287-F

Biotelemetry of White Bass in a South Dakota Glacial Lake

H. Denise Beck[a] and David W. Willis
Department of Wildlife and Fisheries Sciences
South Dakota State University
Brookings, South Dakota 57007-1696 USA

ABSTRACT

Biotelemetry was used to track daily and monthly distributions of white bass (*Morone chrysops*) in Lake Poinsett, a South Dakota glacial lake. Ultrasonic transmitters were implanted into 30 adult white bass (332-450 mm, total length) during May 1997. White bass distribution was monitored from June to October 1997, January and February 1998, and April and May 1998. Distributions were quantified using depth and distance from shore at fish location. Fish distance from shore was significantly different among dates and diel periods ($P<0.05$), and the interaction term was also significant. White bass in Lake Poinsett were offshore during the summer and winter. During the spring and fall, white bass were near shore in shallow waters, which may be related to spawning and feeding activities. White bass tended to be nearer the shore during the evening crepuscular period across seasons. Significant ($P\leq0.05$) but weak ($r\leq0.50$) correlations were found between white bass distance from shore and environmental parameters. Temperature, cloud cover, precipitation, and moon phase were significant contributors to multiple regression models, but no model explained more than 26% of the white bass distribution.

INTRODUCTION

The white bass (*Morone chrysops*) is a popular sport fish in some South Dakota waters (Willis et al. 1996). Substantial research has been completed on white bass reproduction, mortality, food habits, and life history (e.g., Colvin 1993); however, little research has been conducted on white bass distribution and movement. Hasler et al. (1969) found that white bass oriented to directional cues in the environment such as sunlight and wind. However, their study was conducted during one month, and white bass distribution was not well documented.

Our study objectives were to determine monthly and diel white bass distribution in Lake Poinsett, a glacial lake located in eastern South Dakota. We also wanted to determine if white bass distribution was related to environmental parameters such as cloud cover, moon phase, precipitation, water temperature, and wind speed.

STUDY SITE

Lake Poinsett, Hamlin County, is a natural lake of glacial origin located in eastern South Dakota. It has a watershed area of 118,252 ha, a surface area of 3,184

[a]Current address: U.S. Fish and Wildlife Service, 119 Hatchery Loop, Yankton, SD 57078

ha, a mean water depth of 2.9 m, and a maximum water depth is 5.9 m. The shoreline length is 24 km with a shoreline development index of only 1.2, and the lake does not thermally stratify during the summer (Stueven and Stewert 1996). Water temperatures during our field observations ranged from 26.7°C in July 1997 to 1.7°C in February 1998. Lake Poinsett is part of a six-lake system that includes Lakes Mary, Albert, Norden, John, Poinsett, and Dry, and is connected to the Big Sioux River by a human-constructed channel.

METHODS

Ultrasonic transmitters were surgically implanted into 30 post-spawn adult white bass collected by angling from 27 May to 6 June. Fish were captured from Lake Poinsett (N=16) and also below a dam on Lake Norden (N=14) that blocks the upstream movement of spawning white bass. Ultrasonic transmitters were used in our study because of the high conductivity (1,100-1,300 μS/cm) in Lake Poinsett (Winter 1996). Transmitters were 15 mm in diameter and 70 mm long, coded by pulse interval, and had a life expectancy of 14 months. During surgery, white bass were placed ventral side up in a trough with a continuous water supply over the gills. An 70-mm incision was made left of the ventral axis between the pelvic and anal fins. The transmitter was inserted and the incision was closed using interrupted stitches. The fish were released in Lake Poinsett and were not monitored for seven days to allow them to acclimate to the transmitters.

Tracking occurred from June 1997 to October 1997, January and February 1998, and from April to May 1998 to document seasonal differences in white bass distribution. Thus, tracking occurred from postspawn in June of 1997 through the spawning period in April and May of 1998. White bass distribution was monitored during four diel periods: morning crepuscular, daytime, evening crepuscular, and nighttime periods. Crepuscular periods were defined as the two-hour period beginning one hour before and concluding one hour after both sunrise and sunset. White bass locations were recorded when the transmitter signal strength from a 16 position tuning receiver and a directional hydrophone was unidirectional and equal in all directions (i.e., 360°). The transmitters we used did not allow us to determine the vertical position of a fish in the water column; therefore, we measured water depth at each fish location with a sonic depth recorder. Water temperature, wind speed and direction, cloud cover, moon phase, and precipitation were also recorded at each fish location. During January and February, white bass locations were documented in Lake Poinsett during the day by drilling holes through the ice to submerge the hydrophone. Tracking did not occur in March due to unsafe ice.

At each fish location, a coordinate was recorded using a global positioning system (Trimble Geoexplorer II) and differentially corrected from base stations in Sioux Falls and Pierre, South Dakota. Fish coordinates were entered into a geographic information system (ARC-INFO; ESRI 1992) and overlaid onto a digitized map of the lake. Distance from shore was calculated as the minimum distance between fish location and shore.

Two null hypotheses were developed to determine seasonal and diel differences in depth and distance from shore, and to determine if environmental and biotic parameters were related to these variables. The first null hypothesis stated that white bass distance from shore and depth at location did not vary among months and diel periods. The second null hypothesis was that depth at fish location and distance from shore were not correlated with environmental parameters. Because the data were not normally distributed, a two-way analysis of variance (ANOVA) with ranked dependent variables was used to test the first statistical hypothesis (Conover and Iman 1981). Tukey's studentized range test was used to compare multiple ranked means if significant differences were detected among depth and distance from shore by months and diel periods. For the second hypothesis, correlation matrices were performed on all dependent and independent variables using the CORR procedure in SAS (SAS Institute 1988). Multiple regression models were developed using the REG procedure (MAXR INFLUENCE selection; SAS 1988) to further determine if white bass distribution was related to environmental and biotic parameters.

RESULTS

From June 10, 1997 to May 30, 1998, 607 white bass locations were recorded for 29 out of 30 white bass that had been implanted with transmitters. Six fish were captured by anglers during the study. Lake maps indicating individual fish locations by month are available in Beck et al. (1999).

Mean depth at fish location and mean distance from shore for all months and all diel periods were positively correlated ($r=0.70$, $P=0.001$). Therefore, only distance from shore will subsequently be reported and discussed. Data on mean depth at fish location are available in Beck et al. (1999).

White bass distribution varied among months and diel periods in our statistical analysis of ranked data ($P=0.001$). Because the month*diel period ANOVA interaction term was significant ($P=0.001$), we assessed distribution separately for each diel period.

During the morning crepuscular period, white bass were farthest from shore in June and July (Figure 1). Later, white bass moved onshore during August and September, and were closest to shore in May. During the daytime, white bass were offshore in June and July and began moving back onshore in August and September. White bass were offshore in the deepest waters in January and February. In April, white bass were closest to shore compared to other months, and they started moving offshore in May. Distance from shore during the evening crepuscular and nighttime periods were similar to morning crepuscular and daytime values.

Significant correlations ($P \leq 0.05$) were found between white bass distance from shore and environmental conditions. However, correlation coefficients (r) were low for all comparisons, with the high number of observations allowing us to detect significant, but weak, relationships. Daytime distance from shore and daily

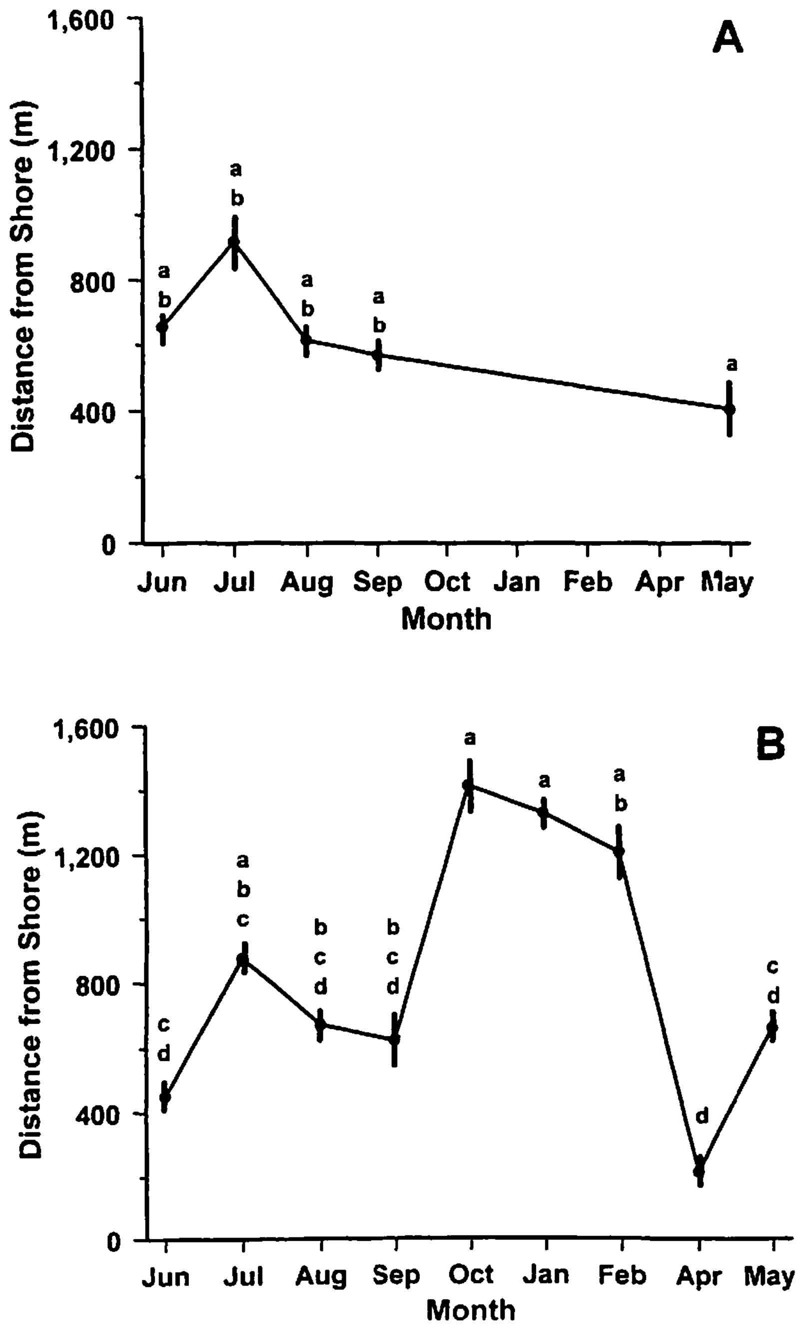
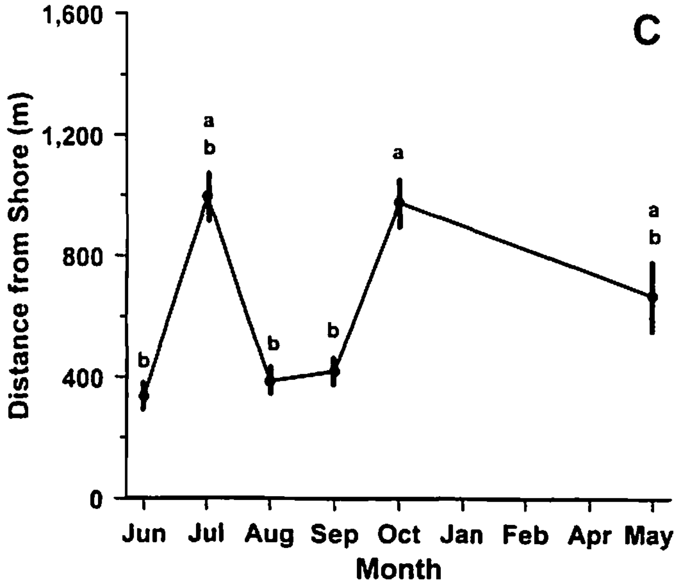
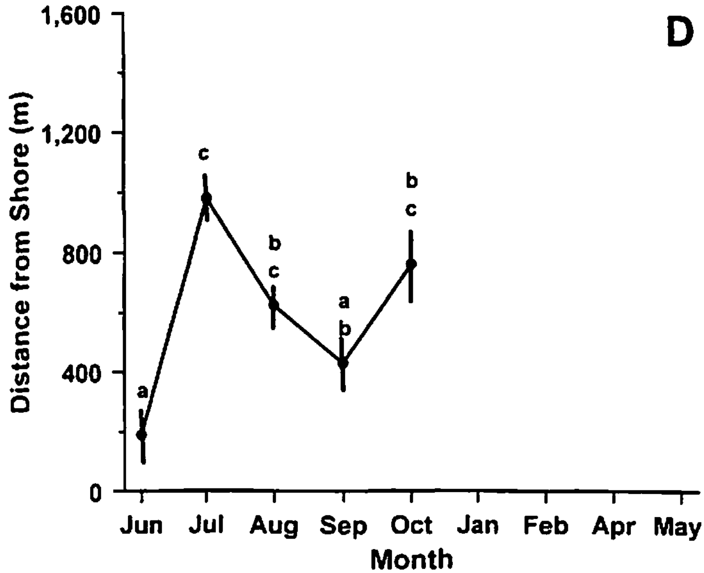


Figure 1. Mean distance from shore during the morning crepuscular period (A), daytime (B), evening crepuscular period (C), and nighttime (D) for white bass in Lake Poinsett, South Dakota, from June 1997 to May 1998. Vertical bars represent the standard error of the mean. Means with the same letter are not significantly different at alpha=0.05 according to Tukey's studentized multiple range test.





precipitation were negatively related (r =-0.24, P=0.017). Distance from shore and cloud cover were positively related during the evening crepuscular period (r=0.24, P=0.026). Nighttime temperature was positively related to distance from shore (r=0.50, P=0.005).

Environmental and biotic variables that were used in our multiple regression analyses explained no more than 26% of white bass distribution (Table 1). Temperature, sex of fish, cloud cover, precipitation, date, and moon phase were significant variables in multiple regression models for each diel period.

Table 1. Multiple regression models predicting white bass distance from shore in Lake Poinsett, South Dakota, from June 1997 to May 1998. Slopes for all independent variables were significantly different from zero (alpha = 0.05).

Period	Model	Model R^2	Model P
Morning crepuscular	-3213.3 (Y-intercept) +42.3(water temperature) +318.5(sex) +10.27(cloud cover)	0.17	0.01
Day	+806.7 (Y-intercept) -367.8(daily precipitation)	0.07	0.02
Evening crepuscular	-339.4 (Y-intercept) +413.4(daily precipitation) +286.0(sex) +154.1(cloud cover)	0.22	0.0004
Night	-491.5 (Y-intercept) +73.2(water temperature)	0.26	0.0001

DISCUSSION

White bass in Lake Poinsett had distinct monthly and diel distributions. White bass were offshore during months with colder temperatures, including January, February, and October. White bass were also offshore during July, the month with the highest mean water temperature. Across all months and diel periods, white bass tended to be closer to shore in spring (April, May, and June) and late summer (August and September) when compared to winter (January and February), midsummer (July), and fall (October). White bass were closest to shore during the prespawn and spawning period in April and May.

White bass were also at different distances from shore during different diel periods in the months of May and June, along with August and September. These results indicate different movement patterns among these months and diel periods. For example, white bass were closest to shore during the morning crepuscular period in May, but farthest from shore during the morning crepuscular period in June. In August, white bass were farthest from shore at night, and closer to shore at night in September. White bass tended to be closest to shore during the evening crepuscular period from May to October, when comparing diel periods across months.

Few white bass locations were recorded during early April in Lake Poinsett. White bass were closest to shore in shallow water during the daytime period, which may be related to spawning and feeding activities. Most white bass were actually located in Dry Lake, a shallow eutrophic lake connected to Lake Poinsett during high water conditions such as occurred in April, and in the outlet to Lake Poinsett. Dry Lake has a lower mean depth than Lake Poinsett, and water temperatures in April were approximately 7°C warmer than water in Lake Poinsett. White bass may have moved to the warmer waters of Dry Lake either for feeding or seeking a physiological advantage for maturation of gonads. Siegwarth et al. (1993) noted a similar use of shallow, warm water by pre-spawn walleyes (*Stiozstedion vitreum*) in Pool 16 of the Mississippi River.

White bass, especially males, were primarily located near the lake inlet during April. Webb and Moss (1968) indicated that male white bass occupied a spawning site about one month before the females. White bass in Lake Poinsett likely began spawning in early May. During May, most white bass locations were documented near the inlet, but some fish had moved offshore into deeper waters. These fish may have been post-spawn fish that were returning to post-spawn activity.

No environmental or abiotic parameters were strongly related to white bass distribution. All significant simple correlations and multiple regression models exhibited low r and R^2 values. However, some trends in environmental and biotic influences on white bass distribution were evident from this analysis. White bass generally were offshore during warmer water temperatures. White bass also appeared to move offshore on cloudy days during the crepuscular periods, with cloud cover being a significant variable in both simple and multiple regression models. Female white bass were farther from shore during the morning and evening crepuscular periods than males.

This study suggests that white bass distribution differs among seasons and diel periods. Environmental parameters appear to have an influence, albeit relatively weak, on white bass distribution. Additional movement information is still needed to understand how white bass behavior (e.g., peak activity times, home ranges, and movements) is related to environmental factors.

ACKNOWLEDGEMENTS

We appreciate the extensive field assistance provided by Heather Willoughby, Andrew Starostka, and Terri Symens. We thank Rex Johnson for mapping assistance, Michael Brown for statistical advice, and Craig Paukert for manuscript review. Partial funding for this project was provided by South Dakota Department of Game, Fish and Parks through the Federal Aid in Sport Fish Restoration Project F-15-R, Study 1561, Job 6. The manuscript represents Journal Series Number 3151 of the South Dakota Agricultural Experiment Station.

LITERATURE CITED

Beck, H.D., D.W. Willis, and A.B. Starostka. 1999. Habitat use and movements of adult white bass in Lake Poinsett. South Dakota Department of Game, Fish and Parks, Fisheries Division Report 99-15, Pierre.

Colvin, M.A. 1993. Ecology and management of white bass: a literature review. Missouri Department of Conservation, Federal Aid in Sport Fish Restoration Project F-1-R-42, Study I-31, Final Report, Jefferson City.

Conover, W.J., and R.L. Iman. 1981. Rank transformations as a bridge between parametric and nonparametric statistics. The American Statistician 35:124-129.

Environmental Systems Research Institute (ESRI), Inc. 1992. Understanding GIS: the ARC/INFO method. Environmental Systems Research Institute, Inc., Redlins, California.

Hasler, A.D., E.S. Gardella, R.M. Horrall, and H.F. Henderson. 1969. Open-water orientation of white bass, *Roccus chrysops*, as determined by ultrasonic tracking methods. Journal Fisheries Research Board of Canada 26:2173-2191.

SAS Institute Inc. 1988. SAS/STAT Users Guide, Version 6, Fourth Edition, Volume 2. Statistical Analysis System, Incorporated, Cary, North Carolina.

Siegwarth, G.L., J.M. Pitlo, D.W. Willis, and A.L. Thompson. 1993. Walleye and sauger spawning habitat survey in Pool 16 of the upper Mississippi River. Report of South Dakota Cooperative Fish and Wildlife Research Unit, Unit Cooperative Agreement No. 14-16-009-1549, Work Order 40, to the U.S. Army Corps of Engineers, Rock Island, Illinois.

Stueven, E., and W.C. Stewart. 1996. 1995 South Dakota lakes assessment final report. South Dakota Department of Environmental and Resources, Pierre.

Webb, J.F., and D.D. Moss. 1968. Spawning behavior and age and growth of white bass in Center Hill Reservoir, Tennessee. Proceeding of the Southeastern Association of Fish and Wildlife Agencies 21(1967):343-357.

Willis, D.W., H.D. Beck, B.A. Johnson, G.D. Simpson, and G.A. Wickstrom. 1996. Growth of white bass in South Dakota waters. South Dakota Department of Game, Fish and Parks, Fisheries Division Report 96-16, Pierre.

Winter, J. 1996. Advances in underwater biotelemetry. Pages 555-590 *in* B.R. Murphy and D.W. Willis, editors. Fisheries techniques, second edition. American Fisheries Society, Bethesda, Maryland.

Received: 26 September 1999

Accepted: 14 February 2000