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, 2018 THROUGH JUNE 30, 2019
REPORT PERIOD: MARCH 1, 2018 THROUGH FEBRUARY 29, 2019


## ABSTRACT

Fort Peck Reservoir reached peak elevation on July 3rd, 2018 at 2247.87 mean feet above sea level (MSL) from a minimum elevation on March 6th, 2018 at 2233.8 MSL, an increase of 14.07 feet. Spawning walleye populations were sampled in the upper Big Dry Arm with modified fyke nets from April 23rd to May 8th, 2018. Walleye eggs were collected and the fertilized eggs were sent to Fort Peck and Miles City fish hatcheries. Trap netting captured 1,280 walleye for a catch rate of 5.7 per net night in 2018 which was down from the previous year of 8.2 per net night. Due to unfavorable spawning conditions, 22 million walleye eggs were collected in 2018. A total of 811,266 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 18th to August 8th, 2018. Walleye, goldeye, and smallmouth bass were the most abundant species captured overall, with catch rates of 4.7, 3.0, and 2.4 per net night, respectively. Relative abundance of walleye in 2018 was up from the previous year at 4.7 per net night and above the long-term average of 3.9 per net for the period from (1988 to 2018). Gill-netted walleye averaged 17.4 inches and 2.5 pounds. In 2018, relative abundance decreased for quality-size walleye while catch rates for all other length groups remained similar. Relative weights of walleye for all size groups increased in 2018. Northern pike relative abundance in 2018 decreased slightly to 1.7 per net night which is below the long-term average of 2.0 per net night for the period of 1988 to 2018. Average size of gill-netted northern pike in 2018 was 27.1 inches and 5.0 pounds. Overall, relative abundance of shoreline forage was similar to the previous year at 160.3 per haul in 2018 and near the long-term average of 160.3 per haul from 1988 to 2018. Relative abundance of young-of-year crappie showed the largest increase in 2018 at 84.4 per seine haul. A total of 379,654 chinook salmon were stocked at Duck Creek, Rock Creek, and Pines Bay in May and June of 2018 at an average size of 43.4 fish/pound. Young-of-year cisco relative abundance decreased to 99 per net night in 2018 which was above the long-term average of 78.5 per net night for the period of 1988 to 2018.

## 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 North and South Dakota fisheries personnel during annual Missouri River mainstem reservoir meetings. This information was also 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. Sixty-six volunteers assisted with the annual walleye egg-taking operation in the upper Big Dry Arm of Fort Peck Reservoir. Reservoir staff assisted with kids fishing clinics and as science fair judges. Staff also assisted the regional information and education officer with multiple press releases, interviews on the Montana Outdoor Radio Show, and fisheries information for the R6 Facebook page. Staff attended Walleyes Unlimited meetings in Billings to present annual updates on the status of the Fort Peck Reservoir fishery. Staff also presented presentations and updates to Region 6 CAC members. 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 reached peak elevation on July 3rd, 2018 at 2247.87 mean feet above sea level (MSL) from a minimum elevation on March 6th, 2018 at 2233.8 MSL, an increase of 14.07 feet (Figure 2). Reservoir elevations are predicted to rise approximately 5 feet from March through July and fall beginning in July of 2019 based on the December median runoff forecast (USACE 2018).

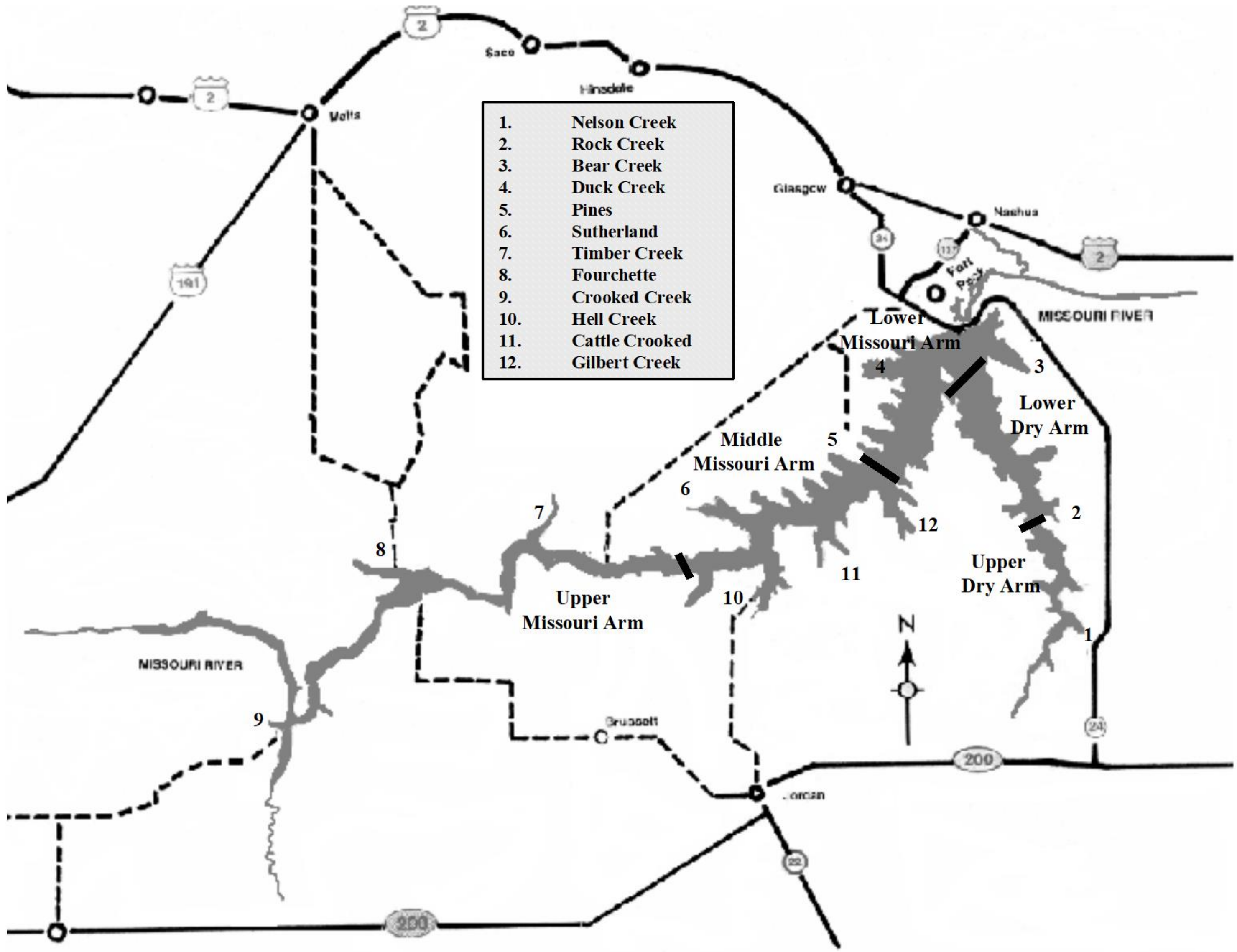



Figure 1. Fort Peck study area describing major sampling zones and select specific locations.

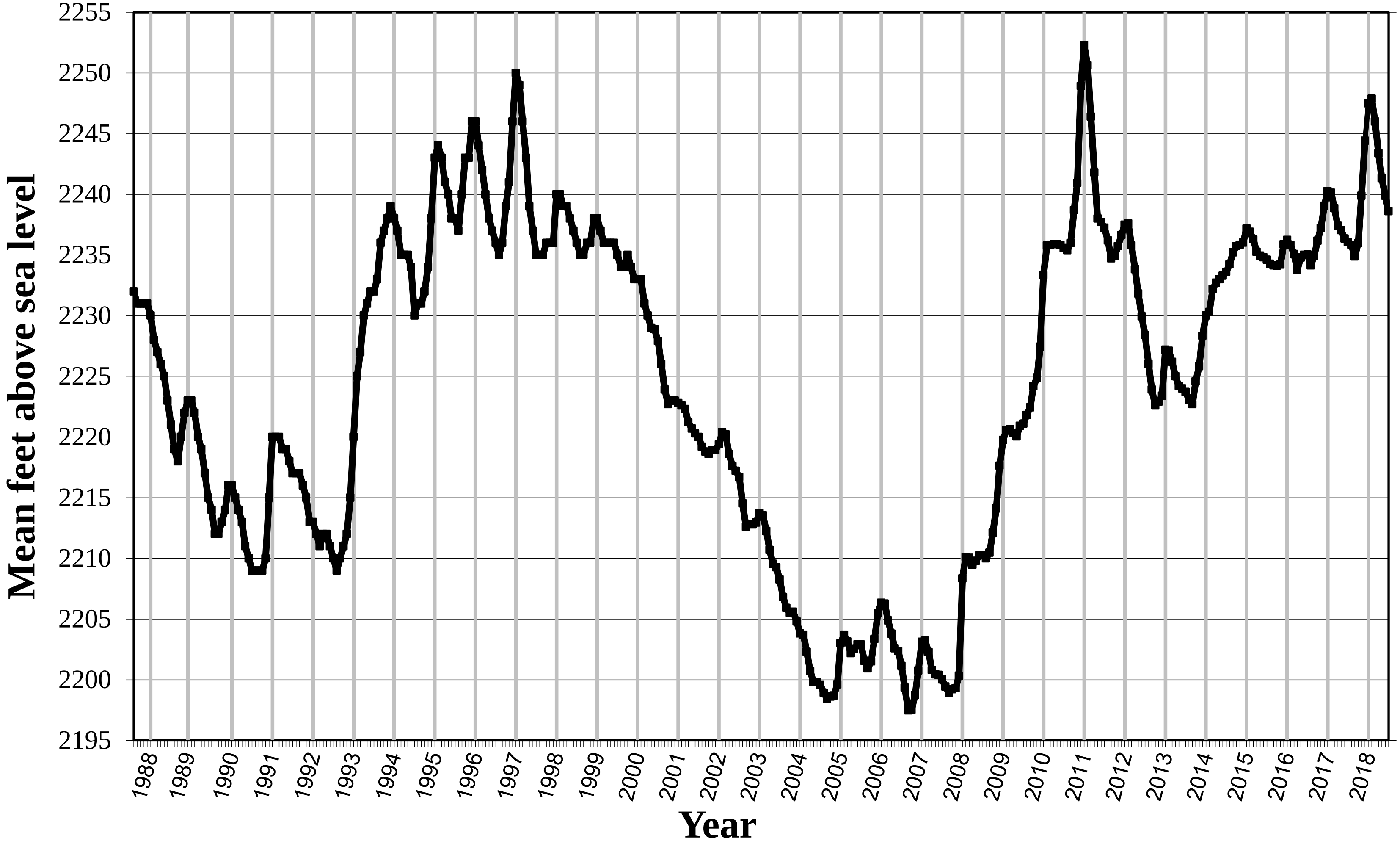



Figure 2. Peak monthly reservoir elevations on Fort Peck Reservoir from January 1988 to January 2018 (Data provided by the U.S. Army Corps of Engineers).

## SAMPLING METHODS

### Data Collection

- Spring sampling was conducted from April 23rd to May 8th, 2018 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 made 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 18th to August 8th, 2018 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.
- All walleye otoliths were collected at all sampling locations. 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 5th to September 6th, 2018 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 21st to September 28th, 2018. 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 Arms 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.
- Electrofishing was used during October 2th to October 24th, 2018 to locate, sample, and collect chinook salmon as part of the annual egg-take effort.
- Chinook salmon otoliths were collected from all mortalities 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, 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 |
| 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), northern pike (Willis 1989), and walleye (Murphy et al. 1990). Calculated values for channel catfish and northern pike are presented in Appendix 4, while values for walleye 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 23rd to May 8th, 2018. A total of 225-trap days were committed to walleye spawning efforts in 2018. Netting effort was lower than the previous year due to late ice cover and unfavorable temperatures during trap netting efforts which led to decreased catch rates of walleye and fewer eggs collected. Ice cover has typically receded by the first week in April and the walleye spawning operation concludes in three to four weeks. Water surface temperatures were 54°F when trap netting efforts commenced and gradually increased to 64°F. Walleye spawning activity peaks when water temperatures are 43°F to 50°F in the north-central United States (Becker 1983).

Because of late ice conditions and rapidly increasing water temperatures in 2018, the egg-take goal of 60 million was met not and only 22 million total eggs were collected. Fluctuations and declines in water temperatures have been shown to prolong spawning or result in females retaining their eggs (Derback 1947). Although ice covered much of the reservoir in mid-April, some of bays and creeks in the uppermost portions of the reservoir opened sooner due to plains snow melt and warmer 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. Higher than normal numbers of spent female walleye were captured in 2018 compared to previous years. In 2018, 61% of the female walleye captured were spent compared to only 7% in 2017. 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. In addition, North Dakota fisheries and hatchery personnel were able to provide some walleye fry to stock rearing ponds at the Fort Peck and Miles City fish hatcheries. No walleye fry were stocked into Fort Peck Reservoir in 2018 due to limited numbers of eggs collected and below average hatching success. A total of 811,266 walleye fingerlings were stocked in various locations throughout Fort Peck Reservoir (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. Warmer than normal water temperatures were observed in the rearing ponds at Fort Peck and Miles City hatcheries during the time of fry stocking (i.e., Wade Geraets, personal communication).

### Walleye

Relative abundance of walleye captured in spring trap nets was 5.7 per net in 2018, which decreased from the previous year, and below the long-term average of 6.7 per net (1988-2018; Table 2). Average length and weight increased slightly from 20.4 inches in 2017 to 21.1 inches in 2018. Furthermore, length frequency distributions showed 64% of walleye were greater than 20 inches in 2018 compared to 56% in 2017 (Figure 3). The combination of more female walleye measured in 2018 and the large 2011-year class as indicated by the higher number of fish from 22-24 inches influenced this trend (Figure 4). Typically, more male walleye are captured than females during trap netting, but more females were captured in 2018. A total of 808 female and 322 male walleye were captured in 2018 compared to 976 female and 1,674 male walleye in 2017. 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 (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, 1982-2017. 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 |
|---|---|---|---|---|---|---|
| 1988 | (4/06-4/22) | 214 | 1,610 | 7.5 | 163 | 0.8 |
| 1989 | (4/25-5/06) | 207 | 2,360 | 11.4 | 383 | 1.9 |
| 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 | 1.0 |
| 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 |

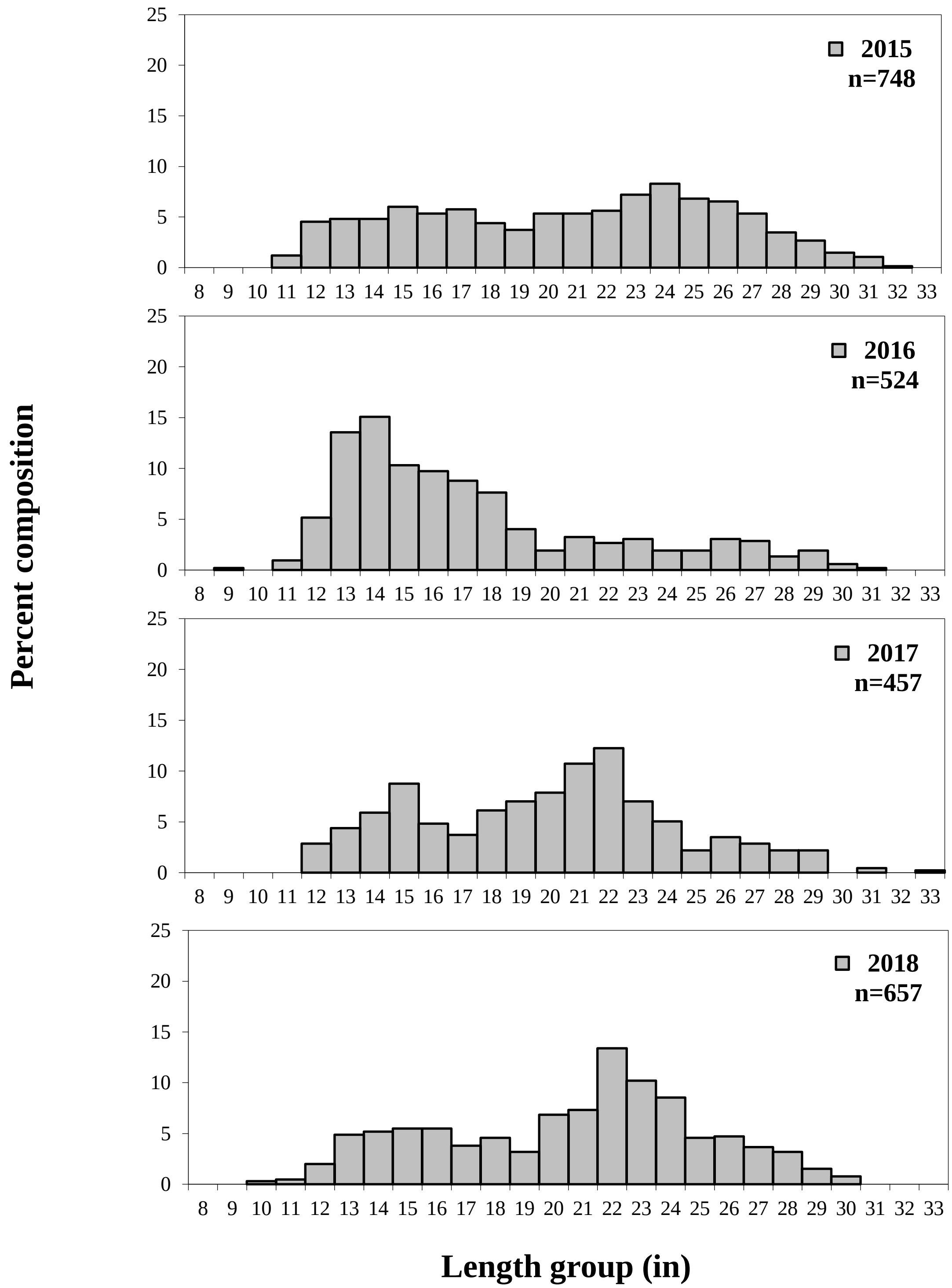



Figure 3. Length frequency of subsampled walleye collected during spring trap netting in the upper Big Dry Arm of Fort Peck Reservoir, 2015-2018.

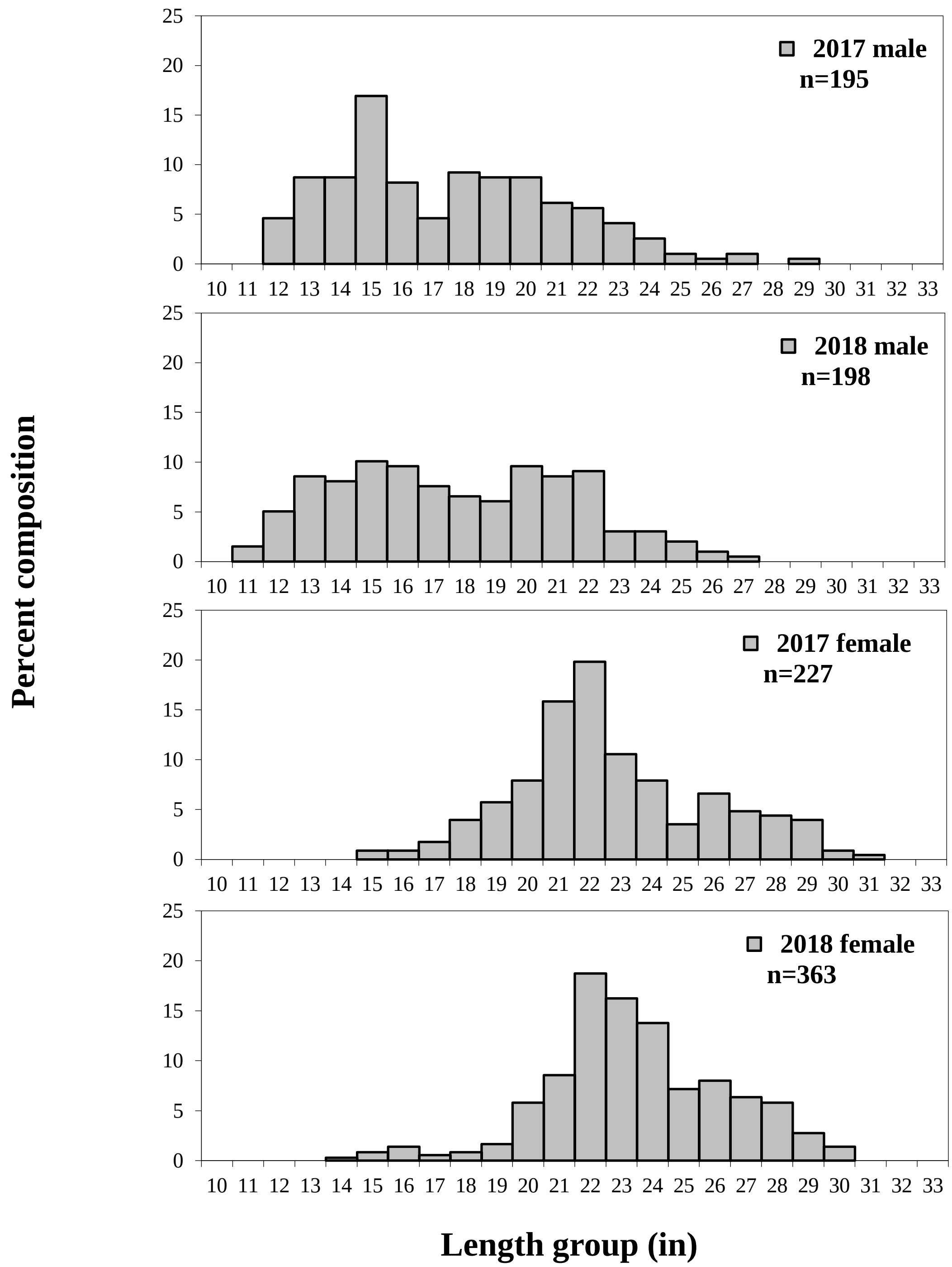



Figure 4. Length frequency of subsampled male and female walleye collected during spring trap netting in the upper Big Dry Arm of Fort Peck Reservoir, 2017-2018.

## LIMNOLOGY AND ZOOPLANKTON MONITORING

Water temperature in Fort Peck Reservoir ranged from 24.2°C at the subsurface to 2.4°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.

Water temperatures were more variable in May compared to previous years on Fort Peck Reservoir due to rapid increases in the ambient temperature. Typically, near isothermal conditions are observed during the month of May at each site (Headley 2018). 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 at the subsurface were highest (10.6 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 at Pines and Hell 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 2018.

The maximum estimated zooplankton density was 95.0/L which occurred in June of 2018. Cyclopoids dominated the zooplankton community throughout the sampling season and highest densities were observed during June at 39.1/L. *Bosmina* and *Daphnia* were the two most abundant cladocerans sampled and were most abundant during June (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 2018 were similar to and slightly higher than those observed in 2017. A possible explanation for slightly higher zooplankton densities in 2018 than 2017 could be explained by higher reservoir elevations and increased flows into the reservoir. Higher inflows into Fort Peck Reservoir occurred in 2018, which increased reservoir elevations, due to higher than normal plains and mountain snowpack. 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).

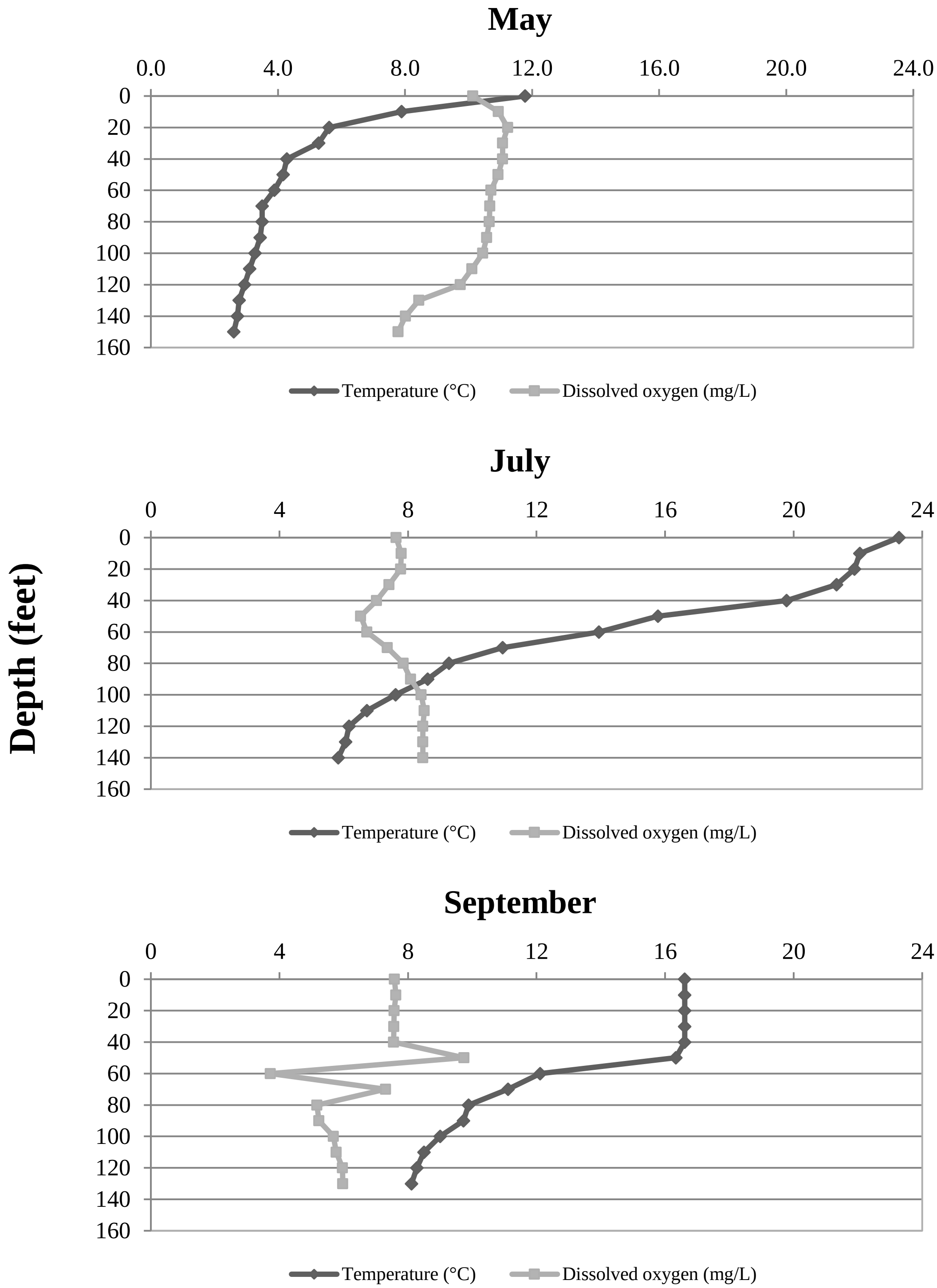



Figure 5. Depth profiles of temperature (°C) and oxygen (mg/L) located near Haxby Point on Fort Peck Reservoir, May-September 2018.

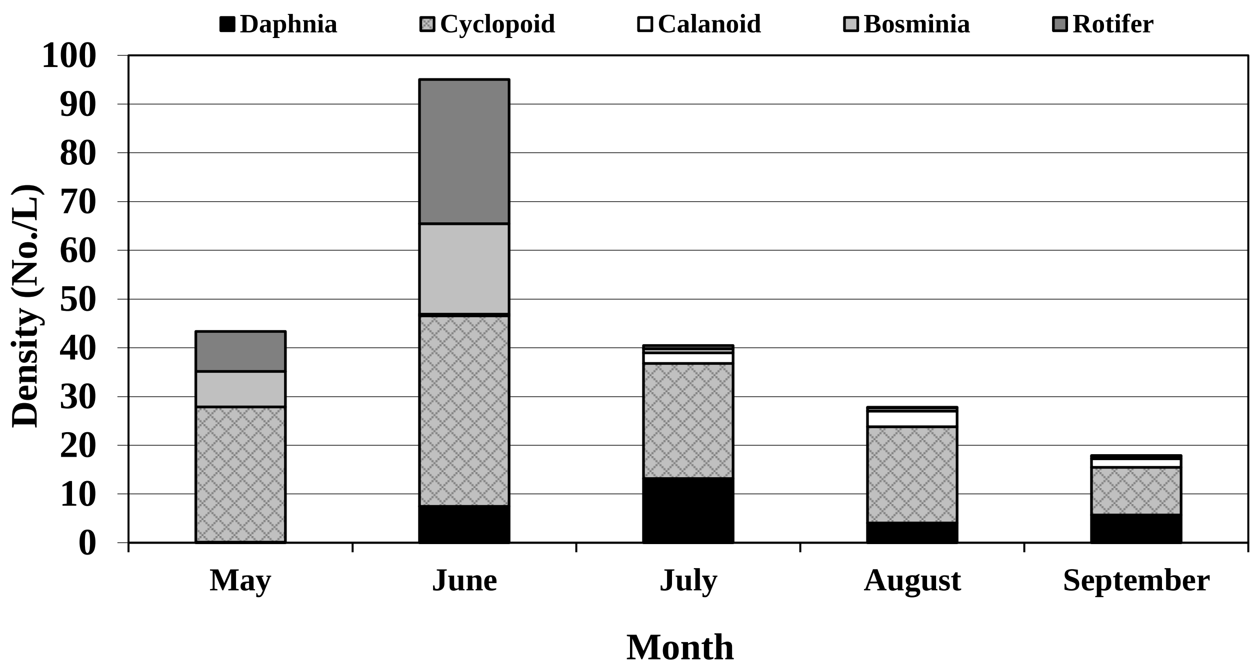



Figure 6. Mean zooplankton density (number of organisms/L) pooled from reservoir-wide samples by taxonomic group and month for Fort Peck Reservoir, 2018.

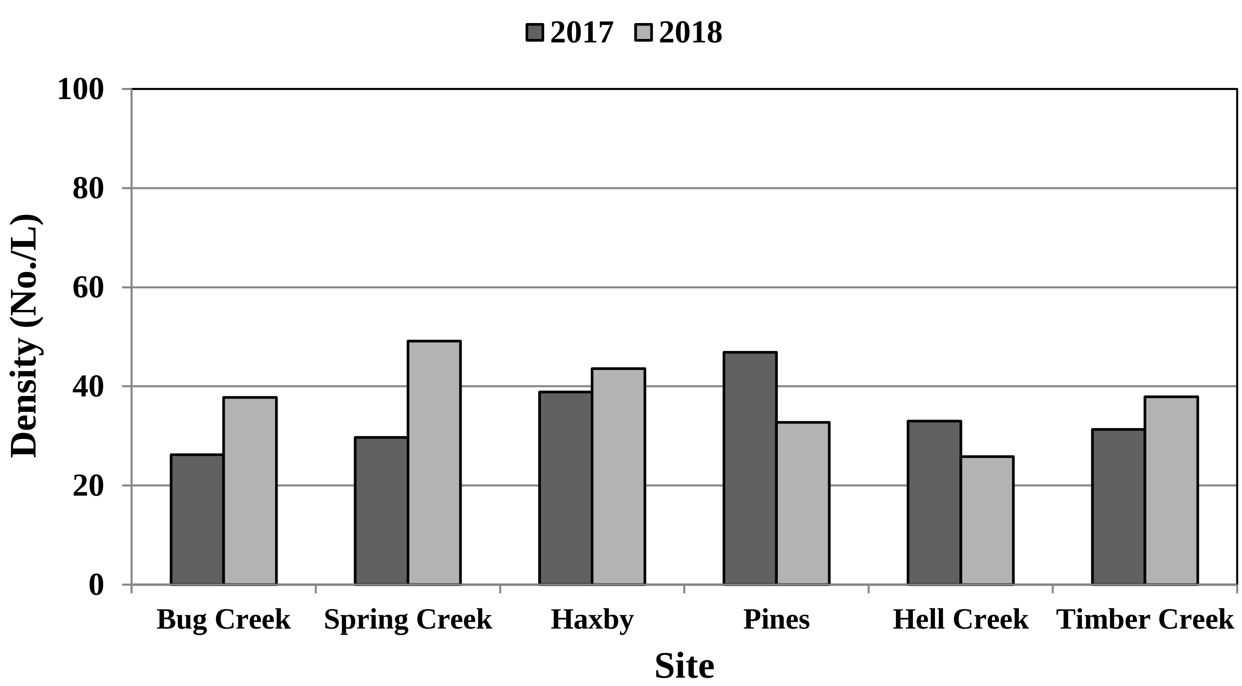



Figure 7. Mean zooplankton density (number of organisms/L) pooled for all months (May-September) for Fort Peck Reservoir, 2017-2018.

## RESERVOIR-WIDE GILL NETTING

Standard experimental gill nets were set throughout the reservoir from July 18th to August 8th, 2018 when water surface temperatures ranged from 69.2°F to 77.4°F. Gill netting provides information on species distribution; composition, relative abundance, population parameters, and stomach contents of game species. Fifteen species were captured for a total of 2,161 fish (Table 2). Walleye, goldeye, and smallmouth bass were the most abundant species captured overall, with catch rates of 4.7, 3.0, and 2.4 per net night, respectively. Fish with catch rates equal to or greater than 1.0 per-net night include: channel catfish, common carp, northern pike, river carpsucker, shorthead redhorse, smallmouth bass, and yellow perch.

### Walleye

Relative abundance of walleye in 2018 was 4.7 per net which was up from the previous year (Figure 8). This was above the long-term average of 3.9 per net from 1988 to 2018. The three-year running average goal of 3.6 per net was met (4.1 per net in 2016-2018) as outlined in the FPRFMP. Quality and stock-length groups comprised the largest group of gill-netted walleye in 2018 suggesting favorable growth and survival (Figure 8). Relative abundance of walleye was greatest in the lower Missouri arm with a catch rate of 5.3 per net (Table 3).

Length frequency distributions of walleye in 2018 indicated a large abundance of 12 to 15-inch fish that comprised 36% of the walleye gill netted in 2018 (Figure 9). There also appeared to be a moderate abundance of larger fish that ranged from 21 to 25-inches. This group represented 32% of all walleye gill netted in 2017 as 19 to 22-inch fish. In 2016, this group was in the 17 to 21-inch range and comprised 39% of all walleye captured. In 2015, this group of fish was in the 12 to 16-inch range and comprised 50% of all walleye gill netted suggesting a large year class(es) 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 2018 varied compared to the six-year average (Table 5). Mean lengths-at-age were slightly higher for age-9 and older fish indicating favorable growth over the last few years due to higher relative abundance of cisco. In contrast, mean lengths-at-age for age-3 to age-7 were lower in 2018 compared to the average due to the continued low relative abundance of shoreline forage. It should be noted that a large group of 7-year old fish (2011-year classes) were observed in 2018 and comprised 21% of all walleye aged. Similarly, this year class comprised 36% of the walleye aged in 2017. Multiple year classes were present with walleye up to age-21.

Overall, relative weights of walleye in 2018 increased compared to the previous year (Table 6). The most notable increase in relative weights were for stock and memorable+ length groups (Figure 10). The increased relative weights for stock-length walleye can be explained by an increase in shoreline forage fish production over the last two years (Figure 15). Relative weights for all length groups of walleyes captured in 2018 were higher than the drought/low water years (2005-2008). The large increase in relative weights of memorable+ length groups of walleye can be attributed to an abundance of adult cisco (>8") currently in the system. Cisco have been found to be an important prey item for walleye greater than 18 inches in Fort Peck Reservoir (Mullins 1991).

Proportional size distribution (PSD) and proportional size distribution-preferred (PSD-P) are measures of balance for fish populations (Gabelhouse 1984). The measures are percents of fish captured at substock (<10"), and numbers of fish of each size and larger for stock (> 10"), quality (>15"), preferred (>20"), and memorable (>25") size fish. Changes in each group can be from increases or decreases in recruitment and natural or fishing mortality. Anderson and Weithman (1978) models of walleye PSD's suggest a range of 30-60 as favorable values for walleye populations. 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 in 2018 decreased to 60 suggesting a slight improvement in stock length fish.

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, 2018. *N* is total number collected for length and weight measurements.

| | | | Average | | | |
|---|---|---|---|---|---|---|
| | | | Length | | Weight | |
| Species | Number | CPUE | Inches | *N* | Pounds | *N* |
| Black crappie | 27 | 0.3 | 8.9 | 26 | 0.5 | 26 |
| Channel catfish | 179 | 1.8 | 17.8 | 179 | 2.4 | 179 |
| Common carp | 181 | 1.8 | 21.7 | 181 | 4.6 | 181 |
| Freshwater drum | 52 | 0.5 | 15.1 | 52 | 1.8 | 52 |
| Goldeye | 299 | 3.0 | 12.7 | 291 | 0.7 | 291 |
| Northern pike | 165 | 1.7 | 27.1 | 165 | 5.0 | 165 |
| Pallid sturgeon | 1 | 0.0 | 15.9 | 1 | 0.4 | 1 |
| River carpsucker | 129 | 1.3 | 20.1 | 128 | 4.3 | 128 |
| Sauger | 19 | 0.2 | 19.7 | 19 | 2.4 | 19 |
| Shorthead redhorse | 110 | 1.1 | 14.6 | 109 | 1.4 | 109 |
| Smallmouth bass | 235 | 2.4 | 12.4 | 235 | 1.2 | 235 |
| Smallmouth buffalo | 111 | 1.1 | 24.4 | 109 | 8.5 | 109 |
| Walleye | 471 | 4.7 | 17.4 | 469 | 2.5 | 469 |
| White sucker | 12 | 0.1 | 15.7 | 12 | 1.7 | 12 |
| Yellow perch | 170 | 1.7 | 6.9 | 169 | 0.2 | 169 |

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, 2018.

| | 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 | 2 | 0.1 | 2 | 0.1 | 0 | -- | 4 | 0.2 | 19 | 1.0 | 27 | 0.3 |
| Channel catfish | 58 | 2.9 | 13 | 0.7 | 8 | 0.4 | 16 | 0.8 | 84 | 4.2 | 179 | 1.8 |
| Common carp | 13 | 0.7 | 20 | 1.0 | 53 | 2.7 | 56 | 2.8 | 39 | 2.0 | 181 | 1.8 |
| Freshwater drum | 7 | 0.4 | 6 | 0.3 | 9 | 0.5 | 16 | 0.8 | 14 | 0.7 | 52 | 0.5 |
| Goldeye | 46 | 2.3 | 5 | 0.3 | 23 | 1.2 | 20 | 1.0 | 205 | 10.3 | 299 | 3.0 |
| Northern pike | 36 | 1.8 | 29 | 1.5 | 36 | 1.8 | 48 | 2.4 | 16 | 0.8 | 165 | 1.7 |
| Pallid sturgeon | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 1 | 0.1 | 1 | <0.1 |
| River carpsucker | 43 | 2.2 | 17 | 0.9 | 4 | 0.2 | 28 | 1.4 | 37 | 1.9 | 129 | 1.3 |
| Sauger | 2 | 0.1 | 1 | 0.1 | 2 | 0.1 | 2 | 0.1 | 12 | 0.6 | 19 | 0.2 |
| Shorthead redhorse | 21 | 1.1 | 13 | 0.7 | 2 | 0.1 | 11 | 0.6 | 63 | 3.2 | 110 | 1.1 |
| Smallmouth bass | 45 | 2.3 | 52 | 2.6 | 26 | 1.3 | 67 | 3.4 | 45 | 2.3 | 235 | 2.4 |
| Smallmouth buffalo | 33 | 1.7 | 35 | 1.8 | 13 | 0.7 | 15 | 0.8 | 15 | 0.8 | 111 | 1.1 |
| Walleye | 97 | 4.9 | 102 | 5.1 | 106 | 5.3 | 75 | 3.8 | 91 | 4.6 | 471 | 4.7 |
| White sucker | 0 | -- | 6 | 0.3 | 3 | 0.2 | 1 | 0.1 | 2 | 0.1 | 12 | 0.1 |
| Yellow perch | 13 | 0.7 | 3 | 0.2 | 23 | 1.2 | 41 | 2.1 | 90 | 4.5 | 170 | 1.7 |
| Total | 416 | 20.8 | 304 | 15.2 | 308 | 15.4 | 400 | 20.0 | 733 | 36.7 | 2,161 | 21.6 |

[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

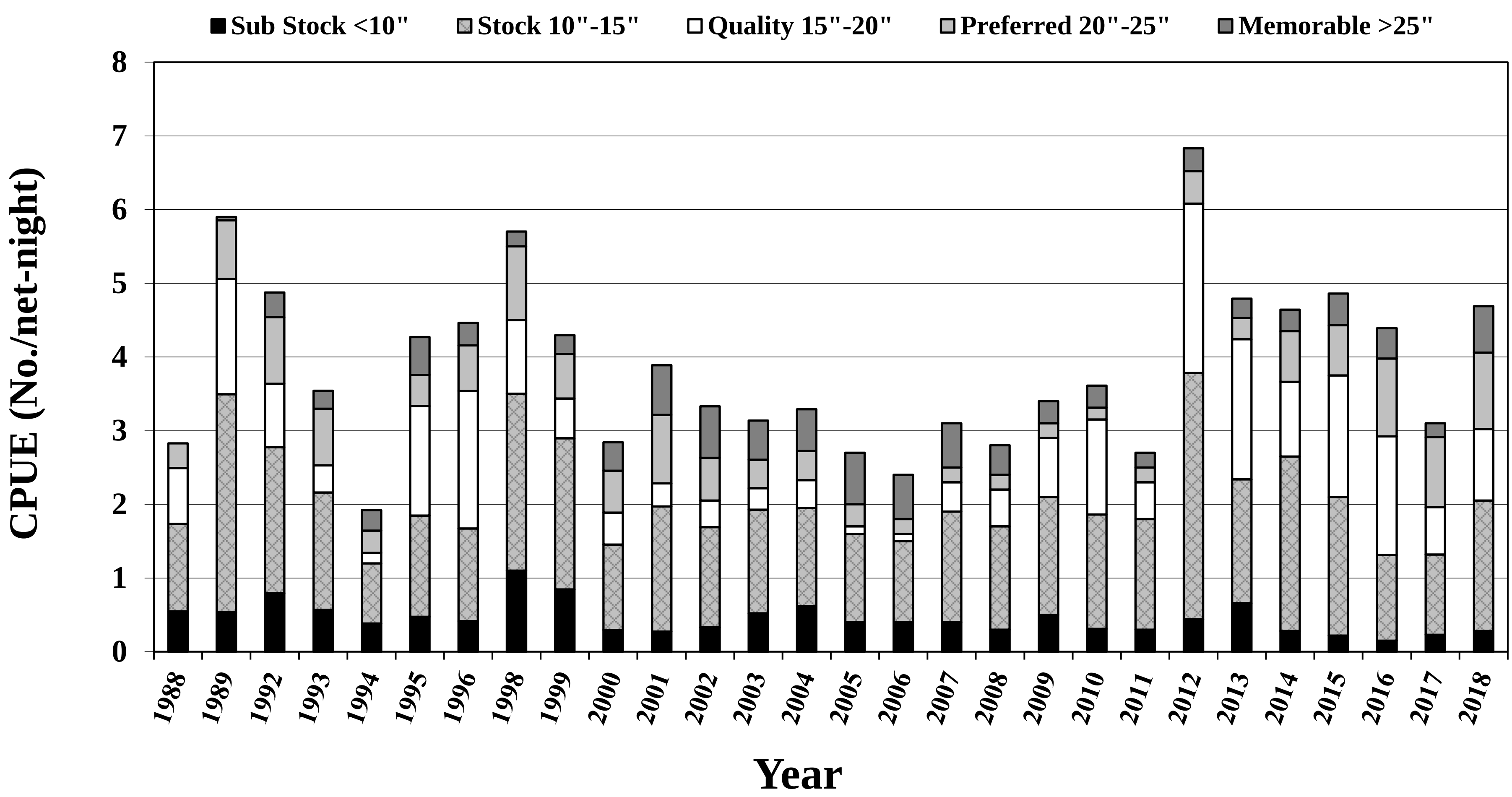



Figure 8. Length structure, in terms of catch per unit effort (CPUE), of walleye collected by experimental gill nets in Fort Peck Reservoir during July-August, 1988-2018 (no data for 1990-1991 and 1997).

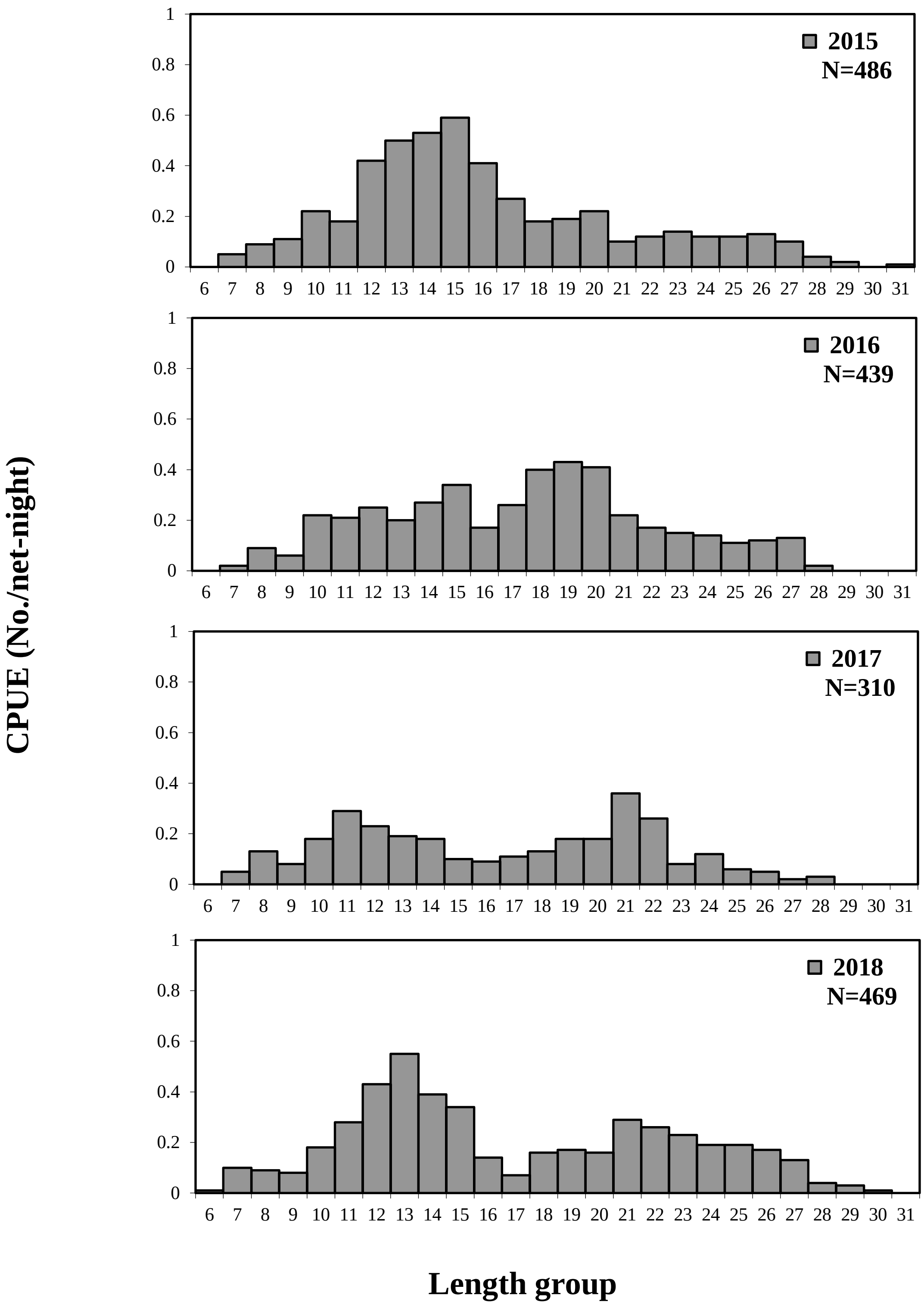
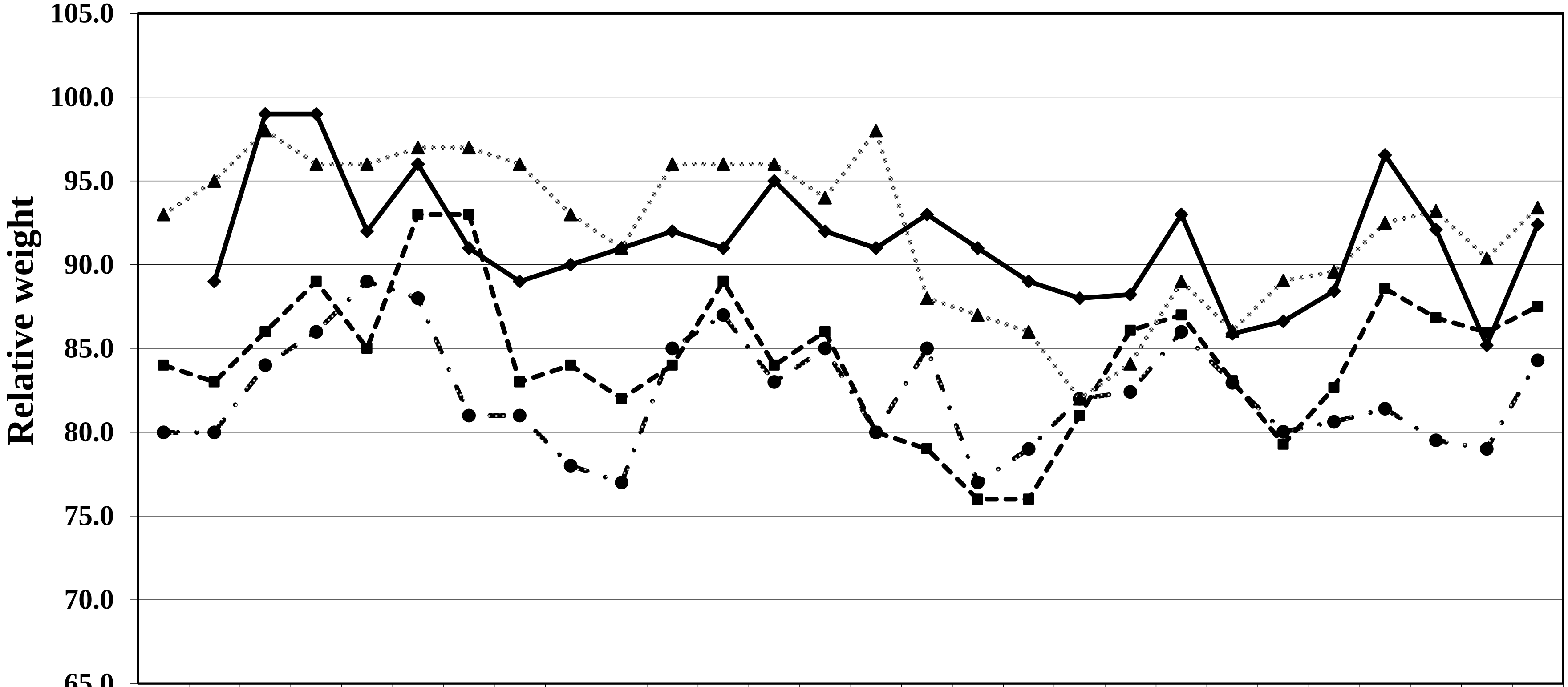



Figure 9. Length frequency, as catch per unit effort, of walleye collected by experimental gill nets in Fort Peck Reservoir during July-August, 2015-2018.




| | 1988 | 1989 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stock 10"-15" | 80.0 | 80.0 | 84.0 | 86.0 | 89.0 | 88.0 | 81.0 | 81.0 | 78.0 | 77.0 | 85.0 | 87.0 | 83.0 | 85.0 | 80.0 | 85.0 | 77.0 | 79.0 | 82.0 | 82.4 | 86.0 | 83.0 | 80.0 | 80.6 | 81.4 | 79.5 | 79.0 | 84.3 |
| Quality 15"-20" | 84.0 | 83.0 | 86.0 | 89.0 | 85.0 | 93.0 | 93.0 | 83.0 | 84.0 | 82.0 | 84.0 | 89.0 | 84.0 | 86.0 | 80.0 | 79.0 | 76.0 | 76.0 | 81.0 | 86.1 | 87.0 | 83.1 | 79.3 | 82.7 | 88.6 | 86.8 | 86.0 | 87.5 |
| Preferred 20"-25" | 93.0 | 95.0 | 98.0 | 96.0 | 96.0 | 97.0 | 97.0 | 96.0 | 93.0 | 91.0 | 96.0 | 96.0 | 96.0 | 94.0 | 98.0 | 88.0 | 87.0 | 86.0 | 82.0 | 84.1 | 89.0 | 86.0 | 89.1 | 89.6 | 92.5 | 93.2 | 90.4 | 93.4 |
| Memorable >25" | | 89.0 | 99.0 | 99.0 | 92.0 | 96.0 | 91.0 | 89.0 | 90.0 | 91.0 | 92.0 | 91.0 | 95.0 | 92.0 | 91.0 | 93.0 | 91.0 | 89.0 | 88.0 | 88.2 | 93.0 | 85.9 | 86.6 | 88.4 | 96.5 | 92.1 | 85.2 | 92.4 |

Figure 10. Relative weights for stock, quality, preferred, and memorable length groups of walleye collected by experimental gill nets in Fort Peck Reservoir, 1988-2018 (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, 2013-2018, 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 |
| 2013 | Mean | 7.7 | 9.7 | 14.1 | 15.5 | 17.2 | 18.2 | 21.6 | 22.7 | 26.5 | 22.9 | 27.8 | -- | 21.4 | -- |
| | N | 6 | 77 | 147 | 27 | 66 | 16 | 9 | 8 | 1 | 4 | 1 | -- | 1 | -- |
| | SE | 0.3 | 0.2 | 0.2 | 0.4 | 0.3 | 0.7 | 1.1 | 1.3 | -- | 1.9 | -- | -- | -- | -- |
| | Range | 7.2-8.8 | 6.7-14.2 | 8.5-18.5 | 11.5-21.1 | 8.9-22.5 | 14.1-22.8 | 17.3-28.5 | 16.9-26.5 | -- | 18.8-27.6 | -- | -- | -- | -- |
| | | | | | | | | | | | | | | | |
| 2014 | Mean | 7.1 | 10.5 | 11.6 | 14.6 | 16.0 | 19.3 | 20.2 | 22.6 | 22.3 | 21.0 | 25.2 | 21.2 | 26.9 | -- |
| | N | 5 | 14 | 169 | 89 | 39 | 56 | 11 | 15 | 12 | 4 | 1 | 3 | 3 | -- |
| | SE | 0.1 | 0.4 | 0.1 | 0.2 | 0.4 | 0.4 | 1.0 | 0.5 | 0.9 | 1.2 | -- | 1.0 | 2.4 | -- |
| | Range | 6.8-7.3 | 6.9-12.6 | 7.7-17.1 | 11.4-23.2 | 10.4-21.6 | 13.2-24.4 | 14.7-24.1 | 19.2-25.2 | 15.5-26.5 | 17.8-23.2 | -- | 19.3-22.4 | 22.2-30.1 | -- |
| | | | | | | | | | | | | | | | |
| 2015 | Mean | 7.8 | 9.5 | 13.0 | 14.2 | 16.8 | 18.7 | 20.9 | 23.7 | 22.3 | 24.1 | 27.0 | 25.8 | 21.4 | 21.0 |
| | N | 2 | 26 | 27 | 184 | 55 | 27 | 45 | 14 | 9 | 11 | 1 | 11 | 3 | 3 |
| | SE | 0.1 | 0.3 | 0.4 | 0.1 | 0.3 | 0.5 | 0.5 | 0.9 | 1.8 | 1.2 | -- | 0.8 | 3.7 | 1.4 |
| | Range | 7.8-7.9 | 7.3-12.5 | 9.4-17.0 | 9.8-19.8 | 12.7-22.1 | 13.4-23.5 | 15.4-26.2 | 15.2-27.4 | 11.6-27.2 | 17.0-29.4 | -- | 21.3-29.1 | 17.4-28.8 | 18.3-22.8 |
| | | | | | | | | | | | | | | | |
| 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 | -- |
| Mean of means | | 7.7 | 9.7 | 12.2 | 14.4 | 16.3 | 18.5 | 20.5 | 22.9 | 23.7 | 22.6 | 25.5 | 25.2 | 24.1 | 21.4 |

### Northern Pike

Relative abundance of northern pike captured in gill nets was 1.7 per net in 2018 which decreased slightly from the previous year (Table 3; Figure 11). The three-year running average goal of 2.0 northern pike per net was not met (1.9 per net in 2018) as outlined in the FPRFMP. Average length and weight of northern pike in 2018 was 27.1 inches and 5.0 pounds which was higher compared to the rising water years (2007-2012; Table 7). This was due to fewer smaller-sized individuals recruiting into the population as a result of limited natural reproduction. Similarly, 71% of the northern pike captured were greater than 25 inches in 2018 (Figure 12). This was comparable to 2005-2006 when 80% of the northern pike captured in gill nets were greater than 25 inches (Headley 2007).

In 2018, northern pike PSD was 94 and PSD-P was 40. 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 decreasing to stable water levels from 2011 to 2017, inundation of terrestrial vegetation has become limited throughout the reservoir decreasing the amount of ideal spawning/rearing habitat. Relative abundance of shoreline forage has also decreased over the last several years limiting food availability for juvenile northern pike. As a result, relative abundance of substock and stock length groups of northern pike has started to decrease over the last several years. Relative weight of northern pike increased from 90 in 2017 to 95 in 2018.

### Channel Catfish

Relative abundance of channel catfish captured by gill netting was 1.8 per net in 2018. This was a slight increase compared to the previous year but just below the 28-year average of 1.9 per net (Figure 13). Similar to previous years, the highest abundance was observed in the Upper Missouri Arm at 4.2 per net (Table 4). In 2018, mean length and weight was 17.8 inches and 2.4 pounds, respectively. This was slightly higher than the long-term average of 16.2 inches and 1.7 pounds (Table 8). Relative weights of channel catfish increased from 85 in 2017 to 88 in 2018. Catfish PSD and PSD-P were 53 and 13, respectively, indicating a population comprised of good numbers of larger 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 2018 was 0.2 per net which was similar to the previous year. Average size of sauger in 2018 was 19.7 inches and 2.4 pounds with a relative weight of 75. 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 upper Missouri arm with a catch rate of 0.6 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, 1994-2018 (no data for 1997).

| Year | No. walleye | CPUE | SE | Length | Weight | *Wr* | Substock[1] | Stock[2] | Quality[3] | Preferred[4] | PSD[5] | PSD-P[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 139 | 1.8 | 0.2 | 15.9 | 2.4 | 92 | 23 | 116 | 54 | 43 | 47 | 37 |
| 1995 | 330 | 4.2 | 0.3 | 16.6 | 2.4 | 91 | 34 | 295 | 189 | 73 | 64 | 25 |
| 1996 | 361 | 4.4 | 0.4 | 16.5 | 2.1 | 89 | 31 | 327 | 228 | 75 | 70 | 23 |
| 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 |

[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, 1988-2018 (no data for 1990-1991 and 1997).

| Year | *N* | CPUE | Length | Weight | *Wr* |
|---|---|---|---|---|---|
| 1988 | 43 | 0.6 | 26.4 | 5.3 | 107 |
| 1989 | 47 | 0.7 | 24.4 | 4.5 | 110.2 |
| 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 |

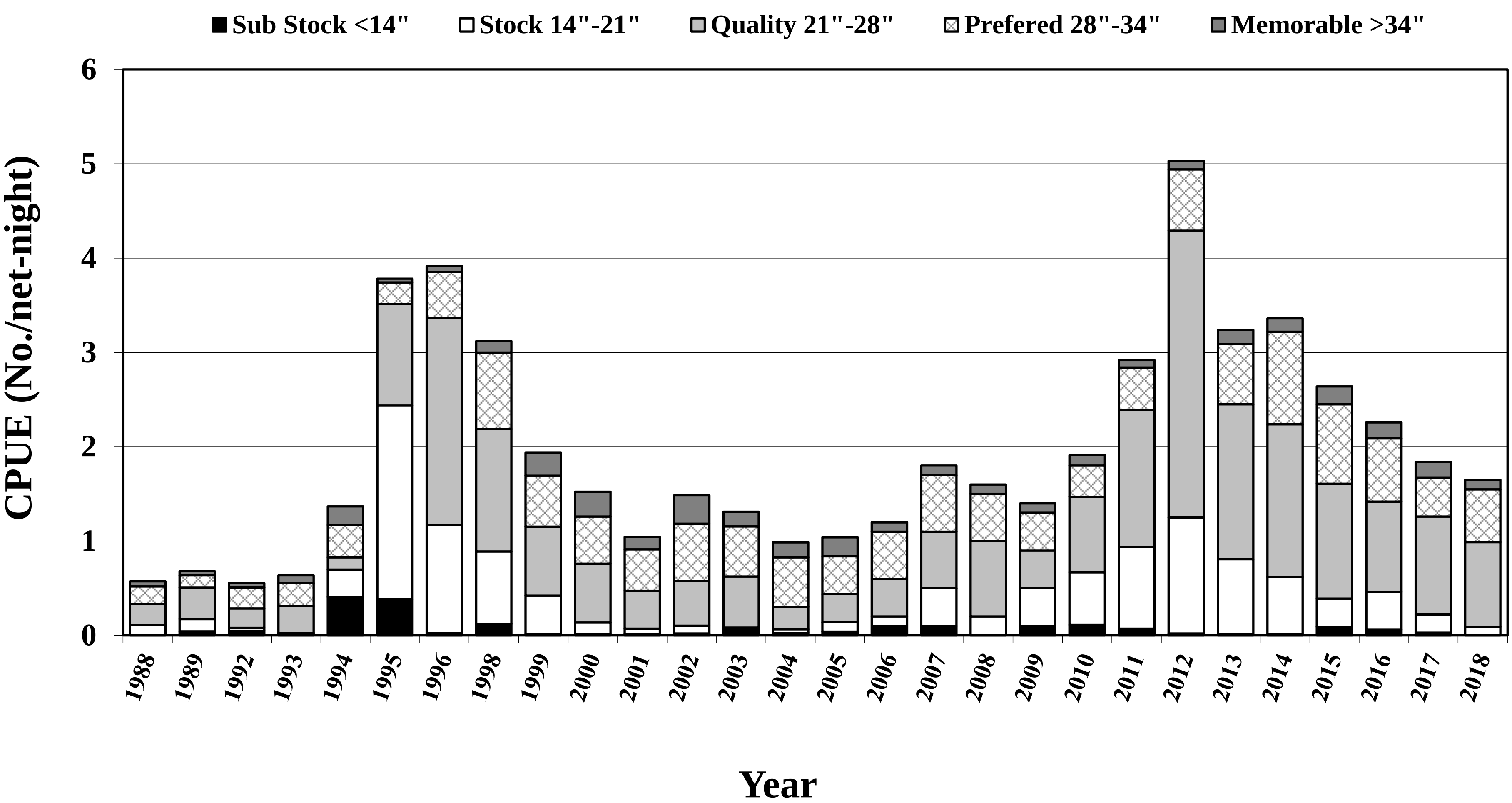



Figure 11. Length structure, in terms of catch per unit effort (CPUE), of northern pike collected by experimental gill nets in Fort Peck Reservoir during, July-August, 1988-2018, (no data for 1990-1991 and 1997).

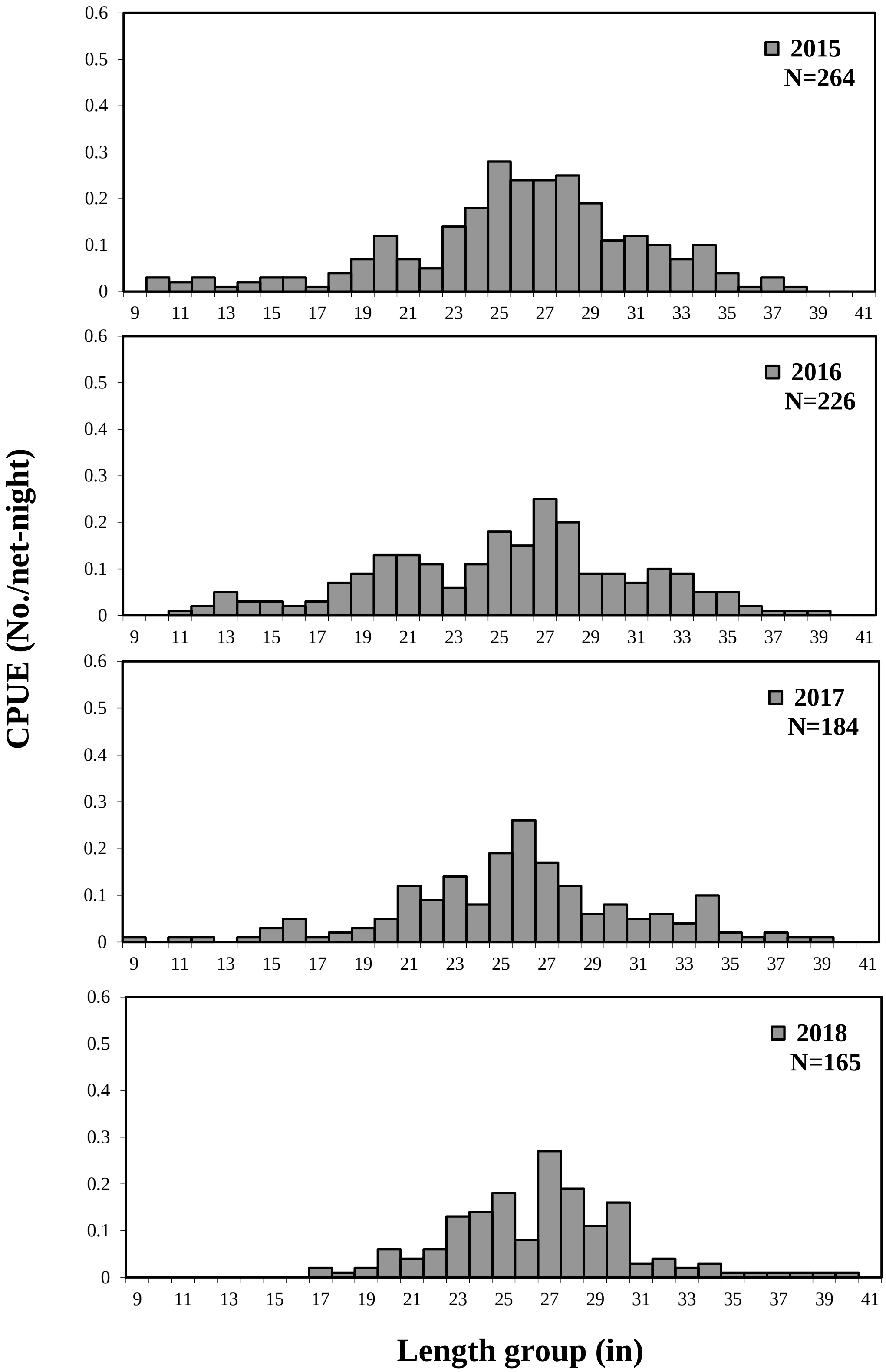
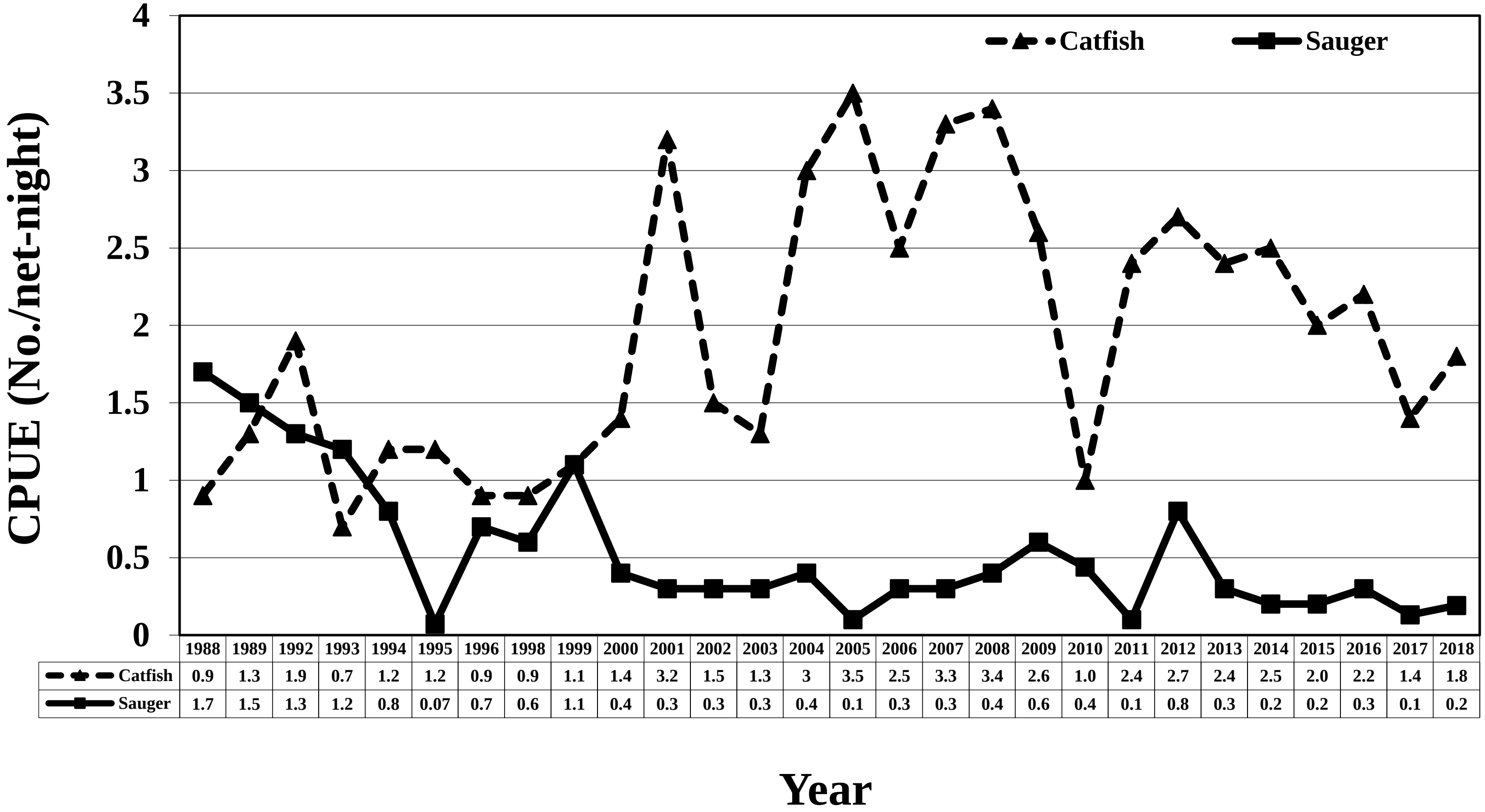



Figure 12. Length frequency, as catch per unit effort (CPUE), of northern pike collected by experimental gill nets in Fort Peck Reservoir during July-August, 2015-2018.




| | 1988 | 1989 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Catfish | 0.9 | 1.3 | 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 |
| Sauger | 1.7 | 1.5 | 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 |

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, 1988-2018 (no data for 1990-1991 and 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, 1988-2018 (no data for 1990-1991 and 1997).

| Year | *N* | CPUE | Length | Weight |
|---|---|---|---|---|
| 1988 | 69 | 0.9 | 15.9 | 1.7 |
| 1989 | 99 | 1.4 | 16.5 | 1.5 |
| 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 |

## STOMACH CONTENTS OF GILL NETTED GAME FISH

Stomach contents of walleye, northern pike, sauger, and smallmouth bass captured in experimental gill nets from July 18th to August 8th, 2018 were examined for the presence of forage items. Walleye had the most diverse diet followed closely by smallmouth bass (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 2018 (Table 14). 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 2018. Sample size is given in parentheses.

| Forage items | Northern pike (*N*=162) | Sauger (*N*=17) | Smallmouth bass (*N*=156) | Walleye (*N*=432) |
|---|---|---|---|---|
| Burbot | -- | -- | -- | 0.2% |
| Chinook salmon | 1.2% | -- | -- | -- |
| Cisco | 14.8% | -- | 1.9% | 9.5% |
| Crayfish | 2.5% | -- | 16.0% | -- |
| Emerald shiner | -- | -- | -- | 0.5% |
| Empty | 67.3% | 76.5% | 37.8% | 44.4% |
| Freshwater drum | -- | -- | -- | 0.2% |
| Invertebrates | -- | -- | 9.6% | 10.0% |
| *Pomoxis spp.* | -- | -- | 0.6% | 3.2% |
| Smallmouth bass | -- | -- | -- | 0.2% |
| Smallmouth buffalo | -- | -- | -- | 0.2% |
| Unknown | 10.5% | 11.8% | 30.8% | 28.5% |
| Walleye | 1.2% | -- | 0.6% | 0.5% |
| Yellow perch | 2.5% | 11.8% | 2.6% | 2.5% |

## BEACH SEINING

Shoreline beach seining was conducted to determine reproductive success of age-0 game and non-game fish from August 5th to September 6th, 2018. Seine hauls at 100 standardized locations throughout the reservoir captured 20 species of young-of-year and forage fish for a total of 21,340 fish (Table 10). Combined relative abundance of spottail shiner, emerald shiner, age-0 yellow perch, and age-0 crappie was similar to the previous year, and near the long-term average of 160 fish per seine haul. Relative abundance of shoreline forage typically follows changes in reservoir elevations (Figure 15). In 2018, reservoir elevations decreased slightly from late winter into summer. Reservoir elevations increased approximately 14 feet from March to July due to increased amounts of plains runoff as well as above average mountain snowpack (Figure 14). An increased amount of terrestrial vegetation was inundated beginning in spring and early summer of 2018.

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 54% of the seining sites in 2017 and 72% of the sites in 2018. The similarity between years could be attributed to stable to slightly increasing reservoir elevations from 2016-2017. Prior to this, reservoir elevations fluctuated greatly. In contrast, 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 these fluctuations 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.

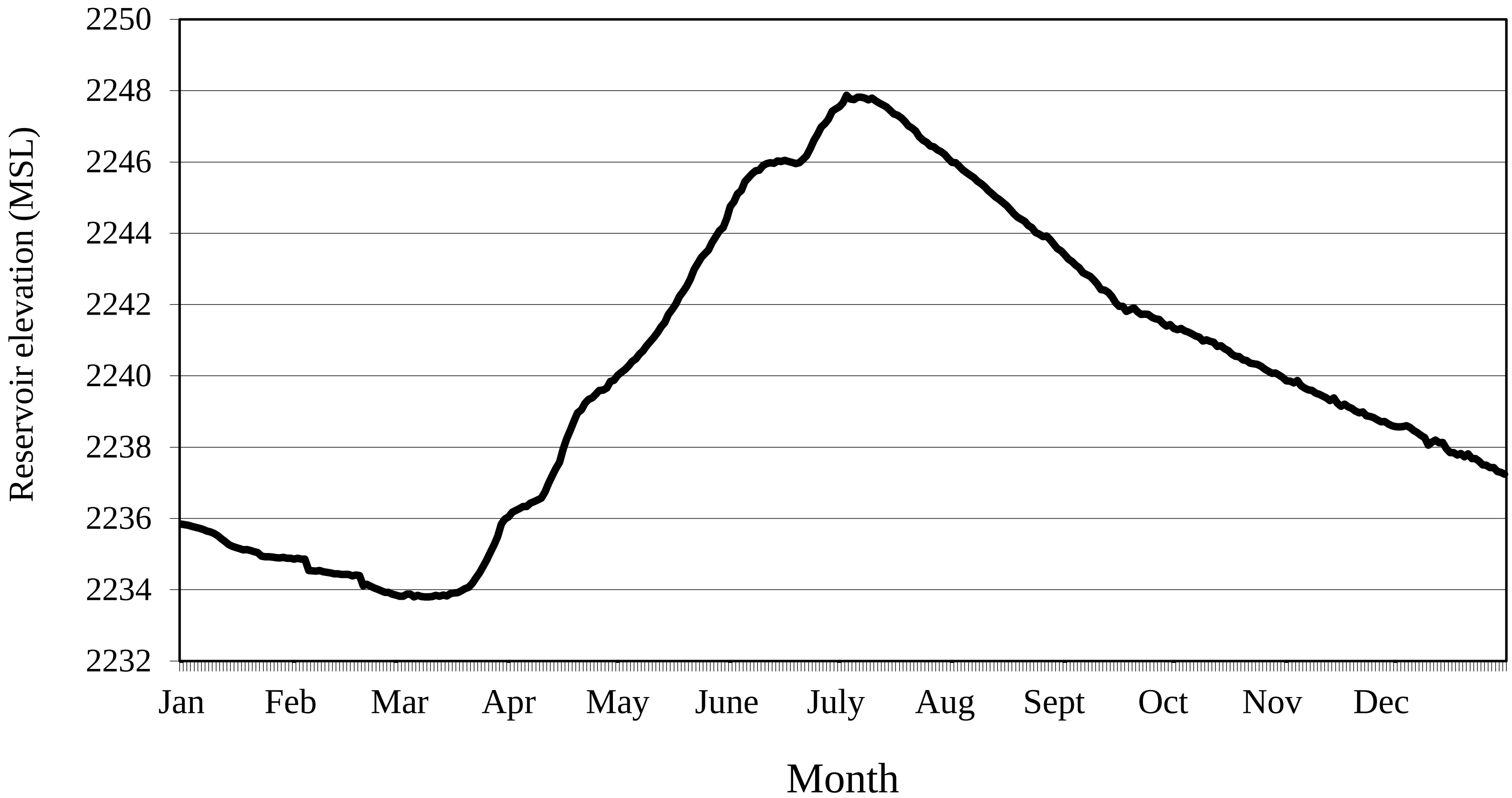



Figure 14. Average daily reservoir elevation for Fort Peck Reservoir from January 1, 2018 to December 31, 2018 (data provided by USACE).

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 2018. 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 |
| Black bullhead | 1,250 | 62.5 | 20 | 1.0 | 0 | -- | 0 | 0.0 | 212 | 10.6 | 1,482 | 14.8 |
| Bluegill | 0 | -- | 0 | -- | 0 | -- | 3 | 0.2 | 0 | -- | 3 | <0.1 |
| Burbot | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 1 | <0.1 | 1 | <0.1 |
| Chinook salmon | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 1 | <0.1 | 1 | <0.1 |
| Cisco | 0 | -- | 0 | -- | 1 | <0.1 | 0 | -- | 0 | -- | 1 | <0.1 |
| Common carp | 3 | 0.2 | 1 | <0.1 | 2 | 0.1 | 1 | 0.1 | 5 | 0.3 | 12 | 0.1 |
| Emerald shiner* | 72 | 3.6 | 7 | 0.4 | 62 | 3.1 | 332 | 16.6 | 1,141 | 57.1 | 1,614 | 16.1 |
| Freshwater drum | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 4 | 0.2 | 4 | <0.1 |
| Goldeye | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 10 | 0.5 | 10 | 0.1 |
| Green sunfish | 0 | -- | 6 | 0.3 | 0 | -- | 1 | <0.1 | 1 | <0.1 | 8 | 0.1 |
| *Hybognathus spp.** | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 131 | 6.6 | 131 | 1.3 |
| Northern pike | 10 | 0.5 | 43 | 2.2 | 44 | 2.2 | 65 | 3.3 | 8 | 0.4 | 170 | 1.7 |
| *Pomoxis spp.* | 13 | 0.7 | 23 | 1.2 | 80 | 4.0 | 1,845 | 92.3 | 6,477 | 323.9 | 8,438 | 84.4 |
| Pumpkinseed | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 11 | 0.6 | 11 | 0.1 |
| Sauger | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 2 | 0.1 | 2 | <0.1 |
| Smallmouth bass | 14 | 0.7 | 41 | 2.1 | 5 | 0.3 | 8 | 0.4 | 24 | 1.2 | 92 | 0.9 |
| Smallmouth buffalo | 0 | -- | 0 | -- | 0 | -- | 0 | -- | 8 | 0.4 | 8 | 0.1 |
| Spottail shiner* | 1,047 | 52.4 | 629 | 31.5 | 671 | 33.6 | 1,743 | 87.2 | 2,341 | 117.1 | 6,431 | 64.3 |
| Walleye | 0 | -- | 0 | -- | 1 | <0.1 | 0 | 0.0 | 3 | 0.2 | 4 | <0.1 |
| Yellow perch | 399 | 20.0 | 374 | 18.7 | 489 | 24.5 | 383 | 19.2 | 1,272 | 63.6 | 2,917 | 29.2 |
| Total | 2,808 | 140.4 | 1,144 | 57.2 | 1,355 | 67.8 | 4,381 | 219.1 | 11,652 | 582.6 | 21,340 | 213.4 |

*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 2018 was 29.2 per seine which was a slight increase compared to 2017 (Figure15). Increases in reservoir elevation beginning in March and rising approximately 14 feet into July appear to have provided some spawning and rearing habitat as terrestrial vegetation was inundated in 2018. This would explain the slight increase in relative abundance of young-of-year yellow perch. Nelson and Walburg (1977) determined that newly flooded vegetation was the most important factor affecting year-class strength of yellow perch in two large Missouri River reservoir systems. Relative abundance of young-of-year yellow perch in 2018 was still lower when compared to the high-water years (i.e., 2009-2012; Figure 15). Yellow perch were most abundant in the upper Missouri arm with a catch rate of 63.6 per seine haul in 2018 (Table 10).

### Crappie

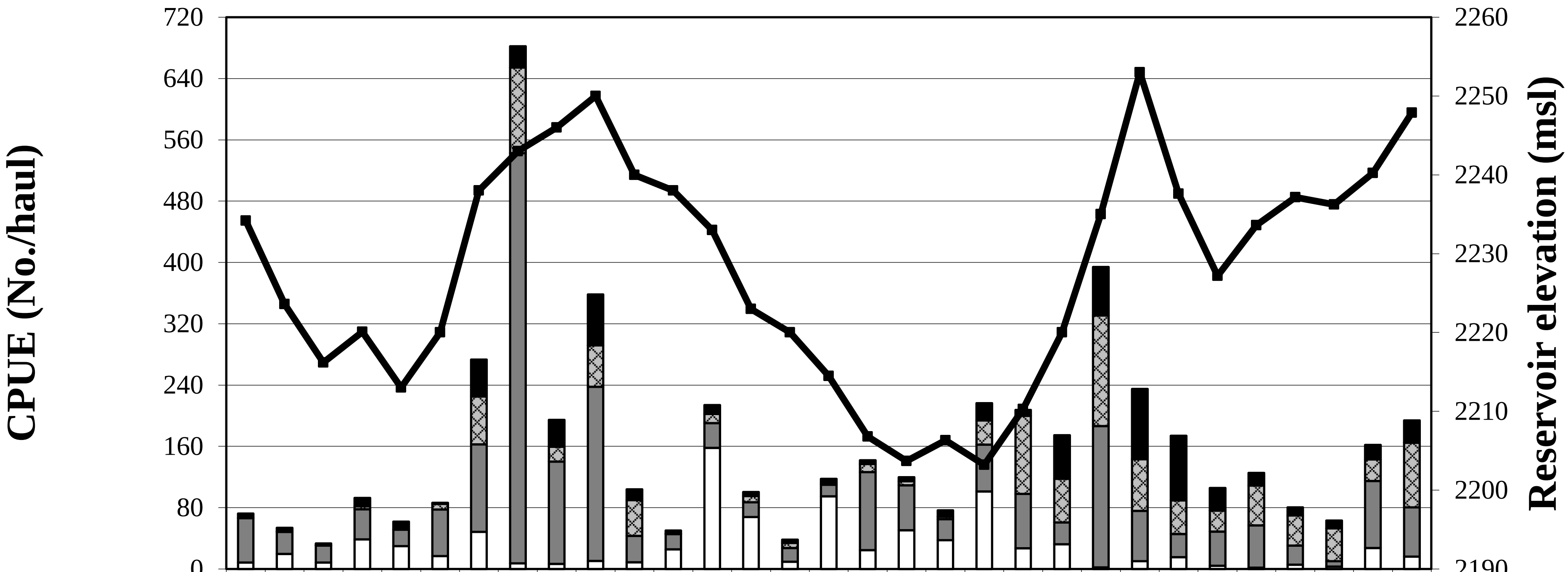
Young-of-year crappie relative abundance increased greatly from 28.0 per seine haul in 2017 to 84.4 per seine haul in 2018. Unlike young-of-year yellow perch, relative abundance of young-of-year crappie remains higher than during the drought years (Figure 15). Crappie were most abundant in the upper Missouri arm with a catch rate of 323.9 per seine haul which comprised 77% of the fish sampled in 2018 (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 2018 was 16.1 per seine haul, which was lower than 27.2 per seine haul in 2017. However, relative abundance of emerald shiners has been relatively 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. In 2018, 71% of the emerald shiners were captured in the upper Missouri arm (Table 10).

### Spottail Shiner

Relative abundance of spottail shiners decreased from 87.7 per seine haul in 2017 to 64.3 per seine haul in 2018 which was slightly lower than long-term average of 75 per seine haul. It is uncertain what caused the slight decrease, but relative abundance typically increase during rising reservoir elevations in late spring/early summer (Figure 15). Spottail shiner relative abundance was highest in the upper Missouri arm at 117.1 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.




| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perch** | 6 | 5.1 | 1.9 | 10.9 | 10 | 1.3 | 47.9 | 27.9 | 35.1 | 66.5 | 14.1 | 4.4 | 11.4 | 5.3 | 4.3 | 5 |
| **Crappie** | 0 | 0.1 | 0.7 | 4.1 | 0.4 | 7.6 | 62.6 | 112 | 19.3 | 54 | 46.7 | 0.2 | 11.9 | 8.2 | 6.7 | 2.5 |
| **Spottails** | 58 | 28.9 | 22 | 39.2 | 21.4 | 60.7 | 114 | 535 | 134 | 228 | 34.4 | 20 | 32.6 | 19.1 | 17.7 | 15.2 |
| **Emeralds** | 8.3 | 19.6 | 8.6 | 38.7 | 29.9 | 16.8 | 48.4 | 7.3 | 6.5 | 10.4 | 8.8 | 25.5 | 158 | 67.9 | 9.6 | 94.8 |
| **Elevation** | 2234 | 2224 | 2216 | 2220 | 2213 | 2220 | 2238 | 2243 | 2246 | 2250 | 2240 | 2238 | 2233 | 2223 | 2220 | 2215 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perch** | 4.9 | 5.2 | 8.4 | 22.6 | 8.01 | 57.2 | 63.3 | 91.8 | 84.5 | 29.6 | 16.7 | 10.5 | 9.85 | 18.9 | 29.2 |
| **Crappie** | 10.6 | 5.2 | 3.1 | 31.6 | 102 | 56.9 | 144. | 67.3 | 43.7 | 27.4 | 52 | 39.6 | 43.2 | 28 | 84.4 |
| **Spottails** | 102 | 58.8 | 27.4 | 61.1 | 70.8 | 28.2 | 184. | 65.7 | 30.2 | 44.7 | 54.9 | 24.8 | 7.02 | 87.7 | 64.3 |
| **Emeralds** | 24.6 | 50.5 | 37.6 | 101 | 27.1 | 32.4 | 2.2 | 10.3 | 15.6 | 4.1 | 1.9 | 5.6 | 3.01 | 27.2 | 16.1 |
| **Elevation** | 2207 | 2204 | 2206 | 2203 | 2210 | 2220 | 2235 | 2253 | 2238 | 2227 | 2234 | 2237 | 2236 | 2240 | 2248 |

**Year**

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 1986-2018.

**Chinook salmon**

A total of 379,654 spring-stocked chinook salmon were released into Fort Peck Reservoir during late May/early June of 2018 at 30-52 per pound. This exceeded 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, the spring-stocked fish were slightly smaller due to cooler than normal temperatures during the rearing period (Table 11). 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). 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). Salmon were stocked further from the dam area in 2018 in hopes of reducing entrainment through the spillway due to evacuation of flood waters (Table 11).

Return of salmon to the release site has been variable over the years. In 2018, the number of females spawned and eggs collected decreased greatly from the previous year (Figure 18). The 2018 egg-take effort for Montana resulted in 110,979 green eggs from 28 females. Fecundity of female salmon was 3,963 eggs per female in 2018 which was similar to 3,995 eggs per female in 2017. The high fecundity can be attributed to a larger, older age group (age-4) captured during both years. In addition, egg size was larger than compared to previous years which likely led to better hatching success and eye-up at the Fort Peck Hatchery (Wade Geraets, personal communication).

Fisheries personnel relied exclusively on electrofishing to obtain brood stock for the annual chinook salmon egg-take in 2018. 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 October 2$^{th}$ to October 24$^{th}$, 2018 in various embayments adjacent to the marina, spillway, Duck Creek and the dam area.

Biological data was collected from adult chinook salmon during spawning to provide more information on age, growth, and stocking-and-rearing history. In 2017, 99% of females spawned were 4-year old due to a strong age class present (Table 12). In contrast, 41% of females spawned in 2018 were 4-year old. It should be noted that a high number of younger, mature male salmon were observed and captured in 2018 when compared to the previous year suggesting a strong year class present. Age-2 male salmon comprised 96% of all males captured during the 2018 egg collection efforts. The earlier maturity observed for males in 2018 could be attributed to improved growing conditions (i.e., increases in 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.

In general, mean weights increased for both male and female chinook salmon spawned in 2018. When examining mean weight at each age, age-4 male and female salmon collected in 2018 were slightly larger than those collected in 2017 (Table 12; Table 13). Four-year old females averaged 17.2 pounds in 2017 compared to 16.4 pounds in 2016. The higher relative abundance of cisco beginning in 2013 and continuing into 2018 has contributed to increased weights at age-2 males as well as the improved numbers observed. 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, 2008-2018.

| Date | Number | Pounds Stocked | No./lb | Mark | Location |
|---|---|---|---|---|---|
| 6/4/2012 | 55,366 | 1,700 | 32.6 | None | Duck Creek |
| 6/4/2012 | 50,203 | 1,512 | 33.2 | None | Bear Creek |
| 6/5/2012 | 75,750 | 2,320 | 32.6 | None | Marina Bay |
| 6/6/2013 | 11,247 | 530 | 21.2 | Adipose Clip | Marina Bay |
| 6/6/2013 | 15,915 | 750 | 21.2 | Adipose Clip | Milk Coulee Bay |
| 6/10/2013 | 33,772 | 1,018 | 34 | None | Duck Creek |
| 6/10/2013 | 59,870 | 1,878 | 33.4 | None | Marina Bay |
| 6/10/2013 | 30,892 | 987 | 32.1 | None | Milk Coulee Bay |
| 6/2/2014 | 32,173 | 663 | 35.2 | None | Marina |
| 6/2/2014 | 32,137 | 915 | 35.1 | None | Milk Coulee Bay |
| 6/2/2014 | 25,040 | 714 | 35.1 | None | Duck Creek |
| 6/3/2014 | 31,123 | 1,350 | 23 | Adipose Clip | Marina Bay |
| 6/3/2014 | 15,213 | 660 | 21.2 | Adipose Clip | Milk Coulee Bay |
| 6/9/2014 | 42,868 | 1,261 | 34 | None | Marina |
| 6/9/2014 | 17,084 | 502 | 34 | None | Milk Coulee Bay |
| 6/9/2014 | 35,202 | 1,034 | 34 | None | Duck Creek |
| 6/8/2015 | 27,224 | 1,131 | 24.1 | None | Milk Coulee Bay |
| 6/8/2015 | 27,310 | 1,134 | 24.1 | None | Marina |
| 6/6/2016 | 25,357 | 1,018 | 24.9 | None | Milk Coulee Bay |
| 6/6/2016 | 31,307 | 1,257 | 24.9 | None | Marina |
| 5/23/2017 | 41,916 | 1,062 | 38.9 | None | Duck Creek |
| 5/23/2017 | 29,732 | 806 | 38.1 | None | Marina Bay |
| 5/23/2017 | 38,989 | 1,037 | 38.9 | None | Milk Coulee Bay |
| 5/30/2017 | 25,111 | 728 | 34.5 | None | Duck Creek |
| 5/30/2017 | 20,663 | 599 | 34.5 | None | Marina Bay |
| 5/30/2017 | 7,015 | 203 | 34.5 | None | Milk Coulee Bay |
| 5/31/2017 | 50,412 | 1,387 | 36.6 | None | Duck Creek |
| 5/31/2017 | 12,980 | 352 | 36.7 | None | Marina Bay |
| 5/31/2017 | 23,011 | 607 | 37.9 | None | Milk Coulee Bay |
| 5/31/2017 | 19,384 | 715 | 27.1 | Adipose Clip | Marina Bay |
| 6/1/2017 | 11,703 | 297 | 39.3 | None | Duck Creek |
| 6/1/2017 | 21,795 | 571 | 38.2 | None | Marina Bay |
| 6/1/2017 | 23,295 | 601 | 38.7 | None | Milk Coulee Bay |
| 6/1/2017 | 19,380 | 750 | 25.8 | Adipose Clip | Marina Bay |
| 5/25/2018 | 57,925 | 1,881 | 30.8 | Adipose | 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 | 45.0 | None | Pines Bay |
| 6/11/2018 | 14,911 | 332 | 45.0 | None | Rock Creek |
| 6/11/2018 | 21,063 | 468 | 45.0 | None | Duck Creek |
| 6/12/2018 | 28,659 | 552 | 52.0 | None | Pines Bay |

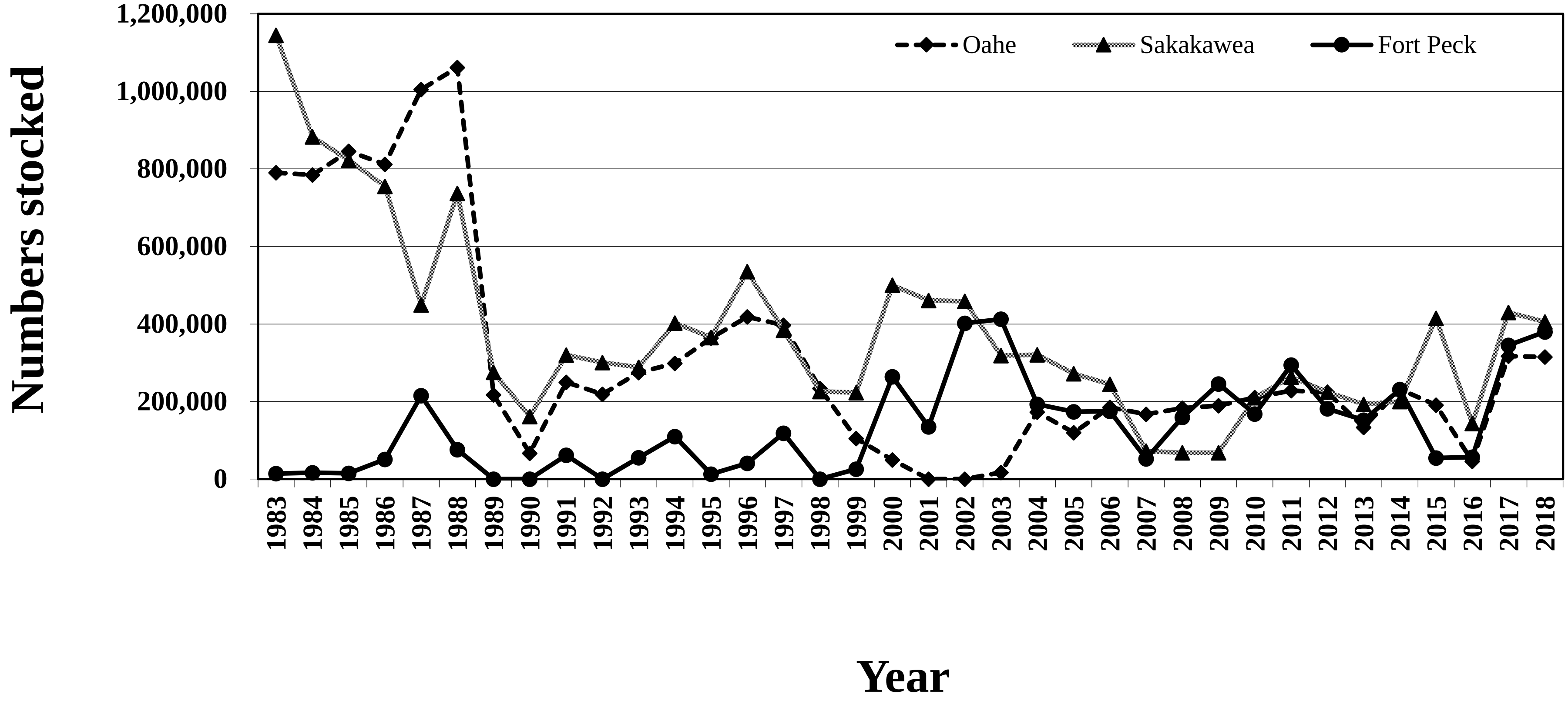



Figure 16. Annual comparison of total chinook salmon numbers stocked in Oahe, Sakakawea, and Fort Peck Reservoir, 1983-2018**.**

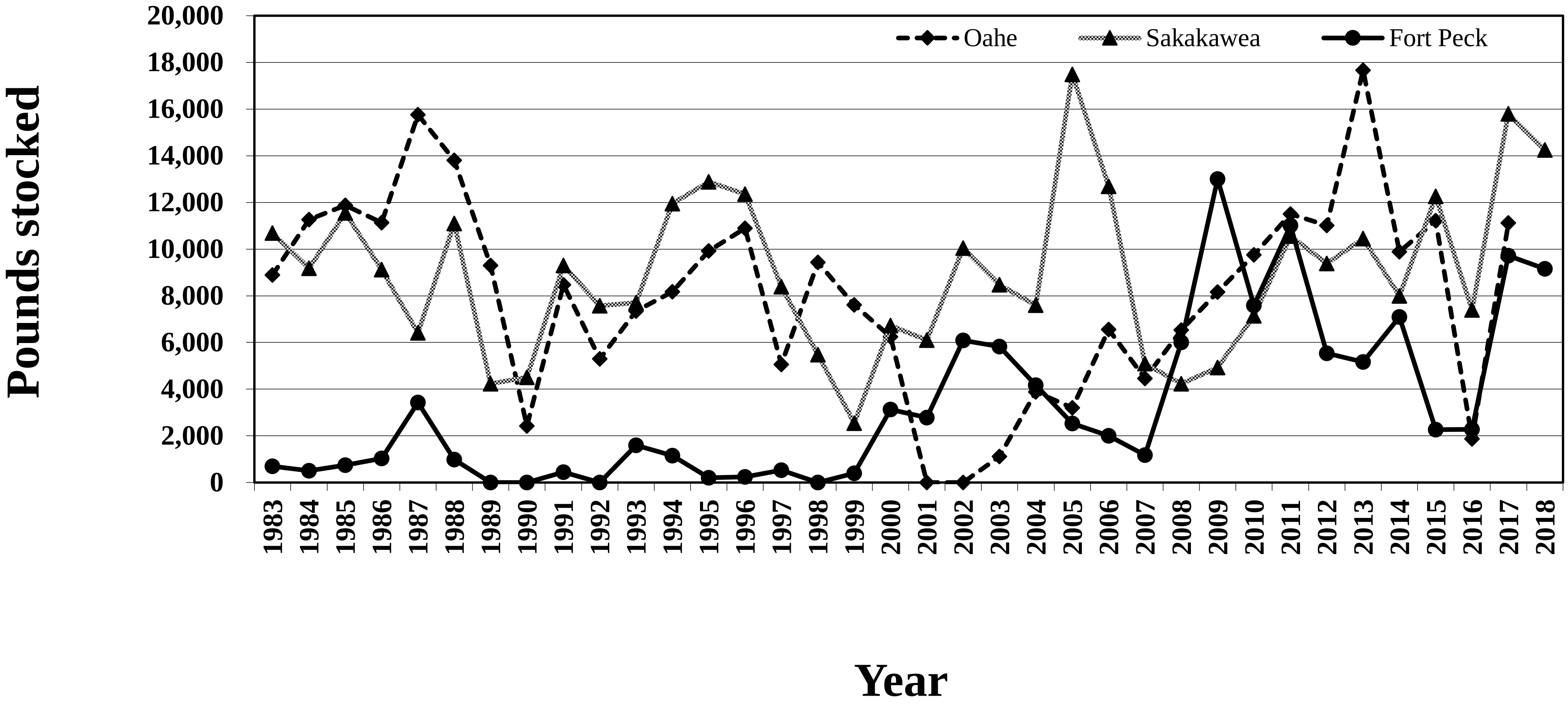



Figure 17. Annual comparison of total chinook salmon pounds stocked in Oahe, Sakakawea, and Fort Peck Reservoir, 1983-2018.

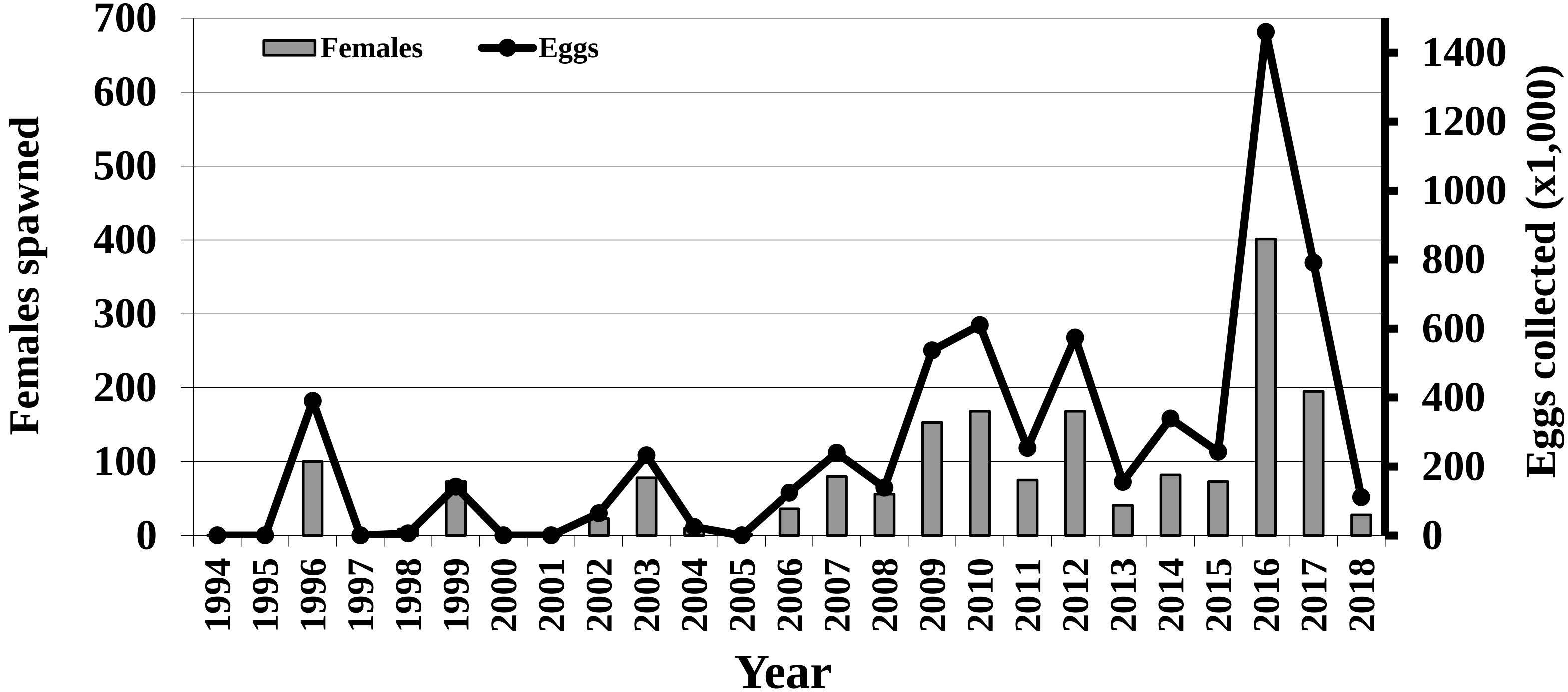



Figure 18. Annual comparison of female chinook salmon spawned and eggs collected from Fort Peck Reservoir, 1994-2018.

Table 12. Age composition, length and weight of 318 chinook salmon collected by electrofishing, fall 2017.

| Age | Sex | Brood year | Number | Mean length (in) | Range | Mean weight (lb) | Range |
|---|---|---|---|---|---|---|---|
| 1 | Male | 2016 | 0 | -- | -- | -- | -- |
| | Female | | 0 | -- | -- | -- | -- |
| 2 | Male | 2015 | 2 | 23.1 | 22.7-23.6 | 6.5 | 5.6-7.4 |
| | Female | | 0 | -- | -- | -- | -- |
| 3 | Male | 2014 | 18 | 27.4 | 23.2-30.5 | 9.2 | 6.2-11.9 |
| | Female | | 1 | 27.9 | -- | 10.5 | -- |
| 4 | Male | 2013 | 77 | 33.2 | 25.3-38.8 | 15.2 | 6.2-26.2 |
| | Female | | 220 | 32.8 | 26.2-37.8 | 16.4 | 4.2-26.7 |
| 5 | Male | 2012 | 0 | -- | -- | -- | -- |
| | Female | | 0 | -- | -- | -- | -- |

Table 13. Age composition, length and weight of 155 chinook salmon collected by electrofishing, fall 2018.

| Age | Sex | Brood year | Number | Mean length (in) | Range | Mean weight (lb) | Range |
|---|---|---|---|---|---|---|---|
| 1 | Male | 2017 | 0 | -- | -- | -- | -- |
| | Female | | 0 | -- | -- | -- | -- |
| 2 | Male | 2016 | 121 | 23.6 | 19.7-26.8 | 5.9 | 3.0-9.9 |
| | Female | | 0 | -- | -- | -- | -- |
| 3 | Male | 2015 | 0 | -- | -- | -- | -- |
| | Female | | 15 | 29.5 | 27.9-33.9 | 12.7 | 9.1-17.4 |
| 4 | Male | 2014 | 5 | 36.3 | 34.6-37.5 | 20.2 | 18.4-23.0 |
| | Female | | 12 | 33.5 | 30.3-35.3 | 17.2 | 14.8-22.8 |
| 5 | Male | 2013 | 0 | -- | -- | -- | -- |
| | Female | | 2 | 32.2 | 31.2-33.1 | 14.8 | 14.1-15.5 |

## Cisco Vertical Gill Netting

### Young-of-year cisco

Relative abundance of young-of-year cisco in Fort Peck Reservoir decreased slightly to 99 per net-night in 2018; down from 120 per net-night in 2017. However, this was above the long-term average of 78 per net-night from 1988 to 2018. 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 (Dave Yerk, personal communication; 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 13$^{th}$, 1985 and December 21$^{st}$, 2000 resulting in two of the largest year classes ever produced. Ice cover occurred on December 31$^{st}$, 2017 and receded on April 23$^{rd}$, 2018 resulting in a moderately high year class.

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 0.1 feet during the 2017-2018 winter months. It is possible that the combination of ice cover and stable reservoir elevations influenced the moderate to high relative abundance of young-of-year cisco in 2018.

### Adult cisco

Additional mesh sizes (¾, 1, 1 ¼, 1 ½-in) were incorporated in 2013 vertical gill netting efforts in an attempt 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 (Dave Yerk, personal communication). The large year classes of cisco produced in 2013 and 2014, which were observed in the ½-in mesh, appear to have 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). In addition, a slight increase in relative abundance was observed in the 1-in mesh during 2017 and 2018. When examining length frequencies from 2015-2018, 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 mm to 190 mm (Figure 21). Length frequency distribution in 2018 suggest multiple year classes with some larger fish present out to 300 mm.

Mean length for cisco captured by vertical gill nets in Fort Peck Reservoir during 2018 was 5.1, 7.7, 9.7, and 9.4 inches for ¾, 1, 1 ¼-in mesh, respectively. No cisco were captured in 1 ½-in mesh during 2018. Overall, relative weight of cisco captured in 2018 was 70 which has been similar over the last several years during this sampling period. The high abundance of adult cisco and low relative weights would suggest intraspecific competition. Rook et al. (2013) observed similar trends with cisco in Lake Superior and also 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).

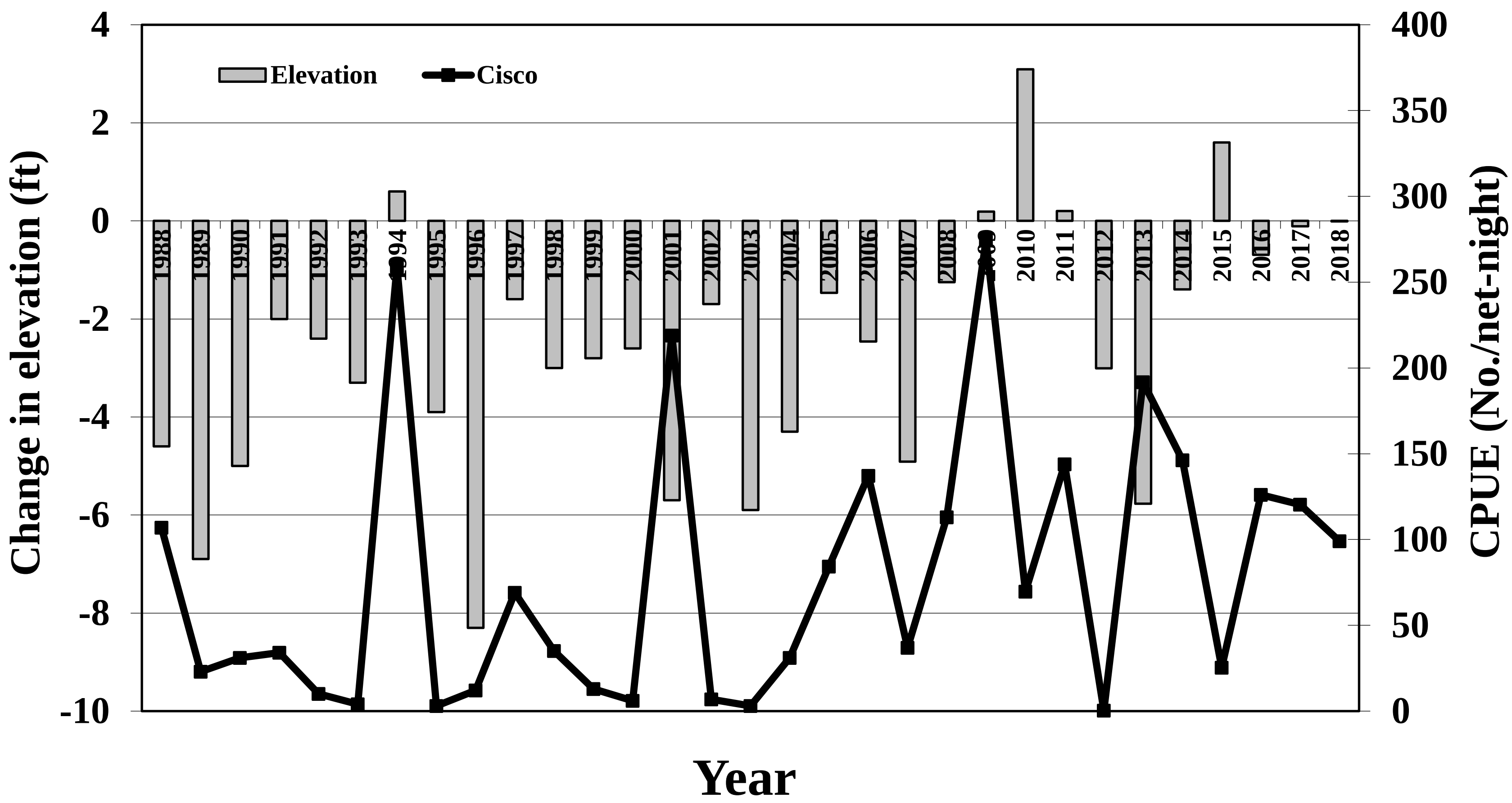



Figure 19. Change in reservoir elevation from December high to March low in contrast to mean CPUE (No./net-night) of young-of-year cisco collected in vertical gill nets on Fort Peck Reservoir, 1988-2018.

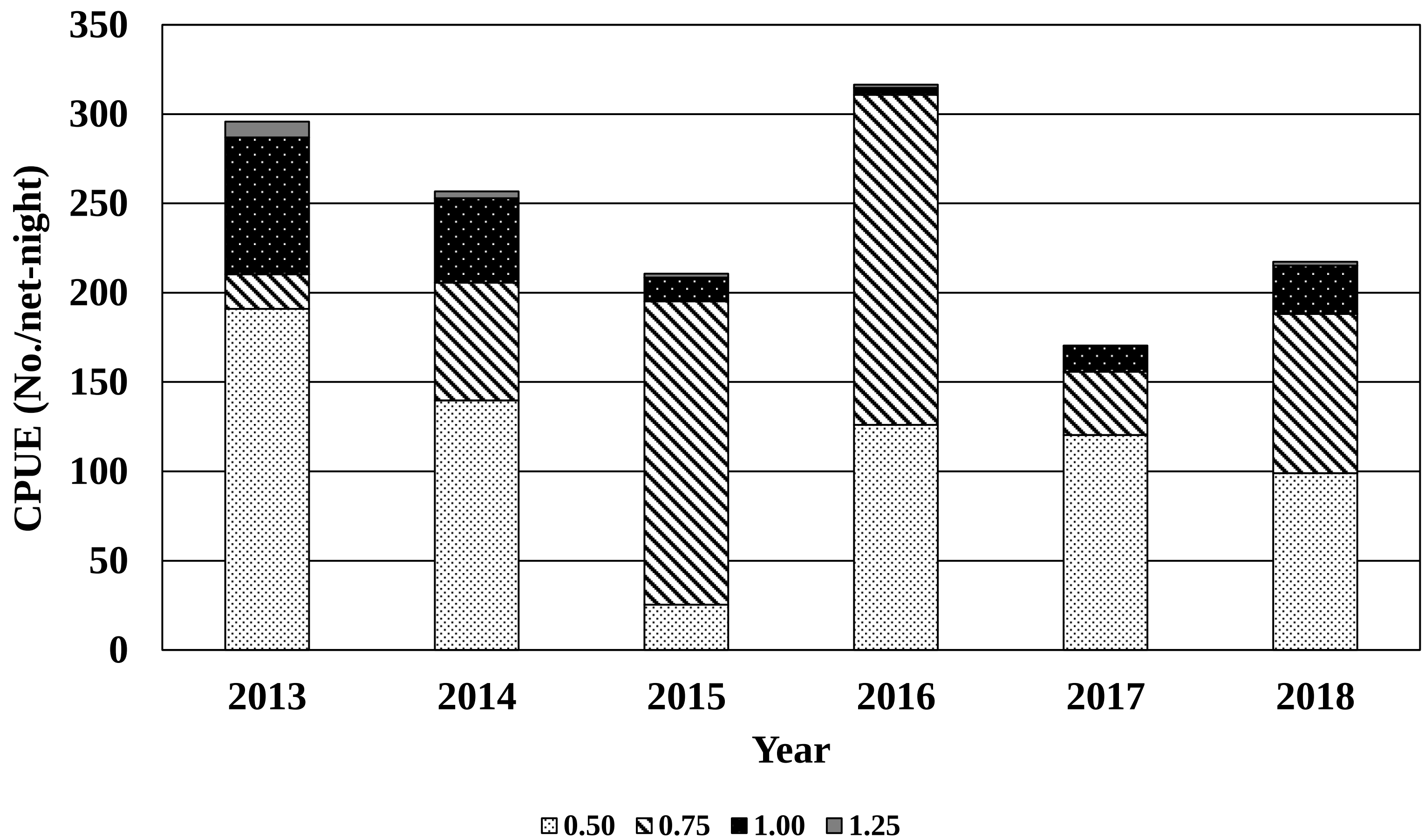



Figure 20.  Mean CPUE (No./net-night) of cisco by mesh size collected in vertical gill nets on Fort Peck Reservoir, 2013-2018.

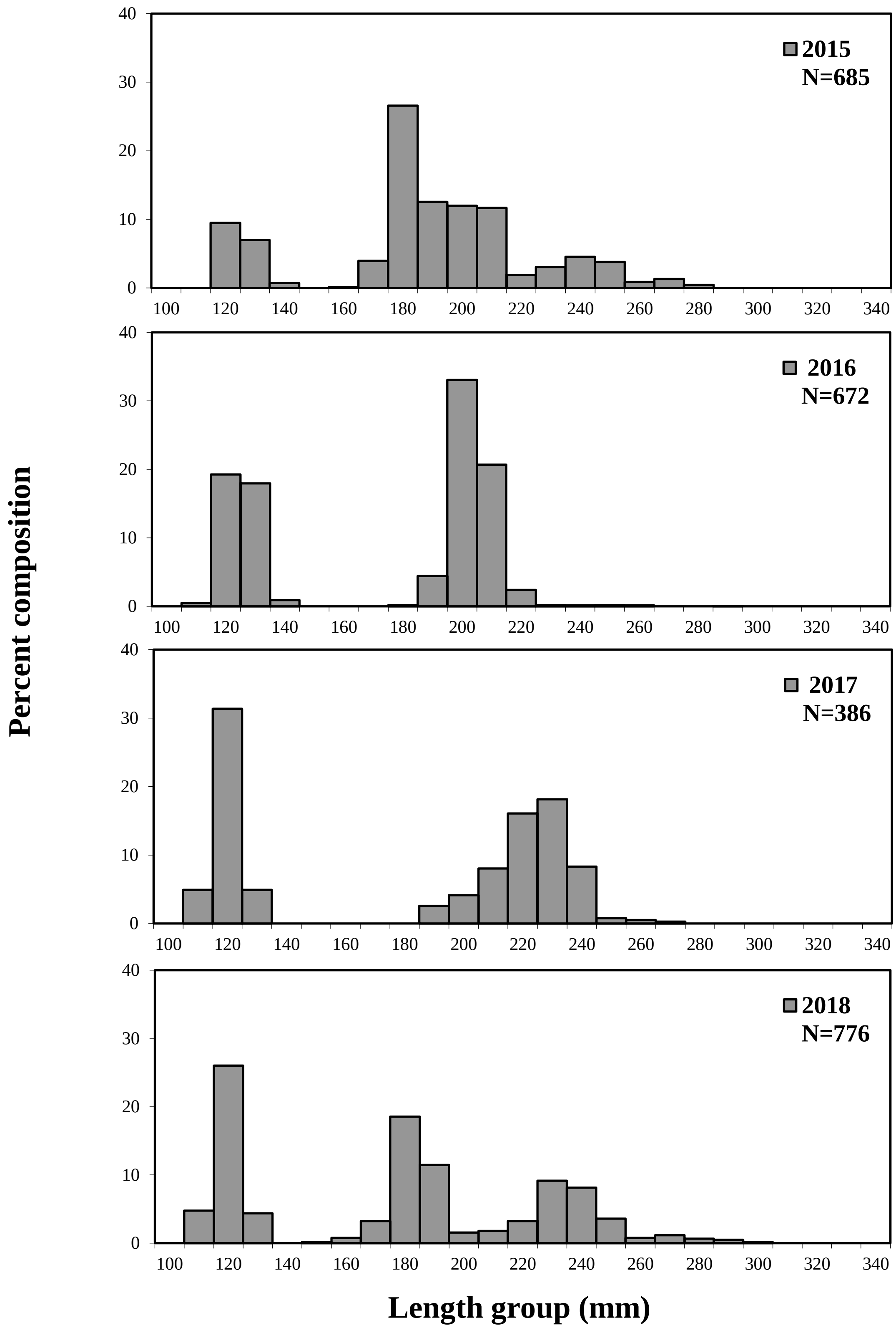



Figure 21. Length frequency of subsampled cisco collected by vertical gill nets in Fort Peck Reservoir during September, 2015-2018.

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.

LITERATURE CITED


Anderson, R. O. and A. S. Weithman. 1978. The concept of balance for coolwater fish populations. Pages 371-378 in R. L. Kendall, editor. Selected coolwater fishes of North America. American Fisheries Society, Bethesda, Maryland.

Anderson, R. O. 1980. Proportional stock density (PSD) and relative weight (*Wr*): interpretive indices for fish populations and communities. Pages 27-33 *in* S. Gloss and B. Shupp, editors. Practical fisheries management: more with less in the 1980's. New York Chapter American Fisheries Society, Ithaca.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison.

Bellgraph, B. J., C. S. Guy, W. M. Gardner, and S. A. Leathe. 2008. Competition potential between saugers and walleyes in nonnative sympatry. Transactions of the American Fisheries Society 137:790-800.

Billington, N., R.N. Koigi, and J. Xiong. 2005. Genetic variation and hybridization with walleye in Montana sauger populations determined by protein electrophoresis. Report of Troy State University to Montana Department of Fish, Wildlife and Parks, Helena.

Bowen, S. H. 1996. Quantitative description of the diet. Pages 513-522 *in* B. R Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Brown, M. L., F. Jaramillo, J., D. M. Gatlin, III, and B. R. Murphy. 1995. A revised standard weight (*Ws*) equation for channel catfish. Journal of Freshwater Ecology 10:295-302.

Brunsing, M. 1998. Fort Peck Reservoir study, Montana Department of Fish, Wildlife & Parks, Fisheries Division, Annual report, Helena.

Derback, B. 1947. The adverse effect of cold weather upon the successful reproduction of pickerel, *Stizostedion vitreum vitreum*, in Heming Lake, Manitoba in 1947. Canadian Fish Culturist 2:22-23.

Engel, S. 1995. Eurasian Watermilfoil as a fishery management tool. Fisheries 20:20-27.

Erickson, C. M. 1983. Age determination of Manitoban walleyes using otoliths, dorsal spines, and scales. North American Journal of Fisheries Management 3:176-181

Fielder, D. G. 1992. Evaluation of stocking walleye fry and fingerlings and factors affecting their success in lower Lake Oahe, South Dakota. North American Journal of Fisheries Management 12:336-345.

Freeberg, M. H., W. W. Taylor, and R. W. Brown. 1990. Effect of egg and larval survival on year-class strength of lake whitefish in Grand Traverse Bay, Lake Michigan. Transactions of the American Fisheries Society 119: 92-100.

Gablehouse, D. W., Jr., 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Gaboury, M. N. and J. W. Patalas. 1984. Influence of water level drawdown on the fish populations in Cross Lake, Manitoba. Canadian Journal of Fisheries and Aquatic Sciences. 41:118-125.

Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional size distribution (PSD): A further refinement of size structure index terminology. Fisheries 32:348.

Headley, H. C. 2007. Statewide fisheries investigations, Fort Peck Reservoir Study. Montana Fish Wildlife and Parks, Fisheries Division, Annual report, Helena.

Headley, H. C. 2010. Statewide fisheries investigations, Fort Peck Reservoir Study. Montana Fish Wildlife and Parks, Fisheries Division, Annual report, Helena.

Headley, H.C., S. Dalbey, and D. Skaar. 2012. Fort Peck Reservoir Fisheries Management Plan 2012-2022. Montana Fish Wildlife and Parks, Fisheries Division.

Isermann, D. A., J. R. Meerbeek, G. D. Scholten, and D. W. Willis. 2003. Evaluation of three different structures used for walleye age estimation with emphasis on removal and processing times. North American Journal of Fisheries Management 23:625-631.

Kerr, S. J. 2011. Stocking and marking: Lessons learned over the past century. Pages 423-449 *in* B. A. Barton, editor. Biology, management, and culture of walleye and sauger. American Fisheries Society, Bethesda, Maryland.

Leathe, S. A. and P. J. Graham. 1982. Flathead Lake fish food habits study-Final report. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana. 137p.

Liebelt, J. 1979. Establishment of Aquatic Baselines in Large Inland Impoundments. National Marine Fisheries Service, U.S. Dept. of Commerce, NOAA.

Lott, J., G. Marrone, D. Stout. 1997. Influences of size-and-date at stocking, imprinting attempts and growth on initial survival, homing ability, maturation patterns and angler harvest of Chinook salmon in Lake Oahe, SD. South Dakota Department of Game, Fish and Parks, Wildlife Division, Report 97-20, Pierre.

Martin, D. B., L. J. Mengel, J. F. Novotny, and C. H. Walburg. 1981. Spring and summer water levels in a Missouri River Reservoir: Effects on age-0 fish and zooplankton. Transactions of the American Fisheries Society 110:370-381.

McMahon, T. E., and W. M. Gardner. 2001. Status of sauger in Montana. Intermountain Journal of Sciences 7:1-21.

Mullins, M. S. 1991. Biology and predator use of cisco (*Coregonus artedi*) in Fort Peck Reservoir, Montana. Master's thesis. Montana State University, Bozeman.

Murphy, B. R., M. L. Brown, and T. A. Springer. 1990. Evaluation of the relative weight (*W*r) index, with new applications to walleye. North American Journal of Fisheries Management, 10:85-97.

Nelson, W. R., and C. H. Walburg. 1977. Population dynamics of yellow perch (*Perca flavescens*), sauger (*Stizostedion canadense*), and walleye (*Stizostedion vitreum*) in four main stem Missouri River reservoirs. Journal of the Fisheries Research board of Canada 34:1748-1763.

Nielsen, L. A., D. L. Johnson, and S. S. Lampton. 1989. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Paragamian, V. L., and R. Kingery. 1992. A comparison of walleye fry and fingerling stockings in three rivers in Iowa. North American Journal of Fisheries Management 12:313-320.

Pratt, T. C., and K. E. Smokorowski. 2003. Fish habitat management implications of the summer habitat use by littoral fishes in a north temperate, mesotrophic lake. Canadian Journal of Fisheries and Aquatic Sciences 60:286-300.

Rook, B. J., M. J. Hansen, and O. T. Gorman. 2013. Biotic and abiotic factors influencing cisco recruitment dynamics in Lake Superior during 1978-2007. North American Journal of Fisheries Management 33:1243-1257.

Rudstrum, L. G., R. C. Lathrop, and S. R. Carpenter. 1993. The rise and fall of dominant planktivore: direct and indirect effects on zooplankton. Ecology 74:303-319.

Ruggles, M. P. 2005. Statewide fisheries investigations, Fort Peck Reservoir Study. Montana Fish, Wildlife and Parks, Fisheries Division, Annual report, Helena.

Secor, D. H., J. M. Dean, and E. L. Laban. 1992. Otolith removal and preparation for microstructural examination. Pages 19-57 *in* D. K. Stevenson, and S. E. Campana, editors. Otolith microsturucre examination and analysis. Canadian Special Publication of Fisheries and Aquatic Sciences No. 117.

Sellers, T. J., B. R. Parker, D. W. Schindler, and W. M. Tonn. 1998. Pelagic distribution of lake trout in small Canadian Shield lakes with respect to temperature, dissolved oxygen, and light. Canadian Journal of Fisheries and Aquatic Sciences 55:170-179.

Scott, W. B., and E. J. Crossman. 1973. The freshwater fishes of Canada. Fisheries Research Board of Canada, Ottawa.

United States Army Corp of Engineers. 2009. Water Quality Modeling Report. Application of the CE-QUAL-W2 hydrodynamic and water quality model to Fort Peck Reservoir, Montana. Omaha, Nebraska.

United States Army Corp of Engineers, Omaha District. 2015. Missouri River Mainstem System 2015-2016 Annual Operating Plan.

Unmuth, J. M. L., M. J. Hansen, and T. D. Pellet. 1999. Effects of mechanical harvesting Eurasian watermilfoil on largemouth bass and bluegill population in Fish Lake, Wisconsin. North American Journal of Fisheries Management 19:1089-1098.

Vokoun, J. C., C. F. Rabeni, and J. S. Stanovick. 2001. Sample-size requirements for evaluating population size structure. North American Journal of Fisheries Management 21:660-665.

Wiedenheft, W. 1985. Development and management of commercial fishing practices in Fort Peck Reservoir. National Marine Fisheries Service, U.S. Department of Commerce, NOAA.

Willis, D. W. 1989. Proposed standard length-weight equation for northern pike. North American Journal of Fisheries Management 9: 203-208.

Zollweg, C. E., and S. Leathe. 2000. Tiber Cisco Spawning Study. Montana Fish, Wildlife and Parks, Fisheries Division, Project report, Helena.

Prepared by: Heath Headley
Date: March 8th, 2019

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 2017 by date, region, location, and size.

| Date | Location | Region | Fingerling | Hatchery |
|---|---|---|---|---|
| 6/19/2018 | Spring Creek | LBD | 21,035 | Fort Peck |
| 6/19/2018 | Bobcat | LBD | 21,226 | Fort Peck |
| 7/2/2018 | Box Elder Bay | LBD | 52,741 | Fort Peck |
| 7/6/2018 | Sand Arroyo | LBD | 34,056 | Fort Peck |
| 6/20/2018 | Third Coulee | LMA | 14,720 | Fort Peck |
| 6/21/2018 | Sage Creek | LMA | 18,629 | Fort Peck |
| 6/21/2018 | Penick Coulee | LMA | 32,359 | Fort Peck |
| 6/22/2018 | Skunk Coulee | LMA | 15,233 | Fort Peck |
| 6/25/2018 | Youth Camp | LMA | 31,218 | Fort Peck |
| 6/25/2018 | Mid Duck Coulee | LMA | 22,523 | Fort Peck |
| 6/26/2018 | Main Duck | LMA | 24,544 | Fort Peck |
| 6/27/2018 | Haxby | LMA | 18,138 | Fort Peck |
| 6/28/2018 | Cut Coulee | LMA | 10,193 | Fort Peck |
| 7/9/2018 | South Fork Duck Creek | LMA | 12,931 | Fort Peck |
| 7/10/2018 | Sturgeon Bay | LMA | 22,853 | Fort Peck |
| 7/10/2018 | Catfish Bay | LMA | 17,256 | Fort Peck |
| 6/18/2018 | Hell Creek Ramp | MMA | 162,236 | Miles City |
| 6/20/2018 | Sutherland | MMA | 85,593 | Miles City |
| 6/27/2018 | Hell Creek Ramp | MMA | 73,045 | Miles City |
| 6/29/2018 | Gilbert Creek | MMA | 40,494 | Fort Peck |
| 6/29/2018 | Pines Ramp | MMA | 40,494 | Fort Peck |
| 7/3/2018 | Seventh Coulee | MMA | 30,545 | Fort Peck |
| 7/9/2018 | Hell Creek Ramp | MMA | 5,344 | Miles City |
| 7/16/2018 | Hell Creek Ramp | MMA | 3,860 | Miles City |
| Total | | | 811,266 | |

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

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, 2018.

| 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 | 13.7 | 9.2 | 8.2 | 2.5 | 0.387 | | 0 | 17.8 | 8.0 | 8.1 | 6.4 | 0.427 |
| 10 | 13.4 | 9.3 | 8.2 | 2.5 | 0.387 | | 10 | 17.1 | 8.0 | 8.1 | 6.4 | 0.426 |
| 20 | 6.6 | 10.8 | 8.1 | 1.9 | 0.403 | | 20 | 17.0 | 8.0 | 8.1 | 6.9 | 0.426 |
| 30 | 4.6 | 10.8 | 8.1 | 1.5 | 0.417 | | 30 | 16.6 | 8.1 | 8.1 | 7.2 | 0.426 |
| 40 | 3.3 | 10.7 | 8.0 | 1.6 | 0.442 | | 40 | 16.3 | 8.2 | 8.1 | 6.1 | 0.427 |
| 50 | 3.0 | 10.6 | 8.0 | 1.4 | 0.451 | | 50 | 15.1 | 8.3 | 8.1 | 7.0 | 0.427 |
| 60 | 2.9 | 10.6 | 8.0 | 1.4 | 0.452 | | 60 | 13.8 | 8.2 | 8.0 | 7.2 | 0.426 |
| | | | | | | | 70 | 10.5 | 8.4 | 7.9 | 5.1 | 0.428 |
| | | | | | | | | | | | | |
| | | **July** | | | | | | | **August** | | | |
| 0 | 24.1 | 7.4 | 8.2 | 1.5 | 0.442 | | 0 | 24.2 | 7.6 | 8.4 | 2.7 | 0.447 |
| 10 | 23.1 | 7.5 | 8.2 | 1.3 | 0.441 | | 10 | 23.4 | 7.7 | 8.4 | 2.9 | 0.446 |
| 20 | 22.7 | 7.5 | 8.2 | 1.5 | 0.440 | | 20 | 23.1 | 7.6 | 8.4 | 3.5 | 0.446 |
| 30 | 20.8 | 7.0 | 8.1 | 2.1 | 0.441 | | 30 | 22.4 | 7.1 | 8.4 | 3.5 | 0.446 |
| 40 | 13.0 | 7.4 | 7.9 | 2.2 | 0.441 | | 40 | 21.7 | 6.4 | 8.3 | 4.4 | 0.446 |
| 50 | 11.7 | 7.6 | 7.8 | 2.5 | 0.440 | | 50 | 16.6 | 5.2 | 7.9 | 5.8 | 0.445 |
| 60 | 10.0 | 7.9 | 7.9 | 2.2 | 0.443 | | 60 | 14.4 | 5.5 | 7.9 | 6.7 | 0.444 |
| 70 | 9.4 | 8.0 | 7.9 | 1.6 | 0.443 | | 70 | 10.9 | 6.4 | 7.9 | 5.8 | 0.446 |
| | | | | | | | | | | | | |
| | | **September** | | | | | | | | | | |
| 0 | 16.4 | 7.8 | 8.5 | 14.7 | 0.446 | | | | | | | |
| 10 | 16.4 | 7.8 | 8.5 | 14.5 | 0.446 | | | | | | | |
| 20 | 16.4 | 7.8 | 8.5 | 14.7 | 0.446 | | | | | | | |
| 30 | 16.5 | 7.8 | 8.6 | 15.0 | 0.446 | | | | | | | |
| 40 | 16.1 | 7.6 | 8.5 | 15.2 | 0.447 | | | | | | | |
| 50 | 14.4 | 6.5 | 8.3 | 20.8 | 0.449 | | | | | | | |
| 60 | 11.4 | 5.3 | 8.0 | 21.3 | 0.450 | | | | | | | |

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, 2018.

| 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 | 10.9 | 10.0 | 8.1 | 2.1 | 0.400 | | 0 | 18.2 | 9.2 | 8.2 | 5.1 | 0.435 |
| 10 | 9.8 | 10.2 | 8.1 | 2.1 | 0.395 | | 10 | 16.6 | 8.4 | 8.2 | 5.7 | 0.438 |
| 20 | 7.4 | 10.8 | 8.1 | 2.1 | 0.402 | | 20 | 16.2 | 8.4 | 8.2 | 6.2 | 0.437 |
| 30 | 6.1 | 10.8 | 8.1 | 2 | 0.405 | | 30 | 16.1 | 8.3 | 8.2 | 6.2 | 0.436 |
| 40 | 5.4 | 10.8 | 8.1 | 1.9 | 0.411 | | 40 | 15.9 | 8.3 | 8.2 | 6.5 | 0.435 |
| 50 | 5.1 | 10.8 | 8.1 | 2.1 | 0.413 | | 50 | 15.7 | 8.3 | 8.2 | 6.5 | 0.433 |
| 60 | 4.3 | 10.7 | 8.0 | 1.9 | 0.416 | | 60 | 15.2 | 8.4 | 8.1 | 7.2 | 0.431 |
| 70 | 3.7 | 10.6 | 8.0 | 1.7 | 0.438 | | 70 | 14.1 | 8.5 | 8.1 | 7.6 | 0.429 |
| 80 | 2.6 | 10.4 | 7.9 | 1.2 | 0.464 | | 80 | 10.8 | 9.0 | 8.0 | 4.4 | 0.430 |
| 90 | 2.5 | 10.3 | 7.9 | 1.4 | 0.466 | | 90 | 8.7 | 9.3 | 8.0 | 4.0 | 0.434 |
| 100 | 2.4 | 9.8 | 7.9 | 1 | 0.476 | | 100 | 6.9 | 9.5 | 8.0 | 3.4 | 0.441 |
| | | | | | | | | | | | | |
| | | **July** | | | | | | | **August** | | | |
| 0 | 23.3 | 7.6 | 8.3 | 2.3 | 0.443 | | 0 | 23.7 | 7.8 | 8.5 | 3.4 | 0.446 |
| 10 | 22.6 | 7.6 | 8.3 | 2.6 | 0.442 | | 10 | 23.2 | 7.8 | 8.5 | 3.1 | 0.446 |
| 20 | 21.8 | 7.7 | 8.3 | 2.2 | 0.442 | | 20 | 22.8 | 7.8 | 47.0 | 3.6 | 0.445 |
| 30 | 21.2 | 7.3 | 8.2 | 3.2 | 0.442 | | 30 | 22.7 | 7.8 | 8.5 | 4.0 | 0.445 |
| 40 | 18.2 | 7.0 | 8.1 | 2.8 | 0.440 | | 40 | 22.0 | 6.9 | 8.4 | 5.6 | 0.444 |
| 50 | 13.3 | 7.5 | 8.0 | 2.4 | 0.439 | | 50 | 16.8 | 5.7 | 8.0 | 6.6 | 0.442 |
| 60 | 9.8 | 8.0 | 7.9 | 2.2 | 0.443 | | 60 | 11.3 | 6.7 | 8.0 | 5.7 | 0.445 |
| 70 | 8.4 | 8.2 | 7.9 | 2.3 | 0.445 | | 70 | 9.6 | 7.1 | 8.0 | 4.0 | 0.445 |
| 80 | 7.9 | 8.3 | 7.8 | 2.3 | 0.446 | | 80 | 9.0 | 7.4 | 8.0 | 3.8 | 0.445 |
| 90 | 7.9 | 8.3 | 7.8 | 2.2 | 0.447 | | 90 | 8.3 | 7.5 | 7.9 | 2.9 | 0.447 |
| 100 | 7.3 | 8.4 | 7.8 | 2.4 | 0.448 | | 100 | 8.1 | 7.5 | 7.9 | 4.9 | 0.448 |
| | | | | | | | | | | | | |
| | | **September** | | | | | | | | | | |
| 0 | 16.2 | 7.8 | 8.5 | 12.2 | 0.442 | | | | | | | |
| 10 | 16.2 | 7.8 | 8.5 | 12.6 | 0.441 | | | | | | | |
| 20 | 16.2 | 7.8 | 8.5 | 12.4 | 0.442 | | | | | | | |
| 30 | 16.2 | 7.7 | 8.5 | 13 | 0.442 | | | | | | | |
| 40 | 14.2 | 6.0 | 8.2 | 13.2 | 0.445 | | | | | | | |
| 50 | 11.4 | 5.5 | 8.0 | 13.2 | 0.446 | | | | | | | |
| 60 | 10.6 | 5.8 | 8.0 | 13.1 | 0.448 | | | | | | | |
| 70 | 10.1 | 5.9 | 8.0 | 13.4 | 0.450 | | | | | | | |
| 80 | 9.7 | 6.0 | 8.0 | 13.5 | 0.449 | | | | | | | |
| 90 | 9.3 | 6.0 | 8.0 | 16.3 | 0.449 | | | | | | | |
| 100 | 9.0 | 6.1 | 8.0 | 15.6 | 0.450 | | | | | | | |

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, 2018.

| 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 | 11.8 | 10.1 | 7.9 | 2.2 | 0.412 | 0 | 17.9 | 8.5 | 8.2 | 3.7 | 0.442 |
| 10 | 7.9 | 10.9 | 8.2 | 1.5 | 0.416 | 10 | 16.3 | 8.5 | 8.3 | 5.1 | 0.440 |
| 20 | 5.6 | 11.2 | 8.1 | 1.0 | 0.419 | 20 | 16.0 | 8.4 | 8.2 | 5.5 | 0.440 |
| 30 | 5.3 | 11.1 | 8.1 | 1.1 | 0.425 | 30 | 15.8 | 8.4 | 8.2 | 5.4 | 0.439 |
| 40 | 4.3 | 11.1 | 8.1 | 0.5 | 0.433 | 40 | 15.8 | 8.4 | 8.2 | 5.7 | 0.438 |
| 50 | 4.2 | 10.9 | 8.0 | 1.0 | 0.439 | 50 | 15.6 | 8.4 | 8.2 | 5.7 | 0.439 |
| 60 | 3.9 | 10.7 | 8.0 | 0.9 | 0.443 | 60 | 15.2 | 8.4 | 8.2 | 5.5 | 0.440 |
| 70 | 3.5 | 10.7 | 8.0 | 1.0 | 0.445 | 70 | 13.4 | 8.6 | 8.1 | 5.7 | 0.439 |
| 80 | 3.5 | 10.7 | 8.0 | 1.2 | 0.445 | 80 | 7.6 | 9.6 | 8.0 | 4.9 | 0.442 |
| 90 | 3.4 | 10.6 | 8.0 | 0.8 | 0.448 | 90 | 7.1 | 9.6 | 7.9 | 3.2 | 0.443 |
| 100 | 3.3 | 10.5 | 8.0 | 1.0 | 0.450 | 100 | 5.7 | 9.6 | 7.9 | 3.3 | 0.448 |
| 110 | 3.1 | 10.1 | 7.9 | 1.3 | 0.455 | 110 | 5.6 | 9.6 | 7.9 | 2.3 | 0.449 |
| 120 | 2.9 | 9.7 | 7.9 | 1.2 | 0.463 | 120 | 5.4 | 9.6 | 7.9 | 3.1 | 0.451 |
| 130 | 2.8 | 8.4 | 7.7 | 1.4 | 0.490 | 130 | 5.1 | 9.5 | 7.9 | 3.4 | 0.455 |
| 140 | 2.7 | 8.0 | 7.6 | 2.5 | 0.500 | 140 | 4.5 | 9.3 | 7.9 | 2.8 | 0.462 |
| 150 | 2.6 | 7.8 | 7.6 | 4.0 | 0.510 | | | | | | |
| | | **July** | | | | | | **August** | | | |
| 0 | 23.3 | 7.6 | 8.3 | 1.7 | 0.449 | 0 | 23.2 | 7.9 | 8.5 | 3.8 | 0.442 |
| 10 | 22.1 | 7.8 | 8.3 | 2.1 | 0.442 | 10 | 23.1 | 7.9 | 8.5 | 40.0 | 0.441 |
| 20 | 21.9 | 7.8 | 8.3 | 2.5 | 0.442 | 20 | 22.4 | 7.5 | 8.4 | 4.3 | 0.442 |
| 30 | 21.3 | 7.4 | 8.3 | 2.7 | 0.441 | 30 | 21.9 | 6.9 | 8.4 | 4.2 | 0.443 |
| 40 | 19.8 | 7.0 | 8.2 | 2.8 | 0.441 | 40 | 21.5 | 6.6 | 8.4 | 4.3 | 0.442 |
| 50 | 15.8 | 6.5 | 7.9 | 3.1 | 0.439 | 50 | 16.6 | 5.4 | 8.0 | 3.2 | 0.440 |
| 60 | 13.9 | 6.7 | 7.9 | 2.3 | 0.440 | 60 | 12.9 | 6.3 | 7.9 | 3.5 | 0.442 |
| 70 | 10.9 | 7.4 | 7.9 | 2.1 | 0.442 | 70 | 11.4 | 6.8 | 7.9 | 3.4 | 0.442 |
| 80 | 9.3 | 7.9 | 7.8 | 2.6 | 0.445 | 80 | 8.8 | 7.6 | 7.9 | 2.8 | 0.446 |
| 90 | 8.6 | 8.1 | 7.8 | 2.5 | 0.446 | 90 | 8.2 | 7.8 | 7.9 | 2.5 | 0.448 |
| 100 | 7.6 | 8.4 | 7.8 | 2.7 | 0.449 | 100 | 7.6 | 7.8 | 7.9 | 2.8 | 0.449 |
| 110 | 6.7 | 8.5 | 7.8 | 2.3 | 0.452 | 110 | 7.4 | 7.7 | 7.8 | 2.5 | 0.450 |
| 120 | 6.2 | 8.5 | 7.8 | 2.2 | 0.455 | 120 | 7.3 | 7.7 | 8.0 | 2.4 | 0.450 |
| 130 | 6.1 | 8.5 | 7.8 | 2.3 | 0.455 | 130 | 7.2 | 7.7 | 8.0 | 2.5 | 0.451 |
| 140 | 5.8 | 8.5 | 7.8 | 1.7 | 0.451 | 140 | 7.1 | 7.8 | 8.0 | 2.4 | 0.451 |
| | | | | | | 150 | 7.1 | 7.8 | 8.0 | 2.3 | 0.451 |
| | | **September** | | | | | | | | | |
| 0 | 16.6 | 7.6 | 8.4 | 3.7 | 0.440 | | | | | | |
| 10 | 16.6 | 7.6 | 8.4 | 3.9 | 0.440 | | | | | | |
| 20 | 16.6 | 7.6 | 8.4 | 4.0 | 0.440 | | | | | | |
| 30 | 16.6 | 7.6 | 8.5 | 4.3 | 0.440 | | | | | | |
| 40 | 16.6 | 7.6 | 8.5 | 4.2 | 0.440 | | | | | | |
| 50 | 16.3 | 9.7 | 8.4 | 4.7 | 0.440 | | | | | | |
| 60 | 12.1 | 3.7 | 7.8 | 4.5 | 0.447 | | | | | | |
| 70 | 11.1 | 7.3 | 7.8 | 4.0 | 0.448 | | | | | | |
| 80 | 9.9 | 5.2 | 7.9 | 4.3 | 0.448 | | | | | | |
| 90 | 9.7 | 5.2 | 7.8 | 3.6 | 0.449 | | | | | | |
| 100 | 9.0 | 5.7 | 7.9 | 3.9 | 0.450 | | | | | | |
| 110 | 8.5 | 5.8 | 7.9 | 3.4 | 0.451 | | | | | | |
| 120 | 8.3 | 6.0 | 7.9 | 3.2 | 0.451 | | | | | | |
| 130 | 8.1 | 6.0 | 7.9 | 3.0 | 0.452 | | | | | | |

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, 2018.

| 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 | 14.4 | 10.0 | 8.1 | 2.6 | 0.421 | | 0 | 17.2 | 8.6 | 8.1 | 4.0 | 0.437 |
| 10 | 10.6 | 10.5 | 8.1 | 2.9 | 0.419 | | 10 | 14.6 | 8.8 | 8.1 | 5.4 | 0.434 |
| 20 | 8.6 | 10.9 | 8.1 | 3.0 | 0.417 | | 20 | 14.0 | 8.5 | 8.1 | 5.2 | 0.431 |
| 30 | 5.8 | 11.2 | 8.1 | 2.5 | 0.419 | | 30 | 12.6 | 8.8 | 8.1 | 5.2 | 0.438 |
| 40 | 5.4 | 11.1 | 8.0 | 2.0 | 0.421 | | 40 | 9.4 | 9.2 | 8.0 | 4.3 | 0.449 |
| 50 | 4.9 | 10.9 | 8.0 | 2.0 | 0.425 | | 50 | 7.8 | 9.5 | 8.0 | 2.9 | 0.441 |
| 60 | 4.6 | 10.7 | 8.0 | 1.9 | 0.427 | | 60 | 6.0 | 9.5 | 7.9 | 2.9 | 0.449 |
| 70 | 4.3 | 10.8 | 8.0 | 2.2 | 0.433 | | 70 | 5.3 | 9.4 | 7.9 | 2.5 | 0.454 |
| 80 | 4.0 | 10.8 | 8.0 | 2.2 | 0.435 | | 80 | 5.1 | 9.4 | 7.8 | 2.9 | 0.456 |
| 90 | 3.9 | 10.7 | 7.9 | 2.0 | 0.437 | | 90 | 5.1 | 9.4 | 7.8 | 2.2 | 0.456 |
| 100 | 3.7 | 10.7 | 7.9 | 1.8 | 0.438 | | 100 | 5.0 | 9.4 | 7.8 | 2.6 | 0.457 |
| 110 | 3.6 | 10.7 | 7.9 | 2.0 | 0.439 | | 110 | 5.0 | 9.4 | 7.8 | 2.1 | 0.459 |
| | | | | | | | 120 | 4.9 | 9.4 | 7.8 | 2.5 | 0.458 |
| | | | | | | | | | | | | |
| | | **July** | | | | | | | **August** | | | |
| 0 | 23.1 | 8.2 | 8.4 | 5.8 | 0.428 | | 0 | 23.6 | 8.8 | 8.6 | 4.6 | 0.426 |
| 10 | 22.2 | 8.4 | 8.4 | 3.1 | 0.427 | | 10 | 22.6 | 7.8 | 8.5 | 4.4 | 0.430 |
| 20 | 21.5 | 7.6 | 8.3 | 6.6 | 0.430 | | 20 | 22.3 | 7.0 | 8.3 | 4.4 | 0.432 |
| 30 | 20.1 | 6.8 | 8.2 | 2.8 | 0.433 | | 30 | 21.9 | 6.4 | 8.3 | 3.5 | 0.433 |
| 40 | 15.6 | 6.4 | 7.9 | 2.3 | 0.438 | | 40 | 20.8 | 5.6 | 8.2 | 4.3 | 0.437 |
| 50 | 11.5 | 7.0 | 7.8 | 2.2 | 0.442 | | 50 | 15.8 | 4.9 | 7.8 | 4.0 | 0.440 |
| 60 | 9.8 | 7.4 | 7.8 | 2.1 | 0.443 | | 60 | 14.3 | 5.1 | 7.8 | 3.8 | 0.439 |
| 70 | 8.7 | 7.6 | 7.8 | 1.9 | 0.446 | | 70 | 11.6 | 6.1 | 7.8 | 3.8 | 0.443 |
| 80 | 7.7 | 7.9 | 7.7 | 2.3 | 0.450 | | 80 | 10.5 | 6.8 | 7.9 | 2.7 | 0.433 |
| 90 | 7.2 | 7.9 | 7.7 | 2.2 | 0.452 | | 90 | 9.4 | 6.8 | 7.8 | 2.4 | 0.4 |
| 100 | 6.5 | 8.1 | 7.7 | 2.2 | 0.454 | | 100 | 8.3 | 6.9 | 7.8 | 2.7 | 0.4 |
| 110 | 6.1 | 8.2 | 7.7 | 2.4 | 0.456 | | 110 | 6.7 | 6.8 | 7.7 | 2.5 | 0.5 |
| | | | | | | | | | | | | |
| | | **September** | | | | | | | | | | |
| 0 | 17.2 | 7.7 | 8.4 | 9.7 | 0.436 | | | | | | | |
| 10 | 17.2 | 7.7 | 8.5 | 1.8 | 0.420 | | | | | | | |
| 20 | 17.2 | 7.7 | 8.5 | 10.3 | 0.420 | | | | | | | |
| 30 | 17.2 | 7.6 | 8.5 | 10.2 | 0.420 | | | | | | | |
| 40 | 17.2 | 7.6 | 8.5 | 10.5 | 0.419 | | | | | | | |
| 50 | 17.2 | 7.7 | 8.5 | 10.6 | 0.419 | | | | | | | |
| 60 | 17.2 | 7.6 | 8.5 | 10.7 | 0.420 | | | | | | | |
| 70 | 17.2 | 7.6 | 8.5 | 11.0 | 0.435 | | | | | | | |
| 80 | 12.3 | 4.5 | 8.0 | 15.5 | 0.443 | | | | | | | |
| 90 | 9.8 | 4.4 | 7.8 | 18.8 | 0.460 | | | | | | | |
| 100 | 9.2 | 4.5 | 7.8 | 12.6 | 0.462 | | | | | | | |
| 110 | 7.7 | 4.9 | 7.8 | 11.9 | 0.459 | | | | | | | |

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, 2018.

| 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 | 14.4 | 10.5 | 8.2 | 13.6 | 0.428 | | 0 | 18.4 | 8.5 | 8.2 | 3.7 | 0.439 |
| 10 | 12.8 | 10.5 | 8.2 | 3.4 | 0.454 | | 10 | 17.0 | 8.2 | 8.2 | 5.3 | 0.436 |
| 20 | 11.8 | 10.5 | 8.2 | 3.1 | 0.443 | | 20 | 14.4 | 8.0 | 8.0 | 6.8 | 0.416 |
| 30 | 10.2 | 11.2 | 8.2 | 3.2 | 0.402 | | 30 | 13.7 | 7.9 | 7.9 | 6.0 | 0.420 |
| 40 | 7.1 | 10.1 | 8.0 | 1.8 | 0.405 | | 40 | 12.2 | 8.2 | 7.9 | 7.6 | 0.427 |
| 50 | 6.7 | 9.7 | 7.9 | 2.1 | 0.424 | | 50 | 10.0 | 8.5 | 7.9 | 6.9 | 0.434 |
| 60 | 5.4 | 9.7 | 7.8 | 2.3 | 0.423 | | 60 | 7.1 | 8.9 | 7.9 | 3.8 | 0.427 |
| 70 | 4.3 | 9.4 | 7.8 | 3.2 | 0.429 | | 70 | 5.7 | 8.9 | 7.8 | 3.5 | 0.455 |
| 80 | 3.9 | 9.3 | 7.7 | 2.3 | 0.438 | | 80 | 5.3 | 8.9 | 7.8 | 3.1 | 0.458 |
| 90 | 3.9 | 9.2 | 7.7 | 2.8 | 0.439 | | 90 | 5.1 | 8.7 | 7.7 | 3.3 | 0.461 |
| 100 | 3.6 | 9.1 | 7.7 | 2.8 | 0.450 | | 100 | 4.8 | 8.6 | 7.7 | 3.4 | 0.466 |
| 110 | 3.6 | 6.9 | 7.3 | 4.1 | 0.633 | | 110 | 4.7 | 8.5 | 7.7 | 3.3 | 0.470 |
| | | | | | | | | | | | | |
| | | **July** | | | | | | | **August** | | | |
| 0 | 23.5 | 8.2 | 8.4 | 4.0 | 0.414 | | 0 | 23.9 | 7.9 | 8.5 | 5.9 | 0.406 |
| 10 | 22.6 | 7.7 | 8.3 | 4.2 | 0.414 | | 10 | 23.7 | 7.5 | 8.4 | 5.7 | 0.407 |
| 20 | 22.3 | 7.3 | 8.3 | 4.4 | 0.413 | | 20 | 23.1 | 7.1 | 8.3 | 5.1 | 0.407 |
| 30 | 21.4 | 6.9 | 8.2 | 3.7 | 0.413 | | 30 | 22.4 | 6.1 | 8.2 | 5.4 | 0.422 |
| 40 | 18.6 | 6.4 | 8.0 | 3.4 | 0.424 | | 40 | 21.6 | 5.4 | 8.1 | 5.6 | 0.419 |
| 50 | 14.0 | 6.2 | 7.8 | 2.6 | 0.436 | | 50 | 13.6 | 4.6 | 7.6 | 4.7 | 0.439 |
| 60 | 10.5 | 6.4 | 7.6 | 2.2 | 0.445 | | 60 | 10.9 | 4.4 | 7.5 | 5.3 | 0.453 |
| 70 | 8.9 | 6.7 | 7.6 | 2.0 | 0.450 | | 70 | 9.1 | 4.8 | 7.5 | 5.1 | 0.454 |
| 80 | 8.3 | 6.7 | 7.6 | 1.9 | 0.454 | | 80 | 8.0 | 5.9 | 7.6 | 4.1 | 0.454 |
| 90 | 8.2 | 6.7 | 7.6 | 2.2 | 0.453 | | 90 | 7.7 | 5.9 | 7.6 | 4.1 | 0.455 |
| 100 | 7.1 | 6.7 | 7.5 | 2.3 | 0.457 | | 100 | 7.6 | 5.1 | 7.6 | 3.5 | 0.455 |
| 110 | 7.0 | 6.7 | 7.5 | 2.3 | 0.450 | | 110 | 7.4 | 6.0 | 7.6 | 3.7 | 0.455 |
| | | | | | | | | | | | | |
| | | **September** | | | | | | | | | | |
| 0 | 18.1 | 7.1 | 8.44 | 8.3 | 0.420 | | | | | | | |
| 10 | 18.1 | 7.2 | 8.46 | 8.2 | 0.420 | | | | | | | |
| 20 | 18.1 | 7.1 | 8.46 | 8.2 | 0.420 | | | | | | | |
| 30 | 18.1 | 7.2 | 8.49 | 9.0 | 0.420 | | | | | | | |
| 40 | 18.1 | 7.1 | 8.47 | 8.4 | 0.419 | | | | | | | |
| 50 | 18.1 | 7.2 | 8.47 | 8.7 | 0.419 | | | | | | | |
| 60 | 18.1 | 7.1 | 8.48 | 9.1 | 0.420 | | | | | | | |
| 70 | 16.4 | 4.8 | 7.98 | 11.8 | 0.435 | | | | | | | |
| 80 | 14.8 | 1.8 | 7.62 | 15.6 | 0.443 | | | | | | | |
| 90 | 12.5 | 1.0 | 7.49 | 18.2 | 0.460 | | | | | | | |
| 100 | 10.7 | 1.6 | 7.52 | 18.0 | 0.462 | | | | | | | |
| 110 | 9.8 | 2.2 | 7.56 | 20.1 | 0.459 | | | | | | | |

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, 2018.

| 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 | 17.4 | 10.6 | 8.3 | 4.8 | 0.501 | 0 | 18.3 | 7.8 | 7.9 | 14.0 | 0.384 |
| 10 | 16.1 | 10.6 | 8.3 | 5.1 | 0.520 | 10 | 18.2 | 7.8 | 7.9 | 14.2 | 0.388 |
| 20 | 13.1 | 9.6 | 8.1 | 4.8 | 0.544 | 20 | 17.9 | 7.6 | 8.0 | 15.0 | 0.390 |
| 30 | 10.9 | 9.1 | 7.9 | 3.9 | 0.527 | 30 | 11.0 | 7.6 | 7.8 | 8.2 | 0.440 |
| 40 | 10.1 | 9.0 | 7.8 | 3.3 | 0.522 | 40 | 8.6 | 7.6 | 7.7 | 4.5 | 0.461 |
| 50 | 9.2 | 8.7 | 7.7 | 3.5 | 0.546 | 50 | 6.7 | 7.7 | 7.7 | 3.2 | 0.479 |
| 60 | 8.2 | 8.5 | 7.7 | 3.6 | 0.549 | 60 | 6.6 | 7.7 | 7.6 | 2.8 | 0.479 |
| | | | | | | 70 | 6.5 | 7.7 | 7.6 | 3.2 | 0.479 |
| | | **July** | | | | | | **August** | | | |
| 0 | 23.9 | 7.7 | 8.2 | 5.5 | 0.383 | 0 | 23.3 | 7.3 | 8.4 | 5.7 | 0.393 |
| 10 | 22.7 | 7.5 | 8.2 | 5.7 | 0.380 | 10 | 23.1 | 7.1 | 8.3 | 6.1 | 0.390 |
| 20 | 21.6 | 6.7 | 8.0 | 6.8 | 0.394 | 20 | 22.7 | 6.2 | 8.2 | 5.9 | 0.391 |
| 30 | 18.7 | 7.9 | 7.8 | 6.8 | 0.410 | 30 | 18.2 | 3.6 | 7.7 | 5.3 | 0.424 |
| 40 | 14.3 | 5.5 | 7.7 | 8.1 | 0.431 | 40 | 14.3 | 2.9 | 7.4 | 6.8 | 0.448 |
| 50 | 12.3 | 5.1 | 7.5 | 10.8 | 0.448 | 50 | 11.1 | 3.9 | 7.5 | 6.6 | 0.460 |
| 60 | 11.0 | 4.8 | 7.4 | 8.6 | 0.464 | 60 | 9.9 | 4.0 | 7.4 | 6.7 | 0.464 |
| 70 | 10.2 | 4.6 | 7.4 | 11.6 | 0.474 | 70 | 9.3 | 3.5 | 7.4 | 6.9 | 0.470 |
| | | **September** | | | | | | | | | |
| 0 | 18.3 | 7.2 | 8.4 | 8.7 | 0.395 | | | | | | |
| 10 | 18.3 | 7.1 | 8.4 | 9.5 | 0.395 | | | | | | |
| 20 | 18.3 | 7.2 | 8.4 | 9.3 | 0.395 | | | | | | |
| 30 | 18.3 | 7.2 | 8.4 | 9.8 | 0.395 | | | | | | |
| 40 | 18.3 | 7.1 | 8.4 | 10.4 | 0.395 | | | | | | |
| 50 | 18.3 | 7.1 | 8.4 | 10.0 | 0.395 | | | | | | |
| 60 | 18.3 | 7.1 | 8.4 | 10.5 | 0.395 | | | | | | |

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) |
| 1994 | 7/19 to 7/27 | 7/26 to 7/29 | 8/2 to 8/3 | 8/4 to 8/16 | 8/16 to 8/18 | 68 to 76 (72.6) | 2238.1 to 2236.7 |
| 1995 | 7/18 to 7/21 | 7/25 to 7/28 | 8/8 to 8/24 | 8/1 to 8/15 | 8/15 to 8/17 | 68 to 76 (71.0) | 2242.6 to 2244.1 |
| 1996 | 7/16 to 7/18 | 7/23 to 7/25 | 7/30 to 8/1 | 8/6 to 8/13 | 8/13 to 8/15 | 66 to 74 (69.4) | 2246.5 to 2244.2 |
| 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 |

[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 2003-2018, for fish collected in the standard July-August gill net survey, on Fort Peck Reservoir.

| Northern pike | | | | |
|---|---|---|---|---|
| Year | PSD | PSD-P | *Wr* | Sample size |
| 2003 | 98 | 55 | 101.1 | 126 |
| 2004 | 96 | 71 | 100.1 | 75 |
| 2005 | 93 | 59 | 100.3 | 86 |
| 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 |

| Channel catfish | | | | |
|---|---|---|---|---|
| Year | PSD | PSD-P | *Wr* | Sample size |
| 2003 | 71 | 5 | 89.4 | 129 |
| 2004 | 57 | 11 | 98.1 | 227 |
| 2005 | 35 | 6 | 91.3 | 297 |
| 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 |