Recruitment of Walleye and White Bass in Irrigation Reservoirs

Annual Performance Report

Project No. F174R001 Segment 3

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TABLE OF CONTENTS

INTRODUCTION 1

METHODS 2

RECRUITMENT BOTTLENECKS 2

RESULTS 3

RECRUITMENT BOTTLENECKS 3

COMPLETED DELIVERABLES 5

DEVIATIONS FROM PROPOSAL 5

PROGRAM PLAN 5

LITERATURE CITATIONS 6

LIST OF FIGURES

Figure 1. Sampling scheme for larval fish, illustrated on Medicine Creek, NE, with 2009 sampling sites. Circles represent paired near-shore and offshore sites during 2009. Sites are randomly selected within reservoir strata and year, and then fixed for a single sampling season.

Figure 2. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Swanson Reservoir, Nebraska.

Figure 3. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Swanson Reservoir, Nebraska.

Figure 4. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Enders Reservoir, Nebraska.

Figure 5. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Enders Reservoir, Nebraska.

Figure 6. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Red Willow Reservoir, Nebraska.

Figure 7. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Red Willow Reservoir, Nebraska.

Figure 8. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Medicine Creek Reservoir, Nebraska.

Figure 9. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Medicine Creek Reservoir, Nebraska.

Figure 10. Mean ± SE catch per unit effort (CPUE; $N \cdot min^{-1}$ of electrofishing) for juvenile walleye during autumn 2007-2009 in the four southwest irrigation reservoirs, Nebraska.

Figure 11. Mean ± SE catch per unit effort (CPUE; $N \cdot min^{-1}$ of electrofishing) for juvenile white bass during autumn 2007-2009 in the four southwest irrigation reservoirs, Nebraska.

Figure 12. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Swanson Reservoir, Nebraska.

Figure 13. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Enders Reservoir, Nebraska.

Figure 14. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Red Willow Reservoir, Nebraska.

Figure 15. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Medicine Creek Reservoir, Nebraska.

Figure 16. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Harlan County Reservoir, Nebraska.

STUDY OBJECTIVE

The purpose of this project is to document the relative importance of spawning habitats and the period of recruitment bottlenecks for walleye and white bass in Enders, Swanson, Red Willow, and Medicine Creek Reservoirs.

INTRODUCTION

The Republican River Basin located in southwest Nebraska encompasses 24,702 km^2 containing 1,818 km of streams (Bliss and Schainost 1973). There are five reservoirs within the Republican River watershed in Nebraska including Enders (on Frenchman Creek), Swanson (on the Republican River), Hugh Butler/Red Willow (on Red Willow Creek), Harry D. Strunk/Medicine Creek (on Medicine Creek), and Harlan County (on the Republican River), all of which were built primarily for flood control and to supply water to irrigation districts in the watershed. Thus, these reservoirs experience large fluctuations in water levels within and between years. These reservoirs also provide important fisheries for anglers in southwest Nebraska; walleye and white bass are of particular importance in these reservoirs. However, continued annual stockings of walleye have been necessitated because of low natural reproduction and recruitment of young. In contrast, white bass populations are self-sustaining within these reservoirs, although recruitment is extremely variable (i.e., weak or missing year-classes are common) in all but Harlan County Reservoir. Thus, we believe that a “recruitment bottleneck” exists for walleye and perhaps white bass in these irrigation reservoirs.

Recruitment is often cited as the most prevailing and variable factor influencing fish population dynamics (Gulland 1982). Water temperature, wind and water-level characteristics have been the most commonly cited factors influencing variability in walleye recruitment (Colby et al. 1979; Carlander 1997). White bass recruitment is also highly variable (Colvin 2002; DiCenzo and Duval 2002), but the factors influencing that variability are not understood (Guy et al. 2002). Large water-level fluctuations that are characteristic of irrigation reservoirs may have a negative effect on fish spawning and recruitment. For example, water fluctuations in irrigation reservoirs generally prevent the establishment of aquatic vegetation to serve as spawning and nursery habitat. Low water levels may also limit the ability of white bass to swim into tributaries to spawn (Quist et al. 2002). A confounding factor in southwest Nebraska irrigation reservoirs that may affect the success of sportfish recruitment is the presence of gizzard shad, which also experience variability in recruitment and adult abundance (Bremigan and Stein 1993). Gizzard shad frequently outcompete larval sportfish for food (e.g., Garvey and Stein 1998).

There exist multiple factors that could influence recruitment of walleye and white bass in irrigation reservoirs. The Nebraska Game and Parks Commission invest an enormous amount of time, resources, and money trying to manage the variable recruitment of walleye and white bass in the southwest Nebraska irrigation reservoirs. There is a need and desire to understand the mechanisms driving recruitment of walleye and white bass in Enders, Swanson, Red Willow, and Medicine Creek Reservoirs, which would facilitate

the effective management of these fisheries. There is also a need to determine the use of these fisheries by anglers (e.g., number of angler trips targeting walleye and white bass) for future cost-benefit analyses.

METHODS

RECRUITMENT BOTTLENECKS

Larval fish sampling

During 2007, we attempted to sample larval walleye and white bass weekly from mid-April to late June using two 0.5-m diameter (bar mesh size = 750 µm) ichthyoplankton nets that were pushed simultaneously along each side of the boat (Harlan County Reservoir was also included) from late April to early June, but encountered logistic difficulties. Based on 2007 experiences, we sampled larval walleye and white bass weekly from mid-April to late June during 2008 and 2009 at Enders, Red Willow, and Medicine Creek Reservoirs. Nine sites (near-shore and open-water within three strata along the longitudinal reservoir gradient) on each reservoir were sampled (Figure 1). A flow meter mounted in the mouth of each net allowed estimation of the volume of water filtered, and hence, determination of larval density. In addition, we sampled larval fish using light traps at three to six of the near-shore sites from mid-April to early June. All collected fish were preserved in ethanol and returned to the laboratory for identification and enumeration.

At the end of each larval fish transect, zooplankton samples were collected using a 2-m tube sampler (75-mm diameter; DeVries and Stein 1991). Samples were filtered through an 80-µm mesh net and preserved in 4% sucrose-formalin (Haney and Hall 1973). In addition, turbidity and surface temperature were quantified and water samples were collected to estimate chlorophyll-a concentration (an index of phytoplankton abundance).

Juvenile fish sampling

During 2007, we sampled juvenile walleye and white bass bi-weekly using night-time electrofishing from early August to early October (n = 5 sampling events per reservoir). During 2008, we sampled juvenile walleye and white bass bi-weekly from early August to early October at all 4 study reservoirs and Harlan County Reservoir (n = 5 sampling events for Red Willow, Medicine Creek, and Harlan County; n = 4 sampling events for Enders and Swanson). During 2009, we sampled juvenile walleye and white bass bi-weekly from mid-August to mid-October at all 4 study reservoirs and Harlan County Reservoir (n = 5 sampling events for all reservoirs). Abundance estimates from electrofishing will be used to index the year-class strengths of walleye and white bass. Abundance estimates will also be compared with lagged gill-net catches of older fishes to determine the existence of any bottlenecks during these periods.

Difficulties distinguishing age-0 white bass from age-0 hybrid striped bass has diminished our ability for early detection of year-class strength for white bass (a necessary component of recruitment bottleneck identification). During autumn 2008, 50

age-0 and 50 age-1 *Morone* fish were collected from each reservoir (Harlan County Reservoir included) during juvenile fish sampling. These fish were identified in the field as either white bass or hybrid striped bass and will be used for developing a technique for distinguishing white bass from their hybrids based on morphometrics. A fin clip will be used for genetic analysis to verify field-based identification of all *Morone* fish.

During autumn 2009, 50 age-0 and 50 age-1 *Morone* fish were collected from each reservoir (Harlan County Reservoir included) during juvenile fish sampling. An additional 50 age-0 *Morone* fish were collected from Johnson Reservoir for classification by Nebraska Game and Parks fishery biologists, graduate students and professors as part of a study to determine agreement between field and genetic identification. This survey was also conducted to see what characteristics are being used by field biologists to distinguish white bass from their hybrids. *Morone* fish collected during 2009 were processed following the same procedure as 2008.

Adult fish sampling

Adult walleye and white bass populations were sampled in conjunction with Nebraska Game and Parks personnel using gillnets during autumn 2007, 2008, and 2009 (Harlan County Reservoir was also sampled). All stock-length fishes (Anderson 1980; Gabelhouse 1984) were measured (TL; mm) and tallied to the nearest cm-length group. A maximum of 10 walleye and 10 white bass per cm-length group were weighed (nearest g), sexed, and otoliths were removed for age determination. During 2008 and 2009, we also recorded liver and gonad weights (nearest 0.1 g).

RESULTS

RECRUITMENT BOTTLENECKS

Larval fish

During 2007, larval fish were sampled with ichthyoplankton nets between 27 April and 5 June. Weather issues (e.g., high winds and severe storms) prevented us from sampling reservoirs each week. Thus, during 2007, Enders was sampled four times, Swanson, Medicine Creek, and Harlan County were each sampled three times, and Red Willow was sampled five times, for a total of 18 nights of sampling. The total volume of water sampled was approximately 21,100 m^3.

During 2008, larval fish were sampled weekly at Enders, Red Willow, and Medicine Creek with icthyoplankton nets between 12 April and 25 June. In total, these three reservoirs were each sampled 11 times for a total of 33 nights of sampling. The total volume of water sampled was approximately 51,479 m^3. Larval fish were also sampled at three to six of the near-shore sites using light traps. Light trap sampling occurred concurrently with icthyoplankton sampling from 13 April to 13 June. Light traps were set for a total of 898 trap-hours during 26 nights of sampling. Laboratory work to identify larval fish is on-going.

During 2009, larval fish were sampled weekly, with icthyoplankton nets, at Enders, Red Willow, and Medicine Creek between 19 April and 30 June. In total, these three reservoirs were each sampled 11 times for a total of 33 nights of sampling. The total volume of water sampled was approximately 42,181 m^3. Larval fish were also sampled at five to six of the near-shore sites using light traps. Light trap sampling occurred concurrently with icthyoplankton sampling. Light traps were set for a total of 822 trap-hours during 33 nights of sampling. Laboratory work to identify larval fish is on-going.

Juvenile fish

During 2007, juvenile walleye and white bass were sampled five times using electrofishing at each study reservoir between 4 August and 8 October. Juvenile walleye were most abundant at Enders and least abundant at Medicine Creek. Juvenile white bass were most abundant at Enders and Medicine Creek, and least abundant at Swanson. In total, 180 random 100-m transects (18-km of shoreline) were electrofished.

During 2008, juvenile walleye and white bass were sampled four to five times using electrofishing at each study reservoir and Harlan County Reservoir between 12 August and 8 October. Juvenile walleye were most abundant at Enders and Swanson, and least abundant at Harlan County. Juvenile white bass were most abundant at Swanson and least abundant at Harlan County. In total, 206 random 100-m transects (20.6-km of shoreline) were electrofished.

During 2009, juvenile walleye and white bass were sampled five times using boat electrofishing at each study reservoir and Harlan County Reservoir between 18 August and 15 October (Figures 2-9). Juvenile walleye were most abundant at Enders and least abundant at Swanson (Figure 10). Juvenile white bass were most abundant at Swanson and least abundant at Medicine Creek (Figure 11). In total, 180 random 100-m transects (18-km of shoreline) were electrofished.

Distinguishing white bass from their hybrids

During autumn 2008, 50 age-0 *Morone* fish were collected from random sites throughout each reservoir. For age-1 *Morone* fish collection, each reservoir was divided into 5 sections of approximate equal shoreline length and 10 fish were collected from each section. In addition to the random sites for juvenile fish sampling, 49 hours of sampling effort has been put forth to obtain the total goal of fish.

During autumn 2009, 50 age-0 *Morone* fish were collected from random sites throughout each reservoir (Figures 12-16). For age-1 *Morone* fish collection, each reservoir was divided into 5 sections of approximate equal shoreline length and 10 fish were collected from each section. In addition to the random sites for juvenile fish sampling, 43.5 hours of sampling effort has been put forth to obtain the total goal of fish.

Adult fish

During winter 2008, we aged all of the otoliths collected during Nebraska Game and Parks 2007 annual gill-net surveys. The percent agreement between otolith and scale

ages for white bass was greater than 80% for fish up to and including age 3. For white bass older than age 3 the agreement between otolith and scale ages declined to 18.1%. The percent agreement between otolith and scale ages for walleye showed a negative linear relationship as the age of the fish increased (Figure 17).

COMPLETED DELIVERABLES

An MS thesis was completed December 2008, which detailed efforts and results to identify spawning habitats of walleye and white bass in irrigation reservoirs (the first portion of our study objective). Citation for this thesis is:

> Martin, D. R. 2008. Habitat selection by spawning walleye and white bass in irrigation reservoirs of the Republican River basin, Nebraska. MS thesis, University of Nebraska, Lincoln.

In addition, one peer-reviewed publication has been completed. Citation is:

> Martin, D.R., L.A. Powell, and K.L. Pope. In press. Spring home ranges of white bass in irrigation reservoirs of the Republican River Basin, Nebraska. Ecology of Freshwater Fish.

DEVIATIONS FROM PROPOSAL

Additional sampling, including spring electrofishing, egg mats, and larval light traps, not described in the funded proposal were included in the study to assist in answering questions related to the relative importance of spawning habitats. These efforts assisted us in determining if larval fish are actually produced in the sites where adult fish are found during the spawning period. This additional sampling was conducted only on Enders and Red Willow reservoirs during 2008 to obtain a more complete understanding of spawning habitat selection at these two reservoirs. This deviation will not be continued for the 2009 field season.

Larval fish during 2007 were not sampled weekly; this deviation was corrected in 2008 and will continue in future years. Thus, during 2008 and 2009 we sampled Enders, Red Willow, and Medicine Creek weekly for larval fish. Juvenile fish were sampled during autumn using a boat electrofisher instead of a seine; this deviation will also be continued in all future years of this study.

PROGRAM PLAN

Laboratory assessments and data analyses on samples will be completed as proposed. The 2010 field season will begin in mid-April on Enders, Red Willow and Medicine Creek reservoirs. Spring sampling gears will include larval light traps and ichthyoplankton nets.

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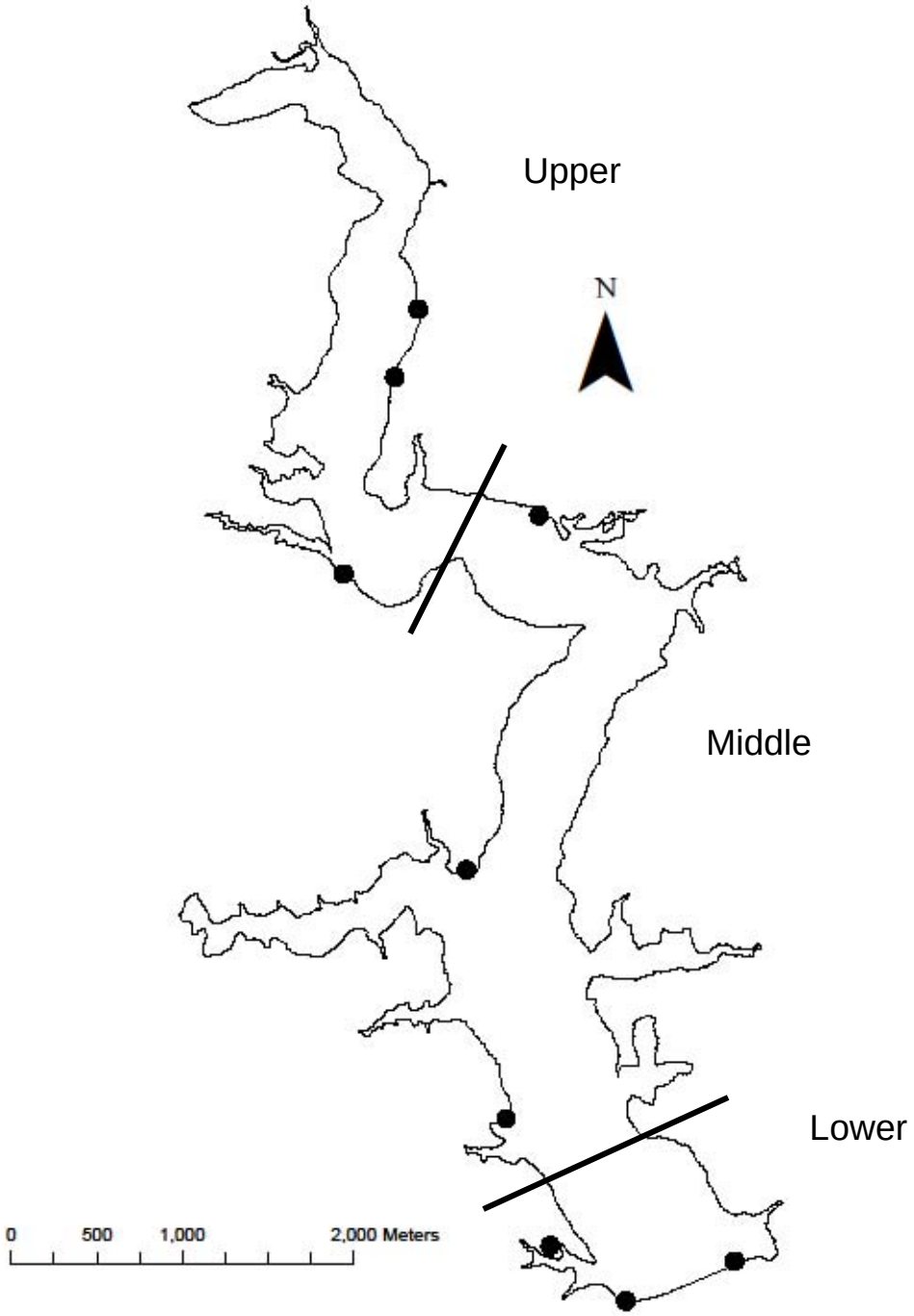

Figure 1. Sampling scheme for larval fish, illustrated on Medicine Creek, NE, with 2009 sampling sites. Circles represent paired near-shore and offshore sites during 2009. Sites are randomly selected within reservoir strata and year, and then fixed for a single sampling season.

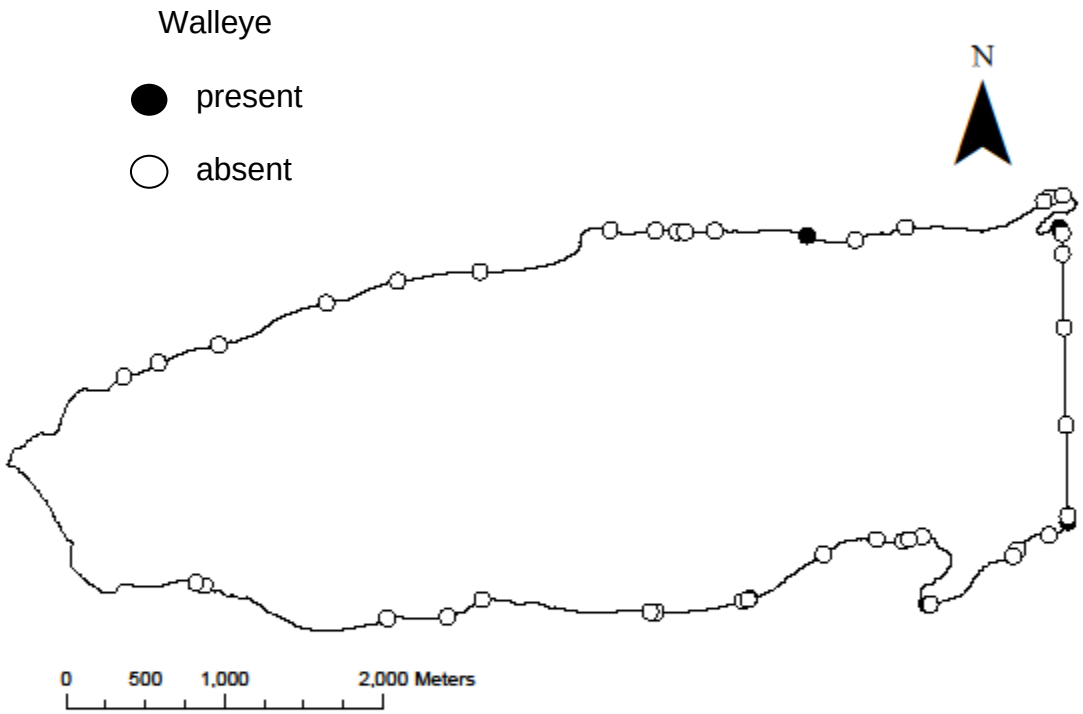

Figure 2. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Swanson Reservoir, Nebraska.

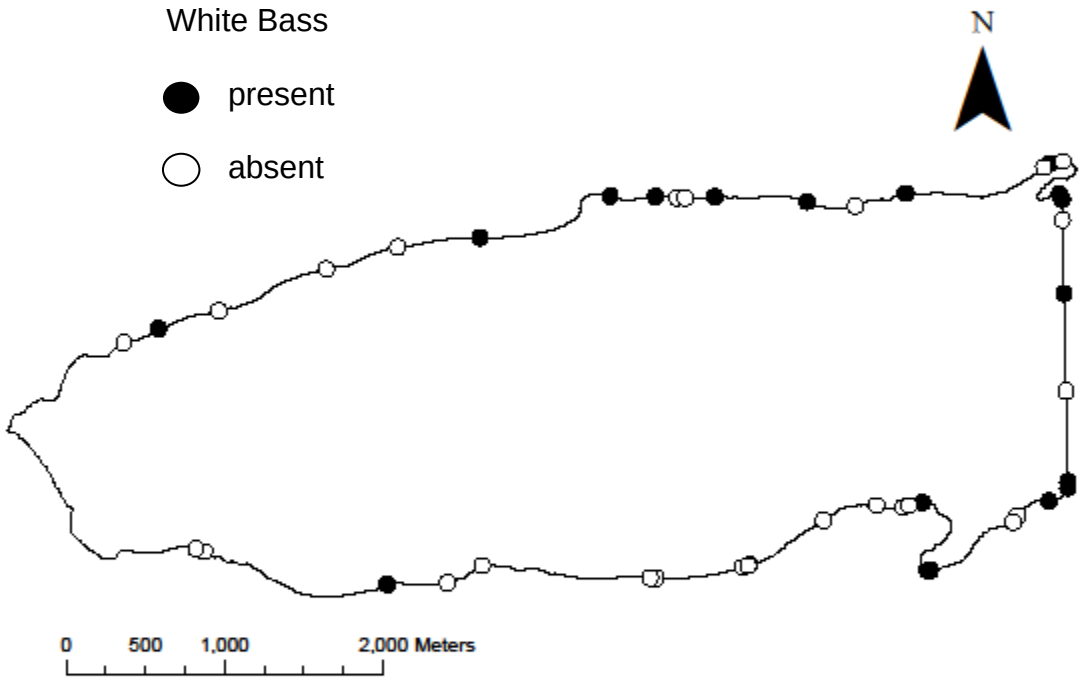

Figure 3. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Swanson Reservoir, Nebraska.

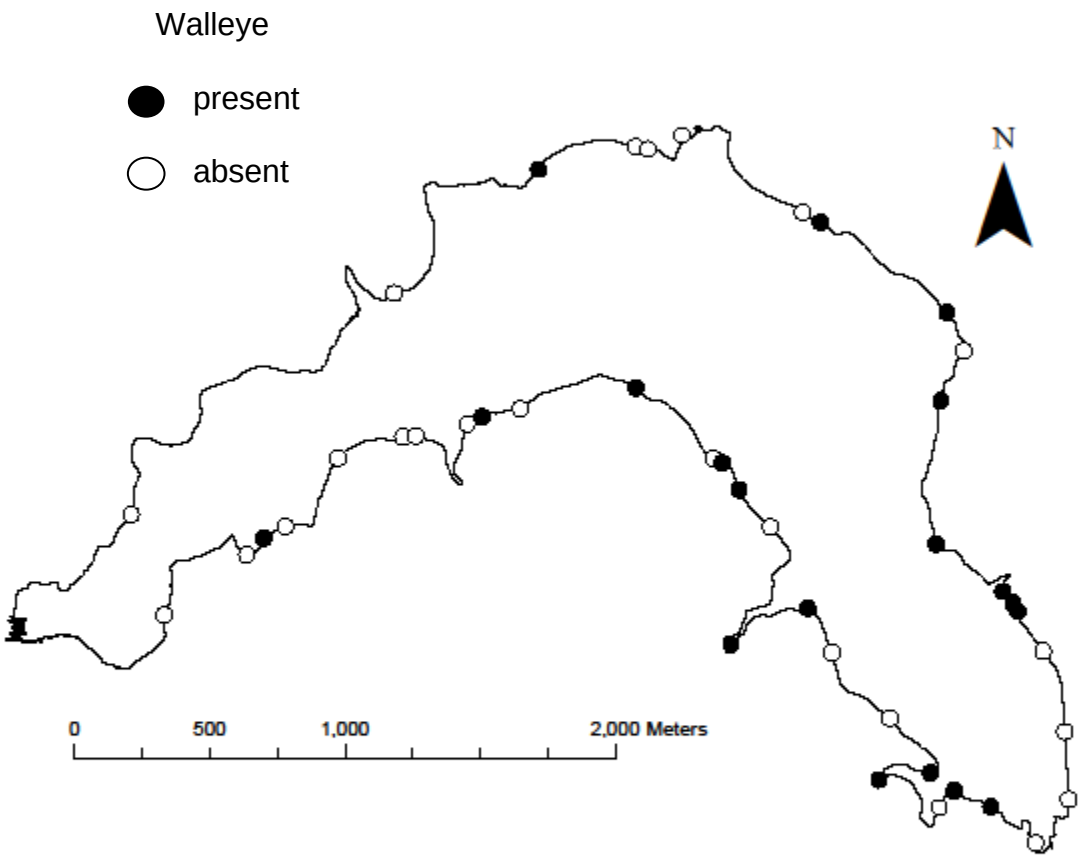

Figure 4. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Enders Reservoir, Nebraska.

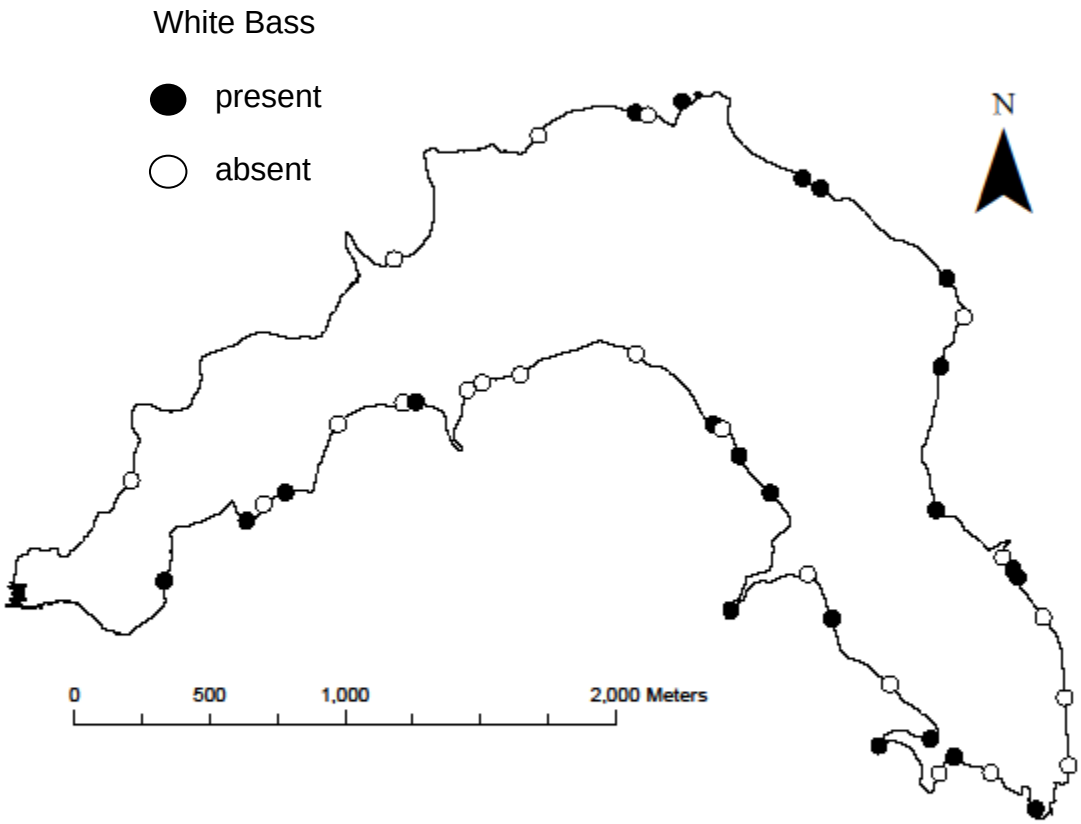

Figure 5. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Enders Reservoir, Nebraska.

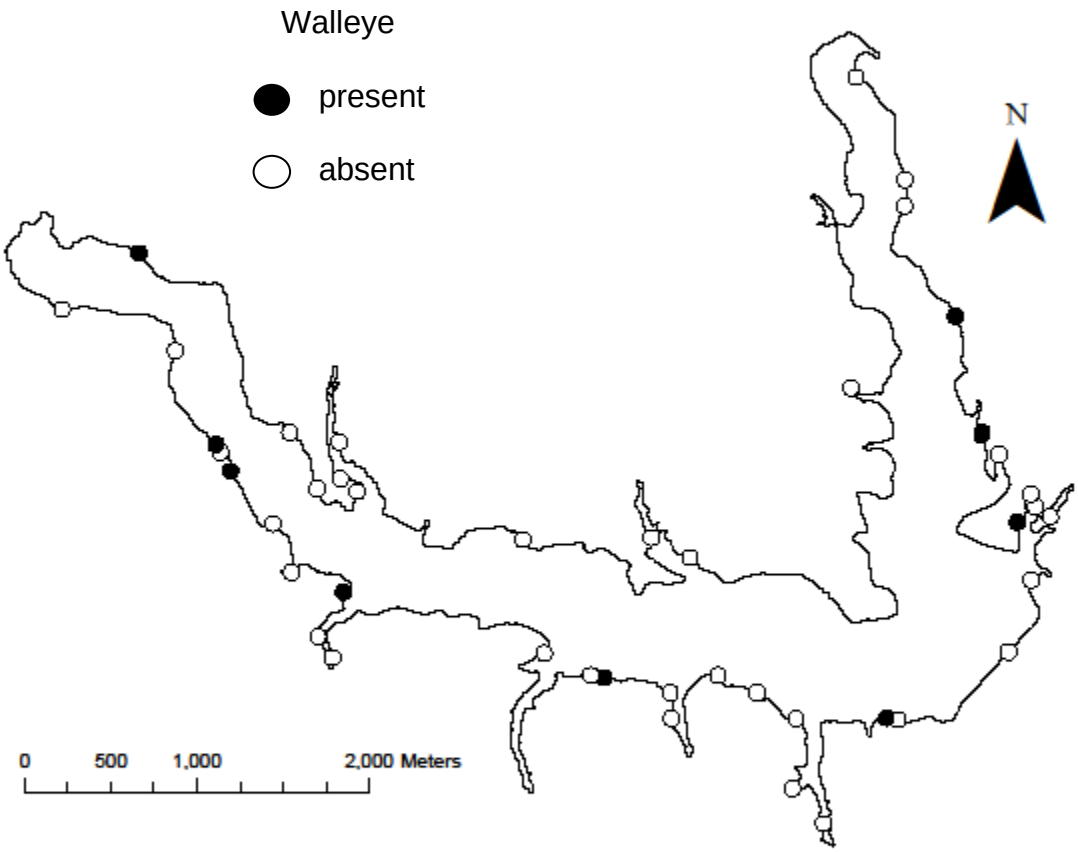

Figure 6. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Red Willow Reservoir, Nebraska.

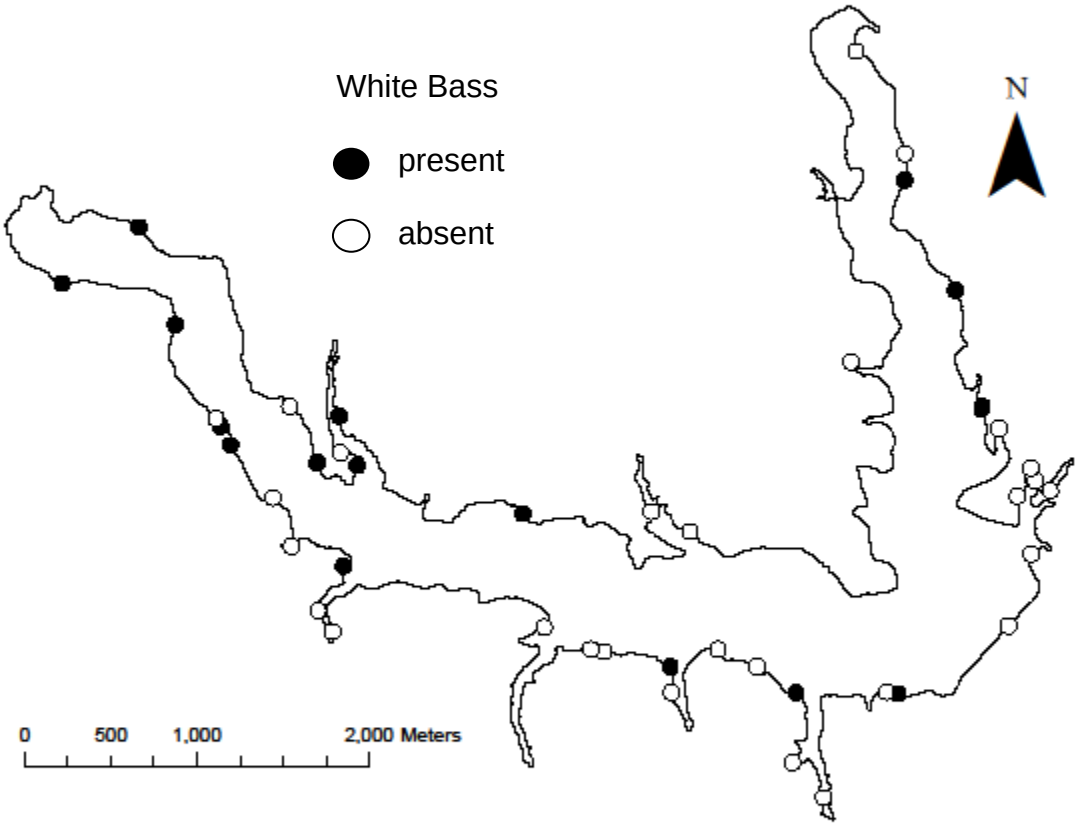

Figure 7. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Red Willow Reservoir, Nebraska.

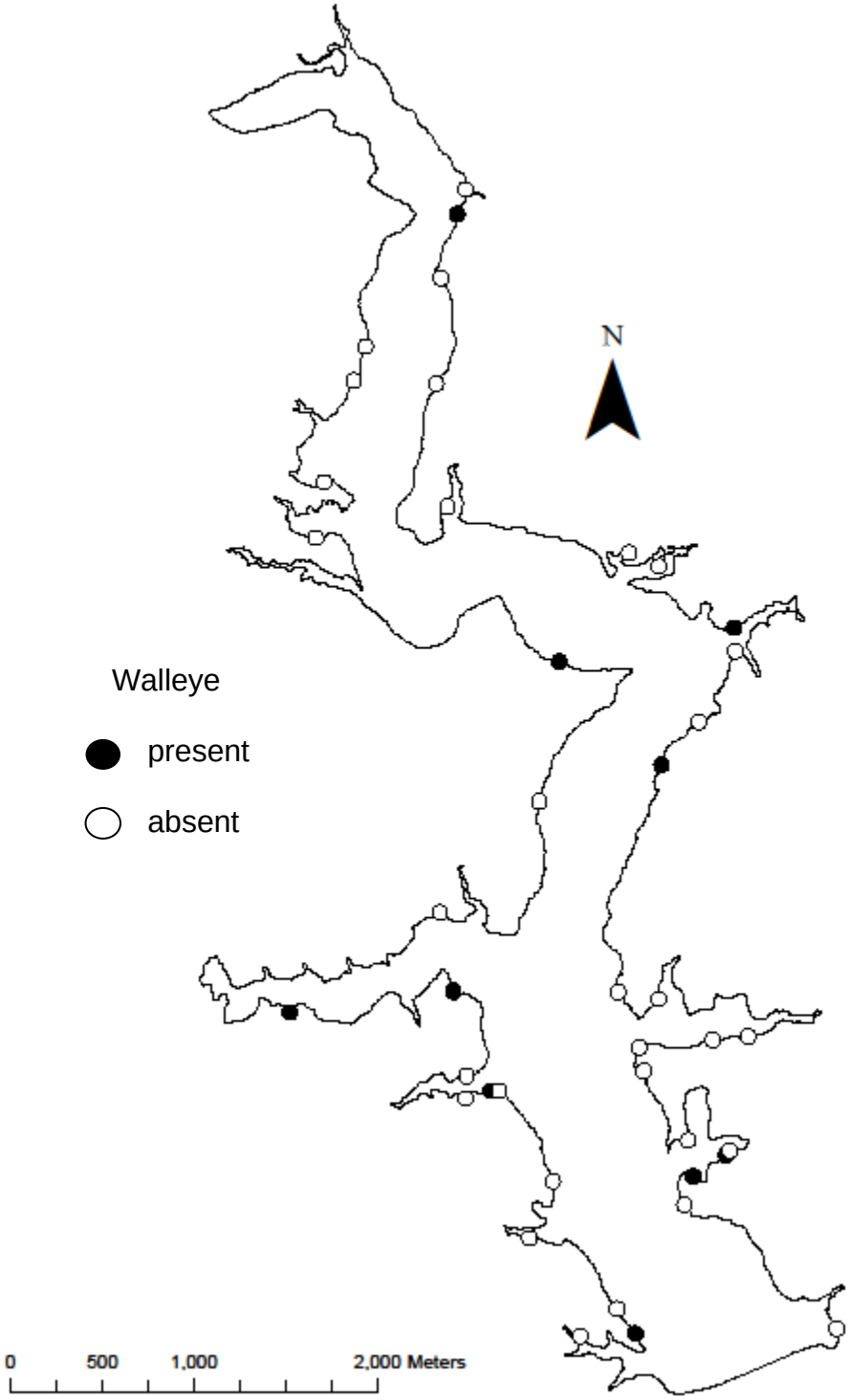

Figure 8. Spatial distribution of random sites sampled for juvenile walleye during autumn 2009 in Medicine Creek Reservoir, Nebraska.

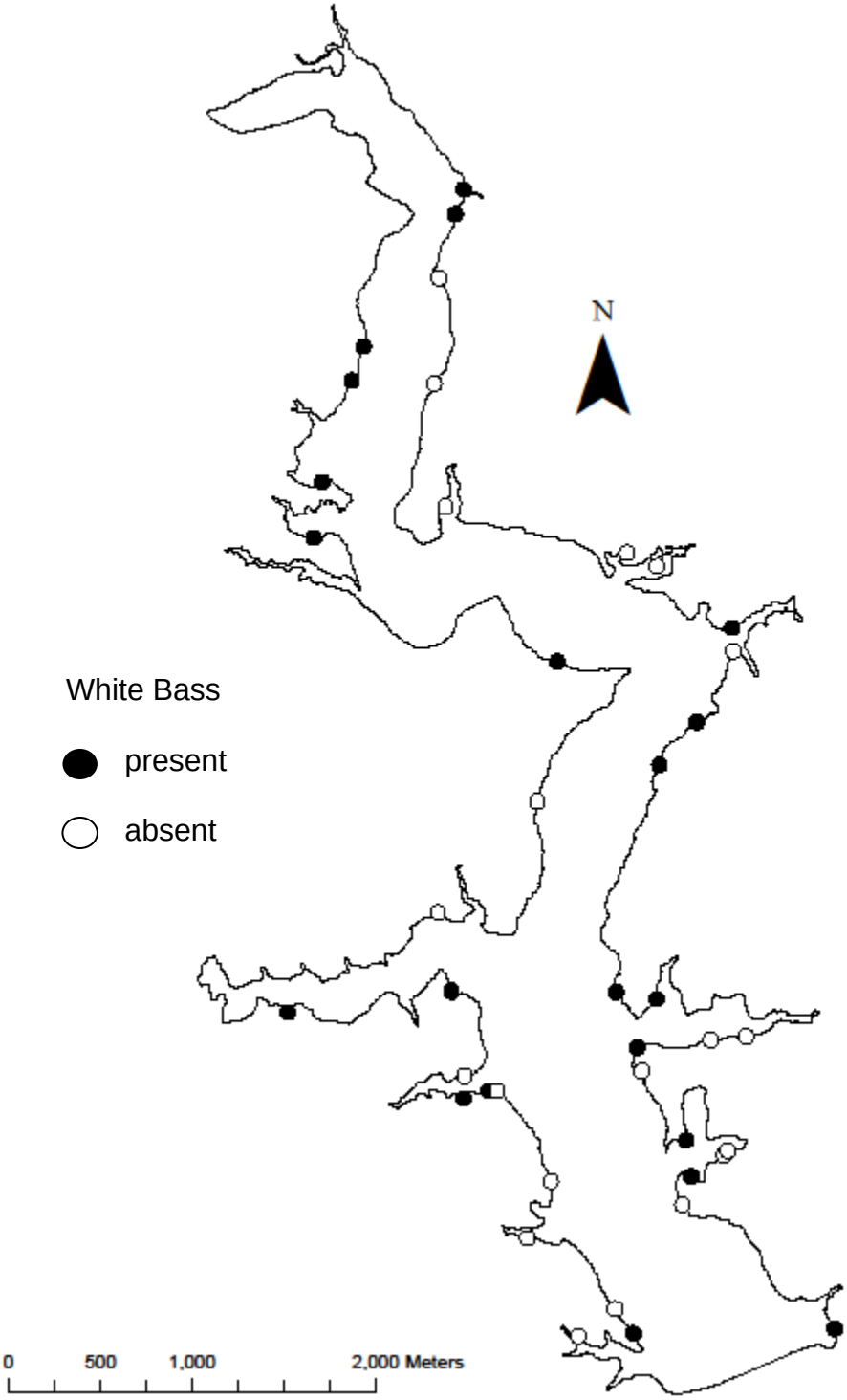

Figure 9. Spatial distribution of random sites sampled for juvenile white bass during autumn 2009 in Medicine Creek Reservoir, Nebraska.

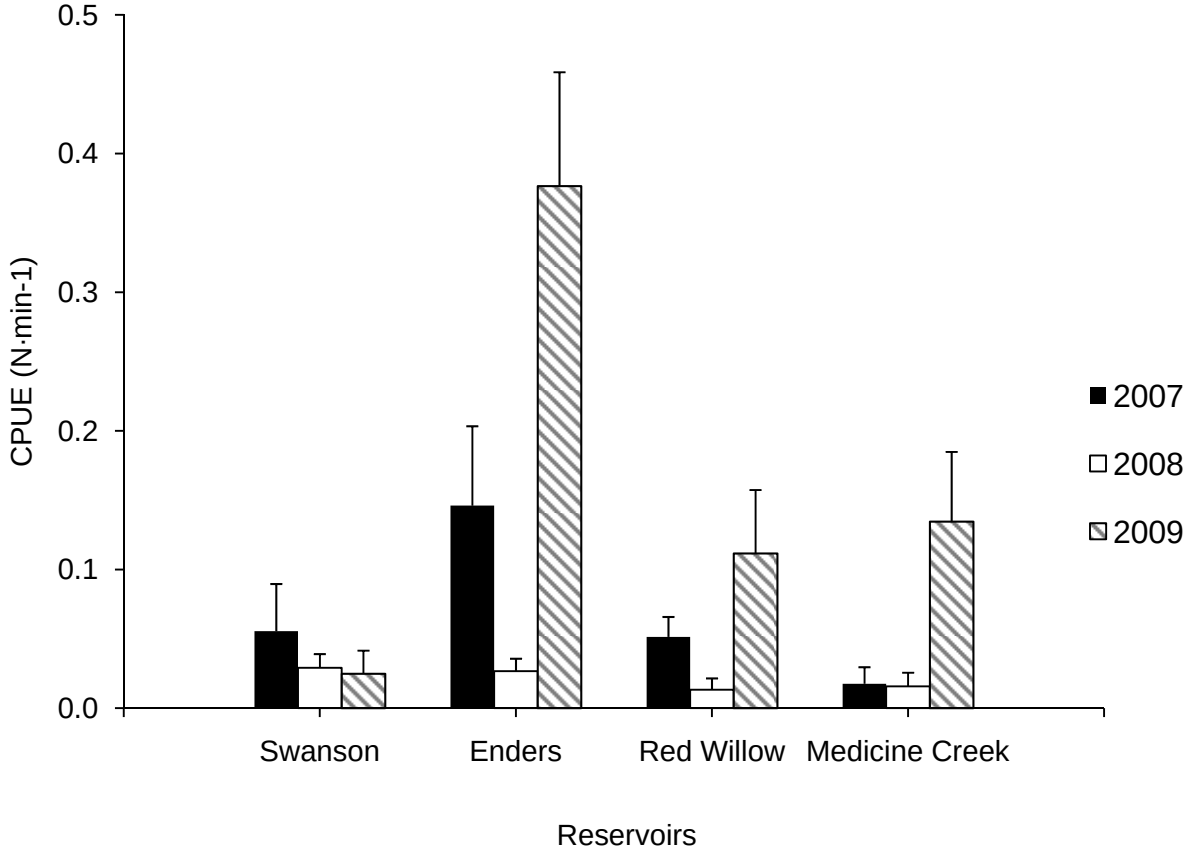

Figure 10. Mean ± SE catch per unit effort (CPUE; N·min^{-1} of electrofishing) for juvenile walleye during autumn 2007-2009 in the four southwest irrigation reservoirs, Nebraska.

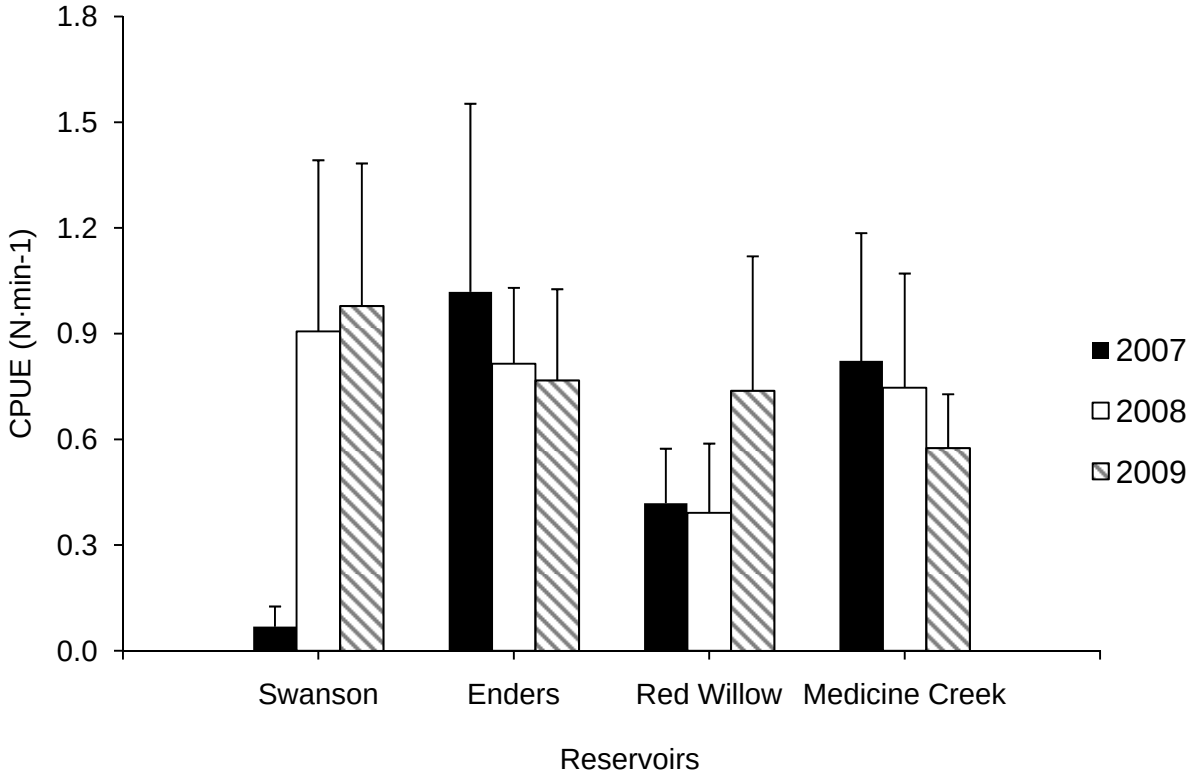

Figure 11. Mean ± SE catch per unit effort (CPUE; $N \cdot min^{-1}$ of electrofishing) for juvenile white bass during autumn 2007-2009 in the four southwest irrigation reservoirs, Nebraska.

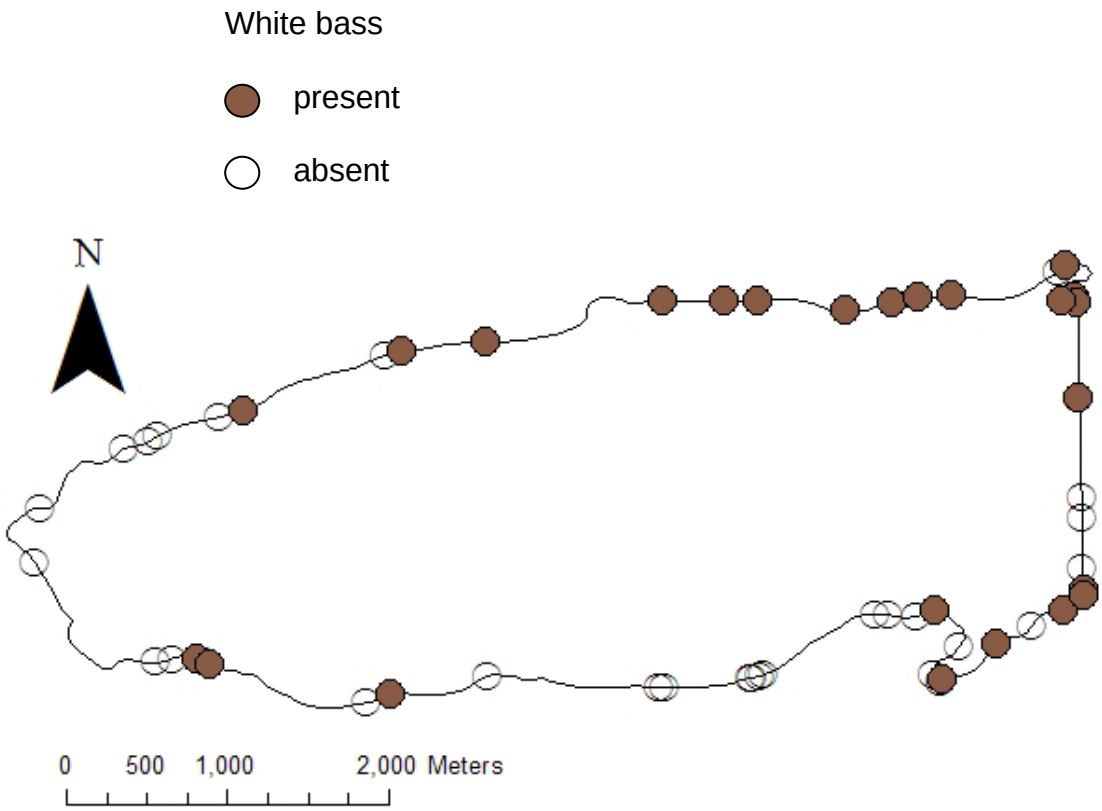

Figure 12. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Swanson Reservoir, Nebraska.

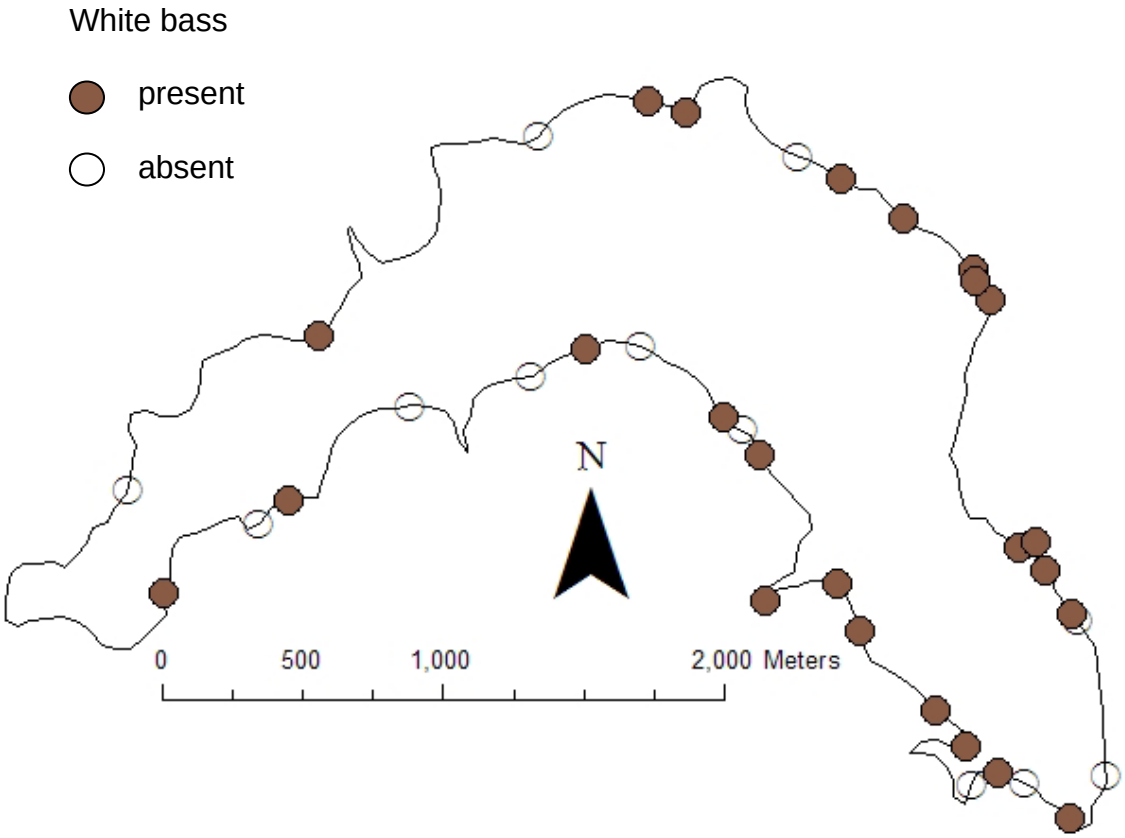

Figure 13. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Enders Reservoir, Nebraska.

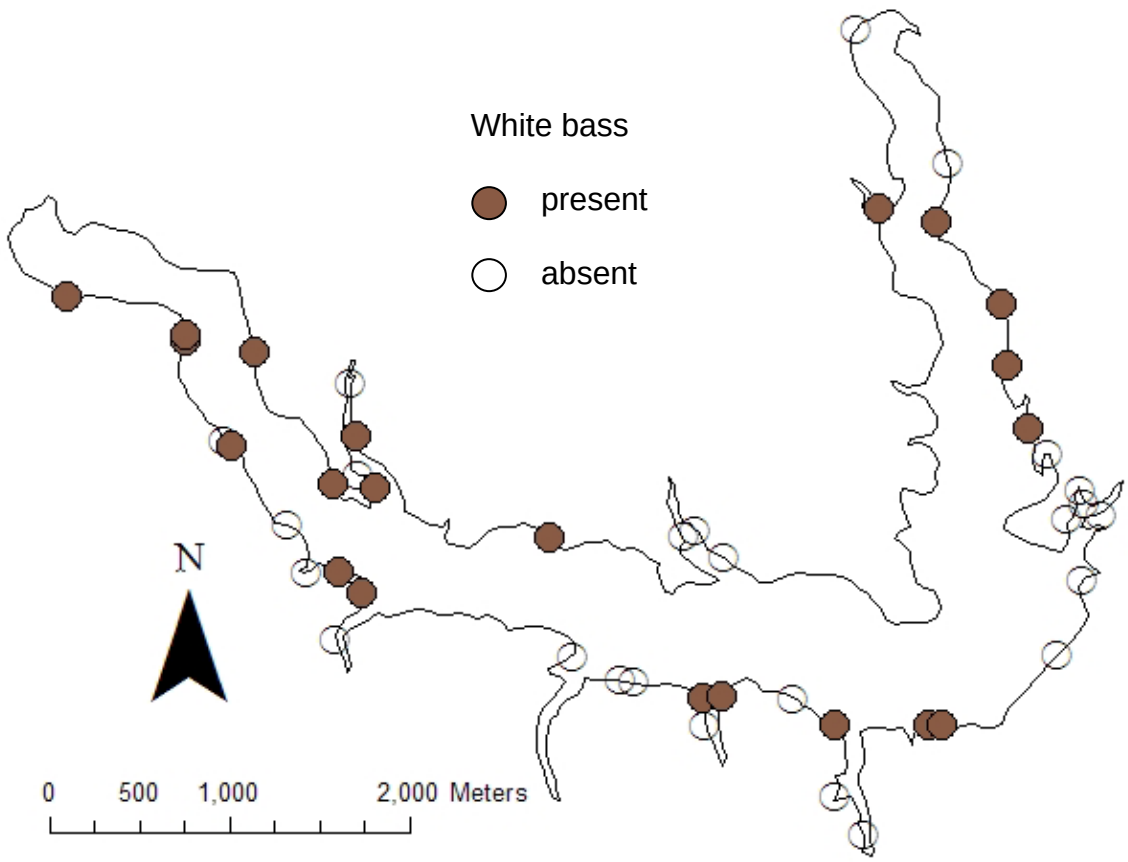

Figure 14. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Red Willow Reservoir, Nebraska.

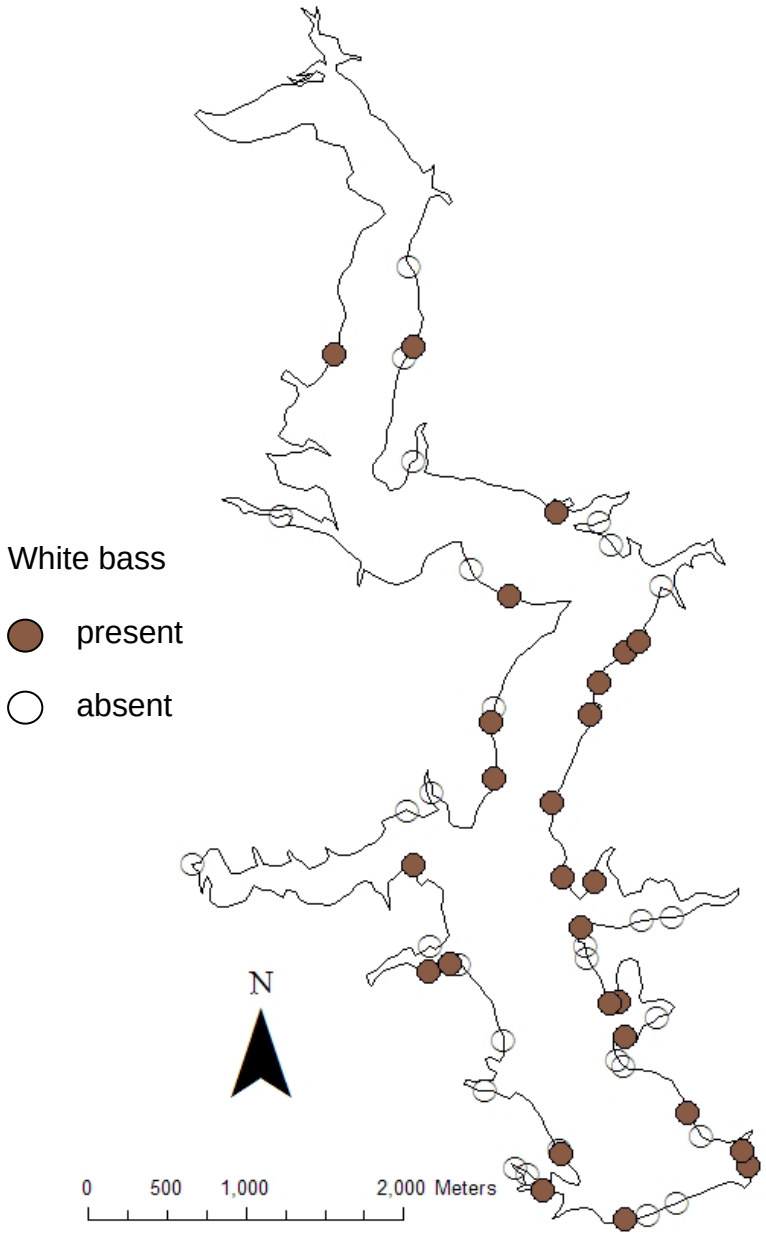

Figure 15. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Medicine Creek Reservoir, Nebraska.

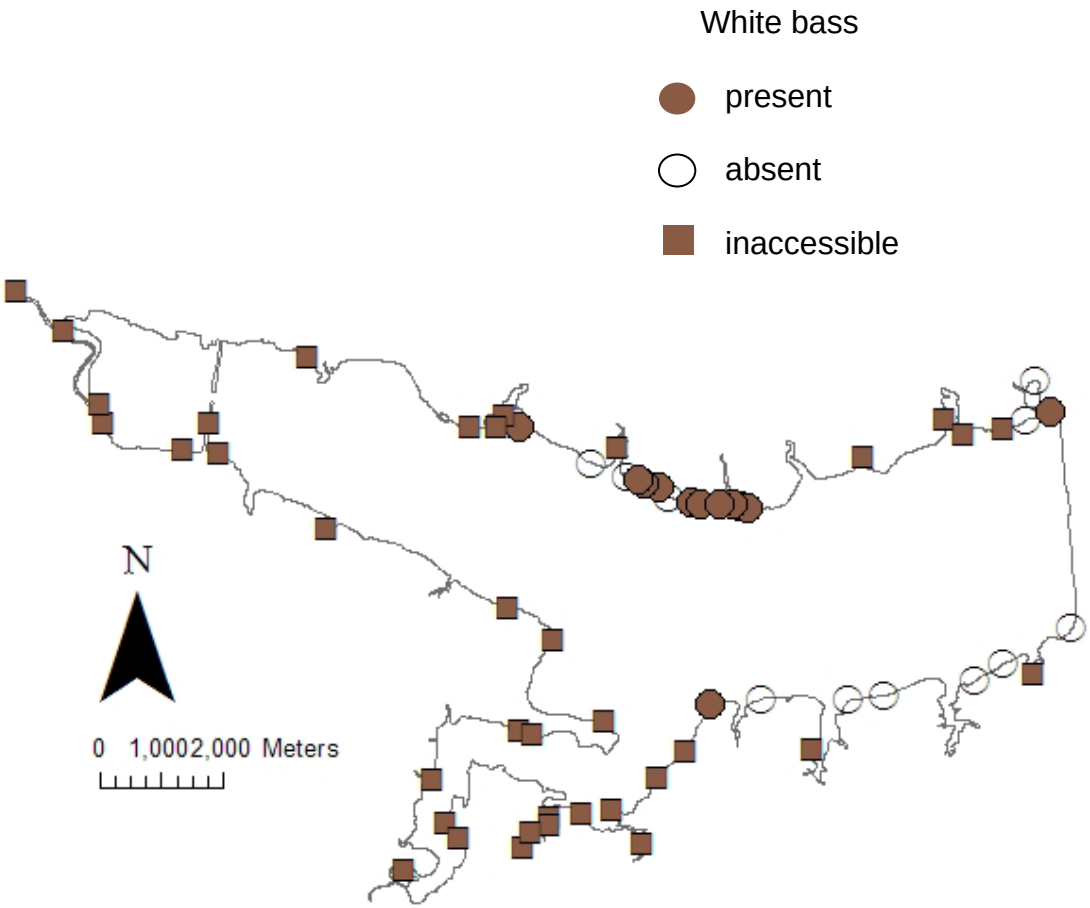

Figure 16. Spatial distribution of random sites sampled for juvenile white bass for hybrid identification study during autumn 2009 in Harlan County Reservoir, Nebraska.

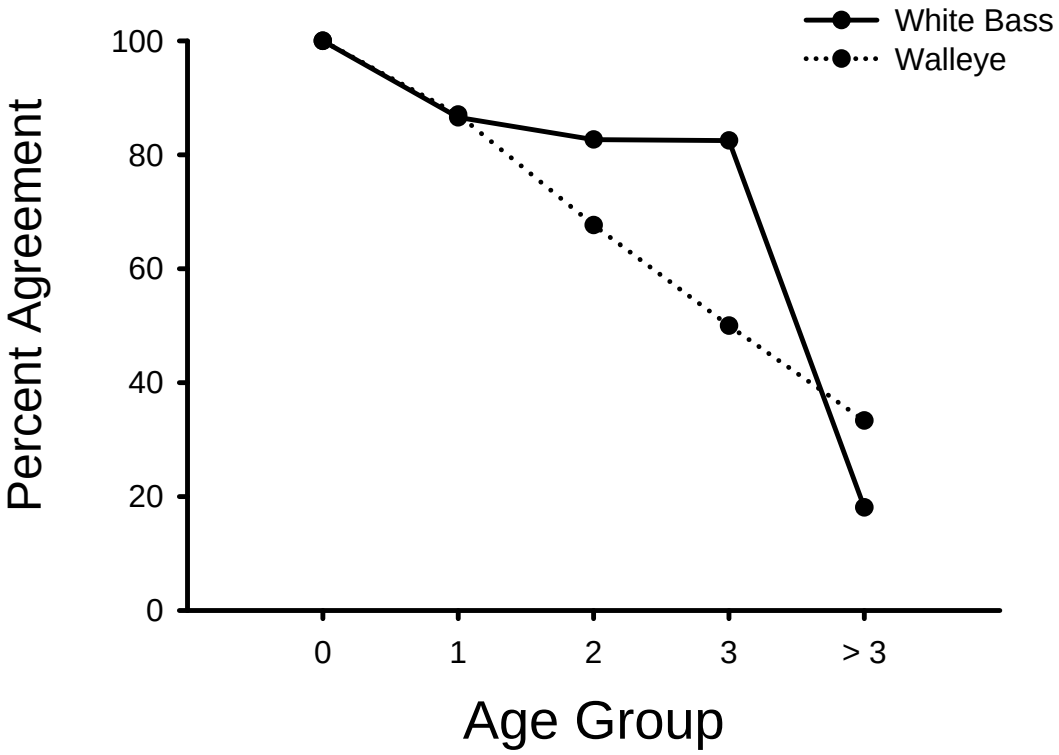

Figure 17. Percent agreement between otolith and scale ages for walleye and white bass captured during autumn 2007 in gillnets.