Waterfowl Aerial Surveys of Monticello and Parr Reservoirs, South Carolina: Final Report

A Final Report of Activities under Contract Agreement between
The University of Georgia Research Foundation, Inc.
Savannah River Ecology Laboratory and
Kleinschmidt Associates

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Executive Summary

As a part of the Federal Energy Regulatory Commission (FERC) relicensing process for the Parr Hydroelectric Project (FERC No. 1894) by the South Carolina Electric & Gas Company (SCE&G), SCE&G formed a Fish and Wildlife and Water Quality Resource Conservation Group (RCG) of interested stakeholders. The RCG submitted a study request asking for an evaluation of wintering waterfowl usage at Monticello and Parr Reservoirs, South Carolina. Kleinschmidt Associates, a consulting firm specializing in engineering, regulatory management and environmental services, is coordinating the relicensing process for SCE&G. In October 2015, the University of Georgia's Savannah River Ecology Laboratory (SREL) of Aiken, South Carolina, was contracted to provide aerial survey data from two consecutive years describing wintering waterfowl use of Monticello and Parr Reservoirs, which are located in Newberry and Fairfield Counties, South Carolina.

In year one, nine fixed-wing aerial surveys of the entire Monticello Reservoir basin and Parr Shoals Reservoir from the Parr Shoals Dam to Henderson Island (including adjacent Enoree and Broad River Waterfowl Management Areas (WMAs) were conducted between 17 November, 2015 and 15 March, 2016, during which nearly 2,200 waterfowl (representing 9 species) were documented using the Monticello Reservoir and over 4,900 waterfowl (representing 11 species) were recorded using Parr Reservoir. In year two, nine additional fixed-wing aerial surveys of the Monticello and Parr Reservoirs were conducted between 15 November, 2016 and 21 March, 2017, during which just over 1,250 waterfowl (representing 10 species) were documented using the Monticello Reservoir and over 3,000 waterfowl (representing 11 species) were recorded using Parr Reservoir.

Greater diversity and numbers of dabbling ducks were seen at Parr Reservoir than at Monticello Reservoir; this was the case in both years. Diving duck diversity and numbers did not differ between reservoirs, but greater numbers of diving ducks were observed in the first year of the study than in the second year. In both years, Canada geese (*Branta canadensis*) were seen at Monticello Reservoir more consistently and in higher numbers than at Parr Reservoir. Snow geese (*Chen caerulescens*) however, were only seen at Parr Reservoir and on only three surveys in the first year. Most waterfowl seen at Parr Reservoir were found at Broad River WMA and/or Enoree WMA, where active management for waterfowl by SCDNR has created favorable conditions (e.g., food, cover, limited human disturbance) preferred by waterfowl. Concentrations of 50+ waterfowl observed at Parr Reservoir included primarily the Broad River and Enoree WMAs. For the Monticello Reservoir, waterfowl concentration locations were spread widely around the reservoir, but flocks appeared to favor the western half of the reservoir, and coves and islands elsewhere, that provided protection from the prevailing winds.

We evaluated the effects of fluctuating reservoir water levels on waterfowl numbers. There was greater variation observed for water levels during the waterfowl aerial surveys at Parr Reservoir (range > 7 ft) than at Monticello Reservoir (range < 3 ft). We were unable to find any indications of relationships (linear or non-linear) between water levels at the time of aerial surveys and numbers of dabbling ducks, diving ducks, or total waterfowl for either reservoir. We noted however, as Broad River WMA impoundments were drawn down for management purposes in February and March, following the hunting season, that waterfowl naturally moved

out of those impoundments. Substantial waterfowl numbers persisted at the Enoree WMA during some late-season aerial surveys because water remained in impoundments there later into the year than for the Broad River WMA impoundments.

During the fall and winter waterfowl aerial surveys of Monticello and Parr Reservoirs, we also recorded boats observed at both locations, so we assessed the effect of recreational boating activity on waterfowl counts. Boat numbers noted on the reservoirs ranged from none to 20 on individual surveys, with more boating activity typically seen on Monticello Reservoir than on Parr Reservoir. Warmer temperatures during the fall and winter waterfowl surveys were associated with higher numbers of boaters using Monticello Reservoir; there was no similar relationship for Parr Reservoir. We expected that, if boating activity at these reservoirs was sufficient to cause any major impacts to waterfowl, increased boating would be accompanied with lower waterfowl numbers. We found no evidence for increasing boat activity being associated with lower total duck or goose numbers for either reservoir.

In addition to the waterfowl observed during the aerial surveys, we also noted other avian species (non-game species) on both reservoirs as they were encountered during the aerial surveys, including mostly piscivorous birds. Among these additional species, most frequently recorded were non-specific gulls/terns and double-crested cormorants (*Phalacrocorax auritus*), which were seen on both reservoirs on most surveys. Bald eagles (*Haliaeetus leucocephalus*) were seen on 13 of 18 (72%) surveys of Parr Reservoir and 6 of 18 (33%) surveys of Monticello Reservoir. These bald eagle sightings included birds identified as both adults (16) and immatures (16).

Introduction

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (hereafter Project; FERC No. 1894). The Project consists of the Parr Shoals Development and the Fairfield Development. Both developments are located along the Broad River in Newberry and Fairfield Counties, South Carolina. The Project is currently involved in a relicensing process which involves cooperation between SCE&G as licensee and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals.

In preparation for relicensing, SCE&G formed a Fish and Wildlife and Water Quality Resource Conservation Group (RCG) which is comprised of interested stakeholders who are working with SCE&G to identify potential issues, make biological study recommendations, and provide technical and experience-based input related to wildlife resources in the Project area. During an initial scoping meeting to identify issues of importance, the RCG identified the need for a waterfowl survey to better understand waterfowl utilization of Project waters. Further, this information will be useful in evaluating potential Project effects (including water level fluctuation effects) on wintering waterfowl utilizing Monticello and Parr reservoirs.

In October 2015, the University of Georgia's Savannah River Ecology Laboratory (SREL) of Aiken, South Carolina, was contracted to provide aerial survey data from two

consecutive years describing wintering waterfowl use of Monticello and Parr Reservoirs. The primary objective of this study was to evaluate the current abundance and distribution of wintering waterfowl (ducks, geese, swans, and coots) using Monticello and Parr Reservoirs. Herein, we summarize data collected by SREL during eighteen (18) aerial surveys of waterfowl conducted during the fall/winter study periods (2015–2016 and 2016–2017), with surveys running each fall and winter from mid-November through March.

Study Area

The Project is located in Newberry and Fairfield Counties, South Carolina, on the Broad River, approximately 26 river miles upstream from the City of Columbia, South Carolina. The Project includes the existing Parr Shoals Dam, which creates the 4,400 acre Parr Shoals Reservoir (Figure 1). The Project also includes the existing Fairfield Development, which utilizes the 6,800 acre Monticello Reservoir (Figure 2). The two developments are operated together as a single hydroelectric generating facility which utilizes pumped storage of water to efficiently provide energy as needed based on customer demand. The facilities can generate as much as 544,000 kilowatts during periods of high electricity demand. Functionally, water in Monticello Reservoir flows through turbine generators and continues into Parr Reservoir where it is held. When energy demands are low, electricity from base-load fossil and nuclear generating plants is used to pump water back into Monticello Reservoir. Monticello Reservoir has little natural inflow other than negligible rainfall in the immediate area of the reservoir, so pumping of water from Parr Reservoir back into Monticello Reservoir is necessary to maintain the needed water resource.

The Project's alternate cycles of generation and pumping cause daily fluctuations in the water levels of both Monticello and Parr Reservoirs. Monticello Reservoir drops as much as 4.5 ft over a 10- to 12-hour period during the generating phase. At the same time, the water is flowing into Parr Reservoir, causing it to fluctuate as much as 10 ft. During the pumping cycle the reverse occurs, with water level rises in Monticello Reservoir and drops in Parr Reservoir.

Both Monticello and Parr Reservoirs offer a variety of recreational opportunities to the public. In particular, portions of Project lands are under management jurisdiction of the South Carolina Department of Natural Resources (SCDNR). Waterfowl management areas located on the Broad River and Enoree River are available for public use and are managed by the SCDNR under its Game Management Program. The Broad River and Enoree River Waterfowl Management Areas (WMAs) provide important habitat for overwintering waterfowl, as well as recreational waterfowl hunting opportunities that are important to the local economy. Both areas were established in the late 1970s as mitigation when Parr Reservoir was expanded during construction of the Fairfield Development. The Broad River WMA includes five impoundments totaling approximately 130 acres of waterfowl habitat. The area includes one green-tree impoundment with an oak canopy; the remaining four impoundments are planted in corn or millet and flooded seasonally. Over 500 acres of the remaining area are either upland or uncontrolled backwater. Although a wide variety of duck species may be present, the primary species harvested are ring-necked ducks (*Aythya collaris*), wood ducks (*Aix sponsa*), mallards

(*Anas platyrhynchos*), and green-winged teal (*Anas crecca*). Mallard numbers have reportedly decreased in harvests from recent years.

Aerial Surveys Methods

On days when aerial surveys were conducted, SREL personnel traveled by UGA vehicle to Daniel Field Airport, on Highland Avenue in Augusta, GA where the services of Augusta Aviation, Inc. (http://www.augustaaviation.com) were engaged to provide fixed-wing aircraft (Cessna Skyhawk) and pilot services for the aerial waterfowl surveys over Monticello and Parr reservoirs. These aerial surveys were conducted in close coordination with V.C. Summer Nuclear Station's security organization (Mr. Greg Douglass) and local air-traffic controllers to assure safety of all aircraft operating in the vicinity of Monticello and Parr reservoirs during the execution of these surveys. Both reservoirs, in their entirety, were surveyed for waterfowl use. Specifically, with respect to Parr Reservoir, aerial surveys were conducted from Parr Shoals Dam to the base of Henderson Island and included the Enoree River and Broad River WMAs, managed by SCDNR (Figure 1).

Because of potential bias associated with multiple observers, all aerial surveys were conducted by a single observer. The SREL observer, C. S. Eldridge, accompanied the pilot in the aircraft; the pilot was instructed to fly at an altitude of approximately 200–300 ft and airspeed of about 80–105 mph, consistent with Federal Aviation Administration (FAA) regulations. Surveys consisted of complete coverages of the lake basins, thus providing what were considered true count data as opposed to randomized line-transect surveys which would yield calculated estimates of bird abundance (this latter technique is often used when study areas are much larger geographic regions). The pilot was instructed to circle above larger flocks of birds while species were identified and counts were made. The ability to observe and identify waterfowl using green-tree impoundments using aerial survey methods can be limited because of tree canopy. The SREL observer identified species and counted all waterfowl (ducks, geese, swans, and coots) observed during aerial surveys. Bird species and numbers of individuals were recorded directly onto field maps of the two reservoirs; after survey completion, observed birds were tallied by reservoir and species and recorded on a summary data sheet. Boats observed during the aerial surveys were noted as well. Additional data provided on each summary data sheet included: date, start/end times of survey, and general weather conditions at the time of the aerial survey (i.e., visibility, wind, temperature, rainfall). Meteorological information from a weather station near Peak, SC (KSCLITTL12) was also gathered for each flight period. Aerial surveys were conducted during the mid-late morning hours, with all surveys being started by 1125hrs. Actual duration of each aerial survey was approximately 1.5 hours, plus additional flight time of about 40 minutes each for travel time to and from Daniel Field Airport in Augusta, GA.

Data were stored on a networked PC-workstation operating in a Microsoft-Windows environment. The JMP Analysis System (SAS Institute, Inc., Cary, NC) was used to summarize and analyze the aerial survey data. Data were summarized in both graphical and tabular format. Summaries below include location graphics of waterfowl numbers, as well as tabular summaries and descriptions of temporal changes in waterfowl distributions (species- and/or subfamily-specific). Waterfowl surveys were conducted during the fall-winter months (mid-November

through late-March) of 2015-2016 and 2016-17. As previously noted, for each of the two years, nine (9) aerial surveys were conducted over a period of five (5) months, executed as follows: 1 in late November, 2 in December, 2 in January, 2 in February, and 2 in March.

Aerial Survey Results and Discussion

Year one (2015–2016)

During year one, nine fixed-wing aerial surveys of the Monticello and Parr Reservoirs were conducted between 17 November, 2015 and 15 March, 2016. Dates of the nine individual aerial surveys and prevailing conditions during the 2015–2016 flights are provided in Table 1.

Nine waterfowl species (includes American Coots [*Fulica americana*]) were identified using Monticello Reservoir during the 2015–2016 aerial surveys (Table 2) and 11 waterfowl species (including coots) were identified using Parr Reservoir during the 2015–2016 aerial surveys (Table 2). A greater diversity of dabbling ducks was seen on Parr Reservoir (5) than on Monticello Reservoir (3; Table 2). However, the same three diving duck species, including ring-necked ducks, lesser scaup (*Aythya affinis*), and buffleheads (*Bucephala albeola*), were seen on both reservoirs (Table 2). Canada geese (*Branta canadensis*), mallards, and ring-necked ducks were seen on Monticello Reservoir during all nine aerial surveys (Table 2); ring-necked ducks (88.9% of surveys) and mallards (77.8% of surveys) were the most-often observed species on Parr Reservoir (Table 2). Most waterfowl seen on Parr Reservoir were found at Broad River WMA and/or Enoree WMA, where active management for waterfowl by SCDNR has created favorable conditions (e.g., food, cover, limited human disturbance) preferred by waterfowl. For the Broad River and Enoree WMAs at Parr Reservoir, the same eight waterfowl species were identified at both WMAs (Table 3), with ring-necked ducks most frequently seen at Broad River WMA (88.9% of surveys), and ring-necked ducks and blue-winged teal (*Anas discors*) most frequently seen at Enoree WMA (44.4% of surveys for each of the two species; Table 3). There was more late-season (particularly late February and March) waterfowl use of the Enoree WMA than had been the case earlier in the fall/winter while the waterfowl hunting season was active.

During these aerial surveys, about 2,200 waterfowl were documented using Monticello Reservoir (Table 4) and more than 4,900 waterfowl were documented using the Parr Reservoir (Table 5). Dabbling duck numbers on Monticello Reservoir never exceeded 78 birds on an individual flight ($\bar{x}$ = 41.2; Table 4), but in contrast, dabbling duck numbers on Parr Reservoir exceeded 100 individuals on five of nine surveys (maximum = 238; $\bar{x}$ = 104.8; Table 5). Diving duck numbers on Monticello Reservoir exceeded 100 individuals on only one survey (330 on 5 January 2016; $\bar{x}$ = 79.2;), but again in contrast, diving duck numbers on Parr Reservoir exceeded 100 individuals on all but one flight, the last one in March of 2016 (maximum = 665; $\bar{x}$ = 385.6; Table 5). In contrast to higher duck use of Parr Reservoir (including Broad River and Enoree WMAs) than Monticello Reservoir, Canada geese were seen on Monticello more consistently and in higher numbers than on Parr Reservoir (Monticello $\bar{x}$ = 99.0, Parr $\bar{x}$ = 26.4; Tables 4 and 5). Snow geese (*Chen caerulescens*) however, were only seen on Parr Reservoir and on only three surveys (maximum = 62; Table 5). American coots were seen on Monticello Reservoir on three aerial surveys (maximum = 100; Table 4), while seen on only a single flight over Parr Reservoir (245 on 21 December, 2015).

Figures 3 and 4 show the respective Parr Reservoir and Monticello Reservoir locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in the winter of 2015–2016. For Parr Reservoir, these locations included primarily the Broad River and Enoree WMAs (Figure 3). For the Monticello Reservoir, these locations were spread widely around the reservoir (Figure 4), but flocks appeared to favor the western half of the reservoir, and coves and islands elsewhere that provided protection from the prevailing winds.

In addition to the waterfowl observed during the aerial surveys, which were of primary concern for the purposes of this study, we also noted other avian species (non-game species) on both reservoirs as they were encountered during the aerial surveys (Table 2). Most of these species were piscivorous birds, foraging largely or exclusively on fish. Among these additional species, most frequently recorded were non-specific gulls/terns and double-crested cormorants (*Phalacrocorax auritus*; Table 2), which were seen on both reservoirs on almost all surveys. On Monticello Reservoir, we also recorded two species of grebes, including the pied-billed grebe (*Podilymbus podiceps*) and the horned grebe (*Podiceps auritus*), as well as the common loon (*Gavia immer*; Table 2). On Parr Reservoir, we also recorded Anhingas (*Anhinga anhinga*), and flocks of non-specific shorebirds using shoreline areas exposed by receding water levels. Perhaps of more interest was the bald eagle (*Haliaeetus leucocephalus*) sightings made during the waterfowl surveys. Bald eagles were seen on eight of nine surveys of Parr Reservoir and three of nine surveys of Monticello Reservoir (Table 2). Bald eagle sightings included both adult (8) and immature (11) birds.

Year two (2016–2017)

During year two, nine fixed-wing aerial surveys of the Monticello and Parr Reservoirs were conducted between 15 November, 2016 and 21 March, 2017. Dates of the nine individual aerial surveys and prevailing conditions during the 2016–2017 flights are provided in Table 6.

Ten waterfowl species (including coots) were identified using Monticello Reservoir during the 2016–2017 aerial surveys (Table 7) and 11 waterfowl species (including coots) were identified using Parr Reservoir during the 2016–2017 aerial surveys (Table 7). Consistent with the previous fall and winter period, a greater diversity of dabbling ducks was seen on Parr Reservoir (7) than on Monticello Reservoir (3 species; Table 7). No more than three diving duck species, including ring-necked ducks, lesser scaup, and buffleheads, were seen on either reservoir in both years (Table 7). Canada geese were the only waterfowl seen on Monticello Reservoir during all nine 2016–2017 aerial surveys (Table 7), but mallards (88.9%) and wood ducks (66.7%) were often seen on Monticello as well. Mallards (100% of surveys) and ring-necked ducks (66.7% of surveys) were the most-often observed species on Parr Reservoir (Table 7). As in the previous year, most waterfowl seen on Parr Reservoir were found at Broad River WMA and/or Enoree WMA. In 2016–2017, eight waterfowl species were identified at Broad River WMA and nine waterfowl species were identified at Enoree WMA (Table 8), with ring-necked ducks most frequently seen at Broad River WMA (77.8% of surveys), and mallards and wood ducks most frequently seen at Enoree WMA (44.4% of surveys for each of the two species; Table 8). There was more late-season (particularly late February and March) waterfowl use of the Enoree WMA than Broad River WMA, likely due to an earlier post hunting-season drawdown schedule for Broad River WMA than for Enoree WMA (further discussion below).

During the 2016–2017 aerial surveys, about 1,250 waterfowl were documented using Monticello Reservoir (Table 9) and more than 3,000 waterfowl were documented using the Parr Reservoir (Table 10), amounting to about 1,000 and 1,900 fewer waterfowl than during the previous year, respectively. Dabbling duck numbers on Monticello Reservoir in 2016–2017 never exceeded 58 birds on an individual flight ($\bar{x}$ = 19.9; Table 9), but in contrast, dabbling duck numbers on Parr Reservoir exceeded 100 individuals on six of nine surveys (maximum = 543; $\bar{x}$ = 219.3; Table 10). In 2016–2017, diving duck numbers on Monticello Reservoir exceeded 100 individuals on only one survey (211 on 10 January 2017; $\bar{x}$ = 36.3;), but again in contrast, diving duck numbers on Parr Reservoir exceeded 100 individuals on three flights, with a maximum of 340 observed on 22 December 2016 ($\bar{x}$ = 88.6; Table 10). In contrast to higher duck use of Parr Reservoir (including Broad River and Enoree WMAs) than Monticello Reservoir, Canada geese were seen on Monticello more consistently and in higher numbers than on Parr Reservoir (Monticello $\bar{x}$ = 77.3, Parr $\bar{x}$ = 24.7; Tables 9 and 10). Snow geese were not seen on Monticello or Parr reservoirs in 2016–2017 (Tables 9 and 10). American coots were seen on Monticello Reservoir on only a single aerial survey, 10 January 2017 (30; Table 9); likewise, coots were seen on only a single flight over Parr Reservoir, 22 December 2016 (40; Table 10).

Figures 5 and 6 show the respective Parr Reservoir and Monticello Reservoir locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in the winter of 2016–2017. As in the previous year, for Parr Reservoir, these locations included primarily the Broad River and Enoree WMAs (Figure 5), and for the Monticello Reservoir, these locations were spread widely around the reservoir (Figure 6).

In 2016–2017, we also noted other avian species (non-game species) on both reservoirs as they were encountered during the aerial surveys (Table 7). Among these additional species, most frequently recorded were again non-specific gulls/terns and double-crested cormorants, which were seen on both reservoirs on most surveys. On Monticello Reservoir, we also recorded two species of grebes, including the pied-billed grebe and the horned grebe, as well as the common loon (Table 7). On Parr Reservoir, we also recorded non-specific shorebirds using shoreline areas exposed by receding water levels. Bald eagles were seen on five of nine surveys of Parr Reservoir and three of nine surveys of Monticello Reservoir (Table 7). These bald eagle sightings included both adult (8) and immature (5) birds.

Examination of Pooled Data

Reservoir and year effects—Using data pooled for the two years of study, we examined potential statistical differences by reservoir and year for dabbling ducks, diving ducks, and geese. Tests for normality of the count data indicated a need for transformations of the data. Natural log-transformations tended to improve normality of the data, so we used log-transformed count data (scaled by the addition of 1 to prevent attempted log-transformations of zero values) as response variables in analysis of variance (ANOVA) models that tested effects of reservoir, year, and their interaction (using JMP, SAS Institute, Cary, NC). We accepted effect significance when $P < 0.05$ and least-squares estimates from the analyses were back-transformed, with the removal of the scaling value, to produce geometric mean estimates and their associated 95% confidence intervals (CI).

For the analysis of dabbling duck numbers, the overall model was significant ($F_{3,32}$ = 4.53, $P < 0.01$, adjusted $R^2 = 0.23$). Reservoirs differed significantly in numbers of dabbling ducks ($F_{1,32} = 9.70$, $P < 0.004$), with Parr Reservoir (geometric $\bar{x}$ = 82.0, 95% CI = 61.1–149.0) used to a greater degree by dabbling ducks than Monticello Reservoir (geometric $\bar{x}$ = 20.9, 95% CI = 11.1–38.7). Dabbling duck counts did not differ by year ($F_{1,32} = 0.068$, $P > 0.5$) or its interaction with reservoir ($F_{1,32} = 3.81$, $P > 0.05$).

For the analysis of diving duck numbers, the overall model was significant ($F_{3,32} = 4.82$, $P < 0.008$, $R^2 = 0.25$). Reservoirs did not differ significantly in numbers of diving ducks ($F_{1,32}$ = 3.26, $P > 0.08$), nor its interaction with year ($F_{1,32} = 0.119$, $P > 0.7$). However, diving duck counts differed significantly by year ($F_{1,32} = 11.07$, $P < 0.003$), with more diving ducks seen in 2015–2016 (geometric $\bar{x}$ = 99.7, 95% CI = 39.8–247.6) than in 2016–2017 (geometric $\bar{x}$ = 10.5, 95% CI = 3.7–27.4).

For the analysis of goose numbers, the overall model was significant ($F_{3,32} = 9.27$, $P <$ 0.009, adjusted $R^2 = 0.41$). Reservoirs differed significantly in numbers of geese ($F_{1,32} = 26.0$, $P < 0.0001$), with Monticello Reservoir (geometric $\bar{x}$ = 66.4, 95% CI = 33.0–132.9) used to a greater degree by geese than Parr Reservoir (geometric $\bar{x}$ = 4.4, 95% CI = 1.7–9.7). Goose counts did not differ by year ($F_{1,32} = 1.64$, $P > 0.2$) or its interaction with reservoir ($F_{1,32} = 0.197$, $P > 0.6$).

Fluctuating water level effects—In 2015–2016, water levels at Monticello Reservoir at the times of the nine fall and winter aerial surveys averaged 423.8 ft and varied by only 2.7 ft from highest to lowest levels during the surveys. There was more variability in water levels during aerial surveys at Parr Reservoir (Figure 7), varying by more than 7 ft during the surveys, while averaging 260.9 ft there. Simple scatter plots showed no indications of relationships (linear or non-linear) between water level at the time of aerial surveys (Table 1) and numbers of dabbling ducks, diving ducks, or total waterfowl for either reservoir (Tables 4 and 5). In 2016–2017, water levels at Monticello Reservoir at the times of the nine fall and winter aerial surveys averaged 422.9 ft and varied by only 2.5 ft from highest to lowest levels during the surveys. As in the previous year, there was more variability in water levels during aerial surveys at Parr Reservoir (Figure 8), varying by almost 5 ft during the surveys, while averaging 262.8 ft. Again, scatter plots elucidated no significant relationships between water level at the time of aerial surveys (Table 6) and numbers of observed dabbling ducks, diving ducks, or total waterfowl for either reservoir (Tables 9 and 10).

Given that greater variation in water levels occurred at Parr Reservoir than at Monticello Reservoir, we expected that the greatest opportunity to demonstrate a water level effect on waterfowl abundance or distributions would be found at Parr. However, most waterfowl associated with Parr Reservoir were found at Enoree and Broad River WMAs, where control of water levels was managed by SCDNR personnel and was generally not impacted by water level fluctuations occurring in the main body of Parr Reservoir. However, the Enoree WMA is situated near the northern limits of the Parr Reservoir dam's influence, and factors affecting water levels there are perhaps somewhat different than at Broad River WMA, particularly in that Enoree WMA is subjected to water conditions (e.g., bottlenecking) of the Enoree river as it

enters the upper Parr Reservoir. Despite these potential limitations, we noted that as Broad River WMA impoundments were actively drawn down for management purposes in March 2016, following the hunting season, waterfowl naturally moved out of those impoundments. Similar to the previous year, in 2017, as Broad River WMA impoundments were dewatered in mid-February and on into March, waterfowl again moved out of the managed impoundments at that WMA. On some late-season occasions in both years, substantial waterfowl numbers persisted at the Enoree WMA impoundments because water remained in impoundments there later into the year than for the Broad River WMA impoundments.

Recreational boating effects—During the waterfowl aerial surveys of Monticello and Parr reservoirs, we also recorded boats observed on both reservoirs. Human disturbance is often a factor affecting abundance and distribution of waterfowl, so we included an assessment of recreational boating activity on waterfowl counts. During 2015–2016 surveys, numbers of boats on Monticello Reservoir averaged 4.1, ranging from 0 to 14 boats, and on Parr Reservoir averaged 2.3, ranging from 0 to 4 boats (Table 1). During 2016–2017 surveys, numbers of boats on Monticello Reservoir averaged 6.9, ranging from 2 to 20 boats, and on Parr Reservoir averaged 3.7, ranging from 0 to 13 boats (Table 6).

As might be expected, warmer temperatures during fall and winter waterfowl surveys were associated with higher numbers of boaters using Monticello Reservoir (Figure 9); there was no similar relationship for Parr Reservoir. We did not find evidence that increasing boat activity was associated with lower total duck or goose numbers for either reservoir. These results suggest no major impacts to waterfowl at current boating activity levels on Monticello and Parr reservoirs during the fall and winter periods. Furthermore, the two SCDNR waterfowl management areas likely contribute substantially as sanctuaries, buffering migratory waterfowl from disturbance, particularly in the post-hunting season period. Maintaining watered impoundments at these WMAs through March annually, before initiating drawdowns, may provide additional benefits to spring migrant waterfowl.

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Table 1. Prevailing conditions during waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir in 2015–2016.

Survey Date:	11/17/2015	12/9/2015	12/21/2015	1/5/2016	1/19/2016	2/4/2016	2/16/2016	3/2/2016	3/15/2016
Observer	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge
Start Time	9:51	10:45	10:39	10:47	11:25	11:06	11:00	11:01	10:00
Stop Time	11:15	12:23	12:20	12:20	12:56	12:39	12:37	12:36	11:30
Noted General Conditions	PC	SNY/CLM	OVC/CLM	SNY/WNDY	SNY/WNDY	CLDY	SNY/WNDY	SNY/WNDY	SNY/CLM
Peak, SC Temp Range (C)*	15-17ºC	14-16ºC	8-10ºC	2-3ºC	0-1ºC	12-13ºC	10-14ºC	12ºC	18-22ºC
Peak, SC Wind (mph)*	NE@3.5-E@6.9	SW@4.6-SW@8.1	CLM-N@5.8	ENE@6.9-NE@8.1	NNW@4.6-NW@5.8	W@3.5	W@6.9-NNW@8.1	NW@10.4-NNW@9.2	CLM-NNW@5.8
Peak, SC Rainfall Rate (mm/hr)*	None	None	None	None	None	None	None	None	None
Peak, SC Sky Conditions*	CLR/BKN	CLR	BKN/OVC	CLR	CLR	SCT	CLR	SCT/BKN	CLR
Monticello Reservoir Water Level (ft)	422.0	424.1	424.4	424.5	423.4	424.0	422.8	423.9	424.7
Parr Shoals Reservoir Water Level (ft)	264.4	257.2	260.4	260.1	262.0	260.4	262.9	261.3	259.5
Monticello reservoir Boats Seen	N/A	6	7	2	0	2	0	2	14
Parr Reservoir Boats Seen	N/A	2	4	2	2	1	4	0	3

*Central School Road (KSCLITTL12), near Peak, SC Lat: N 34.23 °; Lon: W -81.42 °; Elevation: 462 ft; **Abbreviations**: PC=Partly Cloudy, OVC=Overcast, CLDY = Cloudy, FEW=Few Clouds, SCT=Scattered Clouds, CLR=Clear Skies, BKN=Broken Skies, RN = Rain, SNY = Sunny, CLM = Calm, WNDY = Windy.

Table 2. Species list compiled from waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2015–2016. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Monticello	Parr
Waterfowl:				
Geese				
	Canada Goose	*Branta canadensis*	**X** (100%)	**X** (44.4%)
	Snow Goose	*Chen caerulescens*	NONE	**X** (33.3%)
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (100%)	**X** (77.8%)
	Gadwall	*Anas strepera*	NONE	**X** (66.7%)
	American Wigeon	*Anas americana*	NONE	**X** (33.3%)
	Green-winged Teal	*Anas crecca*	NONE	NONE
	Blue-winged Teal	*Anas discors*	**X** (66.7%)	**X** (66.7%)
	Northern Shoveler	*Anas clypeata*	NONE	**X** (44.4%)
	Wood Duck	*Aix sponsa*	**X** (77.8%)	NONE
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (100%)	**X** (88.9%)
	Lesser Scaup	*Aythya affinis*	**X** (44.4%)	**X** (33.3%)
	Bufflehead	*Bucephala albeola*	**X** (55.6%)	**X** (11.1%)
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	**X** (22.2%)	NONE
	Other Merganser	*Mergus sp.*	NONE	NONE
Rails				
	American Coot	*Fulica americana*	**X** (33.3%)	**X** (11.1%)
Other Birds:				
	Common Loon	*Gavia immer*	**X** (55.6%)	NONE
	Anhinga	*Anhinga anhinga*	NONE	**X** (22.2%)
	Double-crested Cormorant	*Phalacrocorax auritus*	**X** (100%)	**X** (100%)
	Pied-billed Grebe	*Podilymbus podiceps*	**X** (88.9%)	NONE
	Horned Grebe	*Podiceps auritus*	**X** (44.4%)	NONE
	Gulls/Terns		**X** (100%)	**X** (88.9%)
	Shorebirds		NONE	**X** (22.2%)
	Bald Eagle	*Haliaeetus leucocephalus*	**X** (33.3%)	**X** (88.9%)

Table 3. Species list compiled from waterfowl aerial surveys of Broad River and Enoree Waterfowl Management Areas in 2015–2016. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Broad River	Enoree
Waterfowl:				
Geese				
	Canada Goose	*Branta canadensis*	**X** (22.2%)	**X** (11.1%)
	Snow Goose	*Chen caerulescens*	NONE	NONE
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (33.3%)	**X** (11.1%)
	Gadwall	*Anas strepera*	**X** (22.2%)	**X** (22.2%)
	American Wigeon	*Anas americana*	**X** (11.1%)	**X** (11.1%)
	Green-winged teal	*Anas crecca*	NONE	NONE
	Blue-winged Teal	*Anas discors*	**X** (33.3%)	**X** (44.4%)
	Northern Shoveler	*Anas clypeata*	**X** (33.3%)	**X** (11.1%)
	Wood Duck	*Aix sponsa*	NONE	NONE
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (88.9%)	**X** (44.4%)
	Lesser Scaup	*Aythya affinis*	**X** (33.3%)	**X** (11.1%)
	Bufflehead	*Bucephala albeola*	NONE	NONE
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	NONE	NONE
	Other Merganser	*Mergus sp*.	NONE	NONE
Rails				
	American Coot	*Fulica americana*	NONE	NONE

Table 4. Counts of waterfowl identified during aerial surveys of Monticello Reservoir in 2015–2016.

Survey Date:	11/17/15	12/9/15	12/21/15	1/5/16	1/19/16	2/4/16	2/16/16	3/2/16	3/15/16	All Surveys
Mallard	31	52	41	29	10	6	13	18	11	211
Gadwall										0
American Wigeon										0
Green-winged Teal										0
Blue-winged Teal			35	35	45	5	23	2		145
Northern Shoveler										0
Wood Duck	3	3	2		4	1		1	1	15
Total Dabblers:	**34**	**55**	**78**	**64**	**59**	**12**	**36**	**21**	**12**	**371**
Lesser Scaup	10	6		115					15	146
Ring-necked Duck	39	77	85	210	30	25	20	5	55	546
Bufflehead			1	5	2	10		3		21
Total Divers:	**49**	**83**	**86**	**330**	**32**	**35**	**20**	**8**	**70**	**713**
Hooded Merganser				7	1					8
Other Merganser										0
Unidentified Ducks										0
Total Ducks:	**83**	**138**	**164**	**401**	**92**	**47**	**56**	**29**	**82**	**1092**
Snow Goose										0
Canada Goose	281	126	74	80	68	59	122	35	46	891
Total Geese:	**281**	**126**	**74**	**80**	**68**	**59**	**122**	**35**	**46**	**891**
American Coot		100			45				70	215
Grand Total:	**364**	**364**	**238**	**481**	**205**	**106**	**178**	**64**	**198**	**2,198**

Table 5. Counts of waterfowl identified during aerial surveys of Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2015–2016.

Survey Date:	11/17/15	12/9/15	12/21/15	1/5/16	1/19/16	2/4/16	2/16/16	3/2/16	3/15/16	All Surveys
Mallard		6		35	45	10	10	4	12	122
Gadwall		2		8	10	60	8		5	93
American Wigeon			40	15				50		105
Green-winged Teal										0
Blue-winged Teal		230	10	45		120		60	8	473
Northern Shoveler			50	25			35	40		150
Wood Duck										0
Total Dabblers:	**0**	**238**	**100**	**128**	**55**	**190**	**53**	**154**	**25**	**943**
Lesser Scaup			19				65	40		124
Ring-necked Duck	600	665	285	420	230	570	100	470		3,340
Bufflehead			6							0
Total Divers:	**600**	**665**	**310**	**420**	**230**	**570**	**165**	**510**	**0**	**3,470**
Hooded Merganser										0
Other Merganser										0
Unidentified Ducks					10					10
Total Ducks:	**600**	**903**	**410**	**548**	**295**	**760**	**218**	**664**	**25**	**4,423**
Snow Goose				62	39	1				102
Canada Goose		20	47	4		65				136
Total Geese:	**0**	**20**	**47**	**66**	**39**	**66**	**0**	**0**	**0**	**238**
American Coot			245							245
Grand Total:	**600**	**923**	**702**	**614**	**334**	**826**	**218**	**664**	**25**	**4,906**

Table 6. Prevailing conditions during waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir in 2016–2017.

Survey Date:	11/15/2016	12/9/2016	12/22/2016	1/10/2017	1/24/2017	2/7/2017	2/16/2017	3/7/2017	3/21/2017
Observer	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge
Start Time	11:11	10:54	11:07	10:51	10:53	10:45	10:53	10:52	10:53
Stop Time	12:37	12:28	12:42	12:25	12:18	12:10	12:15	12:17	11:15
Noted General Conditions	CLR/HAZE	SNY	SNY/WNDY	PC	SNY/WNDY	CLDY/WNDY	SNY	PC/WNDY	SNY/HAZE
Peak, SC Temp Range (C)*	13-16ºC	3-5ºC	14-17ºC	5-8ºC	13-16ºC	20-22ºC	10-12ºC	20-21ºC	22-26ºC
Peak, SC Wind (mph)*	CLM-N@6.9	N@5.8-NW@4.6	W@10.4-SW@10.4	CLM-SW@4.6	W@8.1-W@10.4	SW@12.7-SW@16	WNW@4.3	SW@12.7-SW@16	W@9.2-W@8.1
Peak, SC Rainfall Rate (mm/hr)*	None	None	None	None	None	None	None	None	None
Peak, SC Sky Conditions*	CLR	CLR	CLR	CLR	CLR	CLR/SCT	CLR	SCT	CLR
Monticello Reservoir Water Level (ft)	423.8	424.5	422.2	422.8	422.5	422.0	423.1	422.4	422.8
Parr Shoals Reservoir Water Level (ft)	260.9	259.4	264.1	263.6	261.5	264.1	263.9	263.9	263.4
Monticello Reservoir Boats Seen	6	2	7	4	4	5	5	9	20
Parr Reservoir Boats Seen	13	2	4	0	1	3	1	4	5

*Central School Road (KSCLITTL12), near Peak, SC Lat: N 34.23 °; Lon: W -81.42 °; Elevation: 462 ft; **Abbreviations**: PC=Partly Cloudy, OVC=Overcast, CLDY = Cloudy, FEW=Few Clouds, SCT=Scattered Clouds, CLR=Clear Skies, BKN=Broken Skies, RN = Rain, SNY = Sunny, CLM = Calm, WNDY = Windy.

Table 7. Species list compiled from waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2016–2017. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Monticello	Parr
Waterfowl:				
Geese				
	Canada Goose	*Branta canadensis*	**X** (100%)	**X** (44.4%)
	Snow Goose	*Chen caerulescens*	NONE	NONE
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (88.9%)	**X** (100%)
	Gadwall	*Anas strepera*	NONE	**X** (44.4%)
	American Wigeon	*Anas americana*	NONE	**X** (11.1%)
	Green-winged Teal	*Anas crecca*	NONE	**X** (11.1%)
	Blue-winged Teal	*Anas discors*	**X** (44.4%)	**X** (44.4%)
	Northern Shoveler	*Anas clypeata*	NONE	**X** (33.3%)
	Wood Duck	*Aix sponsa*	**X** (66.7%)	**X** (44.4%)
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (55.6%)	**X** (66.7%)
	Lesser Scaup	*Aythya affinis*	**X** (22.2%)	**X** (11.1%)
	Bufflehead	*Bucephala albeola*	**X** (11.1%)	NONE
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	**X** (22.2%)	NONE
	Other Merganser	*Mergus sp.*	**X** (11.1%)	NONE
Rails				
	American Coot	*Fulica americana*	**X** (11.1%)	**X** (11.1%)
Other Birds:				
	Common Loon	*Gavia immer*	**X** (100%)	**X** (11.1%)
	Anhinga	*Anhinga anhinga*	NONE	NONE
	Double-crested Cormorant	*Phalacrocorax auritus*	**X** (100%)	**X** (100%)
	Pied-billed Grebe	*Podilymbus podiceps*	**X** (100%)	**X** (11.1%)
	Horned Grebe	*Podiceps auritus*	**X** (77.8%)	NONE
	Gulls/Terns		**X** (100%)	**X** (77.8%)
	Shorebirds		NONE	**X** (11.1%)
	Bald Eagle	*Haliaeetus leucocephalus*	**X** (33.3%)	**X** (55.6%)

Table 8. Species list compiled from waterfowl aerial surveys of Broad River and Enoree Waterfowl Management Areas in 2016–2017. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Broad River	Enoree
Waterfowl:				
Geese				
	Canada Goose	*Branta canadensis*	**X** (11.1%)	**X** (11.1%)
	Snow Goose	*Chen caerulescens*	NONE	NONE
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (77.8%)	**X** (44.4%)
	Gadwall	*Anas strepera*	**X** (22.2%)	**X** (22.2%)
	American Wigeon	*Anas americana*	NONE	**X** (11.1%)
	Green-winged Teal	*Anas crecca*	NONE	**X** (11.1%)
	Blue-winged Teal	*Anas discors*	**X** (33.3%)	**X** (33.3%)
	Northern Shoveler	*Anas clypeata*	**X** (11.1%)	**X** (11.1%)
	Wood Duck	*Aix sponsa*	**X** (22.2%)	**X** (44.4%)
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (44.4%)	**X** (11.1%)
	Lesser Scaup	*Aythya affinis*	**X** (11.1%)	NONE
	Bufflehead	*Bucephala albeola*	NONE	NONE
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	NONE	NONE
	Other Merganser	*Mergus sp*.	NONE	NONE
Rails				
	American Coot	*Fulica americana*	NONE	NONE

Table 9. Counts of waterfowl identified during aerial surveys of Monticello Reservoir in 2016–2017.

Survey Date:	11/15/16	12/9/16	12/22/16	1/10/17	1/24/17	2/7/17	2/16/17	3/7/17	3/21/17	All Surveys
Mallard	4	50	8	9	8	19	10		13	121
Gadwall										0
American Wigeon										0
Green-winged Teal										0
Blue-winged Teal		5		10	5	20				40
Northern Shoveler										0
Wood Duck		3		5	2	5		1	2	18
Total Dabblers:	**4**	**58**	**8**	**24**	**15**	**44**	**10**	**1**	**15**	**179**
Lesser Scaup				175					12	187
Ring-necked Duck	18	5	30	30					51	134
Bufflehead				6						6
Total Divers:	**18**	**5**	**30**	**211**	**0**	**0**	**0**	**0**	**63**	**327**
Hooded Merganser				5	8					13
Other Merganser							7			7
Unidentified Ducks										0
Total Ducks:	**22**	**63**	**38**	**240**	**23**	**44**	**17**	**1**	**78**	**526**
Snow Goose										0
Canada Goose	150	119	16	61	202	23	55	14	56	696
Total Geese:	**150**	**119**	**16**	**61**	**202**	**23**	**55**	**14**	**56**	**696**
American Coot				30						30
Grand Total:	**172**	**182**	**54**	**331**	**225**	**67**	**72**	**15**	**134**	**1252**

Table 10. Counts of waterfowl identified during aerial surveys of Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2016–2017.

Survey Date:	11/15/16	12/9/16	12/22/16	1/10/17	1/24/17	2/7/17	2/16/17	3/7/17	3/21/17	All Surveys
Mallard	6	55	311	360	160	110	20	115	15	1152
Gadwall			65	165	40	45				315
American Wigeon					30					30
Green-winged Teal									20	20
Blue-winged Teal			35			55		100	90	280
Northern Shoveler			40		50				40	130
Wood Duck				18	20			7	2	47
Total Dabblers:	**6**	**55**	**451**	**543**	**300**	**210**	**20**	**222**	**167**	**1974**
Lesser Scaup		60								60
Ring-necked Duck	12	60	340	35	235				55	737
Bufflehead										0
Total Divers:	**12**	**120**	**340**	**35**	**235**	**0**	**0**	**0**	**55**	**797**
Hooded Merganser										0
Other Merganser										0
Unidentified Ducks										0
Total Ducks:	**18**	**175**	**791**	**578**	**535**	**210**	**20**	**222**	**222**	**2771**
Snow Goose										0
Canada Goose	195	6		2	19					222
Total Geese:	**195**	**6**	**0**	**2**	**19**	**0**	**0**	**0**	**0**	**222**
American Coot			40							40
Grand Total:	**213**	**181**	**831**	**580**	**554**	**210**	**20**	**222**	**222**	**3033**

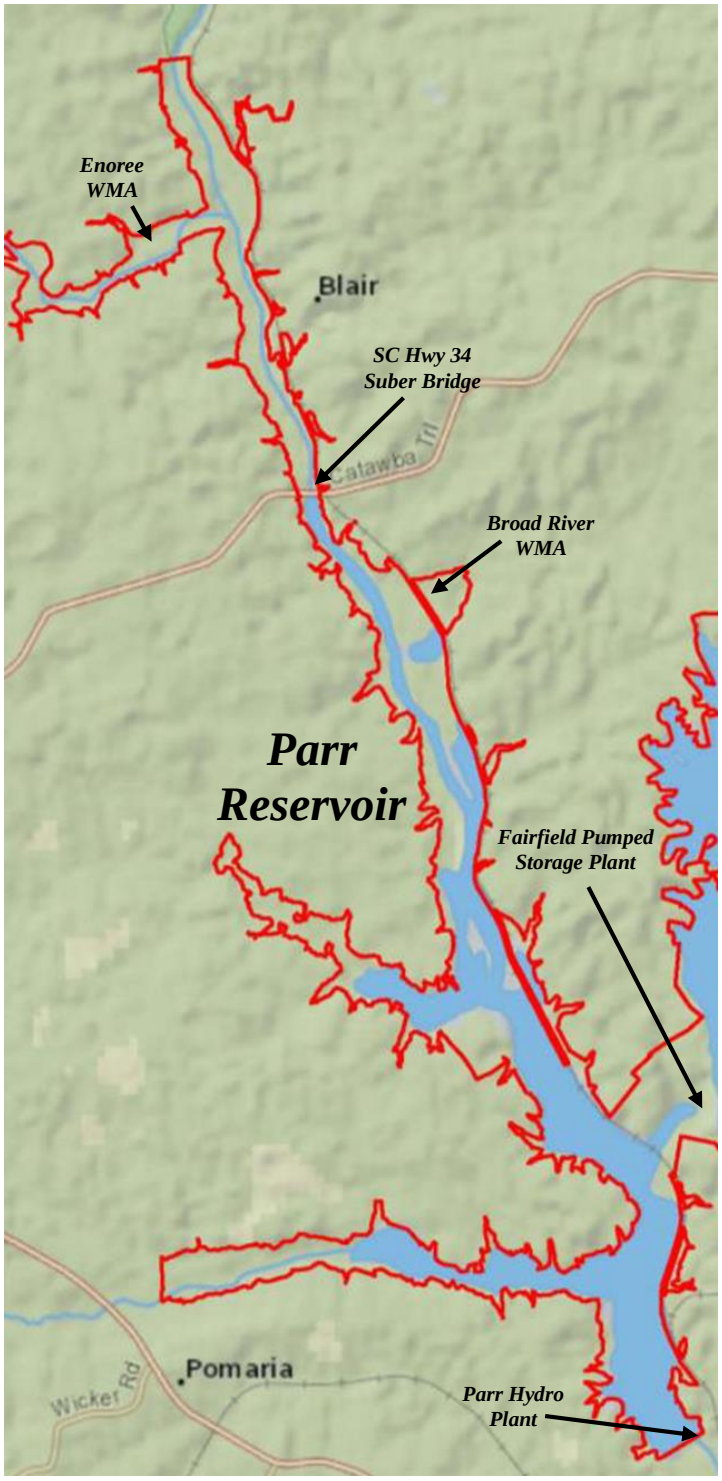

Figure 1. Map of Parr Shoals Reservoir showing locations referred to in the report. The Project boundary is outlined in red.

Figure 2. Map of Monticello Reservoir showing locations referred to in the report. The Project boundary is outlined in red.

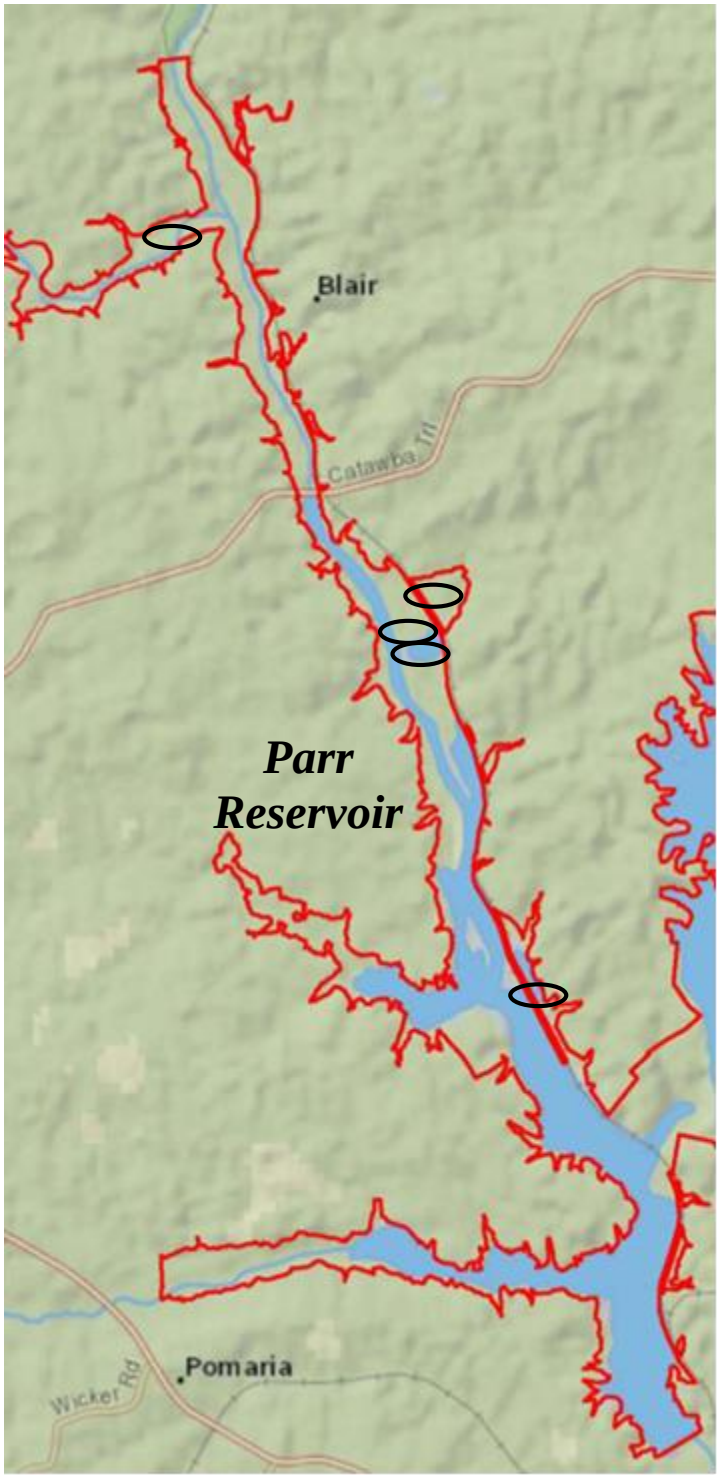

Figure 3. Map of Parr Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2015–2016. The Project boundary is outlined in red.

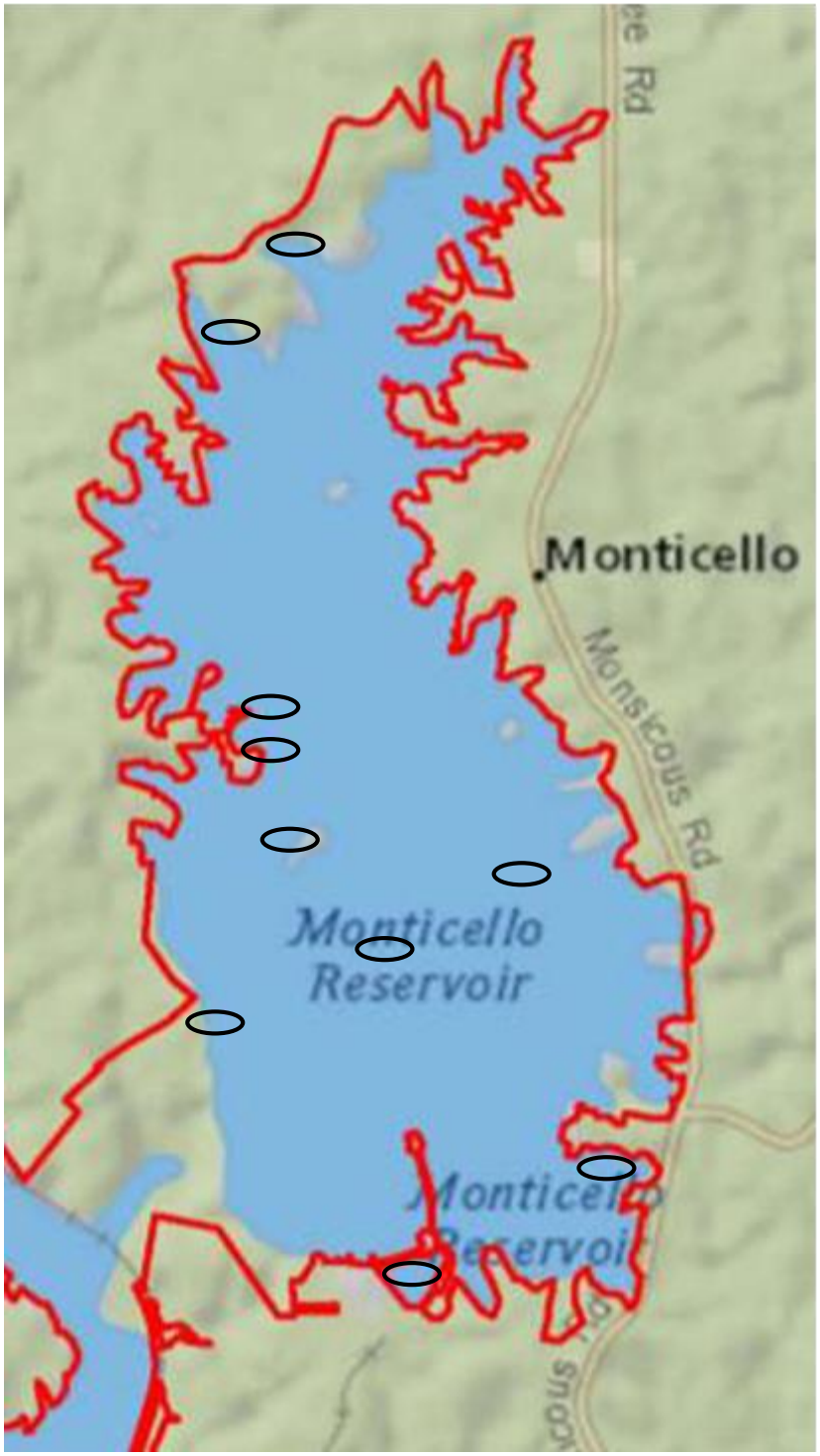

Figure 4. Map of Monticello Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2015–2016. The Project boundary is outlined in red.

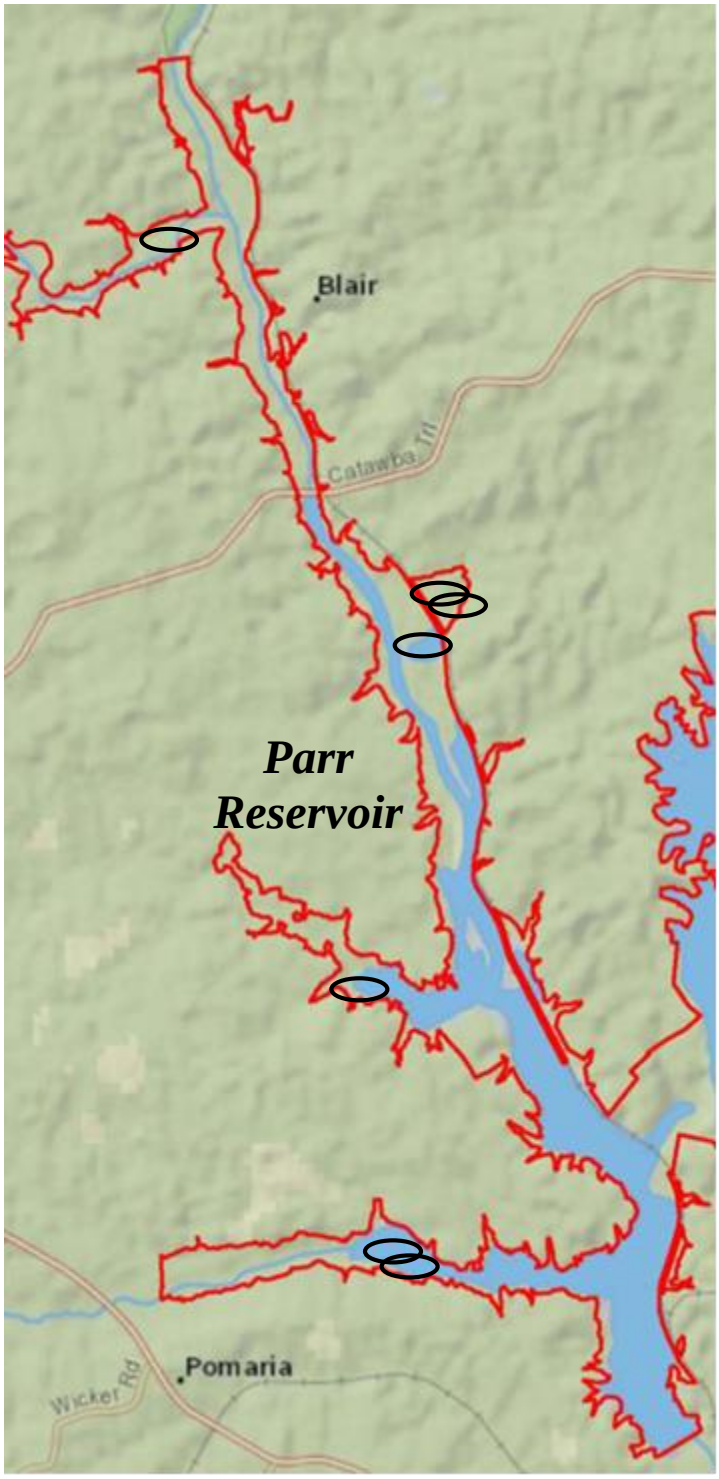

Figure 5. Map of Parr Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2016–2017. The Project boundary is outlined in red.

Figure 6. Map of Monticello Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2016–2017. The Project boundary is outlined in red.

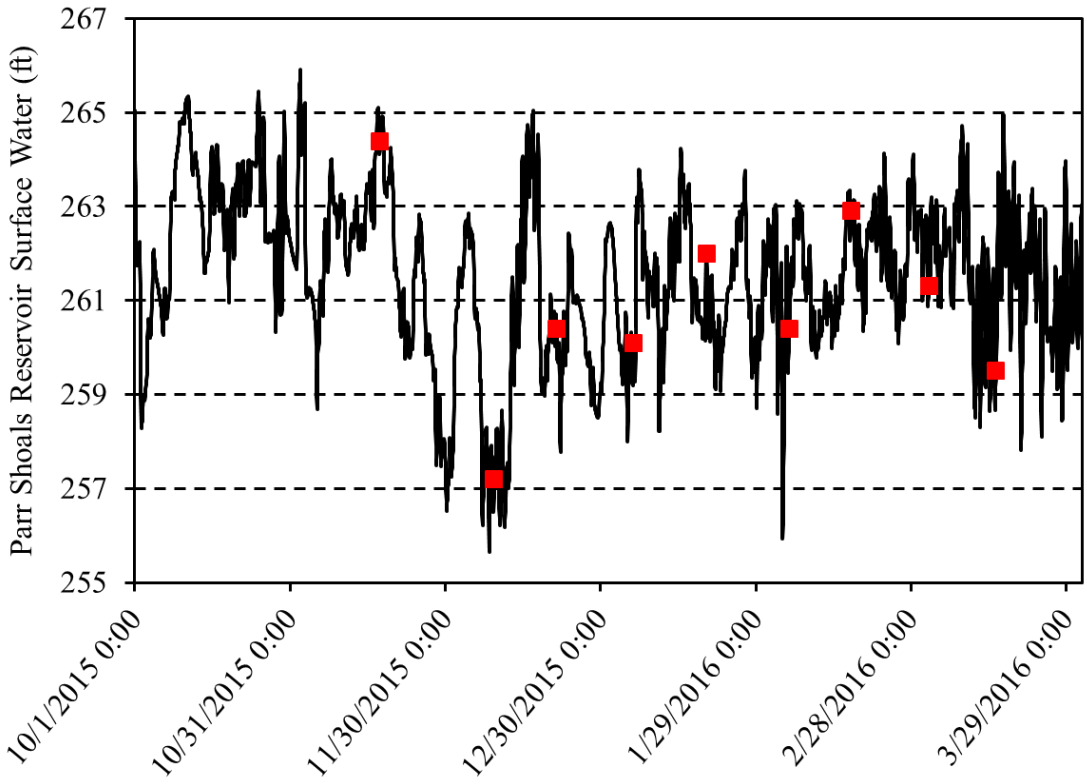

Figure 7. Parr Shoals Reservoir daily gage height (feet; full pool = 266ft [top of crest gates]) during October 1, 2015–March 31, 2016; Location: Latitude 34°15'40", Longitude 81°19'55" (NAD27), Fairfield Co., SC, Hydrologic Unit 03050106; Description: Drainage area: 4,750.00 square miles; Datum of gage: 000 feet above NGVD29. Source: U.S. Geological Survey National Water Information System. Parr Shoals Reservoir water levels at the time of the waterfowl aerial surveys are shown in by the red symbols.

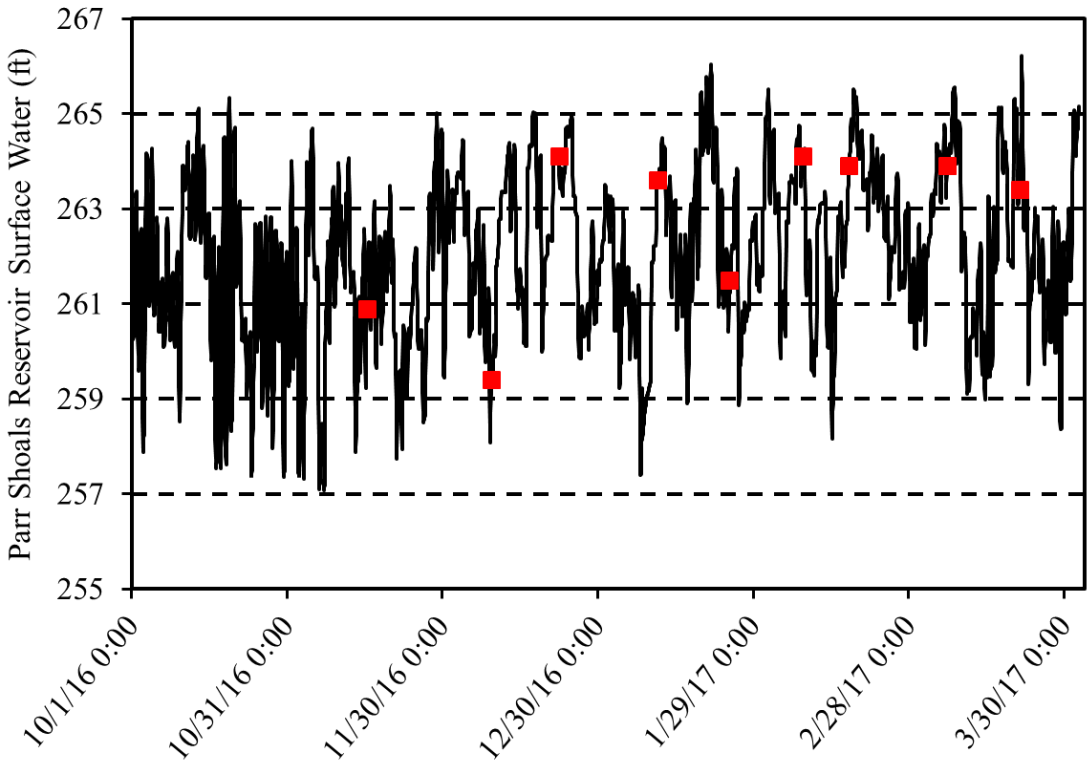

Figure 8. Parr Shoals Reservoir daily gage height (feet; full pool = 266ft [top of crest gates]) during October 1, 2016–March 31, 2017; Location: Latitude 34°15'40", Longitude 81°19'55" (NAD27), Fairfield Co., SC, Hydrologic Unit 03050106; Description: Drainage area: 4,750.00 square miles; Datum of gage: 000 feet above NGVD29. Source: U.S. Geological Survey National Water Information System. Parr Shoals Reservoir water levels at the time of the waterfowl aerial surveys are shown in by the red symbols.

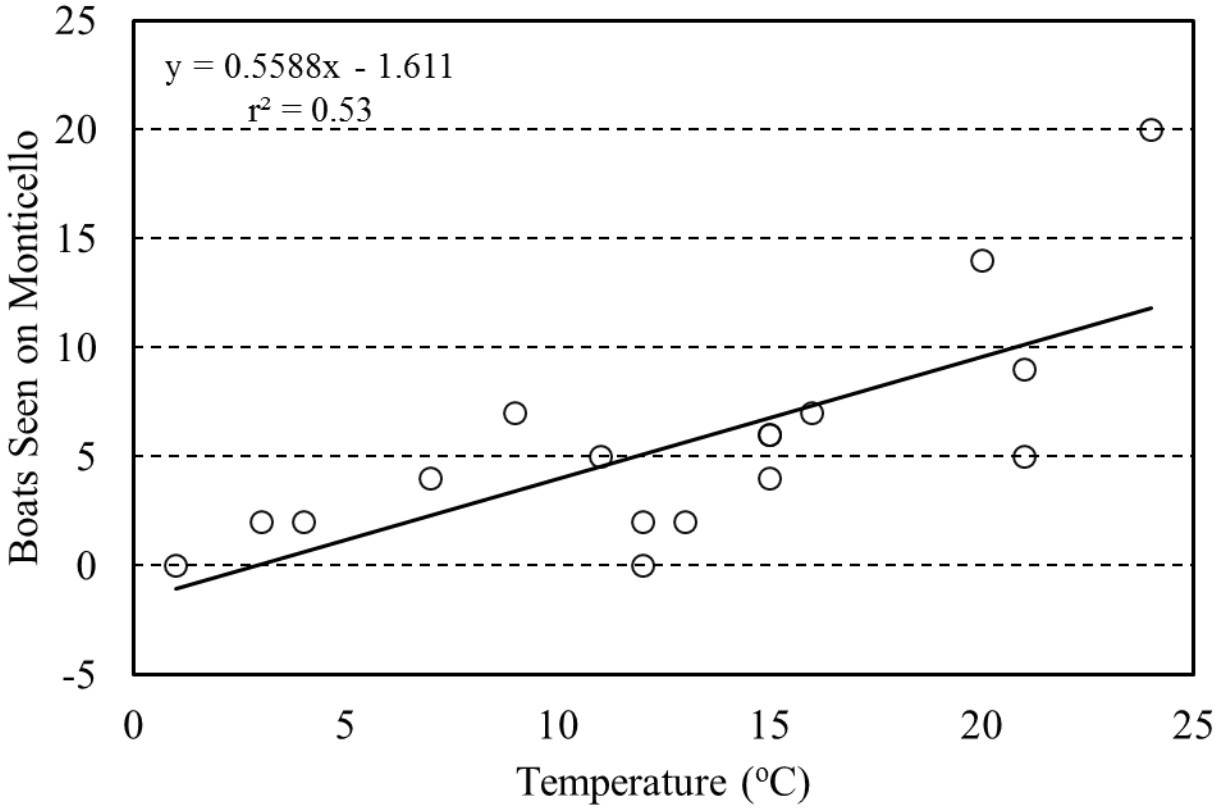

Figure 9. Relationship between temperature (ºC) and numbers of boats seen on Monticello Reservoir at the time of waterfowl aerial surveys during the fall and winters of 2015–2016 and 2016–2017. Temperature data were from Central School Road (KSCLITTL12) weather station, near Peak, SC.