Appendix E. Biological Resources

Kansas River Reservoirs Flood and Sediment Study
Draft Watershed Study Report

October 2023

U.S. Army Corps of Engineers
Kansas City District

RESERVOIR FISHERIES

USACE RESERVOIRS

Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery
Location: Wilson Reservoir
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Wilson Reservoir Located on the Smoky Hill River in Eastern Russell County and Western Lincoln County, Kansas

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History

Wilson Reservoir is a 9,000-acre impoundment of the Saline River located on the eastern border of Russell County, Kansas with a small portion extending into western Lincoln County, Kansas. Construction, operation, and maintenance of the reservoir for flood control, silt control, and irrigation was authorized as part of the comprehensive plan for the Missouri River Basin by the Flood Control Act of 1944 Public Law 78-534 with jurisdiction for construction transferred from the U.S. Bureau of Reclamation to the U.S. Army Corps of Engineers (USACE) in May 1956 by Public Law 84-505. Secondary purposes (i.e., recreation and fish and wildlife) were authorized by the Flood Control Act of 1946 Public Law 79-526. The reservoir is not used for public water supply (drinking water, irrigation). A multitude of recreational activities draw people to the reservoir and its beautiful scenery, clear water, and bountiful sportfish populations.

Construction of Wilson Dam began in 1961 and was completed in 1964 (USACE 1983). The drainage basin above the dam consists of approximately 1,917 square miles. The 1,917 square miles of drainage area is long and narrow and is about 215 miles long with an average width of only 16 miles. Wilson Dam is located approximately 153 river miles above the mouth of the Saline River.

Water Allocation Background

Wilson Reservoir was constructed by the U.S. Army Corps of Engineers (USACE) as a multipurpose facility for flood control, silt control, irrigation, recreation, as well as fish and wildlife purposes. The original reservoir storage capacity included 530,710 acre-feet storage for flood control, 247,835 acre-feet for multipurpose use, and a sediment reserve of 40,000 acre-feet.

Wilson Reservoir is currently not a source of water supply due to salinity and lack of infrastructure and it is not expected for future use. Sediment modeling was completed for the Kansas River Reservoirs Flood and Sediment Study (Watershed Study) to project a baseline and future storage capacity for USACE reservoirs within the basin. Sediment accumulation in Wilson Reservoir is expected to be moderate over the next 50 years with a minor loss of storage capacity from sedimentation. The original pool storage capacity and pool storage capacity under baseline conditions (i.e., 2024) are shown in Table 1.

Table 1. Storage Capacity and Ownership

Year	Pool Owner	Purpose	Quantity (acre-feet [af])
1965	USACE	Flood Control	530,710
1965	USACE	Multipurpose	247,835
20241	USACE	Flood Control	528,728
20241	USACE	Multipurpose Uses	227,814

Note: Storage capacity projected for 2024 with loss to sedimentation as modeled

Wilson Reservoir Fishery

Fisheries Establishment

Wilson Reservoir has tremendous sportfish populations including channel catfish (*Ictalurus punctatus*), largemouth (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*), striped bass (*Morone saxatilis*), and walleye (*Sander vitreus*) (just to name a few). Wilson Reservoir is one of the few reservoirs in Kansas with successful introductions of striped bass, currently holding the state record. Striped bass do not reproduce in Kansas and must be continually stocked. Years of high water (2008 – 2012) provided successful recruitment of largemouth bass at the reservoir and has since been a popular destination for bass tournaments. Walleye is one of the most popular species at the reservoir. Although most Kansas reservoirs experience tenuous recruitment of walleye, due to poor spawning habitat, Wilson Reservoir walleye are often successful at reproducing due to the abundant spawning habitat at the reservoir. Blue catfish (*Ictalurus furcatus*) were first stocked in Wilson Reservoir in 2006 and the population, although slow growing, appears to be on track to become a reasonable fishery.

Tables 2 and 3 list sport and non-sport fish in the Wilson Reservoir. More detailed treatment of recent species-specific stocking efforts is detailed in species narrative in the Sportfish Dynamics & Trends section.

Table 2. Sport Fish Species Known to Inhabit Wilson Reservoir.

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Blue Catfish	*Ictalurus furcatus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Freshwater Drum	*Aplodinotus grunniens*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieu*
Spotted Bass	*Micropterus punctulatus*
Striped Bass	*Morone saxatilis*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
White Perch	*Morone americana*

Table 3. Sport and Non-Sport Fish Species Known to Inhabit Wilson Reservoir.

Common Name	Scientific Name
Bigmouth Buffalo	*Ictiobus cyprinellus*
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Fathead Minnow	*Pimephales promelas*
Gizzard Shad	*Dorosoma cepedianum*
Golden Shiner	*Notemigonus crysoleucas*
Log Perch	*Percina caprodes*
Orangespotted sunfish	*Lepomis humilus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Suckermouth Minnow	*Phenacobius mirabilis*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

Stressors to the fish populations are a combination of some abiotic and biotic concerns seen in both eastern and western Kansas reservoirs. Drought conditions have had dramatic impacts on sport fisheries, especially from 2012 to 2016. Common reed grass (*Phragmites australis*) has become ubiquitous along the shorelines and provides reasonable fisheries habitat, otherwise lacking from this reservoir. However, common reed grass can preclude bank fishing and other recreation in some areas. Gizzard shad (*Dorosoma cepedianum*) is the primary forage species at Wilson Reservoir but the low productivity in terms of nutrients results in inconsistent recruitment of the species. Aquatic nuisance species have altered food webs in the reservoir, but their direct consumption of fish eggs creates recruitment issues for sport fish. White perch *(Morone americana*) have negatively affected walleye and other sport fish, especially inhibiting natural recruitment. Sedimentation is not as concerning here as in other reservoirs due to low inflows and a lower proportion of agricultural land in the watershed.

1. Water Quality

The USACE Kansas City District (KCD) Water Quality Program collects monthly water samples from standardized locations during the recreation season. Chemical, physical, and biological parameters are measured to evaluate water quality at four reservoir sites and the outflow. These data describe conditions and changes from within the main reservoir, and outflow focusing on eutrophication, nutrients, sediment, herbicides, metals, and contaminants. Reservoir water quality improves as water moves through the reservoir as settling, dilution, and biological processes remove sediments and nutrients. Water quality at Wilson Reservoir in 2018 was beneficial to operating purposes and measured parameters did not exceed Kansas state water quality standards for designated uses. Seasonally adjusted total maximum daily load (TMDL) limits for sulfate and chloride ions are in effect to reduce inputs into receiving waters with elevated background concentrations. Water quality monitoring will continue as a critical part of a holistic, environmentally sound water quality management strategy for the project to continue to meet applicable federal and state environmental laws, criteria, and standards.

Wilson Reservoir was characterized as oligo-mesotrophic in 2009 when the reservoir was at or above conservation pool as noted by a value of 36.1 for the trophic state index (TSI) Table 4 below. This is a change from a mesotrophic classification from the previous sampled year of 2006 when the reservoir was several feet below conservation pool with a TSI value of 43.0. With the mesotrophic classification there is neither low or high nutrient concentration and phytoplankton growth, while oligo-mesotrophic is characterized by a low level of planktonic algae. It is also considered the clearest federal reservoir in the state with a mean secchi disk reading of 338 cm (11 ft.) (Table 4). Because of clear water and low nutrient load the reservoir hasn't experienced harmful algae blooms although colonies of blue-green algae occur irregularly.

Table 4. General Limnological Parameters Characteristic of Wilson Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	9040.0
Max depth	feet	52.5
Mean depth	feet	29.0
Area watershed drainage	square miles	1920.2
Hydrologic residence time	days	1548.0
Chlorophyll a	parts per billion	1.8
Secchi depth	centimeters	338.0

Parameter	Unit of Measure	Value
Shoreline development index	ratio	7.7
Agricultural lands	%	40.3
Forest habitat	%	0.5
Grassland habitat	%	53.6
Urban lands	%	3.3
*Trophic state index		36.1

Note: *Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuations

Annual precipitation is variable in Kansas and a gradient of low (10 – 20 inches) precipitation in western Kansas to high (40 – 50 inches) precipitation in southeastern Kansas is a reality. Summer temperatures in western Kansas can reach temperatures more than 43°C (110°F). These temperatures and generally windy conditions on the plains causes the evaporation of approximately 1.2 meters (4 feet) or more each year. Combine these droughty conditions with a steady decline in western Kansas surface water, due partially because of drastic and annual declines in the depth of the Ogallala Aquifer, and you have a recipe for major water level fluctuations.

Wilson Reservoir, situated more closely to central Kansas, isn't used as a public water supply (high salinity) and hasn't experienced the elevation fluctuations of far western Kansas reservoirs (i.e. Cedar Bluff and Webster reservoirs) and up until 2006 had remained generally stable (< 4 feet from conservation pool annually). Nonetheless, in 2016 the reservoir reached its lowest elevation since it filled up over 40 years ago. The reservoir saw some declines in 2006 to nearly 7.2 feet below conservation pool. Inflows in 2008 flooded 2 years' worth of terrestrial vegetation which boosted recruitment of fish populations. However, since 2012 the reservoir has trended downward in elevation to a record low of nearly 10.5 feet below conservation pool in 2016 (Figure 1). With the low lake levels came a lack of aquatic vegetation and structure near the shoreline used for spawning and escape habitat, which resulted in some species (black bass, bluegill, etc.) seeing a great reduction in their populations. The reservoir experienced a momentous fluctuation in water levels in 2016. It reached its historical low in April, but heavy rains and Saline River inflow added 5 feet of much-needed water to the reservoir in June. The reservoir held steady until heavy storms in late August and early September filled the reservoir 2.5 feet beyond conservation pool. Flooded common reed grass and young cottonwoods (*Populus deltoides*) were common. This flooded vegetation throughout the reservoir led to ample spawning habitat and escape cover for all fish species which helped contribute to some excellent sport fish populations from 2016 - 2019. Wilson Reservoir saw significant flooding throughout 2019 which inundated and killed large areas of common reed grass and shoreline vegetation. It was high in 2019 and reached 10 feet above conservation pool for several summer months. The reservoir remained stable throughout 2020.

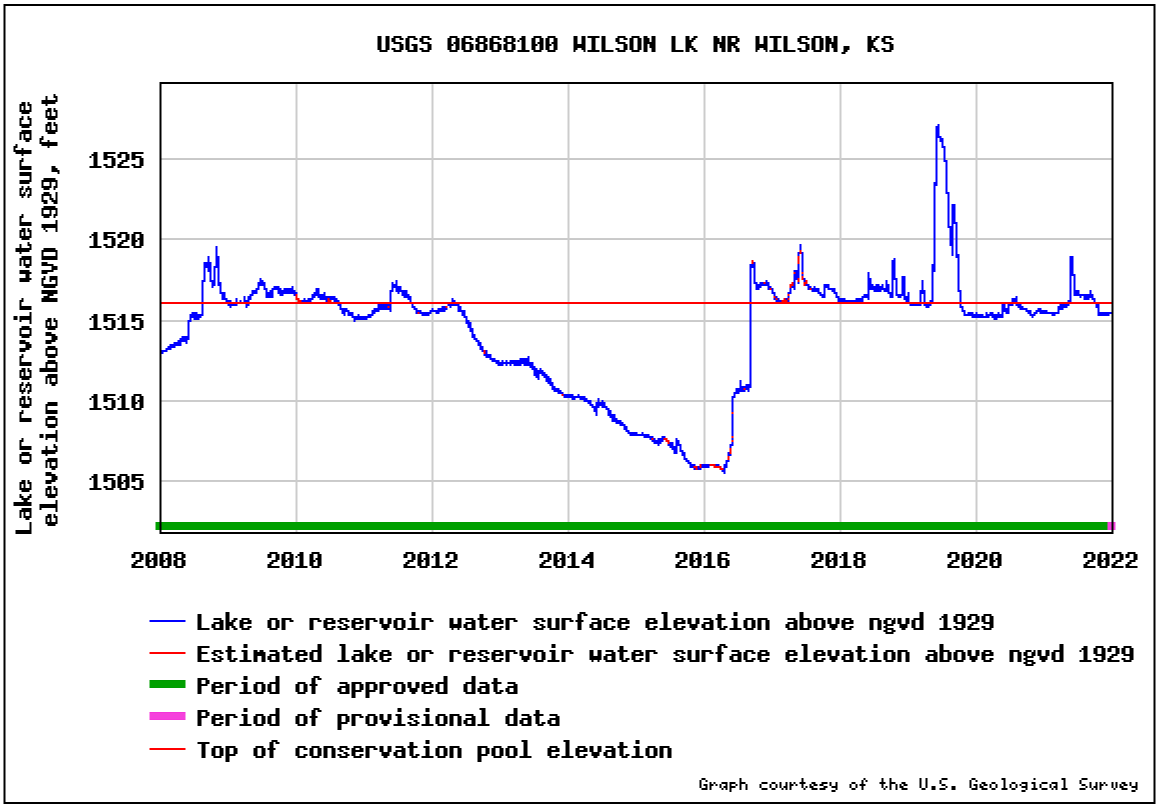

Figure 1. Wilson Reservoir Elevation (feet above sea level) from January 1, 2008, Through January 1, 2021

3. Sedimentation and Shoreline Erosion

Sandstone Outcrops at Wilson Reservoir

The reservoir area is characterized by sandstone outcroppings of the Dakota formation. This formation of the Cretaceous Age is the oldest bedrock exposed in the reservoir area. The sandstone appears in most cases to weather rapidly, but in some instances has become case hardened and quite resistant to weathering. The Saline River has in the past, undercut the channel sandstone causing massive blocks of the sandstone to separate along the vertical jointing and to slump toward the river. Steep sandstone walls and ledges line the valley and adjoining canyons throughout this part of the Saline Valley. In the reservoir areas there are also deposits of limestone, gravel, lignite, and various clays. For the most part, these deposits are buried beneath overburden or water and so are not readily observable. Soils in the reservoir area are generally shallow and have developed under prairie conditions associated with relatively low rainfall. USACE 2020

The multipurpose pool at Wilson Reservoir originally included 247,835 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 4.7% of the multipurpose pool has been filled in with sediment leaving approximately 236,188 ac-ft of capacity (based on 2008 survey results). It is estimated that approximately 459 ac-ft of sediment accumulates on average annually in Wilson Reservoir. Sediment will continue to accumulate in Wilson Reservoir with an expected additional 8.7 % loss of the multipurpose pool over the next 25 years (2049) and 13.2% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 203,400 ac-ft in 2074.

Wilson Reservoir has one of the lowest sedimentation rates of any of the USACE reservoirs located in Kansas. However, shoreline erosion and deposition of silt have become an increasing concern at Wilson Reservoir. Sedimentation is the most critical stressor to fish populations as shorelines erode and leave littoral areas unvegetated. Shallow, silty littoral habitat fills in interstitial spaces in rock and woody cover and leaves most areas unsuitable for fish spawning, nursery habitat, and protective cover. The last shoreline rock armoring on USACE managed areas was in 1992. Much of the pre-existing armor between elevations 1516 mean sea level (msl) and 1519 msl are broke down and exposing vulnerable soils to erosion. The wave and wind erosion from the 2019 flood caused significant loss of soil. Some areas of the KDWP State Park in Hell Creek eroded back into the campsite utilities and exposed water and electric lines. KDWP will be rock armoring these areas in the future. On USACE managed areas, a 5,700-ton rip rap contract has been awarded for 2020 for shoreline rock using placement with a high loader and excavator.

4. Vegetated Fisheries Habitat

Vegetated fisheries habitats occurring in and adjacent to Wilson Reservoir consists of terrestrial, emergent, and submergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. After flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

B. Emergent

Common reed (*Phragmites australis*), cattails (*Typha spp*.), sedges (*Cyperaceae sp*.) and rushes (*Juncaceae sp*.) are the primary emergent aquatic vegetation species. Sedge and rush abundance and their distribution is relatively limited. Cattails were once abundant, but their abundance and distribution has become more limited due to competition with common reed, an aggressive non-native species. Common reed abundance has increased greatly and will likely continue to expand in distribution, especially occupying areas of the lake basin subject to flooding. Common reed seed germinates on moist soil to colonize recently dewatered shores in the fall. Once established, common reed can tolerate dry soil and flooding to a degree. Common reed is capable of establishment through fragmentation and rapid stolon growth allowing common reed to “follow” the declining reservoir water levels.

The first season post-flooding, common reed is capable of culm elongation, sufficient to survive in water depths up to approximately 13 feet. However, in subsequent years common reed appears capable of surviving to depths of 9 to 10 feet, as observed in 2019-2020. Based on observations in 2019-2020 continued inundation of common reed stressed and weakened the plant as stands in deeper water decreased in stem density. Flooded emergent aquatic vegetation provides nutrient input, substrate for periphyton and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of emergent vegetation and increased biological oxygen demand can cause hypoxia in areas of dense stands of vegetation during the summer.

C. Submergent

Submergent aquatic vegetation can establish considerable beds in the littoral zone (zone of shallow water along of shore of the reservoir) of the reservoir. Coontail (*Ceratophyllum demersum*), Sago pondweed (*Potamogeton pectinatus*), American pondweed (*Potamogeton nodosus*), and curly leaf pondweed (*Potamogeton crispus*) constitute the most common submergent vegetation species at Wilson Reservoir. Curly leaf pondweed is not native to the area, however, regardless of native status, presence of all submerged aquatic vegetation species helps diversify littoral zone habitats within the reservoir and provide rearing habitat for young fish and foraging areas for adult fish. Submerged aquatic vegetation beds create shade, thus lowering water temperature immediately below the beds, providing thermal refuge to fish during the summer. Submerged aquatic macrophyte beds also provide fish concealment from avian predators.

5. Invasive/Exotic Species

Within the last two decades zebra mussels (*Dreissena polymorpha*) have been identified within Kansas waterbodies. They can spread by moving off a contaminated boat to an uninfected waterway. They can be transported by infected water that may be within bilge, livewells, or motor water intakes. Zebra mussels were discovered in Wilson Reservoir first in October 2009. Zebra mussels in Wilson Reservoir experienced a decline during the drought of 2013 – 2016. A large education effort by both state and federal agencies about zebra mussels and their mechanism of spread has potentially slowed the spread of this species. Once a waterbody becomes infested the zebra mussel’s clump together and can cover power plants, industrial and public water intakes. They can also fowl boat hulls, cover docks and other structures, and decimate native mussel populations.

White perch, another ANS, first showed up in the mid-1990s in Wilson Reservoir. Since their establishment other sport fish populations have responded variably. While it’s true that white perch provide forage for many of the predators in the reservoir, they provide interspecific competition with white bass and eat large amounts of fish eggs. The historical management response to white perch at Wilson Reservoir has been to increase stocking frequency and rates for large predators, most notably the striped bass. Both the zebra mussel and white perch have experienced dramatic increases in their populations since the reservoir refilled in September 2016.

It should be noted that another impetus for the introduction of blue catfish is their ability to prey on zebra mussels and white perch. This has not been shown to influence their population nor the populations of white perch and zebra mussels, but nonetheless they will provide an additional sportfish for anglers to catch.

Most management efforts have been directed at mitigating the negative effects of ANS. Dense annual stockings of striped bass was the main management technique for controlling white perch from 2000 – 2015. However, the drought from 2012 – 2016 caused poor health and slow growth of the striped bass population and efforts to improve their condition by lowering stocking rates and relaxing harvest regulations began in 2016. These efforts immediately improved conditions for striped bass but, unfortunately white perch numbers rebounded along with the reservoir levels in 2016 and their population has since increased dramatically. Zebra mussel numbers seem to be positively correlated with inflow and typically remain low in abundance, but periods of high inflow experienced in 2016 and 2019 increased their numbers temporarily. Inconsistent recruitment of sport fish caused by white perch and other natural factors are typically mitigated by stockings, but these aren't always successful. It is least expensive in terms of hatchery pond space and personnel time to stock fry, an early phase of fish only a few weeks old. However, due to high density of white perch, fry stockings have been relatively unsuccessful and larger sized, more expensive, fish must be stocked to overcome predation.

Fisheries Management Objectives

Placement of Georgia Cubes for fish habitat improvement

Fisheries in Wilson Reservoir are managed by the fisheries division of the Kansas Department of Wildlife and Parks (KDWP). Fisheries management activities include fish sampling, creel surveys, habitat work, aquatic vegetation enhancement, fish stocking, and special studies to monitor fish populations and improve fishing opportunities. A fisheries habitat improvement plan has been established and each year fish habitat of natural (trees) and synthetic structures (Georgia Cubes) are placed in a variety of spots around the reservoir to provide cover. A variety of sport and non-sport fish species are found in the reservoir.

Specific objectives for Wilson Reservoir are listed below:

1) Blue Catfish: Maintain 10 - 30% of the floatline sample within the protective slot of 32 - 40 inches. If the proportion of blue catfish collected within the protective slot, as measured from floatline surveys, falls below 10% for two consecutive years, consider altering the regulation to promote a balance of conservation and angler harvest. If the proportion is greater than 30% then stock blue catfish, the following year. However, we will not commence more floatline samples until 2021.
2) Largemouth Bass: Maintain a largemouth bass population with a stock Catch per Unit Effort (CPUE) ≥ 30 fish per electrofishing hour (EFH). If stock CPUE < 30 fish/EFH then install more physical habitat. Consider stockings of early-spawn largemouth bass and forage if this objective consistently fails.

3) Smallmouth Bass: Maintain a smallmouth bass population with a CPUE of ≥ 5 individuals per electrofishing hour (EFH). If CPUE < 5 then reduce potential competitor stockings, consider stocking smallmouth bass, and research forage enhancement ideas.
4) Walleye: Maintain a walleye population with a CPUE of at least 3 individuals/GNN and a Proportional Stock Distribution (PSD) less than 90. If both objectives fail, then consider stocking walleye fry, fingerlings (preferred), or intermediates. Major consideration for stocking should occur following a water level rise the previous spawning season but less consideration for stocking if water levels were stable or declining during the previous spawn.
5) Walleye condition: Maintain a mean Relative Weight (Wr) of ≥ 85 for preferred-length (510 mm or 20") walleye. If objective fails, then do not stock walleye and consider reducing Striped Bass stockings.
6) Striped Bass: Maintain a striped bass population with a CPUE of ≥ 1 individual per core panel gill net and a mean Wr value for quality (≥ 510 mm or 21") fish of ≥ 80. If CPUE objective is not met, then consider additional stockings of striped bass fingerlings. If Wr goal fails, then reduce or suspend stockings.

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Wilson Reservoir.

1. Riprap Installation in Areas of Critical Shoreline Infrastructure

Riprap has been added to shorelines and edges of boat ramp slabs to reduce erosion and undermining by wave action. The lake level increases in 2019 caused severe erosion in the State Park and Lucas Park. To combat this erosion riprap was installed into the water to reduce wave action on the exposed shoreline, thus providing habitat to the fishery.

2. Standard and Supplemental Fish Sampling to Monitor Sportfish Trends

Standard fish population sampling is employed on an annual basis and is conducted using standardized methods approved by KDWP Fisheries staff and applied at Wilson Reservoir and other Kansas waters to develop baseline trend data by which Kansas fisheries are managed. At Wilson Reservoir, electrofishing is used to sample the black bass (Largemouth, smallmouth, and spotted bass) population in spring, and core panel gill nets and ½" mesh fyke nets are employed each fall to sample other sportfish species such as bluegill, channel catfish, crappies, white bass, striped bass, and walleye.

Supplemental fish population sampling is conducted at the discretion of the KDWP District Fisheries Biologist to address specific management questions/challenges. Supplemental sampling can consist of accepted or experimental methods and often focuses on finer detail resolution fish population parameters. Currently, supplemental sampling of blue catfish is conducted using low frequency electrofishing and jug lines to monitor population characteristics and to see how the recent regulation change from a 35-inch minimum length limit to the slot limit is affecting the fishery.

3. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries

Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Wilson Reservoir are: 32 to 40- inch protected slot length limit with a creel of two fish per day with only one exceeding 40-inches for Blue Catfish and a two fish daily creel limit for Striped Bass. See Table 5 below for a comprehensive list of fish harvest regulations in effect at Wilson Reservoir.

Table 5. Current Fish Harvest Regulations in Effect at Wilson Reservoir

Species	Length Limit	Creel Limit
Blue Catfish	32- to 40-inch slot length limit	2 fish daily creel limit, only one fish may be over 40-inches
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	N/A	50 fish daily creel limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Smallmouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Spotted Bass	15 - inch minimum length limit	5 fish daily creel limit
Walleye	15 - inch minimum length limit	5 fish daily creel limit
Striped Bass	N/A	2 fish daily creel limit

Source: KDWP 2022

4. Sportfish Stockings

Stocking has been employed on a limited basis at Wilson Reservoir as most species are capable of sufficient natural reproduction and recruitment to maintain fishable populations provided suitable habitat is present. Recently, largemouth bass fry and fingerlings have been stocked between 2015-2018 to supplement the existing population as the lake returned to conservation pool and due to poor recruitment. Striped bass are stocked periodically to maintain the species since it cannot reproduce naturally in Kansas reservoirs. A combination of walleye fry, fingerlings, and intermediates were stocked in 2019, with fry also being stocked in 2018, to improve recruitment to the population.

Angler Use

As for angling, the 2013 Kansas Licensed Angler Survey listed Wilson Reservoir as the #1 preferred reservoir location to fish in the state. It is also the #1 most actually fished reservoir in the state.

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 6) in accordance with KDWP reservoir survey guidelines.

Angler preference for a specific species often varies based upon changes in species dominance that results from water fluctuation history (see Figure 1) and the impact of invasive species in the reservoir. Walleye and striped bass have ranked in the top four species preferred by anglers at Wilson Reservoir the past 4 creel surveys (Table 7). Largemouth bass have been ranked during the last two surveys. Since the last survey the number of anglers targeting bass has increased due to the rise in lake levels creating excellent habitat and an abundant bass population.

Table 6. Total Number of Anglers, Angler-Hours, and Relative Standard Error (RSE) at Wilson Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler Hours	RSE	Angler Hours per Acre
2001	36,577	4.05	142,068.37	5	15.72
2006	23,786	2.63	80,739.83	13	8.93
2010	31,729	3.51	112,504.18	3	12.45
2016	33,406	3.70	65,346.96	8	7.23

Table 7. Average Percentages of the Top Four Most Preferred Species by Anglers at Wilson Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	First	%	Second	%	Third	%	Fourth	%
2001	Walleye	36.1	No Fish Preference	29.6	Striped Bass	12.2	White Bass	7.0
2006	Walleye	63.1	Channel Catfish	8.5	Striped Bass	8.4	No Fish Preference	7.3
2010	Walleye	50.0	Channel Catfish	20.1	Largemouth Bass	8.4	Striped Bass	7.9
2016	No Fish Preference	36.9	Largemouth Bass	18.5	Walleye	17.9	Striped Bass	7.8

Table 8. Estimated Total Number of Sportfish Harvested and Released at Wilson Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Status	Walleye	Largemouth Bass	Striped Bass	Channel Catfish	White Bass
2001	Harvested	16,987	116	4,304	3,371	10,737
2006	Harvested	9,525	79	1,424	4,374	3,787
2010	Harvested	15,178	119	2,414	6,525	2,876
2016	Harvested	3,518	299	1,535	1,094	863
2001	Released	40,002	3,867	6,182	2,033	5,857
2006	Released	18,738	595	1,323	1,010	1,361
2010	Released	6,834	8,093	2,045	533	2,711
2016	Released	2,346	803	2,898	673	447

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below.

Walleye (*Sander vitreus*)

Walleye is most often ranked as the most preferred species to target by anglers at Wilson Reservoir. Walleye was ranked by 25% of anglers as their most preferred species to fish for at Wilson Reservoir in a 2016 angler creel survey. Walleye naturally recruit at the reservoir in most years but supplemental stockings are becoming more necessary, likely due to white perch densities and water level fluctuations.

Walleye were stocked in 2018 and 2019 after not having been stocked since 2010. The population is currently in great shape as recruitment has occurred in both 2019 and 2020 and a high density of larger individuals occurs. The Wilson Reservoir walleye population currently ranks as first in the state for density of 14-inch and larger individuals (Table 9). Walleye harvest is regulated with a 15-inch minimum-length limit.

Table 9. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and RSE Estimates for Walleye Sampled During September, October, and November by Gill Nets

Metric	2015	2016	2017	2018	2019
Total Catch	145	159	146	167	228
Stock Catch	145	159	146	167	213
Units of Effort	30	30	30	30	30
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.5 (27)
Stock CPUE (RSE)	4.8 (13)	5.3 (16)	4.9 (13)	5.6 (10)	7.1 (15)
Quality/Density CPUE (RSE)	3.4 (15)	4.5 (18)	4.8 (13)	5.6 (10)	5.9 (18)
Preferred CPUE (RSE)	0.1 (69)	0.4 (56)	1.3 (17)	3.2 (12)	4.8 (17)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (100)	0.0 (.)	0.0 (.)	0.3 (33)
Total CPUE (RSE)	4.8 (13)	5.3 (16)	4.9 (13)	5.6 (10)	7.6 (15)
PSD S-Q	28.97	15.72	1.37	.	16.9
PSD Q-P	68.28	77.36	72.6	43.11	15.49
PSD P-M	2.76	6.29	26.03	56.89	62.91
PSD M-T	.	0.63	.	.	4.69
PSD	71.03	84.28	98.63	100	83.1
Mean WR S-Q (RSE)	96 (2)	91 (2)	82 (1)	. (.)	103 (1)
Mean WR Q-P (RSE)	94 (1)	90 (1)	93 (1)	97 (1)	103 (1)
Mean WR P-M (RSE)	94 (6)	86 (2)	97 (1)	96 (1)	103 (1)
Mean WR M-T (RSE)	. (.)	80 (.)	. (.)	. (.)	95 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Catfish (*Ictalurus furcatus/Ictalurus punctatus/Pylodictis olivaris*)

Blue catfish, channel catfish, and flathead catfish all occur at Wilson Reservoir and 12% of anglers interviewed in the 2016 angler creel survey indicated they preferred to fish for catfish. Channel catfish are the most targeted and have inhabited the reservoir since it's construction, but blue catfish are growing in popularity since they were first stocked in 2006. Channel catfish numbers have been variable but seems to have increased in recent years (Table 10). Channel catfish is managed with no length restrictions and a 10 per day creel limit. Blue catfish have been controlled mostly by stockings since 2006 but evidence of natural recruitment was finally observed in 2019 (Table 11). Blue catfish are managed with a 32- to 40-inch protective slot and a creel limit of 2 per day, only one of which can be harvested that is greater than 40 inches per day.

Table 10. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled September, October, and November by Gill Nets

Metric	2015	2016	2017	2018	2019
Total Catch	81	72	107	168	147
Stock Catch	81	72	82	112	144
Units of Effort	30	30	30	30	30
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.8 (35)	1.9 (20)	0.1 (56)
Stock CPUE (RSE)	2.7 (10)	2.4 (14)	2.7 (13)	3.7 (14)	4.8 (10)
Quality/Density CPUE (RSE)	1.9 (15)	1.7 (15)	2.6 (13)	3.1 (14)	2.9 (13)
Preferred CPUE (RSE)	0.1 (47)	0.2 (42)	0.1 (56)	0.4 (33)	0.5 (30)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (100)	0.0 (.)	0.0 (100)	0.0 (100)
Total CPUE (RSE)	2.7 (10)	2.4 (14)	3.6 (13)	5.6 (11)	4.9 (10)
PSD S-Q	30.86	27.78	6.1	17.86	40.28
PSD Q-P	64.2	65.28	90.24	72.32	50
PSD P-M	4.94	5.56	3.66	8.93	9.03
PSD M-T	.	1.39	.	0.89	0.69
PSD	69.14	72.22	93.9	82.14	59.72
Mean WR S-Q (RSE)	86 (2)	84 (2)	83 (4)	86 (1)	87 (1)
Mean WR Q-P (RSE)	85 (1)	82 (1)	87 (1)	88 (1)	91 (1)
Mean WR P-M (RSE)	80 (1)	88 (3)	96 (7)	100 (3)	95 (2)
Mean WR M-T (RSE)	. (.)	107 (.)	. (.)	89 (.)	83 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Table 11. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish Sampled During September, October, and November by Gill Nets

Metric	2015	2016	2017	2018	2019
Total Catch	11	15	17	10	7
Stock Catch	11	14	16	10	7
Units of Effort	30	30	30	30	30
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (100)	0.0 (100)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	0.4 (36)	0.5 (32)	0.5 (31)	0.3 (36)	0.2 (39)
Quality/Density CPUE (RSE)	0.3 (36)	0.5 (32)	0.5 (31)	0.3 (40)	0.2 (42)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (100)	0.1 (47)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	0.4 (36)	0.5 (30)	0.6 (29)	0.3 (36)	0.2 (39)
PSD S-Q	9.09	.	.	20	28.57
PSD Q-P	90.91	100	100	70	14.29
PSD P-M	.	.	.	10	57.14
PSD M-T	.	.	.	.	.
PSD	90.91	100	100	80	71.43
Mean WR S-Q (RSE)	95 (.)	. (.)	. (.)	93 (5)	101 (4)
Mean WR Q-P (RSE)	91 (3)	94 (2)	97 (2)	101 (2)	109 (.)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	87 (.)	110 (2)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Metric	2015	2016	2017	2018	2019
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Striped Bass (*Morone saxatilis*)

Striped bass survive very well at Wilson Reservoir but do not naturally reproduce. They must be stocked to maintain the population. Wilson is one of only four reservoirs where Striped Bass are stocked and consistently ranks as the best population in Kansas in terms of numbers of individuals sampled in gill nets annually. Gill net catch data is typically very consistent because large fluctuations due to natural recruitment seen in other fish populations doesn't occur with Striped Bass (Table 12). Nine percent of anglers interviewed in the 2016 angler creel survey indicated that Striped Bass was their most preferred species to fish for. This species doesn't grow very well in warm water conditions when forage is limiting; therefore, the population's health is controlled by stocking density and Gizzard Shad production. Although summer fish kills are common for adult Striped Bass in some reservoir populations in the eastern United States this isn't a common occurrence at Wilson.

Table 12. CPUE, PSD, Wr, and RSE Estimates for Striped Bass Sampled During September, October, and November by Gill Nets

Metric	2015	2016	2017	2018	2019
Total Catch	88	83	60	78	35
Stock Catch	86	83	53	78	35
Units of Effort	30	30	30	30	30
Sub-Stock CPUE (RSE)	0.1 (69)	0.0 (.)	0.2 (44)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	2.9 (15)	2.8 (17)	1.8 (18)	2.6 (26)	1.2 (25)
Quality/Density CPUE (RSE)	2.2 (16)	1.1 (22)	1.6 (20)	2.4 (27)	0.7 (28)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (100)	0.1 (47)	0.1 (69)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	2.9 (15)	2.8 (17)	2.0 (15)	2.6 (26)	1.2 (25)
PSD S-Q	23.26	60.24	11.32	6.41	37.14
PSD Q-P	76.74	39.76	86.79	88.46	57.14
PSD P-M	.	.	1.89	5.13	5.71
PSD M-T	.	.	.	.	.
PSD	76.74	39.76	88.68	93.59	62.86
Mean WR S-Q (RSE)	88 (2)	93 (1)	84 (5)	88 (3)	93 (1)
Mean WR Q-P (RSE)	70 (1)	91 (1)	87 (1)	87 (1)	88 (2)
Mean WR P-M (RSE)	. (.)	. (.)	87 (.)	89 (4)	82 (2)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Largemouth Bass (*Micropterus salmoides*)

Largemouth bass and other sunfish species are dependent on reservoir productivity and habitat. They generally are regulated by abiotic conditions that affect productivity. Periods of drought and reduced surface elevation that allow vegetation to grow along exposed shorelines provide optimal habitat for largemouth bass when the reservoir refills. The populations tend to decline in abundance as these conditions decline and water levels remain stable or decline due to another drought. Wilson Reservoir's water level management plan allows for a 1-foot rise in water level in the early spring to allow for the inundation of shoreline habitat to increase the spawning potential for sport fish, especially largemouth bass. However, in recent years this water level benchmark has not been maintained consistently. Low inflows, flooding, and shoreline erosion maintenance projects have had impacts on maintaining this elevation goal.

The largemouth bass population continues to improve since the reservoir refilled in late 2016 (Table 13). It has ranked as one of the top 3 bass fishing reservoirs in terms of electrofishing catch rates the last two years. Bass tournaments were conducted by anglers nearly every weekend from late April through early October 2019 (Table 14). A 5-fish limit of greater than 19 lbs. was needed to win most tournaments. The number of bass boats anecdotally seen on the reservoir have reached the highest level in nearly a decade. However, only 4% of anglers interviewed during the 2016 angler creel survey indicated they preferred to fish for largemouth bass. This low angler preference is likely the result of the population having been in decline since the drought that lasted through the spawning period in 2016. The population has rebounded, and we would suspect that percentage to be closer to 25%, however no recent creel survey has been conducted to corroborate that estimate.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Largemouth Bass Sampled During May by Electrofishing

Metric	2015	2016	2017	2018	2019
Total Catch	8	13	114	240	276
Stock Catch	8	12	102	231	271
Units of Effort	1.89	3.8	5.82	5.96	4.38
Sub-Stock CPUE (RSE)	0.0 (.)	0.4 (100)	2.0 (27)	1.5 (40)	1.6 (50)
Stock CPUE (RSE)	4.6 (39)	4.1 (31)	16.9 (27)	38.7 (17)	61.4 (11)
Quality/Density CPUE (RSE)	4.6 (39)	3.6 (35)	7.7 (29)	28.7 (18)	50.5 (11)
Preferred CPUE (RSE)	3.7 (43)	3.1 (40)	5.1 (23)	11.2 (19)	24.0 (14)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.2 (100)	0.2 (69)
Total CPUE (RSE)	4.6 (39)	4.5 (28)	18.9 (25)	40.2 (16)	63.0 (11)
PSD S-Q	.	16.67	53.92	25.97	18.68
PSD Q-P	25	16.67	15.69	45.02	45.14
PSD P-M	75	66.67	30.39	28.57	35.80
PSD M-T	.	.	.	0.43	0.39
PSD	100	83.33	46.08	74.03	84.13
Mean WR S-Q (RSE)	. (.)	84 (8)	107 (1)	97 (1)	93 (1)
Mean WR Q-P (RSE)	83 (7)	77 (1)	100 (2)	106 (1)	102 (1)
Mean WR P-M (RSE)	88 (2)	79 (4)	91 (2)	106 (1)	104 (1)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	88 (.)	111 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	0 (.)

Table 14. Bass Tournaments Registered with a State Park Permit at Wilson Reservoir in 2019

Date	Tournament	Days
04/20/2019	I70 Bass Anglers	1
05/04 – 05/05/2019	KS BASS Nation-Youth Division	2
05/04/2019	Sunflower Team Series	1
05/11/2019	Hays Bass Anglers	1
05/18/2019	Hays Bass Anglers	1
06/01/2019	Central KS Wildlife Association	1

Date	Tournament	Days
07/20/2019	I70 Bass Anglers	1
08/03 – 08/04/2019	The Bass Federation of KS	2
08/24 – 08/242019	Kansas BASS Nation	2
09/07/2019	Hays Bass Anglers	1
09/14 – 09/15/2019	East Kansas Bassmasters	2
09/21 – 09/22/2019	Boothill Bass Club	2
09/21/2019	The Bass Federation of KS	1
09/29/2019	Kansas State University	1
10/05 – 10/06/2019	Oregon Trail Bass Masters	2
10/05 – 10/06/2019	Sunflower Team Series	2

Note: This includes only those tournaments that registered for a state park permit in order to have a weigh-in at the state park. All other, non-weigh-in, tournaments are not included here.

Smallmouth Bass (*Micropterus dolomieu*)

Smallmouth bass is a popular sport fish at Wilson Reservoir and 3% of anglers ranked the species as their preferred species to fish for during the 2016 angler creel survey. This population is more stable than largemouth bass as they are not as dependent on aquatic vegetation and swings in productivity. Smallmouth bass abundance was not as negatively affected as other species during the drought. Furthermore, the abundant rocky sandstone provides great spawning habitat smallmouth bass and forage opportunities for crayfish, a common forage item. While the largemouth bass occurs throughout the reservoir the smallmouth bass is restricted to the lower 50-60% of the reservoir and aren't common west of the USACE managed Minooka Park.

Forage Population Dynamics & Trends

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard shad recruitment is inconsistent at Wilson Reservoir, but production has been high during years of high water (e.g., 2016, 2017, 2019; Table 15). This species is the primary forage for pelagic (referring to open-water regions not directly influenced by the shore and bottom; limnetic (Cole, G.A. 1994. Textbook of Limnology, 4th ed. Waveland Press, Prospect Heights, Illinois, USA)) predators in the reservoir such as blue catfish, striped bass, walleye, and white bass but provide ample forage for most other piscivorous (fish-eating) sport fish. The low abundance of gizzard shad during 2012 – 2016 was evident due to the poor body condition and low relative weight values for striped bass during that timeframe.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During September, October, and November by Gill Nets

Estimate Source	Metric	2015	2016	2017	2018	2019
Gill Nets	Total Catch	14	95	90	41	137
Gill Nets	Stock Catch	1	15	76	41	113
Gill Nets	Units of Effort	30	30	30	30	30
Gill Nets	Total CPUE (RSE)	0.5 (30)	3.2 (37)	3.0 (20)	1.4 (21)	4.6 (20)
Gill Nets	PSD S-Q	.	.	94.74	78.05	59.29
Gill Nets	PSD Q-P	.	53.33	.	4.88	40.71
Gill Nets	PSD P-M	100	46.67	5.26	17.07	.
Gill Nets	PSD	100	100	5.26	21.95	40.71
High-frequency Electrofishing	Metric	2015	2016	2017	2018	2019
High-frequency Electrofishing	Total Catch	-	-	-	337	2,692

Estimate Source	Metric	2015	2016	2017	2018	2019
High-frequency Electrofishing	Effort (hr)	-	-	-	1	1
High-frequency Electrofishing	Total CPUE (#/hr)	-	-	-	337	2,692
High-frequency Electrofishing	Mode Length (mm)	-	-	-	200	90

White Perch (*Morone americana*)

White perch catch rates in gill nets had been declining for nearly 10 years at Wilson Reservoir. The droughty conditions precluded their recruitment and numbers reached historic lows in 2015 (Table 16). However, the recruitment was extremely successful as the water levels returned in 2016 and 2018. The mean length of white perch quickly fell from 240 millimeters (mm) during the drought to 140 mm post drought. The high abundance of White Perch has been alarming. Catch rates have approached a nearly all-time high in the 2019 sample. Fortunately, the number of young-of-year and age-0 fish collected in gill nets and trap nets seemed to drop and larger individuals have been collected. This is likely, in part, responsible for the increase in walleye and white bass recruitment. The high water is also responsible. The flooded habitat increased available nursery habitat for all species of fish in the reservoir. White perch provide an alternative forage for sport fish at Wilson Reservoir but their extreme abundance, interspecific competition, and appetite for fish eggs creates more negative than positive results.

Table 16. CPUE, PSD, Wr, and RSE Estimates for White Perch Sampled During September, October, and November by Gill Nets

Metric	2015	2016	2017	2018	2019
Total Catch	229	367	237	104	559
Stock Catch	229	367	201	72	541
Units of Effort	30	30	30	30	30
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	1.2 (42)	1.1 (54)	0.6 (34)
Stock CPUE (RSE)	7.6 (14)	12.2 (13)	6.7 (14)	2.4 (12)	18.0 (14)
Quality/Density CPUE (RSE)	6.9 (15)	6.0 (17)	1.8 (27)	0.5 (25)	3.2 (31)
Preferred CPUE (RSE)	5.3 (18)	3.9 (18)	1.2 (32)	0.3 (33)	1.0 (38)
Memorable/Lunker CPUE (RSE)	1.4 (29)	0.9 (29)	0.7 (38)	0.1 (74)	0.4 (42)
Total CPUE (RSE)	7.6 (14)	12.2 (13)	7.9 (15)	3.5 (19)	18.6 (13)
PSD S-Q	9.61	51.23	72.64	79.17	82.44
PSD Q-P	21.4	16.62	8.96	6.94	11.83
PSD P-M	51.09	25.07	8.46	9.72	3.7
PSD M-T	17.9	7.08	9.95	4.17	1.66
PSD	90.39	48.77	27.36	20.83	17.56
Mean WR S-Q (RSE)	86 (4)	77 (1)	80 (2)	83 (6)	73 (1)
Mean WR Q-P (RSE)	94 (1)	85 (1)	80 (2)	79 (3)	87 (1)
Mean WR P-M (RSE)	102 (1)	96 (1)	80 (2)	86 (2)	94 (2)
Mean WR M-T (RSE)	102 (1)	103 (1)	84 (2)	84 (6)	110 (3)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	0 (6)

Brood Supply

Wilson Reservoir was used as a brood supply source for walleye in 1995, 1996, and 1997. The females were collected, and their eggs were fertilized, hatched in our culture system, and eventually used to stock impoundments throughout the state. This operation collected approximately 25 – 30 million eggs each year in 10 days of effort. Trap nets were used to collect fish, primarily on or near the dam. The introduction of White Perch in 1996 and their prevalence in trap nets led to the cessation of this project at Wilson Reservoir. Walleye collection for brood supply still occurs in other reservoirs and might occur again at Wilson in the future.

Use/Visitation Impacts

1) Drought conditions reduced visitation considerably from 2012 – 2016.
2) Aquatic Nuisance Species are a constant issue at Wilson Reservoir. Walleye anglers have voiced their displeasure with white perch competing with walleye for their bait, specifically earthworms. However, it is their negative interaction with other sport fish and reduction in natural recruitment that has caused inconsistency with some sport fish populations that might deter angler visitation.
3) Competitive bass tournaments have created a positive impact on visitation from 2017 through the present. It is possible that high weekend use by bass anglers have precluded other user groups from visiting but that has not been documented.

The distance from population centers might impact use in years of high gasoline prices. However, that might impact camping and general day use more than angling use and visitation.

Future Without Project Projections

Biennial stockings for striped bass will continue to be requested from the culture system. They do not reproduce naturally at Wilson Reservoir and must be maintained by stocking. Largemouth bass stockings have had some success, especially as the reservoir is rising after an elevation decrease brought on by drought. Stocking largemouth bass during a refilling event allows the population to rebound more rapidly and fill unoccupied niche habitat one or two years quicker than would naturally occur. However, stocking during stable conditions has provided limited success and is not warranted. Walleye and blue catfish will be stocked as needed, generally when natural recruitment fails for one to three years.

Wilson Reservoir was ranked as the most preferred reservoir to fish by anglers during the 2013 Licensed Angler Survey. Due to low sedimentation rate, lack of harmful agal blooms, and quality fishing opportunities it is unlikely that use and visitation at Wilson Reservoir will decline significantly in the next 100 years. Angling will continue at Wilson Reservoir in the future, but targeted species may vary depending on fluctuating factors that affect fish abundance and condition or their habitat. If a fish species highly sought by anglers declines this could affect the angling experience in the future and fisherman may choose to move to another reservoir.

Water levels will continue to fluctuate due to the variable annual precipitation in the region with drought conditions in some years that cause a decline in pool elevations and inundation of specific habitats (e.g., coves, shorelines) leading to a lack of vegetation and structure near the shoreline used for fish spawning and escape habitat. In other years high water elevations that are sustained will provide excellent habitat for young of the year fish allowing some fish species to have good year classes recruited to the fishery (e.g., largemouth bass). However, significant flooding can kill large areas of common reed grass and shoreline vegetation utilized by fish species. Zebra mussels and white perch could continue to increase at Wilson Reservoir altering food webs in the reservoir and consuming fish eggs creating recruitment issues for sport fish.

While sedimentation will continue to occur (3.3% loss of the multipurpose pool over the next 50 years) it is not expected to create impacts to reservoir fisheries or their habitat in the future. Shoreline erosion and deposition of silt will continue to cause stressors to fish populations leaving littoral areas unvegetated and silting in important areas fish use for spawning, nursery habitat, and protective cover.

KDWP will continue to monitor and regulate sport fishing populations to provide the best conservation of the resource for anglers. Habitat improvements, most likely in the form of brush piles as fish attractors and shoreline vegetation for improved littoral productivity, will be accomplished intermittently. Boat ramps will continue to be assessed to provide reasonable boat access for anglers. Shoreline access will be maintained for bank anglers. A new fish cleaning station is being purchased for 2021 to allow ease for anglers to process fish onsite.

Fisheries management objectives will continue to optimize the quality and diversity of angling opportunities through enhancement of population abundance as needed. Fisheries management measures will continue to include fish harvest regulations, habitat work, aquatic vegetation enhancement, fish stocking, and special studies, and sampling to monitor trends. Creel surveys for angler use and preferences will also continue to support management of the fisheries. Fish species that inhabit Wilson Reservoir are not expected to change in the future but will have periods where changes in abundance and shifts in sportfish species dominance occur from conditions that affect habitat quantity and quality, similar to what is now experienced at Wilson Reservoir.

References

U.S. Army Corps of Engineers. 1983. Lake Regulation Manual, Wilson Lake, Kansas.

Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery
Location: Kanopolis Reservoir
Travis Riley, KDWP District Fisheries Biologist

Kanopolis Reservoir Located on the Smoky Hill River in Southeast Ellsworth County, Kansas

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History

Kanopolis Reservoir is an impoundment of the Smoky Hill River located in southeastern Ellsworth County, Kansas. Construction, operation, and maintenance of the reservoir for flood control was authorized by the Flood Control Act of 1938, Public Law 75-761, as modified by the Flood Control Act of 1941, Public Law 77-228, and modified by the Flood Control Act of 1944 Public Law 78-534. Secondary purposes (i.e., irrigation, water supply, low flow supplementation, recreation, and fish and wildlife) were authorized by the Flood Control Act of 1946 Public Law 79-536 and Title I by Public Law 94-423.

Construction of Kanopolis Dam began in 1940 and was completed in 1948 (USACE). It is the oldest reservoir in Kansas and is operated in tandem with upstream Cedar Bluff Reservoir, a USBR project to regulate flows in the Smoky Hill River Basin. The relatively long and narrow drainage basin above the dam consists of approximately 7,850 square miles. Of this, an area of 5,530 square miles is above Cedar Bluff Dam, and since 1950 have been regulated by that project. The 2,330 square miles of drainage area between Cedar Bluff Dam and Kanopolis Dam is about 80 miles long and varies in width from 32 miles at Ellis to 17 miles at Ellsworth, Kansas. Kanopolis Dam is located approximately 184 river miles above the mouth of the Smoky Hill River.

Water Allocation Background

Kanopolis Reservoir was constructed by the U.S. Army Corps of Engineers (USACE) as a multipurpose facility for flood control, irrigation, water supply, low flow supplementation, recreation, as well as fish and wildlife purposes. The original reservoir storage capacity included 447,091 acre-feet storage for flood control and 73,200 acre-feet for multipurpose use. Following sediment surveys in 1993 reservoir storage capacity was reduced and included approximately 418,387 acre-feet storage for flood control and 50,273 acre-feet for multipurpose use.

The State of Kansas entered into an agreement for municipal and industrial water supply with the USACE in 2002. The agreement allowed the State of Kansas to use storage space in the multipurpose pool between elevations 1431 and 1463 feet mean sea level (msl), for 12,500 acre-feet of storage. The original pool storage capacity, pool storage capacity in 1993 following sediment surveys, and pool storage capacity with the 2002 reallocation agreement are shown in Table 1.

Table 1. Storage Capacity and Ownership

Pool Owner	Purpose	Quantity (acre-feet [af])
1948		
USACE	Flood Control	447,091
USACE	Multipurpose	73,200
1993[1]		
USACE	Flood Control	418,387
USACE	Multipurpose	50,273
2002[2]		
USACE	Flood Control	418,387
Kansas Water Office	Municipal and Industrial Water Supply	12,500
USACE	Multipurpose Uses	22,748[3]

Notes: 1. August 1993 Surveys

2. Reallocation Agreement
3. Reflects additional sediment storage loss (1993-2024) of 15,025 acre-feet from multipurpose pool

Kanopolis Reservoir Fishery

Fisheries Establishment

Kanopolis Reservoir, a productive system in terms of total phosphorous and associated phytoplankton growth, has abundant sportfish populations including channel catfish (*Ictalurus punctatus*), crappie (*Pomoxis annularis*), saugeye (*Sander vitreus* X *S. canadensis*) , wipers (*Morone saxatilis* X *M. chrysops*), and white bass (*Morone chrysops*). Unfortunately, the reservoir has struggled to provide an adequate largemouth (*Micropterus salmoides*) or smallmouth bass (*Micropterus dolomieu*) fishery. Smallmouth bass have historically been stocked but water quality conditions precluded their establishment. Walleye (*Sander vitreus*) were stocked commonly over the years and a few still occur but, due to low water retention rates (high flow through), saugeye have been more successful. Kanopolis has regularly ranked in the top 2 reservoirs in the state for saugeye densities. It is currently ranked as the fourth preferred reservoir to fish for saugeye and walleye. Blue catfish (*Ictalurus furcatus*) have been stocked since 2008 but minimal evidence of their contribution to the fishery has been documented. One blue catfish was collected in 2016 and several more were collected in 2017. Dense stockings in 2017 and 2018 seem to have bolstered this population and anecdotal growth estimates seem to be high.

Tables 2 and 3 list sport fish and non-sport fish in Kanopolis Reservoir. More detailed treatment of recent species-specific stocking efforts is detailed in species narrative in the Sportfish Dynamics & Trends section.

Table 2. Sport and Non-Sport Fish Species Known to Inhabit Kanopolis Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Blue Catfish	*Ictalurus furcatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodicitis olivaris*
Freshwater Drum	*Aplodinotus grunniens*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Longear sunfish	*Lepomis megalotis*
Saugeye	*Sander canadensis X S. vitreus*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3 . Non-Sport Fish Species Known to Inhabit Kanopolis Reservoir

Common Name	Scientific Name
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Fathead Minnow	*Pimephales promelas*
Golden Shiner	*Notemigonus crysoleucas*

Common Name	Scientific Name
Orangespotted sunfish	*Lepomis humilus*
Log Perch	*Percina caprodes*
Plains Killifish	*Fundulus zebrinus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Suckermouth Minnow	*Phenacobius mirabilis*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. Water Quality

Kanopolis Reservoir, now greater than 70 years old, is aging. Senescence is a natural process in all lakes but occurs more rapidly in man-made reservoirs. Water inflows carrying sediments and nutrients have decreased water quality at the lake but, fortunately few blue-green algae blooms have occurred, although a brief harmful algal bloom was documented in 2020. As Kanopolis Reservoir has aged it has transitioned into the eutrophic classification (value of 55-59 for trophic state index (TSI)) and almost the very eutrophic classification (value of 60-63 for TSI) as noted by a value of 59.8 for the TSI for the sample collected in 2009 (Table 4). This is a change from a value of 52.1 for TSI in 2006 which would rate the reservoir as slightly eutrophic (value of 50-54 for TSI). Eutrophic lakes are very fertile and have fast fish growth.

Table 4. General Limnological Parameters Characteristic of Kanopolis Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	3500.0
Max depth	feet	42.7
Mean depth	feet	15.0
Mean annual runoff	inches	68.7
Area watershed drainage	square miles	2439.1
Hydrologic residence time	days	149.0
Chlorophyll a	parts per billion	19.7
Secchi depth	centimeters	148.0
Shoreline development index	ratio	3.4
Agricultural lands	%	48.9
Forest habitat	%	0.8
Grassland habitat	%	42.9
Urban lands	%	5.6
*Trophic state index		59.8

Note: *Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuations

Annual precipitation is variable in Kansas and there is a gradient of low (10 – 20") precipitation in western Kansas to high (40 – 50") precipitation in southeastern Kansas. Kanopolis Reservoir is located in central Kansas and receives, on average, 28 – 30" annually. Summer temperatures in central Kansas can reach temperatures more than 43°C (110°F). These temperatures and generally windy conditions on the plains causes the evaporation of approximately 1.2 m (4') or more of water each year. Combine these droughty conditions with a steady decline in western Kansas surface water, due partially to drastic and annual declines in the depth of the Ogallala Aquifer, and you have a recipe for major water level fluctuations.

Kanopolis Reservoir is used as a public water supply and has experienced elevation fluctuations, but not to the extent as far western Kansas reservoirs (i.e. Cedar Bluff and Webster reservoirs). Normal summer elevation is 1467 feet, four feet above conservation pool. After wet years in the mid-1990s, dry years occurred during the mid-2000s. The reservoir experienced very droughty conditions between 2012 and 2013 causing it to drop to an elevation of nearly 1457 feet or 6 feet below conservation pool (Figure 1). Boat ramps were unusable for part of 2013. The South Shore boat ramp is the only useable ramp when the reservoir is below conservation pool but becomes unusable if the elevation drops more than a foot below conservation pool. In July 2019 the reservoir rose approximately 33 feet above conservation pool, the highest elevation since the 1993 flood and the third highest since the reservoir was impounded. This sustained high-water event provided excellent habitat for young of the year fish and allowed several species to have good year classes recruited to the fishery. However, one problem associated with the release of flood waters is the quick nature of the drawdown. These quick drawdowns have led to a decrease in saugeye catch rates in the following years as it is assumed that many were lost through the outflow of the dam. The reservoir was fairly stable in 2020 but was kept below conservation pool for most of the non-recreational season due to maintenance in the spring and dam and spillway inspections in October.

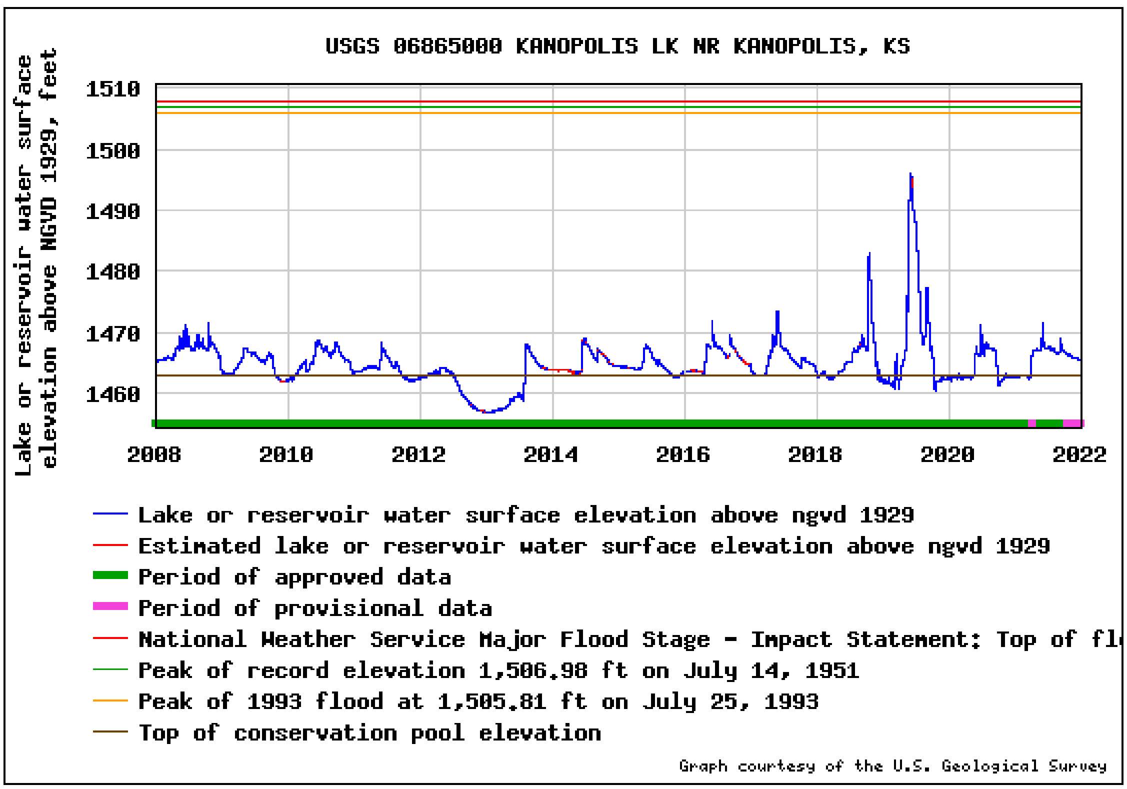


Figure 1. Kanopolis Reservoir Elevation (feet above sea level) from January 1, 2008 Through January 1, 2022

3. Sedimentation

The multipurpose pool at Kanopolis Reservoir originally included 73,200 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 36% of the multipurpose pool has been filled in with sediment leaving approximately 47,170 ac-ft of capacity (based on 2017 survey results). It is estimated that approximately 374 ac-ft of sediment accumulates on average annually in Kanopolis Reservoir. Sediment will continue to accumulate in Kanopolis Reservoir with an expected additional 18.8 % loss of the multipurpose pool over the next 25 years (2049) and 29.4% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 25,300 ac-ft in 2074.

Sedimentation is the most critical stressor to fish populations as shorelines erode and leave littoral areas unvegetated. Shallow, silty littoral habitat fills in interstitial spaces in rock and woody cover and leaves most areas unsuitable for fish spawning, nursery habitat, and protective cover. Addition of woody habitat has been used to mitigate for this loss of habitat but is limited by manpower and budget constraints.

The far upper end of the lake is inaccessible by traditional outboard boats and most of the upper end's shoreline is eroded and shallow. Nonetheless, there is still deeper, unstratified water (approximately 30 feet near the dam) in the middle and lower ends of the reservoir.

4. High Flow Through

The most impactful stressors to the fisheries are high flows through the dam and sedimentation. High flows through the dam causes fish entrainment through the dam that is mostly uncontrollable in years with high inflow. Fish stockings are necessary to resupply the reservoir with sport fish. Walleye typically experience entrainment at high rates so fisheries staff stock saugeye instead. Saugeye are entrained from the reservoir at lower rates than walleye but some are still lost during extreme flow through events (e.g. the 2019 flood).

5. Vegetated Fisheries Habitat

Due to the age, amount of sediment present in the reservoir, and 4 foot draw down in the winter there is limited aquatic vegetation present in Kanopolis Reservoir. This lack of vegetation along with the lack of structure in the littoral zone has led to problems trying to establish some sportfish species in the reservoir (e.g., black bass). Future vegetation establishment projects will be hampered by the large winter draw down which would lead to most vegetation exposed and out of the water during the winter months.

6. Invasive/Exotic Species

Zebra mussels (*Dreissena polymorpha*), an aquatic nuisance species (ANS), were established in Kanopolis Reservoir in 2011 and have since become weakly established throughout the lower portion of the reservoir. There are also Chinese mystery snails (*Bellamya chinensis*) below the reservoir in Sand Creek (referred to as the Kanopolis Seep Stream). No studies have investigated their degree of invasiveness in Kansas. They seem to remain low in abundance here and have had minimal effects.

Fisheries Management Objectives

Fisheries in Kanopolis Reservoir are managed by the fisheries division of the Kansas Department of Wildlife and Parks (KDWP). Fisheries management activities include fish sampling, creel surveys, habitat work, aquatic vegetation enhancement, fish stocking, and special studies to monitor fish populations and improve fishing opportunities.

Specific objectives for Kanopolis Reservoir are listed below.

1. Saugeye: Maintain a percid population with biennial fingerling saugeye stockings. Maintain a stock CPUE of at least 3 saugeye per core panel gill net night (GNN). If stock CPUE is less than 3 then increase saugeye stocking rate for the next stocking year.
2. Wiper (Striped Bass x White Bass hybrids): Maintain a wiper population with biennial fingerling stockings. Maintain a CPUE of at least 5 wiper per GNN. If CPUE is less than 5/GNN then increase wiper fingerling stocking rate for the next year.
3. Largemouth Bass: Obtain a largemouth bass population characterized by a stock CPUE (stock/EFH) of at least 50/EFH. If stock CPUE is less than 50/EFH then stock early spawn largemouth bass fingerlings and enhance brush and synthetic habitat. An objective for PSD-P will be added if the population becomes established.
4. Trout: Continue the trout stocking program in the seep stream with multiple seasonal stockings of catchable sized rainbow and brown trout with the intent of producing a year-round fishery.
5. Continue to maintain catchable fish populations in the various Kanopolis State Park ponds with yearly channel catfish stockings.

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Kanopolis Reservoir.

1. Riprap Installation in Areas of Critical Shoreline Infrastructure

With Kanopolis Reservoir being the oldest reservoir in the state and the subsequent sedimentation issues that it is currently experiencing, there is a lack of structure and vegetation. Riprap that has been installed around boat ramps and other areas experiencing erosion around the reservoir have provided habitat and escape cover to the fishery. These areas also attract anglers where they are present throughout the reservoir.

Standard and Supplemental Fish Sampling to Monitor Sportfish Trends

Standard fish population sampling is employed on an annual basis and is conducted using standardized methods approved by KDWP Fisheries staff and applied at Kanopolis Reservoir and other Kansas waters to develop baseline trend data by which Kansas fisheries are managed. At Kanopolis Reservoir, electrofishing is used to sample the largemouth bass population in spring, and core panel gill nets and ½” mesh fyke nets are employed each fall to sample other sportfish species such as blue catfish, bluegill, channel catfish, crappies, white bass, wipers, and saugeye.

Supplemental fish population sampling is conducted at the discretion of the KDWP District Fisheries Biologist to address specific management questions/challenges. Supplemental sampling can consist of accepted or experimental methods and often focuses on finer detail resolution fish population parameters. Currently, supplemental sampling at Kanopolis Reservoir consist of low frequency electrofishing for blue and flathead catfish.

2. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries

Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Kanopolis Reservoir are, Crappie-20 fish daily creel and a 21- inch minimum length limit on Percids (walleye and saugeye). See Table 5 below for a comprehensive list of fish harvest regulations in effect at Kanopolis Reservoir.

Table 5. Current Fish Harvest Regulations in Effect at Kanopolis Reservoir

Species	Length Limit	Creel Limit
Blue Catfish	35- inch minimum length limit	5 fish daily creel limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	N/A	20 fish daily creel limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Saugeye	18 - inch minimum length limit	5 fish daily creel limit
Walleye	18 - inch minimum length limit	5 fish daily creel limit
Wiper	N/A	2 fish daily creel limit

Source: KDWP 2022

3. Sportfish Stockings

Saugeye and wiper are on a biennial stocking schedule at Kanopolis Reservoir to maintain the population and are stocked more frequently if certain population characteristics are not met. Blue catfish were stocked yearly from 2008 to 2015 at a rate of one per acre, and periodically since at a rate of 10 per acre. Since the change to 10 per acre they have established in the reservoir. Largemouth bass were stocked from 2016 to 2020 with some success, but the high water and subsequent releases from the reservoir seem to have lost those early stockings from the reservoir.

Angler Use

As for angling, the 2013 Kansas Licensed Angler Survey listed Kanopolis Reservoir as the ninth (N = 26) preferred reservoir location to fish in Kansas. It is the tenth most fished reservoir in the state.

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 6) in accordance with KDWP reservoir survey guidelines.

Angler preference for a specific species often varies based upon changes in species dominance that results from water fluctuation history (see Figure 1) and other factors. Walleye have ranked as the most sought-after fish by Kanopolis anglers for the past four creel surveys (see Table 6). There are few walleye left in the reservoir, with most anglers catching and misidentifying saugeye. White bass, channel catfish, and crappie are most often ranked in the top four preferred species, with the ranks changing depending on current abundance of the populations for years surveyed. The most sought-after species tend to show high harvest rates (Tables 5-7). An exception to this is the 2017 creel in which the length limit on walleye and saugeye was changed from 15- inches to 18 inches starting in January of that year. Currently, there are few saugeye above the 18- inch limit due to harvest.

Table 6. Total Number of Anglers, Angler-Hours, and Relative Standard Error (RSE) at Kanopolis Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler Hours	RSE	Angler Hours per Acre
1999	29,966	8.44	62,114.93	9	17.50
2004	9,465	2.67	32,971.30	15	9.29
2009	16,93	4.70	52,785.36	11	14.87
2017	13,208	3.72	45,378.29	12	12.78

Source: KDWP 2022

Table 7. Average Percentages of the Top Four Most Preferred Species by Anglers at Kanopolis Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	First		Second		Third		Fourth	
1999	Walleye	31.1	Crappie	29.6	White Bass	23.5	Channel Catfish	13.8
2004	Walleye	56.5	Channel Catfish	17.3	White Bass	10.9	Crappie	6.9
2009	Walleye	45.1	Channel Catfish	19.9	White Bass	14.2	Other	13.9
2017	Walleye	48.4	No Fish Preference	21.9	Channel Catfish	18.7	White Bass	6.1

Source: KDWP 2022

Table 8. Estimated Total Number of Sportfish Harvested and Released at Kanopolis Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Status	Year	White Bass	Channel Catfish	Walleye	Saugeye	White Crappie
Harvested	1999	6,027	1,525	2,666	463	5,643
Harvested	2004	9,549	5,703	1,807	868	4,325
Harvested	2009	15,421	7,434	5,839	1,028	4,626
Harvested	2017	2,194	5,309	539	158	N/A
Released	1999	5,369	2,414	2,853	62	1,287
Released	2004	1,331	599	6,243	220	388
Released	2009	10,605	2,649	9,396	93	1,777
Released	2017	1,768	2,345	18,198	1,381	N/A

Source: KDWP 2022

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Saugeye and Walleye (Percids) (*Sander vitreus X S. canadensis/Sander vitreus*)

Percids at Kanopolis consist mostly of stocked saugeye, a hybrid of walleye and sauger. Saugeye do not typically naturally recruit in the reservoir and are controlled by stockings. Saugeye were first stocked in Kanopolis in 1996 and annual stockings occurred through 2015. The saugeye population is now stocked biennially to improve growth rates and reduce potential predation of other piscivorous sport fish (e.g., largemouth bass). Many adult saugeye were entrained during the 2019 flooding but juvenile recruitment from stockings has been consistent (Table 8). Walleye still occur but in low abundance.

Percids are most often ranked as the most preferred species to target by anglers at Kanopolis Reservoir. They were ranked by 50% of anglers as their most preferred species to fish for at Kanopolis in a 2017 angler creel survey.

Table 9. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and RSE Estimates for Saugeye Sampled During September, October, and November by Gillnets

Metric	2015	2016	2017	2018	2019
Total Catch	165	63	109	124	106
Stock Catch	164	63	106	124	88
Units of Effort	21	21	21	16	17
Sub-Stock CPUE (RSE)	0.0 (100)	0.0 (.)	0.1 (73)	0.0 (.)	1.1 (29)
Stock CPUE (RSE)	7.8 (15)	3.0 (17)	5.0 (16)	7.8 (14)	5.2 (13)
Quality/Density CPUE (RSE)	6.0 (17)	3.0 (17)	4.8 (16)	7.7 (13)	2.1 (22)
Preferred CPUE (RSE)	0.7 (32)	0.6 (33)	2.2 (22)	5.8 (16)	1.9 (20)
Memorable/Lunker CPUE (RSE)	0.2 (46)	0.0 (100)	0.0 (.)	0.4 (29)	0.2 (54)
Total CPUE (RSE)	7.9 (15)	3.0 (17)	5.2 (17)	7.8 (14)	6.2 (13)
PSD S-Q	23.17	.	5.66	0.81	59.09
PSD Q-P	67.68	80.95	50	24.19	3.41
PSD P-M	6.71	17.46	44.34	69.35	34.09
PSD M-T	2.44	1.59	.	5.65	3.41
PSD	76.83	100	94.34	99.19	40.91
Mean WR S-Q (RSE)	105 (1)	. (.)	103 (2)	113 (.)	105 (1)
Mean WR Q-P (RSE)	99 (1)	97 (1)	101 (1)	106 (1)	108 (3)
Mean WR P-M (RSE)	103 (3)	99 (2)	96 (1)	104 (1)	107 (1)
Mean WR M-T (RSE)	92 (1)	86 (.)	. (.)	107 (2)	100 (6)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Catfish (*Ictalurus furcatus/Ictalurus punctatus/Pylodictis olivaris*)

Blue catfish, channel catfish, and flathead catfish (*Pylodictis olivaris*) all occur at Kanopolis Reservoir and 17% of anglers interviewed in the 2017 angler creel survey indicated they preferred to fish for catfish. Channel Catfish are the most targeted and have inhabited the reservoir since construction but blue catfish are likely to grow in popularity. Blue catfish have been stocked since 2008 at a rate of 1 per acre but few were ever collected with gill nets or low-frequency electrofishing until 2016. Therefore, blue catfish were stocked at a rate of 10 per acre in 2017 and 2018 and those stockings have had success (Table 9). Many catches of blue catfish are now being reported by anglers. Flathead catfish have historically occurred throughout the Smoky Hill River and catches in excess of 50 pounds have been reported at Kanopolis. Hand fishing for flathead catfish has been used by some anglers at Kanopolis but its popularity is minimal. Nonetheless, channel catfish remains the most popular catfish species at Kanopolis with consistent catches in annual samples (Table 10). Due to reservoir senescence, sedimentation, and global climate change it is likely that catfish persist and excel at Kanopolis more so than other pelagic predators.

Table 10. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish Sampled During September, October, and November by Gillnets

Metric	2016	2017	2018	2019
Total Catch	1	7	4	48
Stock Catch	1	1	2	48
Units of Effort	21	21	16	17
Sub-Stock CPUE (RSE)	0.0 (.)	0.3 (43)	0.1 (68)	0.0 (.)
Stock CPUE (RSE)	0.0 (100)	0.0 (100)	0.1 (68)	2.8 (51)
Quality/Density CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	0.0 (100)	0.3 (38)	0.3 (58)	2.8 (51)
PSD S-Q	100	100	100	100
PSD Q-P	.	.	.	.
PSD P-M	.	.	.	.
PSD M-T	.	.	.	.
PSD	0	0	0	0
Mean WR S-Q (RSE)	86 (.)	103 (.)	87 (3)	110 (1)
Mean WR Q-P (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Table 11. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During September, October, and November by Gillnets

Metric	2015	2016	2017	2018	2019
Total Catch	103	64	127	66	198
Stock Catch	103	49	117	35	189
Units of Effort	21	21	21	16	17
Sub-Stock CPUE (RSE)	0.0 (.)	0.7 (24)	0.5 (37)	1.9 (66)	0.5 (29)
Stock CPUE (RSE)	4.9 (13)	2.3 (19)	5.6 (12)	2.2 (29)	11.1 (15)
Quality/Density CPUE (RSE)	4.0 (14)	1.5 (21)	3.7 (14)	1.3 (44)	7.1 (18)
Preferred CPUE (RSE)	0.0 (.)	0.0 (100)	0.0 (.)	0.1 (100)	0.2 (45)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	4.9 (13)	3.0 (18)	6.0 (12)	4.1 (36)	11.6 (15)
PSD S-Q	19.42	36.73	33.33	40	36.51
PSD Q-P	80.58	61.22	66.67	57.14	61.38
PSD P-M	.	2.04	.	2.86	2.12
PSD M-T	.	.	.	.	.
PSD	80.58	63.27	66.67	60	63.49
Mean WR S-Q (RSE)	83 (2)	80 (1)	83 (1)	84 (2)	87 (1)
Mean WR Q-P (RSE)	82 (1)	80 (1)	84 (1)	89 (2)	88 (1)
Mean WR P-M (RSE)	. (.)	100 (.)	. (.)	91 (.)	98 (4)

Metric	2015	2016	2017	2018	2019
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

White Bass (*Morone chrysops*)

White bass survive, grow, and reproduce well at Kanopolis Reservoir and 6% of anglers ranked the species as their most preferred to fish for during the 2017 angler creel survey. Their gill net catch rates ranked first among Kansas federal reservoirs in 2019 (Table 11). White bass move up into the Smoky Hill River in the spring, typically April, to spawn, and while some years this doesn't occur, during years when it occurs it is a popular event for anglers. There is no regulation on size or number that can be harvested, and bountiful harvest occurs during most years.

Table 12. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During September, October, and November by Gillnets

Metric	2015	2016	2017	2018	2019
Total Catch	470	145	171	168	1207
Stock Catch	470	145	171	168	1192
Units of Effort	21	21	21	16	17
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.9 (41)
Stock CPUE (RSE)	22.4 (32)	6.9 (18)	8.1 (17)	10.5 (32)	70.1 (19)
Quality/Density CPUE (RSE)	12.1 (32)	6.9 (18)	8.0 (17)	7.6 (33)	25.2 (20)
Preferred CPUE (RSE)	10.9 (33)	5.7 (19)	7.3 (18)	2.8 (33)	19.1 (21)
Memorable/Lunker CPUE (RSE)	2.8 (36)	2.2 (27)	1.4 (21)	0.6 (58)	3.4 (28)
Total CPUE (RSE)	22.4 (32)	6.9 (18)	8.1 (17)	10.5 (32)	71.0 (19)
PSD S-Q	45.74	.	1.75	27.98	64.01
PSD Q-P	5.53	17.24	8.19	45.24	8.81
PSD P-M	36.17	50.34	73.1	21.43	22.4
PSD M-T	12.55	31.72	16.96	5.36	4.78
PSD	54.26	100	98.25	72.02	35.99
Mean WR S-Q (RSE)	104 (1)	. (.)	98 (5)	99 (1)	101 (1)
Mean WR Q-P (RSE)	102 (1)	95 (1)	97 (1)	101 (2)	104 (1)
Mean WR P-M (RSE)	100 (1)	95 (1)	100 (1)	104 (1)	107 (1)
Mean WR M-T (RSE)	100 (1)	98 (2)	96 (2)	103 (2)	107 (1)
Mean WR T+ (RSE)	. (.)	98 (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

White Crappie (*Pomoxis annularis*)

White crappie are often ranked as one of the most preferred species to fish for at Kanopolis Reservoir and 3% of anglers interviewed during the 2017 angler creel survey listed it as their most preferred species. Crappie grow fast and reproduce well, however recruitment is limited in years with early peaks of inflow and rapid discharges through the dam. The sampling data is highly variable because of the stochastic (random distribution) nature of crappie populations (Table 12). Crappie populations quickly rebound due to their high fecundity (ability to produce an abundance of offspring). Similar to other reservoirs, high water and flooding in 2019 precluded most angler from accessing the reservoir. However, following the flooding event conditions improved and abundance of quality crappie fishing occurred during the winter and spring of 2020. Harvest of crappie was high in 2020 and the public requested protection for the crappie population at Kanopolis Reservoir. The population was protected with a 50 per day creel limit but, due to public objections, the creel limit was reduced to 20 per day beginning in 2021.

Table 13. CPUE, PSD, Wr, and RSE Estimates for White Crappie Sampled During September, October, and November by Trap Nets

Metric	2015	2016	2017	2018	2019
Total Catch	781	887	2643	665	39
Stock Catch	50	39	216	73	13
Units of Effort	14	16	16	9	12
Sub-Stock CPUE (RSE)	52.2 (81)	53.0 (38)	151.7 (34)	65.8 (32)	2.2 (51)
Stock CPUE (RSE)	3.6 (30)	2.4 (31)	13.5 (16)	8.1 (24)	1.1 (33)
Quality/Density CPUE (RSE)	3.5 (31)	2.3 (31)	7.7 (18)	6.9 (25)	0.9 (39)
Preferred CPUE (RSE)	0.9 (47)	1.1 (43)	0.8 (32)	1.6 (49)	0.9 (39)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.1 (68)	0.1 (68)	0.4 (76)	0.0 (.)
Total CPUE (RSE)	55.8 (76)	55.4 (38)	165.2 (31)	73.9 (30)	3.3 (34)
PSD S-Q	2	7.69	43.06	15.07	15.38
PSD Q-P	72	48.72	50.93	65.75	.
PSD P-M	26	38.46	5.09	13.7	84.62
PSD M-T	.	5.13	0.93	5.48	.
PSD	98	92.31	56.94	84.93	84.62
Mean WR S-Q (RSE)	96 (.)	88 (3)	82 (1)	76 (4)	106 (0)
Mean WR Q-P (RSE)	107 (1)	94 (2)	83 (1)	93 (1)	. (.)
Mean WR P-M (RSE)	108 (2)	106 (1)	100 (2)	103 (1)	112 (3)
Mean WR M-T (RSE)	. (.)	108 (0)	108 (6)	103 (2)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Forage Population Dynamics & Trends

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard shad recruitment at Kanopolis Reservoir is consistent and provides ample forage for most sport fish, especially pelagic piscivores including blue catfish, white crappie, saugeye, white bass, and white bass hybrids. Gizzard shad catch during electrofishing in recent years has been extremely consistent and should continue to provide quality forage (Table 13).

Table 14. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During September, October, and November by Gillnets and Electrofishing

Metric	2015	2016	2017	2018	2019
Gillnets					
Total Catch	57	69	48	10	72
Stock Catch	30	66	31	9	68
Units of Effort	21	21	21	16	17
Sub-Stock CPUE (RSE)	1.3 (51)	0.1 (73)	0.8 (33)	0.1 (100)	0.2 (100)

Metric	2015	2016	2017	2018	2019
Stock CPUE (RSE)	1.4 (22)	3.1 (24)	1.5 (29)	0.6 (40)	4.0 (18)
Quality/Density CPUE (RSE)	1.4 (22)	3.1 (24)	1.1 (30)	0.1 (100)	3.4 (18)
Preferred CPUE (RSE)	1.1 (19)	2.4 (22)	1.0 (28)	0.1 (100)	2.3 (22)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	2.7 (25)	3.3 (23)	2.3 (21)	0.6 (44)	4.2 (19)
PSD S-Q	.	.	22.58	88.89	14.71
PSD Q-P	20	24.24	9.68	.	27.94
PSD P-M	80	75.76	67.74	11.11	57.35
PSD M-T	.	.	.	.	.
PSD	100	100	77.42	11.11	85.29
Mean WR S-Q (RSE)	. (.)	. (.)	83 (2)	. (.)	. (.)
Mean WR Q-P (RSE)	89 (3)	82 (2)	89 (0)	. (.)	. (.)
Mean WR P-M (RSE)	91 (2)	83 (1)	88 (1)	86 (.)	. (.)
High-frequency Electrofishing					
Total Catch	-	-	-	1,337	1,383
Effort (hr)	-	-	-	0.8	0.8
Total CPUE (#/hr)	-	-	-	1,671.3	1,728.8
Mode Length (mm)	-	-	-	90	70

Source: KDWP 2020

Kanopolis Seep Spring Fisheries

Sand Creek, referred to as the “Kanopolis Seep Stream”, located on USACE property, flows on the east side of the dam, and is supplemented with water seepage from the bottom of the reservoir. The cool water of this seep stream provides a unique fishery in Kansas, brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). Projects were completed in the late 2000s to provide rock riffles, deepened pools, and concrete lunker bunkers to add recreational value to the stream. Trees were also planted by a local fly-fishing organization to increase shade, further attempting to keep water temperatures low for trout survival. Most of these projects were to improve conditions for trout and allow their survival throughout the year. A comprehensive review of trout growth and survival in the stream recently occurred. Rainbow and brown trout were tagged during a February 2016 stocking event and signs were posted asking anglers to report their catches and confirm tag numbers. Trout were sampled by electrofishing the stream the following September. Seven brown trout were collected but, unfortunately, none were tagged. No rainbow trout were collected. Brown trout seem to survive summer temperatures within the stream, but growth information has yet to be collected.

Use/Visitation Impacts

1. Drought conditions in late 2012 and early 2013 precluded the use of any boat ramps on Kanopolis Reservoir. A temporary, custom ramp made of Marston mats was used to allow boat anglers access to the reservoir. Any decrease of elevation below conservation pool limits access to boats, and in many cases to shore anglers throughout much of the reservoir due to exposing mud flats. Projected sedimentation rates will further reduce access if new boat ramps are not built. Use by anglers will dramatically decline if boats are not able to access the reservoir.

2. Sport fish populations are likely to shift from pelagic predators (e.g. crappie, saugeye) to generalists (catfish species, common carp (*Cyprinus carpio*)) if sedimentation rates continue as projected and overall surface acreage decreases and habitat composition shifts entirely to sand and silt. Water clarity will likely continue to decline as sedimentation worsens and common carp and windy conditions keep benthic silt suspended within the water column. Turbid water conditions can dramatically impact productivity by reducing light penetration and limiting phytoplankton production to the far upper level of the water column. If saugeye and crappie populations decline the angler use is likely to decline as anglers look for alternative locations to fish.

Future Without Project Projections

Biennial stockings for saugeye will continue to be requested from the culture system. They have limited natural recruitment at Kanopolis Reservoir and must be maintained by stocking. KDWP District Fisheries staff have stocked largemouth bass fingerlings for 5 years with limited success. This population is unlikely to improve without dramatic improvements to habitat conditions. Other species will be stocked as necessary but most others (e.g. channel catfish, white bass, crappie) do fairly well without stockings. However, if habitat conditions preclude recruitment of these species, stockings might be attempted and assessed.

Kanopolis Reservoir was ranked as the ninth most preferred reservoir to fish by anglers during the 2013 Licensed Angler Survey. The proximity to Salina and McPherson, Kansas makes this a popular destination for anglers inhabiting these urban centers in central Kansas. Angling will continue at Kanopolis Reservoir in the future but targeted species may vary depending on fluctuating factors that affect fish abundance and condition or their habitat. If a fish species highly sought by anglers declines this could affect the angling experience in the future and fisherman may choose to move to another reservoir.

Water quality concerns are expected to continue in the future with water inflows continuing to carry sediments and nutrients that decrease water quality and further aging of the reservoir causing eutrophic conditions at the reservoir. As the water quality degrades further this will only exacerbate the problem of establishing aquatic vegetation leading to a further loss of escape, nursery, and spawning habitat. Water levels will continue to fluctuate due to the variable annual precipitation in the region with drought conditions in some years that cause a decline in pool elevations and inundation of specific habitats (e.g., coves, shorelines). In other years high water elevations that are sustained will provide excellent habitat for young of the year fish allowing some fish species to have good year classes recruited to the fishery (e.g., crappie). However, rapid drawdowns during future high-water events could lead to decreases in fish species abundance (e.g., saugeye) and catch rates if fish are lost through the outflow of the dam. Future entrainment of fish through the dam may require fish stockings to resupply the reservoir with sport fish (e.g., saugeye).

Sedimentation will continue to occur (29.4% loss over the next 50 years) and has the potential to dramatically reduce use to the reservoir, especially for anglers. Sedimentation will be a stressor to fish populations in the future as shorelines erode and leave littoral areas unvegetated or littoral habitat is silted in leaving areas unsuitable for fish spawning, nursery habitat, and protective cover. Addition of woody habitat could continue in the future to mitigation some of these impacts to the fishery. Dredging should also be incorporated into future enhancement projects. Dredging can be used to clear sediment from boat ramps to improve access but can also be used to improve shoreline depth for bank anglers and to improve fish habitat. Unfortunately, the high effort and cost of dredging will limit these projects to select locations. Alternatives for removing sediment must be researched, and a cost analysis should be performed prior to attempts to improve conditions.

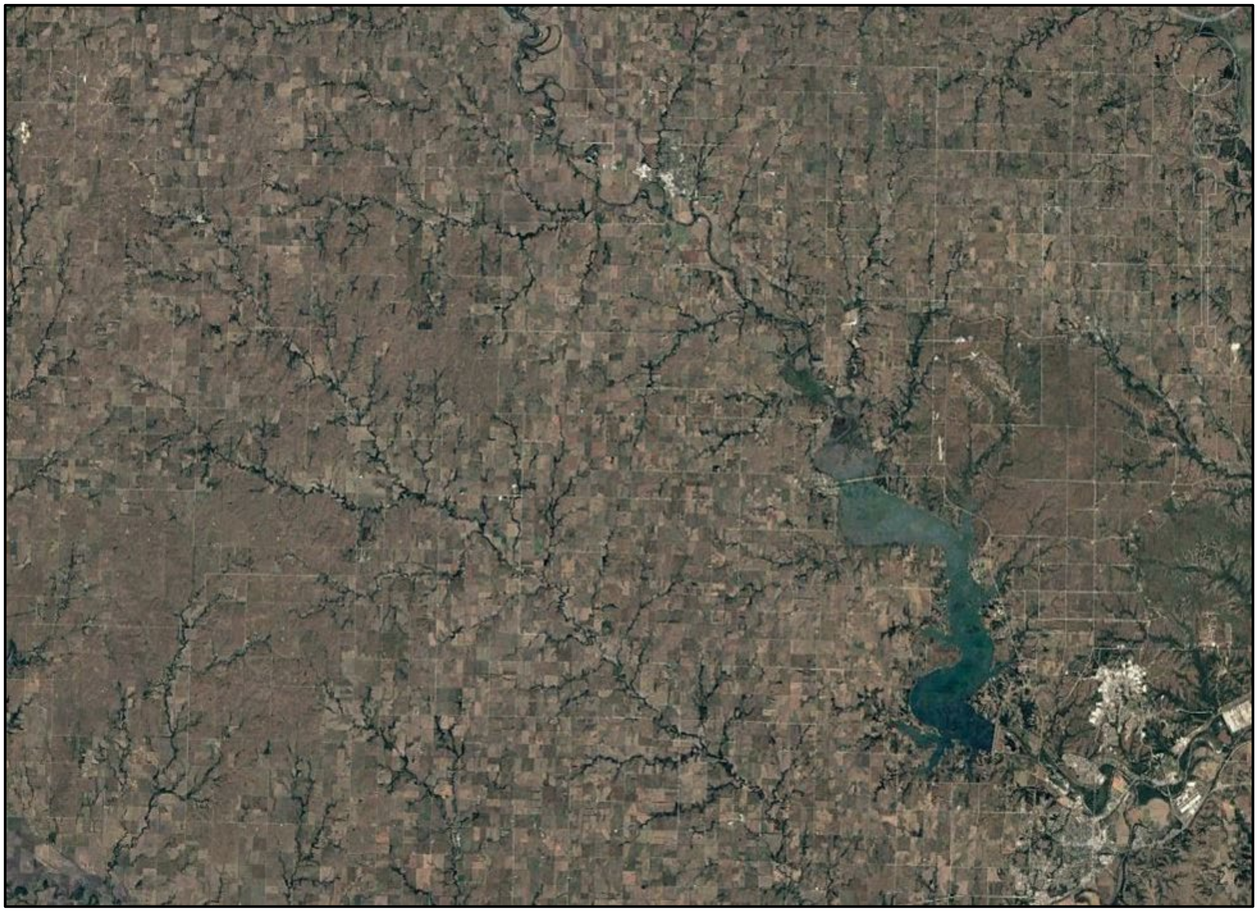
Installation of riprap in areas of critical shoreline infrastructure will continue in the future as needed and would provide habitat and escape cover for the fishery. Boat ramps will need to be constructed in the future as most boat ramps at Kanopolis Reservoir are inaccessible and only one ramp is usable during current top of conservation pool.

Fisheries management objectives will continue to optimize the quality and diversity of angling opportunities through enhancement of population abundance as needed. Fisheries management measures will continue to include fish harvest regulations, habitat work, aquatic vegetation enhancement, fish stocking, and special studies, and sampling to monitor trends. Creel surveys for angler use and preferences will also continue to support management of the fisheries. Fish species that inhabit Kanopolis Reservoir are not expected to change in the future but will have periods where changes in abundance and shifts in sportfish species dominance occur from conditions that affect habitat quantity and quality, like what is now experienced at Kanopolis Reservoir.

Kansas River Reservoirs Flood and Sediment Study – Reservoir Fishery

Location: Milford Reservoir

Brett Miller, KDWP District Biologist



Milford Reservoir Located on the Republican River in Southeast Clay, Southwest Riley, Northeast Dickinson, and Northwest Geary Counties

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History

Milford Reservoir is the largest lake in Kansas (over 15,000 acres) and is located in the Republican River basin (Dickinson, Clay, and Geary counties) of north-central Kansas. This impoundment drains 3,796 square miles in Clay, Cloud, Dickinson, Geary, Jewell, Mitchell, Phillips, Republic, Riley, Smith, and Washington counties and it has a mean and maximum depth of 22 and 65 feet, respectively. Authorized by the Flood Control Act of 1954, Milford Reservoir went under construction in 1962 and began operation in 1967 by the U.S. Army Corps of Engineers with primary purposes including flood control, silt control, and water supply. Secondary purposes authorized include low flow supplementation, recreation, and fish and wildlife. Since the Milford Reservoir and dam began operations in 1967, it has prevented an estimated $165 million in flood damages (USACE 2022).

Milford Reservoir's main function is for flood control, municipal water supply, navigation, downstream water quality, and recreation. The Kansas Water Office allocated 33.88% of the current pool in use and 66.12% is designated for future use. The reservoir also provides excellent habitat for many types of wildlife which contributes to its reputation as one of the prime hunting and fishing areas in Kansas. Each year the lake attracts thousands of visitors who enjoy and take advantage of the many recreational opportunities available.

Water Allocation Background

Milford Reservoir was constructed by the U.S. Army Corps of Engineers (USACE) as a multipurpose facility for flood control, silt control, water supply, recreation, fish and wildlife, and support of navigation on the Missouri River. The original reservoir storage capacity included 757,746 acre-feet storage for flood control, 415,352 acre-feet for multipurpose use, and a sediment reserve of 173,098 acre-feet (Table 1).

The State of Kansas entered into an agreement for municipal and industrial water supply with the USACE in 1974. The agreement allowed the State of Kansas to use storage space in the multipurpose pool between elevations 1,080 and 1144.4 feet mean sea level (msl), for 300,000 acre-feet of storage. Of the 300,000 acre-feet of storage allocated for water supply currently 101,640 acre-feet is in service and 198,360 is designated as future use water supply (see Table 1).

A survey was performed in 2009 of Milford Reservoir and was used to estimate remaining storage. The 2009 survey showed that all of the storage for flood control remained in storage. Sediment modeling was completed for the Kansas River Reservoirs Flood and Sediment Study (Watershed Study) to project a baseline and future storage capacity for USACE reservoirs within the basin. Sediment accumulation in Milford Reservoir is expected to be moderate over the next 50 years with a minor loss of capacity from sedimentation. The original pool storage capacity and pool storage capacity under baseline conditions (i.e., 2024) are shown in Table 1.

Table 1. Storage Capacity and Ownership

Year	Pool Owner	Purpose/Use	Quantity (acre-feet [af])
1967	USACE	Flood Control	757,746
1967	USACE	Multipurpose	415,352
1967	USACE	Sediment Reserve	173,098
2009	USACE	Flood Control	757,746
2009	Kansas Water Office	Municipal and Industrial Water Supply	300,000
2009	USACE	Sediment Reserve	246,250
2009[1]	USACE	Flood Control	756,892
2009[1]	Kansas Water Office	Municipal and Industrial Water Supply	300,000
2009[1]	USACE	Sediment Reserve	239,574

Note: Storage capacity projected for 2024 with loss to sedimentation as modeled

Milford Reservoir Fishery

Fisheries Establishment

Milford Reservoir is one the most popular fishing destinations in Kansas. Several species are sought after, which draws both in-state and out-of-state anglers. Tables 2 and 3 list sport and non-sport fish in Milford Reservoir. A more detailed discussion of recent species-specific stocking efforts is available in the Sportfish Dynamic and Trends section.

Table 2. Sport Fish Species Known to Inhabit Milford Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Blue Catfish	*Ictalurus furcatus*
Channel Catfish	*Ictaurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieu*
Spotted Bass	*Micropterus punctulatus*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis x M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Milford Reservoir

Common Name	Scientific Name
Bigmouth Buffalo	*Ictiobus cyprinellus*
Common Carp	*Cyprinus carpio*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Goldeye	*Hiodon alosoides*
Longnose Gar	*Lepisosteus osseus*
River Carpsucker	*Carpiodes carpio*
Shortnose Gar	*Lepisosteus platostomus*
Smallmouth Buffalo	*Ictiobus bubalus*

Abiotic and Biotic Factors Affecting the Fishery

Stressors to the fish populations are a combination of some abiotic and biotic concerns seen in both eastern and western Kansas reservoirs. Drought conditions have had dramatic impacts on sport fisheries, especially in 1987 to 1988, 2002 to 2003, and from 2012 to 2016 when the reservoir experienced multipurpose pool elevation as low as eight feet below conservation pool (Figure 1). High nutrient loads, sedimentation, toxic cyanobacteria blooms, and dissolved oxygen sags are the main threats to water quality in this impoundment due primarily to agricultural practices within the watershed. Zebra mussels were first documented in Milford Reservoir on November 16, 2009. Harmful algal blooms have become frequent occurrences as well. Sedimentation is not as concerning here as in other reservoirs due to low inflows and a lower proportion of agricultural land in the watershed.

1. Water Quality

The USACE Kansas City District (KCD) Water Quality Program collects monthly water samples from standardized locations during the recreation season. Chemical, physical, and biological parameters are measured to evaluate water quality at inflow, reservoir, and outflow sites. These data describe conditions and changes from within the main reservoir, and outflow focusing on eutrophication, nutrients, sediment, herbicides, metals, and contaminants. This is a summary of the water quality conditions in Milford Reservoir, but more detailed information is provided in Appendix H. High nutrient loads, sedimentation, toxic cyanobacteria blooms, and dissolved oxygen sags are the main threats to water quality in this impoundment due primarily to agricultural practices within the watershed. Milford Reservoir has been listed as impaired by Kansas Department of Health and Environment (KDHE) and is classified as hypereutrophic due to excessive nutrients, specifically biologically available orthophosphate. Hypereutrophic conditions can lead to undesirable conditions for aquatic organisms and negatively affect the longevity and utility of the reservoir. Harmful algal blooms (HABs) have also been an issue in this reservoir by reducing recreational opportunity and economic activity. To minimize the impacts of HABs, the KDHE shifted to a zoned management approach to allow for more recreational opportunity in those zones of the lake that were less prone to HABs; however, this approach did not affect the hypereutrophic conditions in this reservoir. To address these conditions, watershed conservation efforts have become a high priority, including the KDHE Watershed Restoration and Protection Strategy (WRAPS) program, which will implement best management practices designed to reduce nutrient and sediment loads into the reservoir. Additionally, a Natural Resources Conservation Service grant was awarded to start the Milford Watershed Regional Conservation Partnership Program, which is a collaborative relationship between the Kansas Water Office and regional entities to improve water quality in Milford Reservoir and upstream.

The KCD Water Quality Program also began monitoring of lake sediments in 2016 to gather baseline nutrient and contamination data at standardized lake water quality sites. Sediment data from 2016-2017 yielded moderate to high nitrogen and phosphorus concentrations while total metals concentrations did not exceed the “probable effect level” established by the EPA. Water quality monitoring will continue as a critical part of a holistic, environmentally sound water quality management strategy for the project to continue to meet applicable federal and state environmental laws, criteria, and standards. Continued monitoring will also provide valuable information regarding potential impacts to the Milford Reservoir fish community. The general limnological parameters characteristic of Milford Reservoir are shown in Table 3.

Table 4. General Limnological Parameters Characteristic of Milford Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	16,020
Max depth	feet	62.3
Mean depth	feet	24.3
Mean annual runoff	inches	84.6
Area watershed drainage	square miles	24,936
Hydrologic residence time	days	231.0
Chlorophyll a (summer mean)	parts per billion	42.5
Secchi depth (summer mean)	centimeters	146.0
Shoreline development index	ratio	9.4
Agricultural lands	%	51.0
Forest habitat	%	0.6
Grassland habitat	%	43.6
Urban lands	%	3.4
*Trophic state index	Index/class	67.4/Hypereutrophic

Note: *Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

Sources: KDWP 2023;

2. Water Level Fluctuations

The graph provided below (Figure 1) depicts the water level elevations since 1967. The highest lake elevation was recorded on July 25, 1993, at 1181 msl. The lowest lake elevation was recorded on January 13, 2003, at 1136 msl. Annual precipitation is variable as western Kansas typically experiences lower (10 – 20 inches) precipitation compared to eastern portions of the state (40 – 50 inches). Milford Reservoir is used as a public water supply and has experienced elevation fluctuations. The reservoir has experienced drought conditions in the past causing it to drop to elevations below multipurpose pool. Sustained high water events in the multipurpose pool (e.g., 1973, 1993, 2019) can provide excellent habitat for young-of-year fishes, which can support recruitment of strong year classes for some species. However, high water releases often lead to rapid drawdowns in the multipurpose pool, which can lead to loss of fish through the outflow of the dam.

3. Sedimentation

Documenting the effects of sedimentation has been a priority at Milford Reservoir over the decades. This is a summary of the effects of sedimentation on this impoundment, but more detailed information is provided in Appendix D. Sedimentation rangeline surveys were used in 1967, 1980 and 1994 to calculate the capacity of the reservoir and assess sediment deposition. During 2009, a bathymetric survey using single beam sonar was used instead of the sediment rangeline method. Both of these methods provide an estimate of multipurpose pool and flood pool volumes over time. Between 1967 and 1994, the multipurpose pool lost an average of 1,558 ac-ft/year (0.38% of the original volume/year), which totaled 43,011 ac-ft of storage lost to sedimentation (10.36% of the original multipurpose pool volume). During the same period, the flood control pool lost an average of 178 ac-ft/year (0.02% of the original volume/year), which totaled 4,924 ac-ft of storage lost to sedimentation (0.65% of the original flood control pool volume). Using a different comparison method (i.e., Cross Section Viewer estimates) due to a shift to bathymetric survey in 2009, the total deposition rate was estimated to be an average of 938 ac-ft per year, which totaled 14,272 ac-ft, between 1994 and 2009.

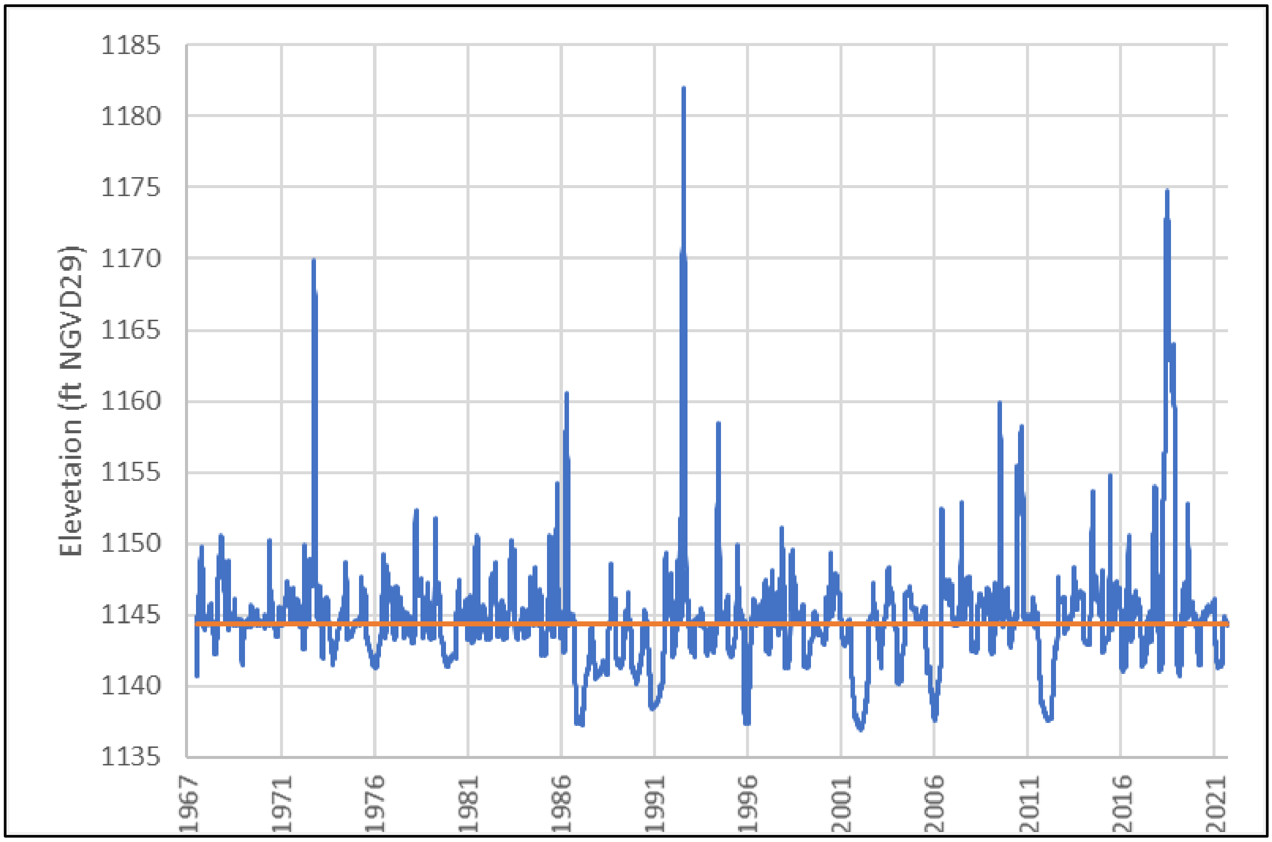


Figure 1. Yearly Ending Reservoir Pool Elevation (feet NGVD29) [blue line] in Relation to Full Conservation Pool [red line]

Source: USACE 2022

The multipurpose pool at Milford Reservoir originally included 415,352 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 11.8% of the multipurpose pool has been filled in with sediment leaving approximately 366,476 ac-ft of capacity (based on 2009 survey results). It is estimated that approximately 468 ac-ft of sediment accumulates on average annually in Milford Reservoir. Sediment will continue to accumulate in Milford Reservoir with an expected additional 2.5 % loss of the multipurpose pool over the next 25 years (2049) and 4.0% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 349,881 ac-ft in 2074.

4. Vegetated Fisheries Habitat

Under favorable conditions, water willow (*Justicia americana*) can become established. High water events can flood the water willow and provide refugia to fish and other aquatic organisms. Otherwise, aquatic vegetation establishment at Milford Reservoir is rare.

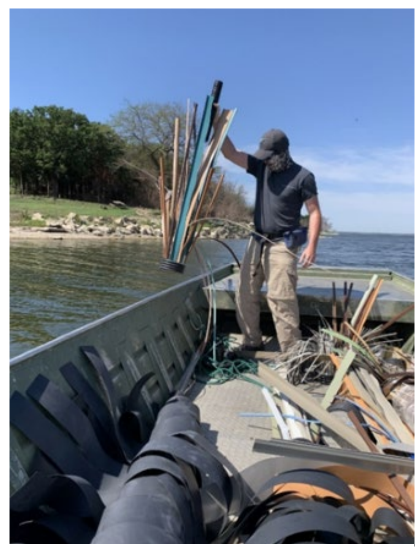
5. Invasive/Exotic Species and Algal Blooms

Within the last two decades zebra mussels (*Dreissena polymorpha*) have been identified within Kansas waterbodies. They can spread by moving off a contaminated boat to an uninfected waterway. They can be transported by infected water that may be within bilge, livewells, or motor water intakes. Zebra mussels were first documented in Milford Reservoir on November 16, 2009.

Once a waterbody becomes infested the zebra mussel's clump together and can cover power plants, industrial and public water intakes. They can also fowl boat hulls, cover docks and other structures, and decimate native mussel populations.

Additionally, harmful algal blooms have become frequent occurrences during the summer months at Milford Reservoir. Commercial fishing has been utilized to remove nongame bottom feeding fish (i.e., common carp, buffalo, etc.). The Kansas Department of Health and Environment (KDHE) previously contracted JD Bell to commercially fish Milford Reservoir. The objective of this was to minimize the amount of sediment being disrupted by those fish, which releases nutrients into the water column that could aid in creating harmful algal blooms. KDHE funded an experimental harmful algae bloom treatment of 200 acres by private contractors on July 28, 2020, with peroxide-based algaecides.

Fisheries Management Objectives



Fisheries in Milford Reservoir are managed by the fisheries division of the Kansas Department of Wildlife and Parks (KDWP). The objective of fisheries management at Milford Reservoir is to create quality fishing opportunities for anglers. Milford Reservoir provides a variety of species to appease many angler groups. Fish populations are managed through setting length limit and creel limit regulations, fish stockings to supplement existing populations, deploying artificial habitat, conducting creel surveys of anglers, and monitoring with sampling activities.

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Milford Reservoir.

1. Habitat Improvements

Cedar Trees and Georgia Cubes Used as Habitat Improvements

In more recent years, deployment of artificial habitat has occurred to increase fish habitat at various locations at Milford Reservoir. Georgia cubes, Fish hiding structures, cedar trees, etc. have been used in various depths to diversify habitat for several fish species. Habitat deployed by KDWP staff is GPS marked to provide to anglers. Therefore, anglers can use these habitat locations to target desired fish species.

2. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest and meet management objectives. Current special fish harvest regulations in effect at Milford Reservoir are: 25 to 40- inch protected slot length limit with a creel of five fish per day with only one exceeding 40 inches for Blue Catfish as well as a 21-inch minimum length limit on walleye and a creel limit of 2 fish/angler/day. A complete list of harvest regulations at Milford Reservoir are provided below in Table 5.

Table 5. Current Species-Specific Fish Harvest Regulations in Effect at Milford Reservoir

Common Name	Length Limit	Daily Creel Limit
Blue Catfish	25-40-inch protected slot	5 (no more than 1 over 40 inch)
Channel Catfish		10
Flathead Catfish		5
Largemouth Bass	15 inch minimum	5
Smallmouth Bass	15 inch minimum	5
Spotted Bass	15 inch minimum	5
Walleye	21 inch minimum	2
Crappie		50
Wiper		5

Note: Species Specific Length and Creel Limits at Milford Lake in 2022

3. Lake Level Management Plans

KDWP makes fisheries recommendations to the USACE at Milford Reservoir for the water level management plan. NWK implements a variety of practices through these water level management plans that address water management for environmental outcomes:

1) October 1 to January 1: Maintain the lake elevation at least one foot over conservation pool. The goal of the fall & winter rise is to keep the lake elevation up as long as possible for waterfowl habitat but at the same time realizing that the lake elevation needs to be drawn down prior to the lake freeze up. This cold weather flexibility can be achieved through the local lake personnel that will monitor the lake conditions and make recommendations to adjust the drawdown and/or discharge rate that will achieve the greatest benefit.
2) January 1 to February 1: Begin controlled drawdown of lake elevation as winter conditions allow with a maximum release of 2000 cfs to reach winter target elevation of 1141.4 NGVD.
3) February 1 to May 1: Maintain the lake elevation at 1141.4 NGVD. This will eradicate exposed zebra mussels and provide clear spawning areas for walleye.
4) May 1 to June 15: Allow the lake elevation to gradually increase to 1143.0 NGVD. Maximum discharge should not exceed 2000 cfs.
5) June 15 to August 1: Maintain lake elevation at 1143.0. The fisheries program prefers that the lake elevation remains steady or a slow rise. Optimal maximum discharge should not exceed 2000 cfs. If there is a large inflow event and the pool rises above conservation pool, discharge should only bring the pool back down to 1144.4 NGVD. Re-vegetation and seeding of the shoreline will be accomplished while the lake is below 1144.4 NGVD.
6) August 1 to October 1: Hold discharge to minimum outflows and allow the lake elevation to increase and then be maintained at 1145.4 NGVD.

The lake level management plan accounts for the natural inflows of the lake to improve both fisheries and wildlife habitat. One of the fisheries functions of the current plan is to control water releases in the early spring during fish spawning. The winter drawdown also helps to provide a cushion against having to release high outflows when the walleye are concentrated along the face of the dam and susceptible to flushing from the lake.

4. Sportfish Stockings

Stocking records at Milford Reservoir date back to 1967. Several species have been stocked over time including walleye, wipers, blue catfish, channel catfish, largemouth bass, smallmouth bass, and sauger. Blue catfish were first stocked in the early 1990s, but no further stockings have been required as this population is producing natural year classes. Currently, wipers and walleyes are stocked on an annual basis on Milford Reservoir. On average, close to 2 million wiper fry and 5 million walleye fry are stocked.

Angler Use

Creel Data, Angler Results, Preferences

In 2022, an estimated 82,252 anglers fished Milford Reservoir totaling up to 219,321 angler hours of effort. KDWP documented 116,816 fish harvested weighing 348,225 pounds during this sampling period. Anglers preferred crappie the most, second was catfish, third was blue catfish specifically, and fourth was "no preference", or "any".

Sportfish Population Dynamics/Trends

The data presented in this document will highlight trends from the past five years excluding 2019 which was not sampled due to flooding.

Black Crappie (*Pomoxis nigromaculatus*)

Black crappie have very specific water conditions, including still clear waters, and are less common at Milford Reservoir compared to white crappie. Black crappie catch rates were the highest in 2020 over the past five years at 3.5 fish/net. Most of the black crappies collected were from 5.5-8-inches with one fish measuring 13-inches (Table 5). In 2022 black crappie catch rates continued to remain fairly low. However, most of the individuals sampled were about 9.5-11-inches with the exception of a few smaller fish. PSD values have been high since 2021 while Wr values continue to remain acceptable (Table 6). Continued monitoring will determine if black crappie populations are increasing.

Table 6. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Black Crappie by Trapnets

Metric	2020	2021	2022
Total Catch	56	101	43
Stock Catch	56	97	36
Units of Effort	16	16	16
Sub-Stock CPUE (RSE)	0.0 (.)	0.3 (100)	0.4 (86)
Stock CPUE (RSE)	3.5 (36)	6.1 (29)	2.3 (33)
Quality/Density CPUE (RSE)	0.1 (100)	5.9 (29)	2.3 (33)
Preferred CPUE (RSE)	0.1 (100)	0.3 (58)	2.1 (33)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	3.5 (36)	6.3 (28)	2.7 (31)
PSD S-Q	96.43	2.06	.
PSD Q-P	1.79	93.81	5.56
PSD P-M	.	4.12	94.44
PSD M-T	1.79	.	.
PSD	3.57	97.94	100
Mean WR S-Q (RSE)	119 (4)	94 (4)	. (.)
Mean WR Q-P (RSE)	104 (.)	105 (2)	95 (2)
Mean WR P-M (RSE)	. (.)	91 (8)	100 (1)
Mean WR M-T (RSE)	99 (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)

Source: KDWP 2022

Blue Catfish (*Ictalurus furcatus*)

Blue catfish are a close relative of channel catfish and are often the most sought-after catfish species in Milford Reservoir. This species is found near similar areas as the channel catfish but are less common. Blue catfish catch rates in 2020 were the second highest recorded since 2016 with 11.7 fish/net. Blue catfish lengths ranged anywhere from 7-43-inches. Only 15 fish collected were in the 25-40-inches protected slot. However, one fish over the slot was collected. 111 individuals were collected via jug lines in 2020. Blue catfish lengths ranged from 9-42-inches. 51 individuals collected were in the 25-40-inches protected slot with three fish caught over the 40-inches. 84 individuals were collected via boat electrofishing in 2020. Blue catfish lengths ranged from 4-34-inches with only two fish being caught in the 25-40-inches protected slot (Table 6). Blue Catfish catch rates in 2022 were similar to those from 2021. Low-frequency electrofishing became the standard gear to assess blue catfish populations in 2021. Of the 601 individuals collected, 10 fish were greater than 40-inches, 30 fish were between 25-40-inches and 561 fish were under 25-inches. The high numbers of smaller fish resulted in low PSD values again in 2022. However, Wr values remain acceptable. In the fall, 162 individuals were collected via gill net. Lengths ranged from 10.8-34.6-inches with an average of 18.3-inches (Table 7).

Table 7. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish by Electrofishing.

Metric	2018	2020	2021	2022
Total Catch	181	234	252	601
Stock Catch	113	212	239	566
Units of Effort	20	20	0.96	2.33324
Sub-Stock CPUE (RSE)	3.4 (23)	1.1 (32)	13.5 (49)	15.0 (22)
Stock CPUE (RSE)	5.7 (19)	10.6 (19)	249.0 (27)	242.6 (12)
Quality/Density CPUE (RSE)	2.0 (21)	3.2 (17)	27.1 (45)	47.1 (14)
Preferred CPUE (RSE)	0.1 (69)	0.4 (38)	1.0 (100)	12.0 (37)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.2 (55)	0.0 (.)	8.6 (37)
Total CPUE (RSE)	9.1 (14)	11.7 (17)	262.5 (25)	257.6 (12)
PSD S-Q	64.6	69.81	89.12	80.57
PSD Q-P	33.63	26.89	10.46	14.49
PSD P-M	0.88	1.89	0.42	1.41
PSD M-T	0.88	1.42	.	3.18
PSD	35.4	30.19	10.88	19.43
Mean WR S-Q (RSE)	90 (3)	86 (1)	90 (1)	80 (1)
Mean WR Q-P (RSE)	81 (4)	85 (1)	85 (2)	81 (2)
Mean WR P-M (RSE)	103 (.)	84 (2)	193 (.)	86 (8)
Mean WR M-T (RSE)	104 (.)	84 (9)	. (.)	104 (5)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Bluegill (*Lepomis macrochirus*)

Bluegill are a very common sunfish in Kansas and can be found in shallow vegetated areas of lakes as juveniles. Adults tend to be in deeper waters during the day. Bluegill continue to produce low catch rates as CPUE values since 2016 have averaged less than 3 fish/net. Bluegill lengths ranged from 2-8-inches with 30% of individuals being sub-stock. The remaining 70% of individuals were greater than 5-inches. PSD values were the highest reported in 2020 since 2016 while Wr values remain above average (Table 7). Bluegill catch rates were the highest in 2022 since 2020. However, smaller individuals were most of the sample. Lengths ranged from 1.6-8.1-inches. PSD values have been low since 2021, but Wr values remain high (Table 8).

Table 8. CPUE, PSD, Wr, and RSE Estimates for Bluegill by Trapnets

Metric	2020	2021	2022
Total Catch	33	131	349
Stock Catch	25	54	59
Units of Effort	16	16	16
Sub-Stock CPUE (RSE)	0.5 (61)	4.8 (44)	18.1 (59)
Stock CPUE (RSE)	1.6 (52)	3.4 (40)	3.7 (44)
Quality/Density CPUE (RSE)	1.3 (52)	0.5 (52)	1.1 (50)
Preferred CPUE (RSE)	0.1 (100)	0.0 (.)	0.3 (77)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	2.1 (39)	8.2 (35)	21.8 (56)
PSD S-Q	16	85.19	71.19
PSD Q-P	76	14.81	22.03
PSD P-M	8	.	6.78
PSD M-T	.	.	.
PSD	84	14.81	28.81
Mean WR S-Q (RSE)	110 (10)	115 (2)	111 (7)
Mean WR Q-P (RSE)	106 (2)	120 (4)	109 (4)
Mean WR P-M (RSE)	99 (2)	. (.)	104 (1)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)

Source: KDWP 2022

Channel Catfish (*Ictalurus punctatus*)

Channel catfish are one of the most abundant types of catfish in the United States. This species can be found near rock shores, windblown flats, and other areas throughout Milford Reservoir. Channel catfish catch rates in 2020 were 1.7 fish/net. These catch rates were similar to 2016. Channel catfish lengths ranged from 6-21-inches with most of the individuals caught between 8 and 16-inches. PSD values remain low over time while Wr values have been average (Table 8). Since 2020, channel catfish catch rates have ranged from 1.0-1.7 fish/net. In 2022, lengths ranged from 9.3-25.4-inches with an average of 15-inches. PSD values continue to be low due to higher numbers of smaller fish being caught, but Wr values are acceptable (Table 9).

Table 9. CPUE, PSD, Wr, RSE Estimates for Channel Catfish by Gillnets

Metric	2018	2020	2021	2022
Total Catch	65	34	20	25
Stock Catch	40	21	17	23
Units of Effort	20	20	20	20
Sub-Stock CPUE (RSE)	1.3 (36)	0.7 (34)	0.2 (55)	0.1 (69)
Stock CPUE (RSE)	2.0 (15)	1.1 (28)	0.9 (20)	1.2 (21)
Quality/Density CPUE (RSE)	0.5 (31)	0.4 (38)	0.2 (46)	0.3 (49)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.1 (100)	0.1 (100)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.1 (100)	0.0 (.)
Total CPUE (RSE)	3.3 (20)	1.7 (28)	1.0 (21)	1.3 (20)

Metric	2018	2020	2021	2022
PSD S-Q	75	61.9	76.47	73.91
PSD Q-P	25	38.1	17.65	21.74
PSD P-M	.	.	.	4.35
PSD M-T	.	.	5.88	.
PSD	25	38.1	23.53	26.09
Mean WR S-Q (RSE)	89 (2)	84 (2)	93 (2)	89 (2)
Mean WR Q-P (RSE)	83 (6)	79 (2)	94 (6)	91 (4)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	83 (.)
Mean WR M-T (RSE)	. (.)	. (.)	98 (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Largemouth Bass (*Micropterus salmoides*)

Largemouth bass can be found near coves with vegetation or near other areas with cover in Milford Reservoir. Largemouth bass catch rates in 2020 were the highest reported since 2016 at 35.3 fish/hr. Largemouth bass lengths ranged from 5-19-inches with 10% of collected individuals achieving harvestable size (15-inches). PSD values in 2020 decreased; however, Wr values continued to remain above average over time (Table 9). Largemouth bass catch rates in 2022 increased from 2021. Lengths ranged from 11.2-19.2-inches with an average of 13.9 inches. 15% of the collected individuals were of harvestable size (15-inches MLL). PSD increased from 2021 to 2022 while Wr remains high (Table 10).

Table 10. CPUE, PSD, Wr, and RSE Estimates for Largemouth Bass by Electrofishing

Metric	2018	2020	2021	2022
Total Catch	86	120	56	59
Stock Catch	74	76	54	59
Units of Effort	2.97	3.4	3.06	2.50005
Sub-Stock CPUE (RSE)	4.1 (32)	12.9 (23)	0.7 (69)	0.0 (.)
Stock CPUE (RSE)	25.0 (23)	22.4 (25)	17.6 (22)	23.6 (27)
Quality/Density CPUE (RSE)	19.6 (22)	5.0 (39)	7.5 (32)	22.0 (27)
Preferred CPUE (RSE)	8.8 (26)	3.5 (44)	2.9 (46)	4.4 (39)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	29.0 (23)	35.3 (21)	18.3 (22)	23.6 (27)
PSD S-Q	21.62	77.63	57.41	6.78
PSD Q-P	43.24	6.58	25.93	74.58
PSD P-M	35.14	15.79	16.67	18.64
PSD M-T	.	.	.	.
PSD	78.38	22.37	42.59	93.22
Mean WR S-Q (RSE)	114 (2)	96 (3)	100 (2)	103 (5)
Mean WR Q-P (RSE)	111 (2)	118 (4)	104 (3)	101 (1)
Mean WR P-M (RSE)	107 (1)	113 (2)	101 (3)	101 (3)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Smallmouth Bass (*Micropterus dolomieu*)

Smallmouth bass are another sportfish in Milford Reservoir that are found near similar areas as the largemouth bass. Smallmouth bass catch rates in 2020 were 15.0 fish/hr. Smallmouth bass ranged from

3-17.5-inches with 20% of collected individuals reaching harvestable size (15-inches). Since 2018, PSD values have remained high while Wr values have continued to be average since 2016 (Table 10). Smallmouth bass catch rates in 2022 were the second highest since 2018. Lengths ranged from 4.3-15.6-inches with an average of 8.4-inches. The sample was pretty even between fish in the sub-stock category and fish stock size or larger resulting in a PSD of 56 (Table 11). Wr values have remained consistent over the past five years. Only one fish was greater than the 15-inches MLL.

Table 11. CPUE, PSD, Wr, and RSE Estimates for Smallmouth Bass by Electrofishing

Metric	2018	2020	2021	2022
Total Catch	90	51	32	48
Stock Catch	43	26	26	23
Units of Effort	2.97	3.4	3.06	2.50005
Sub-Stock CPUE (RSE)	15.8 (22)	7.4 (27)	2.0 (42)	10.0 (37)
Stock CPUE (RSE)	14.6 (21)	7.6 (43)	8.5 (22)	9.2 (22)
Quality/Density CPUE (RSE)	12.6 (23)	7.4 (45)	3.9 (47)	5.2 (35)
Preferred CPUE (RSE)	9.5 (21)	4.4 (61)	2.0 (54)	1.6 (44)
Memorable/Lunker CPUE (RSE)	1.3 (45)	1.8 (73)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	30.5 (16)	15.0 (24)	10.5 (22)	19.2 (25)
PSD S-Q	13.95	3.85	53.85	43.48
PSD Q-P	20.93	38.46	23.08	39.13
PSD P-M	55.81	34.62	23.08	17.39
PSD M-T	9.3	23.08	.	.
PSD	86.05	96.15	46.15	56.52
Mean WR S-Q (RSE)	97 (2)	96 (.)	96 (3)	88 (3)
Mean WR Q-P (RSE)	98 (3)	91 (5)	88 (4)	87 (3)
Mean WR P-M (RSE)	96 (2)	88 (3)	81 (6)	89 (5)
Mean WR M-T (RSE)	96 (3)	84 (4)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Spotted Bass (*Micropterus punctulatus*)

Spotted bass continue to remain in lower abundance compared to largemouth and smallmouth bass. Spotted bass have only been collected in three different years since 2016. Catch rates of spotted bass in 2020 were 3.5 fish/hr. Lengths of collected individuals ranged from 5-9-inch with no fish reaching harvestable size (Table 11). While spotted bass occur in low abundance, this species does provide a unique angling opportunity at Milford Reservoir. Only two spotted bass were collected in 2022 (Table 12). One was about 8.9-inches while the other was 13.4-inches. Spotted bass continue to remain in low abundance.

Table 12. CPUE, PSD, Wr, and RSE Estimates for Spotted Bass by Electrofishing

Metric	2020	2022
Total Catch	12	2
Stock Catch	6	2
Units of Effort	3.4	2.50005
Sub-Stock CPUE (RSE)	1.8 (43)	0.0 (.)
Stock CPUE (RSE)	1.8 (43)	0.8 (68)

Metric	2020	2022
Quality/Density CPUE (RSE)	0.0 (.)	0.4 (100)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	3.5 (28)	0.8 (68)
PSD S-Q	100	50
PSD Q-P	.	50
PSD P-M	.	.
PSD M-T	.	.
PSD	0	50
Mean WR S-Q (RSE)	89 (13)	111 (.)
Mean WR Q-P (RSE)	. (.)	110 (.)
Mean WR P-M (RSE)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)

Source: KDWP 2022

Walleye (*Sander vitreus*)

Walleye are a popular sportfish in Milford Reservoir that can be found in rocky or wind-swept mud banks or along the dam. Walleye catch rates in 2020 mirrored those of 2017 with 4.4 fish/net. Walleye lengths range from 10.5-25-inches with six individuals reaching harvestable size (21-inches). This was the third year following a regulation change from an 18-inch MLL/5 per day to 21-inch MLL/2 per day. Since the regulation change, 21-inch fish have been collected in fall sampling activities. Prior to 2017, only three 21-inch fish were collected since 2014. PSD saw a slight decrease in 2020 while Wr values have remained consistent over time. While normal egg collection activities were cancelled in 2020 due to the COVID-19 pandemic, about 5,000 fingerlings were stocked in Milford Reservoir (Table 12). Typical years see about 5 million fry stocked annually. Walleye catch rates in 2022 were the second highest since 2018. Lengths ranged from 10.8-21-inches with an average of 18-inches. While only one fish was 21-inches in 2022, fish have appeared more often in larger length groups this year compared to 2021 (Table 13). Fish appear to be more abundant in length groups 30-40 mm larger than fish in 2021 suggesting they are continuing to grow. PSD and Wr values continue to remain acceptable.

Table 13. CPUE, PSD, WR, and RSE Estimates for Walleye by Gillnets

Metric	2018	2020	2021	2022
Total Catch	36	88	50	62
Stock Catch	36	88	50	62
Units of Effort	20	20	20	20
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	1.8 (19)	4.4 (14)	2.5 (17)	3.1 (14)
Quality/Density CPUE (RSE)	1.5 (21)	2.6 (21)	2.5 (17)	2.9 (13)
Preferred CPUE (RSE)	0.3 (40)	0.5 (41)	0.1 (100)	0.2 (46)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.1 (100)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	1.8 (19)	4.4 (14)	2.5 (17)	3.1 (14)
PSD S-Q	16.67	40.91	.	6.45
PSD Q-P	69.44	48.86	98	87.1

Metric	2018	2020	2021	2022
PSD P-M	13.89	9.09	2	6.45
PSD M-T	.	1.14	.	.
PSD	83.33	59.09	100	93.55
Mean WR S-Q (RSE)	91 (3)	101 (2)	. (.)	92 (5)
Mean WR Q-P (RSE)	101 (3)	104 (1)	92 (1)	96 (1)
Mean WR P-M (RSE)	89 (11)	104 (1)	93 (.)	85 (2)
Mean WR M-T (RSE)	. (.)	92 (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

White Bass (*Morone chrysops*)

White bass are commonly found in Milford Reservoir near windy banks or along the dam as they prefer currents. In 2020, white bass catch rates were the highest since 2016 at 6.4 fish/net. White bass lengths ranged from 5-15-inches with 10 fish over 12.5-inches being collected. PSD values were high in 2020 while Wr values remain consistent (Table 13). White bass catch rates slightly decreased from 2021 to 2022, but still remain at an acceptable level. Lengths ranged from 5.1-15.7-inches with an average of 11.3-inches. PSD and Wr values continue to remain consistent with previous years (Table 13).

Table 14. CPUE, PSD, Wr, and RSE Estimates for White Bass by Gillnets

Metric	2018	2020	2021	2022
Total Catch	84	128	138	96
Stock Catch	84	95	136	88
Units of Effort	20	20	20	20
Sub-Stock CPUE (RSE)	0.0 (.)	1.7 (30)	0.1 (69)	0.4 (61)
Stock CPUE (RSE)	4.2 (22)	4.8 (20)	6.8 (18)	4.4 (14)
Quality/Density CPUE (RSE)	3.8 (20)	4.6 (20)	5.4 (23)	3.6 (17)
Preferred CPUE (RSE)	1.4 (27)	0.6 (35)	4.6 (27)	3.0 (17)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (49)	0.2 (55)
Total CPUE (RSE)	4.2 (22)	6.4 (20)	6.9 (18)	4.8 (15)
PSD S-Q	10.71	4.21	20.59	19.32
PSD Q-P	55.95	83.16	11.76	12.5
PSD P-M	32.14	11.58	63.24	64.77
PSD M-T	1.19	1.05	4.41	3.41
PSD	89.29	95.79	79.41	80.68
Mean WR S-Q (RSE)	108 (4)	88 (5)	103 (7)	108 (3)
Mean WR Q-P (RSE)	96 (2)	85 (1)	90 (3)	91 (3)
Mean WR P-M (RSE)	90 (3)	92 (2)	94 (1)	91 (1)
Mean WR M-T (RSE)	93 (.)	103 (.)	84 (4)	87 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

White Crappie (*Pomoxis annularis*)

White crappie are a very abundant fish in Milford Reservoir. These fish are most often found in highly vegetated areas where the water is 10 to 20-feet deep. White crappie catch rates in 2020 were the lowest since 2016 at 11.6 fish/net. White crappie lengths ranged from 3.5-14.5-inches with 68 individuals being above 9-inches. Only one sub-stock fish was collected in 2020 compared to a CPUE of 45.8 fish net for sub-stock fish in 2018. 2020 did see high numbers of angler participation with several reports of high harvest of crappies (Table 14). However, creel surveys were cancelled due to the COVID-19 pandemic which could have provided harvest data. White crappie catch rates were the lowest in 2022 since 2020. Low catch rates of crappie could be attributed to high water clarity which had secchi disk readings of 95 and 96 centimeters in some locations towards the lower end of the reservoir. Lengths ranged from 4.3-12.3-inches with an average of 10-inches. PSD and Wr values remain high (Table 15).

Table 15. CPUE, PSD, Wr, and RSE Estimates for White Crappie by Trapnets

Metric	2020	2021	2022
Total Catch	185	139	64
Stock Catch	183	115	59
Units of Effort	16	16	16
Sub-Stock CPUE (RSE)	0.1 (100)	1.5 (57)	0.3 (48)
Stock CPUE (RSE)	11.4 (33)	7.2 (28)	3.7 (32)
Quality/Density CPUE (RSE)	5.4 (36)	6.0 (24)	3.6 (33)
Preferred CPUE (RSE)	4.1 (41)	4.6 (22)	2.5 (33)
Memorable/Lunker CPUE (RSE)	1.3 (53)	0.5 (32)	0.4 (51)
Total CPUE (RSE)	11.6 (33)	8.7 (25)	4.0 (30)
PSD S-Q	52.46	16.52	3.39
PSD Q-P	12.02	20	28.81
PSD P-M	24.04	56.52	55.93
PSD M-T	11.48	6.96	11.86
PSD	47.54	83.48	96.61
Mean WR S-Q (RSE)	108 (2)	107 (3)	111 (10)
Mean WR Q-P (RSE)	94 (3)	96 (3)	98 (2)
Mean WR P-M (RSE)	106 (2)	102 (2)	106 (2)
Mean WR M-T (RSE)	105 (2)	100 (4)	105 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)

Source: KDWP 2022

Wiper – W X S Bass (*Morone saxatilis x Morone chrysops*)

Striped bass hybrids, also known as wipers, are crosses between striped bass and white bass, produced in hatcheries to be stocked in Milford Reservoir. These fish prefer waters like that of true striped bass in areas that are cool, clear, and deep. Wiper catch rates in 2020 were 8.8 fish/net. Wiper lengths ranged from 5.5-24-inches. Since 2018, PSD values have decreased. However, Wr values have remained consistent (Table 15). Wipers are stocked on an annual basis. 1,250,000 wiper fry were stocked in 2020. Wiper catch rates in 2022 were the lowest in the past five years. Lengths ranged from 6.2-24-inches with an average of 17.8 inches. PSD and Wr values continue to remain acceptable (Table 16). Wiper stockings will continue to sustain this fishery.

Table 16. CPUE, PSD, Wr, and RSE Estimates for Wiper – W X S Bass by Gillnets

Metric	2018	2020	2021	2022
Total Catch	200	175	162	105
Stock Catch	176	166	162	102
Units of Effort	20	20	20	20
Sub-Stock CPUE (RSE)	1.2 (37)	0.5 (41)	0.0 (.)	0.2 (73)
Stock CPUE (RSE)	8.8 (28)	8.3 (20)	8.1 (18)	5.1 (20)
Quality/Density CPUE (RSE)	3.5 (18)	3.8 (19)	8.0 (19)	4.0 (19)
Preferred CPUE (RSE)	1.7 (22)	0.9 (25)	2.9 (24)	1.5 (30)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.1 (100)	0.1 (69)	0.1 (100)
Total CPUE (RSE)	10.0 (28)	8.8 (20)	8.1 (18)	5.3 (20)
PSD S-Q	60.8	54.22	1.85	22.55
PSD Q-P	19.89	34.94	62.96	49.02
PSD P-M	19.32	10.24	33.95	27.45
PSD M-T	.	0.6	1.23	0.98
PSD	39.2	45.78	98.15	77.45
Mean WR S-Q (RSE)	90 (2)	84 (2)	94 (5)	88 (3)
Mean WR Q-P (RSE)	80 (4)	87 (1)	86 (2)	94 (1)
Mean WR P-M (RSE)	74 (4)	86 (1)	79 (1)	87 (1)
Mean WR M-T (RSE)	. (.)	101 (.)	78 (5)	83 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Forage Dynamics/Trends

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard shad catch rates in 2020 have remained consistent with previous years at 5.6 fish/net. Gizzard shad lengths ranged from 5-17-inches. 51% of fish collected were sub-stock and 49% were stock size or greater. Boat electrofishing in the summer produced a CPUE of 85.8 fish/hr. Collected individuals ranged from 2-11-inches with 97% of fish collected ranging from 2-6-inches (Table 17). Gizzard shad catch rates in 2022 were the lowest in the past five years. 33% of the samples were smaller individuals while the remaining 67% were adults. Lengths ranged from about 5-18-inches. Boat electrofishing was conducted in the summer of 2022 resulting in about 376 fish/hour Lengths ranged from about 2.5-5-inches (Table 17).

Table 17. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad by Gillnets

Metric	2018	2020	2021	2022
Total Catch	104	112	102	64
Stock Catch	35	55	79	43
Units of Effort	20	20	20	20
Sub-Stock CPUE (RSE)	3.5 (32)	2.9 (41)	1.2 (34)	1.1 (38)
Stock CPUE (RSE)	1.8 (25)	2.8 (32)	4.0 (20)	2.2 (24)
Quality/Density CPUE (RSE)	0.8 (39)	2.8 (32)	3.9 (20)	2.2 (24)
Preferred CPUE (RSE)	0.5 (47)	1.9 (37)	2.1 (33)	2.0 (24)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	5.2 (25)	5.6 (30)	5.1 (21)	3.2 (24)

Metric	2018	2020	2021	2022
PSD S-Q	54.29	.	1.27	.
PSD Q-P	20	32.73	46.84	6.98
PSD P-M	25.71	67.27	51.9	93.02
PSD M-T	.	.	.	.
PSD	45.71	100	98.73	100
Mean WR S-Q (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR Q-P (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Brood Supply

Historically, Milford Reservoir was used to collect walleye eggs for diploid and triploid saugeye production and occasional walleye production. In 2015, El Dorado Reservoir became the new location to collect walleye eggs for saugeye production due to the decline in available brood fish at Milford Reservoir. However, a regulation change for walleye in 2017 has resulted in more 21-inch and larger fish being collected in sampling efforts compared to years before the regulation change. Therefore, walleye egg collection could continue at Milford Reservoir. White bass males are also collected from Milford Reservoir annually for wiper production at the Milford Fish Hatchery.

Use/Visitation Impacts

Milford Reservoir is locally known as the “fishing capital of Kansas”, and is a top destination for anglers, hunters, campers, etc. on a regular basis. Popularity at Milford Reservoir has drawn attention to many guide services and fishing tournament organizers from all over Kansas and surrounding areas. Fishing tournaments happen frequently at Milford Reservoir and are hosted by local fishing clubs all the way up to national tournament trails. In recent years, Milford Reservoir had several bass tournaments each year hosted by groups such as I-70 bass club, Kansas Bass Nation, etc. Local catfish circuits (i.e., Catfish Chasers) also hold tournaments on Milford Reservoir once or twice a year. Milford Reservoir has gained national attention from Cabela’s for both walleye and catfish tournaments. In May of 2015, Cabela’s hosted the Cabela’s National Team Walleye Championship where 185 teams competed for $30,000 and a Ranger boat equipped with an Evinrude E-Tec motor valued at $68,000. In 2019, Milford Reservoir was added to the Cabela’s King Kat Tournament Trail. Cabela’s decided to return to Milford Reservoir in 2020 with both a qualifier tournament and the Cabela’s King Kat Classic. The qualifier was originally scheduled to happen in March, but with the COVID-19 pandemic was rescheduled to early October. The King Kat Classic occurred on October 30-31, 2020, with a $50,000 top prize. Also, Cabela’s has opted to host another qualifier tournament in May of 2021. Also, in May 2021, Milford Reservoir will be a host site for a Crappie USA regional tournament.

Future Without Project Projections

The future of the fishery for Milford Reservoir looks steady for now. However, several factors that fisheries biologists need to continue to monitor into the future are impacts of reservoir aging on fish populations, flooding impacts, increased sedimentation, invasive species presence, and habitat fragmentation. The ability to use the best science available can lead to creating the best management practices to be able to maintain these fish populations in a constantly changing environment. These fish populations are very important to all anglers who utilize Milford Reservoir; therefore, being able to understand how these populations could be impacted in the future can aid in better management of these fish species.

Water level management will also continue to be crucial to sport fisheries and anglers. Available habitats and types, and successful sportfish reproduction and survival, can all be positively or negatively impacted by the timing of water releases and magnitudes thereof. High releases around spawning could be detrimental both on the local and statewide scale, too, if broodfish species are negatively impacted.

There are some positive steps moving in the right direction to try to mitigate some the issues mentioned previously. The Milford WRAPS and Regional Conservation Partnership Program (RCPP) (Figure 2) programs are working with private landowners in the Milford Reservoir watershed to assist in developing, assessing, planning, and implementing best management practices on their land to reduce sedimentation and nutrient loading. KDWP staff along with local volunteers continue to try to deploy fish habitat in crucial areas where habitat is lacking around the reservoir. Educating the public on invasive species identification and prevention is used to try to reduce the spread of invasive species around the state and the country. Stocking efforts for walleyes and wipers are used to supplement the population to provide quality fishing opportunities for anglers. Kansas Department of Health and Environment staff is crucial in continually monitoring the lake's water quality parameters to try to detect the presence of harmful algal blooms to try to keep people safe. Overall, Milford Reservoir is an important resource for many reasons. Therefore, evaluating how the lake is currently managed by all involved could impact how the reservoir looks like in the future. It is expected that these actions will continue in the future.

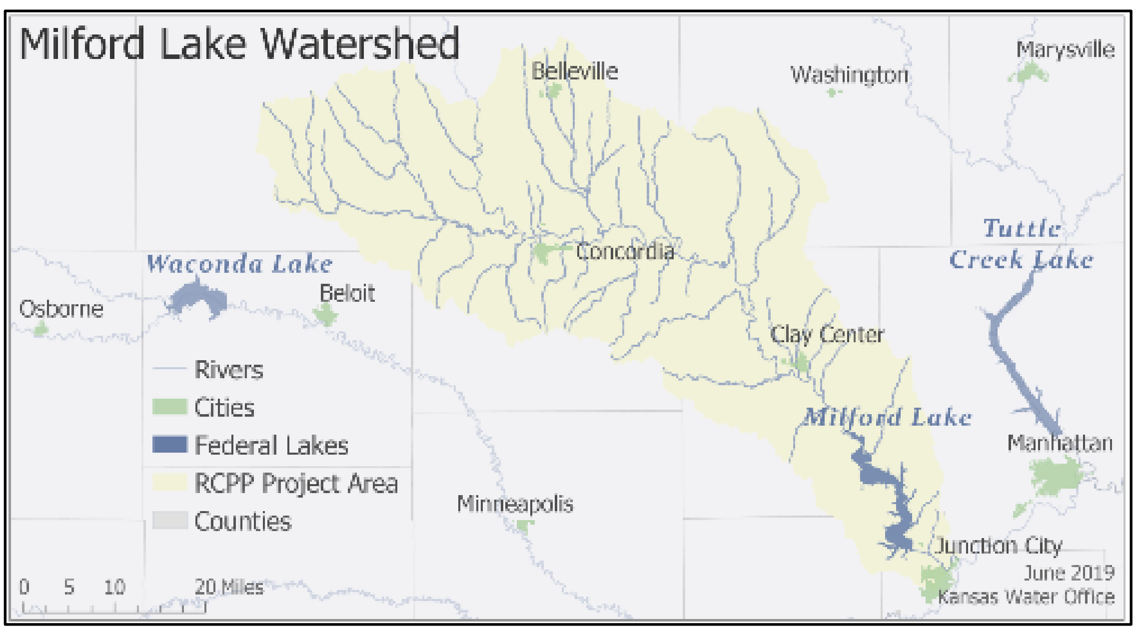


Figure 2. Milford Reservoir Regional Conservation Partnership Program Map

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USACE. 2022. Milford Lake, Learn About the Lake. Accessed online on October 18, 2022, at: https://www.nwk.usace.army.mil/Locations/District-Lakes/Milford-Lake/Learn-About-the-Lake/

Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery

Location: Tuttle Creek Reservoir

Ely Sprenkle, KDWP District Fisheries Biologist

Tuttle Creek Reservoir Located on the Big Blue River Within the Flint Hills Region of Northeast Kansas

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History

The Flood Control Act of 1938 authorized construction of Tuttle Creek Reservoir. Funds were appropriated for initial planning in 1944. The Flood Control Act of 1944, known as the Pick-Sloan Plan, coordinated plans by the U.S. Army Corps of Engineers (USACE) and the U.S. Bureau of Reclamation (USBR) for the entire Missouri River Basin. The first exploratory core hole was drilled in the spillway area on June 6, 1944. A 1950 study looked at the possibility of a series of reservoirs in the upper Blue River Basin as an alternative to Tuttle Creek Reservoir. It found that the single reservoir was the most feasible for controlling floods on the Big Blue River. A series of historic flood events occurred in 1951 causing more than $725,000,000 in damages. In light of these damages, the 1952 Definite Project Report served as the basis for design of Tuttle Creek Dam and Reservoir. Due to various economic and environmental factors actual construction of the dam occurred off and on between early 1950s and early 1960s. Construction was completed, and operation began July 1, 1962.

View of Tuttle Creek Reservoir from Downstream of the Dam

Water Allocation Background

Tuttle Creek Reservoir, constructed by the USACE, is an impoundment of the Big Blue River and controls approximately 9,628 square miles of drainage area. The reservoir storage capacity includes 1,884,312 acre-feet (ac-ft) storage for flood control and 257,014 ac-ft for multipurpose use. The dam and the reservoir currently provides substantial municipal water supply, flood control, navigation, recreation, fish and wildlife conservation, and water benefits. The storage capacity is shown in Table 1.

Table 1. Storage Capacity and Ownership

Pool Owner / Contracted Storage	Purpose	Quantity (acre-feet [af])*
USACE	Flood Control	1,884,312
USACE	Multipurpose	257,014
USACE	Water Quality/Navigation/Other Purposes	72,000
State of Kansas	Water Supply	50,000
USACE	Sediment Reserve	135,014
USACE	Surcharge	1,365,732

Notes: * Based on current capacity table and latest survey in 2009

Water quality storage is used to maintain minimum flow targets downstream of the reservoirs. In the mainstem Kansas River basin, only Tuttle Creek Lake has a water quality pool that is to be used to maintain flow targets on the Kansas River. The Kansas River flow criteria include minimum flows at Topeka and DeSoto in support of both water quality and water supply; the flow targets and their relationship to the Tuttle Creek Lake pool level are summarized in Table 2. Milford, Perry, and Tuttle Creek lakes are operated as a system to support minimum flow criteria on the Kansas River, with the current practice being to make releases from water supply storage volumes within Milford and Perry conservation pools that have not been called into service by the State, and to provide supplemental releases for support of navigation flow targets on the Missouri River.

Table 2. Low Flow Operational Target for the Kansas River

Pool Elevation	Topeka Summer	Topeka Winter	Desoto Summer	Desoto Winter
1075-1070	750	750	1,000	1,000
1070-1065	750	600	1,000	800
1065-1048	600	600	750	700

Notes: Summer: May 1 to October 31; Winter: November 1 to April 30

Typically, the three reservoirs (Perry, Tuttle Creek, and Milford) are operated to maintain 1,000 cubic feet per second (cfs) minimum flow at the DeSoto gage for water quality purposes, as shown in the Table 2 above (USACE Final Draft Navigation Study: Milford, Tuttle Creek, Perry Lakes. 2009).

Navigation releases from Tuttle Creek Lake are made from the water quality storage volume and the flood control storage. With navigation releases possible when the lake level is less than 3 feet below multi-purpose pool level (above 1072.0 feet) during the recreational season and less than 6 feet below multi-purpose pool level (above 1069.0 feet) after October 1.

Storage Loss to Sediment

Sedimentation has impacted operations and maintenance and infrastructure surrounding the lake mainly through the closure of boat ramps and other recreational facilities. Impacts have mostly occurred in the upper portions of the lake as the delta has migrated downstream. A large number of boat ramps have been closed due to insufficient water depths, which generally have to be about three feet to launch a recreational vessel. Maintenance dredging was attempted at several of the boat ramps, which was mostly unsuccessful because of the rapid accumulation of sediment. Also, a marina was once located in Fancy Creek Cove, which was relocated downstream near the dam once the cove silted in. Campground water supply intakes have also been silted in at several sites.

So far there has not been any impacts to the operation of the service gates from sedimentation; maybe because there is sufficient flushing from their operation to prevent the buildup of sediment near the gates.

It is estimated that Tuttle Creek Lake has lost 51% of its initial storage capacity from sedimentation (Table 3). Sedimentation can affect the natural resources in the lake. Suspended sediments carry nutrients and metals which accelerates eutrophication and can limit fishery production for native and game fish species. High turbidity from suspended sediments has impacts on the ability for sight feeding fish to be able to adequately capture food. During periods of extended high turbidity, the fish sampling data records reduced abundance of forage fish species and lower body condition of sportfish species.

Table 3. Tuttle Creek Reservoir Sedimentation

MPP Initial Volume (af)	MPP Recent Volume (af)	% of Initial MPP Volume Lost to Sediment
424,312	257,014	39

Tuttle Creek Reservoir Fishery

Fisheries Establishment

Tables 4 & 5 list sport and non-sport fish in Tuttle Creek Reservoir. The Big Blue River is home to a diverse riverine fish community and many of these fish species became permanent residents of Tuttle Creek Lake following completion of the dam. The lake has also been stocked with additional sportfish species with the intent to improve the recreational fishery. The list of stocked fish over the history of the lake include blue catfish, channel catfish, largemouth bass, northern pike, paddlefish, saugeye, striped bass, and walleye. The northern pike, striped bass and walleye stockings occurred in the early years of the new impoundment and these species have been absent from the sampling recorded for over twenty years and are assumed to be extirpated. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the *Sportfish Population Dynamics & Trends* section.

Table 4. Sport Fish Species Known to Inhabit Tuttle Creek Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Blue Catfish	*Ictalurus furcatus*
Bluegill	*Lepomis macrochirus*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Paddlefish	*Polyodon spathula*
Saugeye	*Sander vitreus* x *Sander canadensis*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*

Table 5. Non-Sport Fish Species Known to Inhabit Tuttle Creek Reservoir

Common Name	Scientific Name
Bigmouth Buffalo	*Ictiobus cyprinellus*
Bluntnose Minnow	*Pimephales notatus*
Common Carp	*Cyprinus carpio*
Emerald Shiner	*Notropis atherinoides*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Grass Carp	*Ctenopharyngodon idella*

Common Name	Scientific Name
Longnose Gar	*Lepisosteus osseus*
Orangespotted sunfish	*Lepomis humilus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Smallmouth Buffalo	*Ictiobus bubalus*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. Water Quality

The Big Blue River is the major source of surface water in the basin. Stream flow is dominated by surface runoff. The drainage area upstream of the dam is over 9,600 square miles. There are no major impoundments above Tuttle Creek Dam, but about one tenth of the drainage area is controlled by various Soil Conservation Service watershed development projects. The remaining vast uncontrolled drainage above the dam results in lake fluctuations which exceed those of other district reservoirs.

The major groundwater aquifers underlying the watershed include portions of the Glacial Drift and Dakota aquifers along with the alluvial aquifers. Water quality in the alluvial aquifers is generally good although nitrates, minerals, pesticides, and bacteria can be localized concerns.

The land surrounding Tuttle Creek Lake is situated in the northern portion of the Flint Hills, an area characterized by flat-topped hills with long, steep slopes, limestone rock outcrops, and well-defined stream channels. Relief between the stream floodplains and the hilltops adjacent to the lake averages about 300 feet. Much of the land is too stony to cultivate. The project is situated in the attenuated drift border, a region which was glaciated and is covered in paces with glacial till and outwash. From about Green Randolph Rd./K-16 Bridge north, glacial drift forms a discontinuous mantle, attaining a maximum thickness of 300 feet. South of Randolph Bridge, alluvial deposits range from 10 to 50 feet deep. Bedrock consists of a sequence of cherty limestones and shales.

Upland soils are commonly very shallow, stony and gravelly. They are developed from limestone and limy shales and occupy slopes of 7% to 20% or more. The topsoils are silty clay loams three to five inches thick. The unweathered parent material is usually encountered at eight to 20 inches. Lower slope and bottomland soils are moderately deep, dark, friable, silty clay loams five to 10 inches thick. They are derived from loess, limestone, and limy shales. The subsoils are silty clay loams found to a depth of 38 inches. Under normal erosion conditions, exposed topsoil may be totally displaced.

Mineral resources within the project area include sand, gravel, crushed rock, gypsum, and very limited oil deposits. Sand, gravel, and limestone are also extracted at several locations within the project's three county area. No known significant deposits of oil, gas or other important minerals are on project lands, and there have been no requests for oil or gas leasing at Tuttle Creek Lake.

Tuttle Creek Lake is defined by a combination of nutrient and sediment input leading to trophic state classification as either eutrophic or argillotrophic (KHDE, 2007 and 2010) depending on sample year. Light availability is a critical metric which is influences biological productivity through light limitation of photosynthesis. In either case, high turbidity due to suspended clay particles can limit the development of a phytoplankton community to varying degree at Tuttle Creek Lake. Reduced primary productivity generally results in lower standing biomass of the fish population and slower fish growth as compared to lakes characterized by high primary productivity. Given the prevalence of wind, the open topography of the landscape, and fluctuating water levels, Tuttle Creek Lake is weakly stratified during some, but not all years. Water column circulation pattern and resulting thermal stratification regime tends to influence fish behavior in that fish tend to avoid occupying the hypolimnion (the lowest layer of water in a stratified lake) during stratified conditions due to reduced dissolved oxygen levels. When dimictic circulation patterns occur, fish tend to occupy the upper 25 feet of the water column in summer. However, in the absence of thermal stratification fish utilize the entire water column. Mean secchi disc (used to measure transparency of water) 2010-2019 was 50 cm (USACE, 2019), indicating that water transparency is typically low. At low reservoir pool elevations, wind-driven currents can suspend bottom sediments adding to inherent turbidity. Increased turbidity can reduce feeding efficiency of sight feeding predators and reduces primary productivity. The general limnological parameters characteristic of Tuttle Creek Lake are shown in Table 6.

Table 6. General Limnological Parameters Characteristic of Tuttle Creek Lake

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	10,900
Max depth	feet	50
Mean depth	feet	
Mean annual precipitation	inches	35.6
Area watershed drainage	square miles	9,628
Hydrologic residence time	days	
Chlorophyll a	parts per billion	12
Secchi depth	centimeters	50
Turbidity	NTU	60.3
Agricultural lands	%	47
Forest habitat	%	7
Grassland habitat	%	39
Urban lands	%	1
*Trophic state index	Index/Classification	56/eutrophic

Note: *****Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

Tuttle Creek Lake possesses adequate water quality to promote sportfish survival. Turbidity is high as evidenced by mean turbidity value and mean secchi disc measurement (Table 6).

2. Water Level Fluctuations

Annual precipitation is variable in Kansas and a gradient of low (10 – 20 inches) precipitation in western Kansas to high (40 – 50 inches) precipitation in southeastern Kansas is a reality. Summer temperatures in western Kansas can reach temperatures in excess of 43°C (110°F). These temperatures and generally windy conditions on the plains causes the evaporation of approximately 1.2 meters (4 feet) or more each year. Combine these droughty conditions with a steady decline in western Kansas surface water, due partially because of drastic and annual declines in the depth of the Ogallala Aquifer, and you have a recipe for major water level fluctuations.

Tuttle Creek Reservoir is used as a public water supply and has experienced elevation fluctuations. The reservoir has experienced drought conditions in the past causing it to drop to elevations below multipurpose pool and most recently in 2013 when the reservoir dropped to an elevation of nearly 1062 feet or 13 feet below conservation pool (Figure 1). Sustained high water events in the multipurpose pool (e.g., 1973, 1993, 2019) can provide excellent habitat for young of year fish and allow some species to have good year classes recruited into the fishery. However, release of high waters often leads to rapid drawdowns in the multipurpose pool which can lead to loss of fish through the outflow of the dam. A common occurrence at Tuttle Creek Reservoir that has had substantial influence on sportfish abundance is high emigration rates out of the lake during periods of elevated release rates. No other factor can reduce sportfish abundance so dramatically or so quickly. One of the best examples of this is the recorded impacts on a robust fishery from a release event in 2007. Water levels reached 26 feet above conservation pool in late May and then returned to conservation pool in less than a month with release rates that were above 10,000 cfs for 20 days with a max of 20,000 cfs. Prior to this, gill net sampling in fall of 2006 produced 216 saugeye, 53 channel catfish, 10 blue catfish, 279 white bass, and 71 gizzard shad. Fall gill netting in 2007 produced 1 saugeye, 4 channel catfish, 1 blue catfish, 2 white bass, and 9 gizzard shad. This is just one example of a dramatic loss in fish due to being flushed out of the lake, which has been a fairly regular occurrence the last twenty years.

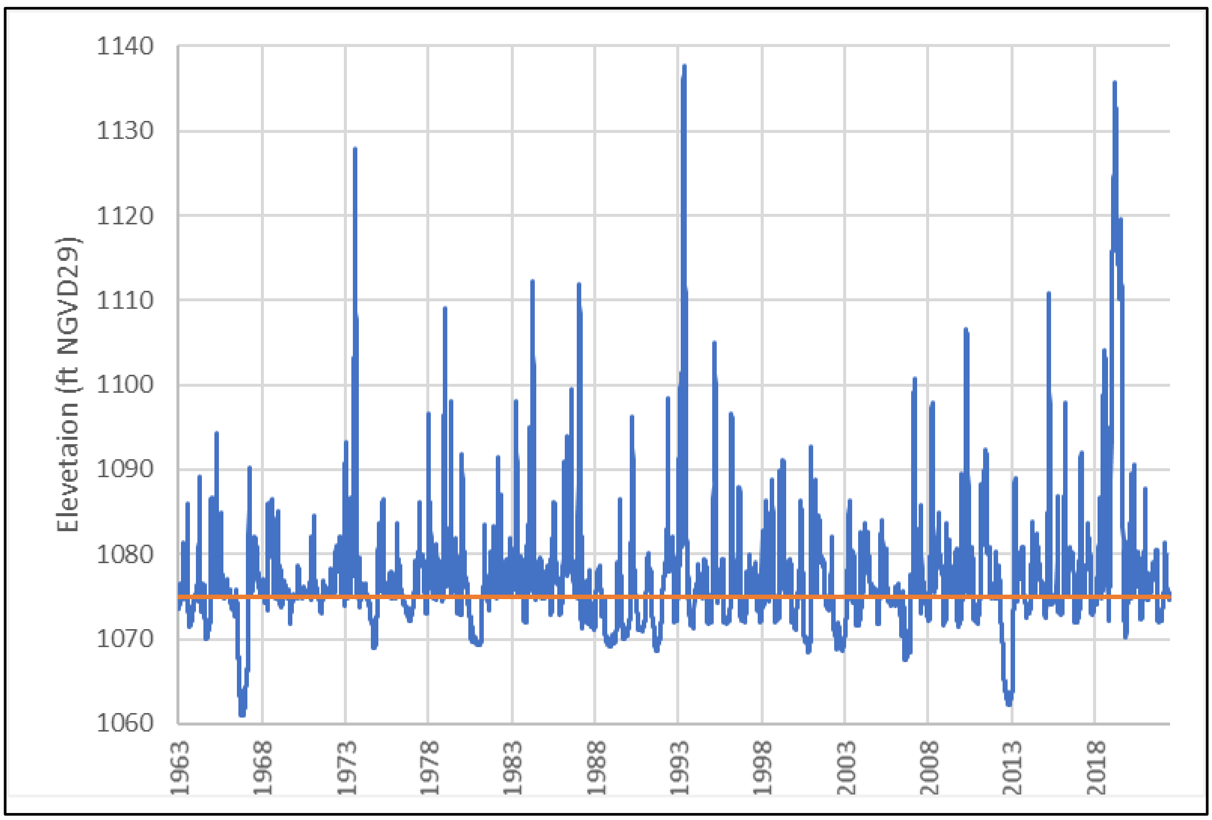


Figure 1. Yearly Ending Reservoir Pool Elevation (feet NGVD29) [blue line]

Source: USACE 2022

3. Sedimentation

The multipurpose pool at Tuttle Creek Reservoir originally included 424,312 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 39% of the multipurpose pool has been filled in with sediment leaving approximately 257,014 ac-ft of capacity (based on 2009 survey results). It is estimated that approximately 3,794 ac-ft of sediment accumulates on average annually in Tuttle Creek Reservoir. Sediment will continue to accumulate in Tuttle Creek Reservoir with an expected additional 25% loss of the multipurpose pool over the next 25 years (2049) and 36% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 106,499 ac-ft in 2074. Sedimentation at Tuttle Creek Lake has reduced the surface area by 4,900 acres between 1957 to 2010. The sedimentation rate in the multi-purpose pool is 3,351 acre feet per year, which is 13% less than expected when designed. Loss of current uses at Tuttle Creek Lake are expected and sediment management options are currently being discussed with stakeholders. Turbidity is a major factor affecting water quality. Sedimentation reduces the lifespan of coves for recreation, creates mudflats which are exposed during low water periods, and limits production of desirable benthic organisms. Typically, 60-80% of suspended matter settles out as water moves from the upper end of the lake towards the dam.

The 2017 assessment by the Kansas Water Office (KWO) quantified annual tons of sedimentation from streambank erosion over the period between 1991, 2002, or 2003 and 2015 in the Tuttle Creek Watershed within the Kansas Regional Planning Area (KS RPA). A total of 367 streambank erosion sites, covering 300,258 feet of unstable streambank were identified. Of the identified streambank erosion sites, 89% were identified as having a poor riparian condition (riparian area identified as having cropland, grass/crop streamside vegetation or narrow woodland (single line of trees between stream and cropland/pastureland)). Sediment transport from identified streambank erosion sites accounts for 947,211 tons (768 acre feet) of sediment per year transported from the Tuttle Creek Watershed streams to Tuttle Creek Reservoir annually, accounting for roughly 21% of the total load estimated from the most recent bathymetric survey performed by a U.S. Army Corps of Engineers in 2009. It should be noted that the identified streambank erosion locations are only a portion of all streambank erosion occurrences in the watershed. Only those streambank erosion sites covering an area 2,000 sq. feet, or more, were identified.

It is estimated that Tuttle Creek Lake has lost 39% of its initial conservation pool storage capacity from sedimentation (Table 7), which has substantially reduced the supply available to maintain operational targets through prolonged drought. This was recently observed during the July 2012 – April 2013 drought period, where Tuttle Creek Lake was drawn down over 15 feet to maintain Kansas River flow targets.

Table 7. Tuttle Creek Pool Volumes 1962-2009

Year	Multipurpose Pool Volume (ac-ft)	Flood Control Pool Volume (ac-ft)	Data Type
1962	424,312	1,942,705	Sedimentation Rangelines
1973	388,598	1,937,366	Sedimentation Rangelines
1983	335,100	1,922,085	Sedimentation Rangelines
1993	298,883	-	Sedimentation Rangelines, partial survey
2000	280,137	1,870,735	Sedimentation Rangelines
2009	257,014	1,884,312	Single beam sonar 250 ft spacing, LiDAR

Table 8 gives the amount of sediment deposition in the reservoir calculated by subtracting the pool volumes measured from the surveys. Since the 1993 survey was only a partial survey, this survey was skipped when calculating deposition. Also, the survey methodology switched for the 2009 survey, which is likely why there is negative deposition from 2000 to 2009 within the flood pool. Similar "negative deposition" has been observed at other lakes in the basin coinciding with the switch from rangelines to LIDAR. Deposition within the multipurpose pool from 2000 to 2009 appears to be reasonable. In Table 8, FP deposition indicates deposition at elevations higher than the multipurpose pool but lower than the top of flood pool.

Table 8. Deposition Amounts (ac-ft)

Years	MPP Deposition	MPP Yearly	FP Deposition	FP Yearly
1963-1973	35,714	3,571	5,339	534
1973-1983	53,498	5,350	15,281	1,528
1983-2000	54,963	5,496	51,350	5,135
2000-2009	23,123	2,312	-13,577	-1,358
Total	167,298	3,794	71,970	1,894

From 1962 to 2009, the multipurpose pool lost 167,298 ac-ft of storage to sedimentation. This represents 39.4% of the original multipurpose pool volume. The average annual rate of loss was 3,560 ac-ft/year or 0.84% of the original volume/year.

From 1962 to 2000, the flood control pool lost 71,970 ac-ft of storage to sedimentation. This represents 3.7% of the original flood control pool volume. The average annual rate of loss was 1,894 ac-ft/year or 0.1% of the original volume per year.

Based on the most recent sedimentation analysis, the incoming sediment load at Tuttle Creek Reservoir was found to be 47.1% clay, 40.8% silt, and 12.1% sand/gravel. Table 9 summarizes the results for 1961 to 2019.

Table 9: Preliminary Incoming Sediment to Tuttle Creek Lake from 1961 to 2020

Years	1962 - 2019
Total Incoming Sediment (tons)	310,192,634
Total Incoming Clay Fraction	47.1 %
Total Incoming Silt Fraction	40.8 %
Total Incoming Sand Fraction	12.1 %

4. Invasive/Exotic Species

A variety of aquatic and terrestrial species inhabit the lake and surrounding project land. A listing of those species and their prominence can be found in Table 10.

Table 10. Invasive/Exotic Species Found at Tuttle Creek Reservoir

Species Group	Species Common Name	Type of Occurrence	Acreage Impacted	% Acreage Impacted
Aquatic and Wetland Animals	Bullfrog	Minor	5	0.01%
Aquatic and Wetland Animals	Zebra Mussel	Significant/Major	10,900	32.4%
Aquatic and Wetland Animals	Common Reed	Minor	3	0.01%
Aquatic and Wetland Plants	Purple Loosestrife	Minor	1	0.01%
Terrestrial Animals	European Starling	Significant/Major	33,000	98.09%
Terrestrial Animals	House Sparrow	Significant/Major	33,000	98.09%
Terrestrial Animals	Rock Dove	Minor	1	0.00%
Terrestrial Plants	Bur Ragweed	Minor	5	0.01%

Species Group	Species Common Name	Type of Occurrence	Acreage Impacted	% Acreage Impacted
Terrestrial Plants	Canada Thistle	Moderate	200	0.59%
Terrestrial Plants	Caucasian Bluestem	Moderate	150	0.45%
Terrestrial Plants	Common Mullein	Significant/Major	500	1.49%
Terrestrial Plants	Crown Vetch	Significant/Major	1,000	0.52%
Terrestrial Plants	Curly Dock	Moderate	400	1.19%
Terrestrial Plants	Field Bindweed	Moderate	300	0.89%
Terrestrial Plants	Japanese honeysuckle	Moderate	50	0.15%
Terrestrial Plants	Johnson Grass	Moderate	125	0.37%
Terrestrial Plants	Kentucky Bluegrass	Moderate	50	0.15%
Terrestrial Plants	Leafy Spurge	Moderate	100	0.30%
Terrestrial Plants	Marijuana	Moderate	150	0.45%
Terrestrial Plants	Common Teasel	Moderate	150	0.67%
Terrestrial Plants	Musk Thistle	Minor	20	0.06%
Terrestrial Plants	Queen Anne's Lace	Significant/Major	700	2.08%
Terrestrial Plants	Red Cedar	Significant/Major	2,000	23.06%
Terrestrial Plants	Sericea Lespedeza	Significant/Major	1,500	4.46%
Terrestrial Plants	Siberian Elm	Significant/Major	650	1.93%
Terrestrial Plants	Smooth Brome	Significant/Major	1,400	4.16%
Terrestrial Plants	Tall Fescue	Moderate	250	0.74%

Fisheries Management Objectives

The general objective of fisheries management at Tuttle Creek Reservoir is to optimize the quality and diversity of angling opportunities while also sustaining the resource into the future. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 11), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Mitigation for Factors Affecting the Sport Fishery

1. Fish Sampling for Long-term Trend Monitoring

Kansas Department of Wildlife & Parks regularly samples the fish populations in Tuttle Creek Lake to monitor for changes within these populations over time. The current annual sampling regime includes a July low-frequency electrofishing sample, an August high-frequency electrofishing sample, an October night-time electrofishing sample, and a fall deployment of 20 core-panel gill nets and 16 trap nets. This annual sampling schedule is considered the minimum and is routinely exceeded as additional supplemental sampling is deemed necessary for enhanced evaluations. The longest running dataset is from netting efforts as data has been collected via gill nets and trap nets every year since 1986, with the only exceptions in 2018 and 2019 when high-water levels during the sampling period prevented the utilization of these gears. Exceptionally high water levels for most of 2019 prevented all forms of fish sampling in the lake that year.

2. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, the statewide largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, with proper justification KDWP District Fisheries Biologists do have the option to use special length and creel limits to assist in shaping fish populations for the benefit of anglers. Current special fish harvest regulations in effect at Tuttle Creek Reservoir are: Largemouth Bass-18-inch minimum length limit and Blue Catfish 35-inch minimum length limit. See Table 11 below for a comprehensive list of fish harvest regulations in effect at Tuttle Creek Reservoir. Other specific management activities include stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Table 11. Current Fish Harvest Regulations in Effect at Tuttle Creek Reservoir*

Common Name	Length Limit	Daily Creel Limit
Blue Catfish	35-inch minimum length limit	5
Channel Catfish	N/A	10
Flathead Catfish	N/A	5
Crappie	N/A	50
Largemouth Bass	18-inch minimum length limit	5
Saugeye	15-inch minimum length limit	5

Note: * Species Specific Length and Creel Limits at Tuttle Creek Lake in 2021

It is anticipated that regulations for Blue Catfish will change in 2022 to allow more angler harvest as the fish population matures and expands into the fishery. The new proposed wording to encompass changes to both the daily creel limit and length base restrictions is “10 fish daily creel limit, may include only one fish 30 inches or longer”. If adopted, this new regulation will hopefully increase harvest opportunities to anglers while limiting the potential for over exploitation of the large, reproductive adults of this slow to mature species.

3. Sportfish Stocking Efforts

Fish stockings at Tuttle Creek Lake are considered to be either introductory stockings or maintenance stockings. Introductory stockings are intended to establish or reestablish a fish species in the lake with the intent that species will sustain itself through natural reproduction. Maintenance stockings are used to increase numbers of a fish species for angler usage, particularly for species that have limitations on natural reproduction within the lake. The lake has received surplus fish when the state’s fish hatcheries annual production exceeds the demand for the stocking of that species. The Table 12 below depicts stocking efforts from 2000 through 2020.

Table 12. Tuttle Creek Reservoir Fish Stocking Data From 2000 Through 2020

Common Name	Total Number Stocked	Stocking Type
Blue Catfish	162,146	Introductory
Channel Catfish	1,002	Surplus
Paddlefish	15,468	Introductory
Saugeye	40,962,770	Maintenance

At this time, the plan for future fish stockings is focused on the perpetuation of saugeye maintenance stockings to sustain the sport fishery. In addition, the continuation of paddlefish stockings will occur to evaluate stocking survival in Tuttle Creek Lake and the potential for the species to produce a self-sustaining population capable of providing a recreational fishery. Channel catfish, rainbow trout, and wiper are stocked in the tailwaters below the dam to provide more diverse fishing opportunities locally.

4. Lake Level Management Plans

NWK implements a variety of practices through lake level management plans (LLMP) that address water management for environmental outcomes:

1) Rise and maintenance of lake elevation in late fall – early winter over conservation pool to benefit waterfowl/shorebird migration and usage.
2) Slight pool raise in spring to enhance boating access, to create and maintain good nursery and growth conditions for fisheries, and for threatened and endangered terns and plovers nesting downstream.
3) Reduction of water level mid-summer to allow for re-vegetation of areas to benefit waterfowl habitat.

One of the main objectives of the LLMP at Tuttle Creek Lake is to increase recruitment of crappie in the lake. Coordination between state and Federal agencies during moderate flood and drought events can minimize damage to the lake's shoreline habitat that is essential for crappie spawning success from such uncontrolled events. Lowering of the lake level in the winter months is primarily to allow additional storage for frequent spring rises in lake levels which would require untimely releases and to lessen the effect of these untimely releases on crappie spawning success.

Angler Use

Angler participation rates at Tuttle Creek Reservoir have been lower than other Federal impoundments in Northeast Kansas. There are multiple factors affecting this, but most of the influences are centered around the water level fluctuations that are common at the lake.

Shoreline access available to anglers is quite limited at Tuttle Creek when compared to other lakes. This is in part to due to how the purchase of the land for the lake was based on elevation, instead of traditional section lines. This makes many shoreline areas landlocked by private property and inaccessible to the general public by land or road. Bank fishing is further restricted when water levels are elevated as this submerges most of the easily accessible shoreline. High water also limits access by causing road closures, further distancing anglers from the water. Flood debris along the shoreline serves as additional hinderance to shore bound anglers. Many of the historically popular bank fishing locations were in the upper end of the reservoir and have since been loss due to the excessive sedimentation. There are few shoreline areas that have been developed in the lower reaches of the lake that would provide suitable bank fishing access. There is likely resistance to invest in shoreline improvements that could be loss due to the expectation that future high-water events will negate any development efforts.

Boat usage is much lower at Tuttle Creek then at other local impoundments and there are multiple factors contributing to this. The lake currently has a low number of boat ramps available to public access. Numerous boat ramps have been loss to sedimentation, road closures, or lack of maintenance. Once the lake is ten feet above conservation pool, which is a fairly common occurrence at this lake, there is only one developed boat ramp still accessible to the public. Only two of the existing ramps regularly have a dock available and one of these has been closed since the 2019 flood event. Docks at boat ramps facilitate easier loading/unloading of boats and the absence of docks at ramps likely contributes to lower participation rates, especially for solitary boaters and people with movement limitations or disabilities. Another factor that limits boat usage is high-water events increasing boating hazards in the form of floating debris which probably negatively influences a boat angler's decision to use this lake.

As to the actual fishing experience, it is considered harder to have a successful fishing trip at Tuttle Creek Reservoir than at many other Kansas lakes. Rapid water level fluctuations and dynamic shifts in water turbidity makes it more difficult to predict fish behavior and reduces angler success per trip. Essentially, it requires an increased amount of effort and skill to be consistently successful at this lake.

Another prominent factor is how sportfish densities tend to have large fluctuations due to negative impacts from inconsistent fish spawning or from high fish emigration events. The lack of stability in fish available to anglers, along with the other listed hindering factors, greatly reduces any consistency in angler usage of Tuttle Creek Reservoir.

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results should be viewed with a degree of uncertainty, requires interpretation by specialized workers, and often requires multiple years of data for representative trends to become apparent.

White Crappie From Tuttle Creek Lake Collected Via Trap Nets

Tuttle Creek Reservoir has provided good fishing opportunities for multiple fish species through the history of the lake. However, the fish populations have overall underperformed due to reoccurring hydrologic characteristics that are commonly problematic to the fishery at this flood control impoundment. One of the main inhibiting factors for most of the sportfish species is inconsistent annual recruitment due to ill-timed water level fluctuations during spawning activities that greatly reducing spawning success. Rapid changes in water levels can leave recently laid fish eggs too deep or too dry to hatch. Many species are sensitive to fluctuations in water levels during spawning times and may simply choose not to complete this annual biological function if conditions are not suitable.

White Crappie (*Pomoxis annularis*)

White crappie has been the most popular sportfish at Tuttle Creek over the history of the lake and maintaining a robust crappie fishery for angler harvest is the primary fisheries management objective for this impoundment. Part of the reason this species performs well is because the negative hydrologic characteristics that commonly hinder the other sportfish species in the lake do not have as great an impact on the white crappie populations. However, Tuttle Creek traditionally has a lower abundance of crappie when compared to similar NE Kansas Reservoirs. Recruitment has been the primary stumbling block in providing a consistently robust crappie fishery. The frequency of ill-timed water level fluctuations during the spring spawning period has prevented the species from consistently producing strong year-classes.

Furthermore, the lake has high water levels on such a regular basis that there are not the benefits to young fish from flooding terrestrial habitat due to the lack of terrestrial vegetation growth when water levels are up. Another factor inhibiting the crappie fishery is the loss of age-1 fish via emigration during high reservoir releases in the summer months. White crappie are sampled annually with trap nets to evaluate species performance and to monitor for changes in population dynamics. Sample abundance has remained fairly steady over the last twenty years, with one main exception in 2012 (Figure 3). The reservoir experienced relatively stable water conditions during the spawning period from 2008 through 2012 which allowed crappie abundance to increase dramatically. This robust fishery was very popular with anglers and angling pressure was elevated for several years. The population regressed back to more traditional levels for abundance post 2012 as the inconsistency of recruitment returned along with the irregularity of spring water levels.

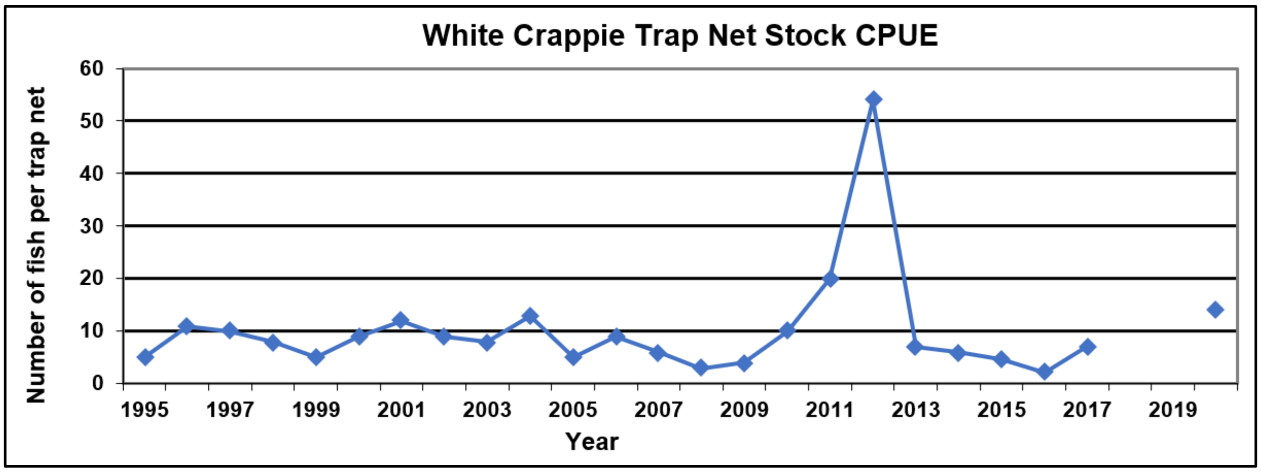


Figure 2. Catch per unit effort (CPUE) for White Crappie Collected During October and November with Trapnets

Channel Catfish (*Ictalurus punctatus*)

The channel catfish population is an important component to the recreational fishery at Tuttle Creek Reservoir. Angler preference has been high for the species in both the reservoir and connected river system. The rocky habitat that is common at Tuttle Creek is well suited for this cavity nest building fish and the historical data records good growth patterns for the species. However, it has been common for there to be a rise in water levels during the species spawning period in early summer which greatly hampers consistent year-class production. This has been offset to some degree at Tuttle Creek due to the influx of individuals from upstream environments. Unfortunately, the recent regularity of water level fluctuations impacting channel catfish spawning has had a cumulative effect resulting in the species underperforming for most of the last decade. The species is evaluated annually with core panel gill nets.

Channel Catfish Collected Via Gill Nets in Tuttle Creek Lake

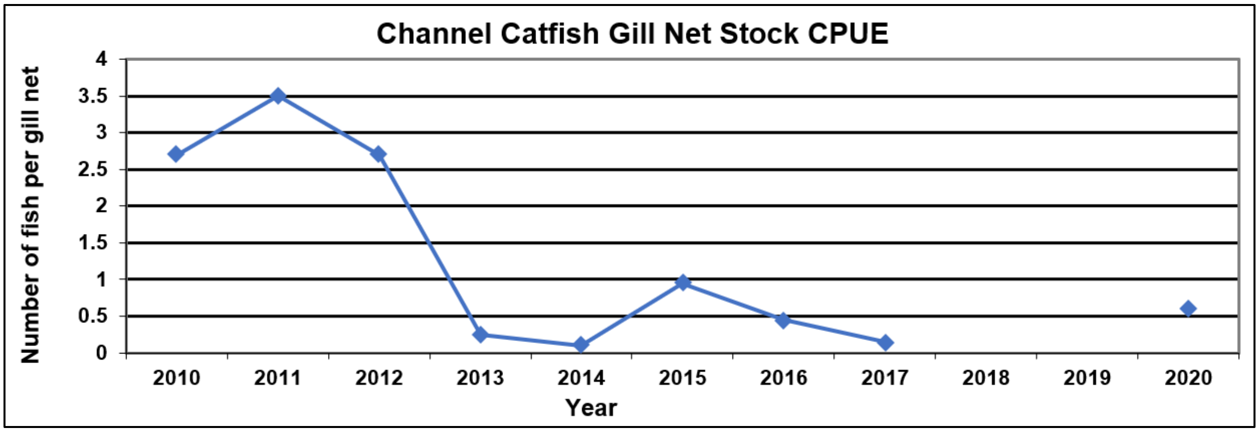


Figure 3. Catch per unit effort (CPUE) for Channel Catfish Collected During October and November Using Gill Nets.

White Bass (*Morone chrysops*)

The white bass population has historically been a popular feature to the fishery even though abundance has been rather dynamic through time, which is not uncommon for this species in Kansas impoundments. Traditionally, the rise and fall in white bass density is associated with spring river inflows during the spawning period and with forage availability in the form of young gizzard shad. The last ten years has been particularly detrimental to the white bass fishery and to the recreational anglers targeting the species. Annual production would benefit from stable water levels during the spawning season. However, the long-term outlook for this species is expected to continue to trend downwards as sedimentation in the upper end of the reservoir restricts connectivity with the tributaries' white bass use for spawning habitat.

White Bass from Tuttle Creek Lake

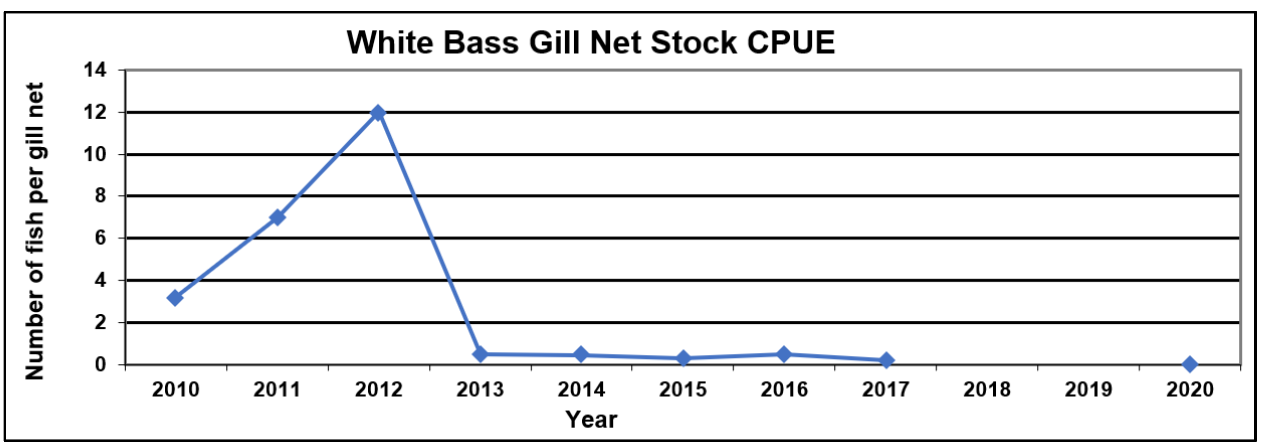


Figure 4. Catch per unit effort (CPUE) for White Bass Collected During October and November with Gill Nets.

Saugeye (*Sander canadensis x vitreus)*

Saugeye have been a part of the Tuttle Creek fish community since 1995. Similar to channel catfish and white bass, the saugeye population has been underperforming most of the last decade. However, unlike the other two fish species, annual year-class production has not been the primary limiting factor. This hybrid is maintained via regular stockings of state reared fry and/or fingerlings which have had a history of good stocking success and producing strong year-classes. Over the last ten years, the lake has been stocked with a total of 17.4 million saugeye fry and 449,079 saugeye fingerlings. A review of the historical fish sampling data and the hydrological records indicates that emigration is the primary factor in determining abundance of saugeye in the lake after their first year of growth. Once saugeye reach age-1, they have exceptionally high emigration rates out of the reservoir whenever release rates reach 10,000 cfs for an extended period in the month of June. Unfortunately, this threshold has been reached five of the last six years through 2020, which is the primary reason that saugeye abundance has been exceptionally low over this time. Saugeye provide some angling opportunities in the lake during periods that they remain in the lake long enough to grow to catchable sizes, but most of the angling benefits are realized in the tailwater fisheries downstream of the dam. Saugeye are evaluated with gill nets and night-time electrofishing each fall. Future saugeye stockings will remain an important component to the reservoir and tail water fisheries.

Young of the Year Saugeye Collected During October Night-Time

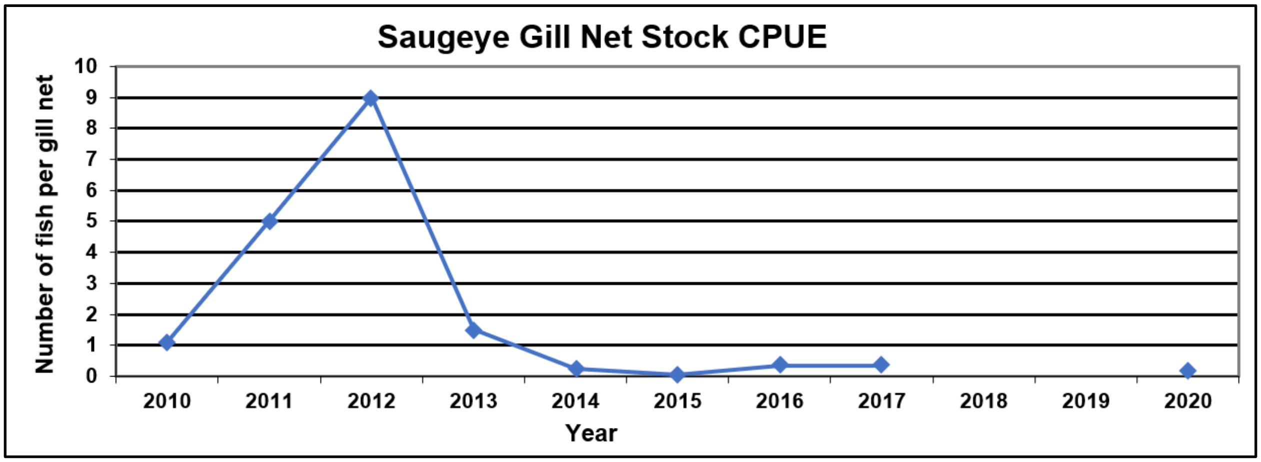


Figure 5. Catch per unit effort (CPUE) for Saugeye Collected During October and November With Gill Nets.

Blue Catfish (*Ictalurus furcatus*)

Tuttle Creek Lake Blue Catfish Collected With Electrofishing

Tuttle Creek Reservoir lies within the historic range of Blue Catfish, but the species was absent from the sampling records post dam construction. The creation of a robust Blue Catfish sport fishery at nearby Milford Reservoir inspired the re-introduction of the species at Tuttle Creek. The lake received ten stockings of hatchery reared fish from 2002 through 2016 for a combined total of 162,146 Blue Catfish being released into the lake. Several of these stockings had good recruitment which led to establishment of the species in the lake and the connected river system. The first natural reproduction of Blue Catfish in Tuttle Creek Reservoir was documented in 2016. Early indications are that this effort will be considered a success in creating a self-sustaining Blue Catfish population that persists into the future.

It was a concern that high angler harvest could hinder the early stages of Blue Catfish establishment, therefore a 35-inch minimum length limit on the species went into effect on January 1, 2018, to protect the emerging population until several more natural year-classes could be created. The 35-inch minimum length limit will likely be removed or modified in the near future as the population matures and management of the species transitions to a focus on angler harvest opportunities.

The Blue Catfish population at Tuttle Creek is evaluated with both gill nets in the fall and with a species-specific summer electrofishing effort. Sampling data over the last decade documents the slow but steady establishment of the species in the lake. One of the primary concerns with the long-term viability of this species was the likelihood that downstream emigration would be the biggest hindrance in species performance. The 2019 flood event does appear to have facilitated emigration of Blue Catfish to negatively affect abundance, but not nearly to the scale that it effected channel catfish, white bass, or saugeye populations. It is hoped that Blue Catfish can provide stability to the fishery and offer consistent opportunities to recreational anglers, despite the dynamic water events that commonly plague the other sportfish species at this lake.

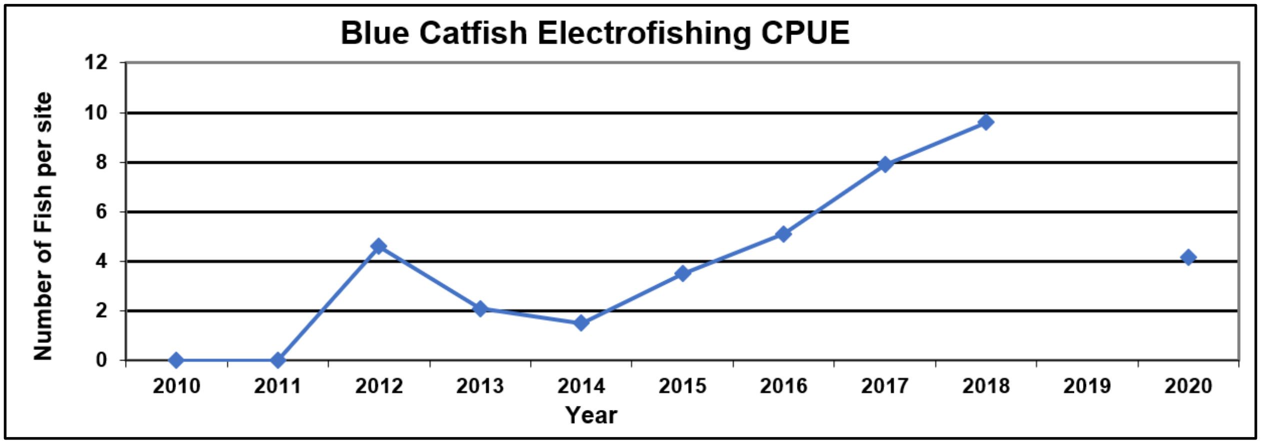


Figure 6. Catch per unit effort (CPUE) for Blue Catfish Collected During Summer Electrofishing Efforts.

To get a better understanding of growth, emigration and angler harvest of Blue Catfish in Tuttle Creek Reservoir and the Big Blue River system, we began tagging fish in 2016 with Floy FD-94 T-bar anchor tags. These tags contain a unique number for each fish, along with a phone number and email address for anglers to report catches. After the first five years of this study, we have tagged 728 Blue Catfish in the lake and tagged another 169 Blue Catfish below the dam in the River Pond. The plan is to tag another 2,000 Blue Catfish in 2021 to complete a mark-recapture study at the lake for a more comprehensive density estimate.

During the 2016 sampling efforts, pectoral spines were removed from 36 Blue Catfish for age estimation of each fish. Fish ranged from 36 cm up to 102 cm. This data was used to estimate the age distribution for Blue Catfish in 2016 from the 211 fish over 35cm that were collected in the lake that year, which is displayed in the pie chart.

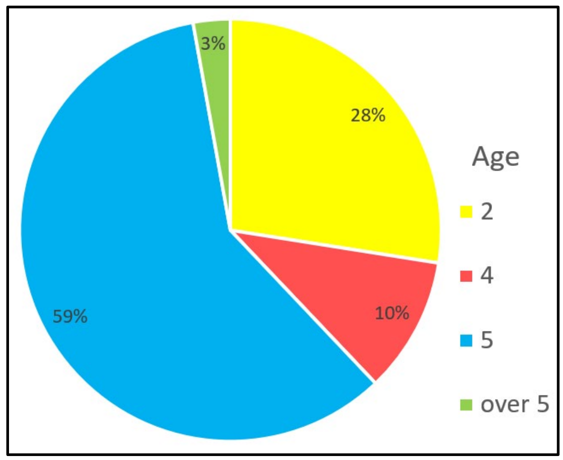


Figure 7. Blue Catfish Age Structure Estimate from All Fish Over 35cm Collected With Electrofishing in 2016

Gizzard Shad *(Dorosoma cepedianum*)

The lake contains a diverse array of cyprinid and centrarchid species, but gizzard shad are considered the main forage base for the sportfish at Tuttle Creek Lake. Gizzard shad have been able to complete a spawn every year, despite the fluctuating nature of the water levels at Tuttle Creek. However, there are years that insufficient numbers of young shad have hampered sportfish growth. One of the main factors influencing annual gizzard shad production is turbidity. If high levels of turbidity persist through most of the growing season, then shad numbers are repressed due to their inability to see for feeding. This is apparent in years when water is not being discharged during high sediment inflows causing the turbidity to be isolated in the upper part of the lake. When this occurs, there is measurably higher abundances of gizzard shad in the lower reaches of the lake and these fish are larger on average than shad in the upper end. Inconsistency in the amount of forage available to predators is just another variable that limits sportfish potential at Tuttle Creek. Annual gizzard shad recruitment is measured each summer with boat electrofishing to help assess annual forage availability.

Young of the Year Gizzard Shad Collected Via Summer-Time Electrofishing

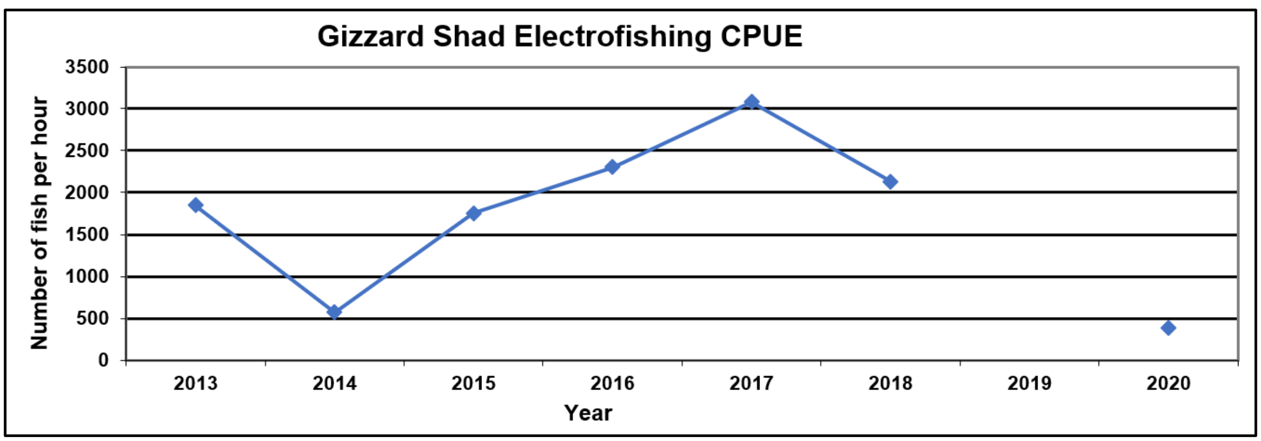


Figure 8. Catch per unit effort (CPUE) for Gizzard Shad Collected During Summer Electrofishing Efforts.

Future Without Project Projections

The future is not overly bright for the fishery at Tuttle Creek Reservoir. It is likely that dynamic water level events will continue to play a prominent role in determining sportfish densities. In addition, the loss of habitat and water volume due to sedimentation will continue to have a compounding effect on the lake's capacity to produce fish. Sedimentation will continue to occur (26% loss over the next 50 years) and has the potential to dramatically reduce use to the reservoir, especially for anglers, as only 25% of the original multipurpose pool is expected to remain in 50 years. Sedimentation will be a stressor to fish populations in the future as shorelines erode and leave littoral areas unvegetated or littoral habitat is silted in leaving areas unsuitable for fish spawning, nursery habitat, and protective cover. Dredging can be used to clear sediment from boat ramps to improve access but can also be used to improve shoreline depth for bank anglers and to improve fish habitat. Unfortunately, the high effort and cost of dredging will limit these projects to select locations. Alternatives for removing sediment must be researched, and a cost analysis should be performed prior to attempts to improve conditions. The role of turbidity on the fishery will likely only increase as water volume continues to decrease. Similar to the past, campground water supply intakes will likely be silted in and will need continual maintenance in the future. An additional stressor has been added to this system as the invasive zebra mussels were first documented in the lake in 2017 and the potential negative aspects have not yet been realized. Other invasive/exotic species at Tuttle Creek Reservoir will continue to be an issue and likely require measures to control their populations.

However, there are some recent positive changes worth noting. Stocking efforts have created an emerging blue catfish population and early indications are that this species may not be as adversely affected as other sportfish species by the negative characteristics common at Tuttle Creek Reservoir. With this success in mind, a new paddlefish stocking effort was initiated in 2019 to hopefully establish another angling opportunity that can thrive in this lake. It is too early to determine success of paddlefish re-introduction efforts, but these first fish grew well, and many young individuals were seen downstream of the lake in 2020.

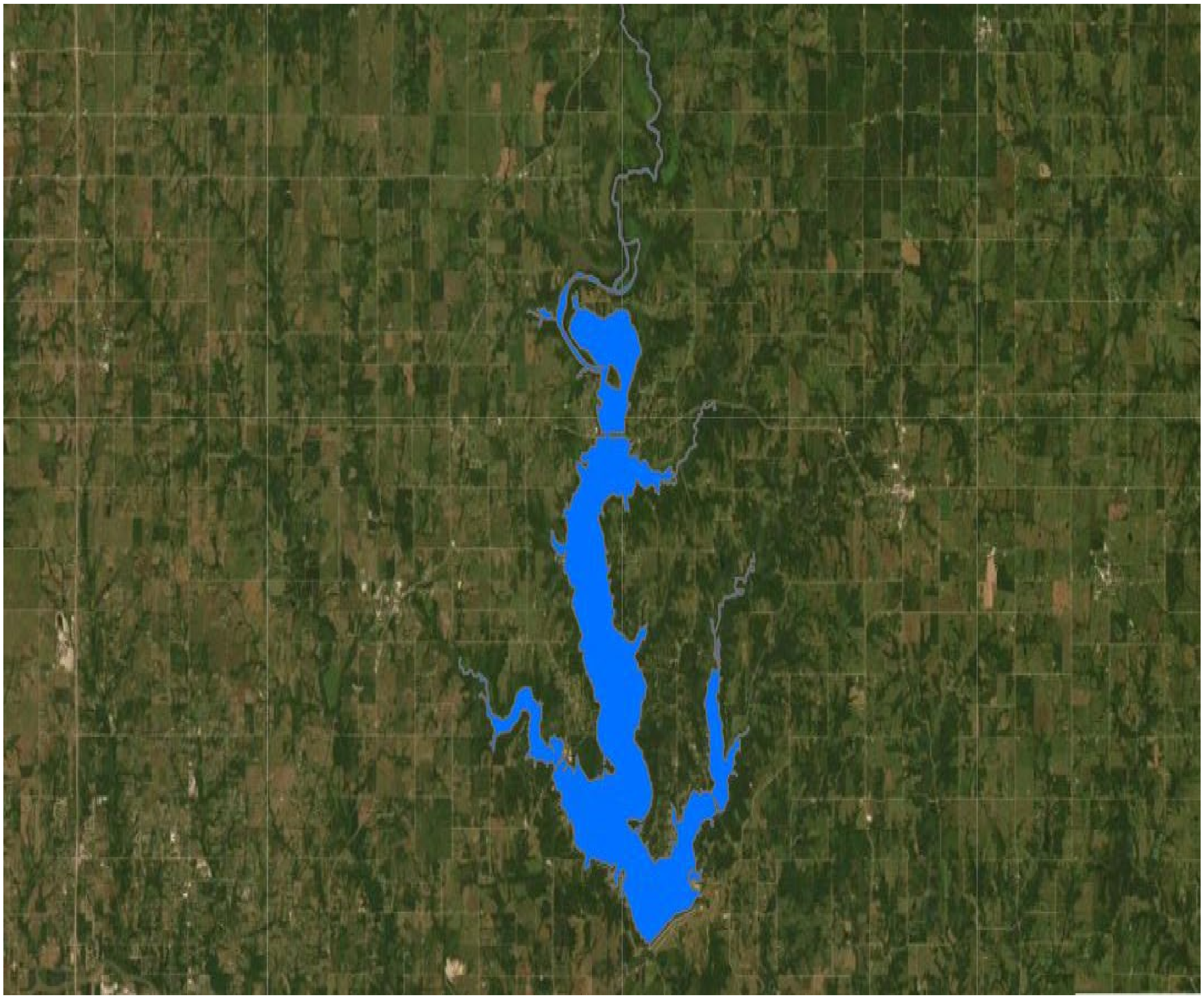
Emigration of fish during periods of elevated release rates will likely occur in the future similar to past events that will lead to periodic reductions in sportfish species and a potential need for additional stocking. Thankfully, anglers are able to utilize some of the sportfish that regularly emigrate out of the lake. There is well developed angler access immediately below the dam at the outlet structure, at the River Pond which is a lake connected to the river below the dam, and at the low head dam Rocky Ford a mile downstream. The most recent angler creel survey estimated that over 47,000 anglers visited these tailwater fisheries from March to October in 2013. There is potential for increasing these angling opportunities as there have been ongoing discussions on how public access can be increased in the undeveloped stretch of the Big Blue River downstream of Tuttle Creek Reservoir.

Figure 9. Aerial Photo of River Pond Directly Downstream of Tuttle Creek Dam

Fisheries management objectives will continue to optimize the quality and diversity of angling opportunities through enhancement of population abundance as needed. Fisheries management measures will continue into the future to include fish harvest regulations, fish stocking, lake level management planning, and sampling to monitor trends.

Angling will continue at Tuttle Creek Reservoir in the future, but targeted species may vary depending on fluctuating factors (i.e., rapid water level fluctuations and dynamic shifts in water turbidity) that affect fish abundance and condition or their habitat. If a fish species highly sought by anglers declines this could affect the angling experience in the future and fisherman may choose to move to another reservoir. There are opportunities for improving angler access within the lake as well that could help offset some of the historic losses and the ongoing chronic hindrances. Shoreline opportunities could greatly be increased by improving vehicle access via opening closed roads, repairing damaged roads, or exploring new areas to add pathways to the water. It would also be beneficial to define potentially promising bank fishing locations, then develop flood resistant improvements in those areas with the intent of increasing shoreline angler access. Similar to in the past, boat ramps will continue to be closed due to insufficient water depths from sedimentation. The addition of new boat ramps would be needed in the future to continue to provide access points to the reservoir for boats. For boating access, it would be beneficial to add new boat ramps, especially ones that are designed to be usable during high water periods. Additional docks at new or existing ramps would likely increase usage, especially for boat operators or passengers with movement limitations or disabilities.

Kansas River Reservoirs Flood and Sediment Study – Reservoir Fishery
Location: Perry Reservoir
Nick Kramer, KDWP District Fisheries Biologist



Perry Reservoir Located on the Delaware River in Western Jefferson County, Kansas

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History

View of Perry Reservoir from Downstream of the Dam

The Delaware River watershed covers approximately 740,772 acres of land in northeast Kansas. The land usage within the watershed is dominated by agriculture (86%). Over 59% of that is pasture and the remaining 41% is crop production which typically occurs in the valleys of the Delaware River and its tributaries. Perry Reservoir sits near the bottom of this watershed. Construction began on the roughly 7,750-foot long and 95-foot tall earthen embankment in March of 1964 and was completed and put into operation in January of 1969. At its multipurpose pool elevation of 891.5 msl, the surface area of the impoundment is 11,146 acres. At a flood control pool elevation, surface acreage is in the area of 25,000 acres.

Water Allocation Background

Perry Reservoir, constructed by the USACE, is an impoundment of the Delaware River and controls approximately 1,117 square miles of drainage area. The reservoir storage capacity includes 515,519 acre-feet (ac-ft) storage for flood control and 200,004 ac-ft for multipurpose use. The dam and the reservoir currently provides substantial municipal water supply, flood control, navigation, recreation, fish and wildlife conservation, and water benefits. The entire multipurpose pool is allocated to water supply purposes. Only a portion is currently in service with the remainder being held as future use storage for water supply. Until all the storage is called into service by the State of Kansas, multipurpose objectives of the remaining storage will be to supplement Missouri River flows for navigation within operating limits selected, to provide a relatively stable pool in the interest of recreation, to augment low flows and improve water quality in the Kansas River, and to enhance fish and wildlife habitat. The storage capacity is shown in Table 1.

Table 1. Storage Capacity and Ownership

Pool Owner / Contracted Storage	Purpose	Quantity (acre-feet [af])[1]
USACE	Flood Control Pool	515,519
USACE	Sediment Reserve in FP	35,519
USACE	Multipurpose Pool	200,004
State of Kansas	Water Supply	150,000[2]
USACE	Sediment Reserve in MPP	50,004
USACE	Surcharge	695,257

Notes: 1. Based on current capacity table and latest survey in 2009
2. 25,000 af – In-service water supply; 125,000 af – Future use water supply

Water quality storage at Tuttle Creek Reservoir and future use water supply storage at Perry and Milford reservoirs is used to maintain minimum flow targets downstream of the reservoirs. In the mainstem Kansas River basin, only Tuttle Creek Reservoir has a water quality pool that is to be used to maintain flow targets on the Kansas River. The Kansas River flow criteria include minimum flows at Topeka and DeSoto in support of both water quality and water supply; the flow targets and their relationship to the Tuttle Creek Reservoir pool level are summarized in Table 2. Milford, Perry and Tuttle Creek reservoirs are operated as a system to support minimum flow criteria on the Kansas River, with the current practice being to make releases from water supply storage volumes within Milford and Perry conservation pools that have not been called into service by the State, and to provide supplemental releases for support of navigation flow targets on the Missouri River.

Table 2. Low Flow Operational Target for the Kansas River

Pool Elevation	Topeka Summer	Topeka Winter	Desoto Summer	Desoto Winter
1075-1070	750	750	1,000	1,000
1070-1065	750	600	1,000	800
1065-1048	600	600	750	700

Notes: Summer: May 1 to October 31; Winter: November 1 to April 30

Typically, the three reservoirs (Perry, Tuttle Creek, and Milford) are operated to maintain 1,000 cubic feet per second (cfs) minimum flow at the DeSoto gage for water quality purposes, as shown in the table above (USACE Final Draft Navigation Study: Milford, Tuttle Creek, Perry Lakes. 2009).

Navigation releases from Tuttle Creek Reservoir are made from the water quality storage volume and the flood control storage. With navigation releases possible when the reservoir level is less than 3 feet below multi-purpose pool level (above 1072.0 feet) during the recreational season and less than 6 feet below multi-purpose pool level (above 1069.0 feet) after October 1.

Storage Loss to Sediment

It is estimated that Perry Reservoir has lost 18% of its initial storage capacity from sedimentation (Table 3). From 1969 to 2009, the multipurpose pool lost 43,216 ac-ft of storage to sedimentation while the flood control pool lost 6,361 ac-ft. Sedimentation can affect the natural resources in the lake. Suspended sediments carry nutrients and metals which accelerates eutrophication and can limit fishery production for native and game fish species. In addition, sedimentation issues have caused Perry Reservoir to close boat ramp access at Paradise Point and Sunset Ridge. More recent sedimentation is also threatening boat access at Old Town Public Park.

Table 3. Perry Reservoir Sedimentation

MPP Initial Volume (af)	MPP Recent Volume (af)	% of Initial MPP Volume Lost to Sediment
243,220	200,004	18

Perry Reservoir Fishery

Fisheries Establishment

There was an existing fishery in the Delaware River, but additional fishes were stocked in the reservoir shortly after completion in 1970. Those fish included bluegill, largemouth bass, and walleye. Over the next decade some additional walleye and largemouth bass were stocked in addition to white bass, channel catfish, and flathead catfish. In the 1980s the only fish that were stocked were largemouth bass and walleye. Walleye stockings on Perry Reservoir ended in 1984 due to high emigration. A decade later sauger were experimentally stocked into the reservoir to fill the void left behind by walleye and have been stocked annually ever since. Annual maintenance stockings of largemouth bass began in 1998 and continued until 2007. The following year smallmouth bass were introduced. Blue catfish were introduced in 2006 and stocked annually until 2012. The latest fish to be stocked into Perry Reservoir is the American paddlefish. These fish were first stocked into the reservoir in 2019 in an attempt to re-establish historical populations that migrated up the Delaware River prior to impoundment. Tables 4 and 5 list sport fish and non-sport fish in Perry Reservoir. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the *Sportfish Population Dynamics & Trends* section.

Table 4. Sport Fish Species Known to Inhabit Perry Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Blue Catfish	*Ictalurus furcatus*
Bluegill	*Lepomis macrochirus*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Paddlefish	*Polyodon spathula*
Sauger	*Sander canadensis*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*

Table 5. Non-Sport Fish Species Known to Inhabit Perry Reservoir

Common Name	Scientific Name
Bigmouth Buffalo	*Ictiobus cyprinellus*
Bluntnose Minnow	*Pimephales notatus*
Common Carp	*Cyprinus carpio*
Emerald Shiner	*Notropis atherinoides*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Grass Carp	*Ctenopharyngodon idella*
Longnose Gar	*Lepisosteus osseus*
Orangespotted sunfish	*Lepomis humilus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Smallmouth Buffalo	*Ictiobus bubalus*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

Stressors on the fishery at Perry Reservoir come in many forms. The highest stressor, in regard to fish, is heavy angling pressure. With Perry Reservoir's proximity to major metropolitan areas and the increasing use of social media, it is not uncommon to see full parking lots and shorelines when the fishing is at its best. No creel survey was conducted in 2020, but from observations of the amount of people fishing that spring, it is likely that any benefit of the lake being essentially closed summer of 2019 was negated by increased harvest spring of 2020. An additional stressor affecting fish populations is the absence of aquatic vegetation. Water levels that fluctuate with the rains and releases from the reservoir make the establishment and development of aquatic vegetation very difficult. Similarly, the degradation of fish habitat is an issue in Perry Reservoir. Any woody habitat that was inundated when the reservoir was created is nearly gone and bathymetric features, such as channels and ledges, have begun to get covered with sediment being washed in from above.

1. Water Quality

Table 6. General Limnological Parameters Characteristic of Perry Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	11,146
Max depth	feet	43
Mean depth	feet	19.5
Mean annual precipitation	inches	37.2
Area watershed drainage	square miles	1150
Hydrologic residence time	days	
Chlorophyll a (summer mean)	parts per billion	18.8
Secchi depth (summer mean)	centimeters	78
Shoreline development index	ratio	
Agricultural lands	%	24
Forest habitat	%	12
Grassland habitat	%	55
Urban lands	%	4
*Trophic state index	Index/Class	59/Eutrophic

Note ***Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuations

Annual precipitation is variable in Kansas and a gradient of low (10 – 20 inches) precipitation in western Kansas to high (40 – 50 inches) precipitation in southeastern Kansas is a reality. Summer temperatures in western Kansas can reach temperatures in excess of 43°C (110°F). These temperatures and generally windy conditions on the plains causes the evaporation of approximately 1.2 meters (4 feet) or more each year. Combine these droughty conditions with a steady decline in western Kansas surface water, due partially because of drastic and annual declines in the depth of the Ogallala Aquifer, and you have a recipe for major water level fluctuations.

Perry Reservoir is used as a public water supply and has experienced elevation fluctuations. The reservoir has experience drought conditions in the past causing it to drop to elevations below multipurpose pool and most recently in 2003 when the reservoir dropped to an elevation of nearly 884 feet or 7 feet below conservation pool and in 2013 when the reservoir dropped 6 feet below conservation pool (Figure 1).

Sustained high water events in the multipurpose pool (e.g., 1973, 1993, 2019) can provide excellent habitat for young of year fish and allow some species to have good year classes recruited into the fishery. However, release of high waters often leads to rapid drawdowns in the multipurpose pool which can lead to loss of fish through the outflow of the dam.

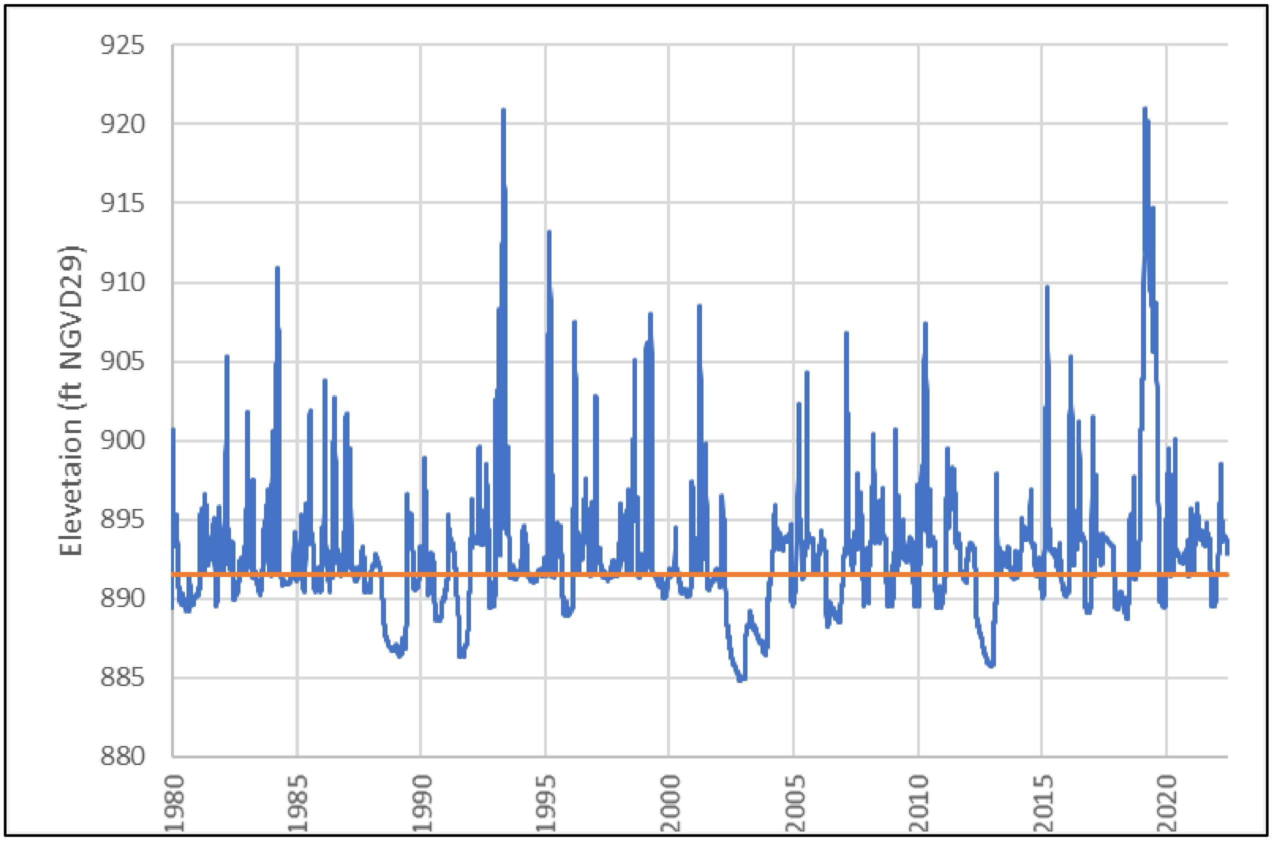


Figure 1. Yearly Ending Reservoir Pool Elevation (feet above mean sea level, MSL) [blue line] in relation to full conservation pool elevation [red line] and total annual precipitation [vertical columns] recorded by USBR

3. Sedimentation

From 1969 to 2009, the multipurpose pool lost 43,216 ac-ft of storage to sedimentation (Table 7). This represents 18% of the original multipurpose pool volume. The average annual rate of loss was 1,080 ac-ft/year or 0.44% of the original volume/year.

Table 7. Pool Volumes Over Time

Survey Year	Multipurpose Pool Volume (ac-ft)	Flood Control Pool Volume (ac-ft)	Data Type
1969	243,220	765,100	Computed from 1960 topographic maps
1979	223,743	740,037	Survey of sediment ranges
1989	209,513	725,308	Survey of sediment ranges
2001	206,682	722,079	Bathymetry survey of sediment ranges, combined with USGS DEM's

Survey Year	Multipurpose Pool Volume (ac-ft)	Flood Control Pool Volume (ac-ft)	Data Type
2009	200,004	715,523	Eisenbraun August 2009 bathymetric survey combined with 2006 and 2010 LiDAR data, computed by Surdex Corporation

Table 8. Perry Reservoir Deposition 1969-2009

Year	Deposition-MP (ac-ft)	Deposition-FC (ac-ft)
1969-1979	19,477	5,586
1979-1989	14,230	499
1989-2001	2,831	398
1989-2009	6,678	-122

Note: * The computed negative deposition in the flood control pool from 1989 to 2009 was most likely due to the change in survey methods. Similar shifts have been observed at other lakes.

From 1969 to 2009, the flood control pool lost 6,361 ac-ft of storage to sedimentation (see Table 8). This represents 1% of the original flood control pool volume. The average annual rate of loss was 159 ac-ft/year or 0.03% of the original volume/year.

Based on the most recent sedimentation analysis, the incoming sediment load at Perry Reservoir was found to be 49.2% clay, 40.5% silt, and 10.3% sand/gravel. Total tons of sediment can be found in Table 9.

Table 9. Incoming Sediment to Perry Reservoir from 1969 to 2019

Years	1969-2019
Total Incoming Sediment (tons)	65,232,018
Total Incoming Clay Fraction (tons)	32,082,292
Total Incoming Silt Fraction (tons)	26,400,721
Total Incoming Sand Fraction (tons)	6,749,005

4. Vegetated Fisheries Habitat

Vegetated fisheries habitats occurring in and adjacent to Perry Reservoir consists of terrestrial, emergent, and submergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. Subsequent to flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

B. Emergent

There is limited to no emergent aquatic vegetation in the areas surrounding Perry Reservoir due to the seasonal and yearly water level fluctuations that provide an inconsistent water level for these plants to become established.

C. Submergent

There is limited to no submergent aquatic vegetation in Perry Reservoir due to the seasonal and yearly water level fluctuations that provide an inconsistent water level for these plants to become established.

5. Invasive/Exotic Species

Zebra mussels (*Dreissena polymorpha*) were first found in Perry Reservoir in October of 2007 and are still currently present in the reservoir. Common carp and grass carp are also present with the former likely precluding the construction of the dam. Other potential invasive/exotic species may include silver carp (*Hypophthalmichthys molitrix*), bighead (*Hypophthalmichthys nobilis*), and black carp (*Mylopharyngodon piceus*), white perch (*Morone americana*), rudd (*Scardinius erythrophthalmus*), and a myriad of crayfish and aquatic vegetation species.

Fisheries Management Objectives

The general objective of fisheries management at Perry Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 9), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

In an ideal scenario, water level management would play a more important role in population management. Following snow melt and spring rains the reservoir would be allowed to fill, inundating shoreline terrestrial habitat and adjacent shallow areas. This newly created, flooded habitat would be ideal spawning and nursery habitat for a variety of fish species. The reservoir's water level would then slowly be drawn down over the course of the summer to allow sufficient time for fish to utilize the flooded areas and move off of them before being left to dry or in isolated puddles. A slower release throughout the summer could also limit the loss of fish through emigration during releases. More consistent water level management patterns may also allow aquatic vegetation to take hold in the reservoir, further bolstering natural fish habitat.

Specific objectives for Perry Reservoir are listed below:

1) Crappie (Black and White Crappie): On Perry Reservoir there is a ten inch minimum length limit and a 20 fish/day creel limit for crappie. This regulation is in place to help achieve the specific management goal of developing a population with a stock CPUE of 40.0 and PSD above 40. This means that achieving a goal at least 40 crappie in each net that are at least five inches long and ideally 40% of those would be over eight inches.
2) Channel Catfish: Channel catfish receive no special management actions on Perry Reservoir. There is a daily creel of 10 fish per day which is the same as the statewide daily creel for this species. The specific management goal for the reservoir is to develop a population with a stock

CPUE of 5.0 and PSD above 25 or more simply, catch 5 channel catfish per gill net with at least 25% over 16 inches.

3) Blue Catfish: As mentioned above, there is a 35-inch minimum length limit in place on blue catfish in Perry Reservoir, along with a 5 fish/day creel limit. This regulation is in place to protect these fish until they are able to spawn sufficiently enough to develop a population. The goal is to develop a population with at least two 12-inch blue catfish in each of the gill nets and 20% of those being greater than 20 inches.
4) Flathead Catfish: Similar to channel catfish there is no special management action for flathead catfish on Perry Reservoir. The Perry Reservoir daily creel of 5 fish per day and requiring a hand-fishing permit to anglers who wish to partake, mirrors the statewide guidelines.
5) Largemouth and Smallmouth Bass: Both of these fish are protected by an 18-inch minimum length limit and a 5 fish/day creel limit. The goal of these regulations is to develop a population of both bass that monitoring staff can electrofish at a rate of at least 25 largemouth bass per hour and at least 15 smallmouth bass per hour. For both species the aim is to have at least 40% of the sample greater than 12 inches.
6) White Bass: There are no special management actions or regulations in place for white bass in Perry Reservoir.
7) Sauger: Perry Reservoir fisheries staff have implemented a very restrictive 18-inch minimum length limit on sauger at Perry Reservoir. There are relatively few fish over this limit but anglers who find some are allowed to take home five per day. The goal of this regulation is largely to protect the broodstock source and maintain a population with a stock CPUE of 2.0 and PSD above 40. Or simply, two fish per net and 40% greater than 12 inches.
8) Paddlefish: There is currently no length or creel limits in place for paddlefish on Perry Reservoir because harvest is not allowed. Snagging is essentially the only way to catch these fish and Perry Reservoir is not a legal snagging location in the state of Kansas.
9) Brood Supply- Sauger: Perry Reservoir is the main source of broodstock sauger in the State of Kansas. Each spring biologists capture roughly 250 individuals from the reservoir and transport them to Milford Fish Hatchery. Once there, sperm is extracted from male fish three times a week for one month to fertilize walleye eggs to make the hybrid saugeye that is stocked across the state in small impoundments as a crappie control. Some of this sperm is also packaged, preserved, and shipped to neighboring states to help with their hatchery efforts. Sauger eggs are also extracted and fertilized with sauger sperm to replenish broodstock sources. These efforts help create over 8 million saugeye and 2.5 million sauger that are stocked in waters across the state.

Mitigation for Factors Affecting the Sport Fishery

1. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Perry Reservoir include; crappie-10-inch minimum length limit with 20 fish creel limit; blue catfish-35-inch minimum length limit; walleye, sauger, and saugeye-18-inch minimum length limit; and largemouth and smallmouth bass-18-inch minimum length limit. See Table 10 below for a comprehensive list of fish harvest regulations in effect at Perry Reservoir.

Table 10. Current Fish Harvest Regulations in Effect at Perry Reservoir *

Common Name	Length Limit	Daily Creel Limit
Blue Catfish	35-inch minimum length limit	5
Channel Catfish	N/A	10
Flathead Catfish	N/A	5
Crappie	10-inch minimum length limit	20
Largemouth Bass	18-inch minimum length limit	5
Sauger	18-inch minimum length limit	5
Saugeye	18-inch minimum length limit	5
Walleye	18-inch minimum length limit	5
Smallmouth Bass	18-inch minimum length limit	5

Note: * Species Specific Length and Creel Limits at Perry Reservoir in 2021

2. Lake Level Management Plans

USACE implements a variety of practices through lake level management plans (LLMP) that address water management for environmental outcomes:

1) Rise and maintenance of lake elevation in late fall – early winter over conservation pool to benefit waterfowl habitat.
2) Maintenance of water levels to create and maintain good spawning, nursery, and growth conditions for fisheries.

The Perry Lake LLMP attempts to consider the natural inflows of the lake to improve both fisheries and wildlife habitat. One of the fisheries functions of the plan is to control water releases in the early spring during fish spawning. For wildlife purposes, the scheduled autumn rise in water level will flood marshy areas, improving waterfowl habitat and hunter access to the upper cove areas of the lake. Although there is enough inflow to achieve the fall rise in only about half the years, when it occurs the two-foot rise provided tremendous benefits for wetlands, waterfowl, and hunting access.

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, in accordance with KDWP reservoir survey guidelines (Table 11).

The number of anglers visiting Perry Reservoir is relatively high when compared to other Kansas reservoirs due to its proximity to major metropolitan areas. The reservoir sees anglers traveling from not just the population centers of Kansas but from all corners, with 91 communities represented. There were also many anglers visiting Perry Reservoir from neighboring or distant states. Of the eleven states, other than Kansas, which anglers hailed from, the majority came from Missouri.

Table 11: Total Number of Anglers, Angler-hours, and Relative Standard Error (RSE) at Perry Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31.

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler	RSE	Angler Hours per Acre
2001	48,732	3.87	123,482.25	21	9.8
2004	44,671	3.55	85,508.94	7	6.79
2011	52,268	4.15	121,014.25	8	9.6
2016	57,784	4.59	154,496.70	13	12.26

Source: KDWP 2022

Anglers at Perry Reservoir historically have shown a strong affinity for both channel catfish and crappie, alternating the two as their top preference. In the five years since the last creel survey was conducted, little has likely changed. Based off anecdotal evidence and angler reports crappie is likely the most preferred or sought after fish, with channel catfish falling second. Blue catfish have been gaining in popularity in recent years and will likely appear in these preference rankings the next time a creel survey is conducted.

Table 12: Average Percentages of the Top Four Most Preferred Species by Angler Ranking at Perry Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31.

Year	First	%	Second	%	Third	%	Fourth	%
2001	No Fish Preference	50.3	Crappie	27.7	Channel Catfish	19	White Bass	1.9
2004	Crappie	50.2	Channel Catfish	31.4	No Fish Preference	11.4	White Bass	5.4
2011	Crappie	63.9	Channel Catfish	25.4	White Bass	7.8	Flathead Catfish	1.1
2016	Channel Catfish	28	No Fish Preference	21.7	No Fish Preference	20.8	Crappie	10.4

Source: KDWP 2022

Table 13. Estimated Total Number of Sportfish Harvested and Released at Perry Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Harvest Status	Channel Catfish	Blue Catfish	Flathead Catfish	Black Crappie	White Crappie	Bluegill	Largemouth Bass	Smallmouth Bass	Sauger	White Bass
2001	Harvested	5,587	0	101	0	81,675	0	47	0	78	2,610
2004	Harvested	11,467	0	39	477	12,079	59	0	0	20	6,223
2011	Harvested	53,512	0	641	72	64,855	86	374	360	0	9,284
2016	Harvested	40,257	207	2,363	446	63,851	624	217	79	2,312	14,272
2001	Released	2,412	0	0	0	68,318	0	94	0	23	23,632
2004	Released	7,522	0	0	2,925	69,471	3,188	591	0	40	1,187
2011	Released	14,867	175	17	50	77,627	594	3,159	230	17	2,705
2016	Released	12,902	3,247	391	716	58,841	2,043	7,926	399	3,341	18,514

Source: KDWP 2022

Anglers at Perry Reservoir usually harvest at least some fish, with only 12% of anglers not harvesting any fish during their trips. Table 12 provides a breakdown of the number of each species of fish harvested and released by anglers at Perry Reservoir for each of the past four creel surveys. Harvest is dominated by white crappie and followed by channel catfish, similar to angler preference. White bass comes in as third for fish harvested, likely a result of bycatch by crappie anglers. Largemouth and smallmouth bass anglers on Perry Reservoir tend to be more catch-and-release oriented, choosing to release more of their catch in hopes that they grow to trophy size.

Sportfish Populations Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below.

Black and White Crappie (*Pomoxis sp.)*

Based on the latest creel survey, at least 32% of anglers visiting Perry Reservoir are targeting crappie. The population is doing quite well with many anglers having success. Numbers were down in the 2021 and 2022 sampling seasons, but this is mostly due to elevated lake conditions causing sampling difficulties and less with a decline in the population. The lake being essentially closed in 2019, due to high water, allowed many crappie to escape harvest resulting in a nice size structure of fish. In fall of 2021, Perry Reservoir had the highest proportion of greater than 12-inch crappie seen in the previous 5 years, and similar for fish in the 10-12-inch range. These larger fish were also extremely healthy and benefited from the flooded terrestrial environment. Relative weights, an index of condition of fishes, is also higher for crappie in 2019 indicating that they had an abundance of prey to feed upon.

Table 14. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and RSE Estimates for Black and White Crappie Sampled During September, October, and November by Gill Nets

Metric	2016	2017	2018	2019	2020 Black	2020 White
Total Catch	725	1316	719	526	113	278
Stock Catch	320	1158	712	317	112	182
Units of Effort	16	16	16	18	18	18
Sub-Stock CPUE (RSE)	25.3 (43)	9.9 (62)	0.4 (51)	10.8 (39)	0.1 (100)	5.3 (50)
Stock CPUE (RSE)	20.0 (21)	72.4 (25)	44.5 (15)	18.9 (30)	6.2 (35)	10.1 (23)
Quality/Density CPUE (RSE)	6.6 (20)	25.7 (30)	17.7 (18)	18.0 (30)	0.2 (54)	5.3 (27)
Preferred CPUE (RSE)	2.3 (22)	7.4 (35)	4.8 (34)	9.4 (36)	0.2 (54)	4.4 (26)
Memorable/Lunker CPUE (RSE)	0.1 (68)	0.6 (38)	0.4 (54)	1.1 (46)	0.0 (.)	0.7 (24)
Total CPUE (RSE)	45.3 (30)	82.3 (24)	44.9 (15)	29.7 (24)	6.3 (34)	15.4 (22)
PSD Stock-Quality (S-D)	67.19	64.51	60.25	5.68	97.32	47.25
PSD Quality-Preferred (Q-P)	21.25	25.3	28.93	46.06	.	9.34
PSD Preferred-Memorable (P-M)	10.94	9.33	9.97	42.9	2.68	36.81
PSD (Memorable-Trophy (M-T)	0.63	0.86	0.84	5.36	.	6.59
PSD	32.81	35.49	39.75	94.32	2.68	52.75
Mean WR S-Q (RSE)	91 (2)	99 (1)	99 (2)	105 (5)	107 (2)	104 (2)
Mean WR Q-P (RSE)	90 (1)	97 (2)	97 (2)	109 (2)	. (.)	92 (3)
Mean WR P-M (RSE)	96 (2)	101 (2)	97 (2)	107 (2)	89 (6)	95 (1)
Mean WR M-T (RSE)	95 (5)	99 (2)	95 (4)	99 (3)	. (.)	96 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Channel Catfish (*Ictalurus punctatus*)

Channel catfish are the second most targeted species at Perry Reservoir. The reservoir has a long history with anglers who enjoy chumming for catfish, and there are a handful of groups still partaking in the activity. Channel catfish numbers have stayed relatively constant in the past five years. A slight dip in 2018 and 2019 could be explained by sampling difficulties due to high waters as there was a return to “normal” levels in the 2020 sample. Perry Reservoir fisheries staff also performed a gill net comparison study, which had two non-standard nets run alongside standard gear which may have sampled some fish before they had the opportunity to encounter the standard net. Similar to crappie, 2019 saw the largest proportion of larger, greater than 28-inch fish caught than in the previous five years. Again, likely due to the reservoir essentially being closed during much of the 2019 season.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During September, October, and November by Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	61	98	48	28	77
Stock Catch	57	91	39	27	75
Units of Effort	20	29	20	23	23
Sub-Stock CPUE (RSE)	0.2 (58)	0.2 (34)	0.5 (41)	0.0 (100)	0.1 (100)
Stock CPUE (RSE)	2.9 (12)	3.1 (14)	2.0 (18)	1.2 (24)	3.3 (14)
Quality/Density CPUE (RSE)	2.3 (15)	2.4 (16)	1.5 (20)	1.0 (23)	2.7 (17)
Preferred CPUE (RSE)	0.3 (40)	0.3 (30)	0.2 (55)	0.1 (55)	0.6 (24)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (100)	0.0 (.)	0.1 (69)	0.0 (100)
Total CPUE (RSE)	3.1 (12)	3.4 (13)	2.4 (20)	1.3 (24)	3.3 (14)
PSD Stock-Quality (S-D)	21.05	21.98	25.64	18.52	17.33
PSD Quality-Preferred (Q-P)	70.18	67.03	66.67	70.37	65.33
PSD Preferred-Memorable (P-M)	8.77	9.89	7.69	3.7	16
PSD (Memorable-Trophy (M-T)	.	1.1	.	7.41	1.33
PSD	78.95	78.02	74.36	81.48	82.67
Mean WR S-Q (RSE)	80 (3)	87 (3)	83 (3)	88 (7)	89 (2)
Mean WR Q-P (RSE)	92 (2)	88 (1)	89 (2)	97 (4)	94 (1)
Mean WR P-M (RSE)	99 (5)	81 (5)	86 (7)	94 (.)	98 (4)
Mean WR M-T (RSE)	. (.)	97 (.)	. (.)	90 (.)	85 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

White Bass (*Morone chrysops*)

The third most targeted species, according to the last creel survey conducted in 2016, is the white bass. This is even more popular with anglers above the reservoir, with many reports of anglers fishing various spots on the Delaware River far above the reservoir when these fish run up the river in the spring as far as 30-50 miles upriver. There are also great opportunities for these fish within the reservoir proper. White bass are a very fast growing and short-lived species with many fish reaching 8-inches in their first year, spawning in their second, and being harvested or succumbing to natural mortality before 4 years.

Table 16. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During September, October, and November by Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	98	266	48	362	171
Stock Catch	98	266	46	360	164
Units of Effort	20	29	20	23	23
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.1 (69)	0.1 (73)	0.3 (32)
Stock CPUE (RSE)	4.9 (22)	9.2 (20)	2.3 (23)	15.9 (16)	7.1 (17)
Quality/Density CPUE (RSE)	4.5 (24)	3.3 (19)	2.3 (24)	1.3 (24)	5.2 (21)
Preferred CPUE (RSE)	1.9 (35)	1.9 (22)	0.3 (43)	0.9 (26)	1.6 (24)
Memorable/Lunker CPUE (RSE)	0.2 (58)	0.1 (47)	0.0 (.)	0.1 (69)	0.3 (29)
Total CPUE (RSE)	4.9 (22)	9.2 (20)	2.4 (23)	16.0 (16)	7.4 (17)
PSD Stock-Quality (S-D)	9.18	64.29	2.17	91.39	27.44
PSD Quality-Preferred (Q-P)	53.06	15.04	84.78	2.78	50.61
PSD Preferred-Memorable (P-M)	33.67	19.17	13.04	5.28	17.07

Metric	2016	2017	2018	2019	2020
PSD (Memorable-Trophy (M-T)	4.08	1.5	.	0.56	4.88
PSD	90.82	35.71	97.83	8.61	72.56
Mean WR S-Q (RSE)	110 (7)	97 (2)	87 (.)	109 (1)	89 (1)
Mean WR Q-P (RSE)	96 (2)	89 (2)	94 (2)	102 (2)	90 (2)
Mean WR P-M (RSE)	102 (1)	92 (2)	91 (1)	103 (2)	98 (2)
Mean WR M-T (RSE)	107 (3)	98 (2)	. (.)	. (.)	99 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Flathead Catfish (*Pylodictis olivaris*)

Flathead catfish are not well targeted using sampling gear but there are a good number of fish in the reservoir. This catfish ranked fourth among angler preference in the last creel survey completed on the lake and Perry Reservoir was the second most targeted location in the state for hand-fishers the last time a survey was completed on that subset of anglers.

Blue Catfish (*Ictalurus furcatus*)

Blue catfish were first stocked in Perry Reservoir in 2006. Since that time a 35-inch minimum length limit has been in place to protect these fish until a population is established. This is a slower process than originally hypothesized; research completed on other reservoirs suggests it takes nearly 20 years before these fish are really producing. Milford Reservoir is considered the crown jewel of blue catfish opportunity in the state of Kansas and was stocked 16 years prior to Perry Reservoir. When comparing the length frequencies of blue catfish sampled in each lake, they are following the same relative trends, only 16 years apart. As Perry Reservoir nears that 20 year mark there is hope that this population could follow the trend of other popular blue catfish impoundments in the state. However, the table below shows a decrease in numbers of fish the past two years. There are a couple of explanations for this: lake elevations in 2018 and 2019 made sampling difficult because of flooded terrestrial vegetation and there was also a running gill net comparison study, which had two non-standard nets run alongside standard gear which may have sampled some fish before they had the opportunity to encounter the standard net.

Table 17. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish Sampled During September, October, and November by Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	24	33	19	4	6
Stock Catch	3	28	19	4	6
Units of Effort	20	29	20	23	23
Sub-Stock CPUE (RSE)	1.1 (39)	0.2 (41)	0.0 (.)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	0.2 (55)	1.0 (17)	1.0 (42)	0.2 (59)	0.3 (36)
Quality/Density CPUE (RSE)	0.2 (55)	0.0 (100)	0.5 (59)	0.1 (55)	0.1 (55)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.1 (100)	0.0 (.)	0.0 (100)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (100)
Total CPUE (RSE)	1.2 (34)	1.1 (16)	1.0 (42)	0.2 (59)	0.3 (36)
PSD Stock-Quality (S-D)	.	96.43	52.63	25	50
PSD Quality-Preferred (Q-P)	100	3.57	42.11	75	33.33
PSD Preferred-Memorable (P-M)	.	.	5.26	.	.
PSD (Memorable-Trophy (M-T)	.	.	.	.	16.67
PSD	100	3.57	47.37	75	50
Mean WR S-Q (RSE)	. (.)	91 (2)	93 (2)	103 (.)	97 (6)

Metric	2016	2017	2018	2019	2020
Mean WR Q-P (RSE)	107 (4)	97 (.)	91 (3)	91 (15)	102 (6)
Mean WR P-M (RSE)	. (.)	. (.)	111 (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Largemouth and Smallmouth Bass (*Micropterus sp.*)

The black bass species have been sampled infrequently in the past 5 years due to increased lake elevations during the spring season. However, fisheries staff was able to get a 2020 sample done in the spring. Biologists saw many fish in the 8-10-inch range with a few larger fish scattered throughout the sample. These fish are the sixth most popular group in the reservoir however they receive the most tournament fishing pressure. There are several bass fishing tournaments held on Perry Reservoir each year.

Table 18. CPUE, PSD, Wr, and RSE Estimates for Largemouth Bass Sampled During September, October, and November by Gill Nets

Metric	2017	2018	2020
Total Catch	17	24	138
Stock Catch	13	12	61
Units of Effort	1.76	0.8	1.76
Sub-Stock CPUE (RSE)	2.3 (77)	15.0 (100)	44.8 (24)
Stock CPUE (RSE)	7.4 (42)	15.0 (31)	35.1 (21)
Quality/Density CPUE (RSE)	2.3 (56)	13.8 (27)	2.6 (54)
Preferred CPUE (RSE)	1.7 (52)	6.3 (32)	2.2 (57)
Memorable/Lunker CPUE (RSE)	0.0 (.)	1.3 (100)	0.0 (.)
Total CPUE (RSE)	9.7 (38)	30.0 (55)	79.9 (17)
PSD Stock-Quality (S-D)	69.23	8.33	91.8
PSD Quality-Preferred (Q-P)	7.69	50	1.64
PSD Preferred-Memorable (P-M)	23.08	33.33	6.56
PSD (Memorable-Trophy (M-T)	.	8.33	.
PSD	30.77	91.67	8.2
Mean WR S-Q (RSE)	94 (4)	111 (.)	88 (1)
Mean WR Q-P (RSE)	99 (.)	108 (4)	100 (.)
Mean WR P-M (RSE)	105 (3)	113 (4)	109 (6)
Mean WR M-T (RSE)	. (.)	112 (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)

Source: KDWP 2022

Table 19. CPUE, PSD, Wr, and RSE Estimates for Smallmouth Bass Sampled During September, October, and November by Gill Nets

Metric	2017	2018	2020
Total Catch	3	11	20
Stock Catch	1	9	10
Units of Effort	1.76	0.8	1.76
Sub-Stock CPUE (RSE)	1.1 (100)	2.5 (100)	5.9 (63)
Stock CPUE (RSE)	0.6 (100)	11.3 (44)	5.9 (60)
Quality/Density CPUE (RSE)	0.6 (100)	10.0 (42)	2.4 (55)
Preferred CPUE (RSE)	0.6 (100)	6.3 (45)	0.6 (100)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.6 (100)
Total CPUE (RSE)	1.7 (71)	13.8 (42)	11.8 (61)

Metric	2017	2018	2020
PSD Stock-Quality (S-D)	.	11.11	60
PSD Quality-Preferred (Q-P)	.	33.33	30
PSD Preferred-Memorable (P-M)	100	55.56	.
PSD (Memorable-Trophy (M-T)	.	.	10
PSD	100	88.89	40
Mean WR S-Q (RSE)	. (.)	91 (.)	80 (4)
Mean WR Q-P (RSE)	. (.)	89 (3)	88 (3)
Mean WR P-M (RSE)	93 (.)	98 (2)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	86 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)

Sauger (*Sander canadensis*)

Perry Reservoir is the main source for broodstock sauger in the state of Kansas. Because of this there is a restrictive 18-inch minimum length limit and there are no, or very few, walleye or saugeye stocked within the Delaware River watershed. The population is doing quite well with a large number of adult fish present. In 2022 monitoring staff sampled a very nice group of smaller young of the year fish that is likely the result of an abundance of "nursery" habitat from the increased lake elevation. The survey did not show as many adult fish the past two years, which is likely a result of the previously mentioned increased lake elevations at the time of fall sampling.

Table 20. CPUE, PSD, Wr, and RSE Estimates for Sauger Sampled During September, October, and November by Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	42	83	36	65	111
Stock Catch	42	83	36	65	111
Units of Effort	20	29	20	23	23
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	2.1 (20)	2.9 (18)	1.8 (19)	2.8 (25)	4.8 (16)
Quality/Density CPUE (RSE)	2.0 (22)	2.8 (18)	1.7 (19)	1.0 (50)	3.9 (15)
Preferred CPUE (RSE)	1.8 (23)	2.4 (19)	0.7 (26)	0.9 (52)	0.7 (23)
Memorable/Lunker CPUE (RSE)	0.8 (33)	0.9 (28)	0.2 (55)	0.4 (64)	0.2 (50)
Total CPUE (RSE)	2.1 (20)	2.9 (18)	1.8 (19)	2.8 (25)	4.8 (16)
PSD Stock-Quality (S-D)	4.76	1.2	5.56	64.62	18.92
PSD Quality-Preferred (Q-P)	11.9	15.66	58.33	1.54	67.57
PSD Preferred-Memorable (P-M)	45.24	50.6	27.78	20	9.01
PSD (Memorable-Trophy (M-T)	30.95	30.12	5.56	10.77	4.5
PSD	95.24	98.8	94.44	35.38	81.08
Mean WR S-Q (RSE)	90 (4)	56 (.)	98 (17)	92 (2)	87 (2)
Mean WR Q-P (RSE)	96 (5)	94 (3)	100 (5)	86 (.)	89 (1)
Mean WR P-M (RSE)	95 (2)	91 (2)	89 (2)	94 (1)	95 (2)
Mean WR M-T (RSE)	99 (2)	93 (3)	100 (4)	93 (2)	96 (3)
Mean WR T+ (RSE)	102 (1)	54 (.)	90 (.)	88 (0)	. (.)

Source: KDWP 2022

Paddlefish (*Polyodon spathula*)

Paddlefish were reintroduced into the reservoir in 2019 in an attempt to restore a historic population and eventually develop a recreational snag fishery. There is a very low abundance of these fish in the reservoir at this time and the chances of sampling one are slim. Stockings are slated to continue for the foreseeable future to further develop the population.

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard shad are the main forage base in Perry Reservoir and the primary prey item for almost all of the fish mentioned above with the exception of paddlefish. Gizzard shad numbers have been good in recent years. The decrease in total catch and CPUE in 2018 and 2019 is more likely attributed to sampling difficulties related to increased lake elevation at the time of sampling and less likely a decrease in population.

Table 21. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During September, October, and November by Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	268	237	58	52	423
Stock Catch	90	230	56	42	204
Units of Effort	20	29	20	23	23
Sub-Stock CPUE (RSE)	8.9 (32)	0.2 (39)	0.1 (69)	0.5 (47)	9.5 (39)
Stock CPUE (RSE)	4.5 (35)	7.9 (16)	2.8 (19)	1.9 (24)	8.9 (15)
Quality/Density CPUE (RSE)	2.4 (43)	0.6 (25)	0.3 (40)	1.8 (23)	8.9 (15)
Preferred CPUE (RSE)	0.3 (60)	0.1 (69)	0.2 (46)	0.0 (100)	1.1 (22)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	13.4 (31)	8.2 (16)	2.9 (19)	2.3 (23)	18.4 (24)
PSD Stock-Quality (S-D)	46.67	92.17	91.07	2.38	.
PSD Quality-Preferred (Q-P)	46.67	6.96	1.79	95.24	87.25
PSD Preferred-Memorable (P-M)	6.67	0.87	7.14	2.38	12.75
PSD (Memorable-Trophy (M-T)	.	.	.	.	.
PSD	53.33	7.83	8.93	97.62	100
Mean WR S-Q (RSE)	73 (4)	83 (2)	73 (.)	. (.)	. (.)
Mean WR Q-P (RSE)	79 (1)	78 (4)	. (.)	. (.)	. (.)
Mean WR P-M (RSE)	. (.)	69 (.)	. (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2022

Future Without Project Projections

Perry Reservoir is filling in with sediment at the detriment of the fish and the anglers who pursue them as well as other interest groups that use the reservoir. Sedimentation of the reservoir reduces the storage capacity and also the fishable areas while also filling in any unique, fish attracting bathymetric features (e.g., river channels). Decreased storage capacity will likely result in Perry Reservoir being more responsive to heavy rains, exhibiting more drastic rises than were experienced when the river was impounded fifty years ago. The more drastic and frequent fluctuations will make the establishment and development of aquatic vegetation even more difficult. Further degradation of existing fish habitat will be countered with the installation of artificial fish habitat, but natural features are likely more appealing to fishes and it is unknown if the rate of replacement can match the rate of degradation.

This reservoir is within close proximity to the majority of the large population centers of Kansas; a one hour drive from the heart of Kansas City. The reservoir is already known for its exceptional crappie fishing and receives a good deal of traffic from tournament bass fishing, which is a growing sport. There is also the possibility that in the next ten years, Perry Reservoir could develop a high quality blue catfish fishery. If this population increases, it is likely to receive increased pressure from metropolitan anglers who would like a closer destination than Milford Reservoir. The reintroduction of paddlefish to Perry Reservoir and the Delaware River could also result in an increase of recreational anglers. If this population increases and some recreational snagging is allowed, there could be a large number of anglers traveling to the reservoir's upper reaches or spillway in the spring when these fish make their spawning runs.

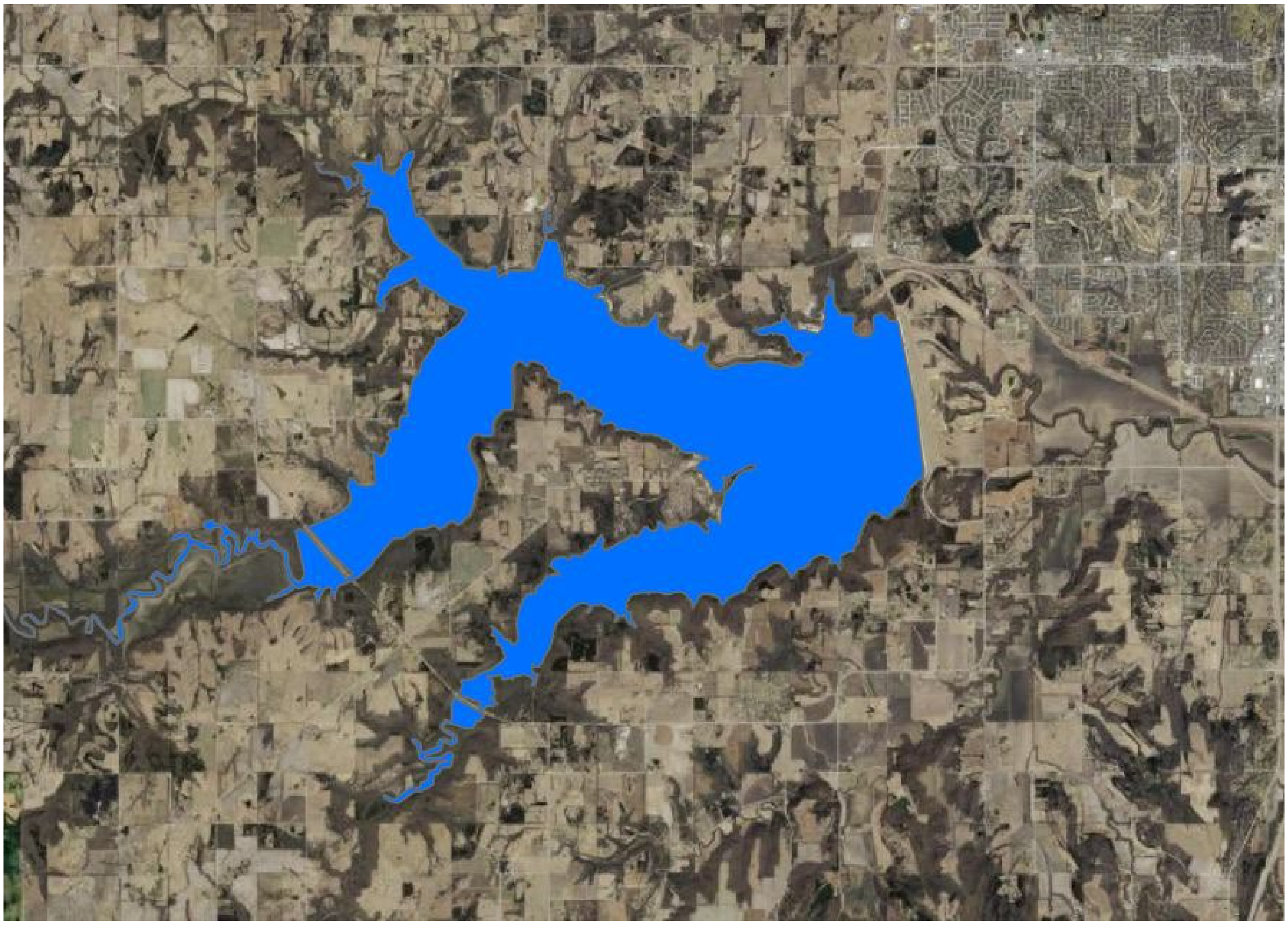
While angler use may remain constant or increase, access to the reservoir may decrease. Continued siltation at the upper end of the reservoir may hinder angler access to that portion of the reservoir resulting in crowding at more southern boat access areas. Similarly, more frequent, or more drastic water level fluctuations could result in most, if not all, boat ramps being closed to angler access. Without construction of new, higher elevation boat access points it is possible that anglers may not be able to access the reservoir during times of the year when rains are more frequent.

The loss of bathymetric features and silting in of natural fish attracting features will also negatively affect fish populations. Fish populations may begin to shift toward more riverine population structures which may not align with angler preference. The only stockings that are planned for the future are the continued maintenance stockings of sauger to supplement the broodstock population and the continued reintroduction stockings of paddlefish. The sauger stockings will continue well into the future, as long as broodstock sauger are required. The paddlefish stockings will continue until 2029; at that point the status of the population will be evaluated.

Aquatic nuisance species prevention will continue to be vital to the future of sportfish populations and those that pursue them. Zebra mussels are currently present, but damaging invaders that require vigilance to keep at bay include carp native to Asia, white perch, rudd, and a myriad of crayfish and aquatic vegetation species.

Water level management will also continue to be crucial to sport fisheries and anglers. Available habitats and types, and successful sportfish reproduction and survival, can all be positively or negatively impacted by the timing of water releases and magnitudes thereof. High releases around sauger spawning could be detrimental both on the local and statewide scale, too. KDWP is dependent on this adult sauger population to produce and stock sauger and saugeye across the entire state of Kansas.

Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery
Location: Clinton Reservoir



Clinton Reservoir Located on the Wakarusa River in Northwest Douglas County, Kansas

Contents

History

Clinton Reservoir is an impoundment on the Wakarusa River located in northwestern Douglas County, Kansas. As a result of numerous flooding events within the Wakarusa valley, construction of the Clinton Dam and Reservoir was authorized under the Flood Control Act of 1962. Construction began in 1972, and the dam was completed in 1975. Impoundment began on November 30, 1977, yet the conservation pool was not filled until 1980. Filling the reservoir slowly helped create a more hospitable environment for fish by allowing the native grass to remain on most of the upper lakebed. In April 1981, the lake began multipurpose operations including flood control, water supply, and recreation.

Aerial View of Clinton Reservoir

Water Allocation Background

Clinton Reservoir, constructed by the USACE, is an impoundment of the Wakarusa River and controls approximately 367 square miles of drainage area. The reservoir storage capacity includes 292,496 acre-feet (ac-ft) of storage for flood control (including sediment reserve) and 118,699 ac-ft for multipurpose use (including sediment reserve). The dam and the reservoir currently provide substantial municipal water supply, flood control, recreation, and fish and wildlife conservation benefits. A large portion of the multipurpose pool is allocated to water supply purposes. However, only a portion is currently in service with the remainder being held as future use storage for water supply (see Table 1). Until all the storage is called into service by the State of Kansas, multipurpose objectives of the remaining storage will be to provide a relatively stable pool in the interest of recreation and to enhance fish and wildlife habitat. Clinton Reservoir also has a water quality pool as part of its reservoir allocation. However, the Kansas Water Assurance District operational agreement prohibits it to be operated to fulfill downstream flow targets on the Kansas River. The storage capacity and the allocation of Clinton Reservoir is shown in Table 1.

Table 1. Storage Capacity and Allocations

Pool Owner / Contracted Storage	Purpose	Quantity (acre-feet [ac-ft])[1]
USACE	Flood Control Pool	292,496
	Flood Control	258,300
	Sediment Reserve in FP	34,196
USACE	Multipurpose	118,699
USACE	Water Quality/Other Purposes	21,200
State of Kansas	Water Supply	89,200[2]
USACE	Sediment Reserve in MPP	8,299
USACE	Surcharge	286,843

Notes: 1. Based on current capacity table and latest survey in 2009
2. 53,520 ac-ft – In-service water supply; 35,680 ac-ft – Future use water supply

Source: USACE 2012

Clinton Reservoir Fishery

Fisheries Establishment

Table 2 and Table 3 provide lists of sport fish and non-sport fish in Clinton Reservoir. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the Sportfish Population Dynamics & Trends section.

Table 2. Sport Fish Species Known to Inhabit Clinton Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Blue Catfish	*Ictalurus furcatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Sauger	*Sander canadensis*
Smallmouth Bass	*Micropterus dolomieu*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Clinton Reservoir

Common Name	Scientific Name
Non-Sport Fish	
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Creek Chub	*Semotilus atromaculatus*
Emerald Shiner	*Notropis atherinoides*
Fathead Minnow	*Pimephales promelas*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Orangespotted sunfish	*Lepomis humilus*
Plains Killifish	*Fundulus zebrinus*
Red Shiner	*Cyprinella lutrensis*

Common Name	Scientific Name
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. Water Quality

Clinton Reservoir has a large watershed (367.3 mi^2) associated with drainage of the Wakarusa River. Many limnological characteristics of Clinton Reservoir are resultant from its large watershed, large surface area (7000 acres), and relatively shallow depths (mean depth = 17.0 ft, maximum depth = 36.1 ft). The reservoirs large watershed contains a variety of land use practices including grasslands (61.7%), forest (14.9%), agriculture (12%), and urban (6.2%). The watershed receives a mean annual precipitation of 39.8 in/yr., from which, 9.8 in/yr. of nutrient rich runoff is collected. High levels of nutrient-rich runoff contribute to high turbidity and high productivity, as evidenced by Clinton Reservoir's relatively low Secchi depth (98 cm), high trophic state (61.9), and high chlorophyll a concentration (24.5 ppb). Morphometric characteristics (i.e., surface area, depth, SDI) of the reservoir are also important features influencing its limnology. Clinton Reservoir has a relatively shallow depths making it susceptible to wind mixing resulting in resuspension of nutrients. Clinton Reservoir has a shoreline development index (SDI) of 7.1, indicating a complex shoreline with abundant coves.

Table 4. General Limnological Parameters Characteristic of Clinton Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	7000.0
Max depth	feet	36.1
Mean depth	feet	17.0
Mean annual precipitation	inches	39.8
Mean annual runoff	inches	9.8
Area watershed drainage	square miles	367.3
Hydrologic residence time	days	258
Chlorophyll a	parts per billion	24.5
Secchi depth	centimeters	98
Shoreline development index	ratio	7.1
Agricultural lands	%	12.0
Forest habitat	%	14.9
Grassland habitat	%	61.7
Urban lands	%	6.2
*Trophic state index		61.9

*****Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Sedimentation

The multipurpose pool at Clinton Reservoir originally included 129,171 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 12% of the multipurpose pool has been filled in with sediment leaving approximately 113,032 ac-ft of capacity (based on 2019 survey results) (Table 5). Sediment will continue to accumulate in Clinton Reservoir with an expected additional 8.0% loss of the multipurpose pool over the next 25 years (2049) and 15% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 94,540 ac-ft in 2074.

Table 5. Tuttle Creek Reservoir Sedimentation

MPP Initial Volume (ac-ft)	MPP Recent Volume (ac-ft)	% of Initial MPP Volume Lost to Sediment
129,171	113,032	12

Source: USACE 2020

Sedimentation can affect the natural resources in the lake. Suspended sediments carry nutrients and metals which accelerates eutrophication and can limit fishery production for native and game fish species. As the lake fills with sediments from upstream it reduces the water volume available to fish. In addition, the sediment covers the habitat that many fish species use for foraging or spawning. Furthermore, the large mudflats created in the upper reaches of the lake serves as a disconnect between the lake and the upstream river system that some fish species use for annual migrations or spawning runs. High turbidity from suspended sediments also has impacts on the ability for sight feeders to be able to adequately capture food. During periods of extended high turbidity, the sampling data records lower abundance of forage species and lower body condition of sportfish.

3. Water Level Fluctuations

Characteristic of, but not limited to Clinton Reservoir, the commonly shrinking reservoir pool often leaves large areas within the basin dewatered for a number of years and allows establishment of terrestrial vegetation. Inundation of vegetation during periods of increased precipitation can increase habitat availability for sportfish. Substantial water level rises promote increased primary productivity resulting from the trophic upsurge associated with flooding of the dewatered reservoir basin. This and change in reservoir trophic status, results in a shift in sportfish species dominance. This translates into increased sportfish body condition and growth. Improved welfare of structure-oriented species occurs until habitat degradation (decomposition) or reduced water availability (receding levels) again limits production and recruitment of this sportfish assemblage. In contrast, primary productivity is reduced during years of declining reservoir levels due to a lack of nutrient input from the watershed above. When suitability or availability of flooded terrestrial vegetation declines, dominance of open-water sportfish increases.

4. Vegetated Fisheries Habitat

Vegetated fisheries habitat occurring in and adjacent to Clinton Reservoir consists of terrestrial vegetation. This vegetation type and the habitat value for reservoir fisheries is described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. Subsequent to flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

5. Invasive/Exotic Species

Exotic and invasive species are both non-native to Clinton Reservoir, which is outside of the species' native range. It is important to distinguish that invasive species are ecologically harmful; whereas exotic species are considered neutral or naturalized, and do not negatively influence ecological processes. Currently, Clinton Reservoir contains one species designated as an Aquatic Invasive (Nuisance) Species by the KDWP, although more invasive species are threatening.

In 2013, zebra mussels were detected in Clinton Reservoir. The species is typically transported by recreational watercraft. Zebra mussels are prolific breeders that are capable of rapid population growth once introduced into a new waterbody. The mussel prefers to attach to hard substrates such as rock, wood, boat docks, and intake pipes. This can result in damage to important infrastructure. Additionally, their sharp-edged shell poses a hazard to recreational activities such as swimming. Zebra mussels can also alter the limnology of newly colonized waterbodies. Zebra mussels are filter-feeders that consume plankton, which are important forage resources for larval fish and native mussels. High competition can result in poor reproductive success of sportfish populations. High abundance of zebra mussels can cause the water to become clearer, thereby increasing light penetration, resulting in more extreme algal blooms.

Although not yet inhabiting Clinton Reservoir, invasive carp (bighead carp, silver carp) pose a significant threat. Bighead and silver carp can be found in the Wakarusa River, below Clinton dam, where they are unable to advance into the reservoir (without human assistance). Where they occur, invasive carp directly compete with larval fish for zooplankton forage resources, as well as other planktivorous fish such as paddlefish and gizzard shad. When disturbed, invasive carp are known to jump up out of the water, posing a serious threat to boaters and collisions can cause serious injury. It is critically important that anglers do not transport live bait between waterbodies, as this is the primary mechanism for invasive carp expansion.

Clinton Reservoir also contains exotic species including common carp and grass carp. These species are well distributed in North America, although their native range is Europe and Asia. Common and grass carps are considered ecologically neutral, although they have some deleterious effects. The two species commonly feed on vegetation or benthic invertebrates and rooting of the benthos causes resuspension of nutrients which contributes to algal blooms. Common carp account for a significant portion of the fish biomass in Clinton Reservoir, however, recreational activities such as hook and line angling and bow fishing are increasing in popularity.

Fisheries Management Objectives

The objective of fisheries management at Clinton Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 6), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Mitigation for Factors Affecting the Sport Fishery

1. Fish Sampling for Long-term Trend Monitoring

The sportfish community in Clinton Reservoir is routinely surveyed using a variety of different techniques for targeting specific species. Typically, all sportfish are measured for total length, weight, and total catch. These data are used to calculate relative abundance, size structure, body condition, and year class strength. These data are used to inform species specific management strategies (i.e., harvest regulations, stocking regime).

Annual electrofishing surveys are conducted to monitor the black bass (largemouth bass, smallmouth bass) populations. Black bass electrofishing surveys are conducted in spring when water temperatures reach 60 degrees Fahrenheit. During this time, bass inhabit shallow littoral areas making them vulnerable to near shore electrofishing. A minimum of 10 locations are surveyed for 10-minute electrofishing runs.

Annual blue catfish surveys are implemented using gill nets, low frequency electrofishing, and float line angling. Gill nets are a poor technique to survey blue catfish populations in Kansas. Alternatively, low frequency electrofishing has been implemented, and is more effective at targeting smaller individuals. A minimum of 24 sites are electrofished for 5-minute intervals. Standard sites (12) are located in preferred blue catfish habitat (near channel breaks, standing timber) and 12 random sites are selected in sub-optimal habitats to determine if distribution is increasing. Float line fishing is an effective technique for surveying the larger individuals in the population. A minimum of 20 grids are selected in preferred blue catfish habitat, and 5 float lines are set in each grid, totaling 100 float lines. Collectively, low frequency electrofishing and float line fishing offer a holistic monitoring approach.

In fall (October and November), trap nets and gill nets are deployed to survey a variety of sport fish populations. Trap nets are targeted toward sunfish (bluegill, redear sunfish, etc.) and crappie (black crappie, white crappie). This gear is efficient at capturing all sizes of sunfish and crappie. Trap nets are placed in depths of 1-5 meters and are set perpendicular to the shoreline. Gill nets are used to survey Percids (walleye, saugeye, sauger), Moronids (white bass, hybrid striped bass), channel catfish, and adult gizzard shad. A minimum of 16 gill nets are deployed at randomly selected sites each year.

2. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Clinton Reservoir are largemouth and smallmouth bass-18-inch minimum length limit, wiper-18-inch minimum length and daily creel limit of 2, blue catfish 35-inch minimum length limit, and crappie-10-inch minimum length and daily creel limit of 20. See Table 6 below for a comprehensive list of fish harvest regulations in effect at Clinton Reservoir. Other specific management activities include stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Table 6. Current Fish Harvest Regulations in Effect at Clinton Reservoir

Common Name	Length Limit	Daily Creel Limit
Blue Catfish	35-inch minimum length limit	5
Channel Catfish	N/A	10
Crappie	10	20
Flathead Catfish	N/A	5
Largemouth Bass	18-inch minimum length limit	5
Sauger	15-inch minimum length limit	5
Smallmouth Bass	18-inch minimum length limit	5
Walleye	15-inch minimum length limit	5
Wiper	18-inch minimum length limit	2

Note: Species Specific Length and Creel Limits at Clinton Lake in 2021

3. Sportfish Stockings

Historically, several sportfish species have been stocked in Clinton Reservoir to maintain sportfish populations or create new angling opportunities. Maintenance stockings have occurred for Percids (walleye, sauger, saugeye), largemouth bass, and channel catfish. Introductory stockings have occurred for blue catfish and hybrid striped bass.

Walleye and sauger have been heavily stocked in Clinton Reservoir to supplement these populations which experience minimal natural reproduction. In recent years, poor stocking success has resulted in a lower abundance of walleye and sauger. In 2021, a statewide study commenced to evaluate saugeye fry stocking as a potential alternative to walleye. The literature suggests that saugeye may offer a suitable alternative to walleye in reservoirs where high turbidity and water-level fluctuations may limit walleye recruitment. Similarly, largemouth bass experience poor natural reproduction in large reservoirs. Subsequently, early spawned largemouth bass fry were stocked to supplement the population. Unfortunately, poor stocking success was observed, and largemouth bass stocking has been discontinued in Clinton Reservoir.

Blue catfish populations have been successfully established in several other Kansas Reservoirs (Milford, Tuttle Creek, El Dorado) and have created popular new fishing opportunities. Blue catfish fingerlings were stocked in Clinton Reservoir from 2006 to 2013. Currently, the population is being monitored to evaluate stocking success and establishment of natural reproduction. Like blue catfish, hybrid striped bass have been stocked in Clinton Reservoir since 2004 to create additional angling opportunities. A hybrid striped bass population has been well established, although population characteristics fluctuate around stocked year classes. Nonetheless, the population supports a fishable abundance of quality and preferred sized individuals.

Table 7. Clinton Reservoir Fish Stocking Data 2012 Through August 2022

Common Name	Year Stocked	Total Number Stocked	Stocking Type
Walleye	2012	3675000	FRY
Sauger	2012	36854	FINGERLINGS

Common Name	Year Stocked	Total Number Stocked	Stocking Type
Largemouth Bass	2012	149728	FINGERLINGS
Blue Catfish	2012	14011	FINGERLINGS
Sauger	2013	700000	FRY
Walleye	2013	3500000	FRY
Largemouth Bass	2013	223915	FINGERLINGS
Sauger	2013	34824	FINGERLINGS
Wiper - W x S Bass	2013	35000	FINGERLINGS
Blue Catfish	2013	14053	FINGERLINGS
Walleye	2014	3500000	FRY
Sauger	2014	35120	FINGERLINGS
Largemouth Bass	2014	112252	FINGERLINGS
Walleye	2015	4200000	FRY
Sauger	2015	750000	FRY
Largemouth Bass	2015	103926	FINGERLINGS
Walleye	2016	4250000	FRY
Sauger	2016	700000	FRY
Walleye	2017	3600000	FRY
Sauger	2017	250000	FRY
Sauger	2017	73824	FINGERLINGS
Walleye	2018	4608853	FRY
Sauger	2018	400000	FRY
Wiper - W x S Bass	2018	350000	FRY
Walleye	2019	4350000	FRY
Sauger	2019	400000	FRY
Smallmouth Bass	2019	8836	FINGERLINGS
Wiper - W x S Bass	2020	350000	FRY
Channel Catfish	2020	5001	INTERMEDIATES
Walleye	2021	1350000	FRY
Saugeye	2021	1350000	FRY
Walleye	2022	1350000	FRY
Saugeye	2022	1350000	FRY
Wiper – W x S Bass	2022	350000	FRY

Note: Fish Stocked in Clinton Lake from 2012 through August 2022

4. Lake Level Management Plans

NWK implements a variety of practices through lake level management plans (LLMP) that address water management for environmental outcomes:

1) Alternating year water level management plans to enhance conditions for migratory waterfowl and fisheries
2) Slight pool raise in the spring to benefit fish spawning and provide food and cover for littoral species
3) Maintenance of water levels to create and maintain good spawning, nursery, and growth conditions for fisheries
4) Reduction of water level mid-summer to allow for re-vegetation of areas to benefit migratory waterfowl

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 8) in accordance with KDWP reservoir survey guidelines.

Table 8. Summary of Angler Participation at Clinton Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Anglers	Anglers per Acre	Total Angler Hours	Hours per Angler	Angler Hours per Acre
2017	2668	0.38	8260	3.10	1.18
2015	2531	0.36	5493	2.17	0.78
2013	2087	0.30	5389	2.58	0.77
2012	2636	0.38	7094	2.69	1.01
2006	1098	0.16	3381	3.08	0.48

Total number of anglers = total # of angling parties interviewed * # of anglers per party
Anglers per Acre = total # of anglers / 7000 acres (CLTR SA)
Total angler hours = # hours fished per party * # of anglers per party
Hours per angler = total # of anglers / total # angler hours
Angler hours per acre = total angler hours / 7000 acres
Source: KDWP 2022

Table 9. Average Percentages of the Top Four Most Preferred Species by Anglers at Clinton Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Species Preference Ranking / Score							
	First		Second		Third		Fourth	
2017	Crappie	36.7%	Catfish	21.1%	No Preference	20.0%	Walleye	11.1%
2015	Crappie	28.8%	No Preference	23.4%	Catfish	18.6%	Walleye	16.1%
2013	Crappie	29.4%	Catfish	24.5%	No Preference	20.5%	Walleye	13.3%
2012	Crappie	33.1%	Catfish	22.0%	No Preference	19.2%	Walleye	14.6%
2006	Crappie	57.0%	Catfish	25.9%	No Preference	9.7%	Walleye	5.8%

Source: KDWP 2022

Table 10. Estimated Total Number of Sportfish Harvested and Released at Clinton Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31.

Year	Total Number of Fish by Species				
	Crappie	Walleye	Catfish	White Bass	Wiper
Harvested					
2017	4745	663	1893	919	202
2015	3526	368	1009	690	70
2013	1779	153	887	367	39
2012	2533	257	1133	372	75
2006	2159	57	1225	62	5
Released					
2017	3268	784	949	2404	1235
2015	2754	185	424	650	128
2013	1106	113	644	518	135
2012	1872	156	666	725	119
2006	1835	471	690	546	102

Source: KDWP 2022

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Black Bass (*Micropterus* sp.)

Largemouth and smallmouth bass, collectively referred to as black bass, are recreationally and ecologically important species in Clinton Reservoir. Largemouth bass are the most preferred species among Kansas anglers. As a predatory species, black bass provide ecological balance through top-down ecological control.

In the late 2000s and early 2010's, largemouth bass were struggling to recruit to the fishery. In response, KDWP stocked 590,000 fingerlings from 2012 – 2015 to supplement the largemouth bass population. Despite several years of intensive stocking, the largemouth bass population failed to improve, and stocking has been discontinued. The species is not likely forage limited, as evidenced by high relative weights (Wr) ranging from 90 – 110. Poor habitat conditions (i.e., minimal aquatic vegetation, sedimentation, water-level manipulation) in Clinton Reservoir may not be suitable for recruitment of largemouth bass. However, Clinton Reservoir still maintains a fishable population of largemouth bass and some natural recruitment is evidenced by relatively stable sub-stock CPUE from 2020 – 2022. However, low levels of natural recruitment may not support a high-quality largemouth bass fishery in Clinton Reservoir, since few fish achieve preferred or memorable sizes.

On the bright side, the smallmouth bass population in Clinton Reservoir has greatly improved in recent years. The total CPUE of smallmouth bass has increased from 2.5 to 10.6 since 2020, and natural reproduction is evidenced by increased abundance of sub-stock length fish. A large year class was produced as a result of the 2019 flooding and accounted for a large proportion of the population in 2021. The strong year class has persisted into 2022, and the population now supports a high proportion of quality-length fish.

Table 11. Catch Per Unit Effort (CPUE), Proportional Stock Density (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Largemouth Bass Sampled During May by Electrofishing

Metric	2018	2019	2020	2021	2022
Total Catch	114	5	187	75	71
Stock Catch	103	2	128	55	45
Units of Effort	8.85	1.18	8.17	5.61	5.95
Sub-Stock CPUE (RSE)	1 (34)	1.9 (68)	6.1 (24)	3.6 (50)	4.5 (28)
Stock CPUE (RSE)	9.6 (18)	1.3 (69)	14.3 (14)	9.8 (24)	7.7 (17)
Quality/Density CPUE (RSE)	9.1 (18)	0 (0)	3.6 (18)	7 (24)	3.9 (24)
Preferred CPUE (RSE)	2.7 (24)	0 (0)	1.8 (26)	1.6 (43)	1.5 (44)
Memorable/Lunker CPUE (RSE)	0 (0)	0 (0)	0 (0)	0.4 (62)	0 (0)
Total CPUE (RSE)	10.6 (18)	3.2 (68)	20.3 (15)	13.4 (28)	12.2 (18)
PSD S-Q	6.8	100	75	29.1	48.9
PSD Q-P	64.1	0	12.5	54.6	31.1
PSD P-M	29.1	0	12.5	12.7	20
PSD M-T	0	0	0	3.6	0
PSD	93.2	0	25	70.9	51.1
Mean WR S-Q (RSE)	97 (3)	91 (3)	98 (1)	99 (2)	98 (3)
Mean WR Q-P (RSE)	102 (1)	0 (0)	109 (2)	101 (2)	96 (3)
Mean WR P-M (RSE)	100 (2)	0 (0)	105 (2)	110 (7)	90 (4)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	105 (2)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2022

*High water level in 2019 confounded fisheries surveys

Table 12. CPUE, PSD, Wr, and RSE Estimates for Smallmouth Bass Sampled During May by Electrofishing

Metric	2018	2019	2020	2021	2022
Total Catch	24	0	23	34	62
Stock Catch	17	0	15	15	29
Units of Effort	8.9	1.2	8.2	5.6	6.0
Sub-Stock CPUE (RSE)	0.8 (49)	0 (0)	0.9 (40)	3.4 (43)	5.7 (33)
Stock CPUE (RSE)	1.6 (30)	0 (0)	1.6 (32)	2.7 (36)	5 (23)
Quality/Density CPUE (RSE)	1.4 (31)	0 (0)	1.6 (32)	0.7 (48)	3.8 (26)
Preferred CPUE (RSE)	0.8 (37)	0 (0)	0.8 (41)	0.7 (48)	1 (39)
Memorable/Lunker CPUE (RSE)	0.4 (61)	0 (0)	0.3 (69)	0.2 (89)	0.3 (80)
Total CPUE (RSE)	2.4 (25)	0 (0)	2.5 (26)	6.1 (31)	10.6 (24)
PSD S-Q	11.8	0	0	73.3	24.1
PSD Q-P	41.2	0	46.7	0	55.2
PSD P-M	29.4	0	40	20	13.8
PSD M-T	17.7	0	13.3	6.7	6.9
PSD	88.2	0	100	26.7	75.9
Mean WR S-Q (RSE)	87 (6)	0 (0)	0 (0)	95 (2)	90 (6)
Mean WR Q-P (RSE)	89 (1)	0 (0)	100 (2)	0 (0)	82 (3)
Mean WR P-M (RSE)	85 (9)	0 (0)	109 (2)	95 (3)	82 (4)
Mean WR M-T (RSE)	92 (5)	0 (0)	101 (3)	101 (0)	82 (17)

Metric	2018	2019	2020	2021	2022
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2022

*High water level in 2019 confounded fisheries surveys

Blue Catfish (*Ictalurus furcatus*)

Blue catfish in Clinton Reservoir maintain a low-density population. The number of blue catfish captured in 2021 fall gill nets remained low, similar to previous years. During the summer of 2021, low frequency electrofishing and float line fishing were used to increase sample size and better understand the size distribution of the population. The additional effort was productive and a total of 142 blue catfish were captured, compared to only 24 individuals in 2020. The size structure of the population is heavily weighted towards large fish (PSD = 96.5); however, a small number of S-Q length fish were detected, possibly indicating a low level of natural reproduction, considering the last stocking event occurred in 2013. Nevertheless, the blue catfish population is aging, and size structure is more heavily weighted towards large fish, as evidence by increases in PSD-P (2020: 16.7, 2021: 31.0) and PSD-M (2020: 4.2, 2021: 12.0). Future management actions will rely on electrofishing and float-line surveys, since these techniques provide a better representation of the population compared to gill nets. Additionally, aging structures will be taken to predict whether fish were naturally reproduced or stocked.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish Sampled During Summer by Electrofishing and Float Line Angling

Metric	2018	2019	2020	2021	2022
Total Catch	18	0	24	142	35
Stock Catch	17	0	24	142	35
Units of Effort	8.8	1.2	8.2	61.3	20
Sub-Stock CPUE (RSE)	0.2 (89)	0 (0)	0 (0)	0 (0)	0 (0)
Stock CPUE (RSE)	3 (50)	0 (0)	5.2 (34)	3.4 (18)	1.8 (14)
Quality/Density CPUE (RSE)	2.9 (47)	0 (0)	4.1 (39)	2.9 (14)	1.8 (14)
Preferred CPUE (RSE)	0.5 (79)	0 (0)	1.1 (51)	1.3 (24)	0.7 (26)
Memorable/Lunker CPUE (RSE)	0 (0)	0 (0)	0.2 (108)	0.3 (50)	0.2 (58)
Total CPUE (RSE)	3.2 (49)	0 (0)	5.2 (34)	3.4 (18)	1.8 (14)
PSD S-Q	5.9	0	20.8	3.5	0
PSD Q-P	76.5	0	58.3	53.5	60
PSD P-M	17.7	0	16.7	31.0	28.6
PSD M-T	0	0	4.2	12.0	11.4
PSD	94.1	0	79.2	96.5	100
Mean WR S-Q (RSE)	111 (0)	0 (0)	83 (2)	91 (3)	0 (0)
Mean WR Q-P (RSE)	98 (3)	0 (0)	89 (4)	96 (3)	95 (3)
Mean WR P-M (RSE)	107 (3)	0 (0)	95 (9)	120 (0)	103 (4)
Mean WR M-T (RSE)	0 (0)	0 (0)	95 (0)	108 (0)	114 (5)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2022

*High water level in 2019 confounded fisheries surveys

*2018-2020 only electrofishing

*2021 both electrofishing and float line angling

*2022 only float line angling

Bluegill (*Lepomis macrochirus*)

The bluegill population in Clinton Reservoir is less desirable as a sport fishery due to the relatively small size structure of the population. Rather, bluegill serve as an important forage resource for other sportfish populations. Bluegill abundance has fluctuated in recent years ranging from a high of CPUE = 28.1 fish/NN in 2020, while abundance greatly decline to CPUE = 2.6 fish/NN in 2021. Size structure has remained fairly consistent over time, as the majority of the population consists of stock length individuals as evidence by PSD values from 7.2 to 41.

Table 14. CPUE, PSD, Wr, and RSE Estimates for Bluegill Sampled During October and November by Trap nets

Metric	2018	2019	2020	2021	2022
Total Catch	227		421	42	
Stock Catch	208		183	11	
Units of Effort	16		15	16	
Sub-Stock CPUE (RSE)	1.2 (43)		15.9 (29)	1.9 (48)	
Stock CPUE (RSE)	13 (56)		12.2 (40)	0.7 (36)	
Quality/Density CPUE (RSE)	0.9 (33)		5 (36)	0.3 (48)	
Preferred CPUE (RSE)	0 (0)		0.1 (67)	0 (0)	
Memorable/Lunker CPUE (RSE)	0 (0)		0.1 (67)	0 (0)	
Total CPUE (RSE)	14.2 (53)		28.1 (21)	2.6 (37)	
PSD S-Q	92.8		59	63.6	
PSD Q-P	7.2		40.4	36.4	
PSD P-M	0		0	0	
PSD M-T	0		0	0	
PSD	7.2		41	36.4	
Mean WR S-Q (RSE)	93 (3)		97 (2)	84 (3)	
Mean WR Q-P (RSE)	95 (3)		100 (1)	101 (5)	
Mean WR P-M (RSE)	0 (0)		0 (0)	0 (0)	
Mean WR M-T (RSE)	0 (0)		0 (0)	0 (0)	
Mean WR T+ (RSE)	0 (0)		0 (0)	0 (0)	

Source: KDWP 2022

*High water level in 2019 confounded fisheries surveys

Channel Catfish (*Ictalurus punctatus*)

Channel catfish also represent a popular sportfish population in Clinton Reservoir. The past three years of gill net data suggest a decline in channel catfish abundance. Channel catfish abundance reached a 4-year high in 2018 (CPUE = 5.5), whereas abundance did not exceed 4 fish/NN in the past three years. Additionally, a small proportion of stock length fish were observed in 2020 (PSD = 96.6) and 2021 (PSD = 95.9). As such, supplemental stocking may be requested in future years since the population is dominated by larger fish, and minimal recruitment has been observed in recent years.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During October and November by Gillnets

Metric	2018	2019	2020	2021	2022
Total Catch	88	37	60	51	
Stock Catch	87	34	59	49	
Units of Effort	16	16	16	16	
Sub-Stock CPUE (RSE)	0.1 (63)	0.2 (68)	0.1 (63)	0.1 (85)	
Stock CPUE (RSE)	5.4 (12)	2.1 (15)	3.7 (19)	3.1 (22)	

Metric	2018	2019	2020	2021	2022
Quality/Density CPUE (RSE)	4.5 (13)	1.6 (19)	3.6 (19)	2.9 (22)	
Preferred CPUE (RSE)	0 (0)	0.2 (50)	0 (0)	0.2 (68)	
Memorable/Lunker CPUE (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	
Total CPUE (RSE)	5.5 (12)	2.3 (15)	3.8 (18)	3.2 (21)	
PSD S-Q	17.2	26.5	3.4	4.1	
PSD Q-P	82.8	64.7	96.6	89.8	
PSD P-M	0	8.8	0	6.1	
PSD M-T	0	0	0	0	
PSD	82.8	73.5	96.6	95.9	
Mean WR S-Q (RSE)	96 (3)	97 (5)	88 (12)	87 (8)	
Mean WR Q-P (RSE)	91 (1)	91 (2)	89 (2)	84 (2)	
Mean WR P-M (RSE)	0 (0)	87 (5)	0 (0)	92 (9)	
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	

Source: KDWP 2022

Crappie (*Pomoxis* sp.)

Typical of crappie (black crappie and white crappie) populations, the crappie population in Clinton Reservoir is highly structured by reproductive success and year class strength. In 2020, a large year class of small crappie (sub-stock length and stock length) was detected, resulting in a low PSD of 16.6 and PSD-S of 83.4. Consequently in 2021, this large year class caused an increase in size structure, as evidence by improved PSD-Q (2020: 4.9, 2021: 52.8), PSD-P (2020: 10.2, 26.1), and PSD-M (2020: 1.5, 2021: 2.5). Overall, CPUE was similar between years (2020: 23.4, 2021: 28.9). Considering the large portion of quality-sized fish in 2021, we would expect to see another large year class produced and a greater number of preferred and memorable sized in the population.

Table 16. CPUE, PSD, Wr, RSE Estimates for Crappie Sampled During October and November by Trap nets

Metric	2018	2019	2020	2021	2022
Total Catch	864		351	462	
Stock Catch	742		265	199	
Units of Effort	16		15	16	
Sub-Stock CPUE (RSE)	7.6 (33)		5.7 (41)	16.4 (73)	
Stock CPUE (RSE)	46.4 (45)		17.7 (37)	12.4 (22)	
Quality/Density CPUE (RSE)	33.9 (48)		2.9 (29)	10.1 (24)	
Preferred CPUE (RSE)	14.2 (50)		2.1 (28)	3.6 (22)	
Memorable/Lunker CPUE (RSE)	1.4 (48)		0.3 (51)	0.3 (73)	
Total CPUE (RSE)	54 (41)		23.4 (37)	28.9 (40)	
PSD Stock-Quality (S-D)	27		83.4	18.6	
PSD Quality-Preferred (Q-P)	42.5		4.9	52.8	
PSD Preferred-Memorable (P-M)	27.6		10.2	26.1	
PSD (Memorable-Trophy (M-T)	2.8		1.5	2.5	
PSD	73.1		16.6	81.4	
Mean WR S-Q (RSE)	84 (3)		95 (1)	93 (2)	
Mean WR Q-P (RSE)	95 (1)		97 (3)	99 (1)	
Mean WR P-M (RSE)	95 (1)		107 (2)	102 (1)	
Mean WR M-T (RSE)	87 (2)		98 (4)	89 (5)	
Mean WR T+ (RSE)	76 (0)		0 (0)	0 (0)	

Source: KDWP 2022

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard shad represent and important prey species in Clinton Reservoir. Annual production of age-0 gizzard shad is often closely related to body condition indices of sport fish populations. Adult Gizzard Shad are surveyed using gill nets, which is also representative of age-0 production that year. Few age-0 shad are suspectable to gill nets, therefore size structure metrics are representative of larger adults, as evidenced by PSD values varying from 85.5 to 100. Relative abundance of shad in 2021 (CPUE = 5.6 fish/NN) was greater than in previous years, indicating a strong year class may be produced in 2022.

Table 17. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During October and November by Gill nets

Metric	2018	2019	2020	2021	2022
Total Catch	56	49	77	89	
Stock Catch	55	47	76	88	
Units of Effort	16	16	16	16	
Sub-Stock CPUE (RSE)	0.1 (63)	0.1 (85)	0.1 (63)	0.1 (63)	
Stock CPUE (RSE)	3.4 (23)	2.9 (20)	4.8 (34)	5.5 (17)	
Quality/Density CPUE (RSE)	2.9 (22)	2.9 (20)	4.3 (33)	5.3 (18)	
Preferred CPUE (RSE)	0.4 (39)	0.9 (30)	3.2 (30)	4.1 (17)	
Memorable/Lunker CPUE (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	
Total CPUE (RSE)	3.5 (23)	3.1 (19)	4.8 (35)	5.6 (17)	
PSD S-Q	14.6	0	10.5	3.4	
PSD Q-P	72.7	68.1	22.4	22.7	
PSD P-M	12.7	31.9	67.1	73.9	
PSD M-T	0	0	0	0	
PSD	85.5	100	89.5	96.6	
Mean WR S-Q (RSE)	0 (0)	0 (0)	0 (0)	84 (1)	
Mean WR Q-P (RSE)	0 (0)	92 (2)	0 (0)	88 (3)	
Mean WR P-M (RSE)	0 (0)	94 (2)	0 (0)	87 (3)	
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	

Source: KDWP 2022

Sauger (*Sander canadensis*) and Walleye (*Sander vitreus*)

Walleye and sauger continue to experience poor recruitment and a decline in abundance, despite heavy fry stocking efforts. Since 2016, CPUE of percids in gill nets has been less than 3 fish/NN and has been steadily declining. For instance, CPUE of percids declined from 2.3 in 2020 to 1.6 in 2021. Additionally, the proportion of the population is heavily weighted towards larger adults and relatively few stock length recruits have been detected, as evidenced by PSD varying from 54.3 to 88.2 over the past 4 years. The decline in percid abundance and recruitment spurred a statewide study evaluating concurrent stocking of saugeye and walleye fry, which commenced in spring of 2021. The literature suggests that saugeye may be a suitable alternative in reservoirs, where high turbidity and water level fluctuations may limit the success of walleye populations. Future management will closely monitor for differences in the population characteristics of walleye and saugeye, with the addition of night electrofishing surveys to monitor age-0 abundance.

Table 18. CPUE, PSD, Wr, and RSE Estimates for Sauger Sampled During October and November by Gill nets

Metric	2018	2019	2020	2021	2022
Total Catch	18	40	36	26	
Stock Catch	17	35	36	26	

Metric	2018	2019	2020	2021	2022
Units of Effort	16	16	16	16	
Sub-Stock CPUE (RSE)	0.1 (63)	0.3 (66)	0 (0)	0 (0)	
Stock CPUE (RSE)	1.1 (27)	2.2 (19)	2.3 (29)	1.6 (28)	
Quality/Density CPUE (RSE)	0.9 (26)	1.2 (28)	1.8 (34)	1.1 (29)	
Preferred CPUE (RSE)	0.9 (25)	0.9 (28)	0.9 (30)	0.5 (32)	
Memorable/Lunker CPUE (RSE)	0.5 (32)	0.6 (30)	0.1 (85)	0 (0)	
Total CPUE (RSE)	1.1 (26)	2.5 (21)	2.3 (29)	1.6 (28)	
PSD S-Q	11.8	45.7	22.2	34.6	
PSD Q-P	5.9	11.4	38.9	34.6	
PSD P-M	35.3	17.1	33.3	30.8	
PSD M-T	47.1	25.7	5.6	0	
PSD	88.2	54.3	77.8	65.4	
Mean WR S-Q (RSE)	91 (3)	96 (3)	92 (3)	99 (3)	
Mean WR Q-P (RSE)	97 (0)	108 (7)	93 (2)	84 (2)	
Mean WR P-M (RSE)	82 (2)	95 (3)	92 (3)	84 (3)	
Mean WR M-T (RSE)	87 (4)	90 (2)	87 (12)	0 (0)	
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	

Source: KDWP 2022

White Bass (*Morone chrysops*)

White bass also constitute a significant portion of the fish community in Clinton Reservoir. White bass maintain a natural reproducing population, as such some annual variation in population characteristics occurs. The proportion of stock length individuals has varied from PSD S-Q = 11.5 to 51.8 over the past 5-years, indicating variation in year class strength. A relatively large year class was produced in 2020, whereas a much smaller year class occurred in 2021, contributing to lower total abundance. In 2021, CPUE declined to 8.4 fish/NN after a 5-year high in 2020 (15.3 fish/NN). Size structure metrics change over time as large year classes age, thereby altering the size structure of the population. Due to a relatively small year class produced in 2021, we would expect another large class to be produce in the next year or two.

Table 19. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During October and November by Gill nets

Metric	2018	2019	2020	2021	2022
Total Catch	188	165	244	135	
Stock Catch	187	164	243	135	
Units of Effort	16	16	16	16	
Sub-Stock CPUE (RSE)	0.1 (63)	0.1 (63)	0.1 (63)	0 (0)	
Stock CPUE (RSE)	11.7 (23)	10.3 (19)	15.2 (11)	8.4 (20)	
Quality/Density CPUE (RSE)	7.9 (21)	4.9 (22)	13.4 (11)	6.8 (18)	
Preferred CPUE (RSE)	6.3 (21)	4.3 (23)	11.7 (12)	6.4 (17)	
Memorable/Lunker CPUE (RSE)	1.3 (30)	0.9 (40)	1.3 (25)	0.8 (26)	
Total CPUE (RSE)	11.8 (23)	10.3 (19)	15.3 (11)	8.4 (20)	
PSD S-Q	32.1	51.8	11.5	20	
PSD Q-P	13.9	6.1	11.5	4.4	
PSD P-M	42.8	33.5	68.3	65.9	
PSD M-T	11.2	8.5	8.6	9.6	
PSD	67.9	48.2	88.5	80	
Mean WR S-Q (RSE)	91 (1)	103 (2)	103 (2)	96 (2)	
Mean WR Q-P (RSE)	93 (1)	96 (3)	96 (2)	104 (6)	
Mean WR P-M (RSE)	97 (2)	104 (1)	97 (1)	100 (1)	

Metric	2018	2019	2020	2021	2022
Mean WR M-T (RSE)	98 (5)	106 (2)	97 (2)	90 (4)	
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	

Source: KDWP 2022

Wiper (*Morone saxatilis* X *M. chrysops*)

Wiper are stocked in Clinton Reservoir to create additional angling opportunities. Wiper fry are stocked annually (~350,000/year) therefore population characteristics are dependent on relative survival of stocked fry. Wiper abundance is relatively low, though consistent as CPUE varied from 1.5 to 3.6 fish/NN over the past four surveys. Size structure metrics in 2021 indicated there is a greater proportion of stock length fish in the population (PSD = 33.3), whereas size structure was larger in previous years. These data suggest high survival of stocked fry in 2021, resulting in a strong year class that shifted size structure towards small fish. Although, few larger individuals were detected, we would expect size structure to improve as the 2021-year class ages.

Table 19. CPUE, PSD, Wr, and RSE Estimates for Wiper -WXS Bass Sampled During October and November by Gill nets

Metric	2018	2019	2020	2021	2022
Total Catch	42	24	57	32	
Stock Catch	29	24	57	30	
Units of Effort	16	16	16	16	
Sub-Stock CPUE (RSE)	0.8 (35)	0 (0)	0 (0)	0.1 (125)	
Stock CPUE (RSE)	1.8 (27)	1.5 (31)	3.6 (27)	1.9 (48)	
Quality/Density CPUE (RSE)	1.2 (35)	1.3 (29)	2.9 (25)	0.6 (57)	
Preferred CPUE (RSE)	0.9 (37)	0.5 (37)	0.4 (56)	0.3 (59)	
Memorable/Lunker CPUE (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	
Total CPUE (RSE)	2.6 (28)	1.5 (31)	3.6 (27)	2 (48)	
PSD S-Q	34.5	16.7	17.5	66.7	
PSD Q-P	13.8	50	70.2	16.7	
PSD P-M	51.7	33.3	12.3	16.7	
PSD M-T	0	0	0	0	
PSD	65.5	83.3	82.5	33.3	
Mean WR S-Q (RSE)	95 (2)	103 (2)	90 (2)	95 (1)	
Mean WR Q-P (RSE)	94 (12)	102 (2)	91 (1)	87 (3)	
Mean WR P-M (RSE)	79 (2)	89 (2)	84 (6)	86 (8)	
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	

Source: KDWP 2022

Future Without Project Projections

Clinton Reservoir is filling in with sediment at the detriment of the fish and the anglers who pursue them as well as other interest groups that use the reservoir. Sedimentation of the reservoir reduces the storage capacity and area available to anglers, and fills in any unique, fish attracting bathymetric features (e.g., river channels). Decreased storage capacity will likely result in Clinton Reservoir being more responsive to heavy rains, exhibiting more drastic rises than were experienced when the river was impounded. The more drastic and frequent fluctuations will make the establishment and development of aquatic vegetation even more difficult. Further degradation of existing fish habitat will be countered with the installation of artificial fish habitat, but natural features are likely more appealing to fishes, and it is unknown if the rate of replacement can match the rate of degradation.

There is no reason to believe that use or visitation of Clinton Reservoir will be decreasing in the future. This reservoir is within close proximity to large population centers. The reservoir is already known for its exceptional crappie fishing and receives a good deal of traffic from tournament bass fishing, which is a growing sport. There is also the possibility that in the next ten years, Clinton Reservoir could develop a high-quality blue catfish fishery. If this population takes hold, it is likely to receive increased pressure from metropolitan catfishermen who would like a closer destination than Milford Reservoir.

While angler use may remain constant or increase, access to the reservoir may decrease. Continued siltation at the upper end of the reservoir may hinder angler access to that portion of the reservoir resulting in crowding at lower reservoir boat access areas. Similarly, more frequent, or more drastic water level fluctuations could result in most, if not all, boat ramps being closed to angler access. Without construction of new, higher elevation boat access points it is possible that anglers may not be able to access the reservoir during times of the year when rains are more frequent.

The loss of bathymetric features and silting in of natural fish attracting features will also negatively affect fish populations. Fish populations may begin to shift toward more riverine population structures which may not align with angler preference. Water level management will also continue to be crucial to sport fisheries and anglers. Available habitats and types, and successful sportfish reproduction and survival, can all be positively or negatively impacted by the timing of water releases and magnitudes thereof. High releases around spawning periods could be detrimental both on the local and statewide scale.

Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery
Location: Harlan County Reservoir

Brad Newcomb, Brad Eifert, and Keith Koupal
Nebraska Game and Parks Commission

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History

Harlan County Reservoir is a U.S. Army Corps of Engineers (USACE) project covering 31,000 acres, including a reservoir with 13,500 surface acres at conservation pool. The reservoir is about seven miles long with 75 miles of shoreline. It is located on the Republican River in the south-central part of the Nebraska (seven miles from the Nebraska-Kansas state line) and drains into the Kansas River. The massive flood of 1935 prompted state and federal officials to investigate flood control measures in the Republican River basin. On May 31, 1935, a storm dumped 24 inches of rain on the Republican River watershed, which wiped out Republican City, Nebraska and resulted in the deaths of over 100 people. Nearly 10,000 cattle were reportedly lost along the Republican River Valley along with 300 county bridges and over 300 miles of roads and railway. The flood was responsible for over $26 million in damages.

The USACE researched a potential location for a dam to prevent such flood loss and a site located between the towns of Republican City and Naponee, Nebraska was selected. The USACE Kansas City District began construction of the Harlan County Dam and Reservoir in 1946. Republican City, Nebraska was eventually moved and rebuilt two miles north on higher ground. The dam, completed in 1953, extends for two miles across the Republican River and is about 100 feet high. The project was developed jointly by the USACE and the U.S. Bureau of Reclamation (USBR) and the reservoir is owned and operated by the USACE for flood control, irrigation, recreation, and fish and wildlife purposes. The reservoir provides a valuable recreation area and popular fishing spot in Nebraska (see Figure 1 for access information). The Nebraska Game and Parks Commission (NGPC) is the administering agency for fish and wildlife management activities on about 31,000 acres of land and water at Harlan County Reservoir.

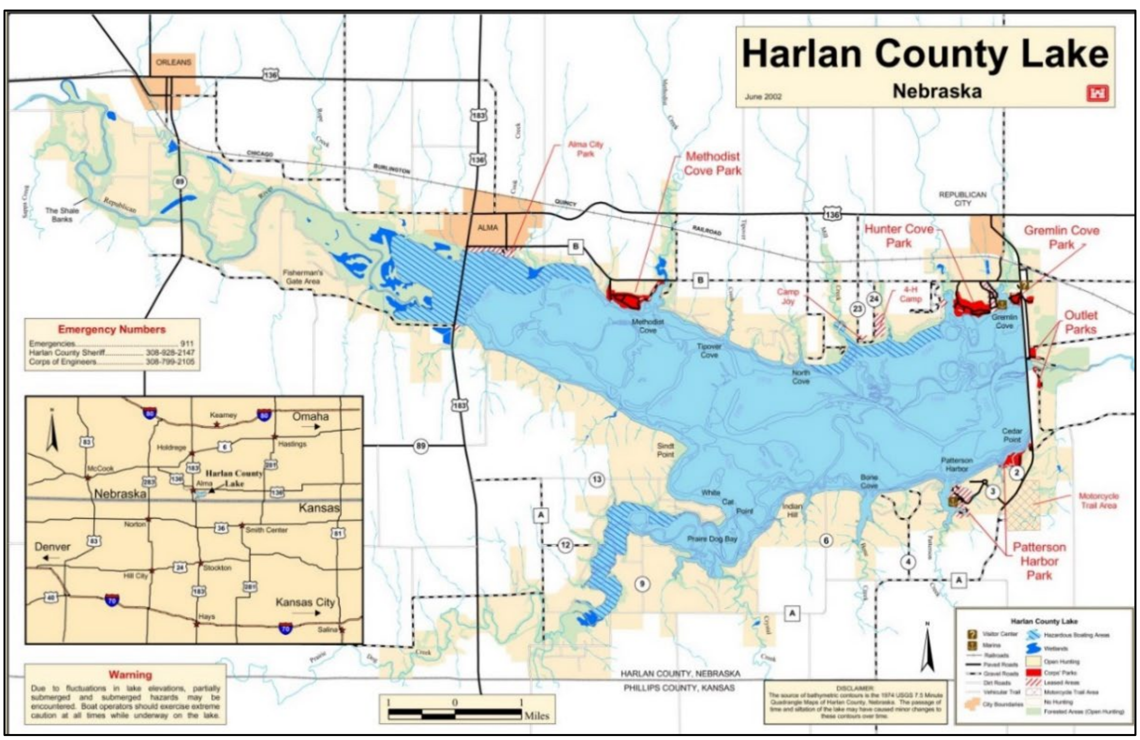

Figure 1. Map of Harlan County Reservoir and Property Owned and Managed by USACE

Water Allocation Background

Harlan County Reservoir was constructed as a multipurpose facility for flood control and irrigation. Water allocation is displayed graphically in Figure 2. The original reservoir storage capacity included 503,488 acre-feet storage for flood control, 346,512 acre-feet for multipurpose use, and a sediment reserve of 164,111 acre-feet (Table 1).

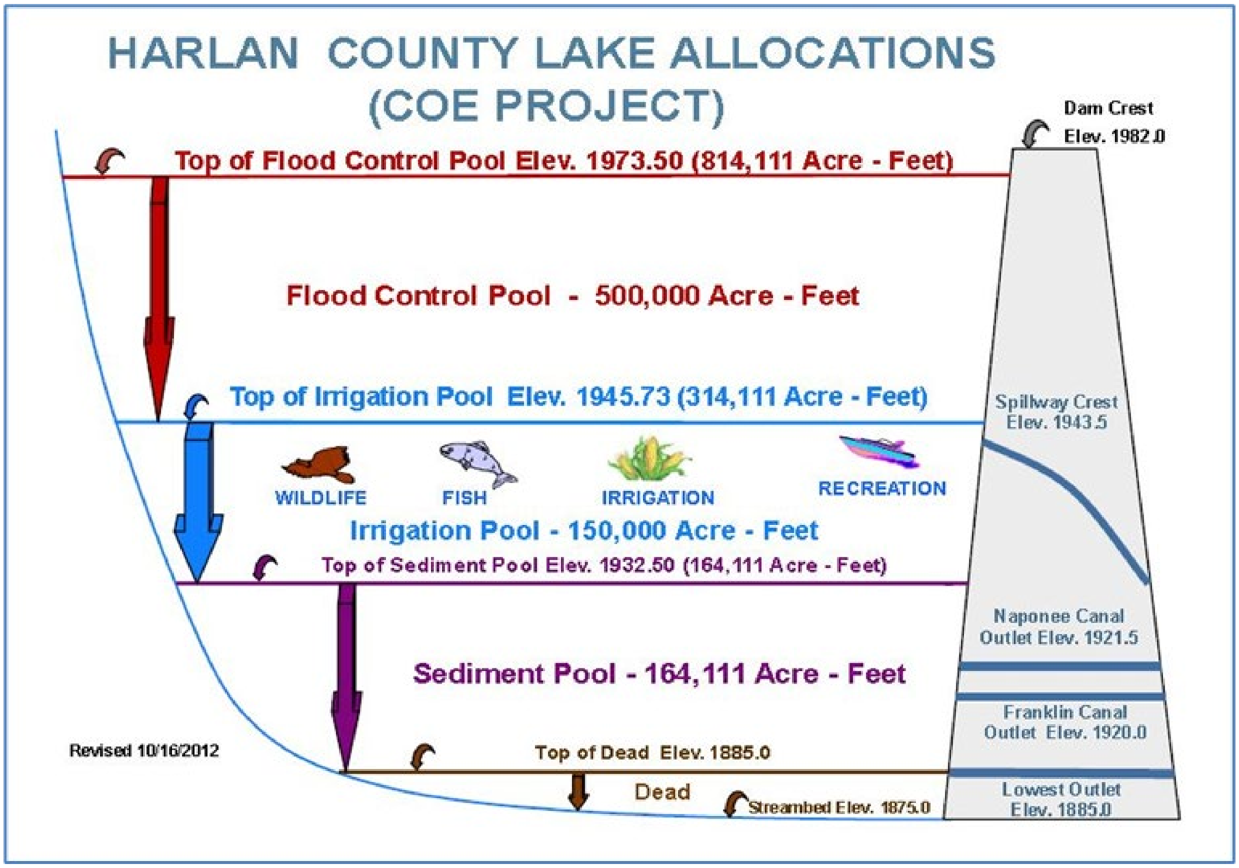

Figure 2. Harlan County Reservoir Water Allocations

It is important to note that reservoir operation is not permitted to take the reservoir level below the sediment pool elevation. However, the sediment reserve can be used for irrigation and other conservation purposes until depleted. The original sediment pool elevation was 1932msl, although it has been lowered in recent years to 1927msl.

Approximately 150,000 acre-feet of multipurpose pool storage is allocated exclusively for irrigation. An additional 46,000 acre-feet of multipurpose pool was allocated as Dual Purpose in 2001. The dual purpose zone can be used for irrigation during drought conditions through a Consensus Plan through USBR and USACE. Harlan County Reservoir provides irrigation water to approximately 100,000 acres of cropland in south-central Nebraska and north-central Kansas under authority of the Bostwick Division, part of the Pick-Sloan Missouri Basin Water Program.

Table 1. Storage Capacity and Ownership

Pool Owner	Purpose	Quantity (acre-feet [af])
1952		
USACE	Flood Control	503,488
USACE	Multipurpose	346,512
2024[1]		
USACE	Flood Control	499,294
USACE	Multipurpose Uses	159,372
Irrigation Districts	Irrigation	150,000

Note: Storage capacity projected for 2024 with loss to sedimentation as modeled

Harlan County Reservoir Fishery

Fisheries Establishment

Modern fish stocking since the 1980's has consisted mostly of channel catfish, walleye, and wipers. Crappie, largemouth bass, northern pike, and tiger muskie are occasionally stocked in conjunction with high water elevations. An experimental stocking of rainbow trout in the stilling basin was attempted in the winter months of 2013-14 but was not continued due to problems with unknown winter release amounts and predation from cormorants.

With the Republican River and other streams as the water source, many fish species have access to Harlan County Reservoir. The current fish population in Harlan County Reservoir consists of a mixture of species stocked by NGPC and species from the watershed.

Tables 2 and 3 provide lists of sport fish and non-sport fish in Harlan County Reservoir. More detail of recent species-specific stocking efforts is provided in species narrative in the Sportfish Dynamics & Trends section.

Table 2. Sport Fish Species Known to Inhabit Harlan County Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Freshwater Drum	*Aplodinotus grunniens*
Largemouth Bass	*Micropterus salmoides*
Northern Pike	*Esox lucius*
Tiger Muskie	*Esox lucius* x *E. masquinongy*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis* x *M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Harlan County Reservoir

Common Name	Scientific Name
Black Bullhead	*Ameiurus melas*
Common Carp	*Cyprinus carpio*
Gizzard Shad	*Dorosoma cepedianum*
Orangespotted Sunfish	*Lepomis humilis*
River Carpsucker	*Carpiodes carpio*
Shortnose Gar	*Lepisosteus platostomus*

Abiotic and Biotic Factors Effecting the Fishery

1. Water Quality

Water quality monitoring has been conducted in a joint long-term monitoring project between University of Nebraska-Kearney and NGPC starting in 2003. The highest mean annual water temperatures were typically seen in late July – early August and can exceed 28^{o}C (Figure3). Dissolved oxygen levels were typically satisfactory to maintain biological function of the aquatic communities, but periodic occurrences of lower summer dissolved oxygen levels were noted. Water clarity in the reservoir is normally poor with Secchi readings normally less than 2 feet during the main summer months. Some years, water clarity is much better in the early spring months, but it is usually a temporary occurrence. Turbidity within Harlan County Reservoir was traditionally associated with high levels of suspended solids, but during the summer are escalated by increasing occurrences of algal blooms.

The reservoir has oscillated between eutrophic to hyper-eutrophic designations, but more publications have depicted the water as hypereutrophic. Blue-green algae blooms occur on occasion and the lake has been placed on the toxic algae advisory list several times in the past 20 years. The Nebraska Department of Environment and Energy conduct weekly algae and bacteria samples during the main recreation season and are responsible for public notices and sign postings. The increase in nutrient levels observed through time in Harlan County Reservoir will potentially lead to more periodic closure for public access and have become a growing concern for the future stability of the aquatic community.

The reservoir was the focal point for an assessment of conditions in irrigation reservoirs between drought and flood cycles (see Olds et al. 2011; 2014 for specifics). Differences in several water quality parameters were associated with changes in zooplankton densities during wet and dry time periods. The reservoir has different environmental conditions as the water levels oscillate.

The USACE Kansas City District Water Quality Program also conducts routine monitoring at this reservoir by collecting monthly water samples from standardized locations during the recreation season. Chemical, physical, and biological parameters are measured to evaluate water quality at inflow, reservoir, and outflow sites. These data describe conditions and changes from within the main reservoir, and outflow focusing on eutrophication, nutrients, sediment, herbicides, metals, and contaminants.

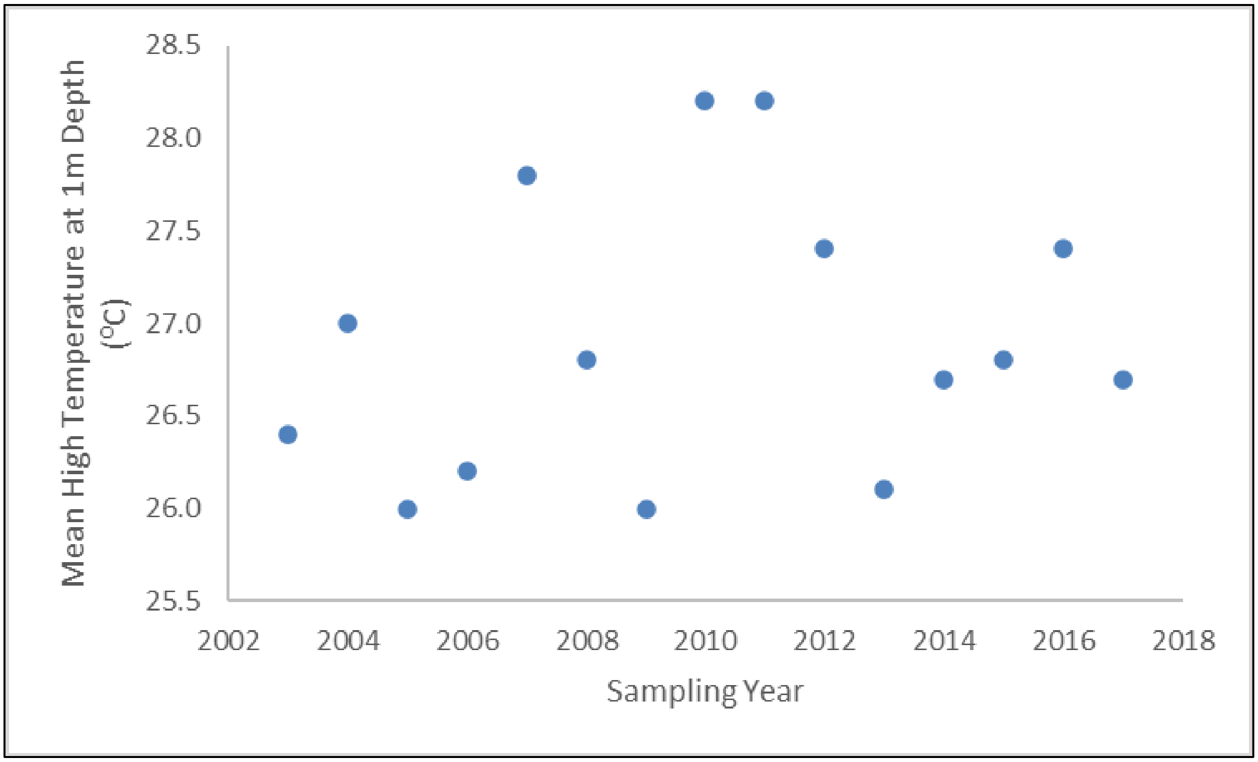

Figure 3. Recorded Highest Annual Mean Temperature at 1m of Depth 2003 – 2017. *Recorded Highest Annual Mean Temperature at 1m of Depth (collected from readings established for the Harlan County Reservoir limnological assessment developed by the NGPC fisheries division during 2003 – 2017)*

Source: NGPC 2023

2. Water Level Fluctuation

Inflows to Harlan County Reservoir are dependent on the Republican River and several smaller streams. Long-term Republican River inflows from 1948 through 2019 averaged 221cfs (source: USGS website). Total reservoir inflows are often slightly higher than just the Republican River due to inputs from Prairie Dog Creek, Methodist Creek, and Mill Creek.

Irrigation releases typically begin in May or June and run through early September. The average annual elevation change (difference from high to low elevation for the year) is about 7.9 feet and has ranged from 1 to 16 feet since 1959 (source: USBR website). Winter releases are often coordinated with NGPC, selecting gate releases and amounts to minimize fish loss from the reservoir and fish stranding downstream.

Figure 4 shows end-of-month water elevations at Harlan County Reservoir from 1980 through 2022, and Figure 5 shows the irrigated area from water released from Harlan County Reservoir.

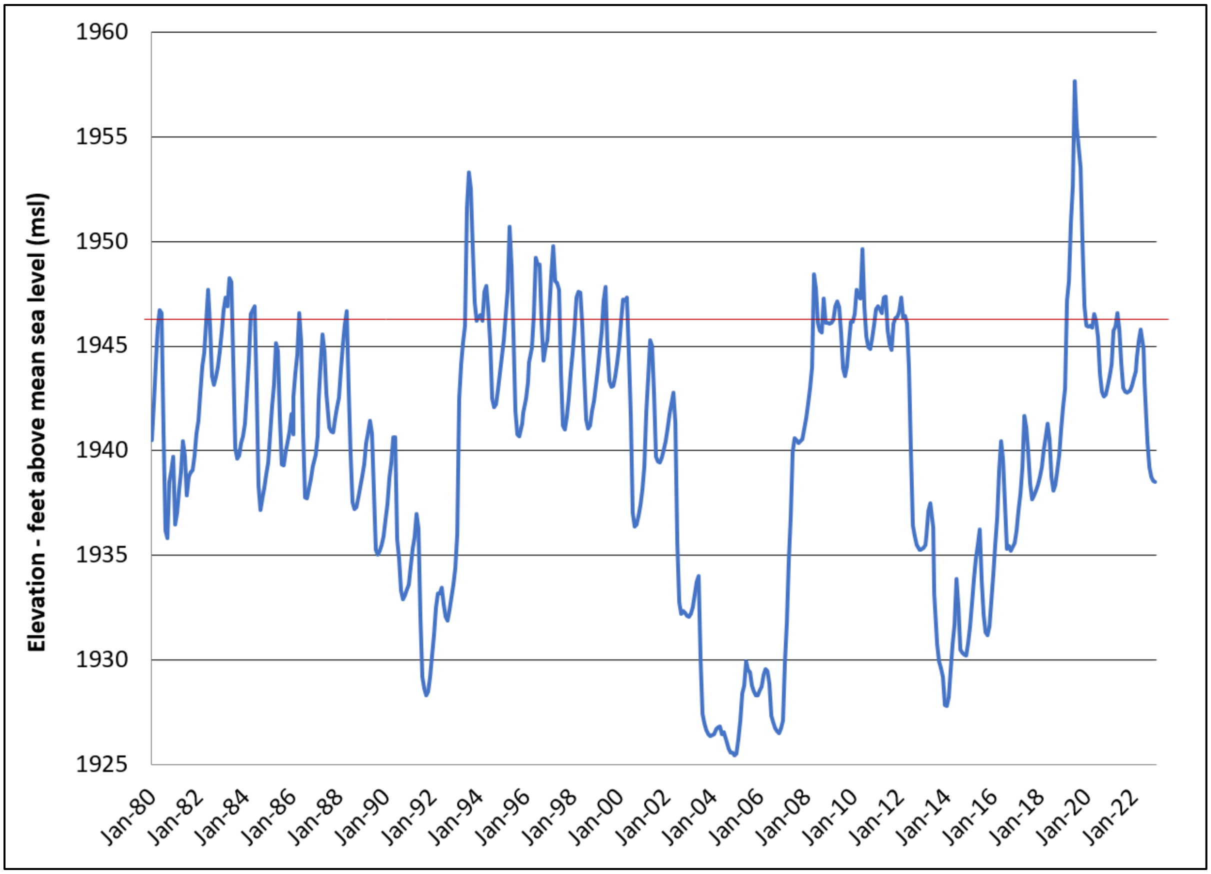

Figure 4. End-of-Month Elevations at Harlan County Reservoir from 1980 to 2022

*The red line shows top of irrigation pool (1945.7 msl)

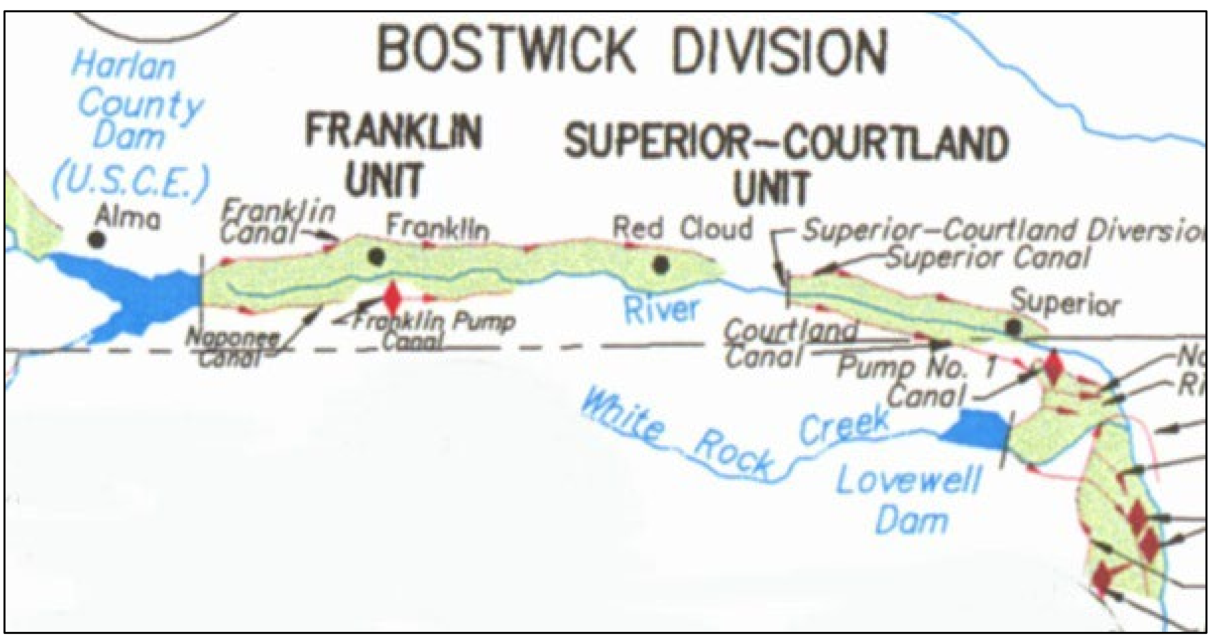

Figure 5. Irrigated Areas From Water Released From Harlan County Reservoir

Source: USBR

3. Vegetation

With wide fluctuating water levels associated with drought periods and contrasting high inflows, reservoir waters levels have varied greatly over time (Figure 4). Some fish species temporarily benefit from water level patterns experienced at Harlan County Reservoir. When years of drought and low reservoir water levels are followed by high inflows and high reservoir water levels, shoreline-oriented species such as largemouth bass and crappie benefit from an abundance of flooded shoreline terrestrial vegetation. The USACE has estimated over 5,000 acres of flooded terrestrial vegetation has been inundated during past drought-high water level cycles. For example, the northeast corner of the reservoir provided about 950 acres of flooded terrestrial vegetation in 2007 (Figure 6). During high-water conditions, emergent and submergent vegetation is abundant in the reservoir. Otherwise, wind and wave conditions keep most shorelines void of aquatic vegetation growth.

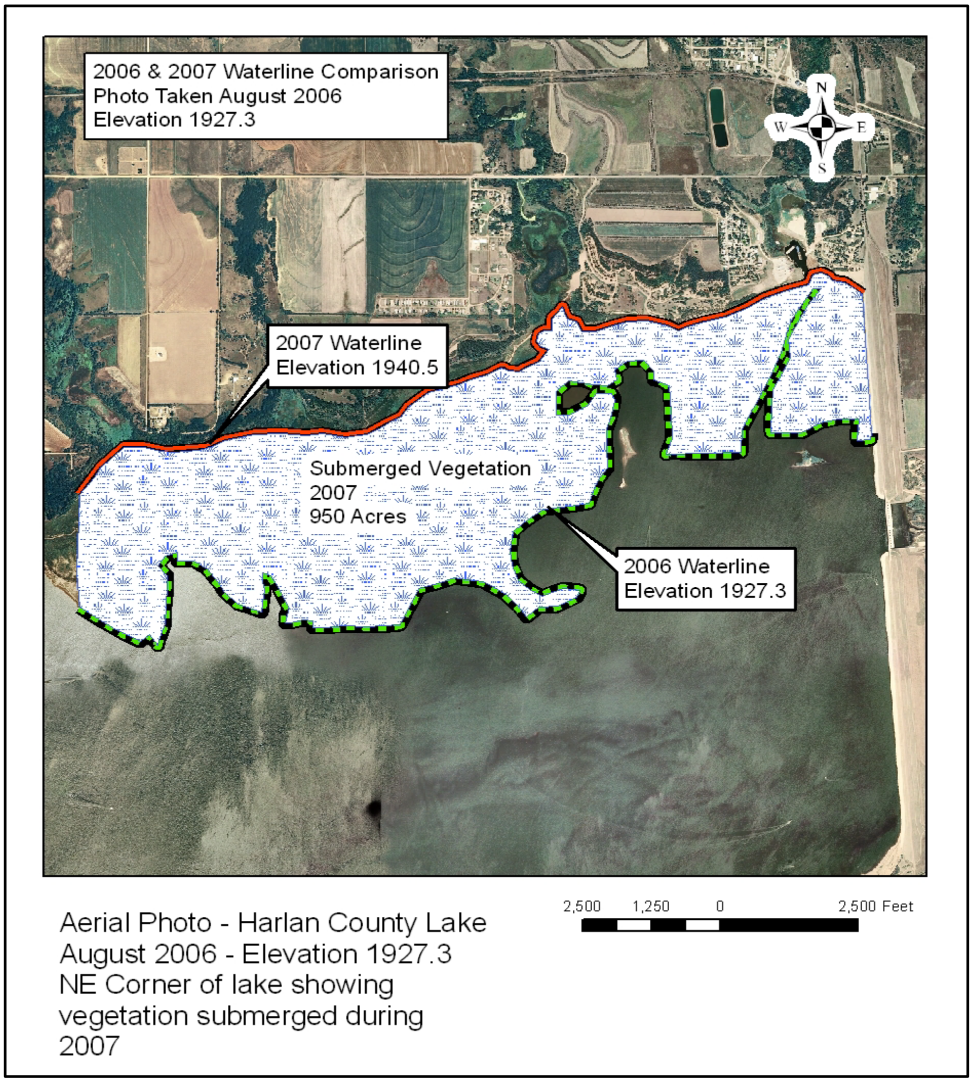

Figure 6. Aerial Diagram Showing the Extent of Flooded Terrestrial Vegetation During the 2006 Low Water and 2007 High Water Cycle at the Northeast Corner of Harlan County Reservoir

Source: USACE, Republican City

4. Invasive/Exotic Species

Documented aquatic invasive species at Harlan County Reservoir include common reed (*Phragmites australis*), salt cedar (*Tamarix spp.*), common carp (*Cyprinus carpio*), and spiny water flea (*Daphnia lumholtzi*). Although zebra mussels (*Dreissena polymorpha*) are commonly found in nearby Kansas reservoirs, they have not been detected at Harlan County Reservoir despite annual monitoring efforts for zebra and quagga mussels (*Dreissena rostriformis bugensis*) that began in 2010. Sampling methods include monthly veliger sampling from May to September, multi-plate samplers deployed from docks during summer months, and monthly visual inspection of docks and shoreline areas for adults. Boat inspections, boating habit surveys and education/outreach efforts are also conducted during the summer months.

5. Sedimentation

Harlan County Reservoir is about 13,500 surface acres at conservation pool (1,945.7 ft. msl) and contains about 314,000 acre-feet of storage. As shown in Table 1, there is about 150,000 acre-feet of water available for irrigation, and a sediment pool of 164,111 acre-feet. Most sedimentation comes from in-lake erosion and not the watershed. The reservoir is oriented on a northwest to southeast axis and wind/wave action causes considerable shoreline erosion. Many coves have experienced major shoreline erosion where they connect to the reservoir and are now separated from the main reservoir during lower water level periods (Figure 7). Coves with major erosion problems include Bone, Indian, Methodist, Prairie Dog, and Tipover Coves. USACE dredging operations are used to maintain connection to the main reservoir at Gremlin and Patterson Coves and provide access for all boating activities. The USACE has placed rock on shorelines at Gremlin, Methodist, and Patterson Coves to protect public access and campground resources.

Figure 7. Example of a Cove Habitat That is Cutoff from The Main Reservoir by Long-term Shoreline Erosion (Tipover Cove)

The multipurpose pool at Harlan County Reservoir originally included 346,512 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 10.5% of the multipurpose pool has been filled in with sediment leaving approximately 310,243 ac-ft of capacity (based on 2010 survey results). It is estimated that approximately 680 ac-ft of sediment accumulates on average annually in Harlan County Reservoir. Sediment will continue to accumulate in Harlan County Reservoir with an expected additional 1.6 % loss of the multipurpose pool over the next 25 years (2049) and 2.5% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 300,735 ac-ft in 2074.

Fisheries Management Objectives

Current fisheries management activities include fish stocking, fishery surveys, fishing regulations (see Table 4), angler access improvements, aquatic habitat restoration, and outdoor education.

Standard fish population surveys, angler surveys, and research projects provide the main source of information to manage the fishery at Harlan County Reservoir. These efforts provide information about the fish populations, angler dynamics, and fishery interactions, which is used to help formulate fish stocking recommendations, fishing regulations, access developments, and education efforts.

Standard fish population surveys have been completed since 1973, and annually since 1989. Experimental gill nets (150 feet long) are used to sample open-water species such as walleye, white bass, and channel catfish. Trap nets (5/8” mesh) are used primarily to assess crappie populations, but only when reservoir elevations allow sampling in cove locations. Electrofishing has been completed with special stocking evaluations and research projects. Most fish population survey work is completed in the fall, and gill net surveys have been completed in early October since the early 1990’s. Standard sampling locations have been utilized since the early 1990’s to facilitate long-term comparisons of fish populations. Station locations are recorded with GPS coordinates, but exact sampling locations can be adjusted annually with changing reservoir elevations. Summary reports of fish population survey information have been completed annually since 2001, and these reports are currently provided to the public via the NGPC website.

Priority management species for the Harlan County Reservoir sport fishery, determined by population histories and angler preferences, are walleye, white bass, and channel catfish. Wipers are managed as a species with trophy potential with a low-density population goal. Crappie, largemouth bass, and northern pike are typically included in sport fishery management details when the reservoir is at higher elevations (1,940msl and above).

Table 4. Current Fish Harvest Regulations in Effect at Harlan County Reservoir

Species	Length Limit	Creel Limit
Channel Catfish	No minimum	5 fish daily creel limit
Flathead Catfish	No minimum; One 30 inches or longer	5 fish daily creel limit
Crappie	N/A	15 fish daily creel limit
Largemouth Bass	15-inch minimum; One 21 inches or longer	5 fish daily creel limit
Northern Pike	No minimum; One 34 inches or longer	3 fish daily creel limit
White Bass	No minimum; One 16 inches or longer	15 fish daily creel limit
Walleye	One from 15 to 18 inches and three longer than 18 inches OR four longer than 18 inches; No more than one 22 inches or longer	4 fish daily creel limit
Wiper	No minimum; One 16 inches or longer	15 fish daily creel limit

Note: Source: NGPC 2023

Angler Use

Creel surveys at Harlan County Reservoir started in 1988 and were completed annually, or every other year through 2017. Most of these surveys were completed from April-October. Starting in 2014, Harlan County Reservoir creel surveys were included in a statewide project coordinated with the Nebraska Cooperative Fish and Wildlife Research Unit (NECFWRU). Creel survey results since 2014 are available on a computer database system called “Crawdad”, which is maintained by NECFWRU and NGPC Fisheries IT staff in the Lincoln Office.

Because of reliability problems with early surveys, comparisons of fishing pressure and catch will be reported from 1992 through 2017 (Figure 8). Walleye, white bass, channel catfish make up the majority of fishing trips, comprising 84% of the total trips on average. The average annual percentages for angler trips seeking walleye, white bass, and channel catfish were 31%, 39%, and 14%, respectively. Average annual trips for anglers seeking walleye, white bass, and channel catfish were 8,533, 11,768, and 3,556, respectively.

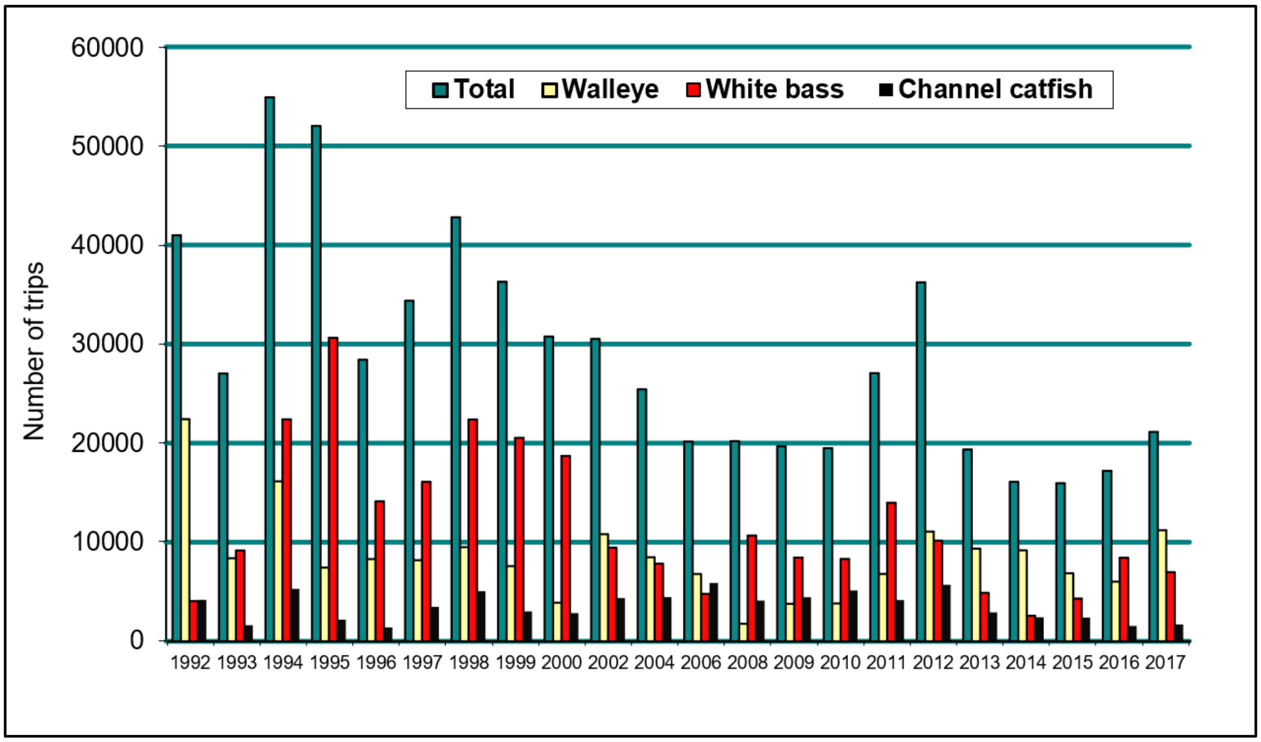

Figure 8. Estimated Angler Fishing Pressure in Trips (total and seeking walleye, white bass, and channel catfish) at Harlan County Reservoir, 1992-2017

For walleye, the long-term averages for annual catch and harvest were 12,748 and 2,834, respectively. Walleye catch and harvest were low from 2008 to 2010, but generally increased since 2010 (Figure 9).

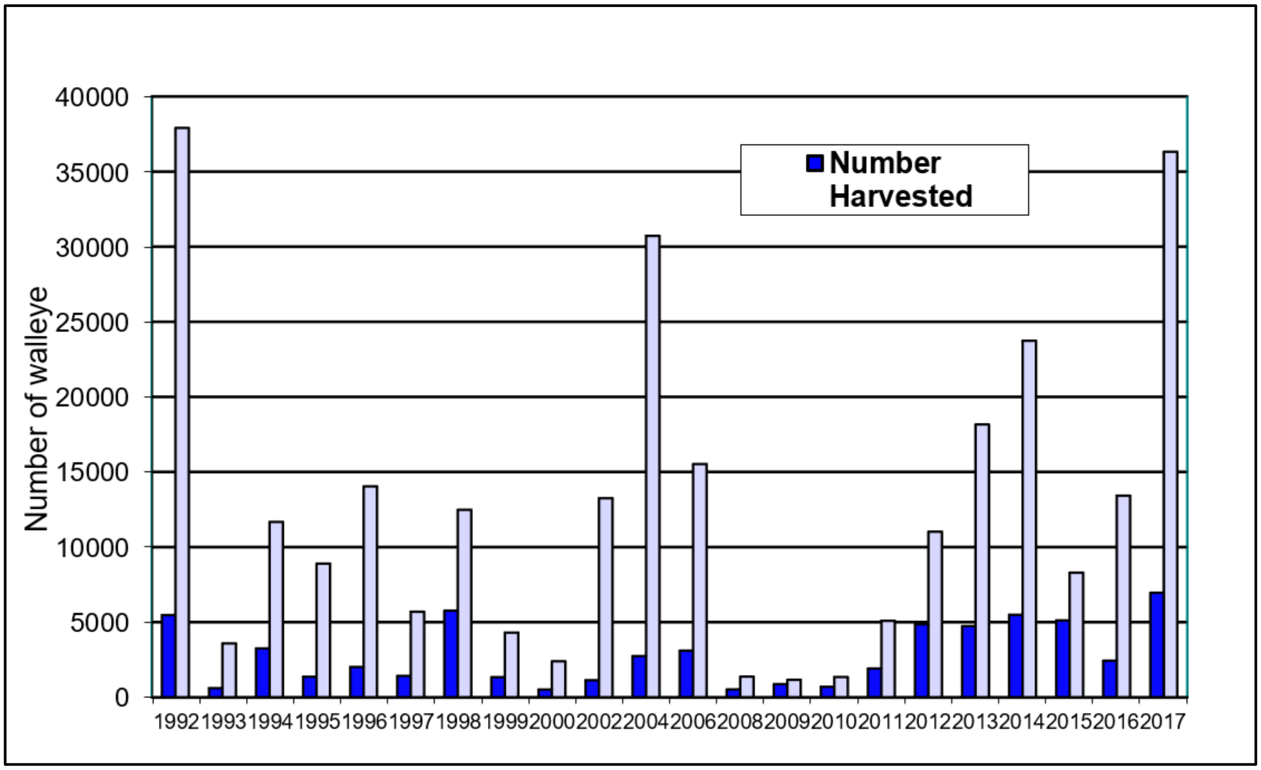

Figure 9. Estimated Angler Catch and Harvest of Walleye at Harlan County Reservoir, 1992-2017

For white bass, the long-term averages for annual catch and harvest were 91,065 and 46,563, respectively. White bass catch and harvest vary considerably over time with little association with population survey results (Figure 10).

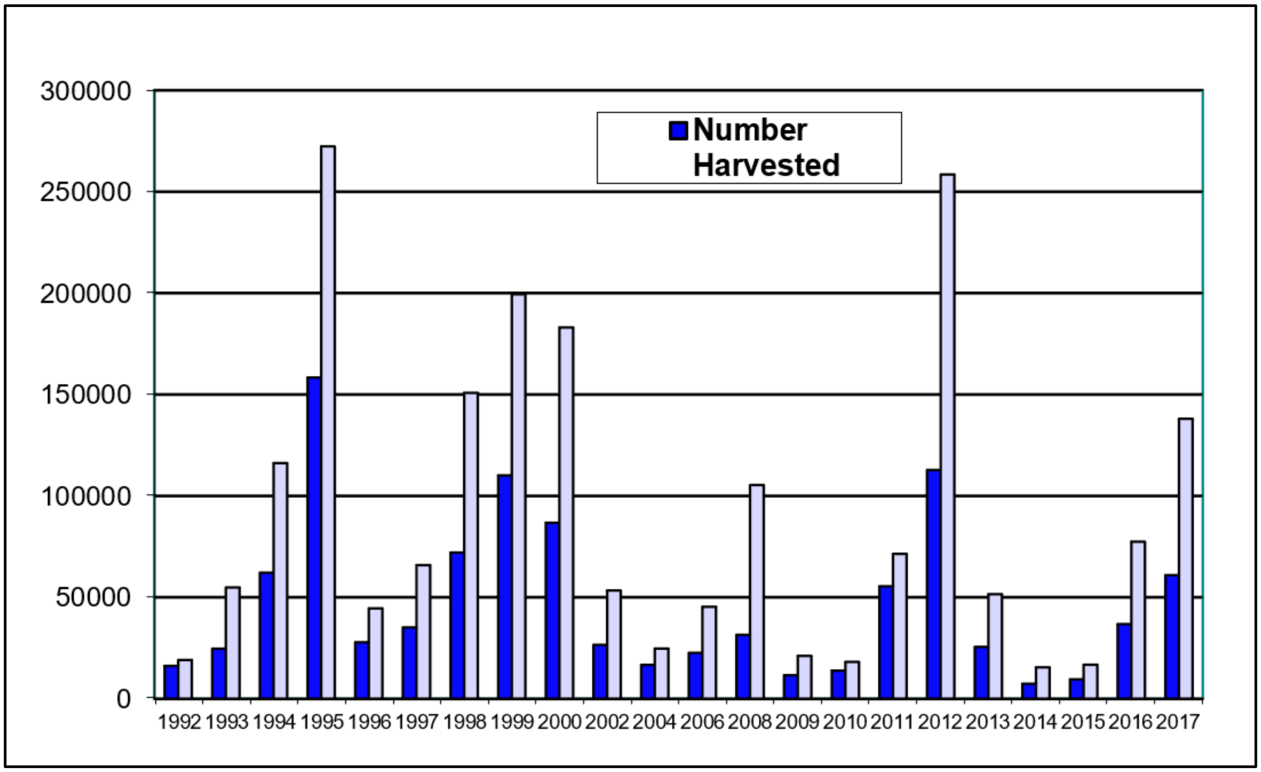

Figure 10. Estimated Angler Harvest and Catch of White Bass at Harlan County Reservoir, 1992-2017

Sportfish Population Dynamics/Trends

Walleye

From the 49-year history of gill net sampling walleye, no real trends are apparent. The 49-year average gill net catch was 11.8 walleye per net, with a range of 3.9 to 30.7. The highest walleye densities were sampled during the middle 1980's through the middle 1990's (Figure 11). Since then, the sampled walleye density has varied from about 5 to 15 walleye per gill net (Figure 11).

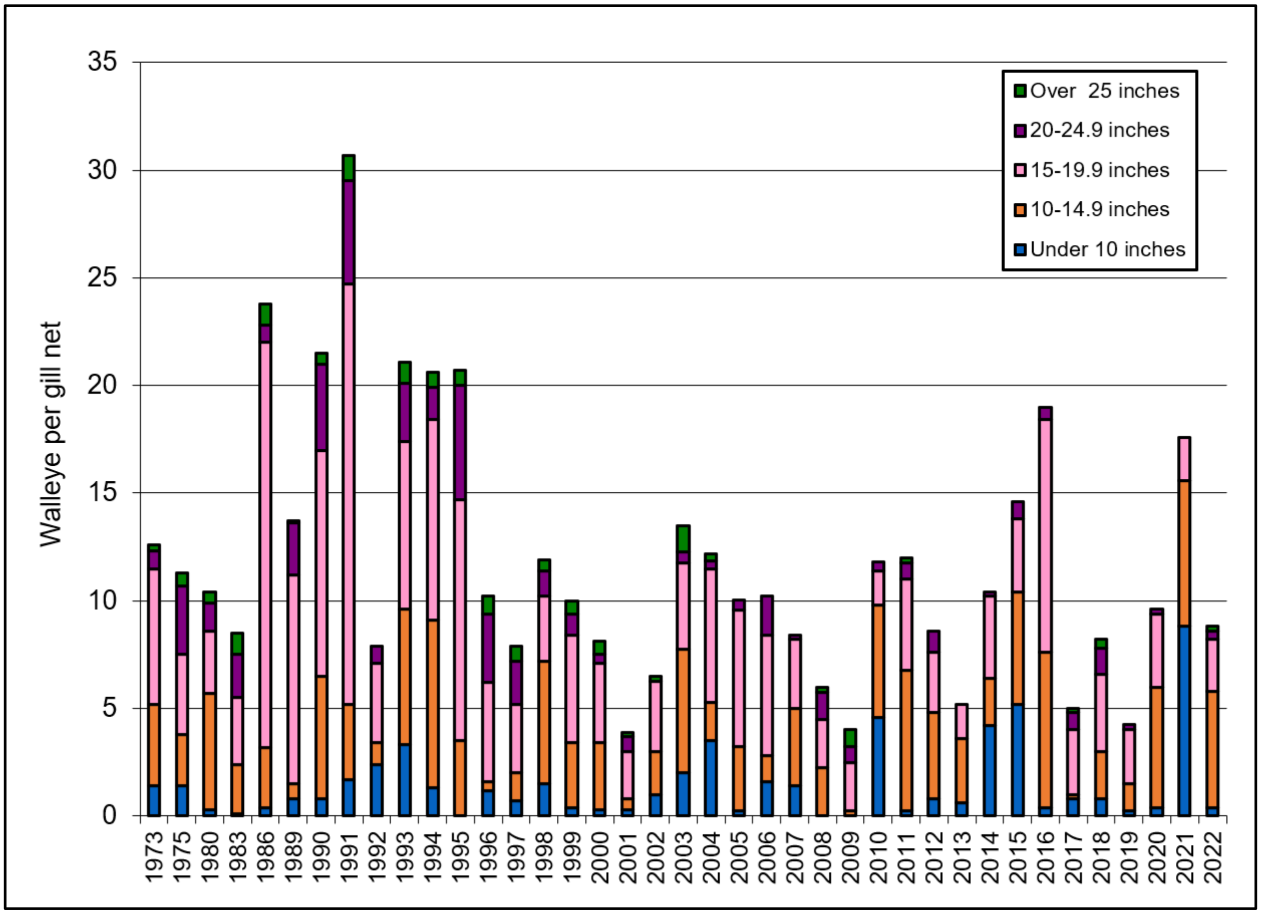

Figure 11. Annual Gill Net Sampling Results for Walleye at Harlan County Reservoir with Length Group Summaries, 1973-2022

White Bass

White bass catch has generally increased during the 49-year history of gill net surveys, but there are a few outlier low catches during the increasing trend (Figure 12). The schooling nature of white bass is a possible explanation of the outlier low net catches.

The 49-year average gill net catch was 18.7 white bass per net, with a range of 0 to 125. The highest densities of white bass were sampled after 2005. Since then, most surveys have catches above 20 white bass per net, with a few outlier catches below 10 (Figure 12).

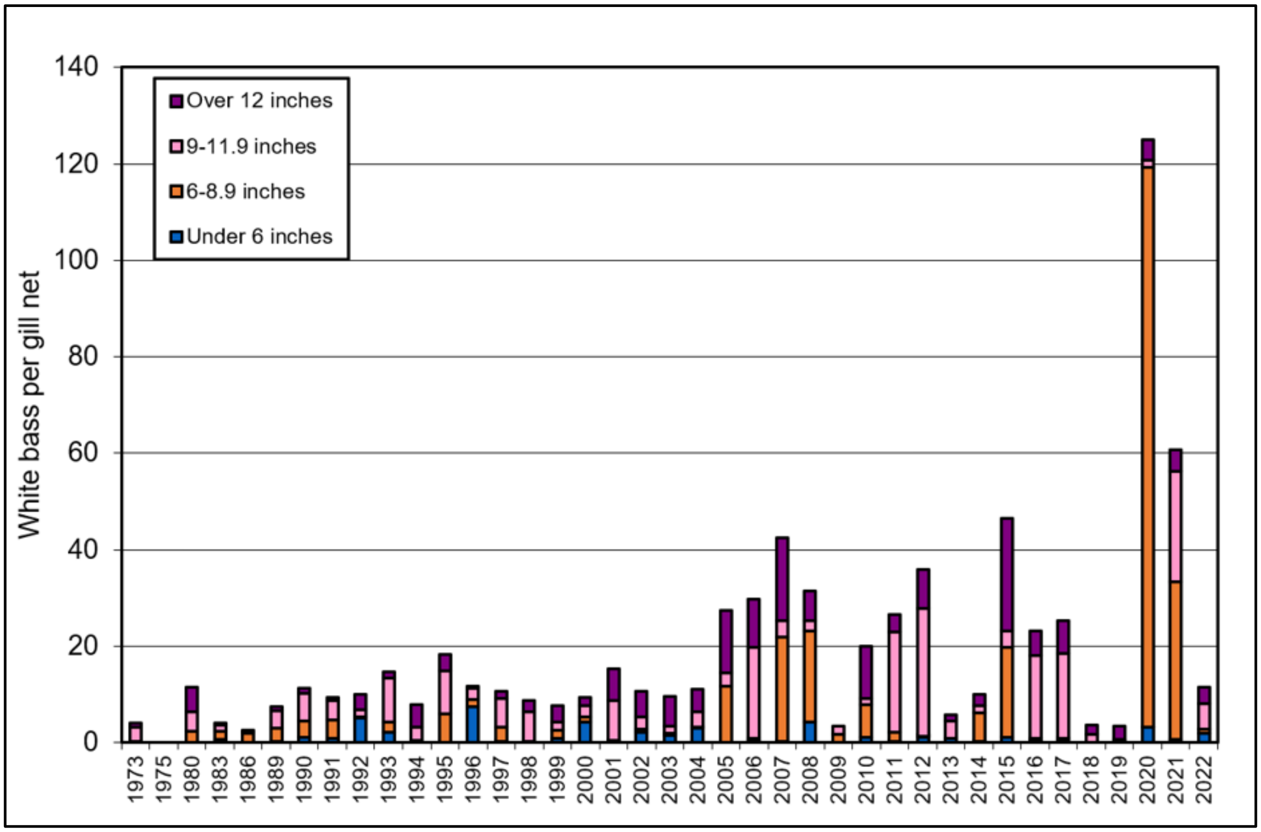

Figure 12. Gill Net Sampling Results for White Bass at Harlan County Reservoir with Length Group Summaries by Year, 1973-2022

Striped Bass Hybrids (Wipers)

Most years, stocking success and recruitment to the sport fishery has been very low and highly variable (Figure 13). That pattern changed with excellent success of wiper fry stockings in 2017, 2018, and 2021.

Most years, total gill net CPUE was below five fish per net, with high catches near 10 fish per net. Excellent survival of wiper fry stockings in 2017, 2018, and 2021 resulted in much higher gill net catches of wipers (Figure 13). Wiper fry were stocked at about 200 fry/acre in 2017 and 2018 but were reduced to 75 fry/acre in 2021. In 2017, the fish were all stocked in Gremlin Cove due to water temperature concerns. In 2018 and 2021 all wipers were boat stocked.

Since wiper fry stocking was initiated in 2017, fall gill net catch has ranged from 2.0 to 54.2 wipers per net (Figure 13). Average gill net catch the past six years is 25.8 fish/net compared to only 1.8 fish/net during the 1990 to 2016 timeframe. Due to current high densities of wipers present in Harlan County Reservoir, stocking strategies have been altered to reduce abundance. Considering the management goal for wipers at Harlan County Reservoir is to maintain a low-density population with trophy potential for anglers, current stocking plans now recommend stocking wiper fry every third year at a rate of 75 fry/acre. Wiper fry are scheduled to be stocked again in 2024.

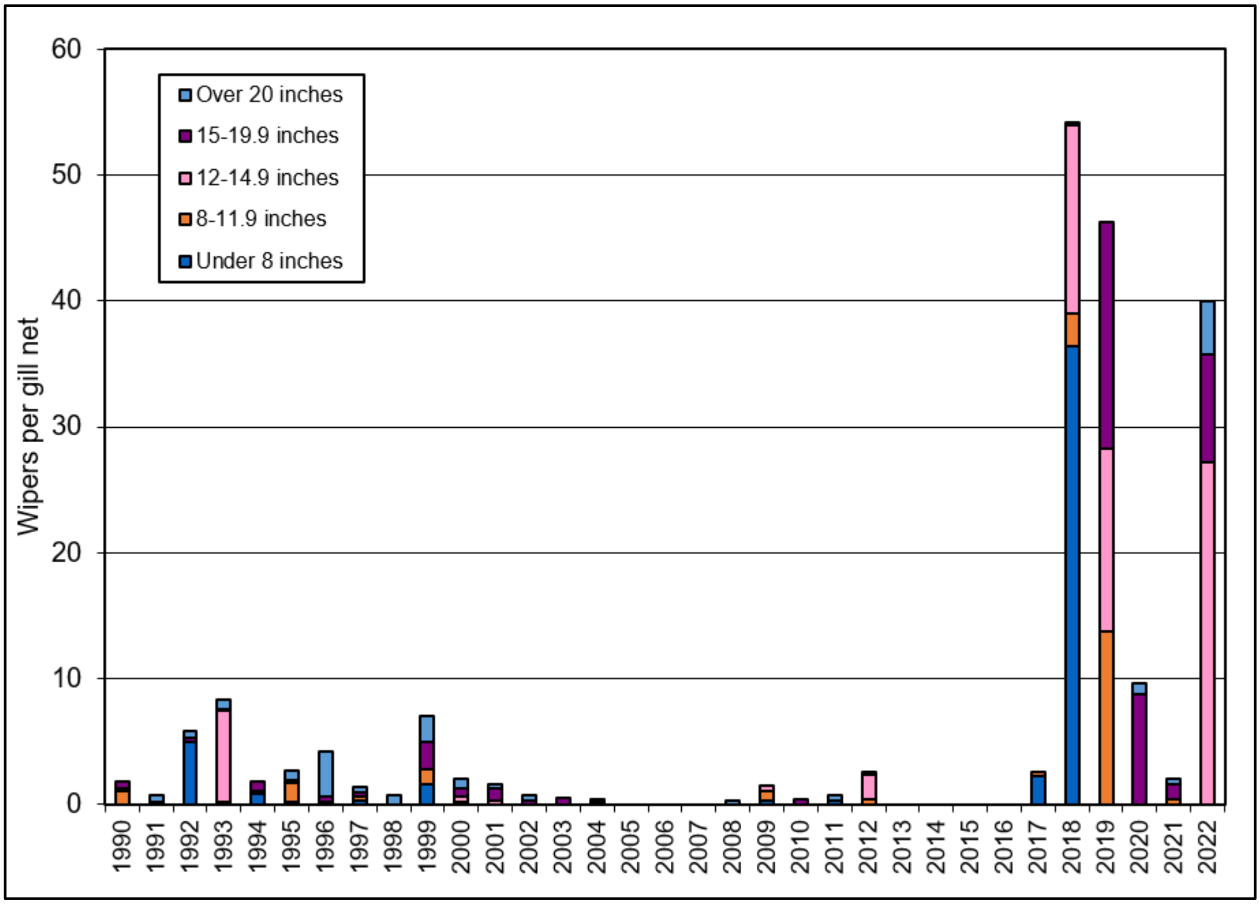

Figure 13. Gill Net Sampling Results for Wipers at Harlan County Reservoir With Length Group Summaries by Year, 1990-2022

Channel Catfish

Channel catfish are native to the Republican River watershed but were also stocked in Harlan County Reservoir in the 1950's and 1960's. Natural recruitment has mostly supported the Harlan County Reservoir channel catfish population since that time. Supplemental stocking has been used to increase the catfish population when gill net surveys indicate a downward population trend (2001-2006 and 2013-2019, Figure 14). Advanced fingerlings from 5 to 10 inches long have been used for these supplemental stockings.

There are no length limit restrictions on channel catfish at Harlan County Reservoir. There is a daily bag limit of five channel catfish in the reservoir, while the daily bag limit is 10 channel catfish in the Republican River upstream of where the Republican River crosses Highway 89 west of Orleans. All anglers must follow the reservoir bag limits while on the reservoir, even if they traveled to the river to fish. The spillway below Harlan County Dam is also regulated with the 10 fish daily bag for channel catfish (as well as all other statewide fishing regulations).

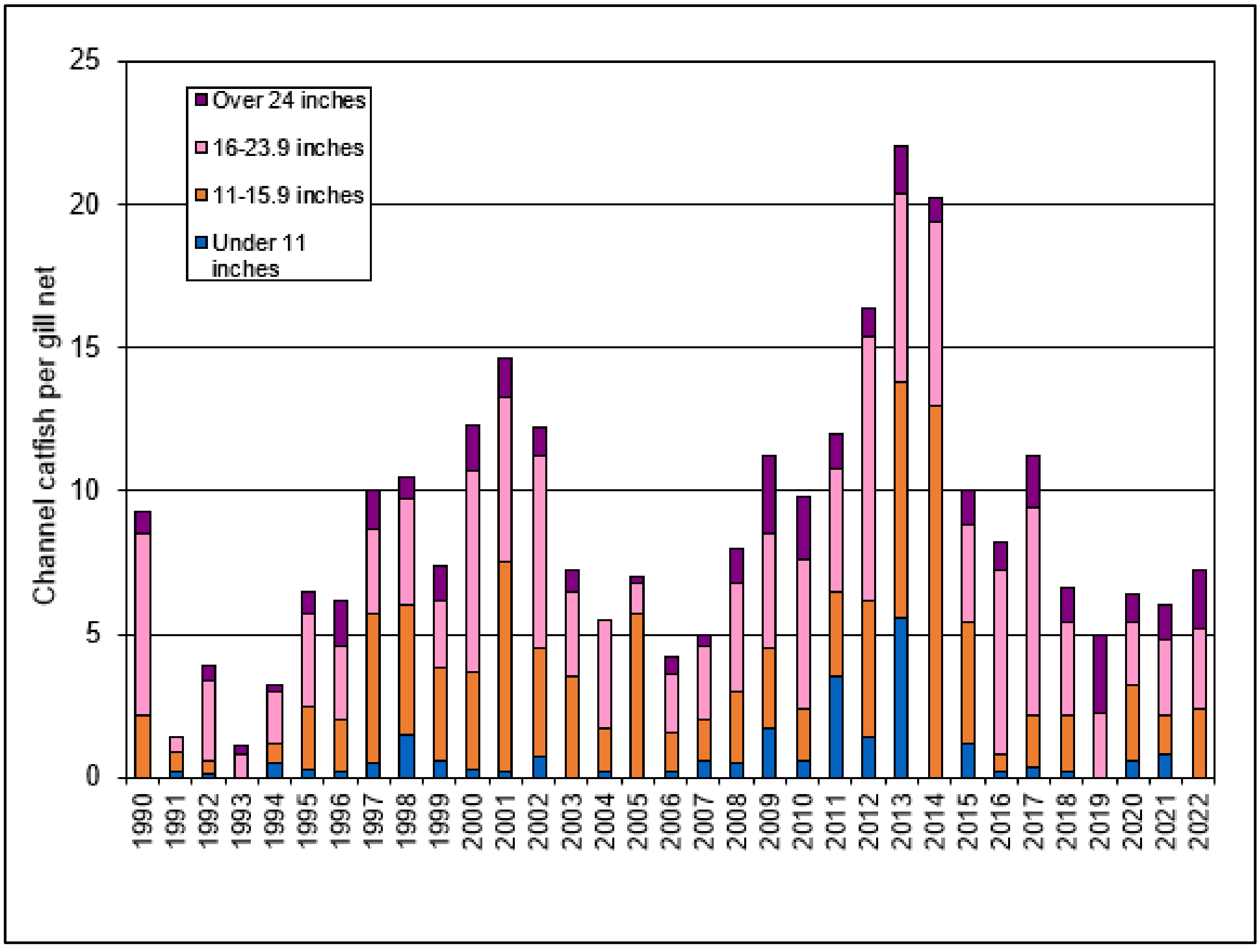

Figure 14. Gill Net Sampling Results for Channel Catfish at Harlan County Reservoir With Length Group Summaries by Year, 1990-2022

Other Sportfish Species

Several shoreline-oriented fish species are managed temporally in Harlan County Reservoir. When reservoir elevations are high (above 1,940' msl), stocking of black crappie, largemouth bass, and northern pike are requested to utilize normally abundant flooded terrestrial vegetation.

Due to hatchery availability, tiger muskie stockings replaced the requested northern pike stockings in 2019 and 2020.

Future Without Project Projections

Large water level fluctuations are likely to continue as this reservoir serves multiple purposes including reducing flood risk and providing irrigation. These circumstances create challenges at low water levels including reduced connectivity with cove habitat, which reduces spawning and rearing habitat for shoreline orientated species such as crappie, largemouth bass, and bluegill. Low water levels can also increase the chances of harmful algae blooms and fish kills while decreasing user access and recreational opportunities. Extremely high-water levels (above conservation pool) can present challenges as well including excessive shoreline erosion and damage to infrastructure such as breakwaters, fishing piers, and boating access developments. Harlan County Reservoir is also used as the storage reservoir for water dedicated to the Republican River compact between Colorado, Nebraska and Kansas, which tends to lead to increased water releases during the time of the year when small fish are vulnerable to entrainment.

Addressing erosion and disconnection of cove habitat has been a priority at Harlan County Reservoir. For example, a large aquatic habitat project was completed in 2012-2013 at Gremlin and Patterson Coves, which included bank stabilization, protection breakwaters, dredging, and angler access improvements. This project was planned and funded by NGPC through the Aquatic Habitat Program. A second aquatic habitat project was initiated in 2022 and is currently in the planning phases with USACE Continuing Authorities Program Section 1135 Ecosystem Restoration funding. This goal of this project is to improve habitat and connectivity at Methodist Cove, which is located on the northwest edge of the reservoir.

The introduction of invasive species is also a concern at Harlan County Reservoir. Although zebra and quagga mussels have yet to be detected in Harlan County Reservoir, these invasives are common in nearby Kansas reservoirs posing a potential future threat to the aquatic resources, infrastructure, and recreational opportunities in this reservoir. Continued monitoring and outreach/education efforts will be important for minimizing the potential for future introductions.

Despite the challenges discussed here, Harlan County Reservoir provides valuable benefits to both humans and fish and wildlife. The Nebraska Game and Parks Fisheries Division will remain committed to managing aquatic resources at Harlan County Reservoir including but not limited to stocking fish, evaluating fish population surveys, conducting aquatic-based research, improving and maintaining aquatic habitat, improving and maintain angler access and providing law enforcement.

References

Olds, B.P., B.C. Peterson, K.D. Koupal, C.W. Schoenebeck, K.M. Farnsworth Hoback, and W.W. Hoback. 2014. Zooplankton density increases in an irrigation reservoir during drought conditions. Transactions of the Nebraska Academy of Sciences and Affiliated Societies 34:27-32.

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RESERVOIR FISHERIES

USBR RESERVOIRS

Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery
Location: Cedar Bluff Reservoir
Dave Spalsbury, KDWP District Fisheries Biologist

Cedar Bluff Reservoir located on the Smoky Hill River in southeast Trego County, Kansas

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History

View of Cedar Bluff Reservoir from downstream of the dam

Cedar Bluff Reservoir is an impoundment on the Smoky Hill River located in southeastern Trego County, Kansas. As a result of severe droughts in the 1930's, the U.S. Bureau of Reclamation (USBR) initiated investigations in 1939 for potential construction of the new reservoir. These and subsequent investigations led to authorization to construct the reservoir as part of the Missouri River Basin Project, a subsidiary of the Pick-Sloan plan, by the Flood Control Act of 1944. Construction of Cedar Bluff Dam began in 1949 and was completed in 1951 (USBR, 1949).

Water Allocation Background

Cedar Bluff Reservoir was constructed by USBR as a multipurpose facility for flood control, irrigation, recreation, municipal water supply, as well as fish and wildlife purposes.

The City of Russell, Kansas entered into contract 14-06-700-3930 (later renumbered 3-07-70-W0079) for municipal water supply with the USBR in 1963. The City obtained Water Right File Number (No.) 7,628 from the Chief Engineer of the Kansas Department of Agriculture, Division of Water Resources in 1957 to authorize the proposed use. Cedar Bluff Reservoir and associated works operated for each of the originally authorized purposes until 1978 when the last delivery of irrigation water was made because of a lack of dependable water supply available (USBR 2003).

In 1987, the U.S. Department of the Interior, the State of Kansas, and the Cedar Bluff Irrigation District No. 6 entered into a Memorandum of Understanding (1987 MOU; USBR 1987) establishing an intent for reformulation and operation of the Cedar Bluff Unit (i.e. unit includes the watershed, reservoir, and irrigation infrastructure) contingent upon Congressional legislation.

Contract 9-07-60-W0387 was entered into by the State of Kansas and USBR in 1989, transferring ownership of the water rights held by the Cedar Bluff Irrigation District No. 6 (Water Right File No. 7,684) and U.S. Department of the Interior, Fish and Wildlife Service (USFWS) (Water Right File No. 7,627) to the State of Kansas in accordance with the 1987 MOU.

Contract 9-07-60-W0387 established four distinct operation pools within the multipurpose pool of Cedar Bluff Reservoir as shown on the following table:

Table 1. Original Pool Ownership

Pool Owner	Purpose	Pool Size (acre-feet [af])
City of Russell	Municipal Water Supply	2,700
Kansas Water Office (KWO)	Artificial Recharge	5,400
Kansas Department of Wildlife and Parks (KDWP)	Fish, Wildlife and Recreation	21,639
KWO & KDWP	Joint Use	147,090
Total		176,829

The United States Congress passed Public Law 102-575, Title IX, Section 901 in 1992 authorizing the reformulation of the Cedar Bluff Unit, including Cedar Bluff Reservoir.

An Operations Agreement for Cedar Bluff Reservoir was entered into February 4, 1994, by the Kansas Water Office and the KDWP concerning the management of the designated operating pool and the joint use pool of Cedar Bluff Reservoir.

In furtherance of Contract 9-07-60-W0387, the State of Kansas sought changes to water right Nos. 7,627 (USFWS, reallocation of storage for the former federal fish hatchery) and 7,684 (Cedar Bluff Irrigation District No. 6) in 1995 to reflect the reformulated uses. The reformulated uses include moving 10,739 acre-feet (af) from Water Right File No. 7,627, and 5,400 af from the Cedar Bluff Irrigation District No. 6, to Water Right File No. 7,684. The reformulated pool ownership is included in Table 2. The changes were approved by the Chief Engineer of the Division of Water Resources in 1996.

Table 2. Reformulated Water Right Pools

Priority of Fill	Water Right File No.	Pool	Holder	Quantity (af)
1	7,627	Fish, Wildlife and Recreation	KDWP	10,900
2	7,628	Municipal Water Supply	Russell	2,700
3	7,684	Artificial Recharge Fish, Wildlife and Recreation Joint Use	KWO & KDWP	163229
Total				176,829

In 2003 an MOU further defined the accounting procedures to be used for storage at Cedar Bluff Reservoir. The allocations of available storage were finalized, and a monthly accounting is provided by the Kansas Water Office.

Storage Loss to Sediment

Periodically, USBR will conduct sediment surveys of Cedar Bluff Reservoir to determine the amount of storage that is available in the multipurpose pool. A sediment survey was completed in 2000 which indicated that a total of 12,608 af of sediment had been deposited in Cedar Bluff Reservoir. Of this total, 8,779 af of sediment was deposited in Cedar Bluff Reservoir between the elevations of 2090.00 and 2144.00. According to the data the flood pool gained 30 af of space and the pool below elevation 2090.00 lost 3,859 af of space.

Storage lost to sediment deposition is not deducted from the KDWP pool, Water Right File No. 7,627 or the City of Russell's pool, Water Right File No. 7,628. The pools associated with these remain at 10,900 af and 2,700 af, respectively. Storage lost to sediment deposition is deducted from the pools with storage covered by Water Right File No. 7,864 (KWO, KDWP, Joint Use), based on the percentages as shown in Table 3.

Table 3. Pools for Water Right File No. 7,684

Water Right No.	Pool	Holder	Percentage Inflow	Quantity (af)
7,684	Artificial Recharge	KWO	3.31 %	5,110
	Fish, Wildlife and Recreation	KDWP	6.58 %	10,161
	Joint Use	KWO& KDWP	90.11 %	139,179
	Total			154,450

Source: USBR 2003

The following table indicates the incorporation of the 2000 sediment data according to water right.

Table 4. Water Right Pools (including 2000 Sediment Survey)

Priority of Fill	Water Right File No.	Pool	Holder	Quantity (af)
1	7,627	Fish, Wildlife and Recreation	KDWP	10,900
2	7,628	Municipal Water Supply	Russell	2,700
3	7,684	Artificial Recharge Fish, Wildlife and Recreation Joint Use	KWO & KDWP	154,450
Total				168,050

Cedar Bluff Reservoir Fishery

Fisheries Establishment

Tables 5 and 6 provide lists of sport fish and non-sport fish in Cedar Bluff Reservoir. Most of the extant (i.e. still present) sportfish species that currently inhabit Cedar Bluff Reservoir were stocked within the first decade of post-impoundment. Yellow perch, northern pike, and striped bass, first stocked in 1954, 1962, and 1968, respectively, are considered extirpated from the fish community as none have been detected in sampling efforts conducted over at least the past ten years. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the *Sportfish Population Dynamics & Trends* section.

Table 5. Sport Fish Species Known to Inhabit Cedar Bluff Reservoir

Sport Fish	
Common Name	**Scientific Name**
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieu*
Spotted Bass	*Micropterus punctulatus*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*

Sport Fish	
Common Name	**Scientific Name**
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 6. Non-Sport Fish Species Known to Inhabit Cedar Bluff Reservoir

Common Name	Scientific Name
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Fathead Minnow	*Pimephales promelas*
Goldfish	*Carassius auratus*
Golden Shiner	*Notemigonus crysoleucas*
Orangespotted sunfish	*Lepomis humilus*
Log Perch	*Percina caprodes*
Plains Killifish	*Fundulus zebrinus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Suckermouth Minnow	*Phenacobius mirabilis*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. General Limnology

The impounded lake that is Cedar Bluff Reservoir has been characterized as mesotrophic (lakes with an intermediate level of productivity). Mesotrophic lake status generally results in lower standing biomass of the fish population and slower fish growth as compared to lakes characterized by high primary productivity. Given the prevalence of wind, the open topography of the landscape, and fluctuating water levels, the lake is weakly dimictic (having two thermal overturns per year) at higher pool elevations to polymictic (waters circulate continuously) at lower pool elevations (Carney, 2010). Water column circulation pattern and resulting thermal stratification regime tends to influence fish behavior in that fish tend to avoid occupying the hypolimnion (the lowest layer of water in a stratified lake) for extended periods due to reduced dissolved oxygen levels. At Cedar Bluff Reservoir when dimictic circulation patterns occur, fish tend to occupy the upper 25 feet of the water column in summer. However, in the absence of thermal stratification fish utilize the entire water column. Mean secchi disc (used to measure transparency of water) readings over the past 10 years have been 149 cm (58.7"), indicating that water transparency has been relatively clear at Cedar Bluff Reservoir over the recent past. At low reservoir pool elevations, wind-driven currents disturb a greater percentage of the reservoir basin and suspend bottom sediments resulting in increased turbidity. Increased turbidity can reduce feeding efficiency of sight feeding predators and reduces the maximum depth at which submerged aquatic vegetation can establish. The general limnological parameters characteristic of Cedar Bluff Reservoir are shown in Table 7.

Table 7. General Limnological Parameters Characteristic of Cedar Bluff Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	6869.0
Max depth	feet	69.2
Mean depth	feet	30.0
Mean annual precipitation	inches	20.98
Mean annual runoff	inches	92.2
Area watershed drainage	square miles	5391.4
Hydrologic residence time	days	902.0
Chlorophyll a	parts per billion	3.8
Secchi depth	centimeters	149.0
Shoreline development index	ratio	4.3
Agricultural lands	%	52.1
Forest habitat	%	0.1
Grassland habitat	%	44.3
Urban lands	%	2.8
*Trophic state index		43.5

Note: *****Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

Cedar Bluff Reservoir generally possesses adequate water quality to promote sportfish survival. Turbidity is low as evidenced by mean secchi disc measurements (Table 7). Indices relative to specific conductivity and total dissolved solids (TDS) are normally high and become extremely concentrated as the reservoir volume decreases. As discussed in the *Invasive/Exotic Species* section degraded water quality occurs in localized areas as residual vegetation decomposes mostly during warm water periods.

2. Water Level Fluctuations

Proliferation of groundwater mining from the Ogallala Aquifer to supply water for agricultural irrigation, that principally occurred from 1960 to 1980, has led to decreased flow in the Smoky Hill River basin in western Kansas (Buchanan et al., 1998). This reduced flow in the Smoky Hill River has resulted in a widely fluctuating reservoir pool (Figure 1). Reallocation of stored water in Cedar Bluff Reservoir reduced water withdrawals such that evaporation and seepage are currently the two primary losses of water from the reservoir pool. Reductions in inflow from reduced inflows, coupled with decreased discharge results in a slow water level decline over a multiple year timeframe, punctuated by periods of water level stability in some years. However, net water level decline is generally the norm in most years. Timing and duration of water level decline is variable and depends upon precipitation and thus inflow patterns but is generally most rapid during summer and fall. However, cyclic periods of increased precipitation occur approximately every 20 to 30 years, resulting in increasing reservoir pool elevation followed by the cycle of slow declines.

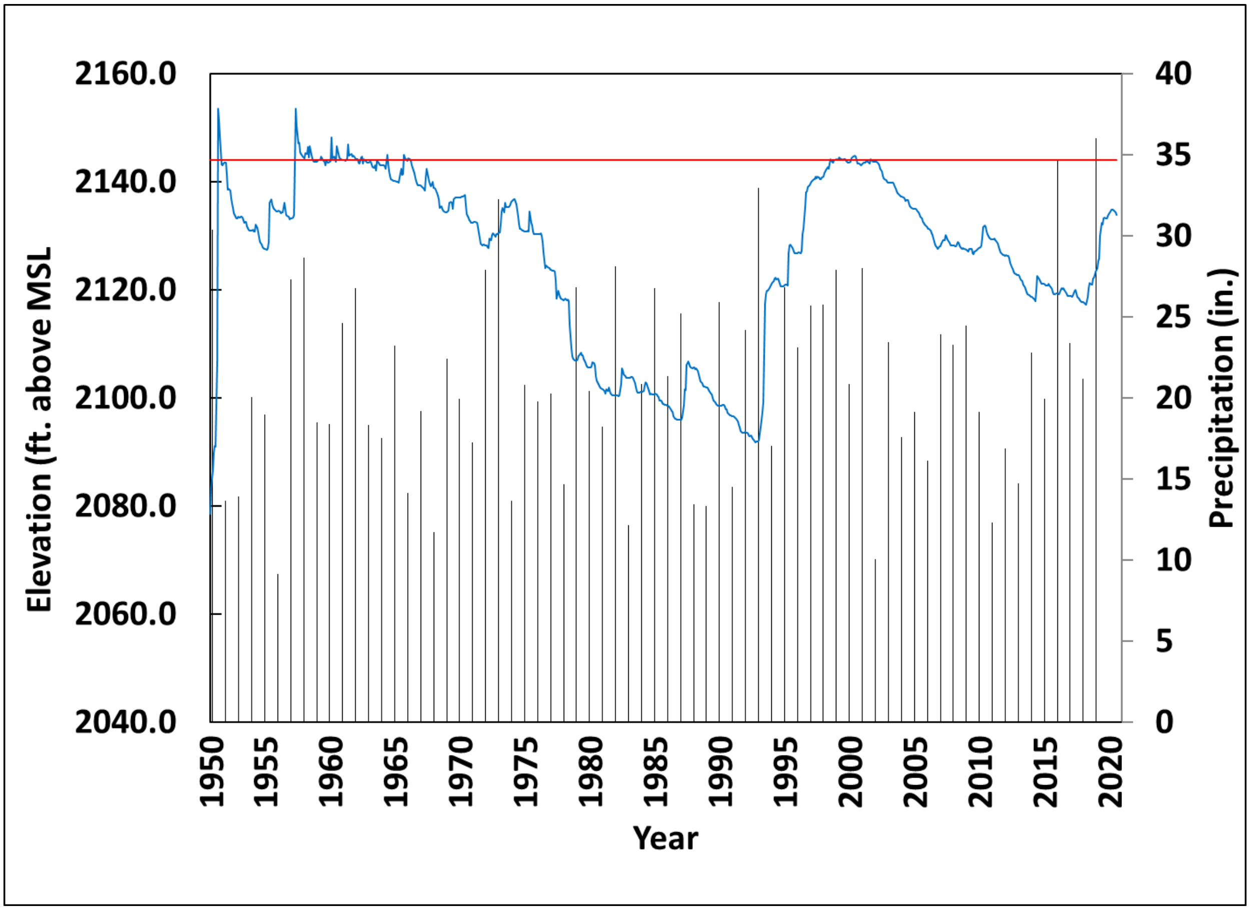

Figure 1. Cedar Bluff Monthly ending reservoir pool elevation 1950 – 2020. Monthly ending reservoir pool elevation (feet above mean sea level, MSL) [blue line] in relation to full conservation pool elevation [red line] and total annual precipitation [vertical columns] recorded by USBR at Cedar Bluff Reservoir from 1950 to 2020.

Characteristic of, but not limited to Cedar Bluff Reservoir the commonly shrinking reservoir pool often leaves large areas within the basin dewatered for a number of years and allows establishment of terrestrial vegetation. Inundation of vegetation during periods of increased precipitation can increase habitat availability for sportfish. Substantial water level rises promote increased primary productivity resulting from the trophic upsurge associated with flooding of the dewatered reservoir basin. This and change in reservoir trophic status, results in a shift in sportfish species dominance. This translates into increased sportfish body condition and growth. Improved welfare of structure-oriented species occurs until habitat degradation (decomposition) or reduced water availability (receding levels) again limits production and recruitment of this sportfish assemblage. In contrast, primary productivity is reduced during years of declining reservoir levels due to a lack of nutrient input from the watershed above. When suitability or availability of flooded terrestrial vegetation declines, dominance of open-water sportfish increases.

Reduced flow in the Smoky Hill River upstream of Cedar Bluff Reservoir can lead to decreased connectivity between the reservoir and the river. Because of this, channel catfish, and possibly other riverine species, experience decreased production of young, thus fewer individuals recruiting to the fishery, and ultimately fewer adult fish in the future. Seepage of reservoir water through the dam stabilizes and supplements flow in the river immediately downstream of the dam. Periodic water releases from the reservoir recharge the cities of Hays and Russell wellfields, as well as other points of diversion. Releases help maintain aquatic communities downstream, but poorly timed releases can impact sportfish reproduction and retention of adult sportfish in the reservoir. For example, during 2013 water was released from Cedar Bluff Reservoir from March 4-18. This timeframe corresponds to the early portion of the walleye spawn. Walleye typically concentrate near the dam to deposit fertilized eggs on riprap on the dam face. Close proximity of spawning adults and hatching fry to the dam toe drain likely entrained individuals of both life stages flushing them from the reservoir.

Cedar Bluff Reservoir water level history over the past decade has fluctuated dramatically. On January 2011 pool elevation was 2129.33' above mean sea level (MSL) (14.67 ft below full conservation pool). A severe drought pattern began in 2011 and resulted in rapid water level decline. Drought conditions eased in the latter half of 2015, slowing the rate of reservoir decline. By April 2018, reservoir pool elevation had declined to 2117.18 ft above MSL (26.82 ft below full conservation pool). Beginning May 2018, the Cedar Bluff Reservoir watershed experienced a period of above average rainfall that increased inflow into the reservoir and effectively increased pool elevation to 2134.74 ft above MSL (9.26 ft below full conservation pool) by the end of March 2020. Extended periods of excessive precipitation are necessary to recharge baseflow in the Smoky Hill River lost to anthropogenic and phreatophyte demands, resulting in inflow sufficient to boost reservoir storage (Figure 2).

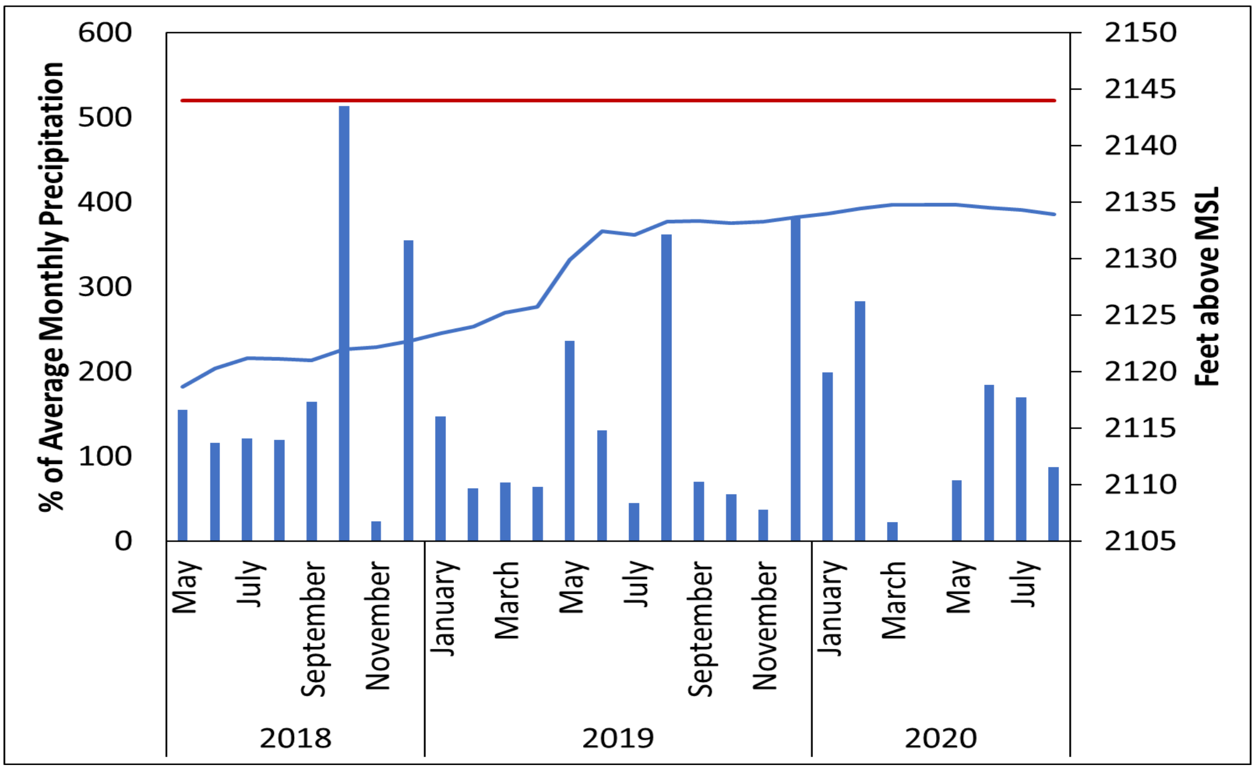

Figure 2. Monthly ending reservoir pool elevation (blue line) in relation to full conservation pool elevation (red line) and ratio observed to average monthly precipitation [vertical columns] recorded by USBR at Cedar Bluff Reservoir from 2018 to 2020.

3. Sedimentation

Geology of the Cedar Bluff area consists of the Blue Hill Shale member of the Carlisle Shale Formation overlaid by the Fort Hays Limestone member of the Niobrara Chalk formation. Terrace deposits of river alluvium silt, sand, and gravel are interspersed over portions of the Blue Hill Shale underlying the reservoir (Hodson, 1965). Fine-grained mud sediments are derived from local soil types of the Armo-Heizer-Brownell soil complex (Watts, et al. 1990).

Namesake Bluffs comprised of Fort Hays Limestone overlaying the Blue Hill Shale

As discussed previously, sediment surveys show that sedimentation is occurring in Cedar Bluff Reservoir (12,608 af of sediment) and that storage within the multipurpose pool has been lost. A primary source of autochthonous sedimentation (formed in situ, or on the spot; authigenic (Cole, G.A. 1994. Textbook of Limnology, 4th ed. Waveland Press, Prospect Heights, Illinois, USA)) results from wind-driven erosion of shorelines, redistribution, and deposition of sediment within the basin. Sedimentation derived from allochthonous (refers to something being formed elsewhere and transported to the site in question; allochthony (Cole, G.A. 1994. Textbook of Limnology, 4th ed. Waveland Press, Prospect Heights, Illinois, USA)) sources has been reduced at Cedar Bluff Reservoir given reduced inflow from the Smoky Hill River. Although sediment is minimized due to reduced inflow to the reservoir, the reservoir acts as a sediment trap, reducing sediment deposition in the river downstream of the dam. Given fluctuating water levels, shoreline erosion occurs over a wide margin of the reservoir basin. A secondary source of sedimentation results from biological processes. Detritus derived from dead plankton, aquatic vegetation, and flooded terrestrial vegetation also contributes to sedimentation and further precipitation of calcium carbonate by photosynthetic activity of phytoplankton results in a minor contribution to in-basin sedimentation.

Exposed lake basin sediments during periods of dewatering from reduced flows are subject to weathering from wind, rain, freeze-thaw processes, and oxidation. Weathering processes remove fine bioaccumulation and sediments from larger grain sediments. Oxidation of nitrogen and phosphorus compounds associated with sediments make nutrients available to vegetation.

Characteristic geology of the Cedar Bluff Reservoir basin results in the patchy spatial distribution and relatively abundant availability of a wide particle size within the context of a basin consisting of mud to sand and gravel. Reservoir bottom substrate primarily consists of soil derived mud, alluvial sand, Blue Hill Shale outcrops, and weathered Fort Hays limestone varying from gravel to boulder particle size. Ecological relationships with most systems are complex, thus what is provided below are specific examples and do not portend to represent a comprehensive characterization of the aquatic food web present at Cedar Bluff Reservoir. Mud substrates provide areas for growth of submerged and emergent aquatic vegetation. These areas act as predator avoidance habitat where small fish can hide yet act as foraging areas for larger piscivorous sportfish. Further, mud substrates are colonized by burrowing invertebrates that provide a forage resource to benthic feeding fish such as channel catfish and river carpsucker. Rock and aquatic vegetation provide substrate for attachment to be colonized by various other taxa typically of lower trophic guilds. Again, benthic feeding fishes will forage on attached algae and associated macroinvertebrates. Sportfish such as smallmouth bass and spotted bass forage on crayfish that utilize rock as predator escape habitat and foraging habitat. Many sportfish such as walleye, white bass, black bass and Centrarchid sportfish prefer to deposit eggs on clean, larger-grain substrates to avoid suffocation of eggs by silt. Thus, availability and diversity of rock substrate is important to successful reproduction of these and other fish species, including those that occur at Cedar Bluff Reservoir.

4. Vegetated Fisheries Habitat

Vegetated fisheries habitats occurring in and adjacent to Cedar Bluff Reservoir consists of terrestrial, emergent, and submergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. Subsequent to flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

B. Emergent

Common reed (*Phragmites australis*), cattails (*Typha* spp.), sedges (Cyperaceae *sp.*) and rushes (Juncaceae *sp.*) are the primary emergent aquatic vegetation species. Sedge and rush abundance and their distribution is relatively limited. Cattails were once abundant primarily at the upper end of the reservoir, but their abundance and distribution has become more limited due to competition with common reed, an aggressive non-native species. Common reed abundance has increased greatly and will likely continue to expand in distribution, especially occupying areas of the lake basin subject to flooding. Common reed seed germinates on moist soil to colonize recently dewatered shores in the fall. Once established, common reed can tolerate either dry soil and flooding to a degree. Common reed is capable of establishment through fragmentation and rapid stolon growth allowing common reed to “follow” the declining reservoir water levels.

The first season post-flooding, common reed is capable of culm elongation, sufficient to survive in water depths up to approximately 13 feet. However, in subsequent years common reed appears capable of surviving to depths of 9 to 10 feet, as observed in 2019-2020. Based on observations in 2019-2020 continued inundation of common reed stressed and weakened the plant as stands in deeper water decreased in stem density. Flooded emergent aquatic vegetation provides nutrient input, substrate for periphyton and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of emergent vegetation and increased biological oxygen demand can cause hypoxia in areas of dense stands of vegetation during the summer.

C. Submergent

Submergent aquatic vegetation can establish considerable beds in the littoral zone (zone of shallow water along of shore of the reservoir) of the reservoir. Coontail (*Ceratophyllum demersum*), Sago pondweed (*Potamogeton pectinatus*), American pondweed (*Potamogeton nodosus*), curly leaf pondweed (*Potamogeton crispus*), and Eurasian watermilfoil (*Myriophyllum spicatum)* constitute the most common submergent vegetation species at Cedar Bluff Reservoir. Curly leaf pondweed and Eurasian milfoil are not native to the area, however, regardless of native status, presence of all submerged aquatic vegetation species help diversify littoral zone habitats within the reservoir and provide rearing habitat for young fish and foraging areas for adult fish. Submerged aquatic vegetation beds create shade, thus lowering water temperature immediately below the beds, providing thermal refuge to fish during the summer. Submerged aquatic macrophyte beds also provide fish concealment from avian predators.

6. Invasive/Exotic Species

A. Phreatophyte (deep root system that draws its water supply from near the water table) Encroachment

Although native to the area, cottonwood (*Populus deltoides*), and peachleaf willow (*Salix amygdaloides*) abundance has increased along the riparian zone of the Smoky Hill River and tributaries, due primarily to fire suppression since the mid to late 1800's. Non-native saltcedar (*Tamarix ramosissima Ledeb*) was introduced to the United States as an ornamental and has also established itself in the Cedar Bluff Reservoir watershed (USDA National Invasive Species Information Center website). High abundance of phreatophytes in the riparian corridor has contributed to reduced flow in the Smoky Hill River through increased evapotranspiration rates.

B. Common Reed Encroachment

Aerial view of the upper end of Cedar Bluff Reservoir showing near monoculture infestation of common reed.

Common reed has formed large, monoculture stands. Rapid colonization and expansion of common reed in the reservoir basin has competitively reduced distribution and abundance of other terrestrial and emergent aquatic vegetation that once occupied the dewatered reservoir basin. This shift in vegetation species assemblage has altered the complexity and diversity of fish habitat available upon inundation. Flooding of large stands of common reed results in localized areas of poor water quality as residual vegetation decomposes. Degraded water quality is most acute during the warm water periods and precludes occupation of affected areas by sportfish and forage fish species. This scenario may be responsible wholly or in part for reduced production and recruitment of Age-0 gizzard shad as well as other species.

A. Zebra Mussels

Zebra mussels (*Dreissena polymorpha*) were first discovered in Cedar Bluff Reservoir in August 2016, and it was apparent that the population was well established as adult mussels were encountered during October fish sampling activities throughout the reservoir. It is likely that plankton abundance has been reduced by the high-volume filter feeding of the cumulative mussel population. Stomach content observations indicated that common carp (*Cyprinus carpio*) prey on adult zebra mussels and it is likely that other fish species such as freshwater drum and bluegill do the same.

B. Eurasian Milfoil and Curly leaf Pondweed

Both species of submerged aquatic macrophyte are often considered undesirable. Depending on the body of water, these species can become overabundant causing reduced angler access and disruption to sportfish/prey interactions. However, at Cedar Bluff Reservoir these exotic species form beds of adequate size that increase diversity of the littoral zone in most years, resulting in increased habitat diversity for existing fish populations.

Fisheries Management Objectives

The general objective of fisheries management at Cedar Bluff Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 8), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Cedar Bluff Reservoir.

1. Reallocation of Pool Storage

Dissolution of Cedar Bluff Irrigation District and elimination of water use for agricultural irrigation has minimized downstream discharges of water and resulted in a more stable reservoir pool elevation. Relative water level stability results in coincident stabilization of habitat availability afforded fish populations thus stabilizing sportfish population dynamics. (The *Water Allocation Background* section above includes further details related to reallocation of pool storage at Cedar Bluff Reservoir).

2. Riprap Installation in Areas of Critical Shoreline Infrastructure

Boat ramps, associated parking areas, and access roads exist at various elevations within the reservoir basin to improve public access to the reservoir at lower pool elevations. Riprap has been added to shorelines and edges of boat ramp slabs to reduce erosion and undermining by wave action. At higher reservoir pool elevations this infrastructure, including riprap, diversify fish habitat. (See *Sedimentation* section above for examples of benefits afforded fish by rock habitat, which could be considered to include gravel/paved boat ramps, parking areas, and roads.)

3. Standard and Supplemental Fish Sampling to Monitor Sportfish Trends

Standard fish population sampling is employed on an annual basis and is conducted using standardized methods approved by KDWP Fisheries staff and applied at Cedar Bluff Reservoir and other Kansas waters to develop baseline trend data by which Kansas fisheries are managed. At Cedar Bluff Reservoir, electrofishing is used to sample the largemouth bass population in spring, and core panel gill nets and ½" mesh fyke nets are employed each fall to sample other sportfish species such as bluegill, channel catfish, crappies, white bass, wipers, and walleye.

Supplemental fish population sampling is conducted at the discretion of the KDWP District Fisheries Biologist to address specific management questions/challenges. Supplemental sampling can consist of accepted or experimental methods and often focuses on finer detail resolution fish population parameters. Recently at Cedar Bluff Reservoir age-and-growth analyses were conducted to characterize growth trajectories exhibited by these populations. Crappie growth information was used to justify implementation and evaluate effect of the 10-inch minimum length limit special harvest regulation on this species. Sex specific length frequency and age-and-growth information was collected during walleye egg collection operations at Cedar Bluff Reservoir to justify implementation and evaluate effect of the 21-inch minimum length limit special harvest regulation on this species.

4. Other Biotic and Abiotic Parameter Sampling

This sampling should be considered supplemental sampling but most often consists of sampling a parameter(s) other than those specifically related to sportfish. Some recent examples include water samples collected by USBR staff to monitor for the presence of zebra mussel larvae and consequently detected establishment of a reproducing population at Cedar Bluff Reservoir. Additionally, dissolved oxygen concentration measurements were collected at various locations around the reservoir to confirm that decomposition of common reed residual resulted in areas of poor water quality within the reservoir.

5. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Cedar Bluff Reservoir are: Crappie-10-inch minimum length limit and Walleye-21-inch minimum length limit. See Table 8 below for a comprehensive list of fish harvest regulations in effect at Cedar Bluff Reservoir.

Table 8. Current Fish Harvest Regulations in Effect at Cedar Bluff Reservoir

Species	Length Limit	Creel Limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	10 - inch minimum length limit	50 fish daily creel limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Smallmouth Bass	15 - inch minimum length limit	5 fish daily creel limit

Species	Length Limit	Creel Limit
Spotted Bass	15 - inch minimum length limit	5 fish daily creel limit
Walleye	21 - inch minimum length limit	5 fish daily creel limit
Wiper	N/A	2 fish daily creel limit

Source: KDWP 2020

6. Sportfish Stockings

Meade Hatchery staff stocking intermediate-sized channel catfish at Cedar Bluff Reservoir

Stocking has been employed on a limited basis at Cedar Bluff Reservoir as most species are capable of sufficient natural reproduction and recruitment to maintain fishable populations provided suitable habitat is present. Recently, intermediate-sized channel catfish have been stocked to supplement a recruitment limited population. Wiper fry have been stocked since the mid-1990's to maintain a population of hybrid species that generally exhibit low fecundity. During May 2019 and 2020 fingerling largemouth bass were stocked approximately a month earlier than they would naturally exist in the environment to accelerate the development of a population exhibiting size structure attractive to anglers. Largemouth bass fingerling were stocked recently to capitalize on optimized habitat conditions (flooded terrestrial vegetation, etc.) resulting from marked increases in reservoir elevation.

Stocking is an important walleye management activity in many Kansas waters. Considering the difficulty to maintain and spawn captive broodstock, and the propensity of sexually mature walleye to concentrate in discrete spawning areas, gametes are harvested from wild broodstock for culture purposes from several Kansas impoundments each spring. The Cedar Bluff walleye population has been an important resource of fertilized walleye eggs since 2006, often contributing 50% or more to the total statewide annual quota (see Table 9). Consequently, optimizing walleye broodfish abundance and welfare has been a management priority at Cedar Bluff.

Table 9. Annual statistics for Walleye egg collection at Cedar Bluff Reservoir from 2006 to 2019.

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Total Females	719	696	602	619	702	701	653	553	777	1274	835	1529	1559	1787	929.0
Ripe Females (% of total)	436 (61)	268 (39)	414 (69)	285 (46)	419 (60)	427 (61)	265 (41)	336 (61)	410 (53)	498 (39)	397 (48)	515 (34)	604 (39)	721 (40)	389.2
Spent Females (% of total)	82 (11)	157 (23)	58 (10)	98 (16)	75 (11)	115 (16)	133 (20)	146 (26)	197 (25)	268 (21)	222 (27)	507 (33)	559 (35)	472 (26)	171.5
Green Females (% of total)	201 (28)	271 (39)	130 (22)	236 (38)	208 (30)	159 (23)	255 (39)	71 (13)	170 (22)	508 (40)	216 (26)	507 (33)	396 (25)	594 (33)	244.3
Mean Length of Females (mm)	584	586	595	592	591	610	596	581	559	521	539	480	477	493	557
% Mortality	3.6	2.2	2.1	0.3	1.3	1.3	14.7	1.1	0.7	0.8	4.5	1.8	1.6	1.2	2.7
Eggs Collected (millions)	47.4	28.2	48.0	40.9	59.8	66.0	39.1	59.4	61.5	54.7	56.7	62.5	54.9	68.5	53.4

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
% Hatch Rate	60.4	61.5	55.5	67.4	57.6	59.3	34.7	63.9	53.7	50.8	48.8	52.3	53.3	56.5	55.4
Eggs/Day (millions)	3.2	2.6	3.7	3.4	6.7	7.3	2.8	5.9	5.1	3.9	3.3	2.8	2.7	5.3	4.2
Mean Water Temp (°F)	45.0	52.1	42.5	46.2	43.5	46.2	52.8	45.2	43.6	45.7	48.2	47.0	44.7	46.6	46.4
Total Days	15	11	13	12	9	9	14	10	12	14	17	22	20	15	13.8

Source: KDWP 2020

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 10) in accordance with KDWP reservoir survey guidelines. It is notable that statistics generated from creel census data collected in 2011 should be viewed with skepticism as resulting statistics were skewed by the clerk's lack of adherence to data collection protocols.

Angler effort (angler-hours/acre) at Cedar Bluff Reservoir often ranks in the 75th percentile or higher when compared to other Kansas reservoirs. Anglers hailing from western Kansas exert the majority of fishing pressure, with users from eastern Kansas and eastern Colorado frequenting the lake to a lesser degree.

Cedar Bluff Reservoir anglers tend to be non-specific in terms of species they prefer. Angler preference for a specific species often varies based upon changes in species dominance that results from water fluctuation history (see Figure 1). For example, largemouth bass were highly preferred by anglers in the 2003 creel survey because refilling of the reservoir in the mid to late-1990's resulted in excellent black bass quality. Conversely, as the reservoir pool elevation declined through the 2000's and early 2010's, increased walleye recruitment promoted development of a population attractive to anglers. Regardless of the reservoir water level and relative sportfish population status, crappie and white bass are popular fisheries among Cedar Bluff Reservoir anglers in most years (see Table 10). Cedar Bluff anglers tend to be harvest minded. Crappie, walleye, and white bass comprise the largest contributions to angler's creel in most years (see Tables 10-12). Cedar Bluff Reservoir black bass anglers tend to be more catch-and-release oriented, choosing to extend the use of an often-limited resource.

Table 10.Total number of anglers, angler-hours, and relative standard error (RSE) at Cedar Bluff Reservoir for the five most recent creel surveys conducted March 1 through October 31.

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler Hours	RSE	Angler Hours per Acre
2003	47,047	18.82	149,694.67	8	59.88
2011	7,240	2.90	29,367.18	9	11.75
2014	32,067	12.83	94,869.94	10	37.95
2018	22,229	8.89	69,802.64	5	27.92
2019	26,008	10.40	97,476.50	3	38.99

Source: KDWP 2020

Table 11. Average percentages of the top four ranked most preferred species by anglers at Cedar Bluff Reservoir for the five most recent creel surveys conducted March 1 through October 31.

Year	First		Second		Third		Fourth	
2003	Largemouth Bass	37.2	Crappie	28.3	Channel Catfish	8.2	White Bass	7.6
2011	No Fish Preference	65.0	Wiper	11.8	White Bass	6.6	Crappie	6.4
2014	No Fish Preference	42.2	Walleye	22.5	Crappie	16.1	White Bass	10.5
2018	No Fish Preference	42.6	White Bass	19.7	Crappie	14.7	Walleye	12.9
2019	No Fish Preference	40.8	Walleye	26.7	Crappie	15.6	White Bass	8.2

Source: KDWP 2020

Table 12. Estimated total number of sportfish harvested and released at Cedar Bluff Reservoir for the five most recent creel surveys conducted March 1 through October 31.

Year	Black Crappie	Largemouth Bass	Walleye	White Bass	White Crappie
Harvested					
2003	20,317	1,141	990	7,532	17,994
2011	766	38	349	7,680	2,718
2014	10,937	1,128	5,621	19,711	28,159
2018	7,888	371	263	17,088	2,333
2019	7,516	85	2,349	13,852	3,955
Released					
2003	7,410	31,516	3,965	9,981	7,412
2011	520	460	440	1,147	585
2014	942	1,884	15,214	5,050	2,385
2018	3,068	2,093	8,482	3,919	247
2019	1,977	1,724	30,476	5,868	1,469

Source: KDWP 2020

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Black Crappie (*Pomoxis nigromaculatus*)

Black crappie is not native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Kansas Fishes Committee, 2014). Origin of the Cedar Bluff Reservoir population likely resulted from fingerling stockings made in 1950 and 1951 by the Kansas Forestry, Fish and Game Commission (now KDWP). Aside from their introductory stocking, natural reproduction/recruitment has been relied upon to maintain the population. This population's dynamics fluctuate based upon reservoir water level history as recruitment is generally limited during stable to slowly declining water levels. Conversely, recruitment tends to correlate positively with reservoir water level increases. Population sampling results from 2015 to 2017 indicated high production of young of year (YOY) individuals (evidenced by sub-stock catch per unit effort (CPUE) and high prevalence of stock length individuals (PSD-S) (the proportion of all fish stock length and larger sampled that fell within the stock PSD category). But lack of substantial increase to stock CPUE over the same period reflected reduced recruitment caused by the combined effect of a declining water level (see Figure 1) and continuous angler harvest of mature individuals. Increased stock CPUE and PSD-S documented in 2019, was the product of improved recruitment of individuals from the 2018 cohort that benefited from improved habitat and trophic conditions derived from increased water level (see Table 13). Increased zooplankton abundance improved body condition of smaller individuals. But, low YOY gizzard shad production resulted in poor body condition exhibited by larger individuals as evidenced by relative weight (Wr) values. Higher water levels in 2019, and relative stability observed during 2020, is expected to foster improved black crappie recruitment over the respective seasons. Abundance of this species is expected to realize a notable increase over the near term (Table 13).

Table 13. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Black Crappie sampled during October and November trapnets.

Metric	2015	2016	2017	2018	2019
Total Catch	2535	2939	2921	598	262
Stock Catch	119	34	56	101	186
Units of Effort	18	18	19	18	18
Sub-Stock CPUE (RSE)	134.2 (23)	161.4 (40)	150.8 (20)	27.6 (28)	4.2 (46)
Stock CPUE (RSE)	6.6 (34)	1.9 (21)	2.9 (21)	5.6 (20)	10.3 (20)
Quality/Density CPUE (RSE)	0.8 (34)	0.4 (52)	1.3 (30)	4.6 (18)	1.6 (34)
Preferred CPUE (RSE)	0.2 (73)	0.1 (100)	0.9 (32)	4.0 (17)	0.9 (43)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.0 (.)	0.2 (54)	1.1 (27)	0.5 (46)
Total CPUE (RSE)	140.8 (23)	163.3 (40)	153.7 (19)	33.2 (24)	14.6 (24)
PSD Stock-Quality (S-D)	88.24	79.41	57.14	17.82	84.95
PSD Quality-Preferred (Q-P)	9.24	17.65	10.71	10.89	5.91
PSD Preferred-Memorable (P-M)	0.84	2.94	26.79	51.49	4.3
PSD (Memorable-Trophy (M-T)	1.68	.	5.36	19.8	4.84
PSD	11.76	20.59	42.86	82.18	15.05
Mean WR S-Q (RSE)	87 (1)	84 (3)	83 (1)	83 (2)	103 (1)
Mean WR Q-P (RSE)	90 (4)	95 (3)	89 (3)	91 (3)	102 (2)
Mean WR P-M (RSE)	91 (.)	87 (.)	92 (3)	92 (1)	88 (2)
Mean WR M-T (RSE)	82 (5)	. (.)	91 (1)	91 (1)	82 (6)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Bluegill (*Lepomis macrochirus*)

Bluegill are not native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Kansas Fishes Committee, 2014). Origin of the Cedar Bluff Reservoir population resulted from fingerling stockings made in 1950 and 1951 by the Kansas Forestry, Fish and Game Commission. There is little doubt that immigration from streams and ponds in the watershed occurs during periods of high flow and resulting connectivity of water bodies. KDWP does not maintain or supplement this population through stocking efforts. This population's dynamics fluctuate based upon reservoir water level history (see Figure 1) as recruitment is generally stable at a lower level under stable to slowly declining water levels, with recruitment correlating positively with reservoir water level. Since the invasion of Eurasian watermilfoil in the late 1990's, recruitment and higher bluegill densities have occurred on a more consistent basis. As evidenced by high sub-stock and stock CPUE's some years (see Table 14), this population can constitute a viable forage source for piscivorous (fish-eating) sportfish by imparting diversity to the overall forage base. Increased zooplankton availability due to recent trophic upsurge has translated into good body condition and growth for bluegill. As such, a wider size range of bluegill were sampled during 2019 (see Table 14). This fishery will become attractive to anglers over the short term, and as long as habitat and trophic conditions remain favorable for bluegill.

Table 14. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Bluegill sampled during October and November by trapnets.

Metric	2015	2016	2017	2018	2019
Total Catch	5360	8869	3493	502	329
Stock Catch	1761	1030	1303	90	258
Units of Effort	18	18	19	18	18
Sub-Stock CPUE (RSE)	199.9 (23)	435.5 (30)	115.3 (39)	22.9 (38)	3.9 (30)
Stock CPUE (RSE)	97.8 (23)	57.2 (34)	68.6 (30)	5.0 (36)	14.3 (41)
Quality/Density CPUE (RSE)	1.2 (42)	1.2 (39)	1.4 (31)	0.3 (42)	2.9 (52)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.1 (100)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	297.8 (20)	492.7 (29)	183.8 (30)	27.9 (37)	18.3 (36)
PSD S-Q	98.81	97.86	98	93.33	79.46
PSD Q-P	1.19	2.14	2	6.67	20.16
PSD P-M	.	.	.	.	0.39
PSD M-T	.	.	.	.	.
PSD	1.19	2.14	2	6.67	20.54
Mean WR S-Q (RSE)	90 (2)	89 (2)	90 (1)	93 (1)	97 (1)
Mean WR Q-P (RSE)	93 (1)	93 (1)	94 (2)	103 (3)	106 (1)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)	103 (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Channel Catfish (*Ictalurus punctatus)*

Whether channel catfish are native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream is unknown (Bruekelman, 1940). Since reservoir impoundment, channel catfish have been stocked by KDWP to supplement the existing population and improve angling opportunities. In recent years, abundance has been low as evidenced by stock CPUE values (see Table 15). It is assumed that recruitment is insufficient to improve abundance by out pacing mortality rates. Low to no flow in the river and other tributaries above the reservoir limits access of adult catfish to these lotic systems most years and may be a factor limiting recruitment. More recently, establishment of large stands of common reed where inflowing streams enter the reservoir proper, limits access to these lotic habitats by adult catfish due to decomposition of residual vegetation in years of elevated flow. In an effort to improve recruitment, supplemental stocking of intermediate-sized catfish was conducted in 2018 and 2019 and is planned for future years over the near term.

Table 15. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Channel Catfish sampled during October and November by gillnets.

Metric	2015	2016	2017	2018	2019
Total Catch	14	17	11	9	7
Stock Catch	14	16	9	9	7
Units of Effort	22	23	23	24	24
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (100)	0.1 (69)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	0.6 (28)	0.7 (26)	0.4 (31)	0.4 (35)	0.3 (38)
Quality/Density CPUE (RSE)	0.5 (31)	0.3 (55)	0.3 (34)	0.3 (43)	0.2 (41)
Preferred CPUE (RSE)	0.0 (100)	0.1 (69)	0.0 (100)	0.0 (.)	0.0 (.)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	0.6 (28)	0.7 (26)	0.5 (26)	0.4 (35)	0.3 (38)
PSD S-Q	28.57	62.5	11.11	33.33	28.57

Metric	2015	2016	2017	2018	2019
PSD Q-P	64.29	25	77.78	66.67	71.43
PSD P-M	7.14	12.5	11.11	.	.
PSD M-T	.	.	.	.	.
PSD	71.43	37.5	88.89	66.67	71.43
Mean WR S-Q (RSE)	83 (3)	81 (1)	. (.)	81 (5)	86 (2)
Mean WR Q-P (RSE)	82 (4)	75 (1)	87 (4)	85 (3)	97 (4)
Mean WR P-M (RSE)	79 (.)	103 (0)	79 (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard shad are likely not native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Kansas Fishes Committee, 2014). This species was introduced by KDWP in 1960 to serve as the primary forage resource for existing fish populations. In recent years, the population consisted of a low abundance of large adults as evidenced by low stock CPUE and high PSD values revealed from annual sampling results (see Table 16). Dynamics of the adult segment of this population generally promoted adequate annual production of YOY individuals. In 2019, following an increase in the water level in 2018, an anomalous lack of gizzard shad production resulted in poor condition and growth of various sportfish species. Pelagic (referring to open-water regions not directly influenced by the shore and bottom; limnetic (Cole, G.A. 1994. Textbook of Limnology, 4th ed. Waveland Press, Prospect Heights, Illinois, USA))) predators including white bass (*Morone chrysops*), palmetto bass (*Morone hybrid*), and walleye (*Sander vitreus*) were the most severely impacted. Likewise, adult crappie (*Pomoxis* spp.)~~,~~ that rely on this forage resource also suffered. The lack of production was possibly associated with poor water quality conditions, precipitated by decomposition of flooded common reed in nursery areas for young shad. Visual observation of YOY shad-inhabiting shoals coupled with better sportfish body condition, pointed towards overall improved shad production in 2020.

Table 16. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Gizzard Shad sampled during October and November by gillnets.

Metric	2015	2016	2017	2018	2019
Total Catch	84	53	40	8	26
Stock Catch	61	52	37	7	26
Units of Effort	22	23	23	24	24
Sub-Stock CPUE (RSE)	1.0 (41)	0.0 (100)	0.1 (55)	0.0 (100)	0.0 (.)
Stock CPUE (RSE)	2.8 (37)	2.3 (23)	1.6 (38)	0.3 (53)	1.1 (28)
Quality/Density CPUE (RSE)	1.9 (28)	1.7 (25)	1.6 (38)	0.3 (53)	0.9 (27)
Preferred CPUE (RSE)	1.6 (29)	1.3 (25)	1.3 (39)	0.3 (55)	0.8 (26)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	3.8 (32)	2.3 (22)	1.7 (37)	0.3 (56)	1.1 (28)
PSD S-Q	31.15	23.08	.	.	19.23
PSD Q-P	9.84	19.23	16.22	14.29	3.85
PSD P-M	59.02	57.69	83.78	85.71	76.92
PSD M-T	.	.	.	.	.
PSD	68.85	76.92	100	100	80.77
Mean WR S-Q (RSE)	. (.)	. (.)	. (.)	. (.)	104 (5)
Mean WR Q-P (RSE)	. (.)	. (.)	. (.)	. (.)	103 (.)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)	102 (1)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Metric	2015	2016	2017	2018	2019
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Black Bass (Micropterus sp.)

Since early in the impoundment of Cedar Bluff Reservoir spotted bass (*M. punctulatus*), smallmouth bass (*M. dolomeiui*), and largemouth bass (*M. salmoides*) have been present. But none of the three species is likely native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Bruekelman, 1940 and Kansas Fishes Committee, 2014). Largemouth bass were first introduced in 1951 and have been periodically stocked on a supplemental basis as recent as 2020. Supplemental fingerling stockings in 2019 and 2020 were in response to improved habitat conditions created by substantial inflow. Smallmouth bass and spotted bass were introduced in 1962. Supplemental stockings of smallmouth bass were made throughout the 1960's and a stocking of 75 adults was made in 2012. The 2012 stocking was conducted to introduce the Tennessee River strain genotype into the population in hopes of improving recruitment. All three species' population dynamics fluctuate based upon reservoir water level history (see Figure 1) as recruitment is generally stable at a lower level under stable to slowly declining water levels with recruitment correlating positively with reservoir water level. Largemouth bass recruitment tends to be influenced more by water level trends than the other two black bass species. This is likely due to differences in habitat requirements. Recent sampling results indicated greater stability in stock CPUE for the latter two species than that documented for largemouth bass (Tables 10-12). Reductions to stock CPUE in 2018 and 2019 was not likely representative of population trends as sampling efficiency was reduced by conditions relating to increased reservoir pool elevation (see Table 17, Table 18, and Table 19). Higher water levels through 2019, with stability observed since, is expected to foster improved black bass recruitment and greater abundance into the future.

Table 17. Catch per unit effort (CPUE), proportional stock density (PSD), and relative weight (Wr) Spotted Bass sampled during September by electrofishing.

Metric	2015	2016	2017	2018	2019
Total Catch	11	7	18	7	12
Stock Catch	10	6	14	6	10
Units of Effort	0.56	0.58	0.94	1.92	0.98
Sub-Stock CPUE	1.8	1.7	4.3	0.5	2.0
Stock CPUE	17.9	10.3	14.9	3.1	10.2
Quality/Density CPUE	3.6	3.4	8.5	0.5	7.1
Preferred CPUE	0.0	0.0	2.1	0.0	2.0
Memorable/Lunker CPUE	0.0	0.0	0.0	0.0	0.0
Total CPUE	19.7	12.0	19.1	3.6	12.2

Metric	2015	2016	2017	2018	2019
PSD S-Q	80.0	66.7	42.9	83.3	30.0
PSD Q-P	20.0	33.3	42.9	16.7	50.0
PSD P-M	.	.	0.1	.	20.0
PSD M-T	.	.	.	.	.
PSD	20.0	33.3	43.0	16.7	70.0
Mean WR S-Q	98	112	100	98	103
Mean WR Q-P	92	98	95	85	101
Mean WR P-M (RSE)	105	.	80	.	95
Mean WR M-T (RSE)	.	.	.	.	.
Mean WR T+ (RSE)	.	.	.	.	.

Source: KDWP 2020

Table 18. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Smallmouth Bass sampled during September by electrofishing.

Metric	2015	2016	2017	2018	2019
Total Catch	9	8	17	4	8
Stock Catch	4	7	17	4	5
Units of Effort	0.56	0.58	0.94	1.92	0.98
Sub-Stock CPUE	8.93	1.72	0.0	0.0	3.1
Stock CPUE	7.14	12.07	18.1	2.1	5.1
Quality/Density CPUE	1.79	5.17	0.0	1.6	1.0
Preferred CPUE	0.00	5.17	0.0	1.0	0.0
Memorable/Lunker CPUE	0.00	1.72	0.0	0.0	0.0
Total CPUE	16.07	13.79	18.1	2.1	8.1
RSD S-Q	75	57	100	25	75
RSD Q-P	25	.	.	25	25
RSD P-M	.	29	.	50	.
RSD M-T	.	14	.	.	.
PSD	25	43	0	75	25
Mean WR S-Q	103	104	96	96	94
Mean WR Q-P	84	.	.	75	92
Mean WR P-M	.	89	.	87	.
Mean WR M-T	.	103	.	.	.
Mean WR T+	.	.	.	.	.

Source: KDWP 2020

Table 19. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Largemouth Bass sampled during May and June by electrofishing.

Metric	2015	2016	2017	2018	2019
Total Catch	55	56	101	43	22
Stock Catch	47	55	98	43	20
Units of Effort	6.02	5.11	4.47	3.06	7.36
Sub-Stock CPUE (RSE)	1.3 (42)	0.2 (100)	0.7 (55)	0.0 (.)	0.2 (71)
Stock CPUE (RSE)	7.7 (14)	10.7 (19)	22.0 (13)	14.2 (20)	2.8 (25)
Quality/Density CPUE (RSE)	6.5 (17)	7.6 (18)	19.5 (13)	12.1 (16)	2.8 (25)
Preferred CPUE (RSE)	5.7 (18)	4.7 (22)	7.2 (18)	5.3 (23)	2.2 (27)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.2 (100)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	9.0 (15)	10.9 (18)	22.6 (13)	14.2 (20)	3.0 (24)
PSD S-Q	17.02	29.09	11.22	13.95	.

PSD Q-P	10.64	27.27	56.12	46.51	20
PSD P-M	72.34	41.82	32.65	39.53	80
PSD M-T	.	1.82	.	.	.
PSD	82.98	70.91	88.78	86.05	100
Mean WR S-Q (RSE)	97 (4)	97 (2)	95 (2)	96 (3)	. (.)
Mean WR Q-P (RSE)	92 (4)	97 (2)	98 (1)	92 (2)	88 (3)
Mean WR P-M (RSE)	92 (1)	93 (2)	94 (1)	89 (2)	87 (2)
Mean WR M-T (RSE)	. (.)	87 (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Walleye (*Sander vitreus*)

Walleye are not native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Kansas Fishes Committee, 2014). Walleye were introduced into Cedar Bluff Reservoir in 1953. Over the past two decades, supplemental stockings were only conducted in 2001 and 2013, as evidence suggested that natural production and recruitment was sufficient to maintain the population. It has been accepted that supplemental walleye stocking has minimal influence on year class strength at Cedar Bluff Reservoir. Long-term evidence suggests that walleye recruitment tends to be negatively correlated with reservoir pool fluctuations such that high recruitment is noted in years of stable to declining pool elevation. Stock CPUE has been stable at a relatively high value especially since establishment of the strong 2014 year-class (Table 14). Lack of forage coupled with high walleye abundance stagnated growth such that angler harvest truncated length distribution at the 21-inch minimum length limit. This was indicated by the low prevalence of PSD-Preferred (PSD-P) and larger individuals. Low stock CPUE value obtained during 2019 reflected lack of entrainment in sampling gear due to alternate foraging behavior (see Table 20). Walleye remain abundant at Cedar Bluff Reservoir in 2020 and YOY gizzard shad dynamics will determine the growth trajectory of existing individuals. Recruitment has been reduced in recent years as evidenced by relatively low catch rates of YOY individuals. As the reservoir stabilizes near the higher, current pool elevation and ultimately begins to decline, walleye recruitment will likely increase.

Table 20. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Walleye sampled during October and November by gillnets.

Metric	2015	2016	2017	2018	2019
Total Catch	156	146	142	168	41
Stock Catch	145	142	139	168	40
Units of Effort	22	23	23	24	24
YOY CPUE (Core Panel Net Night)	0.82	0.39	0.39	0.25	0.04
YOY CPUE (1" Gill Net Night)	6.50	4.83	4.33	2.33	0.33
Stock CPUE (RSE)	6.6 (12)	6.2 (12)	6.0 (10)	7.0 (10)	1.7 (26)
Quality/Density CPUE (RSE)	3.7 (16)	4.7 (11)	5.5 (11)	6.4 (10)	1.6 (25)

Metric	2015	2016	2017	2018	2019
Preferred CPUE (RSE)	0.6 (24)	0.4 (38)	0.5 (34)	0.2 (41)	0.0 (100)
Memorable/Lunker CPUE (RSE)	0.0 (100)	0.0 (100)	0.0 (100)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	7.1 (12)	6.3 (13)	6.2 (10)	7.0 (10)	1.7 (25)
PSD S-Q	43.45	23.24	9.35	8.93	5
PSD Q-P	47.59	70.42	82.73	88.1	92.5
PSD P-M	8.28	5.63	7.19	2.98	2.5
PSD M-T	0.69	0.7	0.72	.	.
PSD	56.55	76.76	90.65	91.07	95
Mean WR S-Q (RSE)	89 (1)	89 (1)	96 (2)	97 (2)	77 (7)
Mean WR Q-P (RSE)	87 (1)	86 (1)	88 (1)	88 (1)	81 (2)
Mean WR P-M (RSE)	83 (3)	83 (3)	82 (2)	82 (4)	77 (.)
Mean WR M-T (RSE)	92 (.)	86 (.)	82 (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

White Bass (*Morone chrysops*)

White bass are not likely native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Kansas Fishes Committee, 2014). White bass were introduced into Cedar Bluff Reservoir in 1951 by the KDWP. This population has been relatively stable in recent years regardless of water level fluctuation. The anomalously low stock CPUE value documented in 2019 was reflective of an increase in reservoir pool spreading out existing individuals (Table 21). This population suffered extreme declines in body condition due to poor YOY gizzard shad as evidenced by low Wr values of PSD-P and larger fish. Smaller white bass capitalized on trophic upsurge initiated by the reservoir water level increase in 2019 and maintained body condition via planktivory. Increased YOY gizzard shad production in 2020 instigated recovery of the population. Future reproduction and recruitment will allow the population to expand and fill vacant reservoir volume.

Table 21. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for White Bass sampled during October and November by gillnets.

Metric	2015	2016	2017	2018	2019
Total Catch	324	321	394	380	103
Stock Catch	322	317	394	375	103
Units of Effort	22	23	23	24	24
Sub-Stock CPUE (RSE)	0.1 (69)	0.2 (59)	0.0 (.)	0.2 (50)	0.0 (.)
Stock CPUE (RSE)	14.6 (23)	13.8 (12)	17.1 (12)	15.6 (12)	4.3 (24)
Quality/Density CPUE (RSE)	14.3 (24)	12.7 (12)	17.1 (12)	12.5 (15)	4.3 (24)
Preferred CPUE (RSE)	11.6 (29)	11.3 (12)	14.8 (12)	12.0 (16)	3.7 (27)
Memorable/Lunker CPUE (RSE)	7.4 (45)	4.2 (14)	4.3 (15)	4.7 (18)	0.2 (78)
Total CPUE (RSE)	14.7 (23)	14.0 (12)	17.1 (12)	15.8 (12)	4.3 (24)
PSD S-Q	2.17	8.2	.	20	0.97
PSD Q-P	18.32	9.46	13.71	2.93	12.62
PSD P-M	29.19	51.74	60.91	46.93	82.52
PSD M-T	50.31	30.6	25.38	30.13	3.88
PSD	97.83	91.8	100	80	99.03
Mean WR S-Q (RSE)	89 (5)	94 (1)	. (.)	97 (1)	81 (.)
Mean WR Q-P (RSE)	91 (1)	96 (1)	90 (1)	98 (3)	95 (4)
Mean WR P-M (RSE)	88 (1)	94 (1)	92 (1)	95 (1)	72 (1)
Mean WR M-T (RSE)	81 (1)	83 (1)	80 (1)	85 (1)	61 (3)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

White Crappie (*Pomoxis annularis*)

White Crappie are likely not native to the Smoky Hill River drainage at what is now Cedar Bluff Reservoir and further upstream (Kansas Fishes Committee, 2014). Origin of the Cedar Bluff Reservoir population likely resulted from fingerling stockings made in 1950 and 1951 by KDWP. Aside from their introduction, this population's dynamics fluctuate based upon reservoir water level history (see Figure 1) as recruitment seems to be positively correlated with increase in water levels. Recent sampling indicated that abundance has declined to a low level as evidenced by low stock CPUE in 2018-2019 (see Table 22). Extreme drought caused rapid water level declines in 2011 through 2013, minimizing recruitment during that period. The population's density has yet to recover. Increased reservoir pool elevation will likely improve recruitment conditions that should increase abundance in the future.

Table 22. Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for White Crappie sampled during October and November by trapnets.

Metric	2015	2016	2017	2018	2019
Total Catch	561	475	567	152	15
Stock Catch	115	43	17	12	12
Units of Effort	18	18	19	18	18
Sub-Stock CPUE (RSE)	24.8 (30)	24.0 (31)	28.9 (28)	7.8 (64)	0.2 (100)
Stock CPUE (RSE)	6.4 (25)	2.4 (24)	0.9 (32)	0.7 (42)	0.7 (30)
Quality/Density CPUE (RSE)	2.1 (28)	2.1 (23)	0.8 (32)	0.7 (42)	0.3 (39)
Preferred CPUE (RSE)	0.4 (45)	1.0 (29)	0.4 (38)	0.2 (58)	0.2 (54)
Memorable/Lunker CPUE (RSE)	0.4 (45)	0.1 (100)	0.4 (37)	0.2 (58)	0.1 (69)
Total CPUE (RSE)	31.2 (28)	26.4 (29)	29.8 (27)	8.4 (61)	0.8 (33)
PSD S-Q	66.96	13.95	5.88	.	58.33
PSD Q-P	26.09	44.19	47.06	66.67	16.67
PSD P-M	.	37.21	5.88	.	8.33
PSD M-T	6.09	4.65	41.18	33.33	16.67
PSD	33.04	86.05	94.12	100	41.67
Mean WR S-Q (RSE)	80 (1)	88 (2)	77 (.)	. (.)	92 (4)
Mean WR Q-P (RSE)	81 (2)	96 (1)	90 (2)	93 (3)	88 (6)
Mean WR P-M (RSE)	. (.)	96 (2)	86 (.)	. (.)	82 (.)
Mean WR M-T (RSE)	81 (6)	67 (3)	92 (4)	81 (5)	73 (7)
Mean WR T+ (RSE)	70 (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Wiper (*Morone saxatilis X M. chrysops*)

Wiper are a hybrid species requiring stocking on a regular basis to maintain population abundance. They were first stocked into Cedar Bluff Reservoir in 1995. Recently, the wiper stocking regime has consisted of biannual plantings of 5-day old fry at a rate of approximately 100 fish/acre. This regime is intended to maintain moderate densities (Table 23), minimizing competition for forage with white bass.

Table 23.Catch per unit effort (CPUE), proportional stock density (PSD), relative weight (Wr), and relative standard error (RSE) estimates for Wiper - W X S Bass sampled during October and November by gillnets.

Metric	2015	2016	2017	2018	2019
Total Catch	100	67	69	66	72
Stock Catch	100	67	50	66	72
Units of Effort	22	23	23	24	24
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.8 (36)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	4.5 (22)	2.9 (22)	2.2 (24)	2.8 (21)	3.0 (28)

Metric	2015	2016	2017	2018	2019
Quality/Density CPUE (RSE)	4.5 (22)	2.5 (25)	2.2 (24)	0.8 (33)	0.9 (39)
Preferred CPUE (RSE)	2.2 (22)	1.5 (22)	1.4 (28)	0.7 (31)	0.2 (50)
Memorable/Lunker CPUE (RSE)	0.2 (50)	0.1 (69)	0.1 (69)	0.0 (100)	0.0 (100)
Total CPUE (RSE)	4.5 (22)	2.9 (22)	3.0 (21)	2.8 (21)	3.0 (28)
PSD S-Q	.	13.43	.	69.7	69.44
PSD Q-P	51	35.82	34	4.55	23.61
PSD P-M	44	47.76	62	24.24	5.56
PSD M-T	5	2.99	4	1.52	1.39
PSD	100	86.57	100	30.3	30.56
Mean WR S-Q (RSE)	. (.)	85 (2)	. (.)	93 (1)	72 (1)
Mean WR Q-P (RSE)	86 (1)	83 (1)	84 (1)	82 (3)	69 (1)
Mean WR P-M (RSE)	78 (1)	76 (1)	75 (1)	79 (1)	69 (3)
Mean WR M-T (RSE)	75 (4)	70 (8)	69 (3)	78 (.)	76 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2020

Future Without Project Projections

Cedar Bluff Reservoir is expected to realize continued pool wide elevation fluctuations. Withdrawal of water from the Ogallala aquifer and Smoky Hill River alluvium for agricultural irrigation at current rates, and continued encroachment of phreatophyte species along the riparian corridors of the river and associated tributaries, will likely decrease baseflow and subsequent inflow into the reservoir. This will likely widen the amplitude of reservoir pool elevation fluctuation and promote the probability of extreme pool dewatering. At reduced pool, decreased water quality and reduced habitat availability and diversity, limit sportfish population abundance and welfare. When Cedar Bluff Reservoir is at low pool elevations, aquatic resource-based recreational opportunities available to the public, become more limited.

The stocking of intermediate-sized channel catfish will be continued in the future, if recent stockings reveal improvement of population abundance. Wiper fry will be stocked at a moderate rate, biannually, for the foreseeable future. Largemouth bass fingerlings will be stocked when trophic and habitat conditions resulting from substantial reservoir pool elevation increases occur.

The direction which angler use and visitation at Cedar Bluff takes is unclear, as changes in socio-economic factors greatly influence public involvement in angling. For example, increased participation of families in youth sporting activities reduces participation in angling. However, the unforeseen emergence and response to COVID-19 in 2020 greatly increased public participation in angling and other outdoor recreation at Cedar Bluff Reservoir during the 2020 visitation season.

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Kansas River Reservoirs Flood and Sediment Study- Reservoir Fishery
Location: Keith Sebelius Reservoir
Mark A. Shaw, District Fisheries Biologist

Keith Sebelius Reservoir Located on the Prairie Dog Creek in Norton County, Kansas

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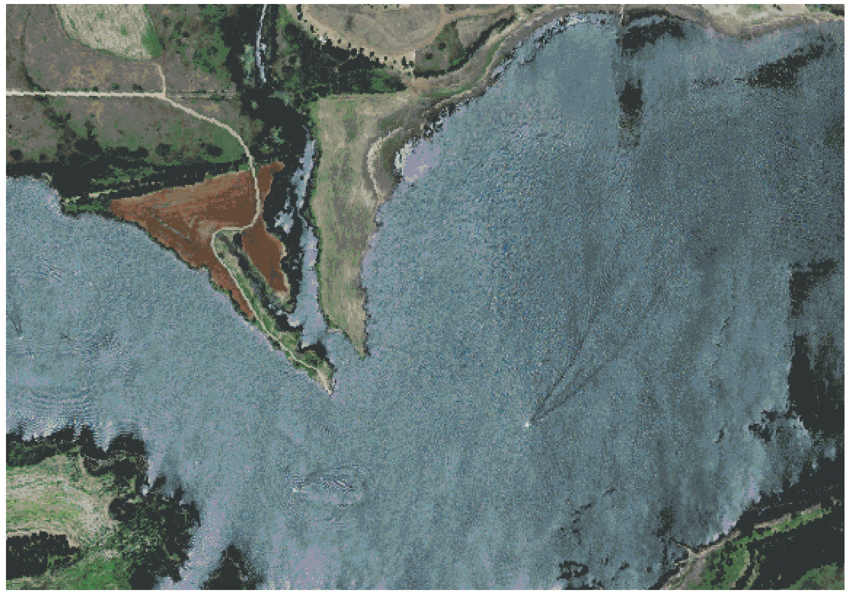
History



Aerial View of Keith Sebelius Reservoir

Keith Sebelius Reservoir is located on Prairie Dog Creek, three miles west and one mile south of Norton, Kansas. The reservoir is formed by a rolled earth filled dam, in which water storage began on December 1, 1964. The drainage area consists of 683 square miles of cultivated and pastureland. Row crop farming and pasture are the main uses of the watershed, as the soil types range from rich silt loam to rolling rocky hillsides. The reservoir was constructed by the U.S. Bureau of Reclamation (USBR) for flood control, municipal water for the City of Norton, and irrigation. At normal pool (elevation 2304.30 feet above mean sea level (MSL)), the reservoir consists of 2,181 surface acres and contains 34,510 ac-ft of water. At maximum capacity, elevation 2341.00 MSL the reservoir can impound 6,713 surface acres and 192,027 ac-ft of water. Water levels from 1965 to 2020 are displayed graphically below in Figure 1.

Water Allocation Background

Norton Dam and Keith Sebelius Reservoir were constructed by the USBR. The reservoir storage capacity includes 99,230 ac-ft storage for flood control and 30,517 ac-ft for multipurpose use (see Table 1). Keith Sebelius Reservoir currently provides flood control, municipal water supply, irrigation, recreation, and fish and wildlife conservation benefits.

Keith Sebelius Reservoir is operated and maintained by the USBR. Water in the flood control capacity is regulated in accordance with instructions furnished by the U.S. Army Corps of Engineers. Keith Sebelius Reservoir stores water for irrigation of the Almena Unit, for flood control, and water for use in the city of Norton, Kansas, along with the secondary benefits of recreation and fish and wildlife. Water rights are held by the Almena Irrigation District Number 5. Current irrigation infrastructure includes Norton Dam and Keith Sebelius Reservoir, the Almena Diversion Dam, Almena Main and South Canals, and a system of laterals and drains.

Table 1. Storage Capacity and Ownership

Pool Owner / Water Rights	Purpose	Quantity (acre-feet [ac-ft])*
USBR	Flood Control	99,230
USBR	Multipurpose	30,517
Almena Irrigation District	Irrigation	27,800
City of Norton	Municipal Water Supply	1,600

Keith Sebelius Reservoir Fishery

Fisheries Establishment

Northern Pike were stocked into Keith Sebelius Reservoir in 1973 and 1976 and are considered extinct. Tables 2 & 3 list sport fish and non-sport fish in Keith Sebelius Reservoir. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the *Sportfish Population Dynamics & Trends* section.

Table 2. Sport Fish Species Known to Inhabit Keith Sebelius Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Saugeye	*Sander vitreus, Sander canadensis*
Smallmouth Bass	*Micropterus dolomieu*
Spotted Bass	*Micropterus punctulatus*
Walleye	*Sander vitreus*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Keith Sebelius Reservoir

Common Name	Scientific Name
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Creek Chub	*Semotilus atromaculatus*
Fathead Minnow	*Pimephales promelas*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Plains Minnow	*Hybognathus placitus*
Red Shiner	*Cyprinella lutrensis*
Sand Shiner	*Notropis stramineus*
Suckermouth Minnow	*Phenacobius mirabilis*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. General Limnology

The Trophic State Index (TSI) is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels, and values of the Carlson Trophic State Index. Generally, some degree of eutrophic conditions is seen with chlorophyll a concentration over 7 g/l and hypereutrophy occurs at levels over 30 g/l. The TSI for Keith Sebelius Reservoir was 57.65 which classifies it at fully eutrophic. The Carlson TSI derives from the chlorophyll concentrations and scales the trophic state as follows: 1. Oligotrophic TSI < 40 2. Mesotrophic TSI: 40 - 49.99 3. Slightly Eutrophic TSI: 50 - 54.99 4. Fully Eutrophic TSI: 55 - 59.99 5. Very Eutrophic TSI: 60 - 63.99 6. Hypereutrophic TSI: 64.

Table 4. General Limnological Parameters Characteristic of Keith Sebelius Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	757.0
Max depth	feet	42.0
Mean depth	feet	16.1
Mean annual precipitation	inches	25.8
Mean annual runoff	inches	0.4
Area watershed drainage	square miles	694.5
Hydrologic residence time	days	1384.0
Chlorophyll a	parts per billion	8.4
Secchi depth	centimeters	186.0
Shoreline development index	ratio	3.8
Agricultural lands	%	63.7
Forest habitat	%	0.0
Grassland habitat	%	31.3
Urban lands	%	3.7
*Trophic state index		57.7

Note: *Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuations

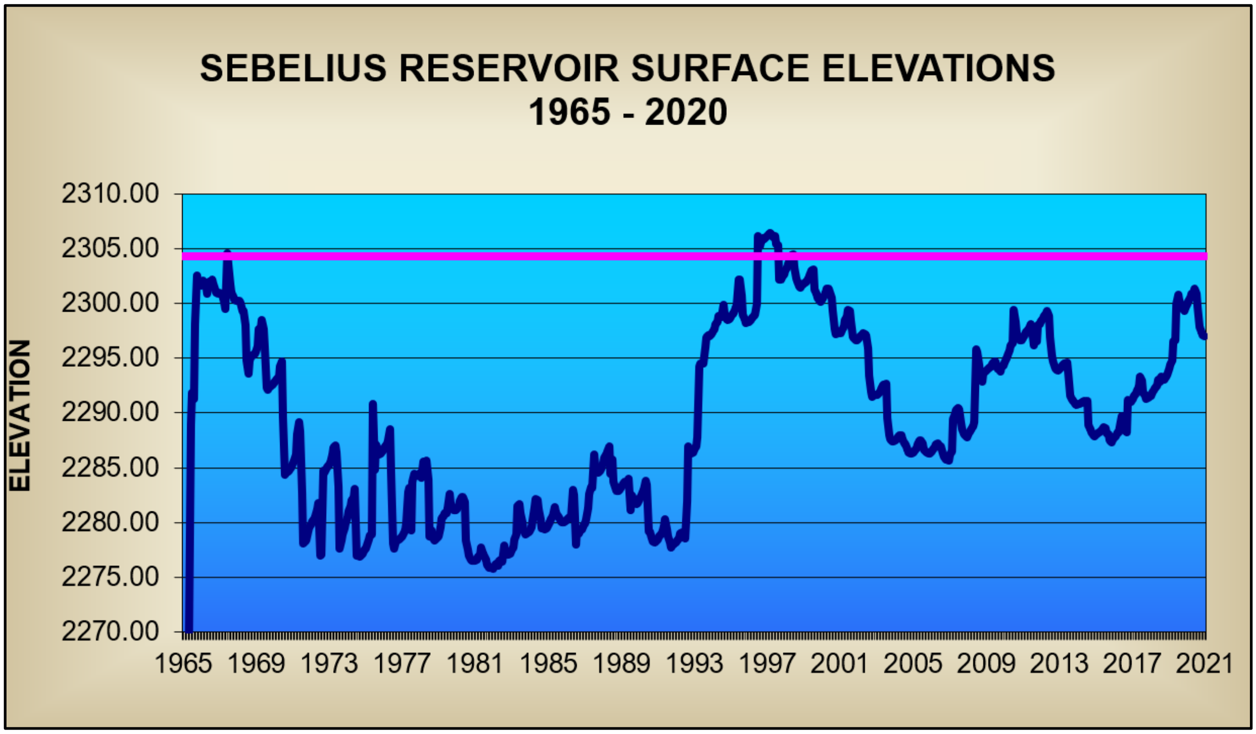


Figure 1. Yearly Ending Reservoir Pool Elevation (feet above MSL) [blue line] in Relation to Full Conservation Pool Elevation [red line] and Total Annual Precipitation [vertical column] Recorded by USBR at Keith Sebelius Reservoir from 1965 to 2020

Irrigation is a main part of Keith Sebelius Reservoir as can be seen in the graph below. Typically, Prairie Dog Creek provide enough flow to keep up with the irrigation demand. Thus, a Memorandum of Understanding (MOU) between the State of Kansas and the Almena Irrigation District concerning reformulation and operation of the Almena Unit was signed in July 2007. This MOU was for a ten-year period that expired on June 30, 2017. The Almena Irrigation District agreed not to release water for irrigation unless the elevation is above 2290.5 MSL and will only release water down to elevation 2288.5 MSL.

Another Memorandum of Agreement (MOA) between the Kansas Department of Wildlife and Parks (KDWP) and the Norton County Community Foundation, INC. (NCCF) was initiated in May 2017 and is set to expire on December 31, 2027. This MOA is a similar agreement to the previous one in that the Almena Irrigation District agrees to stop irrigation withdrawals at 2288.50 MSL elevation.

Typically, the reservoir is drawn down between three to four feet annually. Once releases are shut off the reservoir will usually gain one to two feet of water back over the winter, depending on rain events and if Prairie Dog Creek is flowing. This is what makes the surface elevations in Figure 1 look so jagged in nature. It is not unusual for the reservoir to be 15 to 20 feet below conservation pool and has been down around 30 feet a few different times since construction. This is the primary reason why the MOU and MOA agreements were initiated.

Characteristic of, but not limited to Keith Sebelius Reservoir, the commonly shrinking reservoir pool often leaves large areas within the basin dewatered for several years and allows establishment of terrestrial vegetation. When inundation of this vegetation occurs during periods of increased precipitation habitat availability for sportfish can increase. Substantial water level rises promote increased primary productivity resulting from the trophic upsurge associated with flooding of the dewatered reservoir basin. This and change in reservoir trophic status, results in a shift in sportfish species dominance. This translates into increased sportfish body condition and growth. Improved welfare of structure-oriented species occurs until habitat degradation (decomposition) or reduced water availability (receding levels) again limits production and recruitment of the sportfish assemblage. In contrast, primary productivity is reduced during years of declining reservoir levels due to a lack of nutrient input from the watershed above. When suitability or availability of flooded terrestrial vegetation declines, dominance of open-water sportfish increases.

3. Sedimentation

The multipurpose pool at Keith Sebelius Reservoir originally included 36,127 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 4.5% of the multipurpose pool has been filled in with sediment leaving approximately 34,510 ac-ft of capacity (based on 2000 survey results). It is estimated that approximately 45 ac-ft of sediment accumulates on average annually in Keith Sebelius Reservoir. Sediment will continue to accumulate in Keith Sebelius Reservoir with an expected additional 6.1 % loss of the multipurpose pool over the next 25 years (2049) and 9.2% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 31,164 ac-ft in 2074.

4. Vegetated Fisheries Habitat

Vegetated fisheries habitats occurring in and adjacent to Keith Sebelius Reservoir consists of terrestrial, emergent, and submergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. Subsequent to flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

B. Emergent

Common reed (*Phragmites australis*) and cattails (*Typha* sp.) are the primary emergent aquatic vegetation. Cattails are abundant primarily at the upper end of the reservoir and at the back ends of major coves. Common reed abundance has increased slightly on the upper end and will likely continue to expand distribution. Common reed is capable of establishment through fragmentation. Flooded emergent aquatic vegetation provides nutrient input, substrate for periphyton and other invertebrates, and physical habitat for juvenile and adult fish.

C. Submergent

Submergent aquatic vegetation can establish considerable beds in the littoral zone of the reservoir. This was especially evident once the water level agreement was put into place and a more stable water level was maintained. Coontail (*Ceratophyllum demersum*), American pondweed (*Potamogeton nodosus*), and Sago pondweed (*Potamogeton pectinatus*) constituted the most common species at Keith Sebelius Reservoir. Presence of all submerged aquatic vegetation species diversify littoral zone habitats within the reservoir and effectively act as escape habitat for young fish and foraging habitat for adult fish. Submerged aquatic beds create shade, thus lowering water temperatures immediately below the bed providing a thermal refuge during summer. Submerged aquatic macrophyte beds also provide fish concealment from avian predators.

5. Invasive/Exotic Species

Currently there are no invasive species in Keith Sebelius Reservoir. However, limited areas of Phragmites (*Phragmites australis*) are starting to encroach into the reservoir. Quite a few of the draws leading into the reservoir are now being taken over by phragmites and the species will likely keep working its way into the reservoir.

Fisheries Management Objectives

The general objective of fisheries management at Keith Sebelius Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 4), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Specific objectives for Keith Sebelius Reservoir are described below.

1) Create a fish, wildlife, and recreation pool to eliminate drawdowns to elevations lower than 2288.5 MSL and to avoid withdrawals in excess of 30% of the total reservoir content.
2) Realize shad spawns of sufficient quality to produce mean August CPUE values of at least 500 age-0 shad per 0.1-hour EFT (Smith Root) with at least 50% of the sample under 70 mm.
3) Establish wiper year classes of sufficient density to yield 3 age-0 wipers per gill net compliment core-panel net and maintain a standing stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core-panel net with a sample PSD greater than 50.
4) Establish percid year classes (walleye and/or saugeye) of sufficient density to yield 3 age-0 percids per gill net compliment core-panel net and maintain a standing stock reflected by mean fall catch rates of at least 10 fish per gill net compliment core-panel net with a sample PSD greater than 50.
5) Maintain a crappie population capable of producing mean fall catch rates of at least 15 stock length crappies per trap NN with a sample RSD-P of at least 25.
6) Maintain a black bass population (largemouth and spotted bass) capable of producing mean catch rates of at least 100 stock length fish per hour EFT with a sample RSD-P of at least 20.0 (Smith Root, spring).

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Keith Sebelius Reservoir.

1. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Currently, walleye and saugeye have special fish harvest regulations of an 18-inch minimum length in effect at Keith Sebelius Reservoir. See Table 5 below for a comprehensive list of fish harvest regulations in effect at Keith Sebelius Reservoir.

Table 5. Current Fish Harvest Regulations in Effect at Keith Sebelius Reservoir

Species	Length Limit	Creel Limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	N/A	50 fish daily creel limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Spotted Bass	15- inch minimum length limit	5 fish daily creel limit
Walleye	18- inch minimum length limit	5 fish daily creel limit
Saugeye	18- inch minimum length limit	5 fish daily creel limit
Wiper	N/A	5 fish daily creel limit

Source: KDWP 2020

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 6) in accordance with KDWP reservoir survey guidelines.

Table 6. Total Number of Anglers, Angler-Hours, and Mean Trip Length at Keith Sebelius Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler Hours	Mean Trip Length	Angler Hours per Acre
2016	15,950	10.06	43,821.53	2.95	29.21
2014	33,234	22.16	74,116.65	2.86	49.41
2011	27,072	18.05	66,149.10	2.50	44.10
2006	19,526	13.02	42,238.19	2.41	28.16
2005	20,719	13.81	65,087.32	3.30	43.39

Source: KDWP 2022

Table 7. Average Percentages of the Top Four Most Preferred Species by Anglers at Keith Sebelius Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	First	%	Second	%	Third	%	Fourth	%
2016	No Fish Preference	48.0	Saugeye	18.8	Wiper	12.1	Crappie	10.5
2014	Saugeye	35.2	Crappie	27.1	Wiper	17.6	Largemouth Bass	7.2
2011	No Fish Preference	47.0	Crappie	35.1	Largemouth Bass	7.1	Wiper	3.5
2006	No Fish Preference	52.3	Channel Catfish	15.8	Crappie	14.1	Wiper	7.8
2005	No Fish Preference	50.4	Saugeye	15.9	Channel Catfish	15.1	Crappie	8.3

Source: KDWP 2022

Table 8. Estimated Total Number of Sportfish Harvested and Released at Keith Sebelius Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Status	Year	Number of Fish	Weight of Fish (lbs)	Success Rate	Fish Per Angler	Pounds Per Angler
Harvested	2016	7,591	24,327.77	0.56	0.48	1.53
Harvested	2014	20,526	41,251.94	0.28	0.62	1.24
Harvested	2011	25,798	35,613.53	0.39	0.95	1.32
Harvested	2006	6,109	16,527.31	0.14	0.31	0.85
Harvested	2005	9,489	31,702.67	0.15	0.46	1.53
Released	2016	6,847	16,458	0.16	0.43	1.03
Released	2014	66,603	96,419	0.90	2.00	2.90
Released	2011	40,462	44,819	0.61	1.49	1.66
Released	2006	7,015	13,867	0.17	0.36	0.71
Released	2005	11,575	23,102	0.18	0.56	1.12

Source: KDWP 2022

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Black and White Crappie *(Pomoxis sp.)*

Also known as pomoxis, which includes both black and white crappie and are highly sought after. This can be seen from Table 7, which shows the last five creels that were performed and out of all five years crappie are in the top four preferred species every year. They are also the fourth most sought after species, according to the last creel survey conducted in 2016. The crappie population is rather cyclical since Keith Sebelius Reservoir is an irrigation reservoir. When the water level is around conservation pool (2304.30 above msl) they do rather well, however, when the elevation gets below 2290.00 MSL they suffer. Crappie habitat improved considerable over the last 5 years, especially after re-filling in 2016, as can be seen by the total catch numbers in Tables 9 and 10. This is because the reservoir came up and remained around conservation pool or slightly above conservation pool during crappie spawns.

Table 9. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Black Crappie Sampled During October by Trapnets

Metric	2016	2017	2018	2019	2020
Total Catch	151	935	1657	1381	483
Stock Catch	44	80	106	400	197
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	10.7 (19)	85.5 (20)	155.1 (39)	98.1 (28)	28.6 (72)
Stock CPUE (RSE)	4.4 (28)	8.0 (45)	10.6 (16)	40.0 (29)	19.7 (32)
Quality/Density CPUE (RSE)	1.1 (46)	6.0 (56)	6.0 (18)	25.5 (31)	10.9 (39)
Preferred CPUE (RSE)	0.3 (51)	2.2 (66)	2.3 (27)	14.7 (30)	5.9 (39)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.0 (0)	0.1 (100)	1.4 (43)	0.4 (41)
Total CPUE (RSE)	15.1 (17)	93.5 (17)	165.7 (38)	138.1 (23)	48.3 (44)
PSD Stock-Quality (S-D)	75.00	25.00	43.40	36.25	44.67
PSD Quality-Preferred (Q-P)	18.18	47.50	34.91	27.00	25.38
PSD Preferred-Memorable (P-M)	4.55	27.50	20.75	33.25	27.92
PSD (Memorable-Trophy (M-T)	2.27	0.00	0.94	3.50	2.03
PSD	25.00	75.00	56.60	63.75	55.33
Mean WR S-Q (RSE)	98 (1)	98 (1)	104 (1)	105 (0)	108 (1)
Mean WR Q-P (RSE)	97 (1)	101 (1)	105 (1)	111 (1)	105 (1)
Mean WR P-M (RSE)	109 (8)	101 (1)	104 (1)	112 (0)	105 (1)
Mean WR M-T (RSE)	103 (0)	0 (0)	101 (0)	110 (1)	104 (4)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 10. CPUE, PSD, Wr, and RSE Estimates for White Crappie Sampled During October by Trapnets

Metric	2016	2017	2018	2019	2020
Total Catch	56	123	56	36	32
Stock Catch	52	4	7	10	9
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	0.4 (76)	11.9 (26)	4.9 (24)	2.6 (33)	2.3 (73)
Stock CPUE (RSE)	5.2 (24)	0.4 (67)	0.7 (48)	1.0 (39)	0.9 (45)
Quality/Density CPUE (RSE)	3.3 (23)	0.4 (67)	0.5 (45)	1.0 (39)	0.7 (37)
Preferred CPUE (RSE)	0.4 (41)	0.3 (71)	0.0 (0)	0.4 (55)	0.3 (51)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.0 (0)	0.0 (0)	0.2 (67)	0.0 (0)
Total CPUE (RSE)	5.6 (25)	12.3 (25)	5.6 (20)	3.6 (22)	3.2 (53)
PSD Stock-Quality (S-D)	36.54	0.00	28.57	0.00	22.22
PSD Quality-Preferred (Q-P)	55.77	25.00	71.43	60.00	44.44
PSD Preferred-Memorable (P-M)	5.77	75.00	0.00	20.00	33.33
PSD (Memorable-Trophy (M-T)	1.92	0.00	0.00	20.00	0.00
PSD	63.46	100.00	71.43	100.00	77.78
Mean WR S-Q (RSE)	100 (1)	0 (0)	101 (1)	0 (0)	100 (0)
Mean WR Q-P (RSE)	101 (1)	99 (0)	101 (1)	105 (1)	101 (2)
Mean WR P-M (RSE)	97 (1)	98 (3)	0 (0)	105 (0)	101 (1)
Mean WR M-T (RSE)	100 (0)	0 (0)	0 (0)	101 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Catfish (*Ictalurus sp.*)

Channel Catfish and Flathead Catfish both occur in Keith Sebelius Reservoir and are usually in the top four species that anglers target as can be seen from Table 7. However, they did not appear in the top four species, according to the last creel survey conducted in 2016. Channel Catfish numbers typically stay relatively consistent as you can see in Table 11. However, the population typically does better at the higher water elevations than they do at the lower elevations. Flathead Catfish are also sampled and usually occur in lower numbers than Channel Catfish (Table 12). These big catfish can often be seen in the 30 to 50-pound range.

Table 11. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	4	6	6	3	2
Stock Catch	3	5	6	3	2
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	0.1 (100)	0.1 (100)	0.0 (0)	0.0 (0)	0.0 (0)
Stock CPUE (RSE)	0.3 (51)	0.5 (54)	0.6 (37)	0.3 (51)	0.2 (100)
Quality/Density CPUE (RSE)	0.3 (51)	0.2 (67)	0.3 (51)	0.1 (100)	0.0 (0)
Preferred CPUE (RSE)	0.2 (67)	0.1 (100)	0.2 (67)	0.0 (0)	0.0 (0)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.1 (100)	0.2 (67)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	0.4 (55)	0.6 (44)	0.6 (37)	0.3 (51)	0.2 (100)
PSD Stock-Quality (S-D)	0.00	60.00	50.00	66.67	100
PSD Quality-Preferred (Q-P)	33.33	20.00	16.67	33.33	0.00
PSD Preferred-Memorable (P-M)	33.33	0.00	0.00	0.00	0.00
PSD (Memorable-Trophy (M-T)	33.33	20.00	33.33	0.00	0.00
PSD	100.00	40.00	50.00	33.33	0.00
Mean WR S-Q (RSE)	0 (0)	97 (2)	99 (2)	118 (2)	100 (1)
Mean WR Q-P (RSE)	100 (0)	103 (0)	97 (0)	146 (0)	0 (0)
Mean WR P-M (RSE)	100 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR M-T (RSE)	99 (0)	102 (0)	113 (13)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 12. CPUE, PSD, Wr, and RSE Estimates for Flathead Catfish Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	2	2	1	0	0
Stock Catch	2	2	1	0	0
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Stock CPUE (RSE)	0.2 (67)	0.2 (100)	0.1 (100)	0 (0)	0 (0)
Quality/Density CPUE (RSE)	0.2 (67)	0.2 (100)	0.1 (100)	0 (0)	0 (0)
Preferred CPUE (RSE)	0.1 (100)	0.1 (100)	0 (0)	0 (0)	0 (0)
Memorable/Lunker CPUE (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total CPUE (RSE)	0.2 (67)	021 (100)	0.1 (100)	0 (0)	0 (0)
PSD Stock-Quality (S-D)	0.00	0.00	0.00	0.00	0.00
PSD Quality-Preferred (Q-P)	50.00	50.00	100.00	0.00	0.00
PSD Preferred-Memorable (P-M)	50.00	50.00	0.00	0.00	0.00
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	0.00	0.00
PSD	100.00	100.00	100.00	0.00	0.00
Mean WR S-Q (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR Q-P (RSE)	101 (0)	99 (0)	97 (0)	0 (0)	0 (0)
Mean WR P-M (RSE)	103 (0)	109 (0)	0 (0)	0 (0)	0 (0)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Black Bass (*Micropterus sp.)*

Spotted bass along with the largemouth bass are a highly sought-after species at Keith Sebelius Reservoir. Thus, drawing a lot of bass club tournaments from all over Kansas and the surrounding states. Spotted bass numbers have steadily declined the last five years due to the water clarity during sampling and their ability to avoid our sampling techniques. A bass sample taken at night would be much more effective and would reveal a different picture on the population, since spotted bass tend to be up shallow feeding. Thus, producing more spotted bass in the sample.

Spring 2021 electrofishing CPUE for stock length black bass (largemouth bass (67.06) & spotted bass (6.47) combined) was 73.53 fish per hour EFT falling short of the objective of 100. The RSD-P of 72.73 for spotted bass surpassed the objective of 20. Overall, spotted bass numbers were down slightly from the previous year, however, the habitat responsible for this fishery was up at sampling time. This population should make for good fishing as the fish in the RSD S-Q, RSD Q-P and RSD P-M categories grow up and advance through the system. The 15-inch length limit on spotted bass and largemouth bass remains in effect. Bass density at Keith Sebelius Reservoir will hopefully show improvement with the higher water levels that occurred during the spawning season in 2021. Also, a new agreement with the Almena Irrigation District was signed and went into effect June 1, 2017.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Spotted Bass Sampled During May by Electrofishing

Metric	2016	2017	2018	2019	2020
Total Catch	10	28	17	15	4
Stock Catch	10	25	13	11	2
Units of Effort	1.36	1.44	1.6	1.7	1.7
Sub-Stock CPUE (RSE)	0.0 (0)	2.1 (100)	2.5 (100)	2.4 (76)	1.2 (67)
Stock CPUE (RSE)	7.4 (89)	17.4 (52)	8.1 (63)	6.5 (60)	1.2 (100)
Quality/Density CPUE (RSE)	6.6 (88)	13.9 (53)	7.5 (61)	5.9 (60)	1.2 (100)
Preferred CPUE (RSE)	2.9 (76)	4.2 (66)	4.4 (60)	4.7 (69)	0.6 (100)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	7.4 (89)	19.4 (53)	10.6 (70)	8.8 (52)	2.4 (76)
PSD Stock-Quality (S-D)	10.00	20.00	7.69	9.09	0.00
PSD Quality-Preferred (Q-P)	50.00	56.00	38.46	18.18	50.00
PSD Preferred-Memorable (P-M)	40.00	24.00	53.85	72.73	50.00
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	0.00	0.00
PSD	90.00	80.00	92.31	90.91	100.00
Mean WR S-Q (RSE)	97 (0)	104 (2)	99 (0)	111 (0)	0 (0)
Mean WR Q-P (RSE)	100 (2)	105 (1)	109 (2)	107 (7)	107 (0)
Mean WR P-M (RSE)	96 (1)	100 (1)	105 (1)	105 (2)	109 (0)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 14. CPUE, PSD, Wr, and RSE Estimates for Largemouth Bass Sampled During May by Electrofishing

Metric	2016	2017	2018	2019	2020
Total Catch	128	150	235	190	354
Stock Catch	109	83	175	114	273
Units of Effort	1.36	1.44	1.6	1.7	1.7
Sub-Stock CPUE (RSE)	14.0 (21)	46.5 (40)	37.5 (28)	44.7 (24)	47.6 (23)
Stock CPUE (RSE)	80.1 (42)	57.6 (32)	109.4 (17)	67.1 (28)	160.6 (15)
Quality/Density CPUE (RSE)	72.1 (43)	38.9 (37)	65.6 (22)	45.9 (26)	91.2 (15)

Metric	2016	2017	2018	2019	2020
Preferred CPUE (RSE)	38.2 (49)	29.9 (41)	27.5 (20)	12.9 (38)	32.4 (25)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	94.1 (37)	104.2 (33)	146.9 (17)	111.8 (25)	208.2 (16)
PSD Stock-Quality (S-D)	10.09	32.53	40.00	31.58	43.22
PSD Quality-Preferred (Q-P)	42.20	15.66	34.86	49.12	36.63
PSD Preferred-Memorable (P-M)	47.71	51.81	25.14	19.30	20.15
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	0.00	0.00
PSD	89.91	67.47	60.00	68.42	56.78
Mean WR S-Q (RSE)	105 (1)	107 (1)	106 (1)	104 (1)	105 (1)
Mean WR Q-P (RSE)	98 (1)	106 (2)	112 (1)	101 (1)	107 (1)
Mean WR P-M (RSE)	97 (1)	102 (0)	104 (1)	102 (1)	104 (1)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Saugeye (*Stizostedion vitreum x S. canadense*)

The Saugeye is mainly targeted by anglers in the spring and early summer, usually drawing big crowds. However, at Keith Sebelius Reservoir it appears that anglers are targeting them all year long. They are the second most sought after species, according to the last creel survey conducted in 2016. Saugeye grow rather quickly; this is primarily because Prairie Dog Creek is a very productive system. Saugeye have an 18-inch length limit imposed on them and most anglers are fishing for table fare. Most of the waterbodies in the vicinity have either an 18-inch or 21-inch length limit, therefore, when the fish is 18-inches they are usually harvested. The fish are usually healthy, as can be seen by the Mean Wr's over 90 in Table 15.

The objective for a stock CPUE of at least 10 percids (Saugeye & Walleye combined) per gill net compliment core-panel fell just short, with 9.60 Saugeye per gill net being realized. The objective of a sample PSD greater than 50 was also realized, being 67.71. Growth rates were good for all the length groups, being all over the 99. This population should only get better as the RSD S-Q, RSD Q-P, RSD P-M and RSD M-T fish grow up. It is expected that the saugeye harvest will be good in 2022 as 14% of the saugeye sampled in the fall of 2021 were over 18 inches. There were also another 33 Saugeye caught in trap nets (26 Quality and 7 Preferred). There will be some catch and release as can be seen by the RSD S-Q and RSD Q-P numbers. There is an 18-inch minimum length limit in effect for Saugeye.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Saugeye Sampled During October and November by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	59	85	122	96	124
Stock Catch	59	82	119	96	124
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	0.0 (0)	0.3 (51)	0.3 (51)	0.0 (0)	0.0 (0)
Stock CPUE (RSE)	5.9 (12)	8.2 (18)	11.9 (14)	9.6 (16)	12.4 (20)
Quality/Density CPUE (RSE)	4.2 (15)	3.0 (16)	9.4 (15)	6.5 (19)	12.4 (20)
Preferred CPUE (RSE)	2.3 (16)	1.3 (30)	1.9 (28)	1.3 (33)	2.5 (24)
Memorable/Lunker CPUE (RSE)	0.1 (100)	0.4 (41)	0.9 (35)	0.2 (67)	0.0 (0)
Total CPUE (RSE)	5.9 (12)	8.5 (17)	12.2 (14)	9.6 (16)	12.4 (20)
PSD Stock-Quality (S-D)	28.81	63.41	21.01	32.29	0.00
PSD Quality-Preferred (Q-P)	32.20	20.73	63.03	54.17	79.84
PSD Preferred-Memorable (P-M)	37.29	10.98	8.40	11.46	20.16
PSD (Memorable-Trophy (M-T)	1.69	4.88	7.56	2.08	0.00

Metric	2016	2017	2018	2019	2020
PSD	71.19	36.59	78.99	67.71	100.00
Mean WR S-Q (RSE)	103 (1)	104 (1)	103 (1)	106 (1)	0 (0)
Mean WR Q-P (RSE)	96 (1)	102 (1)	102 (1)	104 (1)	108 (1)
Mean WR P-M (RSE)	96 (1)	97 (1)	101 (1)	105 (1)	106 (1)
Mean WR M-T (RSE)	94 (0)	96 (1)	101 (1)	99 (3)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Wiper (*Morone chrysops x M. saxatilis*)

The third most sought-after species, according to the last creel survey conducted in 2016, is the wiper. Wiper numbers are typically relatively stable, and anglers are pretty good at catching them. There is a five fish creel limit, and they grow rather quickly, thus, enticing anglers of all ages and gender. Occasionally they can be caught up in Prairie Dog Creek, however, most of them are caught and harvested in the reservoir itself.

The core-panel gill nets produced 130 wipers (13.00 fish/net) with a sample PSD of 29.87. Fifty-three young of the year wipers were caught in 2021 in core-panel gill nets, therefore, the objective of 3 to 5 per core-panel gill net compliment was meet with 5.30 being realized. Therefore, a pretty good year class was produced in 2019. Stock CPUE in core-panel gill net compliments was 7.70 fish, thus falling just short of the objective of at least 10 fish per core-panel gill net compliment. The PSD objective of greater than 50 was not realized, being 29.87. The physical conditions observed for wipers, as seen by the mean Wr values were satisfactory being all above 98. Overall, CPUE showed a decrease over the 2018 numbers. A lot of nice fish are coming on as verified by the RSD S-Q, RSD Q-P and P-M numbers. Biggest wiper sampled in 2019 weighted 6.17 pounds.

Table 16. CPUE, PSD, Wr, and RSE Estimates for Wiper - WXS Bass Sampled During October and November by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	95	132	261	130	151
Stock Catch	93	119	172	77	130
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	0.2 (100)	1.3 (38)	8.9 (19)	5.3 (28)	2.1 (46)
Stock CPUE (RSE)	9.3 (21)	11.9 (32)	17.2 (18)	7.7 (26)	13.0 (28)
Quality/Density CPUE (RSE)	8.6 (21)	9.6 (28)	11.0 (23)	2.3 (36)	7.8 (23)
Preferred CPUE (RSE)	3.3 (31)	4.2 (29)	5.4 (21)	0.7 (37)	0.8 (41)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.2 (67)	0.0 (0)	0.1 (100)
Total CPUE (RSE)	9.5 (21)	13.2 (31)	26.1 (16)	13.0 (24)	15.1 (27)
PSD Stock-Quality (S-D)	7.53	19.33	36.05	70.13	40.00
PSD Quality-Preferred (Q-P)	56.99	45.38	32.56	20.78	53.85
PSD Preferred-Memorable (P-M)	35.48	35.29	30.23	9.09	5.38
PSD (Memorable-Trophy (M-T)	0.00	0.00	1.16	0.00	0.00
PSD	92.47	80.67	63.95	29.87	60.00
Mean WR S-Q (RSE)	92 (1)	94 (1)	99 (0)	98 (0)	102 (1)
Mean WR Q-P (RSE)	94 (0)	95 (0)	98 (0)	99 (1)	101 (0)
Mean WR P-M (RSE)	93 (0)	96 (0)	97 (0)	98 (1)	99 (1)
Mean WR M-T (RSE)	0 (0)	0 (0)	100 (1)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	101 (0)

Source: KDWP 2021

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard Shad are the main forage species for larger fish species in the reservoir, with typically catch good numbers in the gillnets, as can be seen in the table below (Table 17). KDWP also samples for young-of-the-year (YOY) fish via electrofishing in August (Table 17). This provides a better estimate of the forage availability in the reservoir and the forage size that will help carry the other species through the winter. The management objectives are 500/0.1 hr EFT with 50 percent being under 70 mm.

Table 17. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During October and November by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	85	98	20	20	38
Stock Catch	79	96	20	6	31
Units of Effort	10	10	10	10	10
Sub-Stock CPUE (RSE)	0.6 (51)	0.2 (67)	0.0 (0)	1.4 (52)	0.7 (43)
Stock CPUE (RSE)	7.9 (13)	9.6 (22)	2.0 (30)	0.6 (37)	3.1 (26)
Quality/Density CPUE (RSE)	2.4 (26)	7.5 (25)	2.0 (30)	0.6 (37)	3.0 (26)
Preferred CPUE (RSE)	2.3 (24)	1.0 (45)	0.8 (36)	0.6 (37)	3.0 (26)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	8.5 (12)	9.8 (22)	2.0 (30)	2.0 (39)	3.8 (23)
PSD Stock-Quality (S-D)	69.62	21.88	0.00	0.00	3.23
PSD Quality-Preferred (Q-P)	1.27	67.71	60.00	0.00	0.00
PSD Preferred-Memorable (P-M)	29.11	10.42	40.00	100.00	96.77
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	0.00	0.00
PSD	30.38	78.13	100.00	100.00	96.77
Mean WR S-Q (RSE)	85 (1)	91 (2)	0 (0)	0 (0)	94 (0)
Mean WR Q-P (RSE)	82 (0)	86 (1)	91 (3)	0 (0)	0 (0)
Mean WR P-M (RSE)	95 (2)	84 (2)	87 (5)	96 (5)	100 (2)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 18. Electrofishing Sampling Data for Age-0 Gizzard Shad Done in August at Keith Sebelius Reservoir

Metric	2016	2017	2018*	2019	2020
NO/0.1 HR. EFT	318.3	653.0	694.8	2009.7	2287.3
% < 70 MM	46.65	10.82	25.77	89.98	93.01

Note: *only 8 of the 10 sites were sampled in 2018 due to equipment complications

Future Without Project Projections

Keith Sebelius Reservoir has within its pool allocations a component for irrigation. If irrigation withdrawals continue the reservoir will continue to see wide fluctuations in the amount of water it contains. Typically, the reservoir elevation drops at least 2-4 feet each year for irrigation if enough water is in the reservoir for the irrigation district to use. Recent years have been wetter than normal, however, when it gets dry the reservoir tends to take a downward trend in elevation due to the cumulation of an irrigation release and the lack of water coming into the reservoir. At reduced pool elevations, decreased water quality and reduced habitat availability and diversity limit sportfish population abundance and welfare. When Keith Sebelius Reservoir is at low pool elevations, aquatic resource – based recreational opportunities available to the public, become more limited. This trend is expected to continue in the future with impacts to the reservoir and to reservoir fisheries occurring when the reservoir is at low pool elevations either from lack of inflows, lowering of conservation pool during irrigation releases, and a combination of the two.

While sedimentation will continue to occur (9.2% loss of the MP over the next 50 years) it is not expected to create impacts to reservoir fisheries or their habitat in the future. If the invasive species Phragmites increases at Keith Sebelius Reservoir there could be issues related to reservoir fisheries unable to access habitat (e.g., shorelines, coves) in the future.

Fisheries management objectives will continue to optimize the quality and diversity of angling opportunities through enhancement of population abundance as needed. Fisheries management measures will continue to include fish harvest regulations, fish attractors, stocking as needed, and sampling to monitor trends. Creel surveys for angler use and preferences will also continue to support management of the fisheries. Fish species that inhabit Keith Sebelius Reservoir are not expected to change in the future but will have periods where changes in abundance and shifts in sportfish species dominance occur from conditions that affect habitat quantity and quality, similar to what is now experienced at Keith Sebelius Reservoir.

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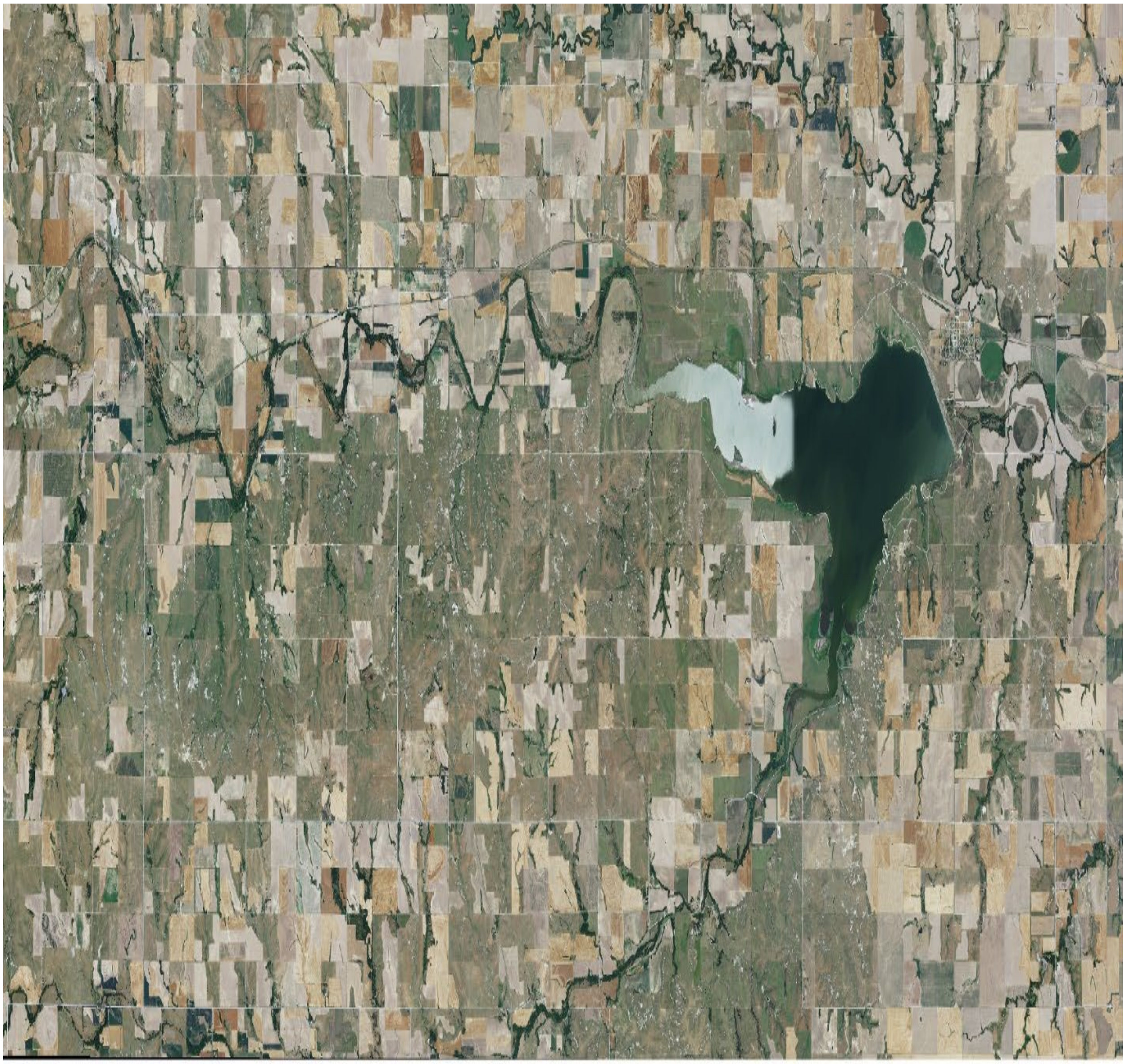
Kansas River Reservoirs Flood and Sediment Study- Reservoir Fishery
Location: Kirwin Reservoir
Mark A. Shaw, District Fisheries Biologist



Kirwin Reservoir Located on the North Fork Solomon River and Bow Creek in Phillips County, Kansas

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History

Aerial View of Kirwin Reservoir

Kirwin Reservoir is located on the North Fork of the Solomon River and Bow Creek, one-half mile south of the town of Kirwin, Kansas. The reservoir is formed by compacted earthen-fill dam, in which water storage began on September 19, 1955. Kirwin reservoir was constructed by the U.S. Bureau of Reclamation (USBR) to be used for flood control and irrigation. The drainage area consists of 1,367 square miles of cultivated and pastureland. At normal pool (elevation 1729.25 feet above mean sea level (MSL)) the reservoir consists of 5,071 surface acres and contains 98,154 acre-feet (ac-ft) of water. At maximum capacity the reservoir can impound 14,660 surface acres and 511,757 ac-ft of water. Row crop farming and pasture are the main uses of the watershed, as the soil types range from fertile silt loam to shallow rocky hillsides.

Water Allocation Background

Kirwin Reservoir was specified as one of three projects (i.e., Kirwin Reservoir, Webster Reservoir, and Cedar Bluff Reservoir) in the Solomon River Basin required to meet flood control and irrigation needs of the basin as part of the Pick-Sloan plan and the Flood Control Act of 1946. The reservoir storage capacity includes 215,136 ac-ft storage for flood control and 89,639 ac-ft for multipurpose use. Kirwin Reservoir currently provides flood control, irrigation, recreation, and fish and wildlife conservation benefits.

Kirwin Reservoir is operated and maintained by the USBR. Water in the flood control capacity is regulated in accordance with instructions furnished by the U.S. Army Corps of Engineers. Water rights are held by the Kirwin Irrigation District. Three canals for irrigation were constructed in 1958 to distribute water to serve 11,435 irrigable acres. Operation and maintenance of canals, laterals, and drains associated with the reservoir are the responsibility of the Kirwin Irrigation District. A petition of organization and an application for water rights were filed with the Division of Water Resources, State of Kansas, by the Kirwin Irrigation District on April 22, 1948, and approved on September 25, 1948. The application is for the maximum use of 35,600 ac-ft of water annually and the storage of all flows of the North Fork Solomon River to a maximum quantity of 80,000 ac-ft. Over the last two decades, less water was available for delivery to the Kirwin Irrigation District due to reduced reservoir elevations, with no deliveries of irrigation waters for a five-year period in the 1980s and early 1990s (USFWS 2006).

The Kirwin National Wildlife Refuge (NWR) was established in 1954 as an overlay project on the irrigation and flood control reservoir. U.S. Fish and Wildlife refuge staff manage all activities on the reservoir and its surrounding lands, except for irrigation and flood control. The primary purpose of the Kirwin NWR is to provide nesting cover, food and shelter for songbirds, waterfowl, upland game birds, and mammals. The storage capacity and water rights are shown in Table 1.

Table 1. Storage Capacity and Ownership

Pool Owner / Water Rights	Purpose	Quantity (acre-feet [ac-ft])*
USBR	Flood Control	215,136
USBR	Multipurpose	89,639
Kirwin Irrigation District	Irrigation	35,600

Kirwin Reservoir Fishery

Fisheries Establishment

Tables 2 and 3 list sport fish and non-sport fish in Kirwin Reservoir. Most of the extant (i.e. still present) sportfish species that currently inhabit Kirwin Reservoir were stocked within the first decade of post-impoundment. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the *Sportfish Population Dynamics & Trends* section.

Table 2. Sport and Non-Sport Fish Species Known to Inhabit Kirwin Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Kirwin Reservoir

Common Name	Scientific Name
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Creek Chub	*Semotilus atromaculatus*
Fathead Minnow	*Pimephales promelas*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Orangespotted sunfish	*Lepomis humilus*
Ozark Logperch	*Percina caprodes fulvitaenia*
Plains Killifish	*Fundulus zebrinus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. General Limnology

The Trophic State Index (TSI) is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels, and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentration over 7 g/l and hypereutrophy occurs at levels over 30 g/l. The TSI for Kirwin Reservoir was 61.73 which classifies it at very eutrophic. The Carlson TSI derives from the chlorophyll concentrations and scales the trophic state as follows: 1. Oligotrophic TSI < 40 2. Mesotrophic TSI: 40 - 49.99 3. Slightly Eutrophic TSI: 50 - 54.99 4. Fully Eutrophic TSI: 55 - 59.99 5. Very Eutrophic TSI: 60 - 63.99 6. Hypereutrophic TSI: 64.

Table 4. General Limnological Parameters Characteristic of Kirwin Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	3445.0
Max depth	feet	39.4
Mean depth	feet	16.0
Mean annual precipitation	inches	25.5
Mean annual runoff	inches	0.8
Area watershed drainage	square miles	1156.0
Hydrologic residence time	days	822.0
Chlorophyll a	parts per billion	12.1
Secchi depth	centimeters	147.0
Shoreline development index	ratio	3.4
Agricultural lands	%	46.5
Forest habitat	%	0.1
Grassland habitat	%	47.2
Urban lands	%	3.5
*Trophic state index		61.7

Note: ***Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuations

Irrigation is a main part of Kirwin Reservoir as can be seen in the graph below. Irrigation releases from Kirwin Reservoir typically start in middle June and are not shut off until late August. Typically, the North Fork Solomon River and Bow Creek do not flow enough water to keep up with irrigation releases. The reservoir is usually drawn down between three to five feet annually. Once releases are shut off the reservoir will typically gain one to two feet of water back over the winter, depending on rain events, and if the North Fork Solomon and Bow Creek are flowing. These conditions are what makes Figure 1 look so jagged in nature. It is not unusual for the reservoir to be 15 to 20 feet below conservation pool and it has been down around 30 feet a few different times since construction. Once the reservoir gets this low it usually takes a significant rain event or series of events to get it back up to conservation pool.

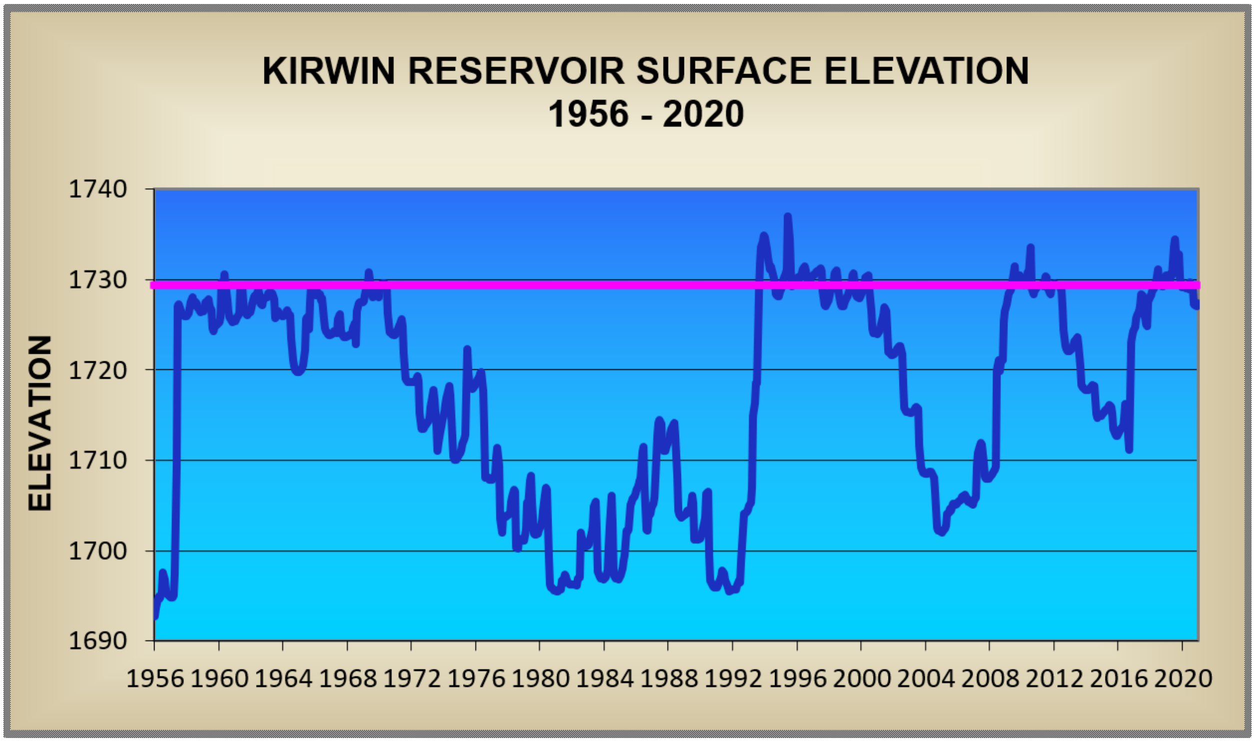


Figure 1. Yearly Ending Reservoir Pool Elevation (feet above MSL) [blue line] in Relation to Full Conservation Pool Elevation [red line] and total annual precipitation [vertical columns] Recorded by USBR at Kirwin Reservoir from 1956 to 2020

Characteristic of, but not limited to Kirwin Reservoir, the commonly shrinking reservoir pool often leaves large areas within the basin dewatered for several years and allows establishment of terrestrial vegetation. When inundation of this vegetation occurs during periods of increased precipitation habitat availability for sportfish can increase. Substantial water level rises promote increased primary productivity resulting from the trophic upsurge associated with flooding of the dewatered reservoir basin. This and change in reservoir trophic status, results in a shift in sportfish species dominance. This translates into increased sportfish body condition and growth. Improved welfare of structure-oriented species occurs until habitat degradation (decomposition) or reduced water availability (receding levels) again limits production and recruitment of this sportfish assemblage. In contrast, primary productivity is reduced during years of declining reservoir levels due to a lack of nutrient input from the watershed above. When suitability or availability of flooded terrestrial vegetation declines, dominance of open-water sportfish increases.

3. Sedimentation

The multipurpose pool at Kirwin Reservoir originally included 99,432 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 1.3% of the multipurpose pool has been filled in with sediment leaving approximately 98,154 ac-ft of capacity (based on 1996 survey results). Sediment will continue to accumulate in Kirwin Reservoir with an expected additional 1.7 % loss of the multipurpose pool over the next 25 years (2049) and 2.4% loss over the next 50 years (2074) (USACE 2022).

4. Vegetated Fisheries Habitat

Vegetated fisheries habitats occurring in and adjacent to Kirwin Reservoir consists of terrestrial and emergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. After flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

B. Emergent

Smartweed (*Polygonum* sp.) is the primary emergent aquatic vegetation at Kirwin. Smartweed seeds are heavily consumed by ducks, small birds, and small mammals. Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates.

C. Submergent

Typically, Kirwin Reservoir does not contain submergent vegetation in the littoral zone. This is primarily due to the wide fluctuations in water levels. When the reservoir is down below the top of conservation pool most of the area is allowed to vegetate naturally with terrestrial species.

5. Invasive/Exotic Species

Currently there are no invasive species in Kirwin Reservoir. However, limited areas of Phragmites (*Phragmites australis*) are starting to encroach into the reservoir. Quite a few of the draws leading into the reservoir are now being taken over by phragmites and the species will likely keep working its way into the reservoir.

Fisheries Management Objectives

The general objective of fisheries management at Kirwin Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 5), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Specific objectives for Kirwin Reservoir are listed below:

1. Create a fish, wildlife, and recreation pool to eliminate irrigation drawdowns to elevations lower than 1702.0 msl and avoid withdrawals more than 45% of the total reservoir content.

2. Realize gizzard shad spawns of sufficient quality to provide mean August CPUE values of at least 250 age-0 shad per 0.1-hour EFT (Smith Root) with at least 50 percent of the sample under 70 mm.
3. Establish walleye year classes of sufficient density to yield at least 3 to 5 age-0 walleyes per gill net compliment core panel net and maintain a standing stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core panel net with a sample PSD greater than 40.
4. Establish wiper year classes of sufficient density to yield at least 3 to 5 age-0 wipers per gill net compliment core panel net and maintain a standing stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core panel net with a sample PSD greater than 50.
5. Maintain a white bass population capable of producing catch rates of at least 3 to 5 age-0 white bass per gill net compliment core panel net and maintain a standing stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core panel net with a sample PSD at or above 50.
6. Maintain a largemouth bass population capable of producing mean catch rates of at least 20 stock length bass per hour EFT with a sample RSD-P of at least 25 (Smith Root, spring).
7. Maintain a crappie population capable of producing mean fall catch rates of at least 20 stock length crappies (black and white combined) per trap NN with a sample RSD-P of at least 15.
8. Kirwin Reservoir has been utilized in the past as a source of walleye eggs as part of our statewide project. Where adult males and females are collected, eggs are removed from the females before returning them back into the water. Then the eggs are fertilized using the males and then the males are returned into the water. However, when Kirwin is not utilized as a source of walleye brood fish, it remains as a backup reservoir if the need would ever arise.

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Kirwin Reservoir.

1. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Currently, Kirwin Reservoir does not have any special fish harvest regulations in effect and are following all state regulated harvest requirements. See Table 5 below for a comprehensive list of fish harvest regulations in effect at Kirwin Reservoir.

Table 5. Current Fish Harvest Regulations in Effect at Kirwin Reservoir

Species	Length Limit	Creel Limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	N/A	50 fish daily creel limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Walleye	15- inch minimum length limit	5 fish daily creel limit
Wiper	N/A	5 fish daily creel limit

Source: KDWP 2020

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 6) in accordance with KDWT reservoir survey guidelines.

Table 6. Total Number of Anglers, Angler-hours, and Mean Trip Length at Kirwin Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler Hours	Mean Trip Length	Angler Hours per Acre
2018	10,178	2.54	45,349.76	4.75	11.34
2013	9,645	2.41	25,093.62	3.18	6.27
2007	7,468	1.87	18,050.05	2.45	4.51
2005	19975	4.99	50,848.03	2.39	12.71
2000	16,711	4.18	67,023.15	4.19	16.76

Source: KDWP 2022

Table 7. Average Percentages of the Top Four Most Preferred Species by Anglers at Kirwin Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	First		Second		Third		Fourth	
2018	White Bass	23.7	Catfish	21.4	Crappie	19.6	Walleye	19.3
2013	No Fish Preference	55.4	Crappie	37.1	Walleye	7.6	N/A	N/A
2007	Channel Catfish	36.0	Walleye	31.7	Wiper	19.5	Crappie	7.1
2005	No Fish Preference	41.3	Channel Catfish	24.4	Wiper	13.7	Crappie	9.1
2000	Walleye	30.9	Crappie	21.2	No Fish Preference	19.4	Wiper	13.2

Source: KDWP 2022

Table 8. Estimated Number of Sportfish Harvested and Released at Kirwin Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Number of Fish	Weight of Fish (lbs)	Success Rate	Fish Per Angler	Pounds Per Angler
Harvested					
2018	19,218	37,062.21	0.42	1.89	3.64
2013	18,400	21,861.07	0.73	1.91	2.27
2007	2,090	9,035.74	0.12	0.28	1.21
2005	24,945	87,220.13	0.49	1.25	4.37
2000	17,271	31,556.57	0.26	1.03	1.89
Released					
2018	11,522	11,176	0.25	1.13	1.10
2013	4,008	4,229	0.16	0.42	0.44
2007	1,282	3,511	0.07	0.17	0.47
2005	10,758	23,342	0.21	1.54	1.17
2000	11,293	19,068	0.17	0.68	1.14

Source: KDWP 2022

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Black and White Crappie *(Pomoxis sp.)*

Also known as pomoxis, which includes both black and white crappie and are highly sought after. This can be seen from Table 9, which shows the last five creels that were performed and out of all five years crappie are in the top four preferred species every year. They are also the third most sought after species, according to the last creel survey conducted in 2018. The crappie population is rather cyclical, due to the fact that Kirwin is an irrigation reservoir. When the water level is around conservation pool (1729.25 above msl) they do rather well, however, when the elevation gets below 1720 msl they suffer. Crappie habitat improved considerable over the last 5 years, especially after re-filling in 2016, as can be seen by the total catch numbers in Tables 9 and 10. This is since the reservoir came up and remained around conservation pool or slightly above conservation pool during crappie spawns.

Table 9. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Black Crappie Sampled During October by Trapnets

Metric	2016	2017	2018	2019	2020
Total Catch	226	2301	1284	416	533
Stock Catch	7	299	522	273	257
Units of Effort	16	16	16	16	16
Sub-Stock CPUE (RSE)	13.7 (24)	125.1 (27)	47.6 (27)	8.9 (43)	17.3 (35)
Stock CPUE (RSE)	0.4 (29)	18.7 (23)	32.6 (25)	17.1 (40)	16.1 (42)
Quality/Density CPUE (RSE)	0.4 (33)	18.3 (23)	17.3 (25)	14.8 (41)	13.2 (43)
Preferred CPUE (RSE)	0.4 (33)	0.5 (55)	3.4 (22)	13.1 (45)	11.7 (44)
Memorable/Lunker CPUE (RSE)	0.1 (68)	0.1 (100)	0.3 (45)	0.8 (39)	3.6 (41)
Total CPUE (RSE)	14.1 (23)	143.8 (23)	80.3 (16)	26.0 (30)	33.3 (23)
PSD Stock-Quality (S-D)	14.29	2.01	46.93	13.55	17.9
PSD Quality-Preferred (Q-P)	0.00	95.32	42.53	9.52	9.34
PSD Preferred-Memorable (P-M)	57.14	2.34	9.77	72.53	50.19
PSD (Memorable-Trophy (M-T)	28.57	0.33	0.77	4.40	22.57
PSD	85.71	97.99	53.07	86.45	82.1
Mean WR S-Q (RSE)	97 (0)	103 (1)	103 (0)	111 (2)	109 (1)
Mean WR Q-P (RSE)	0 (0)	106 (0)	104 (0)	105 (1)	110 (1)
Mean WR P-M (RSE)	100 (1)	110 (1)	103 (0)	111 (0)	107 (0)
Mean WR M-T (RSE)	102 (1)	110 (0)	107 (1)	108 (1)	105 (1)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 10. CPUE, PSD, Wr, and RSE Estimates for White Crappie Sampled During October by Trapnets

Metric	2016	2017	2018	2019	2020
Total Catch	767	1300	1832	143	209
Stock Catch	11	54	165	12	11
Units of Effort	16	16	16	16	16
Sub-Stock CPUE (RSE)	47.3 (24)	77.9 (30)	104.2 (38)	8.2 (34)	12.4 (73)

Metric	2016	2017	2018	2019	2020
Stock CPUE (RSE)	0.7 (34)	3.4 (35)	10.3 (40)	0.8 (48)	0.7 (37)
Quality/Density CPUE (RSE)	0.7 (34)	3.1 (34)	9.8 (39)	0.8 (48)	0.7 (37)
Preferred CPUE (RSE)	0.7 (34)	0.9 (50)	3.1 (42)	0.4 (51)	0.3 (48)
Memorable/Lunker CPUE (RSE)	0.3 (45)	0.3 (63)	1.3 (39)	0.3 (68)	0.3 (45)
Total CPUE (RSE)	47.9 (24)	81.3 (29)	114.5 (34)	8.9 (30)	13.1 (69)
PSD Stock-Quality (S-D)	0.00	7.41	5.45	0.00	0.00
PSD Quality-Preferred (Q-P)	0.00	64.81	64.24	41.67	54.55
PSD Preferred-Memorable (P-M)	63.64	18.52	17.58	25.00	9.09
PSD (Memorable-Trophy (M-T)	36.36	9.26	12.73	33.33	27.27
PSD	100.00	92.59	94.55	100.00	100.00
Mean WR S-Q (RSE)	0 (0)	106 (9)	102 (1)	0 (0)	0 (0)
Mean WR Q-P (RSE)	0 (0)	109 (1)	105 (0)	105 (3)	104 (1)
Mean WR P-M (RSE)	111 (2)	117 (2)	107 (1)	115 (6)	113 (0)
Mean WR M-T (RSE)	110 (3)	105 (1)	106 (1)	112 (1)	102 (2)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	99 (0)

Source: KDWP 2021

Catfish (*Ictalurus spp.*)

Channel Catfish and Flathead Catfish both occur in Kirwin Reservoir and are usually in the top four species that anglers target as can be seen from Table 11. They are also the second most sought-after species, according to the last creel survey conducted in 2018. Channel Catfish numbers typically stay relatively consistent as you can see in Table 10 and Flathead numbers are about the same as you can see in table 12. However, the population typically does better at the higher water elevations than they do at the lower elevations. Flathead Catfish are also sampled and usually occur in lower numbers than channel catfish. These big cats can often be seen in the 30 to 50-pound range.

Table 11. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	11	21	29	21	21
Stock Catch	11	14	27	16	20
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.6 (58)	0.2 (67)	0.4 (36)	0.1 (100)
Stock CPUE (RSE)	0.9 (43)	1.2 (25)	2.3 (20)	1.3 (19)	1.7 (33)
Quality/Density CPUE (RSE)	0.6 (49)	1.0 (28)	1.8 (23)	0.9 (25)	0.8 (29)
Preferred CPUE (RSE)	0.0 (0)	0.1 (100)	0.6 (39)	0.2 (67)	0.0 (0)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	0.9 (43)	1.8 (24)	2.4 (20)	1.8 (21)	1.8 (33)
PSD Stock-Quality (S-D)	36.36	14.29	22.22	31.25	55.00
PSD Quality-Preferred (Q-P)	63.64	78.57	51.85	56.25	45.00
PSD Preferred-Memorable (P-M)	0.00	7.14	22.22	12.50	0.00
PSD (Memorable-Trophy (M-T)	0.00	0.00	3.70	0.00	0.00
PSD	63.64	85.71	77.78	68.75	45
Mean WR S-Q (RSE)	98 (2)	121 (22)	98 (2)	95 (1)	103 (1)
Mean WR Q-P (RSE)	100 (2)	104 (2)	102 (1)	102 (2)	100 (2)
Mean WR P-M (RSE)	0 (0)	115 (0)	104 (2)	102 (4)	0 (0)
Mean WR M-T (RSE)	0 (0)	0 (0)	136 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 12. CPUE, PSD, Wr, and RSE Estimates for Flathead Catfish Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	1	1	3	7	3
Stock Catch	1	1	3	7	3
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Stock CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (72)	0.6 (33)	0.3 (52)
Quality/Density CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (72)	0.4 (46)	0.2 (67)
Preferred CPUE (RSE)	0.0 (0)	0.1 (100)	0.1 (100)	0.1 (100)	0.0 (0)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (72)	0.6 (33)	0.3 (52)
PSD Stock-Quality (S-D)	0.00	0.00	0.00	28.57	33.33
PSD Quality-Preferred (Q-P)	100.00	0.00	66.67	57.14	66.67
PSD Preferred-Memorable (P-M)	0.00	100.00	0.00	14.29	0.00
PSD (Memorable-Trophy (M-T)	0.00	0.00	33.33	0.00	0.00
PSD	100	100	100	71.43	66.67
Mean WR S-Q (RSE)	0 (0)	0 (0)	0 (0)	100 (2)	111 (0)
Mean WR Q-P (RSE)	99 (0)	0 (0)	100 (0)	98 (1)	101 (4)
Mean WR P-M (RSE)	0 (0)	100 (0)	0 (0)	102 (0)	0 (0)
Mean WR M-T (RSE)	0 (0)	0 (0)	92 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Walleye (*Sander vitreus*)

The walleye is mainly targeted by anglers in the spring and early summer, usually drawing big crowds. However, at Kirwin Reservoir it appears that anglers are targeting them all year long. They are also the fourth most sought after species, according to the last creel survey conducted in 2018. Walleye grow rather quickly; this is primarily since the North Fork Solomon River is a very productive system. Walleye have a 15-inch length limit imposed on them and most anglers are out looking for table fare. Most of the waterbodies around have either an 18-inch or 21-inch length limit, therefore, when the fish hits 15-inches they are usually harvested. The fish are usually pretty healthy, as can be seen by the Mean Wr's over 90 in Table 13.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Walleye Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	20	54	36	27	59
Stock Catch	18	46	36	27	58
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.2 (67)	0.7 (50)	0.0 (0)	0.0 (0)	0.1 (100)
Stock CPUE (RSE)	1.5 (31)	3.8 (29)	3.0 (24)	2.3 (17)	4.8 (16)
Quality/Density CPUE (RSE)	0.9 (34)	3.4 (30)	2.0 (30)	2.1 (16)	1.8 (18)
Preferred CPUE (RSE)	0.4 (36)	0.9 (37)	0.8 (46)	0.6 (45)	0.6 (33)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)	0.2 (67)
Total CPUE (RSE)	1.7 (29)	4.5 (27)	3.0 (24)	2.3 (17)	4.9 (16)
PSD Stock-Quality (S-D)	38.89	10.87	33.33	7.41	62.07
PSD Quality-Preferred (Q-P)	33.33	65.22	38.89	66.67	25.86
PSD Preferred-Memorable (P-M)	27.78	21.74	27.78	25.93	8.62
PSD (Memorable-Trophy (M-T)	0.00	2.17	0.00	0.00	3.45
PSD	61.11	89.13	66.67	92.59	37.93

Metric	2016	2017	2018	2019	2020
Mean WR S-Q (RSE)	97 (2)	92 (1)	96 (1)	98 (3)	98 (1)
Mean WR Q-P (RSE)	91 (3)	97 (1)	96 (1)	97 (1)	97 (1)
Mean WR P-M (RSE)	95 (1)	97 (1)	98 (1)	103 (3)	102 (3)
Mean WR M-T (RSE)	0 (0)	97 (0)	0 (0)	0 (0)	95 (2)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

White Bass (*Morone chrysops*)

The first most sought after species, according to the last creel survey conducted in 2018, is the white bass. White bass numbers are typically relatively stable, and anglers are pretty good at catching them. There is no creel limit, and they grow rather quickly, thus, enticing anglers of all ages and gender. Occasionally they can be caught up in the North Fork Solomon River when they spawn, however, most of them are caught and harvested in the reservoir itself.

Table 14. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	93	118	17	113	63
Stock Catch	93	117	17	113	63
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)	0.0 (0)
Stock CPUE (RSE)	7.8 (35)	9.8 (18)	1.4 (51)	9.4 (27)	5.3 (23)
Quality/Density CPUE (RSE)	5.6 (31)	6.0 (15)	1.4 (51)	9.3 (28)	5.1 (23)
Preferred CPUE (RSE)	1.8 (33)	2.1 (22)	0.8 (64)	8.1 (29)	4.4 (23)
Memorable/Lunker CPUE (RSE)	0.4 (46)	0.3 (43)	0.1 (100)	0.0 (0)	0.1 (100)
Total CPUE (RSE)	7.8 (35)	9.8 (18)	1.4 (51)	9.4 (27)	5.3 (23)
PSD Stock-Quality (S-D)	27.96	38.46	0.00	0.88	3.17
PSD Quality-Preferred (Q-P)	49.46	40.17	41.18	13.27	12.70
PSD Preferred-Memorable (P-M)	17.20	17.95	52.94	85.84	82.54
PSD (Memorable-Trophy (M-T)	5.38	3.42	5.88	0.00	1.59
PSD	72.04	61.54	100.00	99.12	96.83
Mean WR S-Q (RSE)	97 (1)	86 (1)	0 (0)	92 (0)	106 (4)
Mean WR Q-P (RSE)	99 (1)	83 (1)	96 (1)	96 (1)	96 (2)
Mean WR P-M (RSE)	97 (1)	81 (3)	99 (1)	95 (0)	94 (1)
Mean WR M-T (RSE)	98 (3)	81 (6)	100 (0)	0 (0)	90 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard Shad are the main forage species in the reservoir. Typically catch good numbers in the gillnets as can be seen in Table 15. KDWP also samples for young-of-the-year (YOY) fish via electrofishing in August (Table 16). This gives us a better idea of the forage that's in the reservoir and the size that will help carry the other species through the winter. The reservoirs management objectives are 250/0.1 hr EFT with 50 percent being under 70 mm.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	123	123	95	36	97
Stock Catch	123	118	93	36	82
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.4 (46)	0.2 (100)	0.0 (0)	1.3 (52)
Stock CPUE (RSE)	10.3 (30)	9.8 (15)	7.8 (16)	3.0 (25)	6.8 (14)
Quality/Density CPUE (RSE)	8.6 (31)	7.8 (21)	7.8 (16)	2.9 (26)	6.8 (14)
Preferred CPUE (RSE)	3.3 (31)	6.2 (22)	2.2 (11)	1.9 (33)	5.5 (10)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	10.3 (30)	10.3 (15)	7.9 (16)	3.0 (25)	8.1 (15)
PSD Stock-Quality (S-D)	16.26	21.19	0.00	2.78	0.00
PSD Quality-Preferred (Q-P)	51.22	16.10	72.04	33.33	19.51
PSD Preferred-Memorable (P-M)	32.52	62.71	27.96	63.89	80.49
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	0.00	0.00
PSD	83.74	78.81	100.00	97.22	100.00
Mean WR S-Q (RSE)	89 (1)	105 (1)	0 (0)	79 (0	0 (0)
Mean WR Q-P (RSE)	88 (1)	111 (2)	89 (1)	89 (4)	90 (2)
Mean WR P-M (RSE)	92 (1)	106 (1)	93 (1)	87 (2)	91 (1)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 16. Electrofishing Sampling Data for Age-0 Gizzard Shad Done in August at Kirwin Reservoir

Metric	2016	2017	2018*	2019	2020
NO/0.1 HR. EFT	617.2	53.5	16.2	1294.7	467.3
% < 70 MM	62.5	56.6	19.2	45.8	50.4

Note: *only 5 of the 10 sites were sampled in 2018 due to equipment complications.

Future Without Project Projections

Kirwin Reservoir has within its pool allocations a component for irrigation. If irrigation withdrawals continue the reservoir will continue to see wide fluctuations in the amount of water it contains. Typically, the reservoir elevation drops at least 4-5 feet each year for irrigation if enough water is in the reservoir for the irrigation district to use. Recent years have been wetter than normal, however, when it gets dry the reservoir tends to take a downward trend in elevation due to the cumulation of an irrigation release and the lack of water coming into the reservoir. At reduced pool elevations, decreased water quality and reduced habitat availability and diversity limit sportfish population abundance and welfare. When Kirwin Reservoir is at low pool elevations, aquatic resource – based recreational opportunities available to the public, become more limited. This trend is expected to continue in the future with impacts to the reservoir and to reservoir fisheries occurring when the reservoir is at low pool elevations either from lack of inflows, lowering of conservation pool during irrigation releases, and a combination of the two.

While sedimentation will continue to occur (2.4% loss of the MP over the next 50 years) it is not expected to create impacts to reservoir fisheries or their habitat in the future. If the invasive species Phragmites increases at Kirwin Reservoir there could be issues related to reservoir fisheries unable to access habitat (e.g., shorelines, coves) in the future.

Fisheries management objectives will continue to optimize the quality and diversity of angling opportunities through enhancement of population abundance as needed. Fisheries management measures will continue to include fish harvest regulations, fish attractors, stocking as needed, and sampling to monitor trends. Creel surveys for angler use and preferences will also continue to support management of the fisheries. Fish species that inhabit Kirwin Reservoir are not expected to change in the future but will have periods where changes in abundance and shift in sportfish species dominance occur from conditions that affect habitat quantity and quality, like what is now experienced at Kirwin Reservoir.

The U.S. Fish and Wildlife Service will continue to manage all activities on the reservoir and its surrounding lands, except for irrigation and flood control. These activities will continue to benefit fish and wildlife species at Kirwin Reservoir.

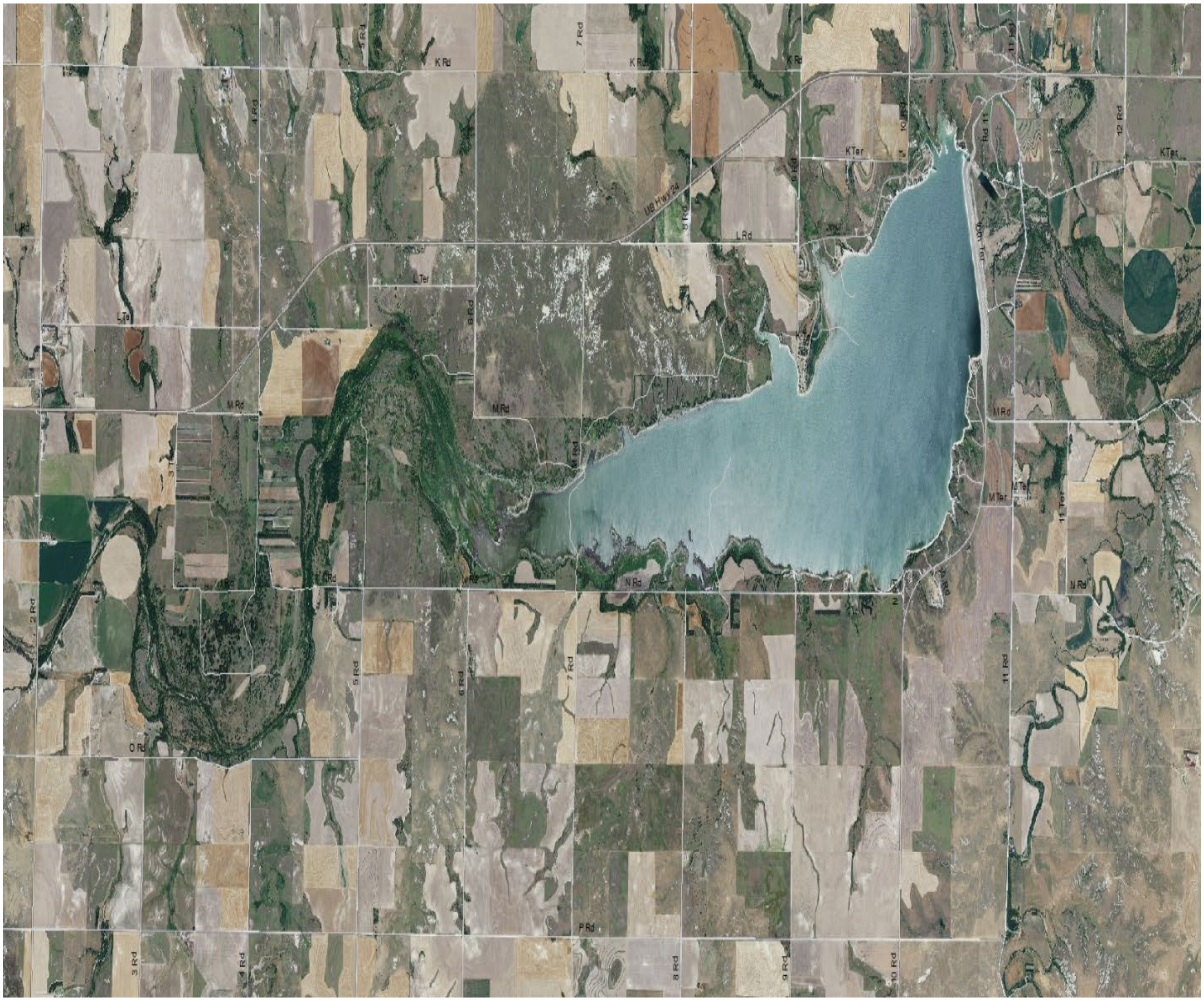
Literature Cited

USACE. 2022. Kansas River Reservoirs Flood and Sediment Study, Appendix X, Reservoir Sedimentation.

USBR. 2006. Comprehensive Conservation Plan, Kirwin National Wildlife Refuge. December

KDWP. 2021. Shaw, M.A. Webster Reservoir Progress and Management Report. Kansas Department of Wildlife and Parks, Fisheries Division. Pratt

Kansas River Reservoirs Flood and Sediment Study - Reservoir Fishery
Location: Webster Reservoir
Mark A. Shaw, District Fisheries Biologist



Webster Reservoir located on the South Fork Solomon River in Rooks County, Kansas

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History

Aerial view of Webster Reservoir

Webster Reservoir is located on the South Fork of the Solomon River, eleven miles west and one-half mile south of Stockton, Kansas. The reservoir is formed by a compacted earthen-fill dam, in which water storage began on May 3, 1956. The drainage area consists of 1,150 square miles of cultivated and pastureland. The reservoir was constructed by the U.S. Bureau of Reclamation (USBR) for flood control and irrigation. At normal pool (elevation 1892.45 feet above mean sea level (MSL)), the reservoir consists of 3,766 surface acres and contains 76,157 acre-feet (ac-ft) of water, with many rocky ledges making up its shoreline. At maximum capacity, elevation 1938.00 MSL the reservoir can impound 11,270 surface acres and 400,422 ac-ft of water. Water levels from 1957 thru 2020 are displayed graphically below in Figure 1.

Water Allocation Background

Webster Reservoir was specified as one of three projects (i.e., Kirwin Reservoir, Webster Reservoir, and Cedar Bluff Reservoir) in the Solomon River Basin required to meet flood control and irrigation needs of the basin as part of the Pick-Sloan plan and the Flood Control Act of 1946. The reservoir storage capacity includes 183,353 ac-ft storage for flood control and 71,926 ac-ft for multipurpose use. Webster Reservoir currently provides flood control, irrigation, recreation, and fish and wildlife conservation benefits.

Webster Reservoir is operated and maintained by the USBR. Water in the flood control capacity is regulated in accordance with instructions furnished by the U.S. Army Corps of Engineers. The primary purpose of Webster Dam is to store water for irrigation of the Webster Unit and for flood control, along with the secondary benefits of recreation and fish and wildlife. The 71,926 ac-ft for multipurpose use is primarily for irrigation. Water rights are held by the Webster Irrigation District Number 4, formed in 1956. Current irrigation infrastructure downstream of Webster Dam includes the Woodson Diversion Dam, four pumping plants, Osborne Irrigation Canal, and a system of laterals and drains. Irrigation water released from Webster Reservoir into the South Fork of the Solomon River is diverted into the Osborne Irrigation Canal at the Woodson Diversion Dam. The Webster Irrigation District has an irrigation water right (approved in June 1956) with the Division of Water Resources, State of Kansas, for 71,700 ac-ft of storage in Webster Reservoir.

Table 1. Storage Capacity and Ownership

Pool Owner/Water Rights	Purpose	Quantity (acre-feet [ac-ft])
USBR	Flood Control	183,353
USBR	Multipurpose	71,926
Webster Irrigation District	Irrigation	71,700

Note: USBR 2012

The Kansas Department of Wildlife and Parks (KDWP) manages Webster State Park, located on the shore of the reservoir, and the Webster Wildlife Area.

Webster Reservoir Fishery

Fisheries Establishment

Striped Bass were stocked into Webster Reservoir in 1974 and 1976. They were last sampled in 1990 and a mounted striped bass hangs in the Webster office that was caught in 1977. No other striped bass have been documented since 1997. Also, an occasional rainbow trout would be caught in the reservoir because they were stocked in the South Fork Solomon River during the winter months in the mid to late 2000's. No rainbow trout have been stocked in the river since 2010. Table 2 provides a list of sport fish and non-sport fish in Webster Reservoir. More detailed treatment of recent species-specific stocking efforts is detailed in species narratives in the *Sportfish Population Dynamics & Trends* section.

Table 2. Sport Fish Species Known to Inhabit Webster Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieu*
Striped Bass	*Morone saxatilis*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Webster Reservoir

Common Name	Scientific Name
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Creek Chub	*Semotilus atromaculatus*
Emerald Shiner	*Notropis atherinoides*

Common Name	Scientific Name
Fathead Minnow	*Pimephales promelas*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Orangespotted sunfish	*Lepomis humilus*
Plains Killifish	*Fundulus zebrinus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Affecting the Fishery

1. General Limnology

The Trophic State Index (TSI) is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels, and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentration over 7 g/l and hypereutrophy occurs at levels over 30 g/l. The TSI for Webster Reservoir was 50.97 which classifies it at slightly eutrophic. The Carlson TSI derives from the chlorophyll concentrations and scales the trophic state as follows: 1. Oligotrophic TSI < 40 2. Mesotrophic TSI: 40 - 49.99 3. Slightly Eutrophic TSI: 50 - 54.99 4. Fully Eutrophic TSI: 55 - 59.99 5. Very Eutrophic TSI: 60 - 63.99 6. Hypereutrophic TSI: 64.

Table 4. General Limnological Parameters Characteristic of Webster Reservoir

Parameter	Unit of Measure	Value
Multipurpose pool size	acres	3445.0
Max depth	feet	42.0
Mean depth	feet	16.0
Mean annual precipitation	inches	24.4
Mean annual runoff	inches	0.8
Area watershed drainage	square miles	1156.0
Hydrologic residence time	days	822.0
Chlorophyll a	parts per billion	12.1
Secchi depth	centimeters	156.0
Shoreline development index	ratio	3.4
Agricultural lands	%	46.5
Forest habitat	%	0.1
Grassland habitat	%	47.2
Urban lands	%	3.5
*Trophic state index		51.0

Note: *Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuations

Irrigation is a main part of Webster Reservoir as can be seen in the graph below. Irrigation releases typically start in middle June and are not shut off until late August. Typically, the South Fork Solomon River does not flow enough water to keep up with irrigation. The reservoir is usually drawn down between three to five feet annually. Once releases are shut off the reservoir will typically gain one to two feet of water back over the winter, depending on rain events and if the South Fork Solomon is flowing. These conditions are what makes the Figure 1 look so jagged in nature. It is not unusual for the reservoir to be 15 to 20 feet below conservation pool and it has been down around 30 feet a couple different times (1972 and 1992) since construction. Once the reservoir gets this low it usually takes a significant rain event or series of events to get it back up to conservation pool.

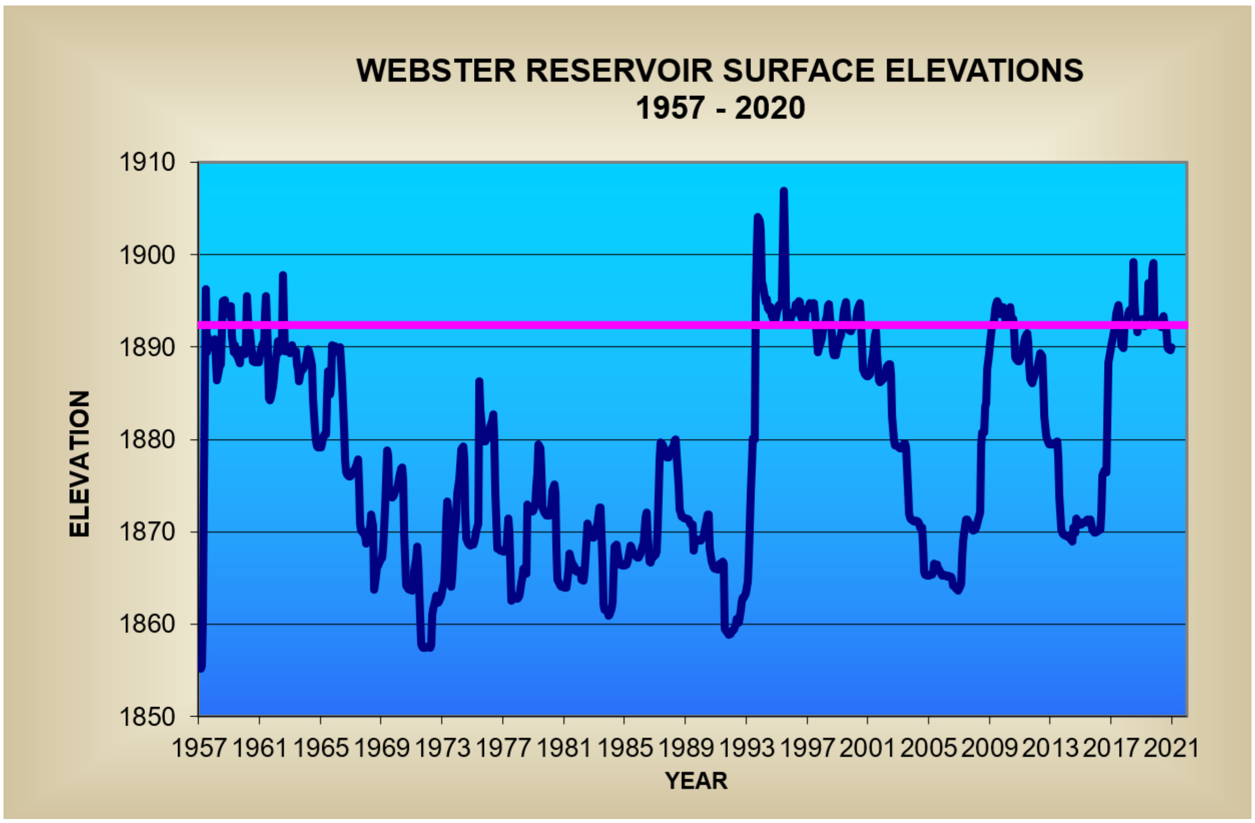

Figure 1. Yearly Ending Reservoir Pool Elevation (feet above MSL) [blue line] in Relation to Full Conservation Pool Elevation [red line] and Total Annual Precipitation [vertical columns] Recorded by USBR at Webster Reservoir from 1957 to 2020

Characteristic of, but not limited to Webster Reservoir, the commonly shrinking reservoir pool often leaves large areas within the basin dewatered for a number of years and allows establishment of terrestrial vegetation. When inundation of this vegetation occurs during periods of increased precipitation habitat availability for sportfish can increase. Substantial water level rises promote increased primary productivity resulting from the trophic upsurge associated with flooding of the dewatered reservoir basin. This and change in reservoir trophic status, results in a shift in sportfish species dominance. This translates into increased sportfish body condition and growth. Improved welfare of structure-oriented species occurs until habitat degradation (decomposition) or reduced water availability (receding levels) again limits production and recruitment of the sportfish assemblage. In contrast, primary productivity is reduced during years of declining reservoir levels due to a lack of nutrient input from the watershed above. When suitability or availability of flooded terrestrial vegetation declines, dominance of open-water sportfish increases.

3. Sedimentation

The multipurpose pool at Webster Reservoir originally included 77,370 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 1.6% of the multipurpose pool has been filled in with sediment leaving approximately 76,103 ac-ft of capacity (based on 1996 survey results). It is estimated that approximately 32 ac-ft of sediment accumulates on average annually in Webster Reservoir. Sediment will continue to accumulate in Webster Reservoir with an expected additional 2.2 % loss of the multipurpose pool over the next 25 years (2049) and 3.3% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 72,034 ac-ft in 2074.

4. Vegetated Fisheries Habitat

Vegetated fisheries habitats occurring in and adjacent to Webster Reservoir consists of terrestrial and emergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation that is common to the area, colonizes the reservoir basin in areas that are dewatered or with reduced levels of inundation during years of low reservoir pool elevation. Subsequent to flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality in localized areas by decreasing dissolved oxygen causing hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species). The degree of lignification that characterizes flooded vegetation determines the ongoing decomposition rate, which impacts the magnitude and duration of oxygen demand.

B. Emergent

American water willow (Justicia americana), an herbaceous perennial wildflower, is an emergent aquatic that usually grows 1-3' above the water line but is also a terrestrial plant of similar height. At Webster Reservoir, water willow was established in the early 2000's to be used as nursery habitat for young of the year fish. Most of the water willow grows within a range that is 2 foot above conservation pool to around 4 feet below conservation pool. Most of the time water willow becomes a terrestrial plant because it is typically high and dry and only becomes emergent once the water levels return to around conservation pool.

C. Submergent

Typically, Webster Reservoir does not contain submergent vegetation in the littoral zone. When the reservoir is down below top of conservation pool most of the area that can be cultivated generally is, or it is allowed to vegetate naturally with terrestrial species.

5. Invasive/Exotic Species

Currently there are no invasive species in Webster Reservoir. However, limited areas of Phragmites (*Phragmites australis*) are starting to encroach into the reservoir. Quite a few of the draws leading into the reservoir are now being taken over by phragmites and the species will likely keep working its way into the reservoir.

Fisheries Management Objectives

The general objective of fisheries management at Webster Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities include tailoring fish harvest regulations to changes in sportfish population trends (see Table 4), stocking fish to enhance population abundance as needed, construction of fish attractors to enhance angling opportunities, and other activities for maintaining/improving angling access.

Specific objectives for Webster Reservoir are listed below.

1) Realize gizzard shad spawns of sufficient quality to provide mean August CPUE values of at least 250 age-0 shad per 0.1-hour EFT (Smith Root) with at least 50% of the sample under 70 mm.
2) Establish walleye year classes of sufficient density to yield at least 3 to 5 age-0 walleye per gill net compliment core panel net and maintain a standing stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core panel net with a sample PSD greater than 40.
3) Establish wiper year classes of sufficient density to yield at least 3 to 5 age-0 wipers per gill net compliment core panel net and maintain a standing stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core panel net gill net with a sample PSD greater than 50.
4) Maintain a white bass population capable of producing catch rates of at least 3 to 5 age-0 white bass per gill net compliment core panel net and maintain a stock reflected by mean fall catch rates of at least 8 fish per gill net compliment core panel net with a sample PSD at or above 50.
5) Maintain a crappie population capable of producing mean fall catch rates of at least 20 stock length crappie (black and white combined) per trap NN with a sample RSD-P of at least 15.

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Webster Reservoir.

1. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Currently, Webster Reservoir does not have any special fish harvest regulations in effect and are following all state regulated harvest requirements. See Table 4 below for a comprehensive list of fish harvest regulations in effect at Webster Reservoir.

Table 5. Current Fish Harvest Regulations in Effect at Webster Reservoir

Species	Length Limit	Creel Limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	N/A	50 fish daily creel limit

Species	Length Limit	Creel Limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Smallmouth Bass	15- inch minimum length limit	5 fish daily creel limit
Trout	N/A	5 fish daily creel limit
Walleye	15- inch minimum length limit	5 fish daily creel limit
Wiper	N/A	5 fish daily creel limit

Source: KDWP 2022

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, (see Table 5) in accordance with KDWP reservoir survey guidelines. Creel surveys are encouraged to be completed a minimum of every 5 years at major reservoirs but are often more frequent following new regulations or during special projects.

Table 6. Total Number of Anglers, Angler-Hours, and Mean Trip Length at Webster Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Angler Trips	Anglers per Acre	Total Angler Hours	Mean Trip Length	Angler Hours per Acre
2002	25,898	7.19	71,559.32	3.43	20.45
2006	13,846	3.96	31,641.20	2.29	9.04
2012	26,769	7.65	37,463.69	2.13	10.70
2017	12,865	3.68	35,572.96	2.95	10.16

Source: KDWP 2022

Table 7. Average Percentages of the Top Four Most Preferred Species by Anglers at Webster Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	First	%	Second	%	Third	%	Fourth	%
2002	Crappie	33.4	Wiper	15.9	Channel Catfish	10.3	No Fish Preference	10.0
2006	Crappie	33.1	Channel Catfish	22.1	White Bass	15.8	No Fish Preference	12.4
2012	No Fish Preference	51.2	Walleye	27.9	Crappie	9.0	White Bass	3.8
2017	Walleye	52.0	Crappie	23.1	Channel Catfish	9.2	White Bass	6.1

Source: KDWP 2022

Table 8. Estimated Total Number of Sportfish Harvested and Released at Webster Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Status	Number of Fish	Weight of Fish (lbs)	Success Rate	Fish Per Angler	Pounds Per Angler
2002	Harvested	19,073	26,425.11	0.27	0.74	1.02
2006	Harvested	15,667	24,380.93	0.77	1.13	1.76
2012	Harvested	14,496	21,490.78	0.39	0.54	0.80
2017	Harvested	39,589	58,429.62	1.11	3.08	4.54
2002	Released	19,974	23,825	0.28	0.77	0.92
2006	Released	7,939	12,747	0.25	0.57	0.92
2012	Released	20,554	23,389	0.55	0.77	0.87
2017	Released	3,331	5,093.91	0.09	0.26	0.40

Source: KDWP 2022

Sportfish Population Dynamics & Trends

Reservoir sportfish species accounts and factors affecting their abundance and distribution are included below. It is notable that inherent variability exists in statistics generated from fish population sampling efforts. Changes in reservoir water level, abundance and distribution of flooded terrestrial vegetation, turbidity or lack thereof, etc. can alter fish behavior and feasibility of deploying sampling gear, thus potentially increasing variability of sampling results. As a result, sampling results must be viewed with a degree of skepticism, require interpretation by workers utilizing the data, and often require a series of greater than one year for representative trends to become apparent.

Black and White Crappie *(Pomoxis sp.)*

Also known as pomoxis, which includes both black and white crappie are highly sought after. This can be seen from Table 6, which shows the last four creels that were performed and out of all four years, crappie are among the top preferred species every year. They are also the second most sought after species, according to the last creel survey conducted in 2017. The crappie population is rather cyclical since Webster Reservoir is an irrigation reservoir. When the water level is around conservation pool (1892.45 above MSL) they do rather well, however, when the elevation gets below 1884 MSL they suffer. Crappie habitat improved considerably over the last four years as can be seen by the total catch numbers in Tables 8 and 9. This is since the reservoir came up and remained around conservation pool or slightly above conservation pool during crappie spawns.

Table 9. Catch Per Unit Effort (CPUE), Proportional Stock Distribution (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Black Crappie Sampled During October by Trapnets

Metric	2016	2017	2018	2019	2020
Total Catch	18	253	212	340	240
Stock Catch	4	161	203	241	124
Units of Effort	16	16	16	16	16
Sub-Stock CPUE (RSE)	0.9 (58)	5.8 (40)	0.6 (43)	6.2 (57)	7.3 (30)
Stock CPUE (RSE)	0.3 (58)	10.1 (26)	12.7 (23)	15.1 (22)	7.8 (12)
Quality/Density CPUE (RSE)	0.3 (58)	5.4 (26)	3.4 (31)	7.3 (24)	6.3 (11)
Preferred CPUE (RSE)	0.1 (100)	0.7 (39)	0.1 (68)	2.6 (23)	2.1 (14)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.4 (48)	0.0 (0)
Total CPUE (RSE)	1.1 (44)	15.8 (28)	13.3 (22)	21.3 (22)	15.0 (16)
PSD Stock-Quality (S-D)	0.00	45.96	72.91	51.87	19.35
PSD Quality-Preferred (Q-P)	75.00	47.20	26.11	31.12	54.03
PSD Preferred-Memorable (P-M)	25.00	6.83	0.99	14.52	26.61
PSD (Memorable-Trophy (M-T)	0.00	0..00	0.00	2.49	0.00
PSD	100.00	54.04	27.09	48.13	80.65
Mean WR S-Q (RSE)	0 (0)	102 (1)	100 (0)	100 (0)	105 (1)
Mean WR Q-P (RSE)	107 (3)	100 (1)	100 (0)	100 (1)	102 (0)
Mean WR P-M (RSE)	100 (0)	100 (1)	103 (1)	102 (1)	102 (1)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	101 (2)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 10. CPUE, PSD, Wr, and RSE Estimates for White Crappie Sampled During October by Trapnets

Metric	2016	2017	2018	2019	2020
Total Catch	8	59	27	184	45
Stock Catch	3	53	22	147	23
Units of Effort	16	16	16	16	16
Sub-Stock CPUE (RSE)	0.3 (63)	0.4 (48)	0.3 (38)	2.3 (63)	1.4 (34)
Stock CPUE (RSE)	0.2 (54)	3.3 (28)	1.4 (27)	9.2 (21)	1.4 (14)
Quality/Density CPUE (RSE)	0.2 (54)	1.6 (41)	1.1 (23)	7.9 (24)	1.1 (16)
Preferred CPUE (RSE)	0.1 (68)	0.0 (0)	0.2 (54)	0.9 (31)	0.3 (45)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.2 (54)	0.0 (0)
Total CPUE (RSE)	0.5 (41)	3.7 (26)	1.7 (23)	11.5 (20)	2.8 (19)
PSD Stock-Quality (S-D)	0.00	52.83	22.73	13.61	21.74
PSD Quality-Preferred (Q-P)	33.33	47.17	63.64	76.87	60.87
PSD Preferred-Memorable (P-M)	66.67	0.00	13.64	7.48	17.39
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	2.04	0.00
PSD	100.00	47.17	77.27	86.39	78.26
Mean WR S-Q (RSE)	0 (0)	97 (1)	96 (2)	99 (1)	95 (1)
Mean WR Q-P (RSE)	105 (0)	97 (1)	100 (1)	101 (0)	100 (1)
Mean WR P-M (RSE)	107 (2)	0 (0)	101 (4)	105 (2)	103 (3)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	104 (3)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Catfish (*Ictalurus sp*.)

Channel Catfish and Flathead Catfish both occur in Webster Reservoir and are usually in the top four species that anglers target as can be seen from Table 6. They are also the third most sought-after species, according to the last creel survey conducted in 2017. Channel Catfish numbers typically stay relatively consistent as you can see in Table 10. However, the population typically does better at the higher water elevations than they do at the lower elevations. Flathead Catfish are also sampled and usually occur in lower numbers than channel catfish (Table 11). These big cats can often be seen in the 30 to 50-pound range.

Table 11. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	11	21	29	21	21
Stock Catch	11	14	27	16	20
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.6 (58)	0.2 (67)	0.4 (36)	0.1 (100)
Stock CPUE (RSE)	0.9 (43)	1.2 (25)	2.3 (20)	1.3 (19)	1.7 (33)
Quality/Density CPUE (RSE)	0.6 (49)	1.0 (28)	1.8 (23)	0.9 (25)	0.8 (29)
Preferred CPUE (RSE)	0.0 (0)	0.1 (100)	0.6 (39)	0.2 (67)	0.0 (0)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	0.9 (43)	1.8 (24)	2.4 (20)	1.8 (21)	1.8 (33)
PSD Stock-Quality (S-D)	36.36	14.29	22.22	31.25	55.00
PSD Quality-Preferred (Q-P)	63.64	78.57	51.85	56.25	45.00
PSD Preferred-Memorable (P-M)	0.00	7.14	22.22	12.50	0.00
PSD (Memorable-Trophy (M-T)	0.00	0.00	3.70	0.00	0.00
PSD	63.64	85.71	77.78	68.75	45
Mean WR S-Q (RSE)	98 (2)	121 (22)	98 (2)	95 (1)	103 (1)

Metric	2016	2017	2018	2019	2020
Mean WR Q-P (RSE)	100 (2)	104 (2)	102 (1)	102 (2)	100 (2)
Mean WR P-M (RSE)	0 (0)	115 (0)	104 (2)	102 (4)	0 (0)
Mean WR M-T (RSE)	0 (0)	0 (0)	136 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 12. CPUE, PSD, Wr, and RSE Estimates for Flathead Catfish Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	1	1	3	7	3
Stock Catch	1	1	3	7	3
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Stock CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (72)	0.6 (33)	0.3 (52)
Quality/Density CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (72)	0.4 (46)	0.2 (67)
Preferred CPUE (RSE)	0.0 (0)	0.1 (100)	0.1 (100)	0.1 (100)	0.0 (0)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	0.1 (100)	0.1 (100)	0.3 (72)	0.6 (33)	0.3 (52)
PSD Stock-Quality (S-D)	0.00	0.00	0.00	28.57	33.33
PSD Quality-Preferred (Q-P)	100.00	0.00	66.67	57.14	66.67
PSD Preferred-Memorable (P-M)	0.00	100.00	0.00	14.29	0.00
PSD (Memorable-Trophy (M-T)	0.00	0.00	33.33	0.00	0.00
PSD	100.00	100.00	100.00	71.43	66.67
Mean WR S-Q (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	100 (2)	111 (0)
Mean WR Q-P (RSE)	99 (0)	0.0 (0)	100 (0)	98 (1)	101 (4)
Mean WR P-M (RSE)	0.0 (0)	100 (0)	0.0 (0)	102 (0)	0.0 (0)
Mean WR M-T (RSE)	0.0 (0)	0.0 (0)	92 (0)	0.0 (0)	0.0 (0)
Mean WR T+ (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)

Source: KDWP 2021

Walleye (*Sander vitreus*)

The walleye is mainly targeted by anglers in the spring and early summer, usually drawing big crowds. They are also the first most sought after species, according to the last creel survey conducted in 2017. Walleye grow rather quickly primarily due to the fact that the South Fork Solomon River is a very productive system. Walleye have a 15-inch length limit imposed on them and most anglers are out looking for table fare. Most of the waterbodies in the vicinity have either an 18-inch or 21-inch length limit, therefore, when a fish reaches 15-inches they are usually harvested. The fish are usually pretty healthy, as can be seen by the Mean Wr's over 90 in Table 12.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Walleye Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	20	54	36	27	59
Stock Catch	18	46	36	27	58
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.2 (67)	0.7 (50)	0.0 (0)	0.0 (0)	0.1 (100)
Stock CPUE (RSE)	1.5 (31)	3.8 (29)	3.0 (24)	2.3 (17)	4.8 (16)
Quality/Density CPUE (RSE)	0.9 (34)	3.4 (30)	2.0 (30)	2.1 (16)	1.8 (18)
Preferred CPUE (RSE)	0.4 (36)	0.9 (37)	0.8 (46)	0.6 (45)	0.6 (33)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)	0.2 (67)

Metric	2016	2017	2018	2019	2020
Total CPUE (RSE)	1.7 (29)	4.5 (27)	3.0 (24)	2.3 (17)	4.9 (16)
PSD Stock-Quality (S-D)	38.89	10.87	33.33	7.41	62.07
PSD Quality-Preferred (Q-P)	33.33	65.22	38.89	66.67	25.86
PSD Preferred-Memorable (P-M)	27.78	21.74	27.78	25.93	8.62
PSD (Memorable-Trophy (M-T)	0.00	2.17	0.00	0.00	3.45
PSD	61.11	89.13	66.67	92.59	37.93
Mean WR S-Q (RSE)	97 (2)	92 (1)	96 (1)	98 (3)	98 (1)
Mean WR Q-P (RSE)	91 (3)	97 (1)	96 (1)	97 (1)	97 (1)
Mean WR P-M (RSE)	95 (1)	97 (1)	98 (1)	103 (3)	102 (3)
Mean WR M-T (RSE)	0 (0)	97 (0)	0 (0)	0 (0)	95 (2)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

White Bass (*Morone chrysops*)

The fourth most sought-after species, according to the last creel survey conducted in 2017, is the white bass. White bass numbers are typically relatively stable, and anglers are pretty good at catching them. There is no creel limit, and they grow rather quickly, thus, enticing anglers of all ages and gender. Occasionally they can be caught up in the South Fork Solomon River when they spawn, however, most of them are caught and harvested in the reservoir itself.

Table 14. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	93	118	17	113	63
Stock Catch	93	117	17	113	63
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.1 (100)	0.0 (0)	0.0 (0)	0.0 (0)
Stock CPUE (RSE)	7.8 (35)	9.8 (18)	1.4 (51)	9.4 (27)	5.3 (23)
Quality/Density CPUE (RSE)	5.6 (31)	6.0 (15)	1.4 (51)	9.3 (28)	5.1 (23)
Preferred CPUE (RSE)	1.8 (33)	2.1 (22)	0.8 (64)	8.1 (29)	4.4 (23)
Memorable/Lunker CPUE (RSE)	0.4 (46)	0.3 (43)	0.1 (100)	0.0 (0)	0.1 (100)
Total CPUE (RSE)	7.8 (35)	9.8 (18)	1.4 (51)	9.4 (27)	5.3 (23)
PSD Stock-Quality (S-D)	27.96	38.46	0.00	0.88	3.17
PSD Quality-Preferred (Q-P)	49.46	40.17	41.18	13.27	12.70
PSD Preferred-Memorable (P-M)	17.20	17.95	52.94	85.84	82.54
PSD (Memorable-Trophy (M-T)	5.38	3.42	5.88	0.00	1.59
PSD	72.04	61.54	100.00	99.12	96.83
Mean WR S-Q (RSE)	97 (1)	86 (1)	0 (0)	92 (0)	106 (4)
Mean WR Q-P (RSE)	99 (1)	83 (1)	96 (1)	96 (1)	96 (2)
Mean WR P-M (RSE)	97 (1)	81 (3)	99 (1)	95 (0)	94 (1)
Mean WR M-T (RSE)	98 (3)	81 (6)	100 (0)	0 (0)	90 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Gizzard Shad (*Dorosoma cepedianum*)

Gizzard Shad are the main forage species for larger fish species in the reservoir, with typically catch good numbers in the gillnets, as can be seen in the Table 14. KDWP also samples for young-of-the-year (YOY) fish via electrofishing in August (Table 15). This provides a better estimate of the forage availability in the reservoir and the forage size that will help carry the other species through the winter. KDWP management objectives are 250/0.1-hour EFT with 50% being under 70 mm. Webster Reservoir also has emerald shiners that also serve as forage however, they are not sampled on a regular basis but are usually monitored while conducting other sampling and are doing pretty well.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During October by Gillnets

Metric	2016	2017	2018	2019	2020
Total Catch	123	123	95	36	97
Stock Catch	123	118	93	36	82
Units of Effort	12	12	12	12	12
Sub-Stock CPUE (RSE)	0.0 (0)	0.4 (46)	0.2 (100)	0.0 (0)	1.3 (52)
Stock CPUE (RSE)	10.3 (30)	9.8 (15)	7.8 (16)	3.0 (25)	6.8 (14)
Quality/Density CPUE (RSE)	8.6 (31)	7.8 (21)	7.8 (16)	2.9 (26)	6.8 (14)
Preferred CPUE (RSE)	3.3 (31)	6.2 (22)	2.2 (11)	1.9 (33)	5.5 (10)
Memorable/Lunker CPUE (RSE)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Total CPUE (RSE)	10.3 (30)	10.3 (15)	7.9 (16)	3.0 (25)	8.1 (15)
PSD Stock-Quality (S-D)	16.26	21.19	0.00	2.78	0.00
PSD Quality-Preferred (Q-P)	51.22	16.10	72.04	33.33	19.51
PSD Preferred-Memorable (P-M)	32.52	62.71	27.96	63.89	80.49
PSD (Memorable-Trophy (M-T)	0.00	0.00	0.00	0.00	0.00
PSD	83.74	78.81	100.00	97.22	100.00
Mean WR S-Q (RSE)	89 (1)	105 (1)	0 (0)	79 (0	0 (0)
Mean WR Q-P (RSE)	88 (1)	111 (2)	89 (1)	89 (4)	90 (2)
Mean WR P-M (RSE)	92 (1)	106 (1)	93 (1)	87 (2)	91 (1)
Mean WR M-T (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean WR T+ (RSE)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: KDWP 2021

Table 16. Electrofishing Sampling Data for Age-0 Gizzard Shad in August at Webster Reservoir

Metric	2016	2017	2018*	2019	2020
NO/0.1 HR. EFT	617.2	53.5	161.2	1294.7	476.3
% < 70 MM	62.5	56.6	19.2	45.8	50.4

Note *only 5 of the 10 sites were sampled in 2018 due to equipment complications

Future Without Project Projections

Webster Reservoir has within its pool allocations a component for irrigation. If irrigation withdrawals continue the reservoir will continue to see wide fluctuations in the amount of water it contains. Typically, the reservoir elevation drops at least 4-5 feet each year for irrigation if enough water is in the reservoir for the irrigation district to use. Recent years have been wetter than normal, however, when it gets dry the reservoir tends to take a downward trend in elevation due to the cumulation of an irrigation release and the lack of water coming into the reservoir. At reduced pool elevations, decreased water quality and reduced habitat availability and diversity limit sportfish population abundance and welfare. When Webster Reservoir is at low pool elevations, aquatic resource – based recreational opportunities available to the public, become more limited. This trend is expected to continue in the future with impacts to the reservoir and to reservoir fisheries occurring when the reservoir is at low pool elevations either from lack of inflows, lowering of conservation pool during irrigation releases, and a combination of the two.

While sedimentation will continue to occur (3.3% loss of the MP over the next 50 years) it is not expected to create impacts to reservoir fisheries or their habitat in the future. If the invasive species Phragmites increases at Webster Reservoir there could be issues related to reservoir fisheries unable to access habitat (e.g., shorelines, coves) in the future.

Fisheries management objectives will continue to optimize the quality and diversity of angling opportunities through enhancement of population abundance as needed. Fisheries management measures will continue to include fish harvest regulations, fish attractors, stocking as needed, and sampling to monitor trends. Creel surveys for angler use and preferences will also continue to support management of the fisheries. Fish species that inhabit Webster Reservoir are not expected to change in the future but will have periods where changes in abundance and shifts in sportfish species dominance occur from conditions that affect habitat quantity and quality, similar to what is now experienced at Webster Reservoir.

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Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery
Location: Glen Elder Dam/Waconda Lake
Scott Waters, KDWP District Fisheries Biologist

Waconda Lake located on the Solomon River in Osborne and Mitchell Counties, Kansas

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History

Glen Elder Dam and its' reservoir, Waconda Lake, is an impoundment on the Solomon River located in western Mitchell and eastern Osborne counties Kansas, approximately seven miles below the confluence of the North and South Forks of the Solomon River, just west of Glen Elder, Kansas. The dam was authorized and constructed primarily as a flood control structure for the lower Solomon River Valley including the towns of Glen Elder, Beloit, and Simpson, Kansas, by the Flood Control Act of 1946.

When working in conjunction with other flood control reservoirs, the reservoir assists in reducing flooding of the Smoky Hill and Kansas Rivers. The dam was completed in December 1968 at a cost of $13.7 million and the reservoir began to fill immediately. The reservoir has a shoreline of over 100 miles and covers 12,586 surface acres at conservation.

Sunset over Waconda Lake

Water Allocation Background

Glen Elder Dam and Waconda Lake were constructed by the U.S. Bureau of Reclamation (USBR). It was specified as one of six units in the Smoky Hill River Basin required to meet flood control and irrigation needs of the basin. The reservoir storage capacity includes 722,988 acre-feet (ac-ft) storage for flood control and 193,183 ac-ft for multipurpose use. Glen Elder Dam and Waconda Lake currently provides substantial municipal water supply, flood control, irrigation, recreation, fish and wildlife conservation, and pollution abatement benefits.

Releases from Waconda Lake are regulated as outlined in two memorandums of understanding between the State of Kansas and USBR. Releases are made for the City of Beloit, Kansas, the Mitchell County Rural Water District, the long-term water service contract with Glen Elder Irrigation District, and for water right administration. The City of Beloit, Kansas has a 2,000 ac-ft water right, the Mitchell County Rural Water District has a 1,009 ac-ft water right, and the Glen Elder Irrigation District utilizes water to irrigate 21,000 acres of farmland and can requested up to 15,170 ac-ft of storage. The storage capacity and water rights are shown in Table 1.

Table 1. Storage Capacity and Ownership

Pool Owner / Water Rights	Purpose	Quantity (acre-feet (af))
USBR	Flood Control	722,988
USBR	Multipurpose	193,183
City of Beloit, Kansas	Municipal Water Supply	2,000
Mitchell County Rural Water District	Municipal Water Supply	1,009
Glen Elder Irrigation District	Irrigation	15,170

Waconda Lake Fishery

Fisheries Establishment

Table 2. Sport Fish Species Known to inhabit Waconda Lake

Sport Fish Common Name	Sport Fish Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Black Bullhead	*Ameiurus melas*
Blue Catfish	*Ictalurus furcatus*
Channel Catfish	*Ictalurus punctatus*
Bluegill	*Lepomis macrochirus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieu*
Spotted Bass	*Micropterus punctulatus*
Striped Bass	*Morone saxatilis*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3. Non-Sport Fish Species Known to inhabit Waconda Lake

Non-Sport Fish Common Name	Non-Sport Fish Scientific Name
Bigmouth Buffalo	*Ictiobus cyprinellus*
Common Carp	*Cyprinus carpio*
Emerald Shiner	*Notropis atherinoides*
Fathead Minnow	*Pimephales promelas*
Gizzard Shad	*Dorosoma cepedianum*
Golden Shiner	*Notemigonus crysoleucas*
Log Perch	*Percina caprodes*
Longnose Gar	*Lepisosteus osseus*
Orangespotted sunfish	*Lepomis humilus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Suckermouth Minnow	*Phenacobius mirabilis*
Western Mosquitofish	*Gambusia affinis*

Most of the extant sportfish species that currently inhabit Waconda Lake were stocked within the first decade of post-impoundment. Northern pike were stocked in 1969, 1970, 1972, and 1976 but were last sampled in 1986. Saugeye fry were accidentally stocked in the late 1990's but were last sampled in 2002. Both species are no longer known to occur at Waconda Lake. Rainbow trout are occasionally caught in the reservoir as these fish can escape the adjacent park pond where these fish are stocked each winter. Tables 2 and 3 provide lists of sport fish and non-sport fish in Waconda Lake. More detailed treatment of species-specific stocking efforts are explained in species narratives below in the *Sportfish Population Dynamics & Trends* section.

Abiotic and Biotic Factors Effecting the Fishery

1. Water Quality

The impounded lake that is Waconda Lake was characterized as very eutrophic in 2010. This is a change in the productivity level from 2007 when it was classified as eutrophic. The trophic state index (TSI) score increased from 42.6 M in 2007 to 61.5 M in 2010 (Carney, 2010). Mean secchi disc readings over the past 10 years have been 160 centimeters (63 inches). Water turbidity plays an important role in fisheries population dynamics and is an indicator of the productivity of a water body. Highly turbid water can inhibit effective fish feeding whereas clear water may indicate a lack of primary productivity and poor production on the bottom of the food chain. Waconda Lake turbidity falls within the ideal range for Kansas reservoirs. The general limnological parameters characteristic of Waconda Lake are shown in Table 4.

Table 4. General Limnological Parameters Characteristic of Waconda Lake

Parameter	Unit of Measure	Value
Size Multipurpose pool	acres	12,586
Max. Depth	feet	56.2
Mean Depth	feet	19.0
Mean Annual Precipitation	inches	25.9
Mean Annual Runoff	inches	3.9
Area Watershed Drainage	square miles	6835.0
Hydrologic Residence Time	days	409.0
Chlorophyll a	parts per billion	3.4
Secchi	centimeters	160.0
Shoreline Development Index	ratio	4.0
Agricultural Lands	%	49.5
Forest Habitat	%	1.3
Grassland Habitat	%	42.9
Urban Lands	%	4.3
*Trophic State Index		42.6

Note: *Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuation

The Waconda Lake watershed is very large and rarely has a shortage of water able to maintain a relatively constant water level. Two reservoirs are located upstream of Waconda Lake, Webster Reservoir on the South Fork Solomon River, and Kirwin Reservoir on the North Fork Solomon River. These also function as water control and irrigation storage impoundments for the surrounding area. Water levels are normally within 3 feet of the top of the conservation pool elevation of 1455.6 feet, whether high during heavy rainfall events or low during drought conditions (Figure 1). A historic flood event in 1993 caused the water level to reach a record high elevation of 1487.0 feet. Other large flood events forced the water level to reach at least 10 feet above top of conservation pool including 1987 (1471.3 feet), 1995 (1467.1 feet), and

2019 (1466.0 feet). Most droughts cause the reservoir level to decrease to 1451 to 1452, just 4 to 5 feet low, but a significant drought through the 2000's caused the reservoir to reach a record low of 1446.2 feet on December 19, 2006. Since that drought, water levels have been maintained near top of conservation pool with releases most years due to excess amounts of inflow. Water levels play a crucial role in fish production and angler participation. This also has a direct effect on state park visitation and the economy surrounding the reservoir. When compatible with flood control operations, the operating criteria for Waconda Lake provide for a stable or rising pool level during the fish spawning period each spring.

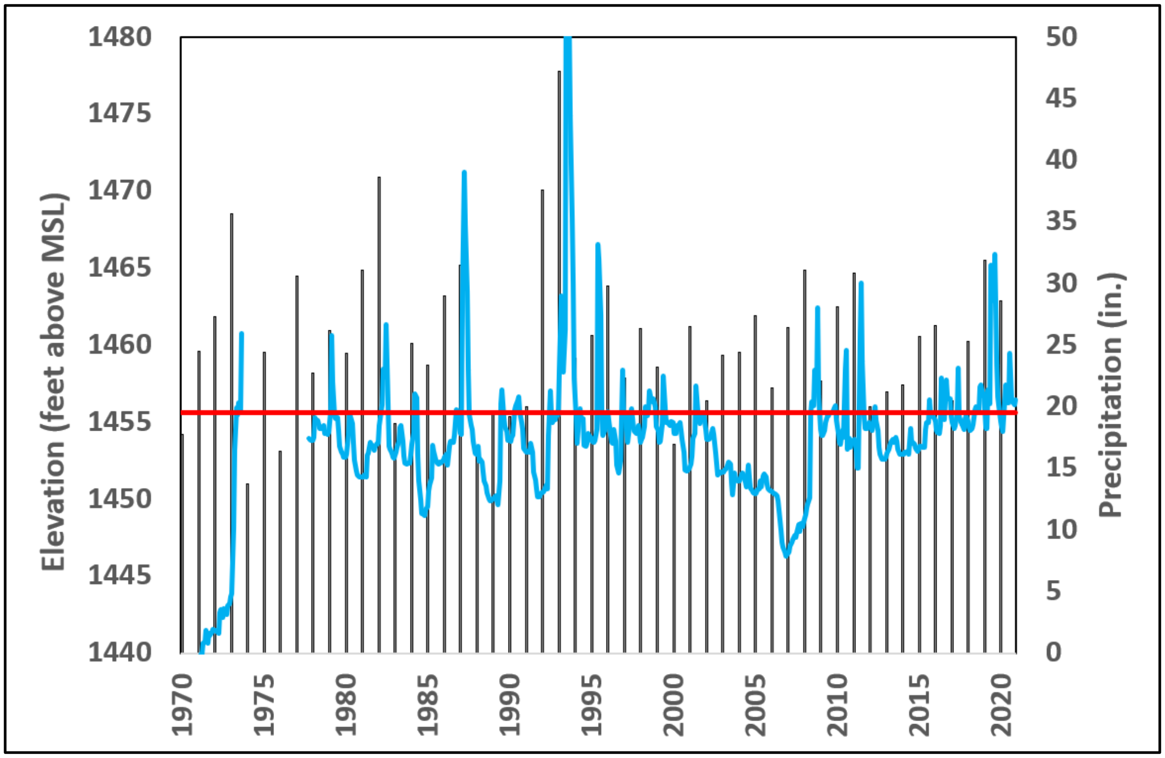


Figure 1. Monthly Ending Reservoir Pool Elevation at Waconda Lake 1970 to 2020. *Monthly Ending Reservoir Pool Elevation (feet above MSL) [blue line] in Relation to Full Conservation Pool Elevation [red line] and Total Annual Precipitation [vertical columns] Recorded by USBR at Waconda Lake from 1970 to 2020*

3. Vegetation

Vegetated fisheries habitats occurring in and adjacent to Waconda Lake consists of terrestrial, emergent, and submergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below. When possible, Waconda Lake is allowed to fill during the late summer and early fall to flood exposed shoreline vegetation. This flooded vegetation is very beneficial to waterfowl management.

A. Terrestrial

Herbaceous to woody terrestrial vegetation common to the area, colonizes the reservoir basin during years of low reservoir pool elevation. Subsequent to flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality by decreasing dissolved oxygen. The degree of lignification that characterizes flooded vegetation, determines the ongoing decomposition rate, impacting the magnitude and duration of oxygen demand.

B. Emergent

Common reed (*Phragmites australis*), cattails (*Typha sp.*), sedges (*Cyperaceae* spp.), and rushes (*Juncaceae* spp.) are the primary emergent aquatic vegetation species. Sedge and rush abundance and their distribution is relatively limited. Cattails are abundant primarily at the upper end of the reservoir and the back ends of the major coves, but their abundance and distribution has become more limited due to extensive high water in 2019. Common reed abundance has increased slightly on the upper end and will likely continue to expand distribution, especially occupying those areas of the lake basin subject to flooding. Common reed is capable of establishment through fragmentation. Flooded emergent aquatic vegetation provides nutrient input, substrate for periphyton and other invertebrates, and physical habitat for juvenile and adult fish.

C. Submergent

Submergent aquatic vegetation can establish considerable beds in the littoral zone of the reservoir. Coontail (*Ceratophyllum demersum*), Sago pondweed (*Potamogeton pectinatus*), American pondweed (*Potamogeton nodosus*), and curly leaf pondweed (*Potamogeton crispus*) constitute the most common species at Waconda Lake. Curly leaf pondweed is not native to the area. Regardless of native status, presence of all submerged aquatic vegetation species diversify littoral zone habitats within the reservoir and effectively act as escape habitat for young fish and foraging habitat for adult fish. Submerged aquatic vegetation beds create shade, thus lowering water temperatures immediately below the bed providing a thermal refuge to fish during summer. Submerged aquatic macrophyte beds provide fish concealment from avian predators.

4. Water Quality/Turbidity

Waconda Lake possesses adequate water quality to promote sportfish survival. Turbidity is low as evidenced by mean secchi disc measurements mentioned earlier. Indices relative to specific conductivity and total dissolved solids (TDS) are normally high and become extremely concentrated as the reservoir volume decreases. Freshwater impoundments with conductivities ranging from 150 to 500 mhos/cm are ideal for supporting diverse fisheries communities while values outside that range may limit the establishment of certain fishes and invertebrates. In addition, specific conductivity strongly affects the ability of biologists to sample fish using electrofishing gear.

5. Invasive/Exotic Species

A. Common Reed Encroachment

A limited amount of common reed has become established in several areas across the reservoir. The infestation has been somewhat limited, however, due to the water level stability. Common reed is most abundant on the upper end of the reservoir in the river channels and in the back end of some of the major coves. Due to its limited expansion this exotic species has not harmed the reservoir ecosystem of Waconda Lake to the extent that has been seen in other impoundments.

B. Zebra Mussels

Zebra mussels (*Dreissena polymorpha*), were first discovered in Waconda Lake during August 2013, and it was apparent by that fall the population was well established as adult mussels were encountered during October fish sampling activities throughout the reservoir. It is likely that plankton abundance has been reduced by the high-volume filter feeding of the cumulative mussel population. Stomach content observations indicated that blue catfish prey on adult zebra mussels and it is likely that other fish species such as freshwater drum and bluegill do the same.

6. Sedimentation

The multipurpose pool at Waconda Lake originally included 242,017 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 9.3% of the multipurpose pool has been filled in with sediment leaving approximately 219,420 ac-ft of capacity (based on 2001 survey results). It is estimated that approximately 670 ac-ft of sediment accumulates on average annually in Waconda Lake. Sediment will continue to accumulate in Waconda Lake with an expected additional 13.4 % loss of the multipurpose pool over the next 25 years (2049) and 20.4% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 164,307 ac-ft in 2074.

Fisheries Management Objectives

The general objective of fisheries management at Waconda Lake is to optimize the quality and diversity of angling opportunities. Specific management activities conducted include tailoring fish harvest regulations to changes in sportfish population trends, stocking fish to enhance population abundance as needed, construct fish attractors to enhance angler success, and maintain/improve angling access. See Table 5 below for a comprehensive list of fish harvest regulations in effect at Waconda Lake.

Table 5. Current Fish Harvest Regulations in Effect at Waconda Lake

Species	Reach	Length Limit	Creel Limit
Blue Catfish	Special	35	5
Channel Catfish	Statewide		10
Flathead Catfish	Statewide		5
Largemouth Bass	Special	18	5
Rainbow Trout	Statewide		5
Smallmouth Bass	Special	21	5
Spotted Bass	Statewide	15	5
Striped Bass	Special		2
Walleye	Special	18	5
White Crappie	Special	10	20
Wiper - W x S Bass	Special		2

Relevance to Fish Culture in Kansas

Stocking is an important walleye management activity in many Kansas waters. Considering the difficulty to maintain and spawn captive broodstock, and the propensity of sexually mature walleye to concentrate in discrete spawning areas, gametes are harvested from wild broodstock for culture purposes from several Kansas impoundments each spring. The Waconda Lake walleye population was one of the primary sources to collect and fertilize walleye eggs between 1988 and 2003 (Table 6), often contributing 40% or more to the total statewide annual quota. Consequently, optimizing walleye broodfish abundance and welfare has been a management priority at Waconda Lake.

Table 6. Walleye Egg Collection Totals from Waconda Lake Between 1988 and 2003.

1988	1989	1990	1991	1992	1993	1994	1995
27,777,250	42,464,345	34,522,250	45,569,226	11,476,450	N/A	8,410,893	15,938,975
1996	1997	1998	1999	2000	2001	2002	2003
18,188,965	7,705,574	18,658,186	25,767,500	N/A	N/A	66,561,000	26,000,000

Source: KDWP 2021

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Waconda Lake.

1. Reallocation of Pool Storage

Releases from Waconda Lake are regulated as outlined in two memorandums of understanding between the State of Kansas and Reclamation. Releases are made for the city of Beloit, the Mitchell County Rural Water District, the long-term water service contract with Glen Elder Irrigation District, and for water right administration. (USBR 2021)

Renewal of the long-term water service contract with the City of Beloit, Kansas was completed in 2008. The new repayment contract became effective on January 1, 2009. The repayment contract with Beloit, Kansas, provides for the annual use of up to 2,000 AF from Waconda Lake storage. Water is measured at the Glen Elder Dam river outlet works. (USBR 2021)

2. Riprap Installation in Areas of Critical Shoreline Infrastructure

Riprap has been added to several locations across the reservoir to reduce shoreline erosion which has been a significant problem and accelerated reservoir aging. Over time, this shoreline armor has been placed near boat ramps, parking areas, and has been used to construct jetties in several areas around Glen Elder state park. The jetty near Osage Cove was recently extended to provide additional boat ramp protection from strong southerly winds. Much of the north shore state park area was recently riprapped following high water which increased the amount of shoreline erosion and further illustrated the need for shoreline protection. These riprap areas also provide excellent fisheries habitat, especially for smallmouth bass, spotted bass, bluegill, and crappie.

3. Standard and Supplemental Fish Sampling to Monitor Sportfish Trends

Standard fish population sampling is employed on an annual basis and is conducted using standardized methods approved by KDWP Fisheries staff and applied at Waconda Lake and other Kansas waters to develop baseline trend data by which Kansas fisheries are managed. At Waconda Lake, electrofishing is used to sample the smallmouth bass and largemouth bass populations in spring, and core panel gill nets and ½" mesh fyke nets are employed each fall to sample other sportfish species such as bluegill, channel catfish, crappies, white bass, wipers, and walleye. Low frequency electrofishing is utilized in the summer to examine flathead catfish and blue catfish populations. In addition, float line sampling is a new technique used each summer for additional blue catfish sampling. Shoreline seining in August provides an estimate of the gizzard shad year class abundance and size structure.

Supplemental fish population sampling is conducted at the discretion of the KDWP District Fisheries Biologist to address specific management questions/challenges. Supplemental sampling can consist of accepted or experimental methods and often focuses on finer detail resolution fish population parameters. Recently at Waconda Lake age-and-growth analyses were conducted to characterize growth trajectories exhibited by these populations. Crappie growth information was used to justify implementation and evaluate effect of the 10-inch minimum length limit and 20 per day creel limit special harvest regulations on this species.

4. Other Biotic and Abiotic Parameter Sampling

This sampling should be considered supplemental sampling but most often consists of sampling a parameter(s) other than those specifically related to sportfish. Some recent examples include water samples collected by USBR staff to monitor for the presence of zebra mussel larvae and consequently detected establishment of a reproducing population at Waconda Lake. In addition, harmful algae blooms (HABs) may be detected in the reservoir which triggers additional water quality sampling to determine the extent of the HAB.

5. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by an 18-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Waconda Lake are: Crappie-10-inch minimum length limit and 20/day creel limit, Blue Catfish-35-inch minimum length limit, Largemouth Bass-18-inch minimum length limit, Smallmouth Bass-21-inch minimum length limit, and Walleye-18-inch minimum length limit. See Table 7 below for a comprehensive list of fish harvest regulations in effect at Waconda Lake.

Table 7. Current Fish Harvest Regulations in Effect at Waconda Lake

Species	Length Limit	Creel Limit
Blue Catfish	35-inch minimum length limit	5 fish daily creel limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	10 - inch minimum length limit	20 fish daily creel limit
Largemouth Bass	18 - inch minimum length limit	5 fish daily creel limit
Smallmouth Bass	21 - inch minimum length limit	5 fish daily creel limit
Spotted Bass	15 - inch minimum length limit	5 fish daily creel limit
Striped Bass	N/A	2 fish daily creel limit
Walleye	18 - inch minimum length limit	5 fish daily creel limit
Wiper	N/A	2 fish daily creel limit

Source: KDWP 2020

6. Sportfish Stockings

The stocking of fry, fingerling, and possibly intermediate-sized walleye will continue an alternate year schedule to continue to boost recruitment and supplement the limited natural reproduction which occurs. Blue catfish were stocked for five years but are now set to expand with natural reproduction and will not be stocked again. Wiper and striped bass fingerlings are stocked at irregular intervals as needed to maintain these low-density populations. In addition, rainbow trout are stocked several times each winter in the adjacent park pond.

Farlington Hatchery Staff Stocking Fingerling Blue Catfish at Waconda Lake

The direction which angler use and visitation at Waconda Lake takes is unclear, as changes in socio-economic factors greatly influence public involvement in angling. For example, increased participation of families in youth sporting activities reduces participation in angling. However, the unforeseen emergence and response to COVID-19 greatly increased public participation in angling and other outdoor recreation at Waconda Lake during the 2020 season.

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, in accordance with KDWP reservoir survey guidelines. Creel surveys are encouraged to be completed a minimum of every 5 years at major reservoirs but are often more frequent following new regulations or during special projects.

Angler effort (angler-hours/ac.) at Waconda Lake ranks anywhere from the 25th to the 75th percentile when compared to other Kansas reservoirs depending on the year (see Table 8). Anglers hailing from the surrounding communities and Nebraska exert the majority of pressure, with fishers from eastern Kansas and south-central Kansas frequenting the lake to a lesser degree.

Waconda Lake anglers tend to be opportunistic in terms of species they prefer to fish for. Angler preference for a specific species often varies based upon changes in species dominance that result from water fluctuation history or recent recruitment. For example, channel catfish were the most popular species in the late 1990's through 2009 in part to the large number of fishing guides that chum for channel catfish and take clients nearly daily throughout the summer. As channel catfish numbers declined and crappie numbers improved around 2010, anglers switched to the more preferred species of crappie and walleye. The indiscriminate selection of target species has become more prominent as well with many anglers less focused on one species but rather preferring a mixed bag or taking advantage of whatever species is most readily available at the time. Waconda Lake anglers tend to be harvest minded. White bass, channel catfish, and crappie comprise the largest contributions to angler's creel in most years (see Table 9 and Table 10). Waconda Lake black bass anglers tend to be more catch-and-release oriented, choosing to extend the use of an often-limited resource.

Table 8. Total Number of Anglers and Angler-hours at Waconda Lake for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Anglers	Anglers per Acre	Total Angler Hours	Angler Hours per Acre
2004	35,055	2.79	146,272	11.62
2007	24,230	1.93	58,290	4.63
2009	25,473	2.02	86,113	6.84
2014	75,012	5.96	243,672	19.36
2019	43,568	3.46	115,713	9.19

Source: KDWP 2021

Table 9. Average Percentages of the Top Four Most Preferred Species by Anglers at Waconda Laker for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Year	First		Second		Third		Fourth	
2004	Channel Catfish	38.6	Walleye	35.3	White Bass	13.8	Crappie	2.5
2007	Channel Catfish	29.0	Walleye	22.0	No Preference	21.0	White Bass	13.0
2009	Channel Catfish	32.0	White Bass	24.0	White Crappie	23.0	Walleye	17.0
2014	No Fish Preference	30.4	Crappie	28.4	Walleye	16.4	Channel	10.7
2019	No Fish Preference	37.8	White Bass	20.9	Walleye	13.2	Channel	13.1

Source: KDWP 2021

Table 10. Estimated Total Number of Sportfish Harvested and Released at Waconda Lake for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Harvest or Release	Year	Channel Catfish	Smallmouth Bass	Walleye	White Bass	Crappie
Harvested	2004	34,744	0	9,376	19,219	2,221
Harvested	2007	8,999	13	2,923	8,772	3,590
Harvested	2009	5,657	11	1,649	14,330	21,881
Harvested	2014	19,054	95	9,511	23,783	33,054
Harvested	2019	4,813	0	3,697	23,261	6,539
Released	2004	5,661	89	1,396	2,141	20
Released	2007	2,943	1,657	4,940	5,305	1,227
Released	2009	477	974	8,247	9,362	1,206
Released	2014	4,642	3,976	26,752	5,790	3,042
Released	2019	1,753	3,917	9,500	8,839	2,488

Source: KDWP 2021

Sportfish Population Dynamics/Trends

Black Crappie (*Pomoxis nigromaculatus*)

Origin of the Waconda Lake black crappie population is unknown as there are no stocking records for this species in Waconda Lake, but they likely immigrated from upstream sources including Kirwin and Webster Reservoirs. The first black crappie were sampled in July 1970 using fyke nets. This came as a bit of a surprise as no black crappie had been sampled prior.

A recent surge in black crappie numbers (Table 11) coincides with high upstream releases from both Webster and Kirwin Reservoirs in 2019. Heavy rainfall and flooding forced each reservoir to release well above their annual average and this led to high immigration of black crappie from those strong populations upstream. A similar situation arose in 2009 when the reservoirs filled and were forced to release a high volume of water. The catch rate rose significantly following those releases but quickly returned to the normal level at Waconda Lake.

Over the years, black crappie have typically maintained a low-density population in only a handful of locations across the reservoir. Waconda Lake does not appear to have suitable black crappie habitat to sustain a high-density population of fish despite infrequent stockings from upstream immigration. The adults either do not pull off successful spawns or the young fish have poor survival rates. While the numbers of adult black crappie are very high now it is likely that this is again a short-lived phenomenon which may decline over the next few years as adults are harvested, entrained, or lost to natural mortality. Either way, anglers should enjoy several years of improved harvest.

Table 11. Catch Per Unit Effort (CPUE), Proportional Stock Density (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Black Crappie Sampled During October Using Trap Nets

Metric	2016	2017	2018	2019	2020
Total Catch	6	20	49	495	284
Stock Catch	3	12	1	401	156
Units of Effort	24	22	22	20	24
Sub-Stock CPUE (RSE)	0.1 (55)	0.4 (53)	2.2 (26)	4.7 (29)	5.3 (35)
Stock CPUE (RSE)	0.1 (55)	0.5 (26)	0.0 (100)	20.1 (31)	6.5 (18)
Quality/Density CPUE (RSE)	0.0 (.)	0.1 (55)	0.0 (100)	16.9 (31)	4.3 (23)
Preferred CPUE (RSE)	0.0 (.)	0.0 (100)	0.0 (100)	3.7 (37)	3.5 (22)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (100)	0.1 (100)	0.2 (41)
Total CPUE (RSE)	0.3 (43)	0.9 (28)	2.2 (25)	24.8 (26)	11.8 (20)
PSD S-Q	100	75	.	15.96	33.97
PSD Q-P	.	16.67	.	65.84	12.18
PSD P-M	.	8.33	.	17.96	50.64
PSD M-T	.	.	100	0.25	3.21
PSD	0	25	100	84.04	66.03
Mean WR S-Q (RSE)	101 (5)	103 (3)	. (.)	111 (3)	99 (2)
Mean WR Q-P (RSE)	. (.)	105 (17)	. (.)	111 (1)	101 (1)
Mean WR P-M (RSE)	. (.)	106 (.)	. (.)	113 (1)	103 (1)
Mean WR M-T (RSE)	. (.)	. (.)	111 (.)	99 (.)	105 (1)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Blue Catfish (*Ictalurus furcatus*)

Blue catfish are not native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014). Blue catfish were first stocked in 2010 to add another catfish species for anglers to harvest, provide an additional predator on the abundant gizzard shad population, and feed on zebra mussels which were soon to be discovered in Waconda Lake. To establish this population, blue catfish were stocked at a rate of 5 fingerlings per acre from 2010 through 2016. Stocking ceased as the original fish began to reach 25 to 30 inches in length and reached the age of sexual maturity. A 35-inch minimum length limit and 5 fish daily creel limit were established to help protect this young population until natural recruitment was documented. The fish that survived the stockings are growing well with the biggest fish collected in 2020 reaching 37 inches and 30 pounds. The length frequency reveals that not every stocking was successful, however, based on the low catch rates of certain sizes. No natural reproduction has been documented despite 10-year old fish residing in the reservoir. Blue catfish are monitored annually using low frequency electrofishing, floatline sampling, and core panel gill nets in the fall (see Table 12). Catch rates have not been high in the past, but recent years have been more productive as their habitat preferences have been narrowed down. A telemetry study of blue catfish is ongoing to better understand their breeding habits in Waconda Lake.

Table 12. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish Sampled During October Using Gill Nets, June Using Floatlines, and July Using Low Frequency Electrofishing

Metric	2017 Core	2019 Core	2019 Float	2020 EF	2020 Float
Total Catch	2	2	12	60	19
Stock Catch	2	2	12	60	19
Units of Effort	24	18	21	4.15	16
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0	0.0	0.0
Stock CPUE (RSE)	0.1 (69)	0.1 (69)	0.6	14.5	1.2
Quality/Density CPUE (RSE)	0.0 (.)	0.1 (69)	0.6	14.5	0.9
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.4	1.0	0.3
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.05	0.2	0.06
Total CPUE (RSE)	0.1 (69)	0.1 (69)	0.6	0	1.2
PSD S-Q	100	.	.	.	.
PSD Q-P	.	100	33	93	79
PSD P-M	.	.	58	5	16
PSD M-T	.	.	9	2	5
PSD	0	100	100	100	100
Mean WR S-Q (RSE)	101 (6)	. (.)	.	.	.
Mean WR Q-P (RSE)	. (.)	100 (6)	100	97	.
Mean WR P-M (RSE)	. (.)	. (.)	110	112	.
Mean WR M-T (RSE)	. (.)	. (.)	129	116	.
Mean WR T+ (RSE)	. (.)	. (.)	.	.	.

Source: KDWP 2021

Bluegill (*Lepomis macrochirus*)

Bluegill are not native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014). Origin of the Waconda Lake population is unknown but likely was the result of fish entering the reservoir from ponds in the watershed. Bluegill were first sampled at Waconda Lake in July 1970. Fish sampling continued to reveal a few bluegills annually. The bluegill population is not often targeted at Waconda Lake but can provide some fair to good angling opportunities at certain times each year. Anglers typically catch these fish during June when they are spawning in the coves or during the winter months when ice fishing for crappie. Following a gradual rise in catch rates between 2014 and 2017 the catch rate declined by 2018 (see Table 13). The bluegill catch rate rebounded very nicely in the fall 2019 sample to the highest catch rate recorded at Waconda Lake (see Table 13). The consistent high-water levels over the past several years have allowed for improved fish production but similar to black crappie there was also likely an influx of fish from upstream sources including reservoirs and farm ponds. High water levels allowed for excellent survival of young bluegill throughout the summer and fall and recruitment was much higher than normal. Fish condition is traditionally excellent with very healthy, fast growing fish. In general, the clearer water caused by the addition of zebra mussels has led to an increase in aquatic vegetation and improved recruitment of bluegill and other structure-oriented species. As evidenced by high sub-stock and stock CPUE's some years (see Table 13), this population can constitute a viable forage source for piscivorous sportfish by providing diversity to the overall forage base. This fishery will become attractive to anglers over the short term, and as long as habitat and trophic conditions remain favorable for bluegill.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Bluegill Sampled During October Using Trap Nets

Metric	2016	2017	2018	2019	2020
Total Catch	113	173	49	828	350
Stock Catch	54	130	20	431	129
Units of Effort	24	22	22	20	24
Sub-Stock CPUE (RSE)	2.5 (41)	2.0 (41)	1.3 (39)	19.9 (38)	9.2 (40)
Stock CPUE (RSE)	2.3 (49)	5.9 (28)	0.9 (35)	21.6 (36)	5.4 (32)
Quality/Density CPUE (RSE)	0.1 (69)	1.1 (29)	0.4 (46)	7.5 (39)	2.2 (47)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.2 (55)	0.4 (68)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.2 (100)
Total CPUE (RSE)	4.7 (38)	7.9 (25)	2.2 (29)	41.4 (24)	14.6 (32)
PSD S-Q	96.3	81.54	60	65.2	58.91
PSD Q-P	3.7	18.46	40	34.11	34.11
PSD P-M	.	.	.	0.7	3.88
PSD M-T	.	.	.	.	1.55
PSD	3.7	18.46	40	34.8	41.09
Mean WR S-Q (RSE)	118 (3)	108 (2)	104 (.)	100 (2)	97 (4)
Mean WR Q-P (RSE)	109 (3)	108 (3)	111 (4)	107 (1)	102 (1)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	105 (5)	101 (5)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Channel Catfish (*Ictalurus punctatus*)

Channel catfish were native to the Solomon River system prior to it being impounded. Despite this, channel catfish were stocked in 1968 with the addition of fry and fingerlings. The channel catfish population had shown a general decline since reaching a high catch rate in 2010 and 2011. Between 2012 and 2014, catch rate averaged 2.8, and declined to an average of 2.1 from 2015 to 2017. The 2017 sample was up slightly from 2016 with catch improving from an all-time low of 1.4 to 2.0 (see Table 14). The 2018 sample showed very nice improvement again with stock CPUE jumping from 2.0 to 3.4 (see Table 14). The 2019 sample was down from 2018 with stock CPUE declining from 3.4 to 2.3 (see Table 14). The 2019 creel survey revealed a harvest of only 4,813 channel catfish compared with 19,000 in 2014 and 5,657 in 2009. These harvest rates are significantly lower than the harvest during the 1990's through 2004 when as many as 34,000 channel catfish were harvested. Given angler concern regarding chumming and this downward trend in CPUE, overfishing could be a contributing factor to this declining population. On the other hand, poor recruitment over consecutive years is more likely the cause. Despite these lower numbers, anglers fishing over chum piles continue to have good success throughout the summer and report steady numbers each year. Whereas limits of channel catfish over chum piles were almost guaranteed 5 to 10 years ago, half limits are now much more common and the expectation for fishing guides.

Table 14. CPUE, PSD, Wr, and RSE Estimates for Channel Catfish Sampled During October and November Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	39	53	83	42	43
Stock Catch	39	47	81	42	42
Units of Effort	24	24	24	18	24
Sub-Stock CPUE (RSE)	0.0 (.)	0.3 (50)	0.1 (69)	0.0 (.)	0.0 (100)
Stock CPUE (RSE)	1.6 (20)	2.0 (20)	3.4 (16)	2.3 (21)	1.8 (18)
Quality/Density CPUE (RSE)	1.4 (19)	1.7 (18)	2.1 (18)	2.2 (23)	1.0 (20)
Preferred CPUE (RSE)	0.3 (32)	0.2 (41)	0.5 (27)	0.6 (48)	0.4 (29)
Memorable/Lunker CPUE (RSE)	0.1 (55)	0.0 (100)	0.1 (55)	0.1 (100)	0.1 (55)
Total CPUE (RSE)	1.6 (20)	2.2 (21)	3.5 (16)	2.3 (21)	1.8 (18)
PSD S-Q	12.82	14.89	38.27	4.76	40.48
PSD Q-P	69.23	74.47	46.91	69.05	35.71
PSD P-M	10.26	8.51	11.11	23.81	16.67
PSD M-T	7.69	2.13	3.7	2.38	7.14
PSD	87.18	85.11	61.73	95.24	59.52
Mean WR S-Q (RSE)	89 (3)	90 (3)	89 (1)	95 (1)	81 (2)
Mean WR Q-P (RSE)	94 (2)	92 (2)	95 (2)	94 (2)	89 (4)
Mean WR P-M (RSE)	97 (7)	97 (4)	98 (3)	103 (3)	97 (3)
Mean WR M-T (RSE)	114 (1)	107 (.)	110 (7)	119 (.)	98 (7)

Source: KDWP 2021

Flathead Catfish (*Pylodictis olivaris*)

Flathead Catfish are native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014). This species was first sampled in July 1970 using gill nets. When the river was impounded with the construction of the Glen Elder Dam, flathead catfish successfully adapted to life in a lentic system. Flathead catfish are annually sampled in June or July using low frequency electrofishing and a chase boat. Similar to blue catfish, sampling was not conducted in 2019 due to the high water in the reservoir making it difficult to collect a representative sample (Table 15). Fish were dispersed from normal summer areas and many of the sample sites were flooded. Despite the flooding, anglers reported catching large flathead catfish summer 2019 on the west end and released most over 20 pounds. A very nice sample was collected in 2020 with over 200 fish sampled in approximately 4.2 hours of effort (see Table 15). Fish size typically ranges from 5 inches to 50 pounds. Flathead catfish will continue to be monitored with annual summer low frequency electrofishing and managed using the statewide creel survey of five fish. Few anglers target flathead catfish throughout the year but the summer months of June, July, and August will see the highest harvest with most fish caught using trotlines and limblines on the west end and in the creek arms.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Flathead Catfish Sampled During June and July Using Low Frequency Electrofishing

Metric	2015	2016	2017	2018	2019	2020
Total Catch	266	116	.	168	.	203
Stock Catch	195	87	.	126	.	185
Units of Effort	3.5	1.4	.	1.8	.	4.15
Sub-Stock CPUE	20.5	20.7	.	23.6	.	4.3
Stock CPUE	56.3	62.1	.	71.3	.	44.6

Metric	2015	2016	2017	2018	2019	2020
PSD S-Q	34	33	.	38	.	11
PSD Q-P	50	48	.	50	.	44
PSD P-M	6	10	.	5	.	18
PSD M-T	9	7	.	2	.	18
PSD T+	1	1	.	5	.	9
PSD	66	67	.	62	.	89
Mean WR S-Q	91	93	.	89	.	91
Mean WR Q-P	87	96	.	92	.	93
Mean WR P-M	87	93	.	91	.	97
Mean WR M-T	104	113	.	106	.	102
Mean WR T+	120	118	.	104	.	107

Source: KDWP 2021

Walleye (*Sander vitreus*)

Walleye are not native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014). Walleye were introduced into Waconda Lake in May 1968 and were stocked again in 1969, 1970, and 1972. Natural reproduction has not been sufficient to maintain a strong population of walleye, thus supplemental stocking is frequently utilized. Most stockings consist of a combination of fry and fingerlings but several years may have included one or the other. In recent years stocking has been limited to an alternate year schedule with both fry and fingerlings stocked. Walleye are traditionally one of the most sought-after species and Waconda Lake has the reputation as one of the top five walleye reservoirs in the state. The Kansas Walleye Association traditionally holds a two-day tournament in June each year. Walleye were historically managed with a 15-inch minimum length limit and a five per day creel limit. This management strategy was successful due to good to excellent recruitment most year through the 1980's and early 1990's. In 2008 the length limit was changed to 18 inches to improve the mean length of fish harvested and to allow females to reach maturity and spawn prior to being available for harvest. With reduced recruitment during recent years, this MLL has worked out well to preserve the walleye and allows for a good amount of catch and release. Walleye should remain one of the top species targeted for at least the next decade.

A local angler with a good catch of Waconda Lake walleye.

Table 16. CPUE, PSD, Wr, and RSE Estimates for Walleye Sampled During October and November Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	42	172	92	102	70
Stock Catch	41	171	79	94	64
Units of Effort	24	24	24	18	24
Sub-Stock CPUE (RSE)	0.0 (100)	0.0 (100)	0.5 (31)	0.4 (37)	0.3 (50)

Metric	2016	2017	2018	2019	2020
Stock CPUE (RSE)	1.7 (26)	7.1 (17)	3.3 (19)	5.2 (27)	2.7 (24)
Quality/Density CPUE (RSE)	1.7 (26)	6.0 (17)	3.1 (20)	4.3 (26)	2.0 (26)
Preferred CPUE (RSE)	0.2 (50)	1.0 (24)	0.4 (35)	0.9 (29)	0.4 (41)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.1 (100)	0.0 (.)
Total CPUE (RSE)	1.8 (25)	7.2 (17)	3.8 (18)	5.7 (26)	2.9 (22)
PSD S-Q	2.44	15.79	6.33	17.02	23.44
PSD Q-P	85.37	70.76	82.28	64.89	60.94
PSD P-M	12.2	13.45	11.39	17.02	15.63
PSD M-T	.	.	.	1.06	.
PSD	97.56	84.21	93.67	82.98	76.56
Mean WR S-Q (RSE)	98 (.)	109 (1)	102 (3)	104 (2)	102 (2)
Mean WR Q-P (RSE)	97 (1)	107 (1)	103 (1)	104 (1)	100 (1)
Mean WR P-M (RSE)	97 (7)	103 (1)	96 (3)	106 (1)	98 (2)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	104 (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

White Bass (*Morone chrysops*)

White bass are not likely native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014) but likely immigrated from upstream sources. The first sampling record for this species is recorded in July 1970 using gill nets. This population has been exceptional in recent years regardless of water level fluctuations and this species maintains high numbers of large fish through natural reproduction (see Table 17). Due to their breeding tenacity and short lifespans, white bass are not regulated with any length or creel limits and anglers are encouraged to harvest liberally. Unlike species such as walleye and crappie which tend to fluctuate annually, white bass offer consistent angling opportunities and anglers are able to harvest these fish throughout the year using a variety of different methods. White bass also operate as a primary predator on the high-density gizzard shad population and feed almost exclusively on gizzard shad. Waconda Lake traditionally ranks in the top three reservoirs for white bass numbers and the current rankings are no different. The white bass population at Waconda Lake ranks first for number over 9 inches, first for number of 12 inches, and first for number of 15 inches per gill net sampled. Anglers can always count on white bass availability when other species may be lacking.

Table 17. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During October and November Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	560	619	606	704	635
Stock Catch	507	613	592	690	624
Units of Effort	24	24	24	18	24
Sub-Stock CPUE (RSE)	2.2 (28)	0.3 (55)	0.6 (40)	0.8 (34)	0.5 (44)
Stock CPUE (RSE)	21.1 (18)	25.5 (12)	24.7 (11)	38.3 (18)	26.0 (14)
Quality/Density CPUE (RSE)	8.8 (19)	19.5 (10)	16.4 (12)	18.1 (22)	21.8 (15)
Preferred CPUE (RSE)	7.2 (18)	13.8 (11)	14.0 (13)	16.7 (23)	14.3 (15)

Metric	2016	2017	2018	2019	2020
Memorable/Lunker CPUE (RSE)	2.0 (17)	2.8 (19)	2.1 (21)	4.7 (26)	3.0 (26)
Total CPUE (RSE)	23.3 (18)	25.8 (12)	25.3 (12)	39.1 (17)	26.5 (14)
PSD S-Q	58.38	23.49	33.61	52.75	16.35
PSD Q-P	7.5	22.68	9.63	3.62	28.53
PSD P-M	24.65	42.74	48.14	31.45	43.43
PSD M-T	9.47	11.09	8.61	12.03	11.7
PSD	41.62	76.51	66.39	47.25	83.65
Mean WR S-Q (RSE)	101 (2)	107 (1)	105 (1)	106 (1)	102 (1)
Mean WR Q-P (RSE)	99 (1)	103 (1)	101 (1)	105 (2)	99 (1)
Mean WR P-M (RSE)	101 (1)	108 (0)	104 (0)	107 (0)	104 (0)
Mean WR M-T (RSE)	100 (1)	102 (1)	101 (1)	109 (1)	104 (1)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

White Crappie (*Pomoxis annularis*)

White Crappie are likely not native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014) but may have been stocked in Webster and Kirwin reservoirs. Origin of the Waconda Lake population likely resulted from immigration from these upstream sources as there are no stocking records. The first white crappie were sampling in July 1970 using fyke nets. White crappie have always dominated the crappie population over black crappie, typically comprising over 90% of the crappie harvested annually. This species can thrive in a broader range of habitats and is found across the reservoir throughout the year. White crappie numbers depend on the availability of ideal spawning and brood rearing habitat for survival and growth. When water levels are low, catch rates decline greatly as observed in the early 2000's when Waconda Lake was one of the worst reservoirs in the state. As water levels rose in 2008 and 2009, terrestrial habitat was inundated, and hundreds of acres of ideal crappie spawning habitat immediately became available. The following 5 years provided anglers with some of the finest crappie angling seen in a Kansas reservoir in the past 30 years. Anglers were easily catching limits of 50 crappie day after day between 2009 and 2012. Due to overharvest and the loss of this habitat, crappie numbers quickly fell and new regulations were placed on both crappie species to avoid this same scenario in the future. A minimum length limit of 10 inches and daily creel limit of 20 fish were enacted to counteract these high harvest rates, allow fish to reach sexual maturity before reaching harvestable size, and spread out the crappie harvest. Currently, white crappie numbers are slowly rising as water levels have stabilized and submergent vegetation has increased (see Table 18). The population may never reach the levels it did around 2010 but should continue to provide anglers with fair to good numbers of quality size fish.

Table 18. CPUE, PSD, Wr, and RSE Estimates for White Crappie Sampled During October Using Trap Nets

Metric	2016	2017	2018	2019	2020
Total Catch	218	1633	359	2573	888
Stock Catch	32	56	50	70	106
Units of Effort	24	22	22	20	24
Sub-Stock CPUE (RSE)	7.8 (25)	71.7 (27)	14.0 (22)	125.2 (33)	32.6 (20)

Metric	2016	2017	2018	2019	2020
Stock CPUE (RSE)	1.3 (36)	2.5 (16)	2.3 (18)	3.5 (27)	4.4 (31)
Quality/Density CPUE (RSE)	1.3 (36)	2.1 (17)	2.1 (19)	3.0 (29)	3.5 (31)
Preferred CPUE (RSE)	0.6 (44)	0.5 (29)	0.6 (28)	1.8 (40)	0.6 (36)
Memorable/Lunker CPUE (RSE)	0.2 (59)	0.2 (40)	0.3 (43)	0.4 (38)	0.3 (47)
Total CPUE (RSE)	9.1 (22)	74.2 (26)	16.3 (19)	128.7 (32)	37.0 (20)
PSD S-Q	.	17.86	8	14.29	20.75
PSD Q-P	53.13	62.5	64	34.29	66.04
PSD P-M	34.38	10.71	16	40	5.66
PSD M-T	12.5	8.93	12	11.43	7.55
PSD	100	82.14	92	85.71	79.25
Mean WR S-Q (RSE)	. (.)	104 (3)	95 (9)	112 (15)	92 (2)
Mean WR Q-P (RSE)	108 (2)	104 (2)	107 (1)	109 (2)	105 (1)
Mean WR P-M (RSE)	108 (2)	111 (4)	108 (1)	114 (1)	104 (3)
Mean WR M-T (RSE)	113 (1)	116 (4)	109 (3)	118 (3)	114 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Wiper (*Morone saxatilis X M. chrysops*)

Wipers are a hybrid species requiring stocking on a regular basis to maintain population abundance. They were first stocked into Waconda Lake in 2006 among controversy from anglers who claim they are a detriment to sportfish species such as walleye and crappie due to their voracious feeding habits. Several research projects have proven that the wiper's diet consists primarily of gizzard shad, thus they are used as a forage control mechanism. Wipers were stocked again in 2008, 2012, and 2013 and are scheduled for stocking in 2021. Wipers grow rapidly in Waconda Lake and easily reach weights of 5 to 6 pounds after approximately 4 years. Older age fish have been collected at 10 to 12 pounds. With no recent stockings, wiper numbers have declined but the population ranks as one of the best in the state for trophy wipers. Like other species, wipers have also immigrated into Waconda Lake from upstream reservoirs, Kirwin and Webster. Wipers will continue to be stocked on an irregular basis to maintain a low-density population and diversify the fishery.

Striped Bass (*Morone saxatilis*)

Striped bass are also stocked infrequently to provide additional species opportunities for anglers as well as a trophy fishery as striped bass can reach sizes up to 40 pounds. Striped bass are not native to the Solomon River area in what is now Waconda Lake and are unable to naturally sustain a population due to a lack of adequate spawning habitat. Striped bass were first stocked in Waconda Lake in 1968 and 1973 through 1977 and have been stocked 20 of the previous 46 years utilizing primarily fingerlings, although a handful of adult and fry striped bass have also been stocked. This species survives at a low density and few are caught each year. Perhaps the best opportunity to catch striped bass is through the ice on the west end of the reservoir as they often congregate in the river channels in the winter.

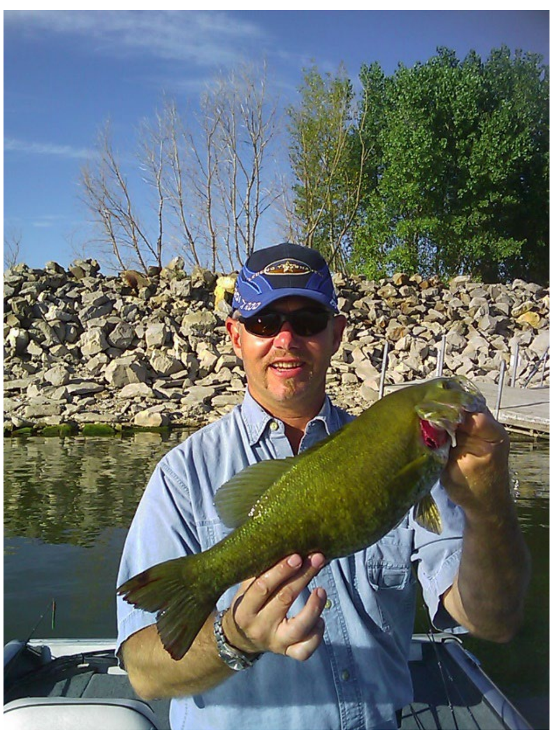
Table 19. CPUE, PSD, Wr, and RSE Estimates for Wiper - W X S Bass Sampled During October and November Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	71	58	52	28	32

Stock Catch	71	58	52	28	32
Units of Effort	24	24	24	18	24
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	3.0 (26)	2.4 (24)	2.2 (20)	1.6 (32)	1.3 (39)
Quality/Density CPUE (RSE)	3.0 (26)	2.4 (25)	2.2 (20)	1.6 (32)	1.1 (48)
Preferred CPUE (RSE)	2.0 (25)	2.2 (25)	2.2 (20)	1.5 (33)	1.0 (52)
Memorable/Lunker CPUE (RSE)	0.0 (100)	0.1 (73)	0.2 (50)	0.3 (42)	0.3 (76)
Total CPUE (RSE)	3.0 (26)	2.4 (24)	2.2 (20)	1.6 (32)	1.3 (39)
PSD S-Q	.	1.72	.	.	18.75
PSD Q-P	33.8	6.9	.	3.57	6.25
PSD P-M	64.79	86.21	90.38	75	50
PSD M-T	1.41	5.17	9.62	21.43	25
PSD	100	98.28	100	100	81.25
Mean WR S-Q (RSE)	. (.)	102 (.)	. (.)	. (.)	93 (2)
Mean WR Q-P (RSE)	94 (1)	98 (2)	. (.)	101 (.)	96 (4)
Mean WR P-M (RSE)	90 (1)	94 (1)	91 (1)	97 (1)	90 (2)
Mean WR M-T (RSE)	86 (.)	100 (2)	93 (2)	103 (2)	90 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Black Bass (*Micropterus sp*.) (Spotted, Smallmouth, and Largemouth Bass)



Since early in the impoundment of Waconda Lake spotted bass, *M. punctulatus*, smallmouth bass, *M. dolomieu*, and largemouth bass, *M. salmoides*, have been present. But none of the three species is likely native to the Solomon River drainage at what is now Waconda Lake and further upstream (Kansas Fishes Committee, 2014). Largemouth bass were first introduced in 1968 with 133,000 fingerlings stocked. Fish were again stocked in 1969 and 1970. In addition, numerous upstream sources have likely contributed to the largemouth bass population which has seen its share of ups and downs. Following the first stocking, habitat conditions were ideal for recruitment, growth, and survival of young largemouth bass and the species flourished. Following two major flood events in 1993 and 1995 much of the littoral habitat was decimated and siltation overtook much of the prime habitat on the west end of the reservoir. Largemouth numbers declined significantly until recently when increased aquatic macrophytes and littoral forage including bluegill have allowed a strong recovery (see Table 21). Smallmouth bass were first stocked in 1984 with 45,000 fingerlings and then again in 1985 via 120,000 fry. Waconda Lake was thought to offer several miles of shoreline ideal to smallmouth bass production and survival consisting of rocky bluffs, deep rocky points, and several miles of concrete substrate along the dam. These stockings did not take however, and the population was unable to develop. Between 1994 and 1996 approximately 150,000 smallmouth bass fingerlings were stocked. These “reservoir strain” fish were much better suited to the available habitat and forage in Waconda Lake and immediately succeeded in developing a self-sustaining population. This species inhabits specific areas of the reservoir and maintains one of the strongest populations in the state via natural reproduction (see Table 20). Recent management objectives include the development of a trophy smallmouth bass fishery by limiting the harvest of adult fish with the use of a 21-inch minimum length limit. This recent regulation change has showed promise thus far. Spotted bass can also be found in Waconda Lake albeit at greatly reduced numbers compared with the other two black bass species. Approximately 150 adults from a Pittsburg State University rearing pond were stocked in May 1985 to establish this population. While spotted bass can still be collected in Waconda Lake, annual samples often include less than five individuals. This species is limited much more than smallmouth bass and can only be found in a couple of locations. Anglers do not target black bass in Waconda Lake as much as most other species despite the availability of fair to good populations most years. Smallmouth bass offer angling opportunities from April through October while largemouth bass are most often caught from May through September. Spotted bass are caught incidentally while targeting other species or by crappie anglers. Future management will focus on trophy smallmouth bass with a 21-inch minimum length limit (MLL) while largemouth bass will continue to be managed with an 18-inch MLL. The future of black bass at Waconda Lake looks very good with consistent, stable water levels. The continued presence of abundant macrophytes would greatly enhance all populations.

Table 20. CPUE, PSD, Wr, and RSE Estimates for Smallmouth Bass Sampled During April and May Using Electrofishing

Metric	2016	2017	2018	2019	2020
Total Catch	226	317	212	176	310
Stock Catch	152	244	210	157	279
Units of Effort	5.44	7.48	8.33	2.89	5.95
Sub-Stock CPUE (RSE)	13.6 (45)	9.8 (40)	0.2 (70)	6.6 (54)	5.3 (49)
Stock CPUE (RSE)	27.9 (21)	32.6 (20)	25.2 (22)	54.3 (21)	44.0 (21)
Quality/Density CPUE (RSE)	17.6 (25)	21.9 (21)	17.8 (27)	41.2 (24)	29.9 (23)
Preferred CPUE (RSE)	11.2 (27)	12.7 (26)	11.4 (30)	26.0 (29)	18.8 (28)
Memorable/Lunker CPUE (RSE)	1.1 (56)	1.6 (40)	1.7 (34)	4.2 (42)	4.8 (32)
Total CPUE (RSE)	41.5 (22)	42.4 (21)	25.5 (22)	60.9 (23)	49.4 (21)
PSD S-Q	36.84	32.79	29.52	24.2	31.9
PSD Q-P	23.03	28.28	25.24	28.03	26.16
PSD P-M	36.18	34.02	38.57	40.13	31.18
PSD M-T	3.95	4.92	6.67	7.64	10.75
PSD	63.16	67.21	70.48	75.8	68.1
Mean WR S-Q (RSE)	99 (1)	98 (1)	101 (1)	100 (1)	98 (1)
Mean WR Q-P (RSE)	99 (2)	99 (1)	101 (1)	96 (1)	100 (1)
Mean WR P-M (RSE)	99 (1)	94 (1)	100 (1)	93 (1)	99 (1)
Mean WR M-T (RSE)	96 (3)	92 (2)	95 (1)	94 (2)	100 (1)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Table 21. CPUE, PSD, Wr, and RSE Estimates for Largemouth Bass Sampled During May Using Electrofishing

Metric	2016	2017	2018	2019	2020
Total Catch	97	123	241	42	98
Stock Catch	32	106	237	33	83
Units of Effort	5.44	7.48	8.33	2.89	5.95
Sub-Stock CPUE (RSE)	11.9 (41)	2.3 (32)	0.5 (48)	3.1 (69)	2.7 (58)
Stock CPUE (RSE)	5.9 (34)	14.2 (27)	28.5 (20)	11.4 (46)	14.6 (20)
Quality/Density CPUE (RSE)	2.2 (41)	10.4 (33)	27.1 (19)	10.4 (47)	9.2 (25)
Preferred CPUE (RSE)	0.9 (58)	2.4 (37)	11.6 (21)	8.0 (46)	5.3 (32)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.1 (100)	0.2 (70)	0.0 (.)	0.2 (100)
Total CPUE (RSE)	17.8 (34)	16.4 (26)	28.9 (19)	14.5 (39)	17.3 (20)
PSD S-Q	62.5	26.42	4.64	9.09	37.35
PSD Q-P	21.88	56.6	54.43	21.21	26.51
PSD P-M	15.63	16.04	40.08	69.7	34.94
PSD M-T	.	0.94	0.84	.	1.2
PSD	37.5	73.58	95.36	90.91	62.65
Mean WR S-Q (RSE)	108 (1)	109 (2)	99 (3)	109 (2)	104 (2)
Mean WR Q-P (RSE)	108 (2)	109 (1)	107 (1)	104 (3)	103 (2)
Mean WR P-M (RSE)	105 (2)	104 (2)	106 (1)	103 (1)	103 (1)
Mean WR M-T (RSE)	. (.)	99 (.)	103 (1)	. (.)	81 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Forage Species

Gizzard Shad (*Dorosoma cepedianum*)

While there are no official records of gizzard shad being stocked in Waconda Lake, this important forage base was most likely introduced soon after the Solomon River was impounded, and this species has thrived since. Almost to the point of an overabundance of gizzard shad in some years. Nevertheless, the sportfish condition values are typically good to excellent and fish growth rates are well above average due to gizzard shad. The first collection record was in July 1970. Adult gizzard shad numbers exhibited a welcome decline in the 2019 sample with stock CPUE dropping from 2.3 in 2018 to 1.7 in 2019 (see Table 15). These lower numbers continue a general decline in the adult shad population when stock CPUE peaked at 12.2 in 2010 but steadily dropped to a low of 2.1 in 2017 before rising slightly to 2.3 in 2018 (see Table 22). This is easily the lowest stock CPUE collected at Waconda Lake with the use of core panel gill nets and puts the gizzard shad population near a manageable number. In addition, sub-stock CPUE remained low at 0.44 which is the ninth time in the past ten years that this value has been less than one. As is often the case, size structure was skewed towards preferred fish with an RSD P-M rating of 100. In fact with the exception of eight sub-stock fish between 130 and 150 millimeters (mm), all of the fish in the sample were between 350 and 490 mm with a peak at 410 mm. Based on these findings, predator numbers consistently remain relatively high with the use of blue catfish, wiper, and striped bass stockings. The growing blue catfish population is an important component of the predator community and is critical in gizzard shad control as well.

Table 22. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During October and November Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	102	65	62	38	34
Stock Catch	92	51	56	30	16
Units of Effort	24	24	24	18	24
Sub-Stock CPUE (RSE)	0.4 (35)	0.6 (32)	0.3 (50)	0.4 (49)	0.8 (35)
Stock CPUE (RSE)	3.8 (17)	2.1 (25)	2.3 (23)	1.7 (25)	0.7 (32)
Quality/Density CPUE (RSE)	3.5 (18)	1.7 (24)	1.5 (26)	1.7 (25)	0.7 (32)
Preferred CPUE (RSE)	3.5 (18)	1.7 (25)	1.0 (32)	1.7 (25)	0.7 (32)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	4.3 (15)	2.7 (22)	2.6 (21)	2.1 (22)	1.4 (29)
PSD S-Q	8.7	19.61	37.5	.	.
PSD Q-P	.	1.96	17.86	.	.
PSD P-M	91.3	78.43	44.64	100	100
PSD M-T	.	.	.	.	.
PSD	91.3	80.39	62.5	100	100
Mean WR S-Q (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR Q-P (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Future Without Project Projections

Waconda Lake is expected to realize fairly stable water levels as it lies on the western edge of the wetter portion of the state that provides adequate rainfall to maintain the water level. Periods of extended drought force the water level to decline 2 to 5 feet occasionally, but outside of extreme drought situations water is abundant. The watershed size is simply too large to avoid significant rainfall over long periods of time and river inflow is steady enough to maintain most water levels. At reduced pool, decreased water quality and reduced habitat availability and diversity limit sportfish population abundance and welfare. When Waconda Lake is at low pool elevations, aquatic resource-based recreational opportunities available to the public, become more limited.

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Kansas River Reservoirs Flood and Sediment Study-Reservoir Fishery

Location: Lovewell Reservoir

Scott Waters, KDWP District Fisheries Biologist

Lovewell Reservoir Located on White Rock Creek in Jewell County, Kansas

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History

Water Allocation Background

Lovewell Dam and Reservoir were constructed by the U.S. Bureau of Reclamation (USBR). Lovewell Reservoir functions as an irrigation reservoir diverting water to serve 12,508 acres above Lovewell Dam and 27,014 acres below Lovewell Dam by diverting water from the Republican River via the Courtland Canal. Lovewell Reservoir also provides flood control to the valley immediately downstream of the impoundment as well as to cities, towns, farms, and lands located far downstream. The reservoir storage capacity includes 50,460 acre-feet (ac-ft) storage for flood control and 24,022 ac-ft for multipurpose use. Lovewell Reservoir also provides recreation and fish and wildlife conservation benefits.

Lovewell Reservoir water surface and major portions of surrounding reservoir lands are administered by the Kansas Department of Wildlife and Parks (KDWP) in accordance with a Memorandum of Understanding. The KDWP has requested that the Kansas Bostwick Irrigation District and USBR maintain, when possible, a flow of 20 cubic feet per second (cfs) into Lovewell Reservoir when the Courtland Canal is in operations and the conservation pool is below capacity. This recommended inflow provides excellent fishing around the canal inlet to the reservoir. The storage capacity and ownership are shown in Table 1.

Table 1. Storage Capacity and Ownership

Pool Owner / Water Rights	Purpose	Quantity (acre-feet (ac-ft))
USBR	Flood Control	50,460
USBR	Multipurpose	24,022

Lovewell Reservoir Fishery

Fisheries Establishment

Most of the extant sportfish species that currently inhabit Lovewell Reservoir were stocked within the first few years of post-impoundment. Northern pike were first captured in 1974 but the only stocking records are from 1978 and 1979. This species was last sampled in 1985 and is no longer known to occur at Lovewell Reservoir. Other species including shorthead redhorse and striped bass have been sampled historically but are no longer found in the reservoir. The state record shovelnose sturgeon was captured in Lovewell Reservoir in 1999 but few are ever sampled. In addition, rainbow trout are occasionally caught in the reservoir as these fish can immigrate from upstream sources in Nebraska. Tables 2 and 3 list sport and non-sport fish in Lovewell Reservoir. More detailed treatments of recent species-specific stocking efforts are explained in species narratives below in the *Sportfish Population Dynamics & Trends* section.

Table 2. Sport Fish Species Known to Inhabit Lovewell Reservoir

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Black Bullhead	*Ameiurus melas*
Blue Catfish	*Ictalurus furcatus*
Channel Catfish	*Ictalurus punctatus*
Flathead Catfish	*Pylodictis olivaris*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Wiper	*Morone saxatilis X M. chrysops*

Table 3. Non-Sport Fish Species Known to Inhabit Lovewell Reservoir

Common Name	Scientific Name
Bigmouth Buffalo	*Ictiobus cyprinellus*
Common Carp	*Cyprinus carpio*
Emerald Shiner	*Notropis atherinoides*
Fathead Minnow	*Pimephales promelas*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Golden Shiner	*Notemigonus crysoleucas*
Goldeye	*Hiodon alosoides*
Log Perch	*Percina caprodes*
Longnose Gar	*Lepisosteus osseus*
Orangespotted sunfish	*Lepomis humilus*
Quillback	*Carpiodes cyprinus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Sand Shiner	*Notropis stramineus*
Smallmouth Buffalo	*Ictiobus bubalus*
Shortnose Gar	*Lepisosteus platostomus*
Suckermouth Minnow	*Phenacobius mirabilis*
Western Mosquitofish	*Gambusia affinis*

Abiotic and Biotic Factors Effecting the Fishery

1. Water Quality

The impounded lake that is Lovewell Reservoir was characterized as hypereutrophic in 2010. This is a change in the productivity level from 2007 when it was classified as very eutrophic. The trophic state index (TSI) score increased from 65.6 M in 2007 to 68.1 M in 2010 (Carney, 2010). Mean secchi disc readings over the past 10 years have been 112 centimeters (44 inches). The general limnological parameters characteristic of Lovewell Reservoir is shown in Table 4.

Table 4. General Limnological Parameters Characteristic of Lovewell Reservoir

Parameter	Unit of Measure	Value
Size Multipurpose Pool	acres	2986.0
Max. Depth	feet	31.2
Mean Depth	feet	14.7
Mean Annual Precipitation	inches	26.3
Mean Annual Runoff	inches	2.8
Area Watershed Drainage	square miles	344.9
Hydrologic Residence Time	days	213.0
Chlorophyll A	parts per billion	35.5
Secchi	centimeters	112.0
Shoreline Development Index	ratio	5.9
Agricultural Lands	%	38.7
Forest Habitat	%	4.9
Grassland Habitat	%	49.9
Urban Lands	%	3.9
Trophic State Index		65.6

Note: ***Kansas Department of Health and Environment uses the Carlson Chlorophyll-a Trophic State Index to classify lake productivity. This metric assigns trophic state based upon measured phytoplankton abundance in ug/L. Classification is adjusted if greater than 50% aerial cover of macrophytes are present at time of measurement (Carney, 2010).

2. Water Level Fluctuation

Lovewell Reservoir covers 2,986 surface acres at conservation pool at a surface elevation of 1582.6 feet. Water volume storage was 41,690 ac-ft but a sediment study was conducted in 1997 which found this had been reduced to 35,666 ac-ft or a 15% loss of storage in the first 40 years of reservoir life. Because water can be diverted from the Republican River, Lovewell Reservoir does not experience long-term drought conditions like other reservoirs in the area. The annual irrigation protocol allows the water level to be manipulated as needed with the level slowly allowed to rise from the end of the irrigation season through spring. Extra water up to 2 or 3 feet above the top of the conservation pool is often stored between April and late May or early June when irrigation releases begin via the Courtland Canal. These releases continue for approximately three months throughout the summer and vary from less than 100 cubic feet per second (cfs) to 550 cfs. Occasionally, water levels are lowered below normal (4 to 6 feet below top of conservation pool) for maintenance work around the outlet, including dredging of accumulated silt material. The two lowest such events occurred in 1991 at 1570.2 feet, approximately 12.4 feet low and 2019 at 1571.6 feet, approximately 11 feet low. During flood events, water levels have reached over 7 feet above the top of the conservation pool four times including 1589.8 feet in 1987, 1590.7 feet in 1974, 1591.6 feet in 1993, and the highest recorded level was 1593.0 feet in 2019, 10.4 feet above conservation (Figure 1). Water levels play a crucial role in fish production and angler participation. This also has a direct effect on state park visitation and the economy surrounding the reservoir.

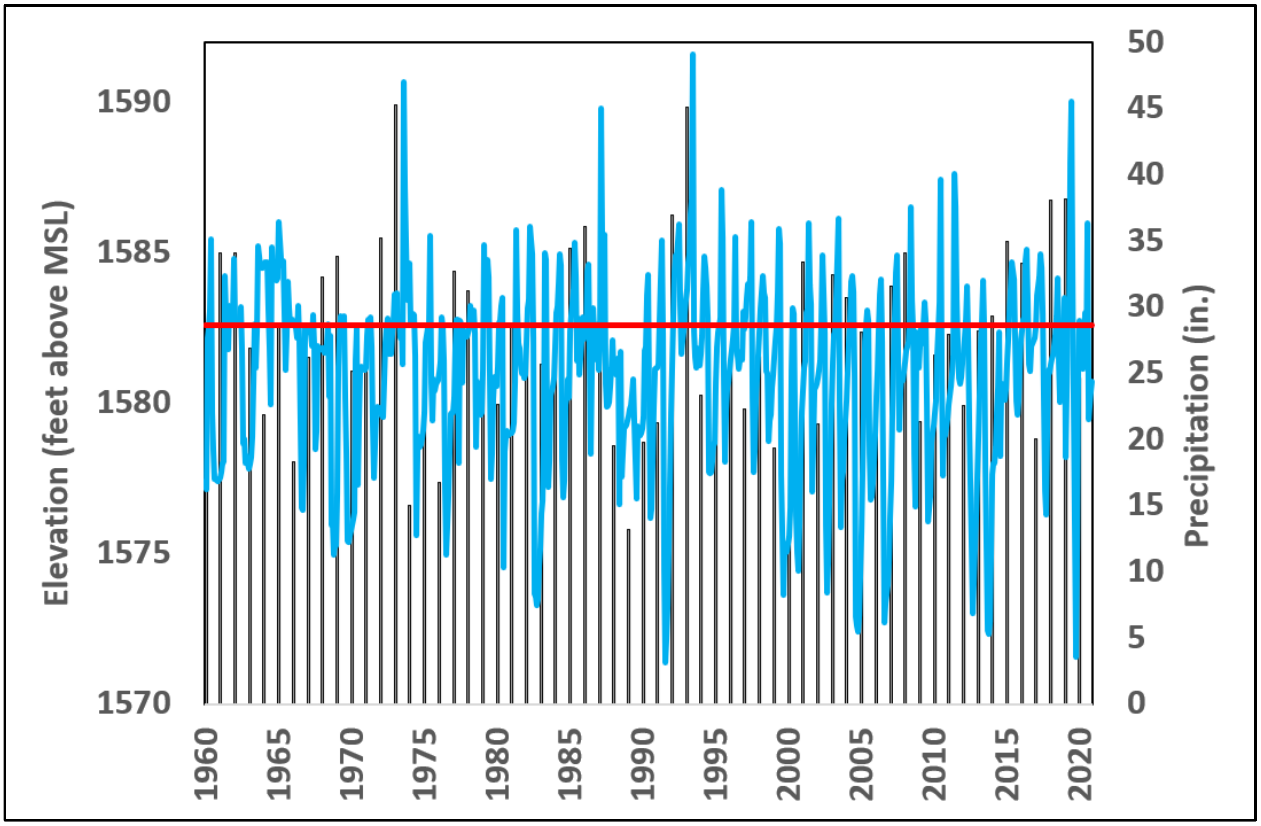

Figure 1. Monthly ending reservoir pool elevation (feet above MSL) [blue line] in relation to full conservation pool elevation [red line] and total annual precipitation [vertical columns] recorded by USBR at Lovewell Reservoir from 1960 to 2020

3. Vegetation

Vegetated fisheries habitats occurring in and adjacent to Lovewell Reservoir consists of terrestrial, emergent, and submergent vegetation. These vegetation types and their habitat value for reservoir fisheries are described below.

A. Terrestrial

Herbaceous to woody terrestrial vegetation common to the area colonizes the reservoir basin during years of low reservoir pool elevation. After flooding, terrestrial vegetation provides temporary nutrient input, substrate for attachment of periphyton (a complex mixture of algae, cyanobacteria, microbes, and detritus) and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of flooded terrestrial vegetation degrades water quality by decreasing dissolved oxygen. The degree of lignification that characterizes flooded vegetation, determines the ongoing decomposition rate, impacting the magnitude and duration of oxygen demand. Due to the annual water level cycle at Lovewell Reservoir, the amount of terrestrial vegetation growth is limited and the reservoir basin stays relatively free of this vegetation type.

Creek arms and low-lying areas will experience this phenomenon annually, however, as rising water levels will often inundate these area for several months each year.

B. Emergent

Swamp smartweed (*Polygonum hydropiperoides*), common reed (*Phragmites australis*), cattails (*Typha spp.*), sedges (*Cyperaceae spp.*), and rushes (*Juncaceae spp.*) are the primary emergent aquatic vegetation species. Sedge and rush abundance and their distribution is relatively limited. Cattails are also relatively limited but can be found primarily at the upper end of the reservoir and the back ends of the creek arms. Their abundance and distribution have become more limited due to the extensive high-water events listed above. Common reed abundance has increased slightly on the upper end and will likely continue to expand distribution, especially occupying those areas of the lake basin subject to flooding. Common reed is capable of establishment through fragmentation. Flooded emergent aquatic vegetation provides nutrient input, substrate for periphyton and other invertebrates, and physical habitat for juvenile and adult fish. Decomposition of emergent vegetation residual causes hypoxia (dissolved oxygen concentrations too low to support fish and other aquatic species) in areas of dense stands of vegetation during the summer.

Swamp Smartweed is a Common Species of Aquatic Vegetation Found in Lovewell Reservoir Throughout the Summer

C. Submergent

Submergent aquatic vegetation can establish beds in the littoral zone of the reservoir but like most species in Lovewell Reservoir it remains somewhat limited due to the annual water level fluctuation cycle. Coontail (*Ceratophyllum demersum*), Sago pondweed (*Potamogeton pectinatus*), American pondweed (*Potamogeton nodosus*), and curly leaf pondweed (*Potamogeton crispus*) constitute the most common species at Lovewell Reservoir. Curly leaf pondweed is not native to the area. Regardless of native status, presence of all submerged aquatic vegetation species diversify littoral zone habitats within the reservoir and effectively act as escape habitat for young fish and foraging habitat for adult fish. Submerged aquatic vegetation beds create shade, thus lowering water temperatures immediately below the bed providing a thermal refuge to fish during summer. Submerged aquatic macrophyte beds provide fish concealment from avian predators.

4. Water Quality/Turbidity

Lovewell Reservoir possesses adequate water quality to promote sportfish survival. Turbidity is moderate as evidenced by mean secchi disc measurements mentioned earlier. Indices relative to specific conductivity and total dissolved solids (TDS) are also moderate but become concentrated as the reservoir volume decreases. Water turbidity plays an important role in fisheries population dynamics and is an indicator of the productivity of a water body. Highly turbid water can inhibit effective fish feeding whereas clear water may indicate a lack of primary productivity and poor production on the bottom of the food chain. Lovewell Reservoir turbidity falls within the ideal range for Kansas reservoirs but can be excessive following high inflow events.

5. Invasive/Exotic Species

A. Common Reed Encroachment

A limited amount of common reed has become established west of the K-14 bridge at Lovewell Reservoir. Several small bunches can be located along the White Rock Creek shoreline, but this has not yet spread to the reservoir itself. Due to its limited expansion this exotic species has not harmed the reservoir ecosystem or the fisheries of Lovewell to the extent that has been seen in other impoundments.

B. Purple Loosestrife

Purple loosestrife is found in a small area on the upper end of Lovewell Reservoir. The right of way ditch along Highway 14 between the K-14 bridge and W Road has a small population which appears every few years. This species is pulled by the roots and burned, and the perimeter is sprayed. This species has not negatively impacted the Lovewell Reservoir fisheries due to its limited establishment.

6. Sedimentation

The multipurpose pool at Lovewell Reservoir originally included 41,687 ac-ft of capacity (including the active pool and the inactive or dead pool). Approximately 16.3% of the multipurpose pool has been filled in with sediment leaving approximately 34,888 ac-ft of capacity (based on 2020 survey results). It is estimated that approximately 31 ac-ft of sediment accumulates on average annually in Lovewell Reservoir. Sediment will continue to accumulate in Lovewell Reservoir with an expected additional 2.2 % loss of the multipurpose pool over the next 25 years (2049) and 4.1% loss over the next 50 years (2074) (USACE 2022) bringing the capacity of the multipurpose pool to 33,189 ac-ft in 2074.

Fisheries Management Objectives

The general objective of fisheries management at Lovewell Reservoir is to optimize the quality and diversity of angling opportunities. Specific management activities conducted include tailoring fish harvest regulations to changes in sportfish population trends, stocking fish to enhance population abundance as needed, construct fish attractors to enhance angler success, and maintain/improve angling access. Recent adjustments to the regulations include the addition of a 10-inch minimum length limit (MLL) and 20 fish per day creel limit on crappie in 2019. Lovewell was the first reservoir to experience a MLL on walleye when the 18-inch length limit was enacted in 1989 to promote female growth and survival in hopes of increasing the annual egg collection totals. Blue catfish are currently protected with a 35-inch MLL and 5 fish per day creel limit until natural recruitment is apparent and harvest can be encouraged. See Table 5 below for a comprehensive list of fish harvest regulations in effect at Lovewell Reservoir.

Table 5. Current Fish Harvest Regulations in Effect at Lovewell Reservoir

Species	Reach	Length Limit	Creel Limit
Blue Catfish	Special	35	5
Channel Catfish	Statewide		10
Flathead Catfish	Statewide		5
Largemouth Bass	Statewide	15	5
Walleye	Special	18	5
White Crappie	Special	10	20
Wiper - W x S Bass	Special		2

Relevance to Fish Culture in Kansas

Stocking is an important walleye management activity in many Kansas waters. Considering the difficulty to maintain and spawn captive broodstock, and the propensity of sexually mature walleye to concentrate in discrete spawning areas, gametes are harvested from wild broodstock for culture purposes from several Kansas impoundments each spring. The Lovewell Reservoir walleye population was one of the primary sources to collect and fertilize walleye eggs between 1990 and 1997, contributing between 6 and 45% to the total statewide annual quota (Table 6). This effort was short-lived, however, and walleye eggs have not been collected in over 30 years. Still, walleye is managed with the same 18-inch MLL and optimizing walleye broodfish abundance and welfare has been a management priority at Lovewell Reservoir.

Table 6. Walleye Egg Collection Totals from Lovewell Reservoir Between 1990 and 1997

1990	1991	1992	1993	1994	1995	1996	1997
23,169,600	0	19,820,645	6,718,843	0	0	0	3,546,461

Source: KDWP 2021

Mitigation for Factors Affecting the Sport Fishery

The actions discussed below provide mitigation for the abiotic and biotic factors that adversely affect the fishery at Lovewell Reservoir.

1. Reallocation of Pool Storage

Lovewell Reservoir was developed in 1957 following completion of the dam intended to impound White Rock Creek. The primary purpose of the reservoir is to provide an annual water supply for irrigators in the Republican River valley of north central Kansas. As a means of providing this water supply, a diversion canal was constructed from the Republican River approximately 9 miles east of Lovewell Reservoir. Inflows from the Republican annually maintain water levels near or above conservation pool prior to the irrigation season and can recharge the reservoir following irrigation releases.

These irrigation releases occur via the Courtland Canal which flows out of Lovewell Reservoir on the south end of the dam. The canal provides a water source for 28,000 acres of irrigated land and returns to the Republican River after approximately 13 miles. The irrigation season lasts from late-May to late-August with the peak between 15 July and 15 August. Depending on weather patterns and demand, total releases range from 25,000-65,000 acre-feet per year with a 10-year average of 45,600 acre-feet. This release leads to a reservoir drawdown from 5-12 feet which normally recharges to full pool by the following spring.

KDWP has requested that the KBID and Reclamation maintain, when possible, a flow of 20 cfs into Lovewell Reservoir when the Courtland Canal is in operation and the conservation pool is below capacity.

This recommended inflow provides excellent fishing around the canal inlet to the reservoir. The seepage below Lovewell Dam into White Rock Creek maintains a small live stream throughout the year. (USBR 2021)

2. Riprap Installation in Areas of Critical Shoreline Infrastructure

Over time, this shoreline armor has been placed near boat ramps, parking areas, and has been used to construct jetties in several areas around Lovewell state park. The jetty near Cedar Point was recently extended to provide additional boat ramp protection from strong westerly and southerly winds. Much of the north shore state park area has been riprapped over the past 20 to 30 years which was needed to decrease the amount of shoreline erosion and has prevented additional sediment issues due to wave-causing erosion. These riprap areas also provide excellent fisheries habitat, especially for largemouth bass, flathead catfish, bluegill, and crappie.

3. Standard and Supplemental Fish Sampling to Monitor Sportfish Trends

Standard fish population sampling is employed on an annual basis and is conducted using standardized methods approved by KDWP Fisheries staff and applied at Lovewell Reservoir and other Kansas waters to develop baseline trend data by which Kansas fisheries are managed. At Lovewell Reservoir, electrofishing is used to sample largemouth bass populations in spring, and core panel gill nets and ½" mesh fyke nets are employed each fall to sample other sportfish species such as bluegill, channel catfish, crappies, white bass, wipers, and walleye. Low frequency electrofishing is utilized in the summer to examine flathead catfish and blue catfish populations. In addition, float line sampling is a new technique used each summer for additional blue catfish sampling. Shoreline seining in August provides an estimate of the gizzard shad year class abundance and size structure.

Supplemental fish population sampling is conducted at the discretion of the KDWP District Fisheries Biologist to address specific management questions/challenges. Supplemental sampling can consist of accepted or experimental methods and often focuses on finer detail resolution fish population parameters. Recently at Lovewell Reservoir age-and-growth analyses were conducted to characterize growth trajectories exhibited by these populations. Crappie growth information was used to justify implementation and evaluate effect of the 10-inch minimum length limit and 20 per day creel limit special harvest regulations on this species.

4. Other Biotic and Abiotic Parameter Sampling

This sampling should be considered supplemental sampling but most often consists of sampling a parameter(s) other than those specifically related to sportfish. Some recent examples include water samples collected by USBR staff to monitor for the presence of zebra mussel larvae. In addition, harmful algae blooms (HABs) may be detected in the reservoir which triggers additional water quality sampling to determine the extent of the HAB.

5. Fish Harvest Regulations

In Kansas, as is the case in many other states, harvest of various sportfish species at waters open to public angling is regulated by length and creel limits. For example, largemouth bass harvest is regulated by a 15-inch minimum length limit and a creel limit of 5 fish/angler/day. Alternatively, KDWP District Fisheries Biologists have special length and creel limits at their disposal to implement, with proper justification, to further regulate angler harvest in an effort to meet management objectives. Current special fish harvest regulations in effect at Lovewell Reservoir are: Crappie-10-inch minimum length limit and 20/day creel limit, Blue Catfish-35-inch minimum length limit, and Walleye-18-inch minimum length limit. See Table 7 below for a comprehensive list of fish harvest regulations in effect at Lovewell Reservoir.

Table 7. Current Fish Harvest Regulations in Effect at Lovewell Reservoir

Species	Length Limit	Creel Limit
Blue Catfish	35-inch minimum length limit	5 fish daily creel limit
Channel Catfish	N/A	10 fish daily creel limit
Flathead Catfish	N/A	5 fish daily creel limit
Crappie	10 - inch minimum length limit	20 fish daily creel limit
Largemouth Bass	15 - inch minimum length limit	5 fish daily creel limit
Walleye	18 - inch minimum length limit	5 fish daily creel limit
Wiper	N/A	2 fish daily creel limit

Source: KDWP 2020

6. Sportfish Stockings

The stocking of fry, fingerling, and possibly intermediate-sized walleye will continue annually to boost recruitment and supplement the limited natural reproduction which occurs. Blue catfish were stocked for five years but are now set to expand with natural reproduction and will not be stocked again. Wiper fry and fingerlings are stocked annually to maintain these low-density populations.

The direction which angler use and visitation at Lovewell Reservoir takes is unclear, as changes in socio-economic factors greatly influence public involvement in angling. For example, increased participation of families in youth sporting activities reduces participation in angling. However, the unforeseen emergence and response to COVID-19 greatly increased public participation in angling and other outdoor recreation at Lovewell Reservoir during the 2020 season.

Angler Use

KDWP periodically conducts creel surveys to quantify angling pressure, harvest patterns, and angler demographics. Data is collected via seasonal clerks conducting random interviews with shoreline and boat anglers during the period March 1 to October 31, in accordance with KDWP reservoir survey guidelines. Creel surveys are encouraged to be completed a minimum of every 5 years at major reservoirs but are often more frequent following new regulations or during special projects.

Angler effort (angler-hours/ac.) at Lovewell Reservoir ranks anywhere from the 25th to the 75th percentile when compared to other Kansas reservoirs depending on the year (see Table 8). Anglers hailing from the surrounding communities and Nebraska exert most of the pressure, with fishers from eastern Kansas and south-central Kansas frequenting the lake to a lesser degree.

Lovewell Reservoir anglers tend to be opportunistic in terms of species they prefer to fish for. Angler preference for a specific species often varies based upon changes in species dominance that result from water fluctuation history or recent recruitment. For example, no preference has been the most popular response when anglers are asked what they are fishing for in two of the past four surveys. The strong walleye population had anglers respond with that species most often in 2005 but walleye have declined to second during the past three surveys. Channel catfish are always found in the top four, ranging from first in 2011 to fourth in 2006 and 2015, depending on other opportunities. White bass are also a critical species for anglers and were in the top three during 75% of the surveys. Crappie numbers fluctuate more than most species and angler effort toward them is highly variable with this species only showing up in 2005. Many of the no preference anglers are likely “crappie fishing” but are happy to catch anything. The indiscriminate selection of target species has become more prominent as well with many anglers less focused on one species but rather preferring a mixed bag or taking advantage of whatever species is most readily available at the time. Lovewell Reservoir anglers tend to be harvest minded. White bass, channel catfish, and crappie comprise the largest contributions to angler's creel in most years (Tables 9 and 10).

Table 8. Total Number of Anglers and Angler-hours at Lovewell Reservoir for the Four Most Recent Creel Surveys Conducted March 1 Through October 31

Year	Total Number of Anglers	Anglers per Acre	Total Angler Hours	RSE	Angler Hours per Acre
2005	18,292	6.13	63,867.85	6	21.39
2006	7,507	2.51	44,080.05	10	14.76
2011	13,317	4.46	50,385.20	8	16.87
2015	10,840	3.63	31,965.28	8	10.71

Table 9. Average Percentages of the Top Four Most Preferred Species by Anglers at Lovewell Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31.

Year	First		Second		Third		Fourth	
2005	Walleye	27.3	White Bass	24.5	Channel Catfish	23.0	Crappie	16.9
2006	No Fish Preference	48.6	Walleye	18.4	White Bass	12.5	Channel Catfish	11.9
2011	Channel Catfish	32.6	Walleye	22.6	No Fish Preference	21.9	White Bass	18.5
2015	No Fish Preference	42.9	Walleye	23.6	White Bass	15.5	Channel Catfish	10.3

Table 10. Estimated Total Number of Sport Fish Harvested and Released at Lovewell Reservoir for the Five Most Recent Creel Surveys Conducted March 1 Through October 31

Harvest Status	Year	Channel Catfish	Wiper	Walleye	White Bass	Crappie
Harvested	2005	3,607	1,052	1,126	9,472	3,475
Harvested	2006	5,608	1,022	627	4,016	1,928
Harvested	2011	10,942	530	1,863	13,993	471
Harvested	2015	4,078	1,201	454	5,472	1,876
Released	2005	333	32	577	218	1,062
Released	2006	1,043	330	4,534	2,507	85
Released	2011	4,554	407	3,208	9,086	0
Released	2015	4,401	1,043	1,094	4,579	2,564

Sportfish Population Dynamics/Trends

Black Crappie (*Pomoxis nigromaculatus*)

The first stocking records of crappie were May 21, 1957, although the records only indicate crappie and do not differentiate between white and black crappie. On that date, 5,000 fingerlings from the Pratt, Kansas hatchery were stocked. Black crappie were first sampled in Lovewell Reservoir on 1 June 1957, shortly after the completion of the dam. The next stocking record consisted of 11,600 fry in 1966.

Fingerling black crappie were also stocked in 2007 and 2008 to boost a struggling population but those stockings were limited.

Crappie were rarely sampled by KDWP biologists during the early years of Lovewell Reservoir; thus, data is limited. Routine fall netting using trap nets began annually in 2003 and has continued annually since with samples sizes ranging from 6 to 16 trap nets. Black crappie has comprised anywhere from 6% (2016) to 35% (2014) of the total crappie stock catch at Lovewell Reservoir over the past decade with a mean of 19%. This contribution to the crappie fishery is significant and anglers often report good catches of black crappie.

The 2020 black crappie sample was down compared to 2019 but this could be partly due to the water level being nearly 9 feet higher, and only 1.5 feet below conservation pool in 2020 (see Table 10). Age-2 and older fish are traditionally rare at Lovewell Reservoir as catch rates of quality and larger fish are low. Only ten fish greater than 200 millimeters (mm) were captured as is often the case despite high catch rates of age-1 fish most years. The new 10-inch minimum length limit should allow these fish to reach preferred size, but few are seen. Anglers should have little trouble catching black crappie in 2021 but most of the fish will be released.

Table 11. Catch Per Unit Effort (CPUE), Proportional Stock Density (PSD), Relative Weight (Wr), and Relative Standard Error (RSE) Estimates for Black Crappie Sampled During October Using Trap Nets.

Metric	2016	2017	2018	2019	2020
Total Catch	299	316	95	219	224
Stock Catch	53	289	70	80	107
Units of Effort	16	11	16	8	14
Sub-Stock CPUE (RSE)	15.4 (27)	2.5 (42)	1.6 (42)	17.4 (26)	8.4 (28)
Stock CPUE (RSE)	3.3 (24)	26.3 (19)	4.4 (25)	10.0 (30)	7.6 (25)
Quality/Density CPUE (RSE)	0.6 (32)	1.3 (32)	2.6 (28)	5.4 (28)	2.1 (38)
Preferred CPUE (RSE)	0.1 (100)	0.3 (52)	0.1 (100)	2.9 (34)	0.2 (100)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.3 (65)	0.1 (100)
Total CPUE (RSE)	18.7 (24)	28.7 (18)	5.9 (23)	27.4 (26)	16.0 (19)
PSD S-Q	83.02	95.16	40	46.25	71.96
PSD Q-P	15.09	3.81	58.57	25	25.23
PSD P-M	1.89	1.04	1.43	26.25	1.87
PSD M-T	.	.	.	2.5	0.93
PSD	16.98	4.84	60	53.75	28.04
Mean WR S-Q (RSE)	98 (2)	97 (1)	103 (1)	93 (4)	100 (1)
Mean WR Q-P (RSE)	100 (3)	99 (2)	100 (1)	98 (6)	100 (1)
Mean WR P-M (RSE)	88 (.)	104 (1)	112 (.)	111 (1)	95 (0)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	104 (4)	99 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Blue Catfish (*Ictalurus furcatus*)

Blue catfish are not native to the White Rock Creek drainage at what is now Lovewell Reservoir and further upstream (Kansas Fishes Committee, 2014). Blue catfish were first stocked in 2010 to add another catfish species for anglers to harvest, provide an additional predator on the abundant gizzard shad population, and feed on zebra mussels which may eventually enter the system. To establish this population, blue catfish were stocked at a rate of 5 fingerlings per acre from 2010 through 2015. Stocking ceased as the original fish began to reach 25 to 30 inches in length and reached the age of sexual maturity. A 35-inch minimum length limit and 5 fish daily creel limit were established to help protect this young population until natural recruitment was documented. The fish that survived the stockings are growing well with the biggest fish collected in 2020 reaching 37 inches and 26 pounds. The length frequency reveals that not every stocking was successful, however, based on the low catch rates of certain sizes. No natural reproduction has been documented despite 10 year old fish residing in the reservoir. Blue catfish are monitored annually using low frequency electrofishing, floatline sampling, and core panel gill nets in the fall. Electrofishing catch rates have been relatively high in recent years and this has been proven as an effective method to sample this species. Floatline sampling was added in 2019 with catch rates of nearly 2.5 fish per 5 line set realized. Fall sampling using core panel gill nets is considered the standard sampling method for blue catfish; however, this often results in the lowest catch rates, and thus, is supplemented using the other methods. Once natural reproduction is documented, the regulations will be altered to allow harvest of smaller individuals while protecting the larger fish. There is great potential for a trophy blue catfish fishery to develop in Lovewell and their predatory influence on gizzard shad is important to maintain as well.

Table 12. CPUE, PSD, Wr, and RSE Estimates for Blue Catfish Sampled During October Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	13	22	11	17	13
Stock Catch	13	22	11	17	13
Units of Effort	20	20	20	12	20
Sub-Stock CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Stock CPUE (RSE)	0.7 (41)	1.1 (27)	0.6 (48)	1.4 (27)	0.7 (36)
Quality/Density CPUE (RSE)	0.5 (30)	0.5 (31)	0.4 (46)	1.3 (27)	0.7 (36)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.3 (52)	0.1 (100)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.1 (100)	0.0 (.)
Total CPUE (RSE)	0.7 (41)	1.1 (27)	0.6 (48)	1.4 (27)	0.7 (36)
PSD S-Q	30.77	54.55	27.27	5.88	.
PSD Q-P	69.23	45.45	72.73	76.47	92.31
PSD P-M	.	.	.	11.76	7.69
PSD M-T	.	.	.	5.88	.
PSD	69.23	45.45	72.73	94.12	100
Mean WR S-Q (RSE)	91 (2)	92 (2)	93 (7)	87 (.)	. (.)
Mean WR Q-P (RSE)	95 (2)	97 (4)	93 (2)	99 (2)	92 (2)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	115 (8)	103 (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	103 (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Bluegill (*Lepomis macrochirus*)

Bluegill are likely native to the White Rock Creek drainage at what is now Lovewell Reservoir and further upstream (Kansas Fishes Committee, 2014). There are no bluegill stocking records in Lovewell, but this species was first sampled on June 1, 1957, shortly after completion of the dam. Similar to crappie, bluegill were rarely sampled before 2000 which limits the available data for this species.

The bluegill population is not often targeted at Lovewell Reservoir but can provide some fair to good angling opportunities at certain times each year. Anglers typically catch these fish during June when they are spawning in the coves or during the winter months when fishing for crappie. After catch rates improved from only 2.4 stock CPUE in 2018 to 15.1 in 2019, they declined to 7.4 in 2020 (see Table 12). The density rating improved, however, from 1.6 to 2.5 as a cohort of fish in the 150 mm size range improved this value. All the adults were of stock and quality size with an RSD S-Q of 66 and RSD Q-P of 34. No fish greater than 180 mm were collected with 35 quality-size fish in the sample ranging from 150 to 180 mm, compared to just 13 in 2019. Most of the sample were fish between 120- and 150-mm. Sub-stock catch rate improved significantly from just 1.1 in 2019 to 7.6 in 2020 (see Table 12). This is the second highest sub-stock CPUE in the past decade. Wr values are always excellent for bluegill and the mean of 102 for this sample is no exception with stock fish averaging 101 and quality-size fish with an excellent mean of 104. Lovewell rose slightly from 12th to 11th among the state's reservoirs for bluegill density and no preferred or larger fish were collected for the eighth time in the past nine years. Given the large number of bluegills just below quality size the density should improve next year as these fish continue to grow and anglers may begin to see fish approaching 200 mm.

Table 13. CPUE, PSD, Wr, and RSE Estimates for Bluegill Sampled During October Using Trap Nets

Metric	2016	2017	2018	2019	2020
Total Catch	101	242	55	130	210
Stock Catch	93	237	39	121	104
Units of Effort	16	11	16	8	14
Sub-Stock CPUE (RSE)	0.5 (32)	0.5 (46)	1.0 (70)	1.1 (43)	7.6 (29)
Stock CPUE (RSE)	5.8 (38)	21.5 (32)	2.4 (44)	15.1 (43)	7.4 (21)
Quality/Density CPUE (RSE)	1.3 (39)	6.6 (52)	1.4 (61)	1.6 (59)	2.5 (24)
Preferred CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	6.3 (35)	22.0 (32)	3.4 (39)	16.3 (40)	15.0 (22)
PSD S-Q	77.42	69.2	41.03	89.26	66.35
PSD Q-P	22.58	30.8	58.97	10.74	33.65
PSD P-M	.	.	.	.	.
PSD M-T	.	.	.	.	.
PSD	22.58	30.8	58.97	10.74	33.65
Mean WR S-Q (RSE)	102 (3)	102 (1)	101 (1)	92 (8)	101 (2)
Mean WR Q-P (RSE)	109 (2)	99 (2)	108 (1)	136 (.)	104 (2)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Channel Catfish (*Ictalurus punctatus*)

Channel catfish were stocked immediately after completion of the dam on June 25, 1957, via 172,500 fry. They were first sampled on June 1, 1957 prior to the stocking, indicating they were likely native to the

White Rock Creek drainage. Lovewell Reservoir traditionally has a strong channel catfish population due to the high number of gizzard shad, abundant spawning and brood rearing areas, and relatively low angling pressure compared to other reservoirs. Channel catfish are managed with the statewide 10 fish per day creel limit and no length limit. Status of channel catfish is listed below (see Table 14).

The 2020 channel catfish sample exhibited a decrease in catch rates from the record numbers collected in 2019 but catch rates are still the second highest in over a decade (see Table 14). Channel catfish numbers have steadily increased since a low of 1.2 in 2014. The stock CPUE of 5.8 in 2020 is down from the 11.7 in 2019 but higher than the 5.4 in 2018 and 5.3 in 2017. The channel catfish population has been thriving for six years and appears to be one of the best in the state. The density rating dropped from 9.8 to 4.3 which is tied for the second highest in the past decade while the preferred rating dropped slightly from 1.2 to 0.9, also the second best. The lunker rating dropped from 0.25 to 0.15. Sub-stock CPUE dropped from the high of 0.6 in 2018 to 0.33 in 2019 and 0.15 in 2020. Like most years, the length frequency graph shows an even distribution of sizes available with 5% of the fish less than 12 inches, 33% were 12 to 16 inches, 43% were between 17 and 21 inches, and 19% were 22 to 30 inches. Size structure was skewed more toward the mid-range sizes with an RSD S-Q at 27, RSD Q-P at 58, RSD P-M at 13, and RSD M-T at 3. The number of fish preferred size and greater has steadily improved from six in 2016 to 18 in 2020. Anecdotal information collected from anglers indicates they often release the bigger catfish and harvest the smaller sizes. This increase in catch rates coincides with a decrease in body condition as overall condition declined again to 80 following an average of 88 in 2018.

Table 14. CPUE, PSD, Wr, and RSE Estimated for Channel Catfish Sampled During October Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	90	118	119	144	119
Stock Catch	82	105	107	140	116
Units of Effort	20	20	20	12	20
Sub-Stock CPUE (RSE)	0.4 (42)	0.7 (41)	0.6 (47)	0.3 (77)	0.2 (73)
Stock CPUE (RSE)	4.1 (13)	5.3 (15)	5.4 (13)	11.7 (9)	5.8 (12)
Quality/Density CPUE (RSE)	2.8 (13)	4.3 (18)	3.0 (18)	9.8 (12)	4.3 (12)
Preferred CPUE (RSE)	0.3 (43)	0.6 (31)	0.6 (44)	1.2 (23)	0.9 (21)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.2 (58)	0.3 (52)	0.2 (55)
Total CPUE (RSE)	4.5 (11)	5.9 (14)	6.0 (14)	12.0 (8)	6.0 (12)
PSD S-Q	32.93	18.1	43.93	16.43	26.72
PSD Q-P	59.76	70.48	44.86	73.57	57.76
PSD P-M	7.32	11.43	7.48	7.86	12.93
PSD M-T	.	.	3.74	2.14	2.59
PSD	67.07	81.9	56.07	83.57	73.28
Mean WR S-Q (RSE)	79 (1)	84 (1)	88 (1)	81 (2)	79 (1)
Mean WR Q-P (RSE)	83 (1)	87 (1)	90 (1)	83 (1)	79 (1)
Mean WR P-M (RSE)	89 (3)	90 (1)	95 (4)	86 (2)	87 (3)
Mean WR M-T (RSE)	. (.)	. (.)	107 (6)	89 (5)	90 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Flathead Catfish (*Pylodictis olivaris*)

Flathead catfish are native to the White Rock Creek drainage at what is now Lovewell Reservoir and further upstream (Kansas Fishes Committee, 2014). When the river was impounded with the construction of the Lovewell Dam, the flathead catfish successfully adapted to life in a lentic system. This species was not sampled at Lovewell Reservoir until June 1968, however. Flathead catfish are sampled each summer using low frequency electrofishing as the best method for sampling all sizes of flatheads. Past samples were not included in the data below (see Table 14) due to the lack of a standardized sample most years. In 2020 sampling locations were selected based on presumed highest catch rates and sampled for 5 minutes EFT. Two chase boats were used and will continue to be used annually to retain standardization.

The 2020 sample collected 119 flathead catfish ranging from 8 to 47 inches with the biggest fish weighing 55 pounds. Stock CPUE was 32.6 with a sub-stock CPUE of 0.6. Approximately 59% of the catch was over 10 pounds, 24% were between 5 and 10 pounds, and 17% were less than 5 pounds. Size structure is skewed toward larger fish most years with 2020 no exception. RSD T+ was highest at 30 followed by RSD M-T of 29, RSD Q-P was 22, P-M was 15, and the lowest was RSD S-Q of 3. Body condition was fair to good with the largest fish exhibiting the best relative weights. Overall population Wr values averaged 94 with M-T fish at 99 and Q-P fish at 86 (see Table 15). Flatheads can be caught along the rocky banks during the spawn in June and July and are often found in the brush piles throughout the year. Set line anglers annually have success for both channel and flathead catfish fishing in the western portion of the reservoir, around the inlet, in Prairie Dog Creek, and Montana Creek.

Table 15. CPUE, PSD, Wr, and RSE Estimates for Flathead Catfish Sampled During June and July Using Low Frequency Electrofishing

Metric	2020
Total Catch	119
Stock Catch	117
Units of Effort	3.59
Sub-Stock CPUE	0.6
Stock CPUE	32.6
Quality/Density CPUE	27.6
Preferred CPUE	18.7
Memorable/Lunker CPUE	12.5
Total CPUE	33.2
PSD S-Q	3
PSD Q-P	22
PSD P-M	15
PSD M-T	2
PSD T+	30
PSD	97
Mean WR S-Q	90.5
Mean WR Q-P	85.5
Mean WR P-M	91.6
Mean WR M-T	98.9
Mean WR T	100.7

Source: KDWP 2021

Gizzard Shad (*Dorosoma cepedianum*)

While there are no official records of gizzard shad being stocked in Lovewell Reservoir, this important forage base was most likely introduced soon after the White Rock Creek was impounded as gizzard shad were first captured in June 1957. This species has thrived since and provides most of the forage for the sportfish in the reservoir, almost to the point of an overabundance of gizzard shad in some years. Nevertheless, the sportfish condition values are typically good to excellent and fish growth rates are well above average thanks to gizzard shad. Stock CPUE in the 2020 sample rebounded to increase from 2.3 to 14.8, the second highest value in the past 9 years (see Table 16). Much of this increase was due to very high numbers of stock-size fish between 180 and 230 mm, most likely age-1, and age-2 fish. In addition, the sub-stock CPUE rose from 2.3 to 14.8 as the age-0 fish grew quickly in 2020 to reach lengths up to 150 mm. Surprisingly, only five gizzard shad between 120 and 150 mm were collected in 14 trap nets. These are easily the fastest growing age-0 shad recorded at Lovewell Reservoir in the past 20 years. They most likely outgrew the age-0 sportfish including walleye, white bass, and wipers. Because of these abundant young fish, RSD S-Q increased from 0 to 94, RSD Q-P dropped from 37 to 0, and RSD P-M dropped from 63 to 6. Gizzard shad comprised only 8% of the core panel gill net catch by number in 2019 but this rose to 63% in 2020. The desired level is approximately 5-10% for a more balanced population but this objective has only been met once in the past ten years. It was thought that this high density gizzard shad population may have been hindering walleye recruitment as they compete for resources within the reservoir. Coincidentally, a nice year class of age-0 walleye was produced in 2019 in conjunction with this reduced gizzard shad catch rate. On the contrary, this high number of fast-growing age-0 shad coincided with no age-0 walleye collected in fall 2020 sampling.

Table 16. CPUE, PSD, Wr, and RSE Estimates for Gizzard Shad Sampled During October Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	328	377	169	52	662
Stock Catch	215	306	167	27	295
Units of Effort	20	20	20	12	20
Sub-Stock CPUE (RSE)	5.7 (23)	3.6 (35)	0.1 (100)	2.1 (35)	18.4 (21)
Stock CPUE (RSE)	10.8 (20)	15.3 (14)	8.4 (19)	2.3 (26)	14.8 (12)
Quality/Density CPUE (RSE)	3.7 (21)	3.1 (18)	1.6 (21)	2.3 (26)	0.9 (43)
Preferred CPUE (RSE)	2.1 (23)	0.8 (38)	0.2 (73)	1.4 (34)	0.9 (43)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	16.4 (19)	18.9 (15)	8.5 (19)	4.3 (18)	33.1 (16)
PSD S-Q	65.58	79.74	81.44	.	93.9
PSD Q-P	15.35	15.03	16.77	37.04	.
PSD P-M	19.07	5.23	1.8	62.96	6.1
PSD M-T	.	.	.	.	.
PSD	34.42	20.26	18.56	100	6.1
Mean WR S-Q (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR Q-P (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR P-M (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Largemouth Bass (*Micropterus salmoides*)

Largemouth bass were first introduced in June 1957 with 90,000 fingerlings stocked from the Farlington fish hatchery. The only other recorded stocking of largemouth bass was in 2010 with 46,700 fingerlings stocked. In addition, numerous upstream sources have likely contributed to the largemouth bass population, which is typically a low density, high quality population. This species was first sampled in June 1957 around the time of the first stocking. Due to the annual water level fluctuations, habitat needed for proper largemouth bass recruitment and survival is limited and the population has never reached a desired number. Anglers will incidentally catch a handful of fish each year while targeting crappie, white bass, or wipers, but few anglers target largemouth bass in Lovewell Reservoir despite the presence of some quality fish as seen in the picture. Sampling consists of electrofishing every 3 or 4 years to keep tabs on the population but no great numbers are ever collected. Therefore, the details (e.g., Table 16) like other species listed is not provided for largemouth bass.

An Example of a Lovewell Reservoir Largemouth Bass

Walleye (*Sander vitreus*)

Walleye are not native to the White Rock Creek drainage at what is now Lovewell Reservoir and further upstream (Kansas Fishes Committee, 2014). Walleye were introduced into Lovewell Reservoir in 1958 and first sampled on 22 October 1958. Natural reproduction has not been sufficient to maintain a strong population of walleye, thus supplemental stocking is frequently utilized. Even though 1.5 million fry were requested, surplus allowed for a total of 4.5 million to be stocked into nearly ideal conditions with high water levels and water temperatures in the mid-50's. The Lovewell Reservoir walleye population generally suffers from poor recruitment despite annual spring stockings. Most stockings consist of a combination of fry and fingerlings but recently the use of intermediate walleye (8 inches) has become available. After not stocking in 2015, a combination of fry and fingerlings were stocked in 2016 and 2017, but only fry were stocked in 2018 due to a shortage of available intermediates. Recruitment was only fair in 2018, however, as evidenced by the catch of only one age-0 fish in the gill nets and none in the trap nets (see Table 17). A combination of fry and intermediate walleye were stocked in Lovewell Reservoir in 2019 and one of the strongest year classes in recent history was produced with an average of 1.1 age-0 walleye per core panel gill net. Due to the Covid-19 pandemic no walleye were stocked in 2020. Anglers will continue to realize a limited walleye population characterized by poor to fair recruitment but excellent growth rates. The future of walleye in Lovewell Reservoir is precarious and saugeye may be the better option given the habitat conditions and their ability to not flush from reservoirs during high release events.

Two Satisfied Anglers with Limits of Lovewell Reservoir Walleye.

Table 17. CPUE, PSD, Wr, and RSE Estimates for Walleye Sampled During October Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	33	32	11	27	29
Stock Catch	31	32	11	14	29
Units of Effort	20	20	20	12	20
Sub-Stock CPUE (RSE)	0.1 (69)	0.0 (.)	0.0 (.)	1.1 (37)	0.0 (.)
Stock CPUE (RSE)	1.6 (29)	1.6 (22)	0.6 (41)	1.2 (39)	1.5 (22)
Quality/Density CPUE (RSE)	1.5 (29)	1.6 (23)	0.5 (45)	0.8 (53)	1.2 (29)
Preferred CPUE (RSE)	0.8 (37)	0.5 (38)	0.2 (73)	0.3 (72)	0.3 (49)
Memorable/Lunker CPUE (RSE)	0.1 (69)	0.1 (69)	0.0 (.)	0.0 (.)	0.1 (100)
Total CPUE (RSE)	1.7 (28)	1.6 (22)	0.6 (41)	2.3 (26)	1.5 (22)
PSD S-Q	6.45	3.13	9.09	28.57	20.69
PSD Q-P	41.94	68.75	63.64	50	58.62
PSD P-M	45.16	21.88	27.27	21.43	17.24
PSD M-T	6.45	6.25	.	.	3.45
PSD	93.55	96.88	90.91	71.43	79.31
Mean WR S-Q (RSE)	102 (2)	89 (.)	100 (.)	94 (3)	95 (2)
Mean WR Q-P (RSE)	100 (2)	98 (2)	101 (2)	98 (1)	106 (2)
Mean WR P-M (RSE)	101 (2)	101 (7)	102 (8)	103 (2)	109 (4)
Mean WR M-T (RSE)	102 (2)	99 (8)	. (.)	. (.)	113 (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

White Bass (*Morone chrysops*)

White bass are not native to the White Rock Creek drainage at what is now Lovewell Reservoir and further upstream (Kansas Fishes Committee, 2014). While there are no official stocking records, white bass were most certainly introduced into Lovewell by KDWP as they were first sampled in September 1958. This population has been good to very good over the past 15 to 20 years but the latest sample (2020) illustrated their numbers had declined. The management objective of seven stocked size white bass per core panel gill net was not met (3.2) and this white bass sample may be the lowest catch rate in Lovewell Reservoir history. Despite setting 20 core panel gill nets in randomly selected sites around the reservoir, only 30 white bass were collected. The previous low was 42 fish collected in 2014 using 17 gill nets (see Table 18). This low catch rate comes as a bit of a surprise as white bass density rating reached a high catch rate in 2019 with stock CPUE of 13.6. This fell to only 1.5 in 2020 with the density rating dropping from 7.6 to 1.1 and the preferred rating dropping from 4.6 to 1.1 (see Table 18). The size structure is skewed toward older fish with only nine stock-size fish and no quality-size fish collected. Recruitment has been down slightly the past 2 years but with white bass there are usually some fish from each year class represented. In this case the age-0 fish were present in low numbers and the age-1 fish were almost nonexistent. This led to an RSD S-Q of 30, P-M of 47, and M-T of 23. Despite the low catch rates, the lunker rating of 0.35 is the highest observed since 2013. Fishing pressure is fairly high on this population and most white bass are caught before reaching 15 inches but the size structure was slightly improved. Wr values were down as well compared to 2019 but remain good to excellent with S-Q fish at 94, P-M fish at 94 and M+ fish at 102 with an average of 96 for all sizes. Lovewell dropped from 8th to 20th among the state's reservoirs for white bass density and is ranked 19th for preferred fish with lunker ranked 12th. Wipers will be stocked in 2021 to help fill this void as it appears white bass recruitment is independent of wiper stockings. White bass recruitment in Lovewell Reservoir has been a bit puzzling in recent years with only two strong year classes produced in the past decade, 2011 and 2015.

Table 18. CPUE, PSD, Wr, and RSE Estimates for White Bass Sampled During October Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	129	102	100	164	30
Stock Catch	98	102	97	163	30
Units of Effort	20	20	20	12	20
Sub-Stock CPUE (RSE)	1.6 (56)	0.0 (.)	0.2 (55)	0.1 (100)	0.0 (.)
Stock CPUE (RSE)	4.9 (24)	5.1 (20)	4.9 (37)	13.6 (14)	1.5 (25)
Quality/Density CPUE (RSE)	4.6 (24)	4.9 (19)	4.3 (36)	7.6 (21)	1.1 (27)
Preferred CPUE (RSE)	1.1 (30)	2.0 (29)	2.2 (36)	4.6 (21)	1.1 (27)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.1 (100)	0.4 (43)
Total CPUE (RSE)	6.5 (26)	5.1 (20)	5.0 (35)	13.7 (14)	1.5 (25)
PSD S-Q	6.12	3.92	12.37	44.17	30
PSD Q-P	72.45	57.84	42.27	22.09	.
PSD P-M	21.43	38.24	45.36	33.13	46.67
PSD M-T	.	.	.	0.61	23.33
PSD	93.88	96.08	87.63	55.83	70
Mean WR S-Q (RSE)	95 (6)	100 (3)	101 (2)	103 (2)	94 (4)
Mean WR Q-P (RSE)	93 (1)	102 (2)	97 (1)	99 (1)	. (.)
Mean WR P-M (RSE)	93 (1)	100 (1)	95 (1)	102 (1)	94 (2)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	102 (.)	102 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

White Crappie (*Pomoxis annularis*)

White Crappie are likely not native to the White Rock Creek drainage at what is now Lovewell Reservoir and further upstream (Kansas Fishes Committee, 2014) but were stocked by KDWP as mentioned in the black crappie summary. Their numbers vary widely with many years of a low density population but recent years have seen an upswing in numbers and Lovewell has become one of the better crappie reservoirs in the state. Similar to black crappie, white crappie catch rates were depressed in the 2020 sample with stock CPUE declining from 67.9 to 31.1 which is the 6th best rating in the past 10 years. Similarly, the density rating plummeted from 64.5 to 11.9 while the preferred rating dropped from 26.8 to 2.3. The record lunker rating from 2019 of 11.9 was almost nonexistent at 0.3 in 2020 with only four fish of memorable size collected. Sub-stock CPUE has been very good the past two years after falling to only 8.8 in 2018. The 2020 catch rate of 132.6 was excellent but was approximately 90 fish less than the 224.6 from 2019. These age-1 fish grew at an excellent rate with most in the 180 to 220 mm range. The age-0 fish also grew well with most between 100 and 130 mm. Catch rates declined significantly near the minimum length limit of 250 mm as angler harvest was very good in 2020 and the legal fish were effectively removed from the population. Size structure was smaller with RSD S-Q fish increasing from only 5 to 62, RSD Q-P dropped from 56 to 31, RSD P-M fell from 22 to 6, and RSD M-T declined from 18 to 1. No lunker fish were collected again in 2020. Body condition was actually depressed in 2020 compared to most Lovewell Reservoir samples. S-Q fish improved slightly from 89 to 91, Q-P fish fell from 109 to 89, P-M fish dropped from 109 to 97, and M+ fish dropped from a record 118 to 100 (see Table 19). Despite these catch rate declines, Lovewell Reservoir still ranks as the fourth best density reservoir for both white crappie and total crappie catch. Anglers should find good success catching good numbers of crappie but harvest may be difficult with just 7% of the stock catch of legal size.

Table 19. CPUE, PSD, Wr, and RSE Estimates for White Crappie Sampled During October Using Trap Nets

Metric	2016	2017	2018	2019	2020
Total Catch	1796	945	392	2340	2293
Stock Catch	823	618	252	543	436
Units of Effort	16	11	16	8	14
Sub-Stock CPUE (RSE)	60.8 (24)	29.7 (55)	8.8 (14)	224.6 (57)	132.6 (50)
Stock CPUE (RSE)	51.4 (24)	56.2 (21)	15.8 (15)	67.9 (39)	31.1 (32)
Quality/Density CPUE (RSE)	4.4 (18)	19.9 (31)	13.0 (17)	64.5 (39)	11.9 (24)
Preferred CPUE (RSE)	1.0 (30)	7.5 (48)	4.3 (27)	26.8 (44)	2.3 (23)
Memorable/Lunker CPUE (RSE)	0.3 (77)	0.3 (52)	0.4 (59)	11.9 (44)	0.3 (57)
Total CPUE (RSE)	112.3 (20)	85.9 (27)	24.5 (11)	292.5 (45)	163.8 (44)
PSD S-Q	91.49	64.56	17.46	4.97	61.93
PSD Q-P	6.56	22.01	55.56	55.62	30.73
PSD P-M	1.46	12.94	24.21	21.92	6.42
PSD M-T	0.49	0.49	2.78	17.5	0.92
PSD	8.51	35.44	82.54	95.03	38.07
Mean WR S-Q (RSE)	84 (1)	83 (1)	102 (2)	89 (4)	91 (2)
Mean WR Q-P (RSE)	89 (1)	100 (1)	105 (1)	109 (1)	89 (1)
Mean WR P-M (RSE)	104 (1)	108 (1)	104 (1)	109 (1)	97 (1)
Mean WR M-T (RSE)	108 (4)	104 (5)	99 (4)	118 (2)	100 (2)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Wiper (*Morone saxatilis X M. chrysops*)

Wiper are a hybrid species requiring stocking on a regular basis to maintain population abundance. They were stocked into Lovewell Reservoir prior to 1980 although no specific stocking records exist. The 1980 sample is the first sample to include wipers with ten fish collected. They have existed at a low density population and supplement the white bass fishery by providing larger, trophy fish while also helping to control the gizzard shad population. Despite extensive stocking of fry and fingerlings, their numbers have never been extremely high as is the case in other Kansas reservoirs. After several years of declining wiper numbers, the catch rate rebounded in 2018 with a nice stock CPUE of 3.2, up from 0.6 in 2017 and was the highest in over 5 years (see Table 20). This improvement was mostly due to the strong 2017 year class of fish between 300 and 340 mm. Age-2 fish stocked in 2016 were also represented with fish between 370 and 420 mm. The 2019 sample was down slightly with no fish produced in 2018 to fill the age-1 length group (see Table 20).

The 2020 stock CPUE declined for the second consecutive year, falling from 2.6 in 2019 to 1.7. The 2017 fish continue to dominate the population as represented by fish between 410 and 490 mm. Despite stocking 15,000 fingerlings and 600,000 fry, only six age-0 fish were collected between 160 and 180 mm. A decent age-1 class was detected between 280 and 390 mm but this class only averaged 0.6 fish per net.

Age-2 and age-3 fish were best represented in the quality and preferred size ranges with a catch rate of 1.1 fish per net for fish between 470- and 550-mm. Size structure consisted of S-Q fish at 33, Q-P fish at 42, and P-M fish at 24. The sub-stock CPUE was low as usual, falling from 1.6 to 0.3 in 2020. (see Table 20) Wipers will be stocked in 2021 to continue to work on establishing this population with 600,000 fry and 15,000 fingerlings requested. This species is needed to help fill the void that the depleted white bass population has left and is necessary to help control gizzard shad numbers as they tend to overrun this reservoir.

Table 20. CPUE, PSD, Wr, and RSE Estimates for Wiper - W X S Bass Sampled During October and November Using Gill Nets

Metric	2016	2017	2018	2019	2020
Total Catch	43	18	64	50	39
Stock Catch	25	11	64	31	33
Units of Effort	20	20	20	12	20
Sub-Stock CPUE (RSE)	0.9 (63)	0.4 (38)	0.0 (.)	1.6 (36)	0.3 (55)
Stock CPUE (RSE)	1.3 (36)	0.6 (43)	3.2 (65)	2.6 (41)	1.7 (33)
Quality/Density CPUE (RSE)	1.3 (36)	0.1 (100)	0.4 (42)	2.6 (41)	1.1 (34)
Preferred CPUE (RSE)	0.4 (64)	0.0 (.)	0.1 (69)	0.0 (.)	0.4 (38)
Memorable/Lunker CPUE (RSE)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)	0.0 (.)
Total CPUE (RSE)	2.2 (38)	0.9 (27)	3.2 (65)	4.2 (30)	2.0 (31)
PSD S-Q	.	90.91	87.5	.	33.33
PSD Q-P	68	9.09	9.38	100	42.42
PSD P-M	32	.	3.13	.	24.24
PSD M-T	.	.	.	.	.
PSD	100	9.09	12.5	100	66.67
Mean WR S-Q (RSE)	. (.)	95 (2)	92 (1)	. (.)	92 (5)
Mean WR Q-P (RSE)	89 (2)	90 (.)	83 (4)	99 (1)	100 (1)
Mean WR P-M (RSE)	102 (2)	. (.)	77 (5)	. (.)	100 (1)
Mean WR M-T (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)
Mean WR T+ (RSE)	. (.)	. (.)	. (.)	. (.)	. (.)

Source: KDWP 2021

Future Without Project Projections

Lovewell Reservoir is expected to continue a similar water level fluctuation pattern soon as irrigation to meet farmland requirements both above and below the reservoir remains of upmost importance. Changes are being made to improve the efficiency of the water delivery system which should take some strain off the water volume requirements. Other discussions have been ongoing regarding future alternatives to water storage including raising the conservation pool of Lovewell Reservoir to increase water volume or construction of another reservoir in the area for additional water storage. These options continue to be discussed but no decisions have been finalized. At reduced pool, decreased water quality and reduced habitat availability and diversity limit sportfish population abundance and welfare. When Lovewell Reservoir is at low pool elevations, aquatic resource-based recreational opportunities available to the public become more limited.

Each Cooler Contains 100,000 Walleye Fry to be Stocked in Lovewell Reservoir

The stocking of fry, fingerling, and intermediate-sized walleye will continue annually to boost recruitment and supplement the limited natural reproduction which occurs. Blue catfish were stocked for five years but are now set to expand with natural reproduction and will not be stocked again. Wiper fry, fingerlings, and intermediates are also stocked annually to maintain this aggressive predator. Saugeye are thought to have the potential to recruit, grow, and survive in Lovewell Reservoir compared with their walleye cousins and may be stocked in the future. With Milford Reservoir downstream containing a viable walleye population, special care must be considered before adding a new species to the watershed. This potential new stocking will continue to be evaluated and ideally a solution that can improve the Lovewell Reservoir fishery while also maintaining the Milford Reservoir fishery can be agreed upon.

The direction which angler use and visitation at Lovewell Reservoir takes is unclear, as changes in socio-economic factors greatly influence public involvement in angling. For example, increased participation of families in youth sporting activities reduces participation in angling. However, the unforeseen emergence and response to COVID-19 greatly increased public participation in angling and other outdoor recreation at Lovewell Reservoir during the 2020 season.

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