Fisheries Management Plan for Black Hills Reservoirs

2015 – 2019

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1. Introduction

The purpose of this five year plan is to guide reservoir fisheries management by the South Dakota Game, Fish and Parks Department (SDGFP) in the Black Hills Fish Management Area (BHFMA). Previously, the BHFMA was named the Black Hills Trout Management Area (BHTMA) but the name was changed to reflect management of other species, including native fish, within the same geographic area (Figure 1). A focus group of Black Hills reservoir anglers, SDGFP staff, a 2014 survey of Black Hills anglers (Longmire 2015), and other public comment were used to identify the issues presented in this plan. Not all issues identified in this plan will be addressed in the form of related management objectives and strategies. Completion of this plan satisfies strategies 9.2 and 9.3 of the Black Hills Fisheries Management Area 2014-2018 Strategic Plan.

This plan has two major components: the strategic and operational portions. In the strategic portion, issues, objectives and strategies are identified. Objectives and strategies include anticipated completion dates for identified work activities. The operational portion of the plan contains specific work direction associated with accomplishment of objectives and strategies.

This plan is the third in a series of management plans dealing with fisheries in South Dakota. First, a Statewide Strategic Plan for 2014-2018 was created which covers aspects of fisheries management that have statewide implications. Second, The Black Hills Fisheries Management Plan dealt with management of the BHFMA and included both aspects of streams and reservoirs. This current plan culminates the series as it addresses issues and strategies that are specific to BHFMA reservoirs.

This document outlines a strategic approach to management with plan implementation expected to be flexible and change in response to changing needs or conditions. Specific reservoir management plans are a subset of this plan and are expected to change more frequently than the five-year time frame used for statewide, fisheries management area, and Black Hills reservoir plans. The goal of these plans is to provide direction to help achieve SDGFP's mission statement of "Serving People, Managing Wildlife" and being flexible with regards to plan implementation is essential for this to occur.

A. Management of Black Hills Reservoirs

There are no natural ponded waters within the Black Hills. Many impounded waters are the result of different public agencies working to provide fishing and recreational opportunities, water storage, or flood control. Most of these waters, including Stockade Lake, were constructed during the 1930's. The larger reservoirs (Sheridan, Deerfield, and Pactola) were constructed in the 1940's and 1950's.

Many reservoirs contain fish that are native to the Black Hills including creek chub and white sucker. A few species found in Black Hills reservoirs are listed with the South Dakota Natural Heritage Program (SDNHP) as threatened or endangered, including lake chub and finescale dace.

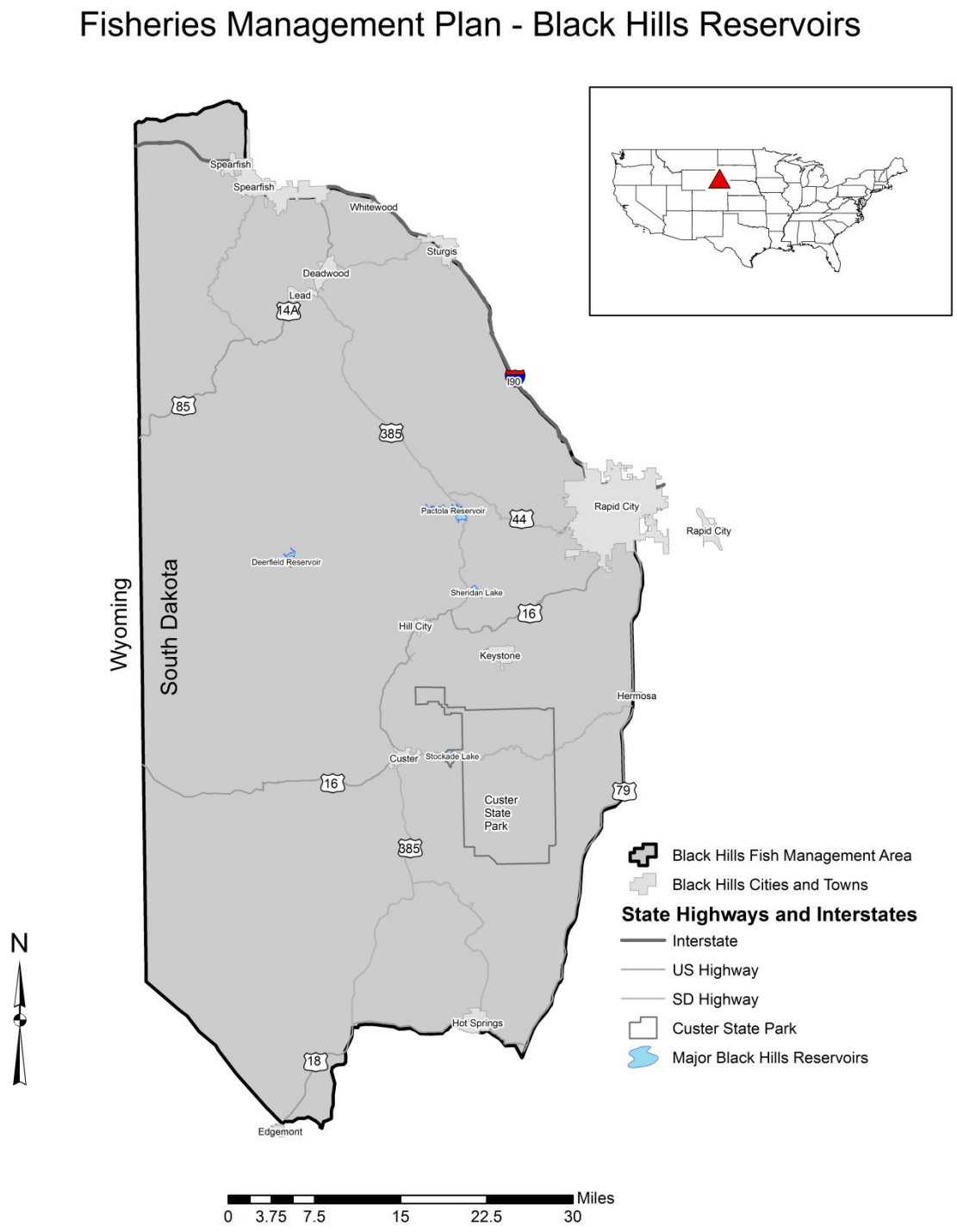

Figure 1. Black Hills Fish Management Area, South Dakota.

Black Hills reservoirs provide cold water habitats conducive to the management of species such as rainbow, brown, brook, and lake trout. Trout species originally introduced into Black Hills streams, like rainbow, brown, and brook trout, were the focus of stocking efforts for many years. Reservoir trout populations are supplemented by stocking at regular intervals, providing year-round fishing opportunities for anglers.

In addition to trout species, SDGFP has introduced selected cool water and warm water species in specific waters to accomplish specific management objectives. Unauthorized or inadvertent angler stockings have complicated management efforts. Warm and cool water fish species present in Black Hills reservoirs currently include largemouth bass, smallmouth bass, black crappie, black bullhead, rock bass, green sunfish, bluegill, yellow perch, northern pike, and European rudd.

B. Classification of reservoirs

Reservoirs within the BHFMA are classified into two groupings: large and small reservoirs. Large reservoirs consist of waters over 120 acres in size which includes Stockade, Sheridan, Deerfield, and Pactola. The other ponded waters are man-made (31 in total) or beaver dams that block portions of some streams.

C. Stocking

Trout fisheries in small reservoirs in the Black Hills can be managed in a number of ways, with current stocking alternatives presented in Table 1. These alternatives include stocking different sizes or numbers of trout and varying the timing of stocking. Many of the current stocking regimes include stocking trout on a schedule starting in the spring and continuing throughout most of the summer. Trout stocking is suspended when water temperatures exceed above 75^{o} F because warm water temperatures reduce fish survival (normally mid-July to mid-August).

Large reservoirs (Pactola Reservoir, Deerfield Reservoir and Sheridan Lake) are now stocked primarily with catchable rainbow trout. Illegal or inadvertent fish introductions of predator fish species have complicated management of these fisheries and return of trout to anglers from fingerling stockings became unacceptable. Catchable (11-inch) trout are now used to achieve reasonable catch rates of trout by anglers.

None of the game fish species currently in the Black Hills are native to the area and the majority of populations of species actively managed by SDGFP in Black Hills reservoirs are currently supported through stocking. The stocking of catchable (11-inch) rainbow trout has recently been the most common method of managing small reservoirs and supports primary fisheries on Sheridan Lake, Deerfield Reservoir, and Pactola Reservoir.

Management goals of trout stockings are varied. Original plans stated that the percentage of stocked trout being caught by anglers should be at least 75% of the total number of fish stocked (Stewart and Thilenuis 1964). This plan did not take into account the possibility of stocked trout surviving overwinter and how this would complicate efforts to evaluate return rates to anglers. Since the 1964 plan, there have only been reservoir specific management plans and the percentage of stocked trout caught or harvested by anglers, based on stocking rate or frequency, has not been sufficiently evaluated in relation to stocking strategies.

Table 1. Current trout stocking options for Black Hills Fish Management Area small reservoirs.

Category 1 – Put-and-Take Trout Option.	
	Stock 11-inch (average length) rainbow trout starting in the spring and continuing through the fall. Stockings normally occur every three weeks for each lake. SDGFP only stocks trout in a few lakes during winter. Higher-elevation lakes generally receive one large stocking in late fall to provide a winter fishery.
	Anglers are accustomed to catch rates and sizes of fish resulting from hatchery stockings. Stocking Objective: to keep catch rates near or greater than 0.5 trout per hour fished.
Category 2 – Big (Memorable) Trout Option	
	15-inch rainbow trout will be stocked into selected waters. These stockings are at a lower density than catchable stockings.
	Catch rates will likely be lower, but the possibility of catching a large trout is increased in these lakes. Stocking Objective: to provide anglers with the chance to catch a large trout in a small reservoir environment.
Category 3 – High Stocking Rate Option	
	Hatcheries stock lakes with catchable size trout (11-inches), but at a higher number/acre and/or more frequently than in the “Put-and-Take Option”.
	It is expected that anglers will catch fish at a higher rate at these waters. Objective: to provide a small reservoir fishery with catch rates above 2 trout per hour.

Cool and warmwater fish species have been stocked in the Black Hills on a limited basis. Smallmouth bass have been stocked into Stockade and Sheridan Lakes. Each of these waters has a minimum length limit of 15-inches on these fish to provide a popular angling opportunity and potential of improving the average size of panfish available to anglers through predation. Except for community and urban fishing ponds, other cool and warmwater fish found in the Black Hills are from unauthorized stockings.

D. Fisheries surveys

Fish population surveys are designed to index or estimate fish abundance, size distribution, and rates of growth, recruitment, and mortality, while angler surveys are designed to estimate angler

satisfaction and catch and harvest of fish In many smaller reservoirs, fish population surveys are normally performed on a five-year cycle, while the large reservoirs are normally sampled every year. Angler surveys are often performed only on large reservoirs. Both fish population and angler use and harvest surveys are used to help evaluate if current management activities for a water are meeting management objectives. The Department of Environment and Natural Resources monitors chemical and biological parameters for adherence to state beneficial uses and water quality standards.

Results of the1993/94 Black Hills Angler Preference Survey (Erickson and Galinat 2005) were used to establish management objectives for Black Hills reservoirs which were incorporated into management plans for specific waters. The recently completed Black Hills Angler Survey (Longmire 2015) will be used in association with other available information to adjust management plans to better meet the needs of anglers currently fishing Black Hills reservoirs.

E. Fisheries research

Research on Black Hills reservoirs is designed to address management issues such as declines in fish populations or changing environmental or fish community conditions within a system. These projects have management-focused objectives and are intended to generate new management strategies. Projects involving the contribution of hatchery fish fed different diets to angler catch and harvest (Barnes et al. 2009), and the comparison of different amounts of creel survey effort to determine effort needed to generate meaningful survey results (Barnes et al. 2014) are just two studies that have been recently completed.

In some instances, SDGFP collaborates with universities like South Dakota State University or South Dakota School of Mines and Technology to address fisheries management issues through research projects. Financing of these projects is normally through Sport Fish Restoration Funds. Examples of recent projects include determining the bioenergetics of top-level predators in Pactola Reservoir (Scheibel 2015) and contributions of naturalized rainbow trout to the Deerfield Reservoir fishery (Kientz *in* prep).

F. Undesirable Fish Introductions

Fish species not stocked by SDGFP have established naturally reproducing populations in many locations throughout the Black Hills (Miller et al. 2010). As an example of species introductions not a part of SDGFP management plans, northern pike, yellow perch, and rock bass have never been stocked by SDGFP in the Rapid Creek (Deerfield and Pactola reservoirs) or Spring Creek (Sheridan Lake) watersheds yet established populations of these species exist there. The introduction of these species complicates management efforts and may lead to costly removal efforts.

G. Fish Removals and Chemical Renovations

Population manipulation is one of the management tools utilized by fisheries managers for reservoirs in the Black Hills. Removal of undesired species has been attempted in specific waters to try and improve the overall fishery. When fish population surveys indicated a high abundance of white suckers in Deerfield Reservoir may have been negatively influencing trout

populations, removal of white sucker using nets was conducted from 1999 through 2009 (Miller et al. 2010).

In cases where removal efforts were likely to have little effect, chemical renovations have been conducted to completely remove all fish from a water body. Deerfield Reservoir has been chemically renovated twice in the past in an attempt to restore the trout fishery (Miller et al. 2010). These chemical renovations occurred in conjunction with dam repairs and are unlikely to be an option in the future. A chemical renovation was also conducted at Mud Lake, Lawrence County in 2006. Finescale dace are native to this drainage and the lack of dace in this lake was likely due to an abundant green sunfish population. The lake was drawn down and rotenone applied to kill the green sunfish, then finescale dace were captured from nearby Cox Lake and reintroduced into Mud Lake.

H. Aquatic Invasive Species (AIS)

Black Hills reservoirs have only a few known AIS species. European rudd are a fish species found in Sheridan Lake and Pactola Reservoir. Curly-leaf Pondweed is a plant found in Sheridan Lake. Impacts of these introduced species on Black Hills fisheries are unknown. The recent discovery of quagga mussel veliger's in nearby Angostura Reservoir is a concern as this invasive species and it's relative, the zebra mussel, have been disruptive to ecosystems.

I. Fish Health

Fish health is a major concern of fisheries managers. In addition to the possible introduction of trout and salmon diseases from outside of South Dakota, several fish health concerns currently exist within the BHFMA. Parasitic yellow grubs are present in Stockade Lake, Bismark Lake, and Lakota Lake in Custer County and have been documented in the area since the early 1890's (Evermann and Cox 1896). These grubs can affect any freshwater fish, but are mostly reported in yellow perch (Miller and Galinat 2009). Additionally, secondary infections of parasitic water molds (*Saprolegina),* possibly correlated with elevated summer temperatures, have been observed in a variety of fish species in Sheridan Lake and Stockade Reservoir.

J. Regulations

Fish harvest regulations are utilized to distribute the harvest of fish among anglers and to increase the average size of fish available for anglers, in some instances. Harvest regulations for Black Hills reservoirs are fairly simple in their design, which allows the best possible voluntary compliance (Appendix A). Current harvest regulations for brook, brown, and rainbow trout, in combination, are five trout per day, of which only one may be 14-inches or longer. A special regulation for harvest of lake trout from Pactola Reservoir includes a 24-inch minimum length limit and a daily limit of one fish. This regulation is an effort to promote a trophy fishery. Specific regulations to improve size structure of game fish are in place at Stockade Lake and Sheridan Lake. Other harvest regulations for fish species found in Black Hills reservoirs are consistent with statewide regulations.

K. Reservoir habitat and access

All of the reservoirs in the BHFMA are man-made with most of them being constructed in the 1930's and 1940's. Over the past 80 years these waters have undergone natural aging. In many instances, nutrient-rich sediments have accumulated around the inlets and have spread to deeper portions of the lake. Road construction, mining, human population growth, grazing, and logging have expedited this process by increasing the sediment and nutrient load in streams feeding the lakes. Associated with increases in nutrient rich sediments in lakes, instances of algal blooms and encroachment of emergent vegetation, such as cattails, has increased, reducing angler access to portions of some lakes.

Watershed protection programs, like the Clean Water Act Section 319 Nonpoint Source Control Program, provide matching funds to educate the public and improve stream and lake conditions through riparian area restoration or protection and other Best Management Practices (BMPs). Programs such as this can help slow down the lake aging process. Sediment removal projects have been completed on several Black Hills lakes to improve depth and water quality. Recent dredging projects include Dumont, Dalton, Roubaix and Yates Pond. Dredging of Horsethief, Bismarck and Lakota Lakes was completed in 2015 as part of the Scenic By-way Project, a cooperative effort between the SD Department of Transportation, the Black Hills National Forest, and SD Game, Fish and Parks. There are numerous State and U.S. Forest Service owned dams that will require sediment removal in the future to prolong the use for fishing and recreation purposes.

Access improvements are an important part of the angler experience and are critical for recruiting new anglers. A number of fishing piers, boardwalks and boat ramps have been installed on ponds and reservoirs to get anglers to fishable water. Access structures are designed to be ADA (Americans with Disabilities Act) compliant. Sunday Gulch pond was created in 2004, providing a fishery and access. Angler access was improved on Sheridan Lake in 2005 and 2012. In 2006 and 2008, the south and north boat ramps were extended on Pactola Reservoir to ensure boating access during drought periods. Boating access was improved with repairs to the south boat ramp at Sheridan Lake in 2012. Three fishing piers, a trail system and access bridge were installed at Dalton Lake in 2012 Various fishing clubs, such as Walleyes Unlimited, have also been involved with installation of fishing piers on lakes such as Sheridan, Bismarck and Major Lake.

2. Issues

Information gained from a 2014 focus group of Black Hills reservoir anglers, public open house events, SDGFP staff, and the 2014 Black Hills Angler Survey (Longmire 2015.) was used to identify management issues. Not surprisingly, many of the issues identified for Black Hills reservoirs were identified for the BHFMA, while other issues were specific to reservoirs or a specific large reservoir.

1. The long-term impacts of illegally introduced species in Black Hills waters may negatively impact currently managed fisheries.
    - *Issue is similar to BHFMA Plan Issue 1*

2. Legal consequences of transporting and introducing Aquatic Invasive Species may be insufficient to deter those activities.

3. Consequences of violating laws prohibiting fish stocking by private individuals may be insufficient to deter those activities.

4. Readily available Black Hills fishing access information is over 15 years old and in need of updating.
    - *Issue is similar to BHFMA Plan Issue 5*

5. Performance measures for Black Hills reservoir fisheries need to be updated and may need to be different for specific fisheries.

6. The rate with which fisheries management activities change may be too slow to quickly respond to changes in fish populations, fish communities, and demands on a fishery.

7. Current efforts to share fisheries information and discuss management plans and implementation with anglers are insufficient.

8. Possible effects of watershed practices which may influence water quality and quantity are not adequately considered during fish management or habitat improvement project decisions.

9. Fisheries management of Angostura and Belle Fourche reservoirs is not considered when developing management plans for Black Hills large reservoirs.

10. Sunfish and perch in many Black Hills waters may not meet angler expectations.
    - *Issue is similar to BHFMA Plan Issue 15*

11. There is a desire to diversify the species managed in Black Hills reservoirs.

12. Ice fishing access can be difficult at specific waters in the Black Hills.

13. Some reservoir fish populations, especially yellow perch, are heavily infested with yellow grub making these fish undesirable to anglers.

3. Goal, Objectives, Strategies

Goal: Manage reservoir fisheries in the Black Hills of South Dakota for long-term sustainable use and enjoyment.

Objectives and strategies are presented here to address general Black Hills reservoir management issues not already addressed in objectives contained in the BHFMA Strategic Plan. Objectives, for issues similar to BHFMA issues, are included in the BHFMA plan.

Objective 1. In association with accomplishment of Statewide Strategic Plan Survey Objectives 1 and 3, develop a system of fishery sampling protocols for Black Hills reservoirs, including standard survey designs and survey frequency, by July 1, 2015.

Strategy 1.1. Determine appropriate sampling effort and methods for reservoirs based on reservoir characteristics, management needs, and fishery potential.

Strategy 1.2. Determine needed level of effort and survey frequency for each waterbody.

Strategy 1.3. Incorporate standards into statewide management survey protocols.

Objective 2. Improve winter fishing access by December 2016.

Strategy 2.1. Consult the 2014 Black Hills Angler Survey to identify additional areas where improved access is needed.

Strategy 2.2. Work with other governmental units to identify roads for possible winter maintenance.

Strategy 2.3. Work with United States Forest Service (USFS) and annually submit a contract request to the Pennington County Highway Department to plow Whitetail Loop Road at Deerfield Reservoir.

Strategy 2.4. Investigate using GFP equipment to plow snow to allow access to the Pactola north boat ramp and Dutchman's Cove at Deerfield Reservoir.

Strategy 2.5. Identify other roads suitable for winter maintenance.

Objective 3. Develop and implement new information sharing and public input procedures by December 2016.

Strategy 3.1. Continue to provide hard copy and online reports to the public.

Strategy 3.2. Continue to conduct informational meetings and open houses.

Strategy 3.3. Design and experiment with new report formats suitable for new media and to more easily share information with the general public.

Strategy 3.4. Involve angler groups, media representatives, and interested individuals.

Objective 4. Revise the Guide to Black Hills Fishing Waters by March 2017.

Strategy 4.1. Involve individual anglers, angling groups, and potentially affected interests.

Strategy 4.2. Involve GFP communications staff, law enforcement staff, and other fisheries staff.

Strategy 4.3. Prepare a Request for Proposal for private firms to produce and publish updated version.

Strategy 4.4. Publish paper copies and put a downloadable version on the website.

Strategy 4.5. Distribute updated version to local sport shops, visitor centers, Custer State Park, and other entities.

Objective 5. Determine cool and warmwater fish management strategies that can contribute to small reservoir fisheries without being detrimental to established put-and-take trout management efforts, by December 2018.

Strategy 5.1. Review stocking histories of cool and warm water fish and hatchery trout into small reservoirs in the Black Hills during the last 20 years.

Strategy 5.2. Review available information on fish population and fishery status over the past 20 years.

Strategy 5.3. Identify instances where cool and warm water fish management strategies were conducive to continuance of a put and take trout fishery.

Strategy 5.4. Incorporate findings into operational plan.

Objective 6. Investigate options and implement management efforts aimed at increasing the quality of panfish populations in Black Hills reservoirs by December 2018.

Strategy 6.1. Review the literature related to management of panfish populations in waters with characteristics similar to Black Hills small and large reservoirs.

Strategy 6.2. Identify potential factors limiting panfish population quality.

Strategy 6.3. Identify potential management activities that may increase panfish quality.

Strategy 6.4. Design and implement a study to compare and evaluate the effects of chosen management activities on panfish population quality.

Strategy 6.5. Use study results to modify management efforts and update the operational plan.

Objective 7. By December 2017, identify cool and warm water fish management strategies that would contribute to large reservoir fisheries without being detrimental to other established fisheries.

Strategy 7.1. Review literature of other popular fish species to identify pertinent parameters for successful fisheries.

Strategy 7.2. Reference the 2014 Black Hills Angler Survey and gather additional information as necessary to determine angler preferences and expectations for specific cool and warm water fish species management

Strategy 7.3. Identify potential results of cool and warm water fish introductions into Black Hills large reservoirs, with regards to population development, impacts on other species, and support of a fishery.

Strategy 7.4. Establish additional or new management objectives and strategies for Black Hills large reservoirs as appropriate.

Objective 8. By December 2018, develop a set of management tools to more rapidly respond to changes in fishery characteristics in small reservoirs.

Strategy 8.1. Review current management techniques and outcomes of use.

Strategy 8.2. Involve regional staff, aquatics section staff, law enforcement, and other potentially affected interests.

Strategy 8.3. Brainstorm alternatives to current techniques.

Strategy 8.4. Determine specific management triggers, which will incorporate management specific actions on Black Hills reservoirs.

Strategy 8.5. Incorporate identified tools into water specific operational plans.

Strategy 8.6. Distribute document for review to administrators, statewide fisheries staff, angling groups, and other potentially affected interests.

Strategy 8.7. Implement approved changes in procedures.

4. Current Operational Plan for Black Hills Fish Management Reservoirs.

A. Management guidelines

The following guidelines provide direction for reservoir fisheries management efforts.

1. The biological characteristics and population dynamics of the reservoir and public input shall be used to determine management objectives.

2. Reservoirs with adequate natural reproduction of trout species will be investigated to determine if stocking is warranted to maintain angler satisfaction and trout catch rates.

3. Large reservoirs will have specific management plans flexible to changing situations. Objectives of these fisheries may take advantage of changing fish population trends and fishery characteristics.

4. Hatchery-reared, catchable (11 inch) trout will be stocked in most reservoirs. Other management options include stocking fingerling (3-5 inches) trout, stocking large trout (15 inches), frequency of stockings, and stocking trout at higher densities.

5. Regulations will be kept as simple and uniform across the BHFMA as possible, but special regulations will be considered to meet management objectives at specific reservoirs.

6. Trout stockings will be restricted to areas where public access is allowed.

7. Trout will not be stocked for fishing derbies or for other promotional programs.

8. To verify reports of unauthorized fish species occurring in BHFMA reservoirs, the reservoir in question will be investigated as soon as possible, with at least one sampling event occurring within the first open-water season after the initial report.

B. Small Reservoir Management

Small reservoirs will be managed using one of the five stocking strategies, or categories, outlined in Table 2, depending on specific fishery objectives.

Table 2. Black Hills small reservoir stocking strategies used to accomplish specific fisheries management objectives.

Category 1 – Put-and-Take option	
	Stock catchable (11-inch) rainbow trout every three weeks beginning in the spring and continuing through the fall. One large stocking will occur late each fall to provide a winter fishery.
	Anglers are accustomed to catch rates and sizes of fish resulting from hatchery stockings. Stocking Objective: to keep catch rates near or greater than 0.5 trout per hour fished.
Category 2 – Memorable trout option	
	Fifteen-inch rainbow trout will be stocked into selected waters. These larger trout are stocked at lower densities than typical catchable stockings.
	Catch rates will likely be lower, but the possibility of catching a large trout is increased in these lakes. Memorable trout stocking is intended to provide anglers with a chance to catch a large fish in selected waters. These waters are not expected to have the higher catch rates found in Category 1 waters. This option is expensive and is only used in a few instances.
Category 3 – High Stocking Rate option	
	Stocking of catchable rainbow trout occurs at a higher number/acre (density) and/or more frequently than in the “Put-and-Take Option”.
	It is expected that anglers will catch fish at a higher rate at these waters with the management objective being to provide a small reservoir fishery with catch rates above two trout per hour fished. Waters that have experienced high angler use and trout harvest may be managed with this approach.
Category 4 – Unique Stocking Option	
	Unique species of fish (tiger trout, cutthroat trout, bass species) are stocked to provide anglers with angling opportunities not common in the Black Hills.
	A limited number of waters are stocked with unique species of fish that are raised in state hatcheries or acquired from other state waters. This option allows for more diverse fishing opportunities for anglers in the BHFMA.

Table 2 Continued Category 5 – Multi-species Management	
	Trout are stocked in a reservoir where cool or warmwater species are also present. Cool and warmwater species, if stocked, may come from hatcheries or be trapped and transferred from other waters.
	Management of these lakes provides a diverse fishing opportunity that many anglers prefer. Return to angler from trout stockings may be less than in trout only waters.

C. Large Reservoir Management

Reservoir-specific management plans exist for Pactola and Deerfield Reservoirs and Stockade and Sheridan Lakes and will be updated in association with the current plan. A brief synopsis of current management options and directions for large reservoirs can be found in the Reservoir Management Overview Section of this plan.

1. Management Options for Small and Large Reservoirs:

1. *Consistent Catch* – emphasizes catching of trout in area lakes.
   a. Standard harvest limits
   b. No restrictions on terminal gear
   c. Generally requires stocking of catchable size trout.

2. *Large Trout* – provides angling opportunity to catch trout in excess of 15 inches.
   a. Restricted harvest limits (e.g. only one fish over 14 inches per day)
   b. No restrictions on terminal gear
   c. Requires stocking of 15 inch trout.

3. *High Catch* – provides anglers with high catch rates through stocking of 11-inch trout at higher than normal rates/acre of water (greater stocking rates than Option1).
   a. Uses standard harvest limits
   b. No restrictions on terminal gear
   c. Requires stocking of catchable size trout.

4. *Unique Trout* – provides fishable populations of species not common in reservoirs.
   a. Special harvest restrictions for the species of concern may be used.
   b. Stocking of unique species may be used.

5. *Memorable Trout* – provides anglers with populations of fish that have the potential for reaching large size for that species as described in Gablehouse 1984.
   a. Special size limits are in effect (e.g. lake trout must reach 24 inches before harvest)

6. *Multi-Management* – indicates waters where management is directed at a diverse number of species. This option is specific to the large reservoirs of the BHFMA, but may be applied to small reservoirs as needed.

   a. May use restricted size limits (e.g. 15-inch minimum length for bass)
   b. Conditions where natural yield sustains many of the species in the reservoirs.

7. *Natural Yield* – fish propagate in wild with no assistance from hatchery resources.

8. *Native Fish* - provides areas specifically managed for native fish.

9. *Fish Removal* – removal of unwanted species that interfere with reservoir management.

10. *Special Regulations* – indicates specific waters where special regulations are used to protect or enhance specific fisheries or opportunities.

Multiple management options may be employed to meet the management objectives for a fishery.

5. Reservoir Management Overview

Lake	Acres	Management Class	Species Present	Current Management Option	Management Direction
Bismarck Lake, Custer County	27.2	Small Reservoir	Rainbow trout Smallmouth bass Crappie species Redear sunfish	Multi-mangement Consistent Catch Unique species Natural Yield	Manage with consistent stockings of rainbow trout. Mange smallmouth bass, panfish species under multi management
Center Lake, Custer County	26.5	Small Reservoir	Rainbow trout Brown trout Tiger trout Creek chub White sucker	High Catch Unique Trout Stocking Unique Trout Stocking	Manage put and take fishery with high stocking rates to support high angling use at a popular fishing lake. Manage tiger trout under unique option.
Grace Coolidge Dams, Custer County	0.1 to 0.4	Small Reservoir	Rainbow trout Brook trout Creek chub	Consistent Catch Natural Yield	Manage rainbow trout fishery with put and take stockings throughout the summer months. Brook trout sustain themselves in the small creek areas. Creek chub are present under natural yield options for native fish. Maintain access bridges at stream crossings.
Lakota Lake, Custer County	9.7	Small Reservoir	Rainbow trout Northern pike Crappie species Redear sunfish	Multi-mangement Consistent Catch Unique species Natural Yield	Manage with consistent stockings of rainbow trout. Mange northern pike, panfish species under multi management
Legion Lake, Custer County	9.2	Small Reservoir	Rainbow trout Largemouth bass Northern pike	Consistent Catch Natural Yield Fish Removal	Manage through consistent stockings from Spring through Fall months. Removal efforts of illegally stocked Northern pike will occur at this reservoir.
Stockade Lake, Custer County	120	Large Reservoir	Largemouth bass Smallmouth bass Black crappie Bluegill Yellow perch Northern pike	Multi-Management	Size limits on all black bass to increase overall size and biomass. Bass used as a tool for controlling smaller panfish species. Supplemental stocking or trap and transfer stockings if necessary. Aeration system installed and needs to be maintained to breakup thermocline normally found in summer. Panfish managed under natural yield.
Sylvan Lake, Custer County	17.3	Small Reservoir	Rainbow trout Brown trout Golden shiner Fathead minnow	Consistent Catch Unique Trout Stocking	Maintain family fishery through stocking.
Coldbrook Reservoir, Fall River County	33.8	Small Reservoir	Rainbow trout Largemouth bass Black crappie Channel catfish Common carp	Consistent Catch Natural Yield Natural Yield	Manage trout fishery with monthly stocking when water temperatures permit adequate survival. Bass are managed under natural yield.

Lake	Acres	Management Class	Species Present	Current Management Option	Management Direction
Cottonwood Springs, Fall River County	13.9	Small Reservoir	Rainbow trout Largemouth bass Green sunfish Black crappie	Consistent Catch Natural Yield	Manage recreational fishing opportunity of rainbow trout and bass as a two-story sport fishery. Stock trout on an annual basis when water levels are adequate to maintain the population. Monitor bass populations and stock if needed.
Coxes Lake, Lawrence County	5.8	Small Reservoir	Rainbow trout Finescale dace	Consistent Catch Native Fish	Provide public family fishing by stocking an a consistent basis from March through October. Finescale Dace are managed under natural yield. Monitor Finescale Dace assemblage and overall ecosystem health.
Dalton Lake, Lawrence County	2.4	Small Reservoir	Rainbow trout Brook trout	Consistent Catch Natural Yield	Manage as a put and take fishery from March through September.
Iron Creek Lake, Lawrence County	21.6	Small Reservoir	Rainbow trout Largemouth bass Creek chub Brown trout Green sunfish Yellow perch Black crappie Emerald shiner Golden shiner	Consistent Catch Natural Yield Native Fish Natural Yield Natural Yield Natural Yield	Manage for recreational fishing through put and take stocking.
Mirror Lake #1 and #2, Lawrence County	0.4	Small Reservoir	Rainbow trout Green sunfish	Consistent Catch	Manage as public family fishing opportunity through stockings of rainbow trout during open water periods. .
Reausaw Lake, Lawrence County	4	Small Reservoir Lake	Rainbow trout Brook trout Green sunfish White sucker	Consistent Catch Natural Yield	Manage as a recreational put and take rainbow trout fishery. Monitor success and satisfaction through creel surveys.
Roubaix Lake, Lawrence County	5.5	Small Reservoir	Rainbow trout Brook trout Fathead minnow Green sunfish White sucker	Consistent Catch Natural Yield	Manage as a recreational put and take trout fishery. Monitor success and satisfaction through creel surveys.
Strawberry Hill Pond, Lawrence County	0.15	Small Reservoir	Rainbow trout Rock bass	Consistent Catch Natural Yield	Manage as a public family fishing opportunity from Memorial Day through Labor Day with put-and-take rainbow trout.
Yates Ponds, Lawrence County	1	Small Reservoir	Brown trout Brook trout	Natural Yield Natural Yield	Manage as a catch and release fishery for wild trout.
Canyon Lake, Pennington County	25	Small Reservoir	Rainbow trout Brown trout White sucker Northern pike	High Catch Natural Yield	Recreational opportunity with an emphasis on high catch rates. Rainbow trout stocking to occur

Lake	Acres	Management Class	Species Present	Current Management Option	Management Direction
					throughout the year.
Canyon Lake Park Ponds, Pennington County	1	Small Reservoir	Rainbow trout White sucker	Consistent Catch	Manage as a trout fishery in an urban setting.
Deerfield Reservoir, Pennington County	414	Large Reservoir	Rainbow trout Splake trout Lake trout Brook trout Lake chub Yellow perch Rock bass White sucker	Consistent Catch Large Trout Unique Trout Stocking Memorable Trout Multi-Management	Manage rainbow trout through 11 inch and 15 inch stockings. Brook trout are recruited to the fishery through natural yield. Manage lake trout for memorable sizes. Removal of white wucker through spring netting commences when densities reach 20 per 150 ft. of overnight gill net.
Horsethief Lake, Pennington County	14.8	Small Reservoir	Rainbow trout Brown trout	Consistent Catch Multi-management	Manage as a recreational put-and-take rainbow trout fishery through stockings. Stock brown trout every 3 to 5 years for additional species option.
Major Lake, Pennington County	5	Small Reservoir	Rainbow trout	Consistent Catch	Manage as an urban pond fishing opportunity through put and take rainbow trout stockings.
Mitchell Lake, Pennington County	5	Small Reservoir	Rainbow trout Brown trout	Consistent Catch Natural Yield	Recreational trout fishing option with put and take stockings.
Newton Fork Dam, Pennington County	0.3	Small Reservoir	Rainbow trout Brook trout	Consistent Catch Natural Yield	Manage as a put and take recreational fishery.
Pactola Reservoir, Pennington County	785	Large Reservoir	Rainbow trout Lake trout Northern pike Largemouth bass Rock bass Yellow perch Bluegill Brown trout White sucker Rainbow smelt Golden shiner Green sunfish Black crappie European rudd	Consistent Catch Trophy Trout Multi-Management	Manage rainbow trout through stockings of put and take sized fish. Lake trout will be managed under natural yield. Continue to have a 24-inch minimum length limit unless changes arise. Encourage harvest of Northern pike, Yellow Perch and Rock Bass through liberal harvest limits.
Sheridan Lake, Pennington County	385	Large Reservoir	Rainbow trout Yellow perch Largemouth bass Smallmouth bass Northern pike Black crappie Brown trout Golden shiner Green sunfish White sucker European rudd	Consistent Catch Multi-Management	Stock rainbow trout twice a year to provide anglers with a diversity of fishing opportunity. Manage perch under natural yield. Largemouth and smallmouth bass are managed with a 15-inch minimum length limit.

Lake	Acres	Management Class	Species Present	Current Management Option	Management Direction
			Black bullhead Rockbass		Northern pike harvest can be limited in order to provide a large fish to the angler.
Slate Creek Dam, Pennington County	0.15	Small Reservoir	Rainbow trout Brook trout Brown trout Creek chub White sucker	Consistent Catch Natural Yield	Stock Rainbow trout on a yearly basis with fingerling sized product.
Sunday Gulch, Pennington County	0.15	Small Reservoir	Rainbow trout Brook trout Northern pike	Consistent Catch Natural Yield Fish Removal	Manage as a family fishing opportunity with put and take Rainbow trout. Brook trout are managed under natural yield. Removal efforts of illegally stocked Northern pike will occur at this reservoir.

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7. Appendices

APPENDIX 1 – Historical Synopsis of Special Management Regulations within the Black Hills Trout Management Area

1981 Creation of Hanna Creek Special Management Area

- Catch and Release.
- Barbless, artificial lure only.
- Possession of trout or natural (organic) baits with 100 feet of stream is prohibited.

Creation of Rapid Creek I Special Management Area (from Kelly Gulch to Castle Creek)

- Daily limit of one trout 15 inches or longer.
- Barbless, Artificial lures only.
- Possession of trout smaller than 15 inches or natural (organic baits) with 100 feet of stream is prohibited.

Creation of Rapid Creek II Special Management Area (from Lake Pactola to the confluence of the north and south forks of Rapid Creek except the waters described in Rapid Creek I above)

- Daily trout limit is 8, only one which may be a brown trout longer than 15 inches.
- October 1 through December 31.

1985 Removal of barbless hooks requirement for artificial lures
Regulations on Rapid Creek II were made year round
Creation of Maurice Special Management Area on Spearfish Creek

- Catch and Release
- artificial lures only
- Possession of trout or natural (organic) baits with 100 feet of stream is prohibited

1988 Rapid Creek Special Management unit I Eliminated

1991 Creation of Pactola Basin Area from bridge below Pactola Dam to Foot Bridge at Placerville Camp

- Catch and release.
- Artificial lures only.

Creation of Silver City Special management area on Rapid Creek from USFS turnaround at Silver City to Confluence with Castle Creek.
Silver City, Hanna, and Maurice areas were changed to the following restrictions

- Daily limit is 4 brown trout 11 inches or less.
- Brown trout over 11 inches and all rainbow, brook and cutthroat trout must be released.
- Artificial lures only.
- Possession of organic bait within 100 feet of stream is prohibited.

Modified text for size limits to include: Where and when size limits applied, all species of fish in possession must be whole and only gills, entrails and scales could be removed.

1993 Only 1 brown or rainbow trout over 14 inches could be included in the daily limit.
Only 1 brook trout over 12 inches could be included in daily limit.
Anglers could take an additional limit of 8 brook trout under 8 inches in length.

1994 Pactola Basin Area expanded to include section of stream from outlet of stilling basin to the footbridge at Placerville.

1997 Artificial Lures definition modified to:
"Article lures include flies, jigs, spoons, spinners and plugs made of metal, plastic, wood, hair, feathers and other nonedible materials. Artificial lures do not include fish eggs, moldable scented baits, naturally occurring foods or man-made food."
Created and Defined Black Hills Trout Management Area
Daily limit reduced to 5 trout with only 1 over 14 inches allowed
Eliminated Silver City Special Management Area on Rapid Creek
Eliminated Hanna Creek Special Management Area
Created of Yates Ponds Special Management Area

- Catch and release.
- Artificial lures only.

Created Crow Creek Special Management area from GFP property to Redwater and Meadow Brook Golf Course Special Management Area on Rapid Creek

- Trout over 10 inches must be released.
- Artificial lures only.

Modified Maurice Special Management Area to allow taking of all trout EXCEPT rainbow trout
Expanded Pactola Basin Special Management Area to include the Stilling Basin

2000 Eliminated Crow Creek Special Management Area

2004 Highgrading of trout within the BHTMA is not permitted

2010 Creek chubs may be taken by hook and line (by licensed anglers) for use in waters where live minnows or baitfish are allowed

8. Glossary

Fisheries terms used in management plans:

PSD = Proportional Size Distribution - A number that helps describe the lengths of fish in a sample used to manage fish populations. Calculated as the percentage of a sample of "stock-length" fish that also are greater than or equal to "quality length". Stock and quality size designations vary by species. Stock length is the minimum fish length that provides recreational value.

PSD-P = Proportional Size Distribution of Preferred Length fish – A number similar to PSD that helps describe the lengths of fish in a sample used to manage fish populations. Calculated as the percentage of "stock-length" fish that also are greater than or equal to "preferred length".

CPUE = Catch Per Unit Effort - The number of fish captured with a certain amount of sampling or fishing effort. An example of CPUE would be the catch of fish per net night of effort, catch per hour of electrofishing or catch of walleye per hour of angling effort.

Wr = Relative Weight – A measurement of how plump or healthy a fish is compared to its length. A typical range for healthy populations is between 90-100. Wr values below 90 for a size group indicates problems may exist in food availability or feeding conditions. *Wr* values above 100 for a size group fish may not be making the best use of surplus prey.

Netting

Net sampling consists of gill net nights and trap net nights. All gill nets are monofilament experimental nets 150 feet long and 6 feet deep. Each experimental net has six different 25 foot long mesh panels with bar mesh sizes measuring ½", ¾", 1", 1¼", 1½" and 2 inches. All trap nets are modified fyke-nets with a 4 foot by 5 foot frame, ¾ inch mesh and a 4 foot by 75½ foot lead.

Night Electrofishing

Night electrofishing is used to sample largemouth and smallmouth bass populations. Electrofishing is conducted using a boat mounted Smith-Root unit with pulsed-DC. Six 10-minute sites, or as many 10-minute sites up to six that can be accomplished in one trip around a lake, are completed during the surveys. Sampling normally occurs when water temperatures are in the 60's F. Due to time constraints, sampling is generally done in spring on lakes with both largemouth and smallmouth bass and in fall on largemouth bass lakes.

Fish Age Determination

Up to 100 collected fish are measured for total length (millimeters) and weight (grams). Age and growth analysis is accomplished using otoliths (inner ear bone) or scales collected from individual fish. Otoliths are generally collected from the first five walleye and first five yellow perch per centimeter group. Aging of other game fish is done with scales. Scale samples are obtained from below the lateral line just behind the pectoral fin.

Balanced fish populations

Balanced fish populations have been defined as populations that consistently produce harvestable-sized fish. In the individual lake plans we use values of PSD that have been widely accepted as representing balanced populations. Below are the values commonly used for different species.

Black crappie	PSD 30 to 60
Bluegill	PSD 20 to 60
Largemouth bass	PSD 40 to 70
Yellow perch	PSD 30 to 60

Pactola Reservoir Management Plan

Introduction/Inventory

Pactola Reservoir (a.k.a. Pactola) is a 785 acre impoundment located 15 miles west of Rapid City. Construction of Pactola Dam on Rapid Creek began in November 1952 and was completed during August 1956. The reservoir is a deep, coldwater lake with a maximum depth near 165 feet, mean depth around 62 feet and capacity of 99,000 acre-feet of water. Pactola Dam and Reservoir are operated and maintained by the Bureau of Reclamation on a pooled storage basis with Deerfield Reservoir (Rapid Valley Project).

The majority of the watershed is public timber and grassland managed by the U.S. Forest Service (USFS), but substantial areas of private ownership also exist. Much of the land immediately adjacent to streams within the Rapid Creek watershed is privately owned with a small portion under tillage. Livestock grazing is widespread on both private and public lands. Most public land is under management for production of saleable timber products. Extensive thinning of ponderosa pine on public land has taken place or is under way, which may enhance water yield. Roads and livestock grazing are major sources of sediment in the streams. Mountain slopes vary from moderate to extreme steepness on the lake shore and throughout the watershed and localized disturbances contribute to increased siltation.
Deerfield Reservoir is located on the upper portion of the Castle Creek watershed above Pactola Reservoir. Slate Creek Dam, Dumont Pond, and many small, unnamed stock ponds and beaver ponds are also located within the Rapid Creek watershed above Pactola. In addition, Silver City, Rochford, and several small developments are also located in the upper Rapid Creek watershed.

Ownership of Lake and Adjacent Lakeshore Properties/Fishing Access

The shoreline around the lake is public land managed by the USFS. The USFS has jurisdiction over campgrounds, picnic areas, boat launches, access areas, and shoreline use. Access to boat launches requires a daily recreation fee or USFS park entrance permit. Camping, marina, and concession operations at the reservoir are leased to private individuals and businesses. The USFS also maintains a visitor center, three parking lots, and overlook areas on the dam. A handicap parking lot with fishing access piers, referred to as Veteran's Point, is located at the north end of the dam.

Fishery Management

Pactola Reservoir's fishery has traditionally been managed as a rainbow trout fishery. Initial stocking strategies involved stocking fingerling trout to provide a put, grow and take fishery but more recent stockings have been catchable size (11-inch) trout and larger (Table 1).

Shortly after impoundment, populations of white sucker, black bullhead and green sunfish dominated the fishery. Reduced water levels from irrigation and little precipitation made it possible to chemically treat the fishery and restock with fingerling trout. In October of 1961, toxaphene was applied in two doses within a 7-day interval. Fisheries personnel also treated Castle Creek, Nugget Creek, Slate Creek, the north and south forks of Rapid Creek and Rapid Creek proper as a part of this renovation effort.

Historically, Pactola Reservoir supported little forage for producing large trout. In an attempt to develop a coldwater prey base, rainbow smelt were netted on Lake Oahe near Mobridge in 1984 and transferred to Pactola. Other rainbow smelt trap and transfer efforts from the Missouri River to Pactola were accomplished in the early 1990's.

In addition to standard rainbow trout stocking strategies, Pactola has been stocked with a number of trout and salmon species. In 1977, lake trout were stocked into Pactola (and again in 1978) and have added a trophy aspect to the reservoir's fishery.

Other notable historic fish stockings were: kokanee salmon (multiple years from 1971 to 1984), cutthroat trout (multiple years from 1985 to 1992), splake trout (1985, 1988), brown trout (1965, 1969, 1973, 1981, 1982, 1989, 1995, 2000, 2002), and spottail shiners (1992).

Rainbow trout are the most sought after fish in Pactola Reservoir (Jones and Simpson *in* prep) and current fish management focuses on rainbow trout stockings (Table 1). To address the popularity of rainbow trout at the reservoir, trout are stocked in early Spring and late Fall at 11 inches and a few at 15 inches. Also, the popularity of a high quality lake trout population has focused management and research activities towards understanding this population and it's interactions with other fisheries within the reservoir (Scheibel 2015).

Unauthorized introductions of other fish species into Pactola Reservoir has complicated management at the reservoir, especially concerning northern pike. Northern pike are a popular sportfish, but unplanned additions of this predatory fish have lead to deleterious results for some trout fisheries (McMahon and Bennett 1996). The sizes of northern pike in Pactola have lead to an additional trophy fishery and anglers are heavily targeting northern pike (Jones and Simpson *in* prep). The popularity of this species has affected how Game, Fish and Parks plans to approach northern pike in this reservoir. Current management direction is to allow the fishery to continue with no removal attempts by the department but also to allow harvest under statewide regulations with no special regulations to promote larger or higher densities of northern pike.

Table 1. Stocking records for Pactola Reservoir, South Dakota, 2005-2014.

Year	Species	Size	Stockings	Number of fish
2005	Lake trout	catchable	1	7,451
	Rainbow trout	catchable	3	14,997
2006	Rainbow trout	catchable	9	26,366
2007	Brown trout	catchable	1	4,700
	Rainbow trout	catchable	2	5,800
2008	Rainbow trout	catchable	4	15,063
2009	Rainbow trout	catchable	11	28,399
	Rainbow trout	fingerling	5	24,443
2010	Rainbow trout	catchable	7	29,044
2011	Rainbow trout	catchable	6	28,742
2012	Rainbow trout	catchable	7	28,934
2013	Rainbow trout	catchable	9	30,724
	Rainbow trout	catchable 15"	1	125

2014	Rainbow trout	catchable	10	29,898
	Rainbow trout	catchable 15”	1	354

Recent Fish Surveys

A gill netting survey was conducted on July 14-17, 2014. Gill nets were monofilament experimental type and measured 45.7 m (150 ft) long and 1.8 m (6 ft) deep with six 7.6 m (25 ft) panels of bar mesh sizes: 12.7 mm (0.5 in), 19.1 mm (0.75 in), 25.4 mm (1.0 in), 31.8 mm (1.25 in), 38.1 mm (1.5 in), and 50.8 mm (2.0 in). Sampling consisted of 12 gill net nights. Depths and GPS location are recorded to facilitate similar placement each year. A modified fyke (trap) net survey consisting of eight net nights was completed on June 2-4, 2014. Trap nets consisted of a 1.3 X 1.5 m frame, 19.1 mm (0.75 in) mesh and a 1.2 X 23 m (3.9 X 75.5 ft) lead.

Thirteen species of fish were collected from Pactola Reservoir in 2014 (Tables 2 and 3). Bluegill and yellow perch were the most abundant fish sampled in gill nets. Bluegill and rock bass were the most abundant in trap nets.

Table 2. Total catch of twelve 150-foot gill nets set in Pactola Reservoir on July 14-17, 2014. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	Wr-S (90%)
Bluegill	72	6.0 (6.8)	6.0 (6.8)	78 (8)	0	94.0 (1.9)
Brown trout	2	0.17 (0.15)	0.17 (0.15)	0	0	81.1 (22.7)
Lake trout	41	3.4 (1.4)	3.1 (1.2)	32 (14)	8 (8)	87.1 (2.4)
Northern pike	6	0.5 (0.5)	0.5 (0.5)	100	33 (43)	116.1 (13.0)
Rainbow smelt	6	0.5 (0.5)	0.5 (0.5)	-	-	-
Rainbow trout	21	1.7 (1.1)	1.4 (1.0)	0	0	132.1 (2.0)
Rock bass	17	1.4 (1.1)	1.3 (1.1)	33 (22)	0	95.1 (4.4)
White sucker	4	0.3 (0.3)	0.3 (0.3)	100	100	111.4 (16.8)
Yellow perch	59	4.9 (6.3)	4.6 (5.9)	13 (8)	0	94.4 (4.6)

Table 3. Total catch of eight trap nets set in Pactola Reservoir on June 5-7, 2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	Wr-S (90%)
Black crappie	17	2.1 (2.5)	2.1 (2.5)	53 (22)	0	90.1 (2.1)
Bluegill	166	20.8 (7.8)	20.6 (7.7)	58 (7)	10 (4)	88.0 (2.1)
Green sunfish	7	0.9 (0.7)	0.9 (0.7)	43 (39)	0	94.6 (13.6)
Largemouth bass	2	0.3 (0.2)	0	0	0	84.8*
Northern pike	1	0.13 (0.2)	0.13 (0.2)	100	100	118.8
Rainbow trout	3	0.38 (0.5)	0.13 (0.2)	0	0	-
Rock bass	264	33.0 (16.2)	31.6 (16.0)	51 (5)	13 (3)	95.1 (3.3)
European rudd	23	2.9 (4.0)	2.9 (4.0)	-	-	-

White sucker	1	0.1 (0.2)	0.1 (0.2)	100	100	86.8
Yellow perch	7	0.9 (0.6)	0.8 (0.6)	57 (39)	0	101.4 (14.5)

*substock length fish

Rainbow trout

Pactola Reservoir is currently managed as a put-and-take rainbow trout fishery and is stocked with over 30,000 catchable rainbow trout annually. Evaluating trends in rainbow trout abundance from netting surveys is complicated for a number of reasons. Catch is not normally high for rainbow trout in the gill net surveys but has been decreasing since 2006, with 20 caught in 2013 (Figure 1). One possible reason for this is increased reservoir volume (Figure 1). Another reason for lower net catches may be better survey scheduling with surveys conducted over a month after stocking to avoid sacrificing stocked fish. A third possible reason for the decrease is the establishment of a population of northern pike, an illegally introduced species first observed in 2003. A recent (2013-2014) graduate study determined that larger northern pike (>600 mm) fed primarily (65% of diet) on stocked rainbow trout (Scheibel 2015).

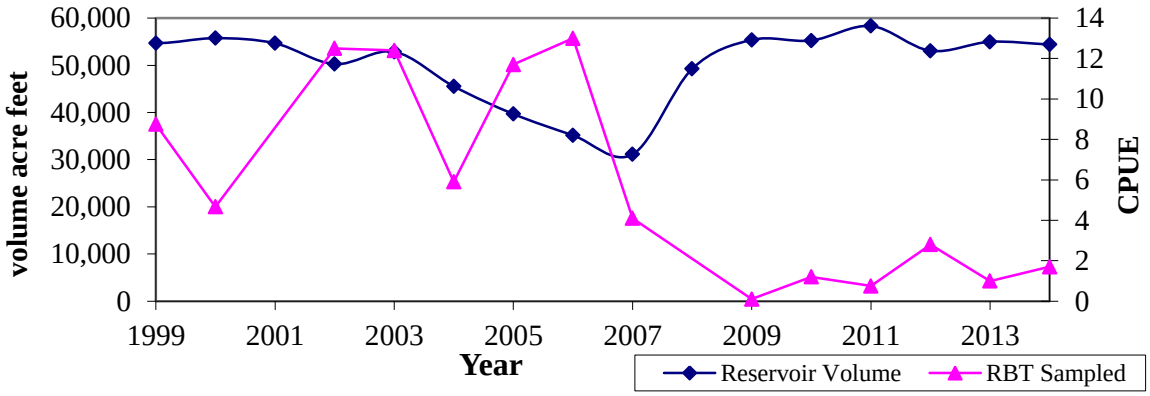

Figure 1. Pactola Reservoir July 31st volume and abundance of rainbow trout sampled with gill nets, 1999-2014.

Brown Trout

The number of brown trout captured in gill nets has generally decreased since 2002, with only two surveyed during 2014 (Figure 2). Brown trout are not annually stocked into Pactola, but approximately 3,000 and 8,000 brown trout were stocked in 2000 and 2002, respectively. Furthermore, 4,700 catchable brown trout were stocked in 2007 which likely explains the slightly higher catch per net prior to 2009. Brown trout relative abundance (CPUE) was lower during the 2009-2014 period than during other years on the 2002-2014 period (Figure 2). Similar to rainbow trout catches, these results may be confounded by a number of influences including the increased volume of water in Pactola Reservoir since 2009, influences of identified stockings, and the recently established northern pike population.

With only two brown trout sampled during the 2014 gill net survey, analysis cannot be extrapolated to the population. Mean condition (*Wr*) for brown trout in Pactola Reservoir has

remained in the 70s and low 80s (Figure 2, Table 4). The 2011 and 2012 surveys yielded some of the largest brown trout ever captured during a survey of Pactola Reservoir with individual fish lengths of 695 mm (27 in) and 640 mm (25 in) being recorded, respectively.

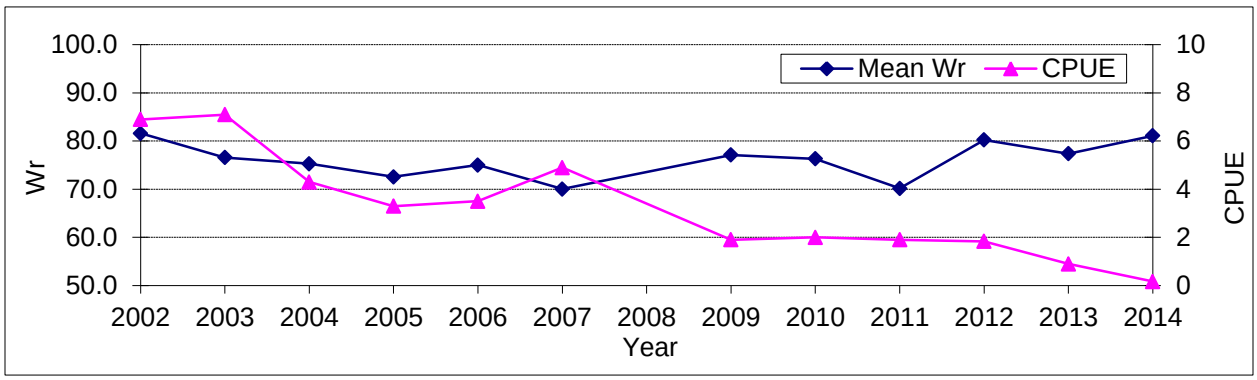

Figure 2. Trends in mean relative weight (*Wr*) and catch per unit effort (CPUE) for brown trout sampled with gill nets from Pactola Reservoir, 2002-2014.

Table 4. Catch per unit effort (CPUE), and mean relative weight (*Wr)* values for brown trout collected during gill net surveys in Pactola Reservoir, South Dakota, 2002-2007 and 2009-2014. Confidence intervals are presented in parenthesis.

Year	N	CPUE (80%)	Mean *Wr* (90%)	*Wr* < 355 mm (90%)	*Wr* > 355 mm (90%)
2002	97	6.9 (0.5)	81.6 (0.1)	81.2 (0.1)	85.3 (0.3)
2003	85	7.1 (2.4)	76.6 (0.1)	74.7 (0.1)	101.0 (1.0)
2004	52	4.3 (1.2)	75.3 (0.2)	72.2 (0.1)	88.1 (0.5)
2005	40	3.5 (1.2)	72.5 (0.2)	70.5 (0.1)	84.0 (0.6)
2006	42	3.5 (1.3)	75.0 (0.1)	74.9 (0.1)	76.2 (0.6)
2007	59	4.9 (1.9)	70.0 (0.1)	69.1 (0.1)	76.8 (0.5)
2009	23	1.9 (1.2)	77.1 (0.2)	76.5 (0.1)	81.4 (0.8)
2010	29	2.4 (1.0)	76.3 (0.1)	75.9 (0.2)	79.0 (0.1)
2011	25	2.1 (0.9)	70.2 (0.3)	68.0 (0.2)	81.7 (1.3)
2012	22	1.8 (0.8)	80.2 (0.2)	77.6 (0.3)	84.2 (0.5)
2013	11	0.9 (0.4)	77.4 (0.3)	77.4 (0.1)	-
2014	2	0.17 (0.15)	81.1 (0.7)	81.1 (0.7)	-

Lake Trout

Relative abundance of lake trout during the past few years, as indexed in the annual gill net survey, has been among the highest level indexed (Table 5). Approximately 9,955 lake trout were stocked in spring 2003 at an average length of 292 mm (11.5 in) with an additional 7,451 fish stocked in the fall of 2005 at an average length of 355 mm (14 in). These fish were differentially marked by fin clips to identify the two stockings. Non-clipped fish are assumed to be naturally reproduced. The percentage of naturally produced lake trout in the annual gill net survey increased to 98% in 2014.

The size range for surveyed lake trout collected in the 2014 survey ranged from 285-700 mm. (Figure 3). Size structure of lake trout has varied greatly since 2003 with the highest value during last year's survey (PSD=64). In 2014, fish captured from the 2005 stocking measured 450-600 mm in length. Mean condition of lake trout over 12 inches (*Wr-S*) in 2014 was slightly lower than the last two years, but remains good. Pactola Reservoir currently has a minimum

length restriction of 610 mm (24 in) for lake trout and a daily limit of one fish.

Table 5. Parameters of lake trout surveyed from gill nets set in Pactola Reservoir including number of non-clipped (wild) fish surveyed and number over the 24 inch (610 mm) angler harvest minimum length. Confidence intervals are presented in parenthesis.

Year	N	N Wild	N >610 mm	CPUE (80%)	CPUE-S (80%)	PSD (90%)	*Wr*-S (90%)	Mean Length (mm)
2003	16	3	3	1.3 (1.1)	0.8 (0.7)	33 (31)	102.1 (14.4)	303
2004	51	5	1	4.3 (1.3)	1.1 (0.4)	8 (13)	84.3 (7.5)	293
2005	16	4	3	1.3 (0.8)	0.8 (0.5)	30 (28)	86.3 (8.9)	389
2006	56	11	2	4.7 (1.6)	4.0 (1.3)	4 (5)	78.6 (1.8)	379
2007	65	21	0	5.4 (1.7)	5.1 (1.6)	0	82.7 (1.1)	370
2009	22	12	0	1.8 (0.9)	1.8 (0.9)	5 (7)	85.8 (2.1)	410
2010	40	30	0	3.3 (1.0)	3.1 (1.0)	24 (12)	87.1 (2.1)	437
2011	40	35	1	3.3 (1.5)	2.2 (0.8)	23 (14)	83.3 (2.8)	383
2012	30	25	1	2.5 (1.3)	2.3 (1.1)	48 (17)	92.7 (1.7)	466
2013	46	42	6	3.8 (1.0)	3.0 (0.6)	64 (14)	91.7 (2.5)	466
2014	41	40	5	3.5 (1.4)	3.2 (1.2)	32 (13)	87.7 (2.5)	410

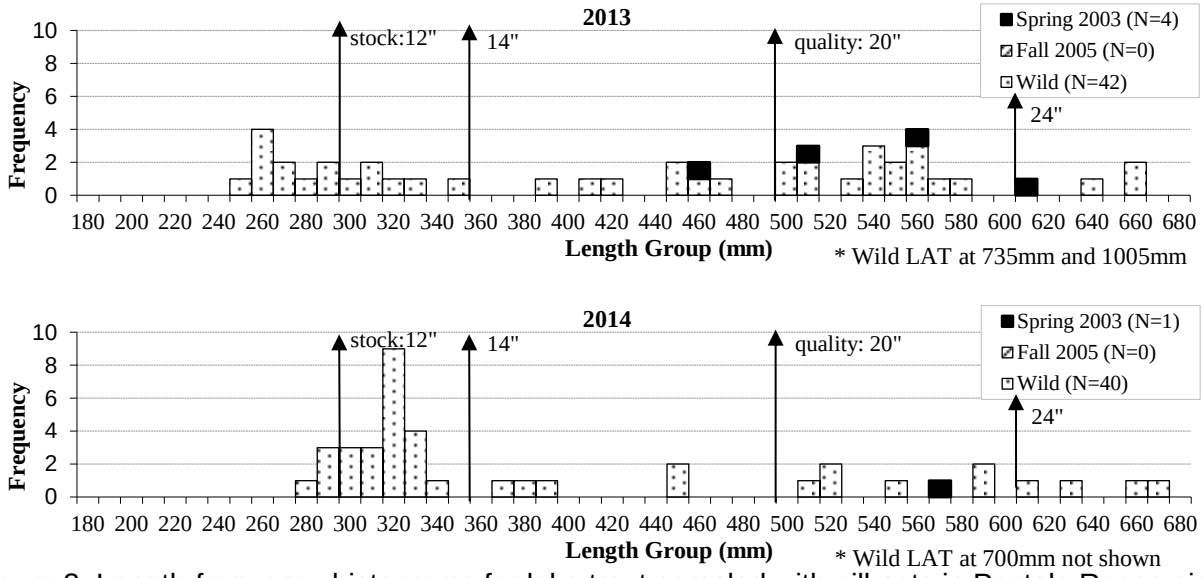

Figure 3. Length-frequency histograms for lake trout sampled with gill nets in Pactola Reservoir, 2013 and 2014.

Bluegill

Increased water levels the past four years, allowed for trap net surveys where steep shorelines usually do not allow for such sampling. Bluegills were the most abundant fish in gill nets and second most abundant in trap nets in 2014, comprising 33% and 32% of the catch, respectively (Tables 2 and 3). Bluegill condition has remained relatively steady with *Wr* values in the upper

80s and 90s (Table 6). Most bluegill caught in trap nets in 2014 were between 100 and 200 mm (4-8 in), in length, and the PSD of 58 was higher than the last two years (Figure 4 and Table 6).

Table 6. Parameters of bluegill captured during trap net surveys of Pactola Reservoir.

Year	N	CPUE	PSD	PSD-P	*Wr*-S
2011	264	32.9 (15.4)	81 (4)	15 (3)	89.9 (2.7)
2012	242	30.3 (10.5)	48 (5)	5 (3)	88.1 (1.2)
2013	248	26.4 (12.2)	38 (5)	1 (1)	94.3 (1.6)
2014	166	20.8 (7.8)	58 (7)	10 (4)	88.0 (2.1)

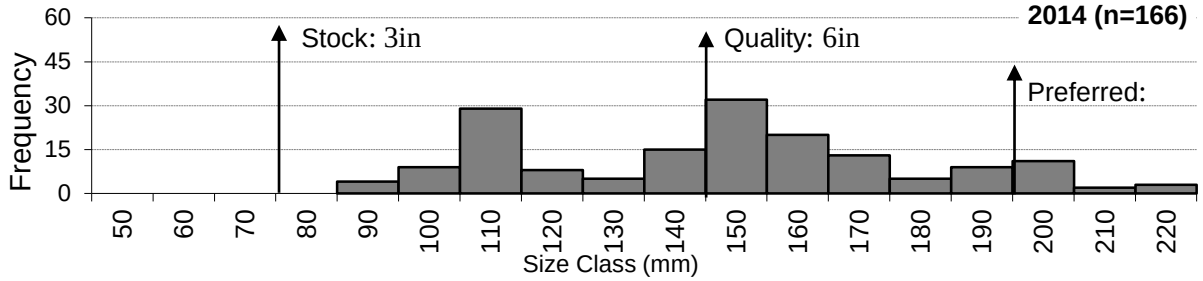

Figure 4. Length frequencies of bluegill captured during trap net surveys of Pactola Reservoir, 2014.

Northern Pike

Gill net catch (CPUE) indicates an established population of northern pike within Pactola Reservoir. Catch was up slightly in 2014 with six fish collected in survey nets (Table 7). All of the fish surveyed were over quality length (530 mm) and ranged from 577-949 mm in length. Pike condition is high, surpassing 90 in six of the eight year in which pike were sampled in the gill net survey.

Table 7. Abundance, condition, and stock indices for northern pike captured during gill net surveys of Pactola Reservoir in 2003-2014. Confidence intervals included in parentheses.

Year	N	CPUE	PSD (90%)	PSD-P (90%)	PSD-M (90%)	*Wr*-S (90%)	Mean length (mm)
2003	1	0.19	100	0	0	97	576
2004	0	0	-	-	-	-	-
2005	0	0	-	-	-	-	-
2006	4	0.3	100	0	0	100 (3)	575
2007	4	0.3	75 (59)	25 (59)	0	99 (9)	621
2009	5	0.4	60 (52)	40 (52)	0	86 (8)	583
2010	10	0.8	50 (36)	13 (23)	0	87 (4)	497
2011	14	0.9	77 (22)	31 (24)	8 (13)	95 (5)	595
2012	11	0.5	82 (22)	45 (28)	27 (25)	100 (6)	679
2013	3	0.3	33 (67)	0	0	93 (10)	458

2014	6	0.5	100	33 (43)	33 (43)	116.1 (13)	734

Yellow Perch

Yellow perch abundance increased in 2014 after two years of low catch rates. They were the second most abundant species in gill nets (Table 2). Size structure was low with a mean total length of 174 mm (6.9 in) and a PSD of 13. Condition (*Wr*) was high at 94.4

Secondary Species

Black crappies are infrequently captured during the Pactola Reservoir survey with two captured in 2002, 21 captured in 2011, and 17 captured in 2014.

Rock bass were the most abundant fish species in trap nets in 2014, making up 54% of the catch. Additionally, largemouth bass, rainbow smelt, rock bass, white sucker, and European rudd were captured in low abundance (Tables 2 and 3).

Issues

1. Different user groups at Pactola Reservoir have different interests and activities that may negatively affect other users.
   - *Issue is similar to BHFMA Plan Issue 3*

2. Angling opportunity may be limited by lack of access to boat docks.

3. Crowding in the parking area may limit access at the south boat ramp at Pactola Reservoir at certain times.

4. Some anglers would like brown trout stocking in Pactola Reservoir to resume to provide a brown trout fishery in the reservoir and to enhance the self-sustaining population in Rapid Creek above Pactola.

5. Historic rainbow trout stocking strategies may no longer meet angler expectations due to the establishment of northern pike.

Objectives and Strategies

Objective 1. Conduct a complete review of trout stockings by December 2015.

Strategy 1.1. Review past stocking numbers, species, strains, sizes, and timing of stockings, as well as historical angler catch, harvest, satisfaction, and regulations.

Strategy 1.2. Research stocking options and regulations used in other states and provinces.

Strategy 1.3. Review recommendations from the August 2014 Pactola Summit in Brookings and Scheibel thesis (2015).

Strategy 1.4. Involve hatchery staff, angler groups, and potentially affected interests.

Strategy 1.5. Update the Pactola Reservoir management plan to include revised management options and stocking strategies.

Strategy 1.6. Develop a plan for evaluating any stocking changes, including a cost-benefit analysis.

Objective 2. Determine catch and harvest rates of lake trout, northern pike, and other game fish by anglers by May 2017.

Strategy 2.1. Compile angler use and catch and harvest survey information.

Strategy 2.2. Compile data from lake trout tag returns.

Strategy 2.3. Identify data gaps and future research needs.

Strategy 2.4. Prepare a study proposal to fill data gaps and submit for funding.

Objective 3. Evaluate brown trout stockings by August 2018.

Strategy 3.1. Stock 8,000 genetically-domestic, 11-inch, brown trout annually beginning in 2016.

Strategy 3.2. Use either traditional marks or genetics to differentiate between stocked and unstocked brown trout.

Strategy 3.3. Collect data on the catch and harvest, as well as population estimates, of stocked and unstocked brown trout using angler use and harvest surveys and fish population surveys specifically targeting brown trout.

Strategy 3.4. Determine the contribution to the creel and population of stocked brown trout.

Strategy 3.5. Document any changes to endemic brown trout reproduction and recruitment occurring as a result of brown trout stockings.

Strategy 3.6. Document any changes to other fish populations occurring as a result of brown trout stockings.

Strategy 3.7. Conduct a cost benefit analysis of brown trout stocking.

Strategy 3.8. Disseminate research information to the public using old media, new media, open houses, and presentations to angler groups.

Strategy 3.9. Adjust brown trout stocking as dictated by the data collected and angler preferences.

Objective 4. Improve non-boat angling opportunities on Pactola Reservoir by 2019.

Strategy 4.1. Coordinate with the United States Forest Service.

Strategy 4.2. Involve angling groups, community organizations, and PAIs.

Strategy 4.3. Develop a proposal, with a vision and plan.

Strategy 4.4. Seek funding for the proposal from both GFP and non-GFP sources.

Strategy 4.3. Complete projects as funding is secured.

Five-Year Operational Plan

1. Continue stocking catchable rainbow trout at an annual rate near 40 fish/surface acre until a different stocking strategy is defined.

   Current Annual stocking schedule:

Month	No.	size / species
April	20,000	11" rainbow trout
September	10,000	11" rainbow trout

2. If lake trout catch rates drop below 1 per 150 ft gill net or 0.7 per hour fished for target anglers, plan for a stocking of 15-inch lake trout at a rate near 15 per surface acre.

3. Annually stock 8,000 (~10/acre) 11 inch brown trout (differentially marked with adipose and pelvic fin clips for each stocking) beginning in spring 2016.

4. Conduct standard fish population surveys annually utilizing a minimum of twelve 24-hour 150-foot experimental gill net sets.

5. Begin annual winter (December – March) angler surveys in December 2015.

6. Conduct a two year 20-40 hour per week angler survey beginning on the date the next catchable brown trout stockings occur.

7. Analyze fishery survey data and angler use data and publish the data in report form in Statewide Fisheries Surveys Annual Reports.

8. Conduct a thorough evaluation of the current management plan and complete a new plan by January 1, 2019 or within 3 years if new stocking recommendations and management options are identified.

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Deerfield Reservoir Management Plan

Introduction/Inventory

Deerfield Reservoir is located in the center of the Black Hills in Pennington County, South Dakota, and lies 17 miles northwest of Hill City and 30 miles west of Rapid City. Deerfield Reservoir is a high altitude impoundment located on Castle Creek. Construction of the dam was started in 1941 and storage of water began in 1945. The dam was constructed by the Bureau of Reclamation with the aid of the Civilian Conservation Corps and the Civil Public Service to provide irrigation water and additional municipal water for Rapid City. The reservoir was placed in operating status on July 1, 1948.

Deerfield Dam, is an earth-fill structure with a height of 133 ft, crest length of 825 ft, and a crest width of 35 ft. Deerfield Reservoir has a side-channel spillway, located in the right abutment, which is concrete lined with an uncontrolled crest 190 feet long and a capacity of 16,700 cubic feet per second. The outlet works consist of a 5-ft diameter concrete conduit through the dam base, extending to a 39-in diameter steel pipe contained within a 6.5-ft horseshoe-shaped concrete conduit. The steel pipe has a discharge capacity of 275 cubic feet per second. Trash racks are present but these prevent the passage of only larger fish. Small releases for fish and wildlife needs can be made through a 6-in diameter pipe which parallels the 39-in diameter pipe. The reservoir has a capacity of 15,700 acre-feet and a 414 acre water surface area. Conservation storage is 15,200 acre-feet; dead and inactive storage totals 600 acre-feet.

The reservoir is slightly less than 3 miles in length, about ¼ mile wide and has an irregular shape providing over 8 miles of shoreline. Shoreline composition is essentially rock, grass/sod and muck. At many places the shore drops abruptly restricting the amount of littoral areas. Most of the existing shoal areas are in the Castle Creek and Gold Run inlets. Shoal bottoms consist of rich humus and silt ranging from 1 to over 4 feet in depth.

The watershed above Deerfield Reservoir is about 95 square miles. About twenty streams occur in the Deerfield watershed but the majority are intermittent. Castle Creek and the South Fork of Castle Creek become confluent about 400 yards above the reservoir and are the main permanent streams in the drainage. Of the lesser inlets, Bear Creek and Gold Run normally have sustained flows; Buck Creek and Bay Run are intermittent streams. All other streams in the watershed contribute a very small portion of total annual inflow. Around 70% of the watershed is owned by the USFS while most of the private land is located in the bottoms adjacent to streams. Much of the watershed's headwater areas are used for cattle grazing and forest production.

Since construction of Deerfield Reservoir in 1942, it has been a popular fishing destination for anglers during both the summer and winter seasons. Castle Creek immediately below Deerfield Reservoir contains brook trout, brown trout and occasionally rainbow trout can be found. Moving downstream from the reservoir, brown trout become the dominant fish species. While the streams are generally self-staining, lakes and ponds in this watershed are stocked with rainbow trout by Cleghorn and McNenny state fish hatcheries. Along with rainbow trout and brook trout, other species exist in Deerfield Reservoir, including white suckers, splake trout, rock bass, lake chub, and yellow perch. Brown trout are not stocked above Deerfield Reservoir to provide a brook trout stream without the predatory effects of brown trout. Recent research has

also documented reproduction and recruitment of rainbow trout above Deerfield Reservoir that is contributing to the Deerfield fishery (Davis 2012).

Ownership of Lake and Adjacent Lakeshore Properties

The Deerfield Dam and water storage rights are owned by the Bureau of Reclamation. The forested areas immediately around Deerfield Reservoir are managed by the United States Forest Service (USFS). Around the reservoir there are three campgrounds with a total of 78 campsites, two picnic areas and two boat launch areas, all maintained by the USFS.

Fishing Access

Vehicle access to reservoir areas is provided through public roads (black top and gravel) under state, county or Forest Service jurisdictions. There are two concrete boat ramps at Deerfield Reservoir. One is located on the north side of the reservoir off of Custer Trail Road. The other boat ramp is on the south eastern portion of the reservoir in Dutchman's Cove. The boat ramp in Dutchman's Cove was replaced in 2012 and a boat dock, provided by the Rapid City Chapter of Walleyes Unlimited, was installed in spring 2013. Boating restrictions (no wake; 5 mph or less) at Deerfield Reservoir limit the high non-angling usage seen at other local popular lakes like Pactola and Sheridan reservoirs. Walking trails surround the lake providing shoreline access.

Fisheries Management

Initial management of Deerfield Reservoir was a put, grow and take rainbow trout fishery with state fishing regulations. The 1949 laws governing trout fishing specified the fishing season as May 1st through September 30th, daily limit of 15, possession limit of 30, and minimum size limit of 6 inches. The daily and possession limits were changed in 1950 to 10 and 20, respectively. In addition to the reservoir stockings, brook trout, brown trout and rainbow trout fingerlings were stocked in streams of the immediate watershed (i.e. Ditch Creek, Lower Gold Run, Pole Creek, Nichols Creek, Castle Creek, and South Fork Castle Creek).

Within 10 years of the reservoir's creation, white suckers were abundant and thought to be the cause of an apparent decline in the trout fishery. The reservoir was drained in summer/fall 1959 and a chemical eradication of all fish in the reservoir and inlet streams was initiated on October 12th. Fish collected during the eradication were rainbow trout, brown trout, brook trout, white suckers, green sunfish, yellow perch, mountain sucker, longnose dace and minnow species. Upon refilling of the reservoir the fishery was again managed as a put, grow and take trout fishery.

In 1970, white suckers were again found in Deerfield Lake and by 1976 white suckers dominated the fishery. A second chance for chemical treatment occurred in 1982 when the reservoir was drained for repairs of the outlet structures. After the chemical renovation, the reservoir was stocked with rainbow trout and brook trout the following year and managed as a put, grow and take trout fishery. Splake trout were introduced to the reservoir in 1984 as an additional species for anglers to pursue.

White suckers were again found in 1988 during a fish survey and by 1999 dominated the fishery once more. Future chemical treatment of the lake is complicated as Deerfield Reservoir is a municipal water supply for Rapid City. Therefore, the Game, Fish and Parks has been conducting removal of white suckers with trap nets often since 1999. During the first year (1999) 4,500 white suckers were removed. Starting in 2004, management has focused on stocking larger, catchable size rainbow trout to provide a better product to anglers (Table 1). Also, recent illegal introductions have led to high density populations of rock bass and yellow perch.

Table 1. Recent stocking history for Deerfield Reservoir, Pennington County, South Dakota, 1999-2014. Catchable size fish are approximately 279 mm (11 in).

Year	Number	Species	Size
1999	120,000	Rainbow trout	fingerling
	2,538	Rainbow trout	catchable
	23,373	Splake trout	fingerling
2000	120,000	Rainbow trout	fingerling
	2,335	Rainbow trout	catchable
2001	60,612	Rainbow trout	fingerling
	7,219	Rainbow trout	catchable
2002	60,000	Rainbow trout	fingerling
	10,471	Rainbow trout	catchable
2003	8,759	Rainbow trout	catchable
	60,625	Rainbow trout	fingerling
2004	12,010	Rainbow trout	catchable
2005	12,000	Rainbow trout	catchable
2006	12,124	Rainbow trout	catchable
	7,124	Splake trout	catchable
2007	8,400	Rainbow trout	catchable
2008	12,280	Rainbow trout	catchable
2009	11,883	Rainbow trout	catchable
2010	11,864	Rainbow trout	catchable
2011	12,000	Rainbow trout	catchable
2012	12,500	Rainbow trout	catchable
	5,853	Splake trout	advanced fingerling
2013	12,000	Rainbow trout	catchable
2014	12,000	Rainbow trout	catchable

Recent Fish Surveys

A gill netting survey was conducted on August 13-15, 2014. Gill nets were monofilament experimental type and measured 45.7 m (150 ft) long and 1.8 m (6 ft) deep with six 7.6 m (25 ft) panels of bar mesh sizes: 12.7 mm (0.5 in), 19.1 mm (0.75 in), 25.4 mm (1.0 in), 31.8 mm (1.25 in), 38.1 mm (1.5 in), and 50.8 mm (2.0 in). Depths and GPS location were recorded to facilitate similar placement each year. A modified fyke (trap) net survey was also completed on August 13-15, 2014. Trap nets consisted of a 1.3 X 1.5 m frame, 19.1 mm (0.75 in) mesh and a 1.2 X 23 m (3.9 X 75.5 ft) lead. All nets remained in the water overnight for a total of six trap net and four gill net nights and catch data is displayed in Tables 2 and 3. Collected fish were measured for total length (TL) to the nearest millimeter (mm) and weighed to the nearest gram (g).

During the 2014 annual survey of Deerfield Reservoir, eight fish species were sampled in gill nets and trap nets totaling 460 and 812 fish captured, respectively (Tables 1 and 2). Rock bass continued to be the most abundant species sampled in trap nets, while yellow perch were the most abundant in gill nets.

Table 2. Total catch of four 150-foot gill nets set in Deerfield Reservoir, South Dakota on August 3-15, 2014. Parameters are reported with confidence intervals in parenthesis.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*-S (90%)
Brook trout	23	5.8 (4.3)	4.5 (2.80)	0	0	87.1 (5.0)
Rainbow trout	11	2.8 (2.5)	2.2 (1.82)	0	0	75.4 (20.6)
Creek chub	2	1.8 (2.1)	-	-	-	-
Rock bass	30	7.5 (8.1)	7.2 (7.8)	0	0	90.7 (3.0)
Splake trout	10	2.5 (2.0)	-	-	-	-
White sucker	34	8.5 (6.6)	8.5 (6.6)	100	100	103.4 (2.9)
Yellow perch	350	87.2 (96.6)	87.0 (96.6)	18 (4)	0	90.5 (0.2)

Table 3. Total catch of six trap nets set in Deerfield Reservoir, South Dakota on August 13-15, 2014. Parameters are reported with confidence intervals in parenthesis.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*-S (90%)
Brook trout	2	0.3 (0.5)	0.3 (0.5)	0	0	66.2 (0)
Rainbow trout	8	1.3 (0.7)	1.3 (0.7)	0	0	126.3 (34.3)
Creek chub	14	2.3 (2.0)	-	-	-	-
Golden shiner	153	25.5 (8.6)	-	-	-	-
Rock bass	473	78.8 (61.5)	45.3 (36.9)	7 (2)	2 (1)	79.8 (1.4)
White sucker	25	4.1 (2.5)	4.1 (2.51)	100	100	91.4 (2.9)
Yellow perch	137	22.8 (22.4)	22.5 (21.95)	16 (6)	1 (1)	85.2 (1.5)

Rainbow Trout

Catchable (279-381 mm) rainbow trout are stocked into Deerfield Reservoir at a rate of approximately 2,000 per month from May through October (Table 4). Survey catch per unit effort (CPUE) and relative weight (*Wr*) are often influenced by the presence of hatchery-reared rainbow trout present in the survey. Eleven were collected from gill nets during the 2014 survey. Mean rainbow trout *Wr* is consistently low (Table 4). Since 2010, hatchery reared fish stocked into Deerfield have received a fin clip in order to differentiate them from wild fish.
Between 2010 and 2014, 47% of surveyed rainbow trout were identified as non-hatchery fish. Studies looking at the contribution of naturally reproduced rainbow trout in Deerfield Reservoir and its primary tributary system, Castle Creek are ongoing.

Table 4. Stocking history (# stocked), number sampled (N), mean catch per unit effort (CPUE), and mean relative weight (*Wr*) from gill net surveys for rainbow trout in Deerfield Reservoir, South Dakota, 2004-2014.

Year	# stocked	N	CPUE (80%CI)	*Wr* (90% CI)
2004	12,010	86	21.5 (9.3)	75.1 (0.1)
2005	12,010	64	16.0 (12.0)	73.3 (0.4)
2006	12,124	77	19.3 (13.6)	70.3 (0.1)
2007	8,400	71	17.8 (8.6)	66.4 (0.1)
2008	12,280	53	13.3 (5.3)	72.1 (0.1)
2009	11,883	17*	8.5 (7.7)	74.4 (0.2)
2010	11,864	30	7.5 (5.4)	70.2 (0.2)
2011	12,000	23	5.7 (6.0)	74.4 (0.2)
2012	12,500	17	4.2 (1.9)	65.8 (0.3)
2013	12,000	43	10.8 (4.5)	79.8 (0.1)
2014	12,000	11	1.33 (0.73)	75.4 (20.6)

*Only 2 gill nets were set and in different locations than previous years.

Rock Bass

In 2008, trap nets were added to the annual sampling to more effectively sample the total fish assemblage. In 2014, rock bass were the most numerous species captured in trap nets comprising 58% of the fish caught. Mean CPUE in 2014 increased from the previous two years (Table 5). The majority of rock bass captured were between 80 mm and 140 mm (3 in - 5 in) which is smaller than quality the quality length of 180 mm (7 in). Mean *Wr* was 91 for gill nets (Table 2) and 81 for trap nets (Table 5).

Table 5. Parameters of rock bass surveyed with trap nets set in Deerfield Reservoir, South Dakota in 2008-2014. Values are reported with confidence intervals in parentheses.

Year	N	CPUE (80%)	PSD (90%)	*Wr*≥S (90%)
2008	1,060	212.0 (126.3)	1 (2)	80.2 (0.4)
2009	449	112.3 (57.6)	6 (10)	79.9 (1.5)
2010	445	111.0 (54.7)	0	82.0 (2)
2011	915	152.5 (47)	2 (1)	78.5 (1)
2012	251	41.8 (23.2)	3 (2)	76.7(1.0)
2013	286	47.7 (32.9)	0	78.8 (1.1)
2014	473	78.8 (61.5)	7 (2)	80.7 (3.01)

Brook Trout and Splake Trout

Splake trout are a hybrid between brook trout and lake trout. Initial stockings in the 1990s involved fingerlings, but recent stockings in 2006 and 2012 have utilized advanced fingerlings. In 2012, stocked splake trout were adipose clipped to identify them from other splake trout or brook trout already present in the lake. In recent years, some fish caught in the annual survey have been difficult to differentiate between the two species. A research study, including

genetics identification, has recently been started to determine the reproductive contribution of brook and splake trout. This information will help determine if either brook trout or splake trout are naturally recruiting to the fishery, and will help positively identify if a fish is a particular species of trout or a hybrid when possible state record fish are caught.

During the 2014 gill net survey, 23 fish identified as brook trout (no fin clip) and 10 splake trout were captured (Table 2). Most brook trout measured 180-280 mm (7-11 in) in length (Figure 1), with clipped splake trout measuring 230-280 (9-11in). No larger individuals were collected during this year's survey, but recent year's surveys have produced fish up to 630 mm (25 in) in length.

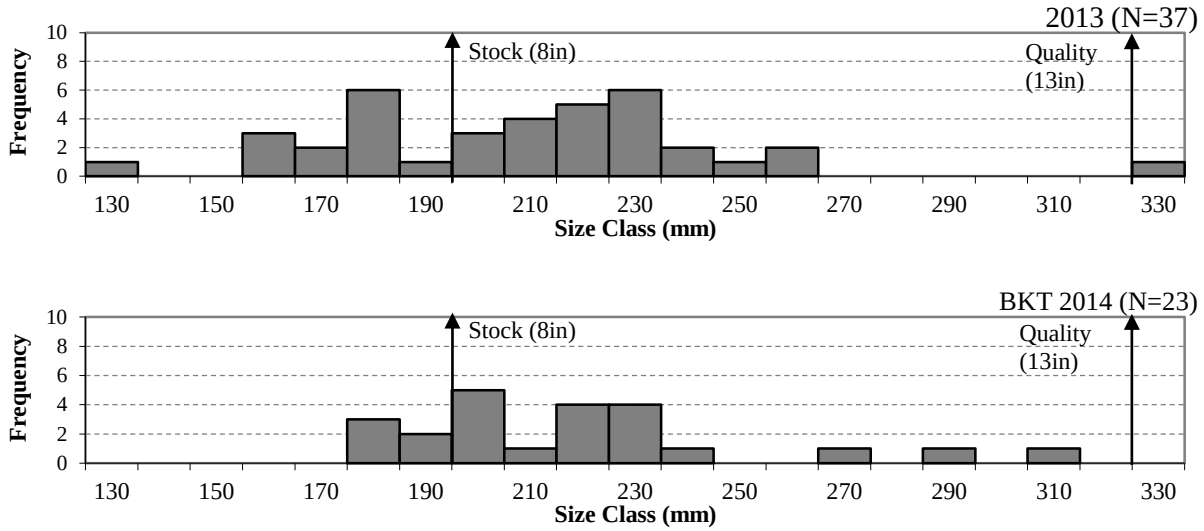

Figure 1. Length frequency histogram for brook trout captured during gill net survey of Deerfield Reservoir, South Dakota in 2013 and 2014.

White Sucker

White sucker densities were high in the late 1990s. To reduce the density of white suckers, removal efforts were conducted from 1999 to 2001, 2006-2009, and in 2012 using trap nets during the spring spawning period (Table 6). The removals appeared to lower densities, as gill net catch did decrease following removals. Values from the past three years' surveys suggest the population is maintaining a lower density with reduced recruitment. It is possible this is a result of rock bass and yellow perch populations displaying a predatory pressure on juvenile white suckers or eggs.

Size structure of white suckers appears to have increased in recent years with PSD of preferred length fish (PSD-P) values increasing from 40 in 2001 to 100 since 2008. In 2014, the majority of fish sampled were over memorable length (410 mm or 16 in) with a proportional stock density of memorable sized fish (PSD-M) of 91 and a mean total length of 443 mm (17.4 in). Mean *Wr* has remained around 100 since 2009, with the highest level observed during the 2014 survey (Table 6).

Table 6. Summary of white suckers removed by trap nets and parameters for fish collected during gill net surveys from Deerfield Reservoir, South Dakota, 2004-2014.

Year	Number Removed	Pounds Removed	CPUE (80%)	PSD (90%)	*Wr*≥S (90%)
2004	0	0	36.3 (14.0)	100	89.8 (0.5)
2005	0	0	35.0 (18.3)	99 (1)	90.7 (0.4)
2006	9,020	14,432	25.8 (13.5)	94 (4)	89.3 (0.1)
2007	1,064	1,809	15.8 (13.5)	95 (4)	93.4 (1.6)
2008	4,706	8,000	11.0 (7.8)	100	94.7 (0.9)
2009	1,500	2,600	24.0 (49.2)	100	101.0 (1.6)
2010	0	0	23.8 (2.25)	100	99.8 (3.8)
2011	0	0	7.0 (5.2)	96 (6)	99.6 (1.7)
2012	~500	NA	7.3 (6.4)	100	99.1 (1.6)
2013	0	0	6.0 (5.8)	100	101.0 (1.7)
2014	0	0	8.5 (6.6)	100	103.4 (2.9)

Yellow Perch

Yellow perch abundance continues to increase in Deerfield Reservoir. Gill net CPUE has increased from three in 2003 to 87.2 in 2014 (Table 7). The decrease in 2011 could be due to placement of nets, specifically a change in depth. Condition increased in 2014 from values documented in 2012 and 2013. The 2014 *Wr* >S of 90, in addition to a PSD of 18 suggests the population is experiencing slow growth due to overabundance or competition with other species (i.e. rock bass and rainbow trout). The majority of yellow perch in the 2014 gill net sample were 150 mm to 210 mm (six to eight inches) in length. A 2014 yellow perch year class was not apparent from 2014 gill net survey results. Deerfield Reservoir has been a source for yellow perch trap and transfer, in recent years. Over 6,650 were relocated to other aquatic systems in May 2014.

Table 7. Parameters of yellow perch surveyed with gill nets in Deerfield Reservoir, South Dakota in 2003-2014. Values are reported with confidence intervals in parentheses.

Year	N	CPUE (80%)	PSD (90%)	*Wr*>S (90%)
2003	12	3.0 (4.9)	33 (26)	83.7 (2.2)
2004	2	0.5 (0.8)	-	80.3 (19.9)
2005	24	6.0 (3.9)	38 (18)	86.7 (1.7)
2006	31	7.8 (6.3)	35 (--)	88.4 (2.0)
2007	155	38.8 (38.0)	20 (6)	90.0 (1.4)
2008	241	60.3 (59.0)	23 (5)	92.4 (0.1)
2009	125	62.5 (81.6)	55 (10)	91.0 (1.1)
2010	300	75.0 (76.0)	39 (5)	92.0 (2.0)
2011	31	7.8 (8.8)	39 (0)	89.7 (2.4)
2012	227	56.8 (92.9)	26 (5)	83.3 (0.5)
2013	327	81.8 (63.4)	29 (5)	81.9 (1.1)
2014	350	87.2 (96.6)	18 (4)	90.5 (0.2)

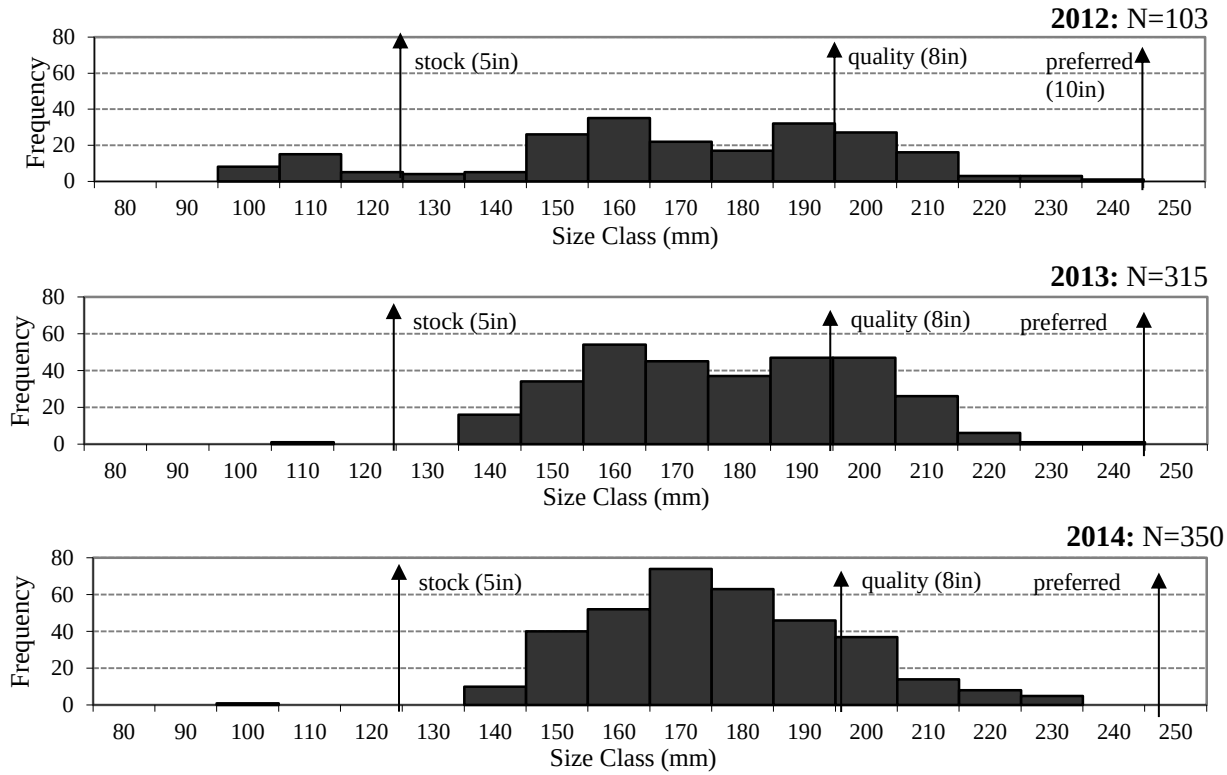

Figure 2. Length frequency histograms for yellow perch collected in August gill net surveys from Deerfield Reservoir 2012-2014.

2010 Angler Survey Summary

The most recent angler survey conducted at Deerfield Reservoir was from May 14 to August 12, 2010 (Simpson 2010). For this survey period, angler use at Deerfield Reservoir was estimated at 20,616 hours. This value was higher than the 2009 estimated for the sam time period of 16,156 hours.

Stocked rainbow trout harvest in 2010 was 34 percent of stocked fish with a catch rate of 0.56 trout/hour. This catch rate meets the most recent objective for Deerfield Reservoir fish management.

Yellow perch have also become a targeted fish during winter at the reservoir and contribute to the angler catch during the summer months. Yellow perch had the highest catch and harvest rates of the May 14 – August 12 survey period during August, with a harvest rate greater than 3 fish/hour in August. As for stocked fish, rainbow trout catch and harvest numbers were the highest during May and lowest in August.

Overall angler satisfaction at Deerfield Reservoir was 90% and greatly exceeded the rate of 66% stated by Gigliotti (2003) for Black Hills anglers. Similar high angler satisfaction was observed in 2009.

Issues

1. Some anglers are concerned about poor condition trout.
2. Stocking hatchery rainbow trout may have negative impacts on the self-sustaining population.
3. Rock bass are overly abundant.

Objectives and Strategies

Objective 1: Identify factors possibly affecting rainbow trout condition by January 2017.

Strategy 1.1. Review historical fish community survey data.

Strategy 1.2. Review historical stocking data, both from the stocking database and hatchery records, to determine the condition factor of stocked fish.

Strategy 1.3. Determine as much as possible the long-term post-stocking condition of hatchery-reared trout.

Strategy 1.4. Conduct a thorough literature review.

Strategy 1.5. Utilize results from current SDSU project (Kientz *in* prep) that is quantifying diets of naturally-reproduced trout, stocked trout, and other fish populations to evaluate possible competition.

Strategy 1.6. Quantify any differences in condition between wild and hatchery origin fish.

Strategy 1.7. Disseminate research information to the public using old media, new media, open houses, and presentations to angler groups.

Strategy 1.8. If dictated by research and angler input, adjust stocking numbers, sizes, and timing.

Strategy 1.9.Evaluate the effects of any stocking changes.

Objective 2. Reduce the density of undesirable fish species, if feasible, by 2019.

Strategy 2.1. Conduct literature review on optimal densities.

Strategy 2.2. Establish stock densities that meet management goals and angler expectations.

Strategy 2.3. Conduct literature review to identify potentially effective reduction methods.

Strategy 2.4. Determine the economic, biological, and social feasibility of possible reduction methods.

Strategy 2.5. Enact density reductions if needed and economically-efficient, biologically-sound, and socially acceptable.

Objective 3: Investigate introductory stockings of other species or sizes of trout stocked, and if deemed appropriate, complete a written proposal addressing possible introductions and implement as soon as possible.

Strategy 3.1. Through a literature review, identify locally popular sportfish that have the potential to prey on overabundant rock bass, low potential impact on stocked rainbow trout, and will possibly provide a trophy or unique fishery.

Strategy 3.2. Review angler comments and angler surveys to determine acceptance of a new sportfish in Deerfield Reservoir.

Strategy 3.3. Investigate potential impacts of stocking 15 inch rainbow trout and decreasing the number of 11 inch rainbow trout stocked into Deerfield Reservoir to the overall condition of wild trout.

Five Year Operational Plan

1. Survey Deerfield Reservoir annually utilizing a minimum of four 24-hour trap net sets and two 150-foot experimental gill net sets.

2. Analyze fishery survey data and publish the data in report form in Statewide Fisheries Surveys Annual Reports.

3. Stock 11-inch Rainbow trout at a rate of 35/surface acre/year until a different stocking strategy is defined.

   Current Annual stocking schedule:

Month	No.	size / species
April (mid)	2,000	11 inch Rainbow trout
May (mid)	2,000	11 inch Rainbow trout
June (mid)	2,000	11 inch Rainbow trout
July (mid)	2,000	11 inch Rainbow trout
August (mid)	2,000	11 inch Rainbow trout
September (mid)	2,000	11 inch Rainbow trout
October (mid)	2,000	11 inch Rainbow trout

4. If netting surveys indicate white sucker density at a level above previous stated objective values (more than 20 per 150 ft gill net during annual sampling) then use trap nets in Spring to remove adult white suckers from the lake.

5. Conduct a literature review, and complete a written proposal of possible sportfish that could use rock bass as a forage source, and also provide a popular target species for anglers. Upon approval/acceptance, begin the process of acquiring approved sportfish for stocking as soon as possible.

6. Continue to remove rock bass and white sucker when spring trap and transfers of yellow perch occur.

7. Conduct a thorough evaluation of the current management plan and complete a new plan by January 1, 2019.

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Sheridan Lake Management Plan

Introduction/Inventory

Sheridan Lake is a 383-acre impoundment located 15 miles southwest of Rapid City. Under the leadership of the Rapid City Isaac Walton Chapter this lake was constructed by the Civilian Conservation Corps and the Works Progress Administration. The lake was created solely for recreational purposes. Construction of the dam structure for Sheridan Lake began in 1938 and the reservoir filled in 1940. The lake is under control of the United States Forest Service (USFS) and recreation continues to be the management strategy for the reservoir.

The ownership of the Sheridan Lake watershed is 85.8% USFS (81,818 acres) and 14.2% private (13,493 acres). The bulk of USFS land is managed for timber production, but is also grazed through a permit process. Most of this land is covered by pine or spruce forest interspersed with meadows. Logging, thinning, and other timber management practices are ongoing. Highway reconstruction and flood plain development have also occurred within the watershed. Private land is less often forested and more often used as horse pasture, cattle grazing land, home sites, or campgrounds. The watershed also contains the town of Hill City and several other small developments. Allof these activities contribute to the sediment load into Sheridan Lake carried by Spring Creek and Horse Creek. The watershed also contains the town of Hill City and several other small developments. Small reservoirs including Mitchell, Major, Newton Fork, Thompson, Marshall Gulch, and several unnamed farm ponds are located within the watershed. Most of the watershed consists of hills with moderate to steep inclines. Roads and trails are prevalent throughout the watershed.

Ownership of Lake and Adjacent Lakeshore Properties

Sheridan Lake and its dam are maintained and operated by the USFS. The operation and maintenance of campgrounds, picnic areas, parking lots, and boat launch facilities are managed under a special use permit by non-government entities. These entities also cooperate with the USFS during major maintenance and improvement in the off season. The marina and concession operations are leased to private enterprise under other long-term use permits.

Fishing Access

The access and facilities at Sheridan Lake are excellent. The lake levels and recreation facilities are managed by the USFS emphasizing recreation. There are two boat ramps located on the lake. In the summer months parking lots become full and some users may be turned away. The USFS does charge an entry fee for the marina area on the north side of the lake, in the camping area on the south side of the lake and at the day use area on the southwest portion of the lake. Other uses of the lake include boating, water skiing, swimming and personal water craft. Some user conflicts occur. The lake is patrolled by the SD Game, Fish and Parks (SDGFP) law enforcement almost every summer weekend.

Fisheries Management

Initial management of Sheridan Lake was as a rainbow trout fishery. Recent management of Sheridan Lake has been primarily as a yellow perch fishery. Stocking of rainbow trout was discontinued in 1997 when angler surveys and anecdotal information indicated anglers were catching very few trout. Poor return of the trout was thought to be caused by illegally introduced northern pike preying on trout and warm-water species competing with the trout. Stockings resumed in 2004 due to low density of northern pike and a change in trout stocking size from large fingerling to catchable (11 inches; Table 1).

Current management at Sheridan Lake continues to be for yellow perch but rainbow trout are again included. Other sportfish such as black crappie, northern pike, and largemouth bass are also common in the reservoir and actively sought by some anglers. A 15-inch-minimum regulation was implemented on the largemouth bass fishery in 2006. It is intended the minimum length restriction will increase density of smaller (<15 inches) bass, thereby, influencing panfish populations (i.e. improving size structure of the yellow perch population and help control other panfish species such as rock bass and black crappie) through predation. The regulation was proposed and implemented following an angler survey in 2005 that found 92% of interviewed anglers would support the restriction. Current fish surveys at Sheridan Lake consist of annual gill net surveys and night electrofishing surveys, stocking rainbow trout, and interviewing anglers.

Table 1. Stocking record for Sheridan Lake, South Dakota, 2005-2014.

Year	Species	Size	Stockings	Number
2005	Brown trout	catchable	1	2,664
	Rainbow trout	catchable	4	15,700
2006	Rainbow trout	catchable	4	15,789
2007	Brown trout	catchable	1	726
	Rainbow trout	catchable	4	11,590
2008	Rainbow trout	catchable	2	8,582
2009	Brown trout	catchable	1	1,000
	Rainbow trout	catchable	4	20,637
	Rainbow trout	fingerling	1	6,000
2010	Brown trout	catchable	1	900
	Rainbow trout	catchable	3	18,630
	Smallmouth bass	fingerling	1	7,800
2011	Rainbow trout	Catchable	3	17,550
	Rainbow trout	fingerling	1	7,933
	Smallmouth bass	adult	1	200
	Smallmouth bass	fingerling	1	5,600
2012	Rainbow trout	catchable	3	19,000
	Smallmouth bass	adult	1	285
2013	Rainbow trout	catchable	3	19,000
2014	Rainbow trout	catchable	5	19,079

Recent Fish Community Surveys

The Sheridan Lake fishery was sampled using gill nets and night electrofishing in 2014. Two 150 foot experimental gill nets were set on July 22, 2014 at approximately 15-20 ft. deep, as this has been determined to be the depth below which oxygen usually drops below a habitable level during July. Nets remained in the water overnight for a total of two gill net nights. Night electrofishing was conducted at Sheridan Lake on June 12, 2014 to sample largemouth bass and smallmouth bass. Six 10-minute sites were completed.

Five species were caught in gill nets with yellow perch making up the majority (90.1%) of the catch (Table 2). In past surveys more species have been caught including black crappie, black bullhead, golden shiner, and European rudd. Night electrofishing results are included in the largemouth and smallmouth bass sections of this report.

Table 2. Total catch for two 150 ft experimental gill nets set in Sheridan Lake, South Dakota on July 22, 2014. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Northern pike	1	0.5 (1.5)	0.5 (1.5)	100	0	110.7
Rainbow trout	5	2.5 (4.6)	2.5 (4.6)	0	0	89.9 (4.3)
Rock bass	2	1.0 (0)	1.0 (0)	0	0	81.2
White sucker	1	0.5 (4.1)	0.5 (4.1)	100	100	99.3
Yellow perch	82	41.0 (6.2)	40.0 (9.2)	40 (9)	1 (2)	105.5 (0.2)

Largemouth Bass

A total of 107 largemouth bass were captured during the one hour of night boat electrofishing (Table 3). This is similar to 2012-2013 and over twice the number of fish captured each year from 2008-2011.

Sheridan Lake is managed using a 15 inch (381 mm) minimum length limit for largemouth bass. The size structure of largemouth bass has been good, with a PSD (>300mm) of 64 and PSD-P (>380 mm) of 17 in 2014. These values exceed the management goal of a PSD value of 40-60 and a PSD-P value of 10. Largemouth bass between 80 mm to over 500 mm (19.9 in) (Figure 1) were collected during the 2014 electrofishing survey. Fish condition (*Wr*) continues to be very good, ranging from 99 to 106 over the past ten years.

Aging of largemouth bass from the 2014 survey indicated most were three to seven years old (Table 4). Some fish were aged past seven, but because it is very difficult to age these fish, their values are not included. Length at age for largemouth bass in 2014 was within the range estimated for previous survey years. Largemouth bass growth rates still average one to three inches per year slower than the SD mean and half an inch per year slower than the Region 1 (western SD) mean (Figure 2) (Willis et. al 2001). They are reaching stock length (200 mm or 8 in) at about three years of age; whereas statewide they reach this at two to three years.

Table 3. Results of largemouth bass captured during night electrofishing surveys of Sheridan Lake, 2003 - 2014.

Month/Year	N	Effort (sec)	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
9/2003	82	3,600	82 (45)	69 (36)	20 (8)	7 (5)	102 (0.1)
9/2004	57	3,600	57 (20)	38 (19)	37 (14)	3 (4)	102 (1.4)
9/2005	57	3,488	58 (23)	33 (20)	39 (14)	0	99 (1.3)
9/2007	111	3,450	115 (25)	102 (23)	26 (8)	1 (2)	104 (0.6)
9/2008	54	3,600	54 (22)	46 (19)	61 (12)	9 (7)	105 (1.7)
9/2009	50	3,550	50 (17)	37 (13)	43 (14)	0	104 (1.1)
9/2010	62	3,600	62 (39)	42 (30)	31 (12)	7 (7)	101 (1.8)
5/2011	52	3,676	52 (19)	50 (19)	34 (11)	10 (7)	98 (1.4)
6/2012	113	2,400	170 (50)	152 (59)	42 (9)	6 (4)	107 (1.0)
6/2013	101	3,600	101 (20)	75 (15)	56 (10)	5 (4)	106 (0.2)
6//2014	107	3,600	107 (25)	75 (19)	64 (9)	17 (8)	99 (0.3)

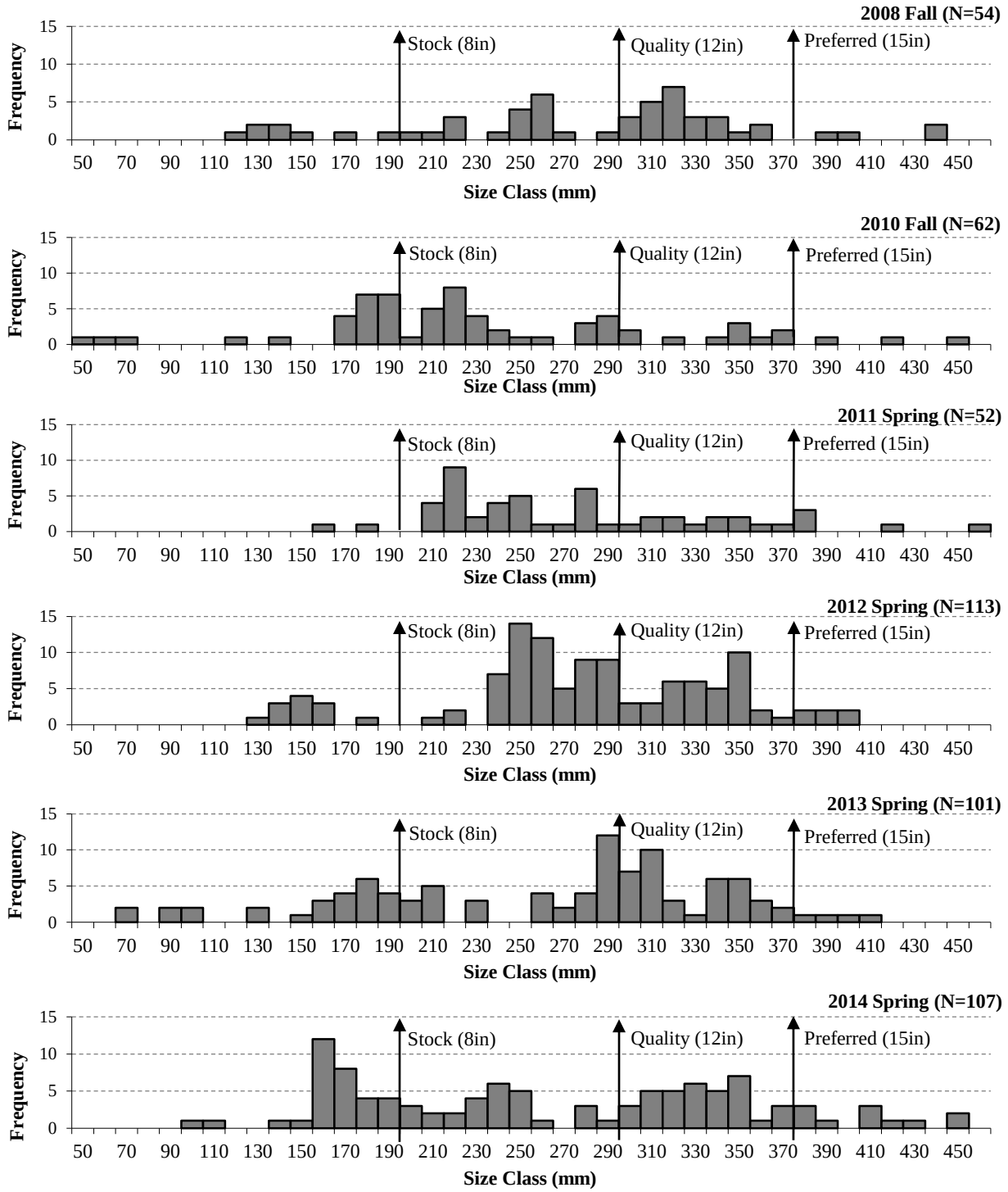

Figure 1. Length frequency histograms for largemouth bass collected by night electrofishing from Sheridan Lake, Pennington County, South Dakota, 2008, 2010-2014.

Table 4. Length (mm) at age (yr) for largemouth bass surveyed in Sheridan Lake by night electrofishing in 2014, with population means for 2012-2013 and the statewide and region 1 (western S.D.) means.

Age →			1	2	3	4	5	6	7
Year	Age	N							
2012	2	4	104	167					
2011	3	14	71	127	176				
2010	4	21	71	154	215	260			
2009	5	6	76	150	227	269	300		
2008	6	10	75	149	226	287	331	357	
2007	7	8	62	129	198	249	289	323	351
2014 mean			73	142	205	264	305	337	355
2013 mean			69	139	202	257	292	321	351
2012 mean			67	119	167	221	267	302	326
Statewide mean			96 (3)	182 (6)	250 (7)	305 (8)	342 (8)		
Region 1 mean			78 (4)	154 (10)	214 (11)	272 (13)	318 (13)		

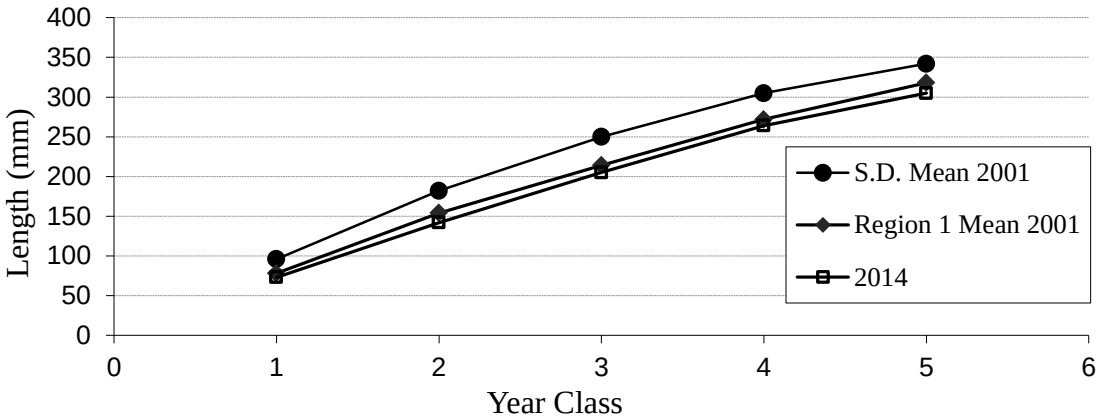

Figure 2. Length-at-age for largemouth bass captured in Sheridan Lake by night electrofishing in 2014 plotted with the South Dakota mean and Region 1 (western South Dakota) mean.

Smallmouth Bass

Smallmouth bass fingerlings were stocked into Sheridan Lake in 2010 and 2011 (13,400 total), with adults stocked in 2011 and 2012 (485 total). In 2014, ten were captured ranging from 90-350 mm in length.

Yellow Perch

Gill net catch per unit effort of yellow perch was higher during the 2011-2014 period than for the 2007-2010 period (Table 5). The proportion of stock-length yellow perch in the 2014 gill net survey over quality length (PSD) and over preferred length (PSD-P) was at its lowest level with values of 40 and 1, respectively. These values are still within the management goal of a PSD of

30-60. Condition (*Wr*) for yellow perch captured in gill nets has been excellent and remained relatively constant with values over 100.

Lengths of yellow perch collected during the 2014 gill net survey ranged from 150 to 250 mm (6 to 10 inches) 150-250 mm (Figure 3). Yellow perch in Sheridan Lake may not get much longer than 250 mm possibly due to high fishing pressure and anglers cropping off the larger yellow perch. Estimated yellow perch harvest during the January-March period of 2011 was estimated at 7,700 fish, with a high proportion of harvested fish exceeding 220 mm (8 inches)(Simpson 2011).

Otoliths were taken from yellow perch captured in gill nets (Table 6). The majority of fish aged were between two and seven years old. Some Sheridan Lake yellow perch do exhibit faster growth, reaching quality length (200 mm or 8 in) at age-3, but on average, it takes four years for them to grow to quality length. This is similar to the mean length at age-4 for South Dakota but faster than the Region 1 (Western South Dakota) mean (Willis et. al, 2001).

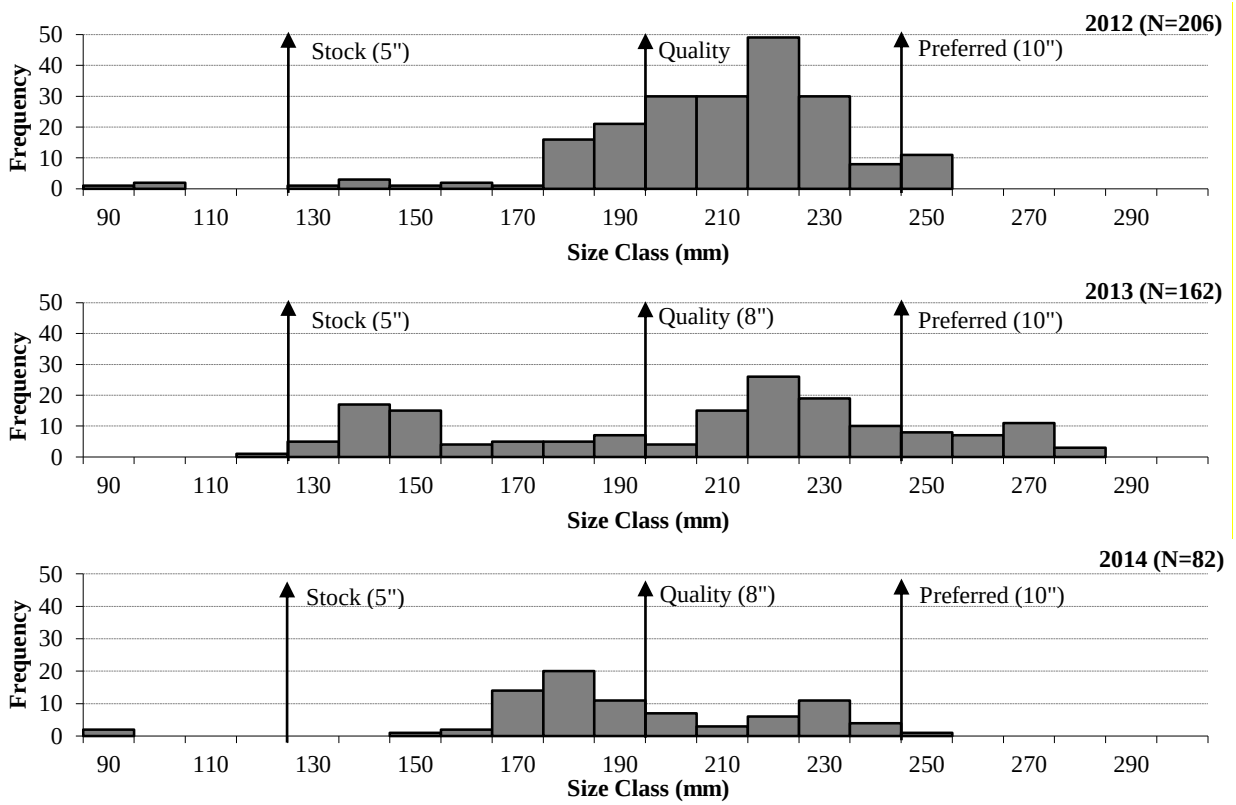

Figure 3. Length frequency histogram for yellow perch captured during gill net surveys of Sheridan Lake, South Dakota, 2014.

Table 5. Catch data, stock indices, and condition for yellow perch captured with gill nets in Sheridan Lake, South Dakota, 2003 - 2014. Confidence intervals are reported in parentheses.

Year	N	Effort	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*-S (90%)
2003	147	2	73.5 (69.2)	73.5 (69.2)	75 (6)	5 (3)	101.8 (0.5)
2004	231	2	115.5 (113.9)	115.5 (113.9)	81 (4)	7 (3)	98.1 (0.4)
2005	89	2	44.5 (84.6)	44.5 (84.6)	83 (6)	8 (5)	97.4 (0.7)
2006	193	2	96.5 (238.5)	71.0 (160.1)	78 (6)	1 (2)	99.4 (0.5)
2007	54	2	27.0 (15.4)	27.0 (15.4)	93 (6)	11 (7)	96.5 (0.8)
2008	92	2	46.0 (12.3)	46.0 (12.3)	98 (3)	20 (7)	100.4 (0.1)
2009	21	2	10.5 (13.8)	10.5 (13.8)	100	24 (17)	100.3 (2.3)
2010	14	4	3.5 (3.1)	3.5 (3.1)	93 (13)	14 (17)	103.5 (2.5)
2011	148	2	74.0 (0)	74.0 (2.0)	74 (8)	10 (4)	101.8 (1.2)
2012	219	2	110.0 (60.0)	108.0 (55.0)	79 (4)	11 (3)	106.2 (0.4)
2013	162	2	81.0 (156.9)	80.5 (155.4)	64 (6)	18 (5)	100.4 (0.7)
2014	82	2	41.0 (6.2)	40.0 (9.2)	40 (9)	1 (2)	105.5 (0.2)

Table 6. Sheridan Lake yellow perch minimum, maximum, and weighted mean lengths (mm) by age (from otoliths) for fish caught in experimental gill nets during the 2014 fishery survey, and Region 1 and Statewide mean lengths by age (from scales) (Willis et al. 2001).

Age	Minimum	Weighted Mean length	Maximum	N	Region 1 Mean	S. Dakota Mean
2	167	180	196	9	117	145
3	173	188	210	23	158	190
4	205	205	205	1	186	220
5	223	227	230	3	208	242
7	228	236	246	8	-	-
11	233	233	233	1	-	-

Rainbow Trout

Five rainbow trout were captured in gill nets during the 2014 survey. Sheridan Lake was stocked with 10,000 catchable rainbow trout in April and May, over two months prior to the survey. A number of anglers report having high catch rates of rainbow trout over 14 in, indicating either a fast growth rate or carryover from prior years' stockings.

Issues

1. Different user groups at Sheridan Lake have different interests and activities that may negatively affect other users.
    - *Issue is similar to BHFMA Plan Issue 3*

2. Some anglers would like to have the opportunity to catch species other than rainbow trout in Sheridan Lake.
    - *Issue is similar to Black Hills Reservoirs Issue 11*

3. The lake is becoming eutrophic and stratification within the water column occurs through the summer with little oxygen left in the lower layer (hypoliminion).

4. Anglers routinely comment about catching only rainbow trout greater than 14 inches, removal of the current length restriction, and concern for releasing large trout that will likely not survive.

5. Curlyleaf pondweed and European rudd (AIS species) exist in the lake.

6. Sheridan Lake is near Rapid City, receives high fishing pressure, and over-harvest of yellow perch is a concern.

7. There is a desire by many anglers to diversify fish management in Black Hills reservoirs to include cool and warm water species.

Objectives and Strategies

Objective 1. Annually monitor and work to maintain a quality yellow perch fishery.

Strategy 1.1. Survey fish populations and periodically anglers to determine if yellow perch densities and size structure are meeting angler expectations.

Strategy 1.2. If quality of yellow perch drop below accepted values (PSD 30-60), determine what caused the decline through angler surveys, fish surveys and literature reviews and identify feasible mitigation (e.g. reduced daily limits, stocking, removal of undesirable fish species, predator management) to restore the population to accepted values.

Strategy 1.3. If growth rates are identified as a limiting factor in population quality, quantify diets of yellow perch and other fish populations to evaluate possible competition and predation.

Strategy 1.4. If food availability and diet composition are the reason for slow growth, investigate means of increasing food availability and/or quality.

Objective 2. Maintain the rainbow trout fishery and recommend any new regulation ideas by July 2016.

Strategy 2.1. Continue to stock catchable rainbow trout at an annual rate near 50/surface acre.

Strategy 2.2 Conduct angler surveys to determine trout angler satisfaction.

Strategy 2.3. Determine angler attitudes about trout regulation options.

Objective 3. Establish (and maintain) a smallmouth bass fishery by December 2017.

Strategy 3.1. Stock up to 500 adult smallmouth bass along the dam face and rock structures near the Hwy 385 access area in 2015 and 2016 and as needed after to maintain electrofishing catch rates near 20 adults (≥ 7 inches) per hour in rocky areas.

Strategy 3.2. Evaluate smallmouth bass stockings through spring night electrofishing and angler surveys.

Objective 4. To maintain a largemouth bass fishery with a minimum night-time electrofishing CPUE for stock-length fish of 20, a PSD greater than 40, and a PSD-P near 10.

Strategy 4.1. Evaluate the largemouth bass population and 15-inch minimum-length-limit regulation by conducting nighttime electrofishing and angler surveys.

Strategy 4.2. Stock adult bass to supplement the existing population when nighttime electrofishing CPUE of stock-length largemouth bass is below 20.

Objective 5. Determine feasibility of managing a northern pike fishery by the next update of this management plan in January 2019.

Strategy 5.1. Through literature review, identify possible regulations and other management options with potential to produce trophy northern pike in association with other reservoir fisheries.

Strategy 5.2. Survey lake anglers to determine acceptance of possible northern pike management options at Sheridan Lake.

Five Year Operational Plan

1. Survey Sheridan Lake annually utilizing a minimum of four 24-hour frame net sets, a minimum of two experimental gill net sets and six 10-minute night electrofishing stations.

2. Analyze fishery survey data and publish the data in report form in Statewide Fisheries Surveys Annual Reports.

3. Stock 11-inch rainbow trout at a rate of 30/surface acre/year (7,490 in May; 3,500 in Oct).

4. If electrofishing indicates largemouth bass density is too low to meet stated objective values then stock adult largemouth bass at a rate of 1 lb per surface acre (2 to 3 adults per surface acre) to supplement the population.

5. Conduct a thorough evaluation of the current management plan and complete a new plan by January 1, 2019.

6. Stock up to 500 adult smallmouth bass in 2015 and 2016.

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Stockade Lake Management Plan

Introduction/Inventory

Stockade is a 130 acre impoundment located on French Creek in Custer County, three miles east of Custer, SD. Primary uses of the Stockade Lake watershed are for timber and grazing. Cattle grazing has occurred on private land and United States Forest Service (USFS) land above the lake. Bismarck Lake has a surface area of 25 acres and drains into one of Stockade Lake's north bays. Custer Municipal Pond has an estimated surface area of 4 acres and is located on French Creek above Stockade Lake on the west edge of Custer.

Developments at the lake include: boat ramp, gravel parking lot and picnic area with vault toilets on the east side; a reserved group campground and the South Campground on the south side of the lake; and the North Campground and a day use area with paved road, fishing pier and vault toilets on the north side.

Aquatic vegetation mostly consists of cattails and pondweed. Stands of cattail are prevalent along shorelines with shallow areas and in bays. Submerged vegetation consists mostly of pondweed in shallow, shoreline areas. Summer algae blooms have sometimes been heavy and contributed to past summer kills.

The water level control valve was repaired in either 1989 or 1990 and a few attempts at aeration were done with a final system installed in the fall of 1998. Siltation occurs from highway runoff, grazing, mining, and forestry practices via French Creek and Bismarck Lake Creek. In addition, added nutrient loading has been a problem since construction of Stockade dam due to a faulty municipal sewer system located upstream. Nutrient loading became evident in the mid 1960's with increase in aquatic weeds and algae, and trout die-offs. An experimental aeration system was setup in Stockade Lake in the late 1960's to determine if airflow could "breakup" the lake stratification conditions (Van Ray 1968). A second aeration system was tried in 1981 which showed the lake could be fully "mixed" in this manner (Anonymous 1981a). Conditions in the watershed improved after the city of Custer began pumping sewage effluent to a different drainage in 1986 and silt removal from 1987 to 1990 in the French Creek inlet which was accomplished by dredging and construction equipment (i.e. loaders and dump trucks). However, the much of the enriched sediment still was present in the lake even after the dredging effort. Finally, in fall of 1998 another attempt at an aeration system was installed to break up the thermocline. The three small air pumps (one ½-Hp and two 1-Hp Thomas pumps) of the original aeration system failed during the summer of 2000. A new generator (5-Hp Quincy) was installed during late summer of 2000 to replace the original pumps. The aeration system is operated through most of the ice-free months (mid-May to mid-October). An evaluation of the aeration system did show a successful thermocline break up (Simpson 2005). The same evaluation also indicated improved sizes, density and condition of sportfish populations after the aeration system was installed and operated.

Ownership of Lake and Adjacent Lakeshore Properties

Stockade Lake is within the boundaries of Custer State Park and all facilities are managed by the Parks Division of the South Dakota Department of Game, Fish and Parks. The shoreline is primarily managed as a recreational area and the lake is accessible around its entire periphery.

Fishery Management

Past management of Stockade Lake has been for trout with the last scheduled stocking of rainbow trout in 2002, a couple of fingerling and adult rainbow trout stockings after that and brown trout in 2004 and 2005 (Table 1). Brown trout were experimentally stocked to see if growth and return to angler could produce a quality fishery. While growth rates were high, densities remained low with few found during sampling (Miller et al. 2007) and no reports from angler catch. Current management efforts are focused on warm water species such as largemouth bass, smallmouth bass and yellow perch. The 15-inch minimum-length-limit on largemouth bass was expanded in January 2004 to include smallmouth bass also.

Since construction of the lake, stockings (Table 1) have been the primary fisheries management tool in the reservoir. Trout were stocked nearly annually from 1951 until 2006. Largemouth bass were stocked in 2003 and smallmouth bass were last stocked in 2013.

Table 1. Stocking records for Stockade Reservoir, South Dakota, 2002-2013.

Year	Species	Size	Number of fish
2002	Rainbow trout	adult	20
	Rainbow trout	catchable	1,194
	Rainbow trout	fingerling	30,000
2003	Largemouth bass	catchable	409
	Rainbow trout	adult	50
2004	Brown trout	catchable	3,250
2005	Brown trout	catchable	3,250
2009	Rainbow trout	fingerling	1,500
2013	Smallmouth bass	fingerling	10,647

Recent Fish Community Surveys

A trap net survey consisting of eight net nights was completed on May 28-30, 2013. Trap nets were modified fyke nets consisting of a 1.3 X 1.5 m frame, 19.1 mm (0.75 in) mesh and a 1.2 X 23 m (3.9 X 75.5 ft) lead. Trap nets have been set in similar locations during previous surveys. Beginning in 2011, trap net surveys have been conducted in May instead of July, as in previous years to improve panfish sampling. Prior to setting two gill nets on Sept 8, 2013, water column parameter data was collected using a YSI meter. Gill nets were then set at approximately 15-20 ft deep, as this was determined to be the depth below which oxygen dropped below a habitable level. Gill nets were monofilament experimental type and measured 45.7 m (150 ft) long and

1.8 m (6 ft) deep with six 7.6 m (25 ft) panels of bar mesh sizes: 12.7 mm (0.5 in), 19.1 mm (0.75 in), 25.4 mm (1.0 in), 31.8 mm (1.25 in), 38.1 mm (1.5 in), and 50.8 mm (2.0 in). All nets remained in the water overnight for a total of six trap net and two gill net nights. Otoliths were collected from the first five yellow perch of each centimeter group collected from gill nets.

Night electrofishing was conducted at Stockade Lake on June 11, 2013 to sample largemouth and smallmouth bass. Six ten-minute sites are usually completed for this survey; however, only three sites were completed due to a thunderstorm.

Seven different species of fish were caught during the survey (Tables 2 and 3). Yellow perch was the most abundant species in gill nets and trap nets, comprising 92% of the gill net catch and 88% of the trap-net catch. Night boat electrofishing results for largemouth and smallmouth bass are in Table 4.

Table 2. Total catch for two gill nets in Stockade Lake, South Dakota on September 8-9, 2013. Parameters are reported with confidence intervals in parentheses.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Black bullhead	2	1.0 (3.1)	1.0 (3.1)	50 (50)	50 (50)	114.3 (11.4)
Black crappie	22	11.0 (30.8)	8.5 (26.2)	23 (15)	6 (16)	108.4 (0.5)
Bluegill	13	6.5 (1.5)	6.5 (1.5)	100	62 (25)	112.3 (1.5)
Northern pike	2	1.0 (3.1)	1.0 (3.1)	100	100	88.1 (0)
Yellow perch	437	218.5 (399)	219 (399)	76 (4)	30 (3)	94.2 (0.7)

Table 3. Total catch of eight overnight trap net sets in Stockade Lake, South Dakota on May 28-30, 2013. Parameters are reported with confidence intervals in parentheses.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Black bullhead	2	0.25 (0.23)	0.25 (0.23)	100	100	101.6 (55.5)
Black crappie	5	0.63 (0.35)	0.38 (0.25)	40 (52)	67 (33)	103.7 (21.9)
Bluegill	37	4.6 (3.2)	4.6 (0.35)	86 (10)	19 (11)	120.7 (6.5)
Northern pike	7	0.88 (0.56)	0.88 (0.56)	71 (29)	57 (39)	98.1 (4.3)
Yellow perch	384	48.0 (28.6)	48.0 (28.6)	99 (1)	26 (4)	96.4 (1.1)

Table 4 Total catch of three sites of night electrofishing in Stockade Lake, South Dakota on June 11, 2013. Parameters are reported with confidence intervals in parentheses.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Largemouth bass	23	46.0 (47.3)	36.0 (45.7)	72 (19)	22 (18)	111.1 (4.2)
Smallmouth bass	2	4.0 (3.8)	4.0 (3.8)	100	50 (50)	64.4 (142.90)

Yellow Perch

Gill net catch rates for stock-length yellow perch in 2013 increased for the third year in a row (Table 5). The size structure of yellow perch has increased slightly over the last few years with more quality-length fish (PSD=76) (200 mm or 8 in) and a large increase in preferred length fish (250 mm or 10 in) (PSD-P=30) in 2013 (Figure 1). Condition (*Wr*) is good with values still in the

90s. The management objective for Stockade Lake yellow perch is to maintain a gill-net CPUE value for stock-length fish greater than 10, maintain PSD between 30 and 50 and PSD-P greater than 5. Stockade Lake has met and exceeded these goals for the past three years.

Aging results indicate that this population reaches quality length (200 mm or 8 in) by age-3 (Table 6). Growth rates for Stockade Lake yellow perch are similar to the South Dakota scale-aged mean and slightly faster than the Region 1 (Western SD) scale-aged mean (Willis, et al. 2001). However, ages collected by scales vs. otoliths should be cautiously compared. Otoliths will be taken from yellow perch in Stockade Lake for the next few years before conclusions can be made about growth in this fishery.

Yellow grubs were documented in all yellow perch collected during the 2013 survey. The grub occurs naturally in the area and appears to have a successful life cycle through birds, fish, and snails at Stockade Lake. They are not harmful to humans, either by eating infected fish or by contact with the water. Movement of water and fish from Stockade should be highly restricted to prevent transporting the grub to other lakes. Yellow grubs are also found in higher densities in fish at Bismarck and Lakota Lakes. Both lakes have illegally introduced yellow perch populations and are most likely a result of anglers transporting these fish and grubs from nearby Stockade Lake. Many anglers complain about the grubs and it is likely that this causes lower harvest rates than expected.

Table 5. Results for yellow perch captured during gill net surveys in Stockade Lake, 2004-2013. Parameters are reported with confidence intervals in parenthesis.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2004	113	37.7 (12.0)	37.7 (12.0)	63 (8)	2 (2)	94.8 (1.4)
2005	113	56.5 (47.7)	56.5 (47.7)	79 (7)	16 (6)	93.7 (0.5)
2006	100	50.0 (18.5)	34.5 (4.6)	48 (10)	23 (9)	90.7 (0.9)
2007	56	56.0 (--)	56.0 (--)	2 (3)	0	86.9 (0.6)
2008	86	43.0 (9.2)	32.5 (4.6)	5 (4)	0	86.3 (0.4)
2009	176	88.0 (49.2)	87.5 (50.8)	13 (5)	0	89.2 (1.1)
2010	44	22.0 (67.7)	22.0 (67.7)	48 (13)	0	97.5 (1.0)
2011	278	139.0 (95)	138.5 (93.9)	65 (4)	2 (1)	98.5 (0.8)
2012	351	175.5 (7.6)	160.0 (6.2)	74 (4)	9 (3)	99.5 (0.7)
2013	437	218.5 (399)	219.0 (399)	76 (4)	30 (3)	94.2 (0.7)

Table 6. Stockade Lake yellow perch length range and weighted mean length (mm) at capture by otolith aged gill net sample during the 2013 lake survey, and Region 1 and South Dakota mean lengths by age (from scales) (Willis et al. 2001).

Age	Minimum	Weighted Mean	Maximum	# surveyed	Region 1 Scale-Aged Mean	S. Dak. Scale-Aged Mean
2	174	192	219	22	117	145
3	215	230	239	3	158	190
4	207	229	243	4	186	220
5	224	241	256	7	208	242
6	216	249	287	17	n/a	n/a
7	218	242	252	2	n/a	n/a
8	231	254	282	8	n/a	n/a
9	265	265	265	1	n/a	n/a

Largemouth Bass

A 15-inch (381 mm) minimum length limit for largemouth bass was implemented in 1995 in an attempt to improve largemouth bass and panfish population sizes. The largemouth bass population is sampled annually each spring to monitor the population and determine if the regulation is performing as intended. Nighttime electrofishing was accomplished on June 11, 2013.

Due to a reduced sampling effort, 2013 catch rates are not compared to values for previous years (Table 7). Size structure in the 2013 electrofishing sample was high and above management objectives, with a PSD of 72 (quality length of 12 inches) and a PSD-P of 22 (preferred length of 15 inches). Fish condition remained high in 2013 with a mean *Wr* for stock-length-and-larger fish at an all-time high of 115.

Survey data supports that the 15 inch minimum length limit is helping produce a quality largemouth bass fishery. The previous management goal for largemouth bass in Stockade Lake was to maintain a minimum night-time electrofishing CPUE for stock-length fish of 20, a PSD range between 20 and 40, and a PSD-P between 0 and 10. It appears that abundance and size distribution have been exceeding these goals for several years.

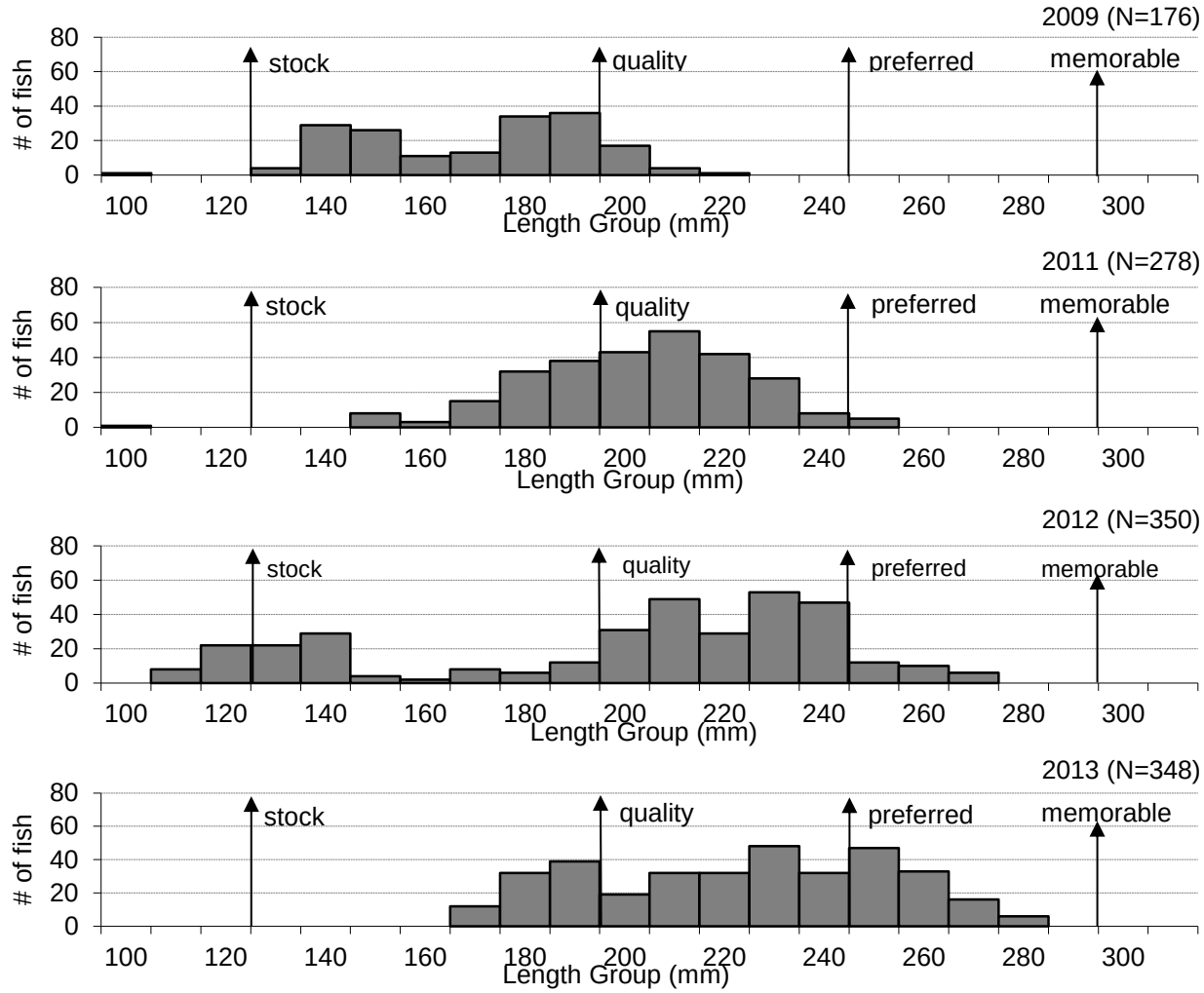

Figure 1. Length frequencies for yellow perch from gill nets at Stockade Lake, South Dakota in 2009-2013 (2010 is excluded due to low sample size).

Table 7. Results for largemouth bass collected during night-time electrofishing surveys of Stockade Lake, 2007-2013. Parameters are reported with confidence intervals in parentheses.

Year	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2007	214	214.0 (36.1)	210.0 (35.6)	52 (6)	12 (4)	113.0 (0.7)
2009	147	148.2 (49.2)	148.2 (49.2)	76 (6)	19 (6)	109.3 (0.5)
2010	72	72.7 (10.2)	67.7 (7.9)	73 (9)	24 (9)	97.4 (3.3)
2011	98	100.6 (37.6)	97.6 (38.9)	76 (8)	22 (7)	107.5 (0.3)
2012	213	213.0 (65.6)	171.0 (49.8)	76 (5)	12 (4)	114.7 (0.7)
2013	23	46.0 (47.3)	36.0 (45.7)	72 (19)	22 (18)	111.1 (4.2)

Smallmouth Bass

Smallmouth bass were stocked into Stockade Lake in 1990, 1992, and 1993. They were added to the 15" minimum length limit in 2004. Smallmouth bass catch rates (CPUE) have been low except for the 2007 and 2012 surveys. The 2013 survey only sampled two individuals, but only three passes were completed. The 2012 survey CPUE of 28 bass/hour was higher than values for 2010, 2011, and 2013 (Table 8). Size structure was very good with PSD (quality length of 11 inches) and PSD-P (preferred length of 14 inches) values of 70 and 30, respectively. Fish condition remained high with an average *Wr* value for stock length and longer fish of 97.

Table 8. Results for smallmouth bass captured in Stockade Lake during night electrofishing surveys, 2007-2012. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2007	58	58.0 (22.4)	58.0 (22.4)	98 (3)	52 (11)	105.7 (1.0)
2009	13	13.2 (8.8)	12.2 (9.0)	92 (15)	42 (27)	96.4 (2.9)
2010	6	6.1 (3.2)	6.1 (3.2)	33 (43)	0	99.6 (8.6)
2011	6	6.0 (5.6)	6.0 (5.6)	83 (33)	67 (45)	104.4 (41.5)
2012	28	28.0 (18.0)	20.0 (11.6)	70 (18)	30 (18)	97.6 (4.5)
2013	2	4.0 (3.8)	4.0 (3.8)	100	50 (50)	64.4 (142.90)

Black Crappie

Black crappie is a highly targeted species in Stockade Lake. During an angler use survey in 2011 (Simpson 2011), they were the most frequently caught species from May through July. Trap nets are used annually to monitor this popular game fish and the management goal is to maintain a CPUE-S greater than 10 fish/net-night, a PSD (quality length of 8 inches) greater than 20 and a PSD-P (preferred length of 10 inches) greater than 5.

Trap net CPUE has been low in recent surveys and was less than 1 fish/net-night in 2013 (Table 9). Only five black crappies were collected in trap nets and 22 in gill nets during the 2013 survey (Tables 2 and 3). With so few individuals caught, size structure and condition analyses are difficult.

The previous management goal for CPUE has not been reached with trap net surveys within the last few years. Prior to 2011, trap nets were set in September and this is an important factor to consider when comparing samples from previous years. Possible reasons for the recent low catch rates in trap nets are timing of the survey, placement of nets, or the fact that most of the crappies harvested during 2011 were from a single year of high production and those fish have not been replaced in the population.

Table 9. Results for black crappie collected in trap nets during surveys of Stockade Lake, 2007-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
9/2007	93	11.6 (8.7)	11.6 (8.7)	1 (2)	1 (2)	97.5 (0.6)
9/2008	29	3.6 (1.6)	2.3 (0.9)	11 (13)	0	99.4 (--)
9/2009	77	9.6 (3.5)	8.8 (3.4)	39 (10)	0	101.3 (0.3)
9/2010	65	8.1 (2.6)	8.1 (2.6)	46 (10)	0	100.2 (1.6)
6/2011	7	0.8 (0.7)	0.8 (0.7)	100	0	90.8 (0.6)
5/2012	13	1.6 (1.1)	1.5 (1.1)	75 (23)	0	102.8 (2.3)
5/2013	5	0.63 (0.35)	0.38 (0.25)	40 (52)	67 (33)	103.7 (21.9)

Northern Pike

Northern pike are an angler targeted species in Stockade Lake. Catch rates of northern pike have been low in surveys the last few years (Tables 10 and 11). A majority of the fish captured were over preferred length (28 inches) in 2013. Population analysis is difficult with low catch rates, but condition (*Wr*) for northern pike has been excellent for several years with values near 100. With the high number of prey fish available, northern pike should continue to experience good growth and condition.

Table 10. Results for northern pike captured in gill net surveys in Stockade Lake, 2008-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2008	14	7.0 (9.2)	7.0 (9.2)	100	7 (13)	98.0 (3.1)
2009	14	7.0 (6.2)	7.0 (6.2)	93 (13)	0	96.1 (2.4)
2010	1	0.5 (1.5)	0.5 (1.5)	100	100	104.3
2011	5	2.5 (1.5)	2.5 (1.5)	100	100	95.7 (5.7)
2012	1	0.5 (1.5)	0.5 (1.5)	100	0	98.0
2013	2	1.0 (3.1)	1.0 (3.1)	100	100	88.1 (0)

Table 11. Results for northern pike captured in trap nets in Stockade Lake, 2008-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2008	4	0.5 (0.4)	0.5 (0.4)	0	0	n/a
2009	8	1.0 (0.5)	1.0 (0.5)	88 (24)	13 (23)	91.0 (5.1)
2010	5	0.6 (0.4)	0.6 (0.4)	60 (52)	40 (52)	102.6
2011	8	0.9 (0.3)	1.0 (0.3)	100	43 (39)	95.1 (4.9)
2012	2	0.2 (0.2)	0.2 (0.2)	50 (50)	50 (50)	96.5
2013	7	0.88 (0.6)	0.88 (0.6)	71 (29)	57 (39)	98.1 (4.3)

Bluegill

Thirty adult bluegill were stocked upstream in Custer Municipal Pond (a.k.a. West Dam) in 2007 and the species appears to have quickly made their way to Stockade Lake. Adult bluegill abundance increased through 2010 comprising 66% of the total frame net catch that year. Abundance (CPUE) was low in the 2013 survey at 4.6 fish/net-night (Table 12). Length frequencies from 2008-2010 show the dominance of fish produced in year class and growth of those fish over that first three year period (Figure 2). Few fish were surveyed in 2013, though the majority of the fish were quality length (>150 mm or 6 in). The PSD-P (preferred length of 8 inches) was 19 (Table 12) for fish captured in the 2013 gill net survey. Bluegill condition remains high, with an average *Wr* for stock-length-and-larger fish of 121.

Bluegill were the second most caught fish during the 2011 creel with an estimate of over 7,000 caught (Simpson 2011). Bluegill, despite being the third most harvested species, was not noted as being a species anglers were targeting.

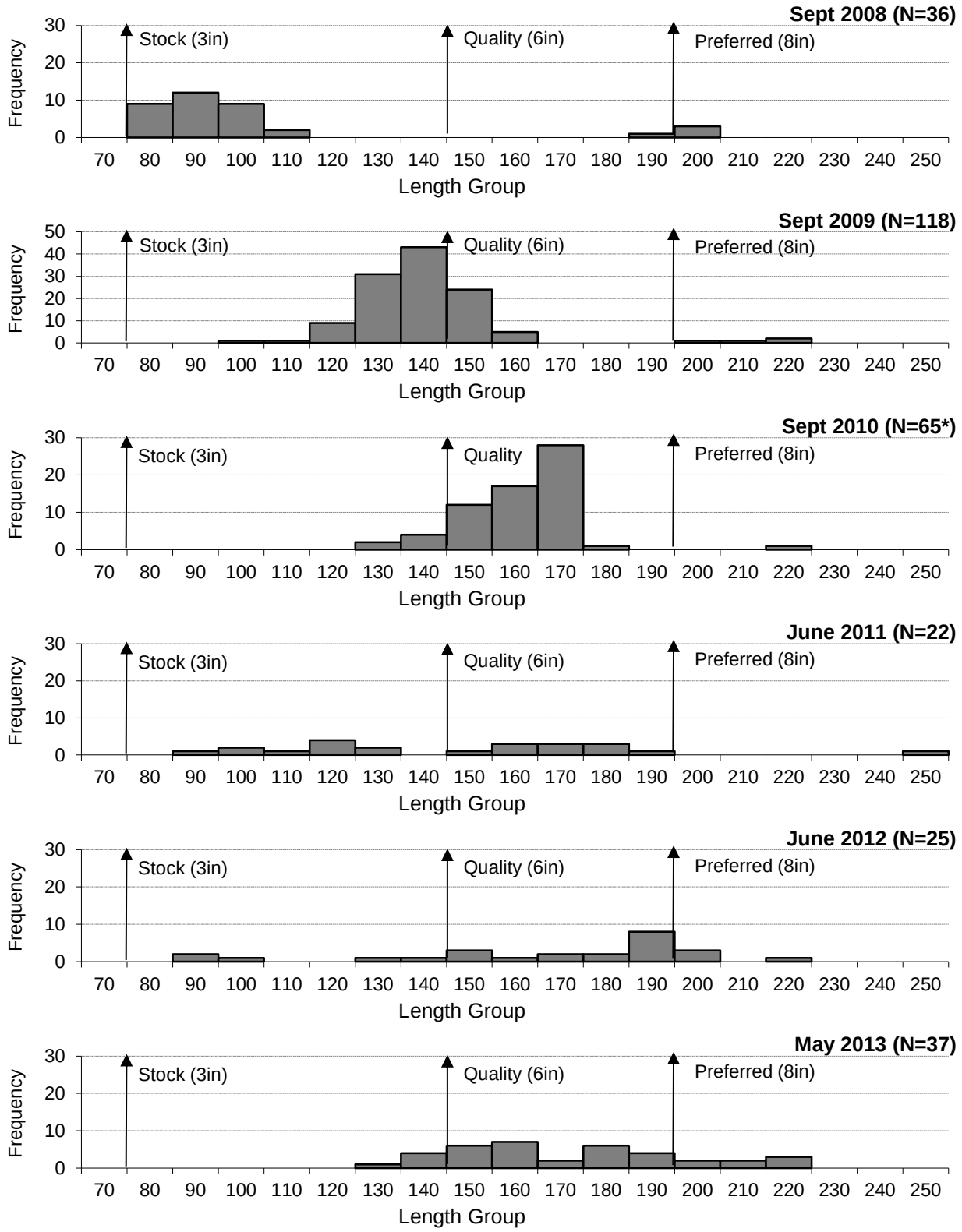

Figure 2. Length frequency histograms for bluegill collected during trap net surveys of Stockade Lake in 2007-2012. *only measured fish are included in 2010.

Table 12. Results for bluegill collected in trap nets during surveys of Stockade Lake, 2007-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2007	26	3.3 (3.1)	3.3 (3.1)	81 (14)	0	96.2 (2.7)
2008	36	4.5 (1.6)	4.5 (1.6)	11 (9)	8 (8)	117.9 (4.5)
2009	126	15.8 (12.2)	15.8 (12.2)	28 (7)	3 (3)	112.4 (1.1)
2010	467	58.4 (37.8)	58.4 (37.8)	93 (3)	2 (1)	114.8 (2.8)
2011	22	2.7 (1.8)	2.7 (1.8)	55 (19)	5 (7)	107.7 (3.5)
2012	25	3.1 (2.1)	3.1 (2.1)	80 (14)	16 (13)	128.6 (4.2)
2013	37	4.6 (3.2)	4.6 (0.35)	86 (10)	19 (11)	120.7 (6.5)

Issues

1. Fish species are heavily infested with the parasite known as the yellow grub.

2. The lake is eutrophic and stratification within the water column occurs heavily in the summer, leaving little oxygen in the lower layer (hypoliminion).

3. High angling pressure and multiple fish species complicate management of fish populations.

4. There is a desire by many anglers to diversify fish management in Black Hills reservoirs to include cool and warm water species.

Objectives and Strategies

Objective 1: Annually work to maintain balanced-to-quality panfish (bluegill, black crappie and yellow perch) populations.

Strategy 1.1. Annually survey panfish populations and periodically survey anglers to determine if catch rates and sizes of fish being caught are meeting angler expectations.

Strategy 1.2. Incorporate age and growth analysis into fish population surveys for bluegill and black crappie to help determine patterns in recruitment and potential factors affecting recruitment.

Strategy 1.3. If indices of panfish populations drop and remain below accepted values, (i.e. bluegill PSD ≥ 20; black crappie PSD ≥30; yellow perch PSD ≥30) determine what caused the decline through angler surveys, fish surveys and literature reviews and identify feasible mitigation (e.g. stocking, predator management) to restore the population to accepted values.

Strategy 1.4. Quantify diets of sportfish populations to evaluate possible competition and predation.

Objective 2. Increase smallmouth bass abundance by December 2017.

Strategy 2.1. Stock up to 500 adult smallmouth bass in 2015 and in 2016 and as needed afterwards to maintain electrofishing catch rates near 20 stock length and longer fish per hour.

Strategy 2.2. Evaluate smallmouth bass stockings through spring night electrofishing and angler surveys.

Objective 3. To annually maintain a largemouth bass fishery with a minimum night-time electrofishing CPUE for stock-length fish of 20, a PSD greater than 40, and PSD-P greater than 10.

Strategy 3.1. Evaluate the largemouth bass population and 15-inch minimum-length-limit regulation by conducting nighttime electrofishing surveys and an angler survey.

Strategy 3.2. Stock adult largemouth bass to supplement the existing population when nighttime electrofishing CPUE of stock-length l bass is below 20.

Objective 4. Determine feasibility of managing a northern pike fishery by the next update of this management plan in January 2019.

Strategy 4.1. Through literature review, identify possible regulations and other management options with potential to produce northern pike in association with other reservoir fisheries.

Strategy 4.2. Survey lake anglers to determine acceptance of possible northern pike management options at Stockade Lake.

Objective 5. Continue to explore possible mitigation methods for yellow grubs.

Strategy 5.1. Conduct a literature review on possible methods for yellow grub reductions and complete a written proposal for any feasible methods to reduce yellow grub infestations.

Strategy 5.3. Upon any needed approvals, begin using methods identified in a written proposal as soon as possible.

Objective 6. Annually improve fish habitat by mixing the water column and breaking up the thermocline through use of the aeration system in the summer months.

Strategy 6.1. Begin operation of the aeration system in May and continue through September every year. Work with Custer State Park to restart system when electricity faults occur.

Strategy 6.2. Perform annual maintenance as needed.

Strategy 6.3. Develop a sediment removal project and submit for funding.

Five Year Operational Plan

1. Survey Stockade Lake fish populations annually utilizing a minimum of four 24-hour frame net sets, two 150-foot experimental gill net sets and six 10-minute night electrofishing stations.

2. Analyze fishery survey data and publish the data in report form in Statewide Fisheries Surveys Annual Reports.

3. Stock up to 500 adult smallmouth bass in 2015 and 2016 and as needed after that to keep adult night electrofishing catch rates near 20/hour.

4. In 2015, begin evaluation of possible regulations or management options for northern pike and if any are identified, plan for an angler survey to determine fish catch and harvest, and angler satisfaction and attitudes towards northern pike management at the reservoir.

5. Conduct a thorough evaluation of the current management plan and complete a new plan by January 1, 2019.

6. Determine amount of sediment within Stockade Lake and, if needed, propose project for funding that would remove needed amounts of sediment to benefit the water condition or fishing access within Stockade Lake.

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