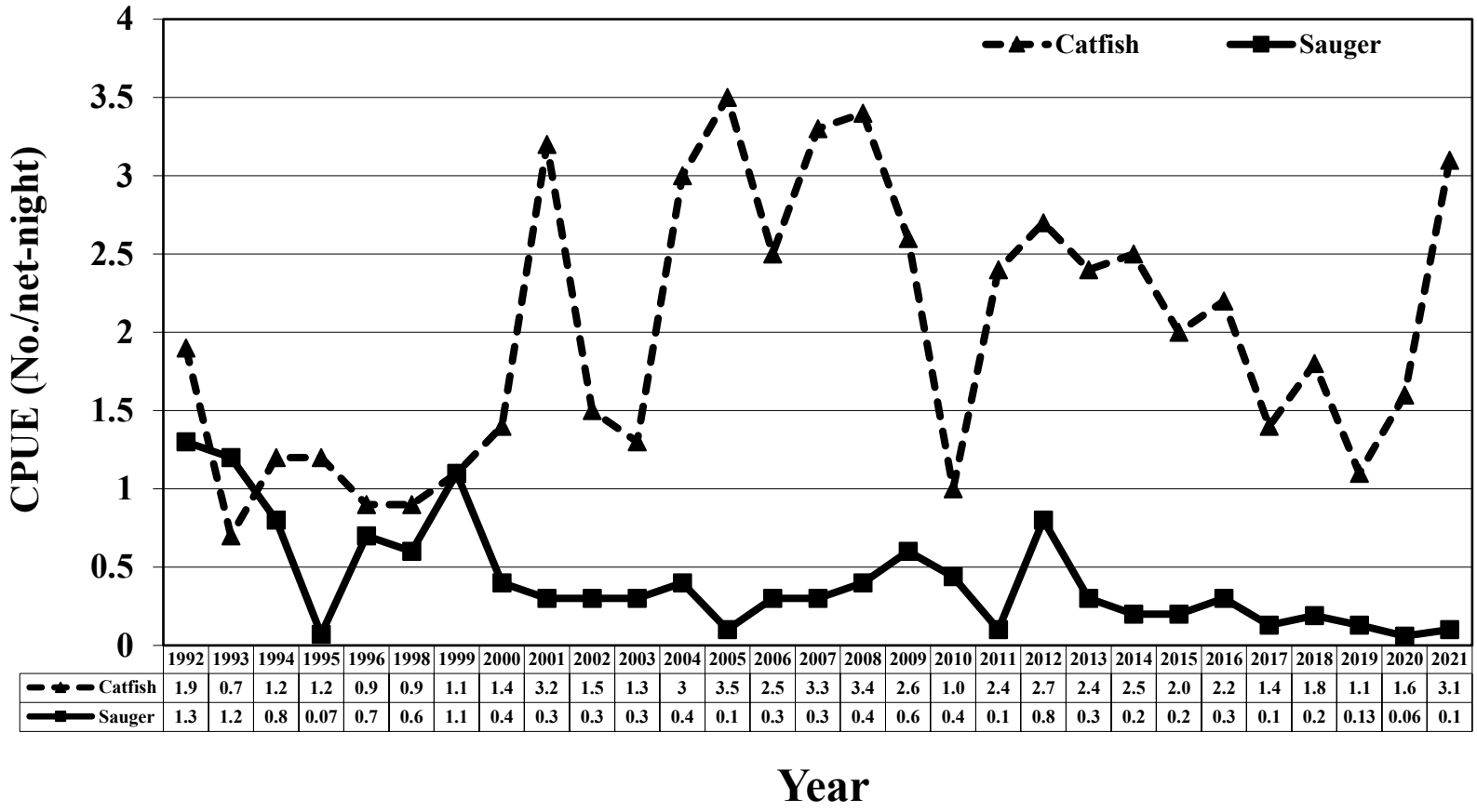


Figure 12. Length frequency, as catch per unit effort (CPUE), of northern pike collected by experimental gill nets in Fort Peck Reservoir during July-August, 2018-2021.



	1992	1993	1994	1995	1996	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Catfish	1.9	0.7	1.2	1.2	0.9	0.9	1.1	1.4	3.2	1.5	1.3	3	3.5	2.5	3.3	3.4	2.6	1.0	2.4	2.7	2.4	2.5	2.0	2.2	1.4	1.8	1.1	1.6	3.1
Sauger	1.3	1.2	0.8	0.07	0.7	0.6	1.1	0.4	0.3	0.3	0.3	0.4	0.1	0.3	0.3	0.4	0.6	0.4	0.1	0.8	0.3	0.2	0.2	0.3	0.1	0.2	0.13	0.06	0.1

Figure 13. Mean catch per unit of effort (CPUE; No./net-night) of channel catfish and sauger collected by experimental gill nets in Fort Peck Reservoir, 1992-2021 (no data for 1997).

Table 8. Summary of mean catch per unit of effort (CPUE; No./net-night), mean length (in) and mean weight (lb) of channel catfish collected in experimental gill nets on Fort Peck Reservoir, 1992-2020 (no data for 1997).

Year	*N*	CPUE	Length	Weight
1992	165	2.6	15	1.4
1993	68	0.9	14.9	1.4
1994	119	1.6	14.4	1.1
1995	123	1.6	16.3	1.6
1996	93	1.1	15.6	1.4
1998	91	1.2	18	2.3
1999	88	1.1	17.2	2.0
2000	122	1.4	17.5	2.0
2001	222	3.2	17.6	2.1
2002	145	1.5	18	2.1
2003	129	1.3	17.6	2.1
2004	227	3.0	15.7	1.8
2005	297	3.5	14.3	1.3
2006	215	2.5	15.1	1.4
2007	278	3.3	15.3	1.3
2008	289	3.4	14.2	1.1
2009	314	2.6	16.8	1.9
2010	104	1.0	18.4	2.4
2011	241	2.4	17.9	2.3
2012	272	2.7	17.4	1.8
2013	240	2.4	17.5	1.9
2014	246	2.5	18.0	2.0
2015	201	2.0	18.5	2.1
2016	217	2.2	17.1	1.8
2017	140	1.4	18.0	2.0
2018	179	1.8	17.8	2.4
2019	110	1.1	20.3	3.1
2020	158	1.6	19.9	3.1
2021	307	3.1	18.1	2.1

STOMACH CONTENTS OF GILL NETTED GAME FISH

Stomach contents of walleye, northern pike, sauger, and smallmouth bass captured in experimental gill nets from July 15th to August 4th, 2021 were examined for the presence of forage items. Northern pike had the most diverse diet followed closely by walleye (Table 9). Cisco were the most commonly identified fish found in northern pike and walleye. The high frequency of occurrence of cisco observed in stomach contents can be explained by the high abundance of young-of-year and adult cisco observed in 2021 (Table 14). Similar to previous years, empty stomach contents comprised a large portion of the walleye, northern pike, sauger, and smallmouth bass stomachs, which is attributed to purging of the stomach during stress (Bowen 1996).

Table 9. Percent frequency of occurrence for various forage items found in stomach contents of northern pike, sauger, smallmouth bass, and walleye collected in experimental gill nets in Fort Peck Reservoir 2021. Sample size is given in parentheses.

Forage items	Northern pike (*N*=192)	Sauger (*N*=7)	Smallmouth bass (*N*=129)	Walleye (*N*=499)
Chinook salmon	0.5%	-	-	0.2%
Cisco	16.7%	-	3.1%	6.2%
Crayfish	3.1%	-	3.1%	0.2%
Empty	61.5%	85.7%	30.2%	42.7%
Grasshopper	-	-	27.1%	0.2%
Invertebrates	2.1%	-	12.4%	27.3%
Northern pike	0.5%	-	-	-
Pomoxis spp.	-	-	-	0.4%
Smallmouth bass	1.0%	-	-	-
Spottail shiner	0.5%	-	-	-
Unknown	10.4%	14.3%	22.5%	22.0%
Walleye	2.1%	-	-	0.2%
Yellow perch	1.6%	-	1.6%	0.6%

BEACH SEINING

Shoreline beach seining was conducted to determine reproductive success of age-0 game and non-game fish from August 4th to September 3rd, 2021. Seine hauls at 100 standardized locations throughout the reservoir captured 18 species of young-of-year and forage fish for a total of 18,236 fish (Table 10). Combined relative abundance of spottail shiner, emerald shiner, age-0 yellow perch, and age-0 crappie increased to 163 fish per seine haul in 2021 compared to the previous year but below the long-term average of 174 fish per seine haul. Relative abundance of shoreline forage typically follows changes in reservoir elevations (Figure 15). In 2021, reservoir elevations remained stable from March to July due to lack of plains runoff and below average mountain snowpack (Figure 14). As a result, no terrestrial vegetation was inundated beginning in spring and early summer of 2021.

Eurasian watermilfoil (EWM) was first discovered in Fort Peck Reservoir by Montana Fish, Wildlife & Parks and the U.S. Army Corp of Engineers in 2010. Since then, it has become established throughout the reservoir. EWM was documented at 88% of the seining sites in 2021 compared to 57% of the sites in 2020. The increase of EWM could be attributed to stable reservoir elevations during the 2021 spring and summer months (Figure 15). Prior to this, reservoir elevations fluctuated greatly throughout much of the season. Reservoir elevations during 2012-2013 experienced a loss of 15 feet resulting in EWM present at 46% of the seining sites. Furthermore, a gain of 10 feet was observed in 2013-2014 and only 24% of the seining sites contained EWM. It appears large fluctuations in reservoir elevation from year to year and within a year make it difficult for EWM to become established in littoral areas of the reservoir.

It is uncertain what impacts EWM have to the fishery on Fort Peck Reservoir. Some studies have suggested slow growth and poor size structure for some fish species (Unmuth et al. 1999). In contrast, EWM has proved beneficial to fisheries if it occurs in lakes that typically do not support much growth of native submersed species (Engel 1995). Similarly, Pratt and Smokorowski (2003) found more fish and invertebrates in areas with EWM than areas devoid of any submerged aquatic vegetation. Due to Fort Peck Reservoir's fluctuating reservoir elevation, lack of native submerged aquatic vegetation, and complex basin characteristics, it is possible that EWM may provide spawning and rearing habitat for some forage and/or game fish species.

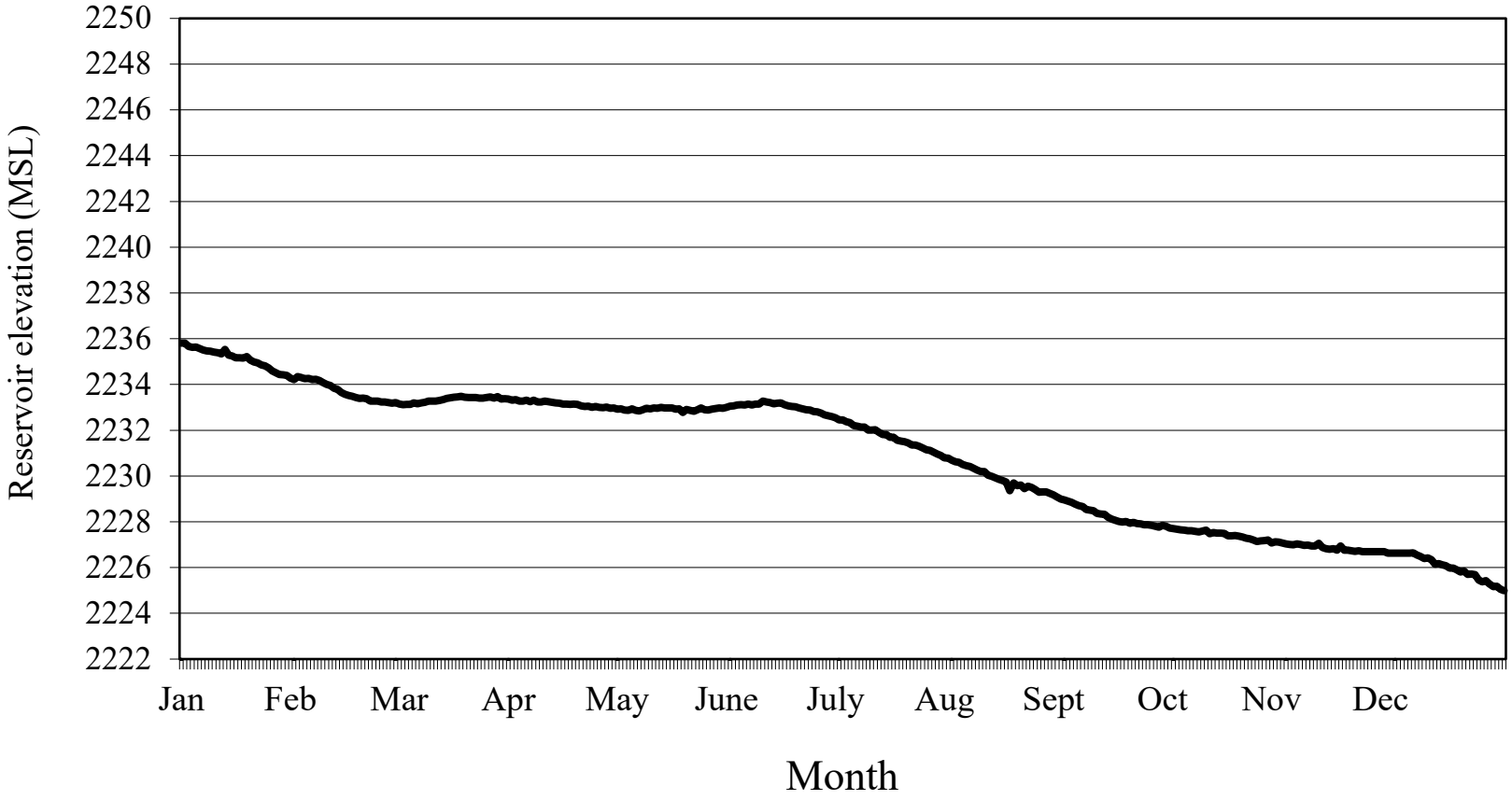


Figure 14. Average daily reservoir elevation for Fort Peck Reservoir from January 1, 2021 to December 31, 2021 (data provided by USACE).

Table 10. Number (*N*) and mean catch per unit effort (CPUE; No./haul) for fish species collected by seine hauls in Fort Peck Reservoir during August-September 2021. Catches are for young-of-year fishes except where noted.

	UBD[1]		LBD[2]		LMA[3]		MMA[4]		UMA[5]		Total	
Species	*N*	CPUE	*N*	CPUE	*N*	CPUE	*N*	CPUE	*N*	CPUE	*N*	CPUE
Bigmouth buffalo	1	<0.1	0	--	1	<0.1	5	0.3	0	--	7	0.1
Cisco	0	--	0	--	1	<0.1	0	--	0	--	1	<0. 1
Common carp	14	0.7	22	1.1	63	3.2	53	2.7	55	2.8	207	2.1
Emerald shiner*	726	36.3	30	1.5	2	0.1	263	13.2	730	36.5	1,751	17.5
Freshwater drum	5	0.3	0	--	38	1.9	24	1.2	10	0.5	77	0.8
*Hybognathus spp.**	0	--	0	--	0	--	0	--	5	0.3	5	0.1
*Lepomis spp.**	0	--	0	--	0	--	2	0.1	0	--	2	<0.1
Northern pike	5	0.3	10	0.5	4	0.2	4	0.2	0	--	23	0.2
Pomoxis spp.	915	45.8	471	23.6	29	1.5	397	19.9	2,595	129.8	4,407	44.1
River carpsucker	1	<0.1	4	0.2	3	0.2	2	0.1	14	0.7	24	0.2
Shorthead redhorse	0	--	0	--	0	--	0	--	9	0.5	9	0.1
Smallmouth bass	150	7.5	135	6.8	198	9.9	344	17.2	494	24.7	1,321	13.2
Smallmouth buffalo	24	1.2	0	--	0	--	24	1.2	176	8.8	224	2.2
Spottail shiner*	117	5.9	773	38.7	910	45.5	3,365	168.3	998	49.9	6,163	61.6
Walleye	3	0.2	4	0.2	9	0.5	7	0.4	10	0.5	33	0.3
White sucker	2	0.1	0	--	1	<0.1	0	--	0	--	3	<0.1
Yellow perch	1,279	63.9	1,033	51.7	246	12.3	1,071	53.6	350	17.5	3,979	39.8
Total	3,242	162.1	2,482	124.1	1,505	75.3	5,561	278.1	5,446	272.3	18,236	182.4

*Includes all ages.
[1]Upper Big Dry (UBD): Nelson Cr., Lone Tree Cr., McGuire Cr., Bug Cr., Lost Cr.
[2]Lower Big Dry (LBD): Box Cr., S. Fork Rock Cr., N. Fork Rock Cr., Box Elder Cr., Sand Arroyo, Spring Cr.
[3]Lower Missouri Arm (LMA): Spillway Bay, Bear Cr., N.Fork Duck Cr., S. Fork Duck Cr., Main Duck
[4]Middle Missouri Arm (MMA): Pines, Gilbert Cr., Cattle Crooked Cr., Hell Cr., Sutherland Cr., Snow Cr.
[5]Upper Missouri Arm (UMA): Bone Trail, Timber Cr., Seven Blackfoot, Fourchette Bay, Devils Cr.

Yellow Perch

Young-of-year yellow perch relative abundance in 2021 was 39.8 per seine which was an increase from 18.9 per seine in 2020 (Figure15). It's possible the increased presence of EWM in 2021 provided alternative spawning and rearing habitat for yellow perch despite no shoreline vegetation was inundated in during the spring. Relative abundance of young-of-year yellow perch in 2021 was still lower when compared to the high-water years (i.e., 2009-2012; Figure 15). Nelson and Walburg (1977) determined newly flooded vegetation was the most important factor affecting year-class strength of yellow perch in two large Missouri River reservoir systems. Yellow perch were most abundant in the upper Big Dry arm with a catch rate of 63.9 per seine haul in 2021 (Table 10).

Crappie

Young-of-year crappie relative abundance increased slightly from 41.3 per seine haul in 2020 to 44.1 per seine haul in 2021. Unlike young-of-year yellow perch, relative abundance of young-of-year crappie remains higher than during the drought years (Figure 15). Similar to previous years, crappie were most abundant in the upper Missouri arm with a catch rate of 129.8 per seine haul which comprised 59% of the fish sampled in 2021 (Table 10). Typically, the upper Missouri arm contains a majority of the young-of-year crappie captured due to more suitable spawning and rearing habitat (i.e., submerged brush and aquatic macrophytes).

Emerald Shiner

Emerald shiner relative abundance in 2021 was 17.5 per seine haul, which was an increase from 1.1 per seine haul in 2020. Relative abundance of emerald shiners has been low over the last several years making them similar to the mid to late 1990's when reservoir elevations were relatively high or increasing (Figure 15). A possible explanation for these decreases could be upstream movement into more riverine type habitat. Furthermore, distribution of emerald shiner relative abundance was highest in the upper Big Dry arm and upper Missouri arm at 36.3 and 36.5 per seine haul, respectively (Table 10).

Spottail Shiner

Relative abundance of spottail shiners increased from 25.4 per seine haul in 2020 to 61.6 per seine haul in 2021 which was slightly lower than long-term average of 77.6 per seine haul. Relative abundance in 2021 was still lower compared to rising reservoir elevations during the mid to late 1990's (Figure 15). Spottail shiner relative abundance was highest in the middle Missouri arm at 168.3 per seine haul (Table 10). Typically, relative abundance is higher in main lake portions (i.e., lower Big Dry arm, lower Missouri arm, middle Missouri arm) of the reservoir.

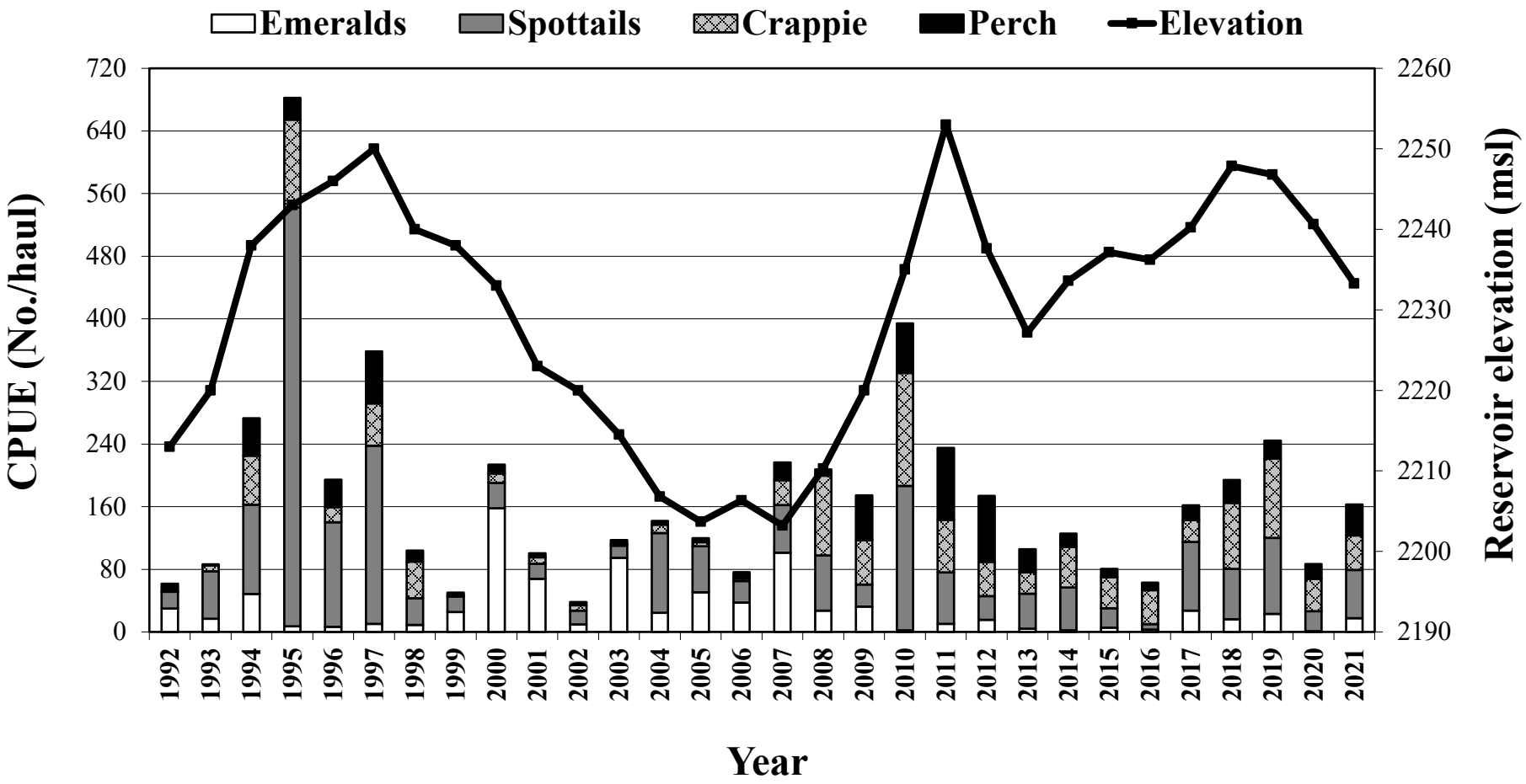


Figure 15. Maximum annual reservoir elevation compared to mean catch per unit effort (CPUE; No./haul) of emerald, spottail, young-of-year yellow perch, and young-of-year crappie collected by seine hauls in Fort Peck Reservoir from 1992-2021.

Chinook salmon

A total of 208,154 spring-stocked chinook salmon were released into Fort Peck Reservoir during in early June of 2021 averaging 26 per pound. This met the management goal of 200,000 fingerlings as outlined in the Fort Peck Reservoir Fisheries Management Plan (Headley et al. 2012). Compared to previous years, this was fewer salmon released since the program began but at a larger size (Table 11; Figure 16). In the past, Montana has typically stocked fewer fingerlings and less total pounds than North and South Dakota. However, Montana has increased stocking numbers and/or size in efforts to create a more stable fishery and more fish for spawning beginning in 2000 (Figure 16 and 17). North and South Dakota Game and Fish have used this strategy and been successful in developing a return run from larger spring-stocked chinook salmon (Lott et al. 1997).

Return of salmon to the release site has been variable over the years. In 2021, the number of females spawned and eggs collected was lower compared to the previous year (Figure 18). The 2021 egg-take effort for Montana resulted in 184,514 green eggs from 45 females. Fecundity of female salmon was 4,100 in 2021 which was slightly lower than 4,388 eggs per female in 2020. The lower fecundity can be attributed to a combination of 3 and 4-year old female salmon compared to a larger, older age group (age-4) captured in 2020.

Fisheries personnel relied exclusively on electrofishing to obtain brood stock for the annual chinook salmon egg-take in 2021. This has proven to be a more cost effective and efficient manner due to limited time and manpower issues as opposed to the fish ladder. Electrofishing was conducted from September 29th to October 28th, 2021 in various embayments adjacent to the marina, spillway, Duck Creek and dam area.

Biological data was collected from adult chinook salmon during spawning to provide more information on age, growth, and stocking-and-rearing history. Age-4 male salmon comprised only 40% of males captured in 2020; however, age-4 females comprised 94% of all females collected (Table 12). In contrast, age-4 male salmon comprised only 6% and age-4 females comprised 63% of the salmon captured in 2021 (Table 13). The large proportion of mature age-2 male salmon captured in 2021 suggests a strong year class from the 2019 brood year. Earlier maturity was observed for age-2 males in 2021 could be attributed to improved growing conditions (i.e., increases in young-of-year cisco abundance) which would allow more energy to be allocated to gonad production instead of somatic growth. Lott et al. (1997) noted a similar trend with chinook salmon age classes in Lake Oahe, SD when rainbow smelt populations, which are the primary forage, were at peak abundances.

Mean weights at age varied for male and female chinook salmon captured and spawned in 2021. When examining mean weight at each age, age-4 male and female salmon collected in 2020 were larger than those collected in 2021 (Table 12; Table 13). Four-year old females averaged 19.2 pounds in 2020 compared to 17.1 pounds in 2021. However, age-2 males averaged 5.4 pounds in 2021 which was the second highest on record. The higher relative abundance of young-of-year and adult cisco observed in 2021 likely contributed to increased weights at age-2 for male salmon. Cisco have been found to be the primary forage item of age 1+ chinook salmon in Fort Peck Reservoir (Brunsing 1998; Headley 2010).

Table 11. Chinook salmon stocked by number, size, and location in Fort Peck Reservoir, 2018-2021.

Date	Number	Pounds Stocked	No./lb	Mark	Location
5/25/2018	57,925	1,881	30.8	Adipose Clip	Duck Creek
6/5/2018	65,815	1,489	44.2	None	Pines Bay
6/6/2018	34,386	770	44.7	None	Pines Bay
6/6/2018	37,814	847	44.7	None	Rock Creek
6/7/2018	31,296	720	43.4	None	Rock Creek
6/8/2018	31,222	757	41.3	None	Rock Creek
6/8/2018	42,298	1,025	41.3	None	Duck Creek
6/11/2018	14,265	317	45	None	Pines Bay
6/11/2018	14,911	332	45	None	Rock Creek
6/11/2018	21,063	468	45	None	Duck Creek
6/12/2018	28,659	552	52	None	Pines Bay
5/30/2019	45,750	1,536	29.8	OTC	Duck Creek
5/30/2019	25,450	854	29.8	OTC	Marina
5/30/2019	25,455	854	29.8	OTC	Spillway
5/31/2019	7,147	162	44.2	None	Duck Creek
5/31/2019	29,547	669	44.2	None	Marina
6/3/2019	73,301	1,581	46.4	None	Duck Creek
6/3/2019	52,667	1,136	46.4	None	Marina
6/4/2019	27,388	605	45.3	None	Duck Creek
6/4/2019	33,004	729	45.3	None	Marina
6/11/2019	82,524	1,685	49	None	Pines
6/11/2019	41,490	847	49	None	Rock Creek
6/12/2019	24,324	454	53.6	None	Pines
6/12/2019	65,820	1,228	53.6	None	Rock Creek
6/1/2020	34,833	1,326	22.8	None	Marina
6/1/2020	33,606	1,668	22.8	None	Duck Creek
6/2/2020	18,567	414	27.6	None	Duck Creek
6/2/2020	43,204	1,615	26.9	None	Flat Lake
6/2/2020	16,084	616	26.1	None	Marina
6/7/2021	11,361	428	26.6	None	Duck Creek
6/7/2021	14,029	554	25.5	None	Spillway
6/7/2021	15,436	622	24.8	None	Marina
6/8/2021	48,273	1,705	28.3	None	Spillway
6/8/2021	43,204	1,000	43.2	None	Duck Creek
6/8/2021	34,024	1,154	29.9	None	Marina
6/9/2021	18,564	688	27.0	None	Marina
6/9/2021	23,263	862	27.0	None	Duck Creek

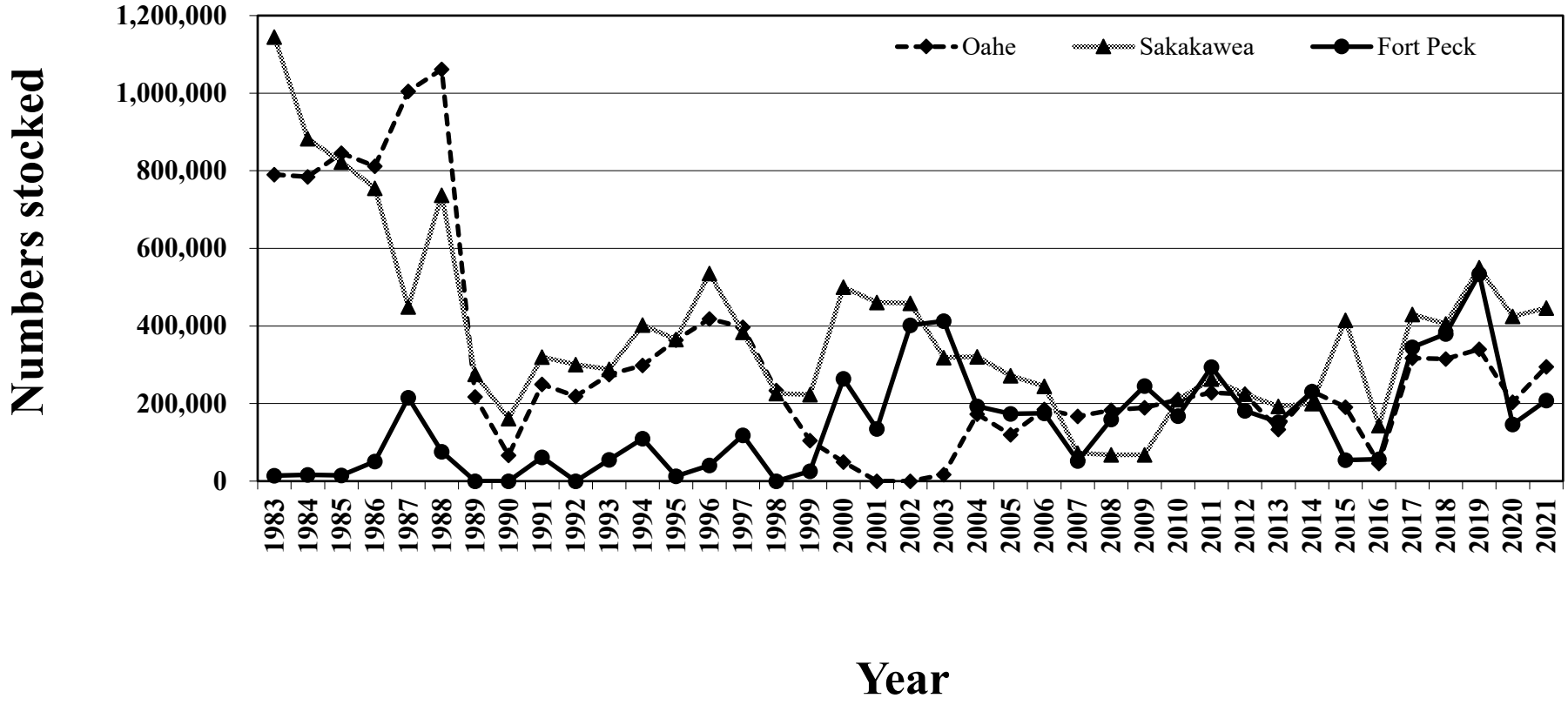


Figure 16. Annual comparison of total chinook salmon numbers stocked in Oahe, Sakakawea, and Fort Peck Reservoir, 1983-2021.

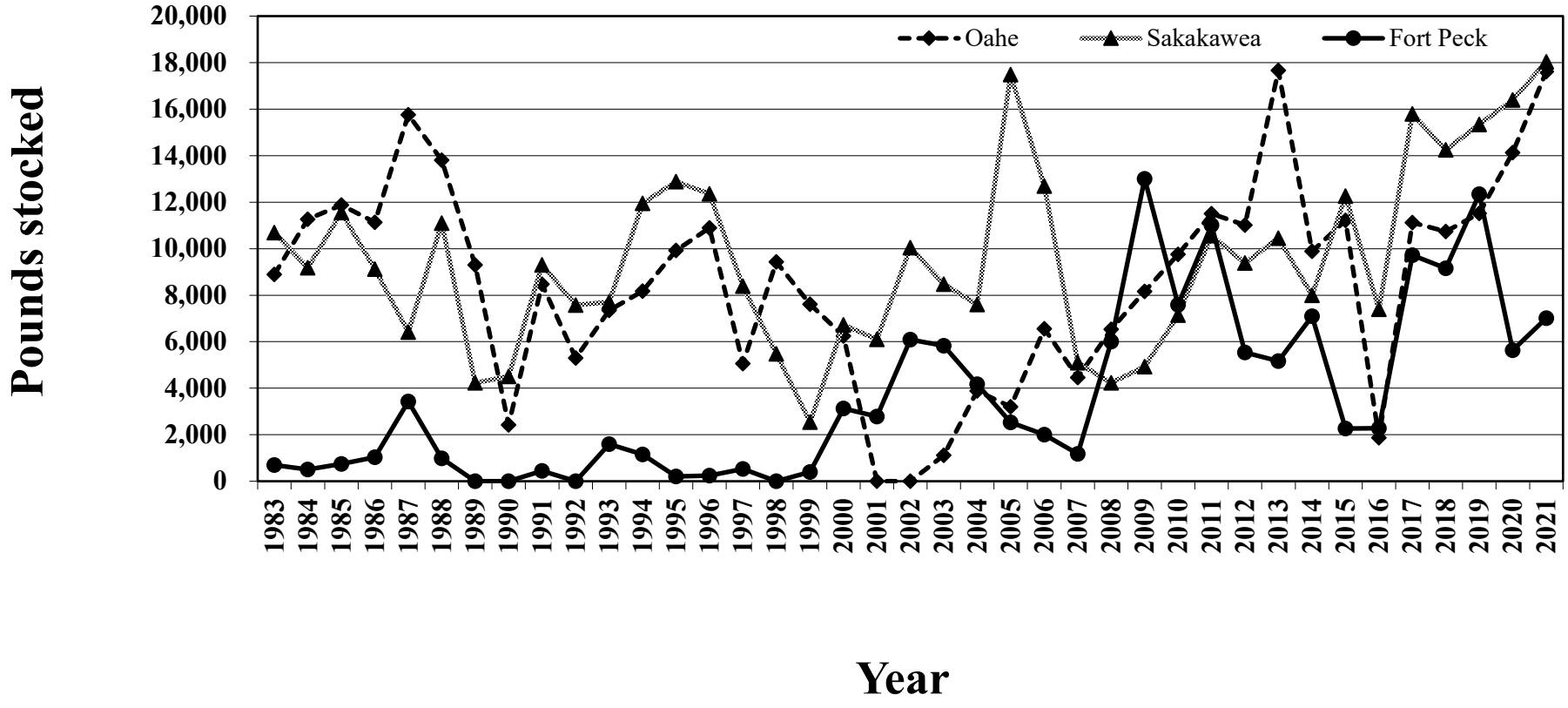


Figure 17. Annual comparison of total chinook salmon pounds stocked in Oahe, Sakakawea, and Fort Peck Reservoir, 1983-2021.

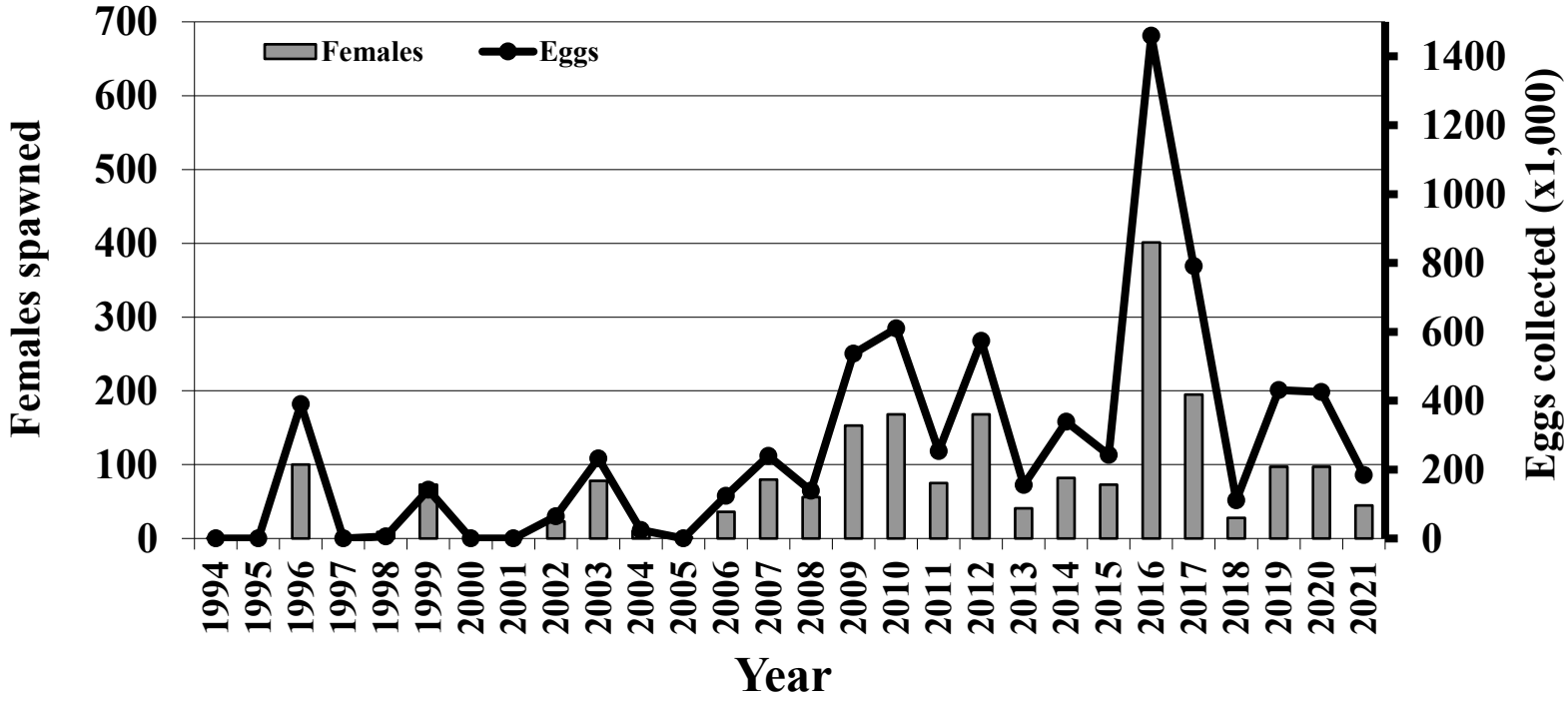


Figure 18. Annual comparison of female chinook salmon spawned and eggs collected from Fort Peck Reservoir, 1994-2021.

Table 12. Age composition, length and weight of 184 chinook salmon collected by electrofishing, fall 2020.

Age	Sex	Brood year	Number	Mean length (in)	Range	Mean weight (lb)	Range
1	Male	2019	0	--	--	--	--
	Female		0	--	--	--	--
2	Male	2018	2	16.0	15.7-16.2	2.2	1.9-2.5
	Female		0	--	--	--	--
3	Male	2017	43	27.3	21.3-35.6	9.5	3.8-18.0
	Female		4	29.9	26.3-32.1	9.1	8.4-22.0
4	Male	2016	31	35.2	31.1-40.9	17.0	7.9-27.1
	Female		101	34.7	29.9-39.4	19.2	10.9-28.0
5	Male	2015	1	35.2	--	17.9	--
	Female		2	34.7	33.7-35.8	21.8	20.8-22.7

Table 13. Age composition, length and weight of 155 chinook salmon collected by electrofishing, fall 2021.

Age	Sex	Brood year	Number	Mean length (in)	Range	Mean weight (lb)	Range
1	Male	2020	0	--	--	--	--
	Female		0	--	--	--	--
2	Male	2019	68	23.2	22.7-27.3	5.4	2.9-8.0
	Female		1	22.6	--	4.7	--
3	Male	2018	13	25.7	23.4-29.4	7.5	5.8-13.2
	Female		18	27.3	24.5-30.1	9.5	6.2-12.2
4	Male	2017	5	32.7	28.4-34.8	14.6	12.4-16.9
	Female		33	32.9	28.7-37.9	17.1	9.9-25.8
5	Male	2016	0	--	--	--	--
	Female		0	--	--	--	--

Cisco Vertical Gill Netting

Young-of-year cisco

Relative abundance of young-of-year cisco in Fort Peck Reservoir was a 152.7 per net-night in 2021 which was down from 172.8 per net-night in 2020. This was above the long-term average of 82 per net-night from 1990 to 2021. Young-of-year cisco relative abundance has fluctuated over the years on Fort Peck Reservoir and similar trends have been observed in other reservoirs where cisco populations occur (Vivian and Frazer 2021; Figure 19).

Limited ice cover appears to correlate with decreases in young-of-year cisco relative abundance on Fort Peck Reservoir. Duration of ice cover has been shown to reduce the wind and wave action, which decreases sedimentation over incubating eggs, and ultimately reduces mortality (Freeberg et al. 1990; Rook et al. 2013). For example, in 1987 and 1992 the reservoir did not freeze over and resulted in very few young-of-year cisco captured. In contrast, ice cover occurred on December 13th, 1985 and December 21st, 2000 resulting in two of the largest year classes ever produced. Ice cover occurred on February 6th, 202 and receded on April 4th, 2021.

Decreases in reservoir elevation could also explain reductions in young-of-year cisco on Fort Peck Reservoir. Decreases in reservoir elevation, which dewater incubating eggs, have been shown to reduce to young-of-year cisco abundance in other reservoir systems (Gaboury and Patalas 1984; Zollweg and Leathe 2006). For example, large decreases in reservoir elevation during 1989, 1996, 2003, and 2007 resulted in low relative abundance of young-of-year cisco (Figure 19). In contrast, when water levels were increasing over winter of 1993-1994 and again in 2008-2009, two of the best year classes of cisco were produced. Reservoir elevations decreased 4 feet during the 2020-2021 winter months. Scott and Crossman (1973) indicated cisco spawn in three to 10 feet of water which may in part explain the high relative abundance of young-of-year cisco observed in 2021.

Adult cisco

Larger mesh, vertical gill netting efforts have continued to provide additional information on the adult cisco population in Fort Peck Reservoir. This technique has been used successfully on other water bodies that contain cisco and other pelagic species (Hubert 1996). Large year classes of cisco produced in 2013 and 2014, which were observed in the ½-in mesh, recruited to the population as indicated by the increase in relative abundance of cisco captured in the ¾-in mesh from 2015-2016 (Figure 20). When examining length frequencies from 2018-2021, similar trends exist as age-0 fish ranging from 110 to 130 mm grow and recruit to the population as age-1 fish that range from 170 to 190 mm (Figure 21). No young-of-year cisco were captured in 2019 and that trend was apparent in 2020 with the absence of fish in the 150 to 190 mm length groups. However, multiple age classes were observed based on length frequency distribution in 2021.

Lengths of cisco captured in Fort Peck Reservoir are currently lower than those observed shortly after their introduction (Wiedenheft 1989; Mullins 1991). Mean length-at-age for cisco captured by vertical gill nets in Fort Peck Reservoir during 2021 suggested slow growth when compared to other cisco populations (Figure 22; Ebener et al. 2008). In addition, relative weight of adult cisco decreased from 80 in 2020 to 73 in 2021. The slow growth rates, low relative weights, and high relative abundance would suggest intraspecific competition. Rook et al. (2013) observed similar trends with cisco in Lake Superior and found a negative correlation to post year class survival. Currently, it is uncertain what impacts these large year classes are having on the overall zooplankton density and composition in Fort Peck Reservoir because long-term zooplankton data is unavailable. Large year classes of cisco have been shown to alter the zooplankton community by selecting for the largest zooplankters in the system (Rudstrum et al. 1993).

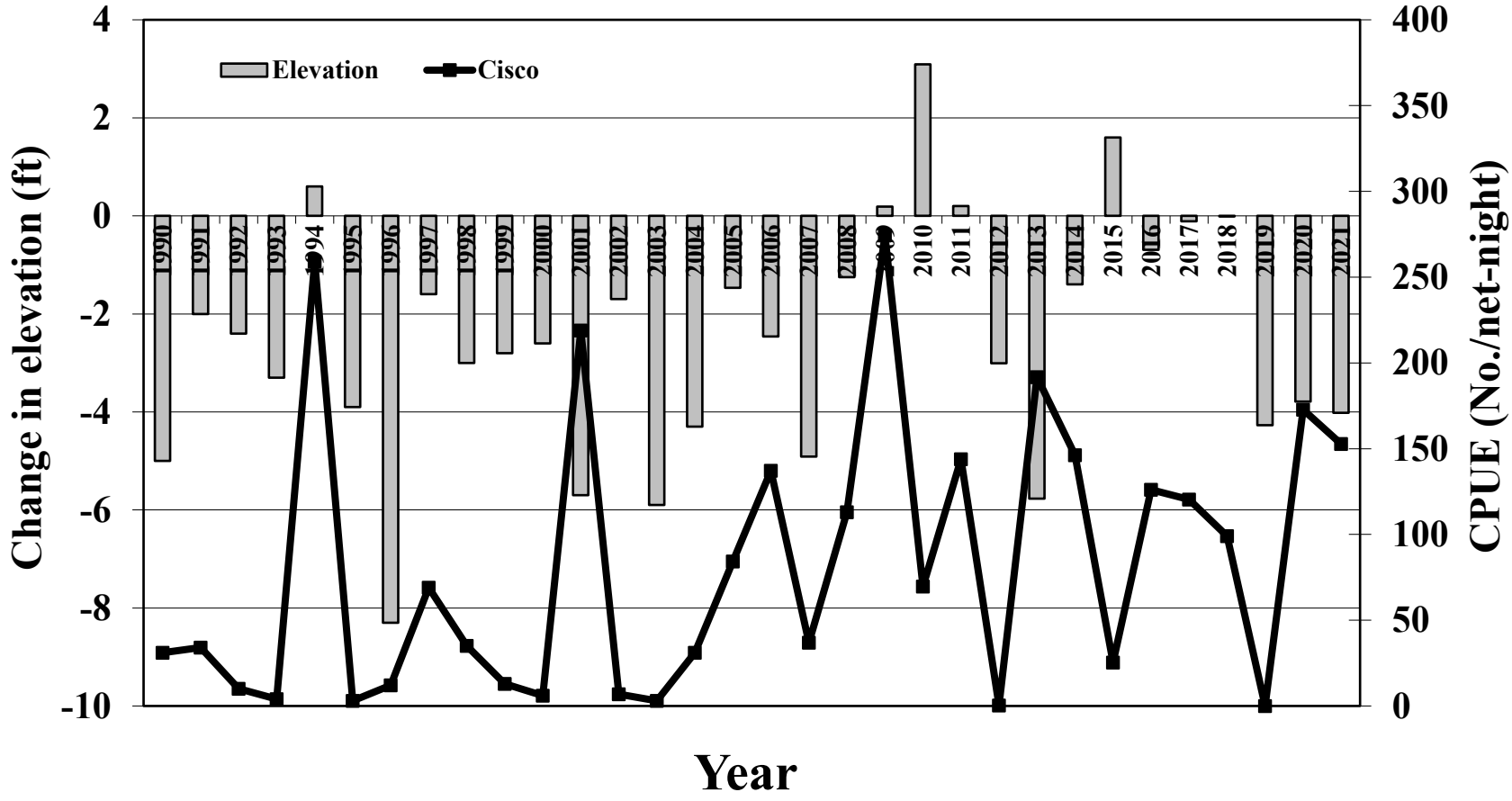


Figure 19. Change in reservoir elevation from December high to March low in contrast to mean CPUE (No./net-night) of young-of-year cisco collected in vertical gill nets on Fort Peck Reservoir, 1990-2021.

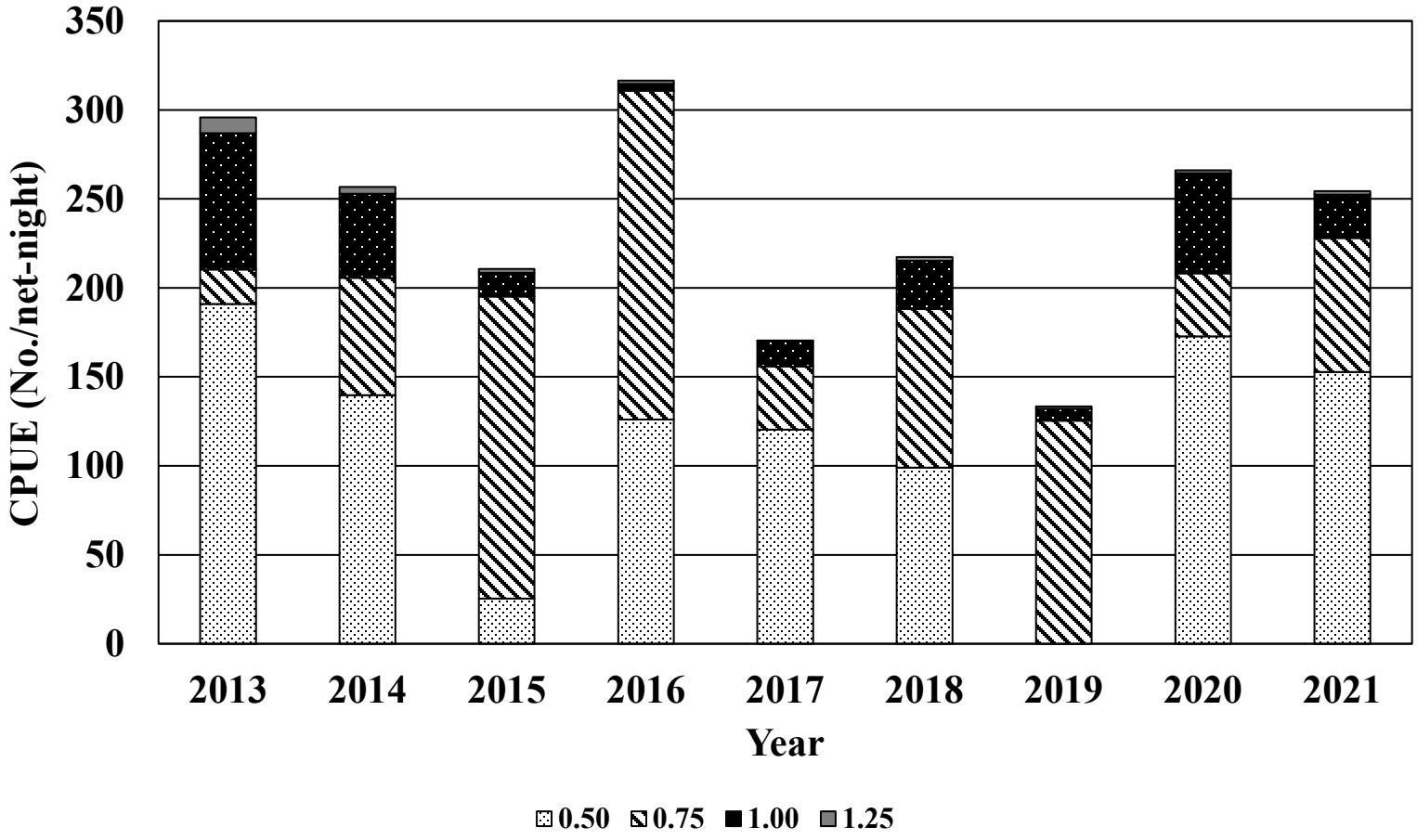


Figure 20. Mean CPUE (No./net-night) of cisco by mesh size collected in vertical gill nets on Fort Peck Reservoir, 2013-2021.

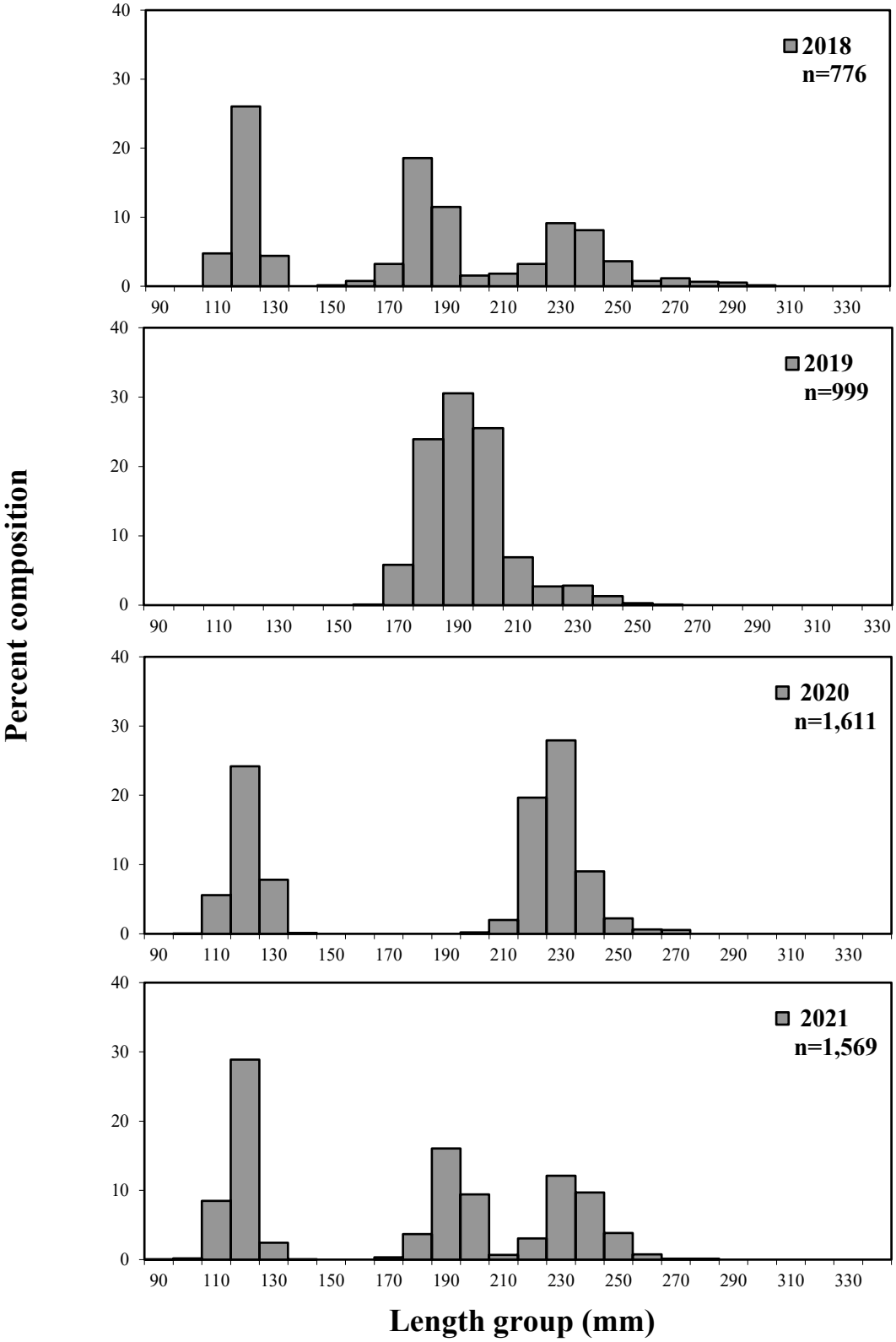


Figure 21. Length frequency of subsampled cisco collected by vertical gill nets in Fort Peck Reservoir during September, 2018-2021.

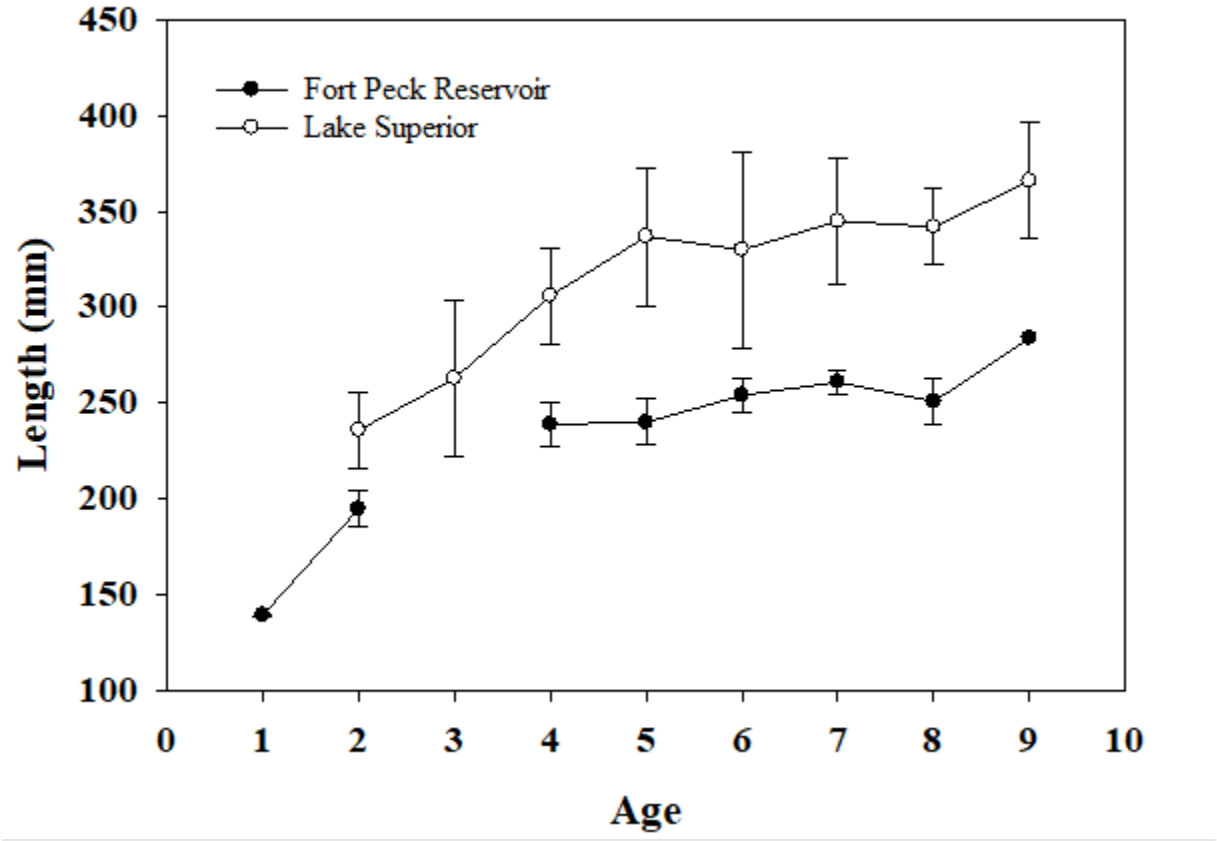


Figure 22. Mean length-at-age (±SD) of cisco caught in vertical gill nets on Fort Peck Reservoir in September 2021 compared to mean length-at-age of cisco captured in the Apostle Islands area of Lake Superior. Lake Superior data are from Ebener et al. (2008). No age-2 cisco were captured in 2021.

RECOMMENDATIONS

- Spring trapping of walleye and northern pike will continue to provide an egg source for supplementing Fort Peck Reservoir and sport fisheries in and out of state.

- Provide walleye eggs to Fort Peck Hatchery staff to develop methods to produce sterile walleye.

- Annual standardized sampling with modified fyke nets, experimental gill nets, vertical gill nets and beach seines will continue to obtain relative abundance data on game and forage fish distribution, abundance, production and condition.

- Evaluate native species (sauger, channel catfish, burbot) more closely by continuing to collect additional length, weight, and age information during routine sampling.

- Reservoir water levels will be monitored to determine impacts to the overall fishery. Information will be utilized to make recommendations to Corps of Engineers for Annual Operating Plan in conjunction with the Missouri River Natural Resource Committee.

- Continue working with South Dakota and North Dakota to develop a stronger tri-state chinook salmon fishery. This may require traveling out of-state to help collect and spawn salmon to receive additional eggs or collection of eggs from Fort Peck to support North and South Dakota needs.

- An evaluation of stocking strategies indicates the size of salmon released is more important than the timing of release. Efforts should be made to increase the numbers of total pounds stocked as opposed to total numbers of fish.

- Continue efforts to spawn Fort Peck salmon when numbers of adults permit. Adults should be captured with the aid of an electrofishing boat due to time and manpower constraints.

- Continue to evaluate the use of deepwater summer gill netting surveys to determine relative abundance and population dynamics of lake trout.

- Continue young-of-year and adult cisco standardized monitoring (vertical gill netting) to further explore the population dynamics of this species. Work to develop age structure and growth information for adult cisco.

- Continue annual public informational meetings and press releases to disseminate information from the previous year’s work and to discuss stocking goals and work plans for the coming year.

- Continue transferring or entering historical data to create a full database of all documented work with Fort Peck’s fishery while ensuring data is proofed and error checked.

- Continue limnological sampling program for Fort Peck Reservoir and collect water samples for “baseline” information to use in conjunction with walleye otolith microchemistry study. Evaluate chemical marking of hatchery-reared walleye fry for the use of otolith microchemistry.

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Prepared by: Heath Headley
Date: March 9th, 2021

Appendix 1. Common and scientific names of fishes mentioned in this report.

Common Name	Scientific name
Bigmouth buffalo	*Ictiobus cyprinellus*
Black bullhead	*Ictalurus melas*
Black crappie	*Pomoxis nigromaculatus*
Brassy minnow	*Hybognathus hankinsoni*
Brook stickleback	*Culaea inconstans*
Brown trout	*Salmo trutta*
Burbot	*Lota lota*
Channel catfish	*Ictalurus punctatus*
Chinook salmon	*Oncorhynchus tshawytscha*
Cisco	*Coregonus artedii*
Common carp	*Cyprinus carpio*
Creek chub	*Semotilus atromaculatus*
Emerald shiner	*Notropis atherionoides*
Fathead minnow	*Pimephales promelas*
Flathead chub	*Hybopsis gracilis*
Freshwater drum	*Aplodinotous grunniens*
Goldeye	*Hiodon alosoides*
Green sunfish	*Lepomis cyanellus*
Lake chub	*Couesius plumbeus*
Lake trout	*Salvelinus namaycush*
Largemouth bass	*Micropterus salmoides*
Northern pike	*Esox lucious*
Paddlefish	*Polyodon spathula*
Pallid sturgeon	*Scaphirhynchus albus*
Plains minnow	*Hybognathus placitus*
Rainbow trout	*Oncorhynchus mykiss*
River carpsucker	*Carpoides carpio*
Sauger	*Sander canadense*
Shorthead redhorse	*Moxostoma macrolepidotum*
Shovelnose sturgeon	*Scaphiryhynchus platorynchus*
Silvery minnow	*Hybognathus argyritis*
Smallmouth bass	*Micropterus dolemieu*
Smallmouth buffalo	*Ictiobus bubalus*
Spottail shiner	*Notropis hudsonius*
Walleye	*Sander vitreum*
White crappie	*Pomoxis annularis*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

Appendix 2. Number of walleye stocked in Fort Peck Reservoir during 2021 by date, region, location, and size.

Date	Location	Region	Fry	Fingerling	Hatchery
5/10/2021	Nelson Bay	UBD	5,650,000		Miles City
5/17/2021	McGuire Creek	UBD	4,800,000		Fort Peck
5/18/2021	Little Bug Creek	UBD	3,600,000		Fort Peck
5/24/2021	North Fork Rock Creek - Ramp	LBD	1,300,000		Fort Peck
6/24/2021	Sand Arroyo	LBD		117,295	Fort Peck
6/25/2021	Box Elder Creek Bay	LBD		83,872	Fort Peck
6/28/2021	Spring Creek	LBD		57,491	Fort Peck
6/29/2021	Sage Creek	LBD		114,975	Fort Peck
6/30/2021	Cut Coulee	LBD		78,595	Fort Peck
7/1/2021	Bobcat Coulee	LBD		67,242	Fort Peck
7/6/2021	Box Coulee	LBD		91,373	Fort Peck
7/6/2021	North Fork Rock Creek - Ramp	LBD		89,176	Fort Peck
6/22/2021	Fifth Coulee	LMA		82,159	Fort Peck
6/22/2021	Marina - Ramp	LMA		25,147	Fort Peck
6/23/2021	Third Coulee	LMA		77,448	Fort Peck
6/24/2021	Bear Creek	LMA		137,567	Fort Peck
6/24/2021	Skunk Coulee	LMA		68,293	Fort Peck
6/29/2021	Mid Duck Creek	LMA		57,488	Fort Peck
6/29/2021	South Duck Creek	LMA		49,419	Fort Peck
6/29/2021	Main Duck	LMA		49,419	Fort Peck
7/1/2021	Spillway Bay - Ramp	LMA		110,508	Fort Peck
7/1/2021	Marina - Ramp	LMA		40,863	Fort Peck
7/8/2021	Duck Creek - Ramp	LMA		153,038	Fort Peck
7/8/2021	Spillway Bay - Ramp	LMA		51,036	Fort Peck
5/7/2021	Hell Creek - Ramp	MMA	4,550,000		Miles City
5/27/2021	Hell Creek - Ramp	MMA	1,200,000		Miles City
6/16/2021	Hell Creek - Ramp	MMA		18,399	Miles City
6/18/2021	Beebe Coulee	MMA		12,399	Miles City
6/21/2021	Middle Eighth Coulee	MMA		72,526	Miles City
6/22/2021	Gilbert Creek Bay	MMA		107,139	Fort Peck
6/30/2021	Seventh Coulee	MMA		61,516	Fort Peck
7/7/2021	Pines Bay	MMA		103,248	Fort Peck
7/8/2021	Cattle/Crooked Creek Bay	MMA		78,119	Fort Peck
Total			21,100,000	2,055,750	

[1]Upper Big Dry (UBD), Lower Big Dry (LBD), Lower Missouri Arm (LMA), Middle Missouri Arm (MMA).

Appendix 3. Temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L), profiles by month at Bug Creek site, Fort Peck Reservoir, 2020.

Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)		Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)
		May							**June**			
0	12.8	10.2	8.1	1.7	0.451		0	18.4	9.0	8.2	2.7	0.460
10	11.4	10.4	8.1	1.9	0.449		10	18.3	9.0	8.2	2.6	0.459
20	7.3	11.2	8.1	0.7	0.446		20	14.1	9.7	8.1	1.6	0.448
30	6.7	11.3	8.1	0.2	0.445		30	12.7	9.8	8.1	1.9	0.444
40	6.4	11.3	8.0	0.3	0.446		40	12.4	9.8	8.1	1.2	0.443
50	6.2	11.3	8.0	0.5	0.445		50	12.2	9.8	8.1	1.8	0.444
60	6.1	11.2	8.0	0.2	0.446		60	12.0	9.7	8.0	4.3	0.445
		July							**August**			
0	23.1	8.4	8.3	3.4	0.457		0	21.8	8.2	8.5	4.7	0.453
10	22.7	8.4	8.3	2.8	0.460		10	21.6	8.1	8.1	5.0	0.452
20	22.6	8.3	8.3	0.9	0.461		20	21.3	7.8	8.4	4.8	0.457
30	16.3	7.9	8.0	2.9	0.449		30	21.2	7.7	8.4	6.7	0.456
40	12.8	8.2	7.9	1.8	0.446		40	21.2	7.7	8.4	7.1	0.456
50	11.9	8.3	7.9	1.4	0.445		50	21.2	7.6	8.4	8.9	0.456
		September										
0	19.1	8.3	8.6	1.9	0.455							
10	19.1	8.2	8.6	1.9	0.455							
20	19.1	8.2	8.6	1.8	0.455							
30	19.1	8.2	8.6	2.5	0.456							
40	19.0	7.9	8.6	3.9	0.458							
50	15.6	5.6	8.2	10.1	0.453							

Appendix 3 continued. Temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L), profiles by month at Spring Creek site, Fort Peck Reservoir, 2020.

Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)		Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)
		May							**June**			
0	10.3	10.8	8.1	0.7	0.448		0	16.3	9.3	8.2	1.7	0.448
10	8.9	11.1	8.1	0.5	0.449		10	15.7	9.6	8.1	1.5	0.447
20	8.5	11.1	8.1	0.6	0.447		20	14.2	9.7	8.2	2.1	0.445
30	7.6	11.2	8.1	0.9	0.447		30	13.8	9.8	8.1	1.6	0.444
40	6.7	11.3	8.1	0.2	0.446		40	12.4	9.8	8.1	3.1	0.444
50	6.5	11.3	8.1	0.6	0.446		50	12.0	9.8	8.0	4.7	0.443
60	5.9	11.3	8.0	0.3	0.445		60	11.8	9.8	8.0	5.0	0.444
70	5.7	11.4	8.0	0.5	0.445		70	9.3	10.0	8.0	1.3	0.444
80	5.5	11.4	8.0	0.2	0.445		80	8.7	10.1	7.9	0.6	0.444
90	5.4	11.4	7.9	0.3	0.445		90	8.4	10.1	7.9	0.8	0.444
		July							**August**			
0	23.0	8.5	8.3	0	0.449		0	21.5	7.9	8.4	10.4	0.448
10	22.5	8.5	8.3	0	0.447		10	21.3	8.0	8.5	5.4	0.447
20	22.0	8.5	8.3	0	0.447		20	21.1	7.9	8.5	3.7	0.448
30	20.6	8.7	8.3	0.7	0.446		30	21.1	7.9	8.4	3.2	0.447
40	15.8	8.5	8.1	0.9	0.446		40	20.9	7.8	8.4	3.4	0.446
50	12.3	8.4	7.9	0.8	0.442		50	20.8	7.8	8.4	4.1	0.445
60	11.1	8.5	7.9	1	0.443		60	14.8	7.1	8.1	4.8	0.447
70	10.5	8.7	7.9	1.1	0.443		70	12.1	7.4	8.0	2.7	0.443
80	9.9	8.7	7.8	0.7	0.443		80	10.2	7.9	8.0	1.6	0.443
90	9.6	8.9	7.8	0.4	0.444							
		September										
0	18.9	8.5	8.6	1	0.444							
10	18.9	8.5	8.6	1.1	0.444							
20	18.9	8.5	8.6	1.2	0.444							
30	18.8	8.4	8.6	1.5	0.445							
40	18.7	8.3	8.6	1.6	0.444							
50	18.1	7.5	8.5	1.9	0.446							
60	15.1	6.6	8.3	2.7	0.445							
70	12.8	6.7	8.1	2.2	0.444							
80	12.1	6.7	8.1	3	0.443							

Appendix 3 continued. Temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L), profiles by month at Haxby site, Fort Peck Reservoir, 2020.

Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)		Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)
		May							**June**			
0	8.9	11.2	8.0	1.4	0.442		0	13.4	10.1	7.8	0.6	0.434
10	8.6	11.3	8.1	1.4	0.441		10	13.4	10.1	8.0	1.3	0.434
20	6.6	11.6	8.0	0.9	0.439		20	13.2	10.2	8.0	1.1	0.433
30	6.3	11.4	8.0	1.1	0.439		30	13.1	10.1	8.1	0.9	0.433
40	5.9	11.5	8.0	0.5	0.438		40	12.8	10.1	8.1	0.7	0.433
50	5.8	11.5	8.0	0.1	0.437		50	12.3	10.0	8.0	0.8	0.433
60	5.8	11.6	8.0	0.3	0.437		60	11.8	10.0	8.0	1.7	0.435
70	5.7	11.4	8.0	0.3	0.437		70	11.4	10.0	8.0	1.4	0.439
80	5.7	11.5	8.0	0.1	0.438		80	10.6	10.1	8.0	1.2	0.439
90	5.7	11.5	8.0	0.5	0.438		90	9.4	10.3	8.0	0.2	0.441
100	5.5	11.5	7.9	0.3	0.437		100	9.1	10.3	8.0	0.7	0.440
110	5.3	11.4	7.9	0.2	0.440		110	9.0	10.3	8.0	1.1	0.441
120	5.2	11.6	7.9	0.0	0.440		120	8.5	10.3	7.9	1.1	0.441
130	5.2	11.2	7.9	0.0	0.443		130	7.7	10.5	7.9	0.6	0.442
140	4.6	11.4	7.9	0.0	0.441							
		July							**August**			
0	22.1	8.4	8.2	0.0	0.437		0	21.5	8.0	8.4	1.6	0.442
10	21.9	8.4	8.3	0.0	0.438		10	21.4	8.0	8.4	2.2	0.441
20	21.7	8.5	8.3	0.7	0.441		20	21.2	8.0	8.4	2.1	0.439
30	21.4	8.6	8.2	0.7	0.444		30	21.2	7.9	8.4	2.5	0.440
40	17.6	8.4	8.1	0.7	0.445		40	21.2	7.9	8.4	2.9	0.439
50	14.6	8.4	8.0	0.6	0.439		50	20.9	7.8	8.4	2.9	0.439
60	13.2	8.5	8.0	0.3	0.439		60	14.6	7.4	8.1	2.7	0.443
70	12.0	8.6	7.9	0.0	0.441		70	12.9	7.4	8.1	2.5	0.443
80	10.2	8.9	7.9	0.0	0.441		80	11.5	7.8	8.0	1.8	0.440
90	9.7	9.1	7.9	0.2	0.440		90	10.4	8.2	8.0	1.3	0.439
100	9.4	9.2	7.9	0.1	0.438		100	10.2	8.2	8.0	1.2	0.438
110	9.1	9.3	7.9	0.0	0.438		110	10.0	8.2	8.0	0.9	0.439
120	9.1	9.3	7.9	0.1	0.440		120	9.8	8.3	8.0	0.6	0.439
130	8.9	9.3	7.9	0.0	0.439		130	9.8	8.3	8.0	0.9	0.439
		September										
0	18.8	8.5	8.6	1.6	0.439							
10	18.8	8.4	8.6	1.7	0.439							
20	18.8	8.3	8.6	1.7	0.439							
30	18.8	8.4	8.6	1.8	0.439							
40	18.8	8.3	8.6	2.1	0.439							
50	18.8	8.3	8.6	2.4	0.439							
60	18.1	7.7	8.5	2.3	0.439							
70	14.2	6.7	8.3	2.3	0.440							
80	12.8	6.9	8.2	2.2	0.440							
90	12.0	6.8	8.2	1.7	0.437							
100	11.4	6.8	8.1	1.6	0.435							
110	11.0	6.8	8.1	1.9	0.435							
120	10.7	6.9	8.1	2.0	0.436							
130	10.3	6.8	8.0	2.7	0.436							

Appendix 3 continued. Temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L), profiles by month at Pines site, Fort Peck Reservoir, 2020.

Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)		Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)
		May							**June**			
0	9.0	11.1	8.1	0.0	0.424		0	14.5	9.7	8.1	1.2	0.427
10	8.3	11.4	8.1	0.0	0.422		10	14.4	9.6	8.1	1.6	0.427
20	6.9	11.6	8.1	0.1	0.421		20	14.3	9.7	8.1	2.2	0.426
30	6.4	11.6	8.1	0.0	0.420		30	14.2	9.7	8.1	2.1	0.426
40	6.1	11.4	8.1	0.0	0.420		40	14.1	9.7	8.1	2.2	0.427
50	5.7	11.5	8.0	0.0	0.420		50	13.4	9.7	8.1	1.8	0.427
60	5.6	11.5	8.0	0.0	0.421		60	12.9	9.7	8.1	2.3	0.427
70	5.6	11.4	8.0	0.1	0.426		70	12.5	9.8	8.1	2.6	0.428
80	5.3	11.5	7.9	0.2	0.432		80	11.9	9.8	8.0	1.7	0.431
90	5.2	11.5	7.9	0.0	0.434		90	11.2	9.9	8.1	2.2	0.430
100	5.1	11.4	7.9	0.0	0.430		100	10.6	9.9	8.0	1.1	0.432
		July							**August**			
0	23.3	8.2	8.4	0.0	0.425		0	22.0	7.8	8.5	1.6	0.421
10	22.0	8.7	8.5	0.0	0.427		10	21.9	7.8	8.5	1.7	0.421
20	21.7	8.6	8.3	0.1	0.427		20	21.8	7.7	8.5	2.1	0.421
30	19.8	8.0	8.2	0.2	0.431		30	21.7	7.6	8.5	2.1	0.423
40	15.4	8.0	8.1	0.4	0.429		40	20.3	7.3	8.4	2.1	0.433
50	13.3	8.2	8.0	0.7	0.425		50	19.1	7.1	8.3	2.7	0.434
60	12.2	8.3	7.9	0.7	0.435		60	14.7	6.8	8.1	2.6	0.432
70	11.7	8.3	7.9	0.3	0.433		70	13.2	7.1	8.0	1.7	0.435
80	11.4	8.4	7.9	0.1	0.435		80	12.6	7.1	8.0	1.4	0.432
90	10.9	8.5	7.9	0.0	0.434		90	11.6	7.2	8.0	1.0	0.431
100	10.6	8.7	7.9	0.0	0.435		100	10.5	7.5	7.9	0.7	0.433
							110	9.8	7.7	7.9	1.2	0.434
		September										
0	19.2	8.5	8.6	1.5	0.429							
10	19.2	8.4	8.6	1.3	0.429							
20	19.2	8.4	8.6	1.4	0.429							
30	19.1	8.3	8.6	1.6	0.428							
40	19.0	8.2	8.6	1.4	0.431							
50	18.6	7.7	8.5	2.0	0.434							
60	17.7	7.2	8.4	2.2	0.438							
70	13.2	6.1	8.1	2.1	0.433							
80	12.6	6.0	8.1	3.6	0.432							
90	10.8	5.5	7.9	3.8	0.428							

Appendix 3 continued. Temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L), profiles by month at Hell Creek site, Fort Peck Reservoir, 2020.

Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)		Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)
		May							**June**			
0	9.1	11.3	8.0	0.1	0.388		0	16.3	9.6	8.2	2.5	0.399
10	8.5	11.6	8.0	0.0	0.386		10	15.6	9.5	8.2	2.6	0.397
20	8.0	11.5	8.0	0.0	0.386		20	15.4	9.4	8.2	2.8	0.397
30	7.2	11.4	8.0	0.1	0.387		30	14.9	9.4	8.2	2.8	0.397
40	6.7	11.3	8.0	0.6	0.387		40	14.0	9.5	8.2	3.2	0.398
50	6.4	11.2	8.0	0.5	0.387		50	12.6	9.4	8.1	3.7	0.401
60	6.3	11.2	7.9	0.3	0.386		60	10.5	9.4	8.0	3.1	0.411
70	6.3	11.2	8.0	0.3	0.385		70	8.7	9.6	8.0	2.4	0.420
80	6.2	11.1	7.9	0.2	0.384		80	8.2	9.7	7.9	1.6	0.422
90	6.1	11.1	7.9	0.7	0.389		90	8.1	9.8	7.9	0.5	0.422
100	5.7	10.9	7.9	0.6	0.396		100	8.1	9.7	7.9	0.6	0.422
		July							**August**			
0	23.8	8.3	8.4	0.0	0.404		0	22.6	7.7	8.5	2.9	0.396
10	23.3	8.5	8.4	0.0	0.407		10	22.3	7.7	8.5	3.1	0.394
20	23.0	8.6	8.4	0.4	0.409		20	22.2	7.5	8.5	3.6	0.393
30	21.6	7.6	8.3	1.0	0.408		30	22.1	7.4	8.5	3.8	0.386
40	15.7	6.0	7.9	1.3	0.403		40	15.8	5.3	8.0	3.6	0.410
50	13.4	6.6	7.8	1.0	0.406		50	13.1	8.8	7.9	1.9	0.417
60	11.3	7.5	7.8	0.4	0.413		60	10.8	6.5	7.9	1.4	0.422
70	10.4	7.6	7.8	0.4	0.416		70	10.0	7.1	7.9	1.5	0.427
80	9.7	7.8	7.8	0.0	0.418		80	9.7	6.6	7.8	1.3	0.425
90	9.3	7.9	7.9	5.6	0.420		90	9.6	6.7	7.8	1.7	0.425
		September										
0	19.7	8.4	8.64	0.7	0.401							
10	19.7	8.3	8.65	1.4	0.401							
20	19.7	8.3	8.66	1.8	0.401							
30	19.7	8.3	8.65	1.9	0.401							
40	19.5	8.0	8.61	2.5	0.401							
50	18.4	6.9	8.46	2.7	0.418							
60	17.5	6.2	8.34	2.3	0.424							
70	16.1	5.1	8.12	2.9	0.419							
80	14.1	3.5	7.88	4.5	0.410							
90	12.8	3.2	7.79	9.6	0.414							

Appendix 3 continued. Temperature (°C), dissolved oxygen (mg/L), pH (standard units), turbidity (NTU), and total dissolved solids (g/L), profiles by month at Timber Creek site, Fort Peck Reservoir, 2020.

Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)		Depth (feet)	Temperature (C)	Dissolved oxygen (mg/L)	pH (units)	Turbidity (NTU)	TDS (g/L)
		May							**June**			
0	10.6	11.3	8.0	22.1	0.383		0	17.1	9.4	8.2	5.9	0.385
10	9.9	11.6	8.1	12.6	0.384		10	17.0	9.4	8.2	5.2	0.385
20	9.3	11.1	8.0	5.1	0.385		20	15.3	9.0	8.2	5.2	0.386
30	8.6	10.8	7.9	2.9	0.384		30	14.1	8.6	8.1	5.9	0.387
40	8.4	10.5	7.8	2.3	0.384		40	12.1	7.8	7.9	8.5	0.386
50	8.2	10.0	7.8	1.4	0.389		50	10.9	8.3	7.9	9.6	0.389
60	7.6	10.0	7.8	2.6	0.384		60	10.1	7.9	7.8	16.4	0.388
		July							**August**			
0	24.3	8.3	8.4	2.4	0.383		0	21.4	7.7	8.4	3.4	0.359
10	24.1	8.2	8.4	1.7	0.380		10	21.3	7.6	8.4	5.0	0.360
20	22.8	7.6	8.3	1.4	0.380		20	20.1	5.6	8.2	4.1	0.357
30	20.3	5.3	8.0	1.4	0.379		30	13.8	4.1	7.8	4.7	0.405
40	15.7	3.1	7.5	2.1	0.389		40	12.6	4.5	7.8	4.1	0.409
50	12.8	3.9	7.5	4.5	0.390		50	11.8	4.4	7.7	4.5	0.409
		September										
0	19.8	8.7	8.7	6.8	0.363							
10	19.5	8.5	8.6	4.5	0.364							
20	19.4	8.3	8.6	4.4	0.363							
30	19.3	8.1	8.6	4.0	0.363							
40	19.1	7.6	8.5	3.5	0.364							
50	18.4	5.6	8.3	10.2	0.371							

Appendix 4. Gill netting dates by region, water surface temperature range (°F), and reservoir elevation (MSL) during standard experimental gill net surveys on Fort Peck Reservoir. Mean water surface temperatures are given in parentheses.

	Region[1]					Water surface	Reservoir
Year	UBD	LBD	LMA	MMA	UMA	Temperature (°F)	Elevation (MSL)
1998	7/17 to 7/28	7/15 to 7/21	7/14 to 7/30	8/5 to 8/11	8/11 to 8/13	NA	2239.7 to 2239.9
1999	7/13 to 7/20	7/15 to 7/22	7/23 to 7/28	7/29 to 8/9	8/10 to 8/11	67 to 76 (71.6)	2238.0 to 2236.9
2000	7/26 to 9/8	7/19 to 7/27	7/11 to 7/14	8/8 to 8/11	8/23 to 8/24	NA	2232.6 to 2231.0
2001	7/31 to 8/2	8/7 to 8/16	8/16 to 8/17	8/21 to 8/28	7/23 to 8/28	NA	2222.5 to 2221.8
2002	7/17 to 9/6	7/18 to 9/6	7/23 to 8/1	7/25 to 9/4	8/6 to 8/14	68 to 81 (74.3)	2220.2 to 2219.3
2003	7/10 to 8/20	7/10 to 8/5	7/8 to 8/13	7/15 to 8/12	7/22 to 7/24	NA	2213.0 to 2211.6
2004	7/14 to 7/15	7/13 to 7/15	7/20 to 7/22	7/21 to 7/27	7/27 to 7/29	69 to 77 (73.6)	2203.2 to 2201.6
2005	7/19 to 7/21	7/21 to 7/27	7/28 to 8/2	8/2 to 8/17	8/16 to 8/17	68 to 78 (72.1)	2203.4 to 2202.7
2006	7/11 to 7/13	7/18 to 7/20	7/20 to 7/26	7/26 to 8/3	8/3 to 8/16	69 to 80 (74.3)	2205.6 to 2204.2
2007	7/17 to 7/24	7/24 to 7/27	7/27 to 8/1	8/1 to 8/7	8/14 to 8/15	70.3 to 84.9 (78.2)	2202.9 to 2201.6
2008	7/15 to 7/17	7/17 to 7/23	7/24 to 7/30	7/30 to 8/4	8/4 to 8/6	67.1 to 80.2 (74.3)	2209.9 to 2210.0
2009	7/16 to 7/21	7/21 to 7/23	7/24 to 7/28	7/29 to 8/3	8/3 to 8/5	66.7 to 76.3 (71.1)	2220.5 to 2220.4
2010	7/13 to 7/20	7/20 to 7/22	7/22 to 7/28	7/28 to 8/5	8/3 to 8/5	67.3 to 77.9 (73.3)	2235.2 to 2235.7
2011	7/26 to 7/28	7/28 to 7/29	8/2 to 8/3	8/3 to 8/5	8/9 to 8/11	70.5 to 79.8 (75.2)	2249.3 to 2244.7
2012	7/17 to 7/19	7/19 to 7/20	7/24 to 7/25	7/25 to 8/1	7/30 to 8/1	67.2 to 83.5 (75.5)	2236.6 to 2235.8
2013	7/23 to 7/25	7/25 to 8/1	8/1 to 8/7	8/8 to 8/9	8/13 to 8/15	63.5 to 77.9 (72.3)	2236.3 to 2234.9
2014	7/17 to 7/22	7/22 to 7/24	7/24 to 7/30	7/30 to 8/7	8/5 to 8/7	67.8 to 79.8 (74.0)	2230.3 to 2229.9
2015	7/21 to 7/23	7/23 to 7/31	7/31 to 8/5	8/5 to 8/13	8/11 to 8/13	67.9 to 79.2 (73.0)	2236.4 to 2235.9
2016	7/19 to 7/21	7/21 to 7/27	7/27 to 8/3	8/2 to 8/5	8/9 to 8/11	69.4 to 77.7 (73.1)	2235.4 to 2234.7
2017	7/18 to 7/20	7/20 to 7/26	7/26 to 8/3	8/2 to 8/9	8/7 to 8/9	68.6 to 75.5 (72.1)	2239.6 to 2238.5
2018	7/18 to 7/20	7/20 to 7/24	7/24 to 7/31	7/31 to 8/8	8/6 to 8/8	69.2 to 77.4 (74.4)	2233.8 to 2247.9
2019	7/17 to 7/19	7/19 to 7/23	7/23 to 8/1	7/30 to 8/15	8/14 to 8/16	69.4 to 79.4 (73.2)	2246.7 to 2245.2
2020	7/15 to 7/17	7/17 to 7/22	7/22 to 7/28	7/28 to 8/4	8/4 to 8/6	68.7 to 78.7 (73.4)	2240.4 to 2240.0
2021	7/13 to 7/15	7/15 to 7/21	7/21 to 7/29	7/29 to 8/5	8/3 to 8/5	70.7 to 80.5 (75.7)	2231.8 to 2230.5

[1]Upper Big Dry (UBD), Lower Big Dry (LBD), Lower Missouri Arm (LMA), Middle Missouri Arm (MMA), and upper Missouri Arm (UMA).

Appendix 5. Northern pike and channel catfish proportional stock density (PSD) relative stock density of preferred-length (PSD-P) fish and mean relative weight values (*Wr*), for 2006-2021, for fish collected in the standard July-August gill net survey, on Fort Peck Reservoir.

Northern pike				
Year	PSD	PSD-P	*Wr*	Sample size
2006	89	60	98.9	108
2007	75	41	101.0	147
2008	89	39	100.0	137
2009	73	39	93.1	176
2010	68	24	100.0	191
2011	69	18	100.5	293
2012	75	15	99.0	503
2013	75	24	93.1	324
2014	82	33	96.2	336
2015	88	40	97.5	264
2016	82	38	92.9	226
2017	90	32	90.3	184
2018	94	40	95	165
2019	81	24	96.1	302
2020	85	25	96.5	206
2021	89	27	94.2	201

Channel catfish				
Year	PSD	PSD-P	*Wr*	Sample size
2006	46	10	95.1	215
2007	38	4	85.3	278
2008	35	2	88.2	289
2009	57	5	91.6	314
2010	74	11	88.2	104
2011	72	8	90.5	241
2012	65	3	87.9	272
2013	64	4	85.7	240
2014	80	3	84.7	246
2015	86	3	85.5	201
2016	65	4	86.5	217
2017	73	6	84.7	140
2018	53	13	88.2	179
2019	83	14	87.9	110
2020	75	19	85.0	158
2021	45	7	85.6	307