South Dakota
Department of Game, Fish and Parks
Missouri River Strategic Plans
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Fisheries Management Plan for Lake Oahe

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Vision statement for management of Lake Oahe

The state of South Dakota manages Lake Oahe's aquatic resources for the continued use and enjoyment of South Dakota residents and its visitors.

Introduction

The Missouri River and its reservoirs provide considerable economic and recreational activity for South Dakota. Lake Oahe and its fisheries are part of a reservoir system which supports 40% of the angler use in South Dakota. Strategic planning is required to focus use of available resources to provide recreational opportunities that meet user expectations at the present time, while protecting resources for future use. Plans for the management of these resources are fundamental to their sustained and equitable use. This plan identifies current issues related to fisheries management of Lake Oahe and objectives to address these issues. Fisheries management strategies are outlined to accomplish specific objectives.

The Missouri River system provided anglers over 2.4 million hours of fishing opportunity in 2008. In 2010, approximately 37% of all angler days in South Dakota were spent on the Missouri River system, and about 50% of all South Dakota resident licensed anglers fished the Missouri River system. Specifically, Lake Oahe has supported between 94,000 and 338,000 angler days and contributed between $6.3 and $22.7 million annually to local and regional economies, from 2005-2015. Lake Oahe is an important resource in South Dakota and its fish assemblage and aquatic habitats must be managed to maintain and enhance its value to various user groups. The importance of Lake Oahe to South Dakota fisheries is documented in the issues, objectives and strategies provided herein.

Study Area

Lake Oahe is a mainstem Missouri River storage reservoir located in north-central South Dakota and south-central North Dakota. Lake Oahe is the 4th largest reservoir in North America with a surface area of 273,000 ac, 2,250 mi of shoreline and mean and maximum depths of 60 and 205 ft, respectively at normal operating pool. Because Lake Oahe is a storage reservoir, elevation, surface area, and volume change frequently over time. Consequently, sampled habitats are not the same each year during standard surveys. Additionally, Lake Oahe water elevation fluctuations can have dramatic impacts on aquatic habitat, lake productivity, water temperatures, water residency time, and many other physical variables. Extreme changes in water elevation likely influence year-to-year variation of survey efficiency and precision and greatly influence angler access.

Lake Oahe's drainage area spans 62,000 sq mi with 4 major tributaries including the Missouri, Cheyenne, Moreau, and Grand Rivers. Lake Oahe storage capacity is 23.1 million ac-ft of which 4.3 million ac-ft is used for flood control. Record pool elevation is 1,618.7 msl in 1995 and 1996; however, this was topped in 2011 at 1619.7 msl. Prior to 2011, record flows out of Oahe Dam were 59,000 cfs but this was dwarfed by the 2011 Missouri River Flood which resulted in 160,300 cfs being released in mid-June. Sedimentation is ongoing in Lake Oahe and from dam construction to 1988, 2.6% of Lake Oahe's water storage was lost due to sedimentation or about 19.8 ac-ft/yr.

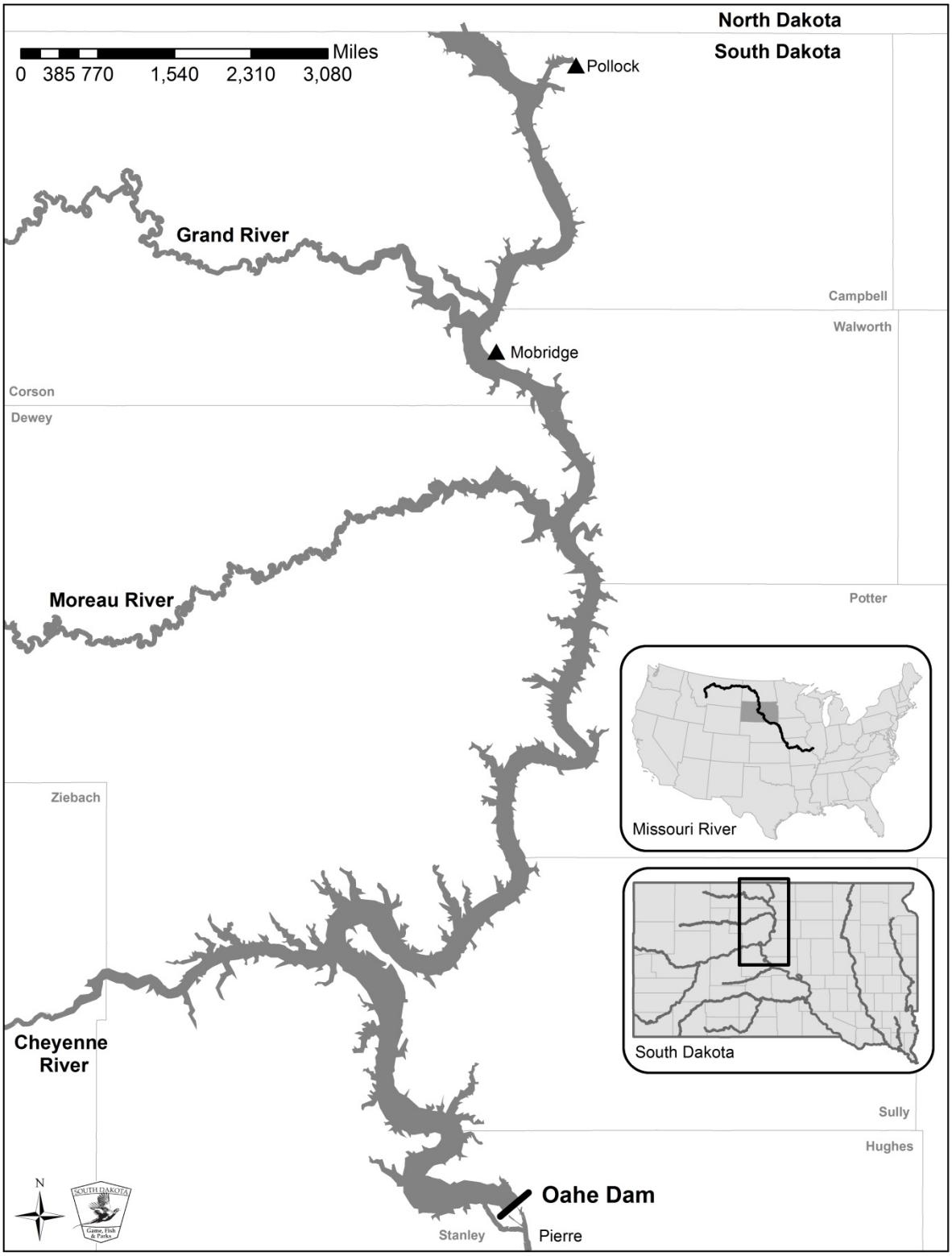

Figure 1. Depiction of Lake Oahe in central South Dakota.

Management of Lake Oahe

Stocking

In the early 1970's, attempts were made to develop a salmonid sport fishery in Lake Oahe that would use available cold-water habitat and diversify the fishery. Introductions of kokanee salmon, lake whitefish and opossum shrimp were made with the objective of establishing a cold-water prey base for a large predator species. These introductions were deemed unsuccessful; however, rainbow smelt stocked into Lake Sakakawea in 1971, had become abundant in Lake Oahe by 1977. Chinook salmon had also reached Lake Oahe as early as 1979 from Lake Sakakawea. As a result of the Chinook salmon and rainbow smelt successful introductions in North Dakota, the South Dakota Department of Game, Fish and Parks implemented its own Chinook salmon program in 1982. A popular Chinook salmon fishery developed and Chinook salmon have been stocked ever since.

High numbers of rainbow, brown, and steelhead trout were also stocked in the 1980’s and 1990’s. The return-to-anglers of these stockings were low but it is likely these stockings were responsible, at least in part, for the high walleye condition observed over the same time period (through walleye predation of stocked smolts). Because of the success of the cold-water sportfish program, Whitlock Bay Spawning Station was constructed in 1982 and functional in 1984. The Whitlock Bay Spawning Station was constructed to facilitate collection and spawning of Chinook salmon to meet annual egg needs.

From 1983 to 1998, small walleye fingerlings were annually stocked in the lower two thirds of Lake Oahe in an effort to increase presumed poor recruitment. However, walleye stockings were considered unsuccessful. Introductory stockings of smallmouth bass fingerlings occurred from 1983 through 1989. Various life stages of lake herring were stocked in the 1980’s and 1990’s in attempts to diversify the prey base for predators and to provide large predators with prey items larger than rainbow smelt. Both smallmouth bass and lake herring introductions were successful at establishing self-sustaining populations. Currently, only Chinook salmon are stocked in Lake Oahe on an annual basis.

Table 1. Species, years when stocked, maximum number of individuals stocked in a given year, and total number of individuals stocked in Lake Oahe in a given year. Data include all Lake Oahe stockings since 1979.

Species	Years Stocked	Max # stocked per year	Total # stocked
Brown trout	1981, 1984-1990	93,700	519,225
Burbot	2008	9,110	9,110
Chinook salmon	1982-2000, 2003-2016	884,542	9,172,520
Gizzard shad	1982, 2012-2015	85,000	88,837
Lake herring	1984, 1988, 1990-1992	4,460,000	32,208,700
Lake trout	1979-1985	198,392	1,398,557
Lake whitefish	1979	2,900,000	2,900,000
Northern pike	1988-1992	594,150	1,193,861
Paddlefish	1985	88,000	88,000
Rainbow trout	1979-2000, 2012	257,370	2,983,776
Smallmouth bass	1983-1989	227,500	1,088,000
Steelhead trout	1982, 1985-1989	50,000	228,559
Walleye	1983-1998	982,358	74,677,853

Fisheries Surveys

Standardized annual adult population gill-net surveys and shoreline baitfish surveys were initiated on Lake Oahe in 1982. In 1988, the deep water hydro-acoustic survey was initiated and in 2012, the deep water prey-fish gill-net survey was initiated. Other surveys have been developed and discontinued based on various reasons. Current and historic surveys include:

1. Standardized gill-net survey
2. Shoreline prey fish seining survey
3. Hydro-acoustic survey
4. Deep-water prey fish gill-net survey
5. Larval trawling survey
6. Midwater prey fish trawl survey
7. Small mesh age-0 and age-1 walleye recruitment gill-net survey
8. Fall age-0 walleye electrofishing survey
9. Spring rainbow smelt trap-net survey

A suite of gears are currently used to collect fish throughout the summer on Lake Oahe. The standardized adult sportfish population survey consists of setting three standard gill-nets overnight (approximately 20 h) in two depth zones (0- to 10-m and 10- to 20-m) at nine stations (total of 54 net sets). Gill-nets are placed on the bottom in each depth zone for a total of six nets at each station. All walleye collected are measured for total length (mm) and weighed (g). Otoliths are removed from 10 fish within each 25-mm

length class for walleye, sauger, and hybrids at each sampling station. When possible, representative samples (up to 50 individuals per sampling location) of all other species are measured and weighed.

A 6.4-mm nylon mesh bag seine, measuring 30.5-m long by 2.4-m deep with a 1.8-m by 1.8-m bag, is used to collect age-0 and small-bodied littoral fishes. Four seine hauls are made at each sampling location. All fish collected are identified and counted.

Hydro-acoustic surveys have been conducted since the late 1980's to monitor cold-water species that are less susceptible to the standardized gill net surveys. Since 2008, a Biosonics DT-X digital Echosounder and a split-beam transducer has been used. Roughly 20 transects are completed during the hydro-acoustic survey. Number of fish/m^3 of water sampled is extrapolated to the entire volume of cold-water habitat in Lake Oahe to derive population estimates of specific length classes of fish.

Beginning in 2012, a suspended deep water gill-net survey was introduced and paired with the hydro-acoustic survey. Suspended deep water gill-nets are 38.1 m long and 7.3 m deep. Nets are hung with sufficient flotation to allow for neutral buoyancy while in the water column. Netting effort has varied between years depending upon staffing, weather conditions, and net-placement locations; however, the goal is to sample 4-5 locations with two nets each.

These population surveys are designed to provide biological information regarding:

1. Species composition
2. Relative abundance
3. Age
4. Growth
5. Condition
6. Recruitment
7. Survival and mortality rates

Recent Fish Survey

In 2015, 20 species were captured in the adult gill-net survey. Walleye comprised 26% and channel catfish comprised 40% of all fish captured. Mean abundance for fish species in 2015 was similar to 2014. Black and white crappie were the most abundant species captured during the seine survey. Also abundant were yellow perch and emerald shiners. Proportional size distribution of walleye in 2015 was greater than the previous two years. Walleye condition tends to fluctuate as a function of prey abundance. All zones within Lake Oahe saw a slight decrease in condition from 2014 to 2015. Walleye growth has improved, and is similar to the five-year mean for age-1 to age-3 walleye. Walleye age-4 and older were generally smaller when compared to the five-year mean.

The 2015 annual hydro-acoustic survey estimated 24,890,873 age-0 rainbow smelt and 18,868,034 age-1+ rainbow smelt. The hydro-acoustic survey also documented a large number (13,899,525) of age-0 and age-1 (5,605,178) lake herring. In years when rainbow smelt abundance is low, high abundances of age-0 to age-2 lake herring may provide sufficient prey for sportfish in Lake Oahe. Age-0 and age-1 lake

herring are similar to the size range of rainbow smelt and may provide a suitable alternative to rainbow smelt.

In 2012, walleye and lake herring comprised the majority of fish captured in the deep water gill-net survey. Lake herring and rainbow smelt had the highest CPUE in 2015 (278 and 119 fish/net night, respectively). Lake herring ranged in size from 80 to 490 mm in the years of 2012 to 2015. The size distribution of rainbow smelt ranged from 80 to 220 mm in 2015, with a large percentage in the 110 and 120 mm length groups.

Angler-Use Surveys

Angler-use and harvest surveys were initiated on Lake Oahe in 1981. Sampling includes aerial counts of boat and shore anglers to estimate fishing pressure and angler interviews at lake access areas to estimate harvest, catch rates, release rates, mean party size, mean angler day length, target species and angler state of residency. Flight dates and interview dates are selected using a stratified random design based on the assumption of different levels of fishing pressure for weekdays and weekend days/holidays. Lake access areas for angler interviews were also assigned using a stratified random design with probabilities of assignment differing by access area and month.

Angler-use surveys are conducted from 1-May through 31-July for the sunrise to sunset period. Angler satisfaction and attitude questions are included in angler interviews. Anglers are also asked specific questions to help guide management practices on Lake Oahe. For instance, in 2015, anglers were asked “What factors would increase your satisfaction level to ‘very satisfied’”?

Recent Angler-Use Survey

In 2015, anglers fished an estimated 151,269 angler-days on the South Dakota portion of Lake Oahe during May-July which is slightly lower than the 10 year average of 157,464 angler-days. Of the estimated 358,533 fish harvested from Lake Oahe during the May-July daytime period, 308,513 (86%) were walleye. Smallmouth bass, channel catfish, northern pike, and white bass were also harvested, to a lesser extent. Walleye compromised the majority of fish released. Anglers generally begin harvesting walleye at approximately 300-mm in length. The average length of walleye harvested by anglers during 2015 was 402-mm.

Walleye catch rates exceeding 0.30 fish/angler-h are generally considered excellent and mean angler catch rates for walleye on Lake Oahe have exceeded this number over the last 10 years. Walleye catch rate was greater than twice this in 2015 at 0.77 fish/angler-h. The percentage of angling parties catching zero walleye was similar to 2014 (14%) and the percent of angling parties harvesting a daily limit (4 fish/person) decreased slightly from 30% in 2014 to 26% in 2015.

Lake Oahe is one of the largest and most economically important fisheries in the state of South Dakota, with anglers averaging 157,464 trips annually over the last ten years. Approximately 151,269 trips occurred during the May-July daylight period, for an estimated economic input of $10.1 million in local and regional revenues. Resident anglers represented 76% of the parties interviewed on Lake Oahe, which was similar to previous years. Lake Oahe continues to be recognized as a destination walleye fishery and 2015 was no exception, with 52% of anglers traveling ≥ 100 miles (one-way) to fish.

Walleye were the most sought after species for the last five years, with 90% of anglers targeting walleye.

Overall satisfaction on Lake Oahe during the May-July period was 83%. Trip satisfaction generally increased with the percent of daily limits attained by anglers. If an angler responded to trip satisfaction as anything less than “very satisfied”, creel clerks then asked the respondent what it would take to increase their ranking to “very satisfied.” Of the anglers that rated their satisfaction as “moderately satisfied” or below, 57% of parties indicated that catching more fish would increase their satisfaction rating.

Fisheries Research

Lake Oahe has gone through phases of high/low research attention. After impoundment through the mid/late 1990’s, many research projects were undertaken focusing on a range of topics. These include examining northern pike abundance and atresia (June 1970), describing influences of sport fish year class strength in Lake Oahe (Hassler 1970), mercury levels in fishes of Lake Oahe (Walter et al. 1974), population dynamics of percids (Nelson and Walburg 1977), reproduction patterns of warm-water fishes of Lake Oahe (June 1977), sturgeon population dynamics (Kallemeyn 1983), movements and behavior of rainbow smelt (Burczynski et al. 1987), impacts of mining on water quality in the Cheyenne river drainage (Horowitz et al. 1988), evaluation of Lake Oahe walleye stockings (Fielder 1992a, Fielder 1992b), age-0 walleye food habits (Jackson et al. 1992), adult walleye diets (Jackson et al. 1993; Bryan et al. 1995), impacts of walleye tournaments (Fielder and Johnson 1994), channel catfish food habits (Hill et al. 1995), rainbow trout food habits (Lynott et al. 1995), caloric densities of Lake Oahe sport- and prey-fish (Bryan et al. 1996), factors influencing white bass abundance (Beck et al. 1997), walleye mercury levels (Mauk and Brown 2001), walleye ageing techniques (Isermann et al. 2003).

Since the early 1990’s, Lake Oahe has also been the impetus of many hatchery related research projects. These projects have primarily focused on salmonids (Barnes and Cordes 1992; Barnes et al. 1997; Barnes et al. 1999a,b,c; Barnes et al. 2000a,b; Barnes et al. 2001a,b; Barnes et al. 2003a,b,c; Barnes and Gaikowski 2004; Barnes et al. 2010; Barnes et al. 2013); however, some cool-water research has been conducted (Mauk and Brown 2001b; Barnes et al. 2005).

Since the mid/late 2000’s, Lake Oahe has once again been the focus of many research projects. These projects span a wide research breadth and include: using strobe lights to deter rainbow smelt from Oahe Dam intake structures (Hamel et al. 2008), the long term impacts of the 1997 flood (Graeb et al. 2008), the application of nonlethal isotope walleye sampling (Fincel et al. 2012a), determining use of prey fish stable isotopes in sport fish food webs (Fincel et al. 2012b), sedimentation in the Missouri River reservoirs (Skalak et al. 2013), gizzard shad reproduction characteristics in Lake Oahe (Fincel et al. 2013a), mercury and selenium concentrations in Lake Oahe walleye (Fincel et al. 2013b), Lake Oahe walleye diets and growth (Fincel et al. 2014a), using stable isotopes to determine Lake Oahe walleye trophic position (Fincel et al. 2014b), walleye natal origins in the Missouri River impoundments (Carlson et al. 2016a,b), potential walleye/sauger competition (Fincel et al. 2016a), and rainbow smelt entrainment during the 2011 flood (Fincel et al. 2016b).

There are several ongoing research projects on Lake Oahe. Most notable is the walleye tagging research project. This is a joint project with South Dakota Game, Fish, and Parks, North Dakota Game and Fish, and South Dakota State University. This project aims at identifying dynamic rate functions, exploitation and movement patterns of Lake Oahe walleye. Other ongoing research projects include 1) evaluating dynamic rate functions, spawning habitat description and quantification, and spatial distribution of lake Oahe's cold-water prey fish, 2) evaluating stocking adult pre-spawn gizzard shad in select bays of Lake Oahe, 3) determining Lake Oahe angler expenditures, 4) examining long-term impacts of the 2006 white bass die off, and 5) examining the impacts of stocking location on angler returns of Chinook salmon.

Aquatic Invasive Species

Concern, knowledge and awareness of Aquatic Invasive Species (AIS) were largely non-existent until relatively recently on Lake Oahe. From impoundment through the mid 2000's there were no AIS specific surveys performed on the lake, and very little data on species now considered AIS in South Dakota exist prior to this time. Monitoring surveys were instituted on Lake Oahe in 2008 and are currently incorporated into standard fish management surveys. Dreissenid mussel veliger sampling is performed annually as an early detection method for Zebra and Quagga mussels. Surveys have identified few AIS populations in Lake Oahe. Invasive plant species present in the reservoir include Curly pondweed, and Eurasian water milfoil. Common carp and European rudd are the two AIS fish species in Lake Oahe

Regulations

Walleye harvest regulations for Lake Oahe have differed from standard statewide regulations since 1990. Initially, a 356-mm minimum length limit was placed on Lakes Oahe, Sharpe, and Francis Case from April through June with a daily limit of four fish. In 1999, the harvest regulations were amended so only one fish in the daily limit could be 457-mm or longer and the April through June minimum length limit was removed. Following high walleye recruitment in 1993 and a high release event through Oahe Dam shortly after, a predator-prey imbalance was recognized in Lake Oahe and the daily walleye limit was increased from four to 14 fish in 2001 of which, at most, four fish could be 381-mm or longer and only one of those could be 457-mm or longer. The objective of this regulation was two-fold: to reduce predation on rainbow smelt which saw rapid population declines in the late 1990's and to reduce the high abundance of walleye less than 381-mm. Following liberalization of the Lake Oahe walleye regulations, a decrease in angler satisfaction was associated with anglers unable to attain high daily limits. Thus, the daily limit was reduced to ten fish in 2002 and six fish in 2004. In an effort to standardize regulations statewide, the daily limit was reduced to four walleye with only one fish allowed over 508-mm in 2006, and the possession limit of 12 fish was reduced to eight fish in 2007.

In 2011, the Missouri River once again experienced a massive flood that moved much of the Lake Oahe prey fish biomass through Oahe Dam. Following this high entrainment event, prey fish populations decreased greatly resulting in poor condition and high natural mortality of Lake Oahe walleye. At the same time, a very large 2009 walleye year class attained a size sought by anglers. Thus, the population was made up

of fewer large fish of poor condition and many small fish (less than 381-mm) of below average condition. In reaction to the change in population size structure a change to the 2013 walleye regulations was made in an effort to take advantage of the exceptionally large 2009 year class. This regulation permitted the harvest of eight fish daily, of which, at most, four fish could be 381-mm and longer and only one of those could be 508-mm or longer. The 2013 regulation for four additional walleye on Lake Oahe was removed in 2014, and fishing limits returned to the state-wide limit of four walleye of which one may be 508 mm or longer.

Reservoir Access and Habitat

Lake Oahe's shoreline has undergone dramatic changes since impoundment due to fluctuating water levels and shoreline erosion. Major sources of sediment are the Cheyenne, Moreau, and Grand Rivers and reservoir bank erosion. The western shore of Lake Oahe is primarily composed of deposits of Pierre shale, which is highly erodible and vulnerable to mass soil movement. The eastern shore is composed of less-erodible, glacial till. From 1964-1968, the average annual rate of sediment deposition in Lake Oahe was 35 million m^3. The estimated time for Lake Oahe to completely fill with sediment is 700 years (US Army Corps of Engineers unpublished data). Lake Oahe contains a handful of sub-embayments. These unique habitats provide excellent spring-time shore angling opportunities and can promote over-winter survival of warm water prey fish.

Lake Oahe has also experienced multiple high water evacuation periods. In the mid-1990's and in 2011, above average snow accumulation and heavy spring rains produced record flood conditions. Record releases of water were discharged through both the powerhouse and stilling basin release structures and high entrainment of fish through Oahe Dam was recorded.

Submerged macrophytes have been slow to develop in Lake Oahe due to fluctuating water levels, unsuitable substrate, windswept shorelines and shoreline turbidity. Small areas of pondweed have developed along the lower east shore of the reservoir. Most submerged vegetation is terrestrial in nature. Coldwater habitat (water less than 15^oC and >5mg/l of oxygen) is limited during summer stratification. The water outlets of Lake Oahe are 38 m above the base of the dam and are within the cold-water zone during most years. Therefore, many cold- and cool-water species are susceptible to entrainment and loss from the reservoir during water discharges.

The Parks Division maintains 39 boat ramps along Lake Oahe's shores, including low water ramps that may be unusable except during periods of drought. These ramps vary in terms of angler-use with ramps like Bush's Landing exhibiting extremely high use with >100 boats serviced daily during peak times to ramps like Garrigan's Landing that might cater to 50 boats a year. Additionally, the Title 6 land transfer has provided SDGF&P and NDG&F with 2,250 miles of shoreline on Lake Oahe in the mid 2000's.

Issues and Opportunities

1) ***Issue*** **– <u>Shoreline and boat access on Lake Oahe can be limited due to a variety of factors.</u>**

Lake access is limiting for much of Lake Oahe. Boat ramps are interspersed throughout the lake, but there are vast areas lacking adequate access. Similarly, and to a greater extent, shore and ice access is greatly limiting on Lake Oahe as most of lake's shoreline is inaccessible to motor vehicles. During times of low water elevation, lake access can become even more limiting as water elevation limits boat ramp operation and designated roads do not extend to low water elevations to allow shoreline angling access. Currently, there is only 1 ADA facility located on Lake Oahe. Crowding at boat ramps, as well as on the main lake, has also been brought forth as an issue by Lake Oahe users.

Opportunities

The Wildlife Division has the opportunity to coordinate with the Parks Division to develop boat and shore access on Lake Oahe. Some of these can be done at relatively low costs to the state. For instance, developing low maintenance gravel roads (with driving restrictions) over state land can increase shoreline access and potentially be developed along much of Lake Oahe shoreline. Moreover, agreements with private land holders could be pursued for the same avenue. At a higher expense, additional boat ramp construction could add ramps to critical, high use locations thus increasing access and decreasing ramp-specific crowding simultaneously. These ramps could also be coupled with habitat initiatives outlined in the following *Issue 2*. There are also locations that could be suitable for ADA fish access locations throughout the lake.

2) ***Issue*** **– <u>Habitat quantity and quality may negatively impact anglers and fish populations.</u>**

Siltation on Lake Oahe has had pronounced effects. Embayment siltation, and overall indications of reservoir ageing, have filled in embayments and rendered some boat ramps and popular angling locations unusable. Wave action has had noticeable impacts on shoreline habitat, most of which has not been formally documented. Additionally, specific habitat requirements for sport fish (and prey fish) reproduction and recruitment may be lacking in particular years dependent on lake elevation characteristics. In general, shoreline habitat available to shore anglers is reduced or non-existent for most of Lake Oahe. Most shoreline angling locations provide anglers a windswept shoreline that is dominated by loose shale and small gravel, devoid of habitat complexity that is associated with concentrating sport fish.

Opportunities

Many avenues exist to improve existing and constructing new habitat on Lake Oahe. Because of the size of the lake, some of these projects will come at a substantial monetary cost. However, small scale renovations could be completed over long periods of time to defray large one-time expenses. Larger scale habitat additions such as development of hard surface reefs, construction of warm shallow water embayments, construction of warm water wells (thermal refugia), changes to Lake Oahe outlet structures, etc. could contribute to sport and prey fish reproduction, recruitment, and

retention and will ultimately benefit anglers. Additionally, small-scale habitat modifications could include focusing habitat efforts in rather small, back water bays. These efforts could not only increase fish production, but attract fish to accessible shore fishing locations. All of these habitat modifications could be evaluated continuously so that further manipulations could be continued, modified, or discontinued dependent on specific outcome criteria.

Sedimentation in some areas could be used to benefit sport and prey fish production. Directed sedimentation (with some physical manipulation) could decrease water depth and increase macrophyte growth in select bays and creek arms. Shallow water areas could warm quicker, have higher productivity and serve as potential nursery locations for fishes. Physical manipulations in these areas could further promote the roles of these high sediment laden areas to increase Lake Oahe fish production. These types of habitat modifications could be implemented through construction of shallow water sub-embayments. These could function as potential spawning and nursery habitats for a suite of prey and sport fish.

3) ***Issue*** **– <u>Many knowledge gaps exist for fish population and community dynamics in Lake Oahe.</u>**

Many knowledge gaps exist for Lake Oahe sport and prey fish. Recruitment, growth, mortality, and movement patterns are unknown for many species, making management recommendations ill informed. Additionally, information on habitat use by specific species is unknown but greatly warranted. Little information exists on Lake Oahe non-sport fish. Although some unique large-river species are found in Lake Oahe, no concerted effort to document population characteristics or trends of these rare fishes have been carried out.

Information regarding stocking dynamics on Lake Oahe is lacking. There is little information to guide any ongoing or future stocking strategies. There is also skepticism with standard surveys as to how representative they are of the population on which they are monitoring. Moreover, there is little information documenting the impacts of current or potential regulations on the sport fish populations of Lake Oahe.

Opportunities

Although knowledge gaps regarding fish population dynamics in Lake Oahe are common, a number of avenues exist to answer many of these questions. For instance, with recent advances in fish telemetry systems, understanding fish movements is becoming more affordable while concurrently producing more comprehensive results. Additionally, current research projects are examining growth, recruitment and mortality on important sport and prey fish of Lake Oahe. Future studies could parallel these in an attempt to better quantify the dynamic rate functions of Lake Oahe fishes.

Work is also being conducted to optimize stocking and spawning strategies on Lake Oahe. This work can be expanded to gain better knowledge of the impacts of fish

stocking and spawning practices on Lake Oahe. Standard surveys are currently under scrutiny with many projects examining the assumptions inherent in any survey methodology. Like the stocking/spawning effort, these labors could be expanded to better refine, or increase, current survey methodology. With the stocking, spawning, and survey initiatives, evaluating population response to current and potential regulations could be examined for multiple focal species.

4) ***Issue*** **– <u>Lake Oahe cold-water sport fishery exhibits boom/bust cycles creating discourse among anglers and making propagation efforts difficult.</u>**

There is a general instability in the cold-water sport-fish populations of Lake Oahe. This is not just caused by infrequent high entrainment events but also occurs frequently year-to-year. Periods of poor Chinook salmon production are often perpetuated by poor salmon propagation following these years. This creates lagging effects for many years. To complicate matters, many knowledge gaps also exist for Lake Oahe cold-water sport-fish. Optimal stocking densities, locations, prey buffering, and species/strains have not been recently evaluated for Lake Oahe. Moreover, there is a lack of information on dynamic rate functions, movement patterns, and genetic quality of Lake Oahe cold-water sport-fish at all life stages.

Opportunities

Research could examine ways to optimize stocking and propagation strategies on Lake Oahe. This includes refining the current Chinook salmon program, increasing propagation potential, or examining the potential for other cold-water sport-fish to help support current populations.

5) ***Issue*** **– <u>Water management practices impact people, fish, and habitat on Lake Oahe.</u>**

Water management impacts fish habitat in a number of ways, many of which are unknown. Lake Oahe experiences routine changes in surface elevation which corresponds to high/low growth, recruitment, and mortality of different species. Moreover, changes in surface elevation can limit natural lakeshore habitat formation and high discharges have been associated with substantial loss of fish through Oahe Dam. Water level management can hinder spawning success of many sport- and prey-fish species. Additionally, water management effects on lake elevations can severely limit both boat and shore angler access.

Opportunities

Most habitat, access, and fish population issues are the result of water management practices. This provides South Dakota the justification to take a stronger position in the water management operation procedures set forth by government entities. An opportunity is present to better manage water elevation fluctuations in an attempt to improve water management practices benefiting Lake Oahe's resources and users.

6) ***Issue*** **– <u>User group conflicts.</u>**

Many user group conflicts exist on Lake Oahe. These include, but are not limited to, conflicts between anglers targeting different species, non-tournament and tournament anglers, conventional anglers and spearfishers, boat and shore anglers, residents and non-residents, different angler types, etc.

Opportunities

With an increase in social media, the ability to interact with users from a wide geographic range is possible. Recorded videos, webinars, podcasts, etc. could be used to aid in Lake Oahe information dissemination and user feedback. Additionally, more opportunity exists for biologists to physically meet with anglers from across the state. Moreover, competent staff is located throughout the state making Lake Oahe information dissemination feasible for staff other than those directly working on Lake Oahe and the Missouri River.

7) ***Issue*** **– <u>New and established aquatic invasive species could potentially impact the fishery and recreation on Lake Oahe.</u>**

Aquatic Invasive Species (AIS) are non-native species of fish, invertebrates and plants that negatively impact the ecosystem or the human use of the ecosystem. Several species such as curly pondweed and common carp are already present in Lake Oahe, and many more potentially harmful species are present in the Missouri River Basin in South Dakota.

The primary vector for the movement of AIS invertebrates and plants is the overland transport of boats. The risk of AIS introductions into Lake Oahe is high since it attracts many anglers and recreational boaters from across the state and country and due to a large portion of the state lying within the Lake Oahe basin. The establishment of dreissenid mussels in Lake Oahe would likely impact the operation of Oahe Dam, could further complicate water management issues on the reservoir, and would serve as a source population for downstream reservoirs and other water bodies.

Opportunities

Many opportunities exist to slow the spread of AIS to and from Lake Oahe, including education, control and regulation. Prevention through education and compliance with regulations are likely the most effective and feasible means to slow the spread of AIS. This requires a cooperative effort from tribal, state, federal, nongovernment agencies and the various user groups. Control and eradication opportunities may exist in some instances, but are largely infeasible at this time.

8) ***Issue*** **– <u>Lack of public and government interactions</u>**

Lake Oahe is frequented by anglers from across South Dakota and the United States. As such, information dissemination and feedback from anglers across a wide geographic area is difficult. Lake Oahe also has multiple government entities including federal, border states and tribes, with management jurisdiction. Communication between all of these entities can be challenging though warranted.

Opportunities

The opportunity exists to increase communication between the state, federal entities, border states and tribes. Recently, a state tribal liaison was hired by Game, Fish and Parks, showing the commitment the state has to increasing interaction with South Dakota's tribes. Moreover, collaboration with border states and various federal entities could benefit the research and management efforts on Lake Oahe.

Objectives and Strategies

Objectives and strategies are presented here to address Lake Oahe management issues not already addressed in objectives contained in the MRFMA Strategic Plan. Objectives, for issues similar to MRFMA issues, are included in the MRFMA plan.

Objective 1. Increase shore fishing and boat access opportunities at two locations along Lake Oahe by December 31, 2021.

Strategy 1.1 Work with the Parks Division, the USACE, local municipalities, and anglers to identify priority areas for access development and improvement based on potential use and feasibility.
Strategy 1.2 Develop designs for shore fishing access improvements that function over a wide-range of reservoir elevations and are ADA compliant.
Strategy 1.3 Create specific structural habitat designs to concentrate fish in developed shore fishing areas.
Strategy 1.4 Construct shore fishing access improvements in coordination with Parks, the USACE, and local partners.
Strategy 1.5 Construct boat access improvements in coordination with Parks, the USACE, and local partners.

Objective 2. Develop a physical habitat management plan for Lake Oahe by December 31, 2021.

Strategy 2.1 Work with the Corps of Engineers on funding and implementation of a base-line inventory of bottom substrates in Lake Oahe.
Strategy 2.2 Conduct a literature review to determine species-specific habitat requirements at various life stages.
Strategy 2.3 Determine what, if any, habitat limitations exist for specific fish populations and their ability to support the Lake Oahe fishery.
Strategy 2.4 Identify potential locations where habitat manipulations could enhance sport- and prey-fish production and angler use.
Strategy 2.5 Identify potential funding sources for habitat improvements.
Strategy 2.6 Compile the information obtained via the prior strategies into a habitat management plan, including prioritized habitat projects and funding sources.

Objective 3. Increase 3-year average juvenile gizzard shad production by 50% by December 31, 2021.

Strategy 3.1 Determine likelihood of water right applications to use ground water to increase water temperature to increase overwinter survival of adult gizzard shad.
Strategy 3.2 Determine current use of embayments by gizzard shad to prioritize potential well locations.

Strategy 3.3 Explore the feasibility, including costs, of using wells, water retention, and water control structures, to create warm water habitats necessary for adult gizzard shad overwinter survival.

Strategy 3.4 When funding is available, obtain water rights, and initiate construction of infrastructure required to create warm water refuges in select embayments.

Strategy 3.5 Evaluate the use of newly-created warm-water areas by over-wintering gizzard shad.

Strategy 3.6 Continue to stock select embayments with adult pre-spawn gizzard shad following years of long ice cover duration.

Objective 4. Decrease yearly variability (3-year average) of Lake Oahe cold-water sport-fishery by 25% by December 31, 2021.

Strategy 4.1 Review stocking histories (including stocking location, sizes, hatchery history, etc.) of cold-water fish and angler use to determine optimal stocking strategies for cold-water sport fish.

Strategy 4.2 Determine dynamic rate functions and movement patterns of stocked age-0 and adult Chinook salmon.

Strategy 4.3 Improve fall capture of pre-spawn Chinook salmon to ensure egg demands are met in future years.

Strategy 4.4 Construct a quarantine facility within the state hatchery system to address disease issues for possible sources of Chinook salmon eggs from outside the state of South Dakota.

Strategy 4.5 Determine the need and options for diversifying the genetic composition of the Lake Oahe Chinook salmon population.

Strategy 4.6 Initiate stocking of Atlantic salmon to stabilize and diversify the Lake Oahe cold-water sport-fishery.

Objective 5. Increase knowledge of status of native species in Lake Oahe, its tributaries, and intermittent streams by December 31, 2021.

Strategy 5.1 Work with North Dakota Game and Fish to conduct native species surveys and determine native species presence and status in the upper end of Lake Oahe and the stretch of Missouri River just upstream of Lake Oahe.

Strategy 5.2 Conduct surveys of portions of tributaries and intermittent streams not included in other prairie stream sampling efforts to determine species presence and status.

Strategy 5.3 Establish native species sampling protocols and survey frequency to begin collecting trend data on species status.

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