

**NANTAHALA PROJECT - FERC NO. 2692-NC**  
**EAST FORK PROJECT - FERC NO. 2698-NC**  
**WEST FORK PROJECT - FERC NO. 2686-NC**

**SHORELINE HABITAT SURVEY**

**INTRODUCTION**

During the biological studies consultation process subsequent to the issuance of the First Stage Consultation Package for the Nantahala Hydroelectric Project, East Fork Hydroelectric Project and West Fork Hydroelectric Project, the state and federal resource agencies identified the need for shoreline habitat data for the projects' reservoirs. A Technical Leadership Team (TLT) comprised of representatives from the North Carolina Wildlife Resources Commission (NCWRC), the United States Fish and Wildlife Service (USFWS), the United States Forest Service (USFS), the North Carolina Department of Environment and Natural Resources, Division of Water Resources, Friends of Lake Glenville and the applicant was established to develop a study plan for shoreline habitat surveys of the projects' reservoirs. The shoreline habitat surveys were conducted primarily to identify critical spawning and nursery habitat for reservoir fishes.

The objectives of this study were: (1) develop shoreline habitat classifications for the applicable reservoirs, (2) map the littoral shoreline habitat of each reservoir, based upon the classifications developed in objective 1 and (3) evaluate any project-related impacts on aquatic habitat identified in mapping study.

**METHODS**

The study plan called for the aquatic habitat surveys to be conducted through a two-phase approach. The first phase involved an initial identification of shoreline features and exposed lakebed from an examination of aerial photography. The second phase involved ground surveys for actual mapping and quantification of the various habitat types. The aerial photography that was to be used for the initial phase was generated for the GIS Database study.

Shoreline Habitat Mapping

During the initial phase of the study, the TLT determined that the resolution of the aerial photographs was insufficient to delineate shoreline habitat as the basis for identifying areas of focus for the ground surveys. Consequently, the TLT conducted site visits to Lake Glenville and Wolf Lake to develop the habitat classifications. A pontoon boat was used to tour the shorelines of the two reservoirs. Based on the site tours, the TLT developed the shoreline habitat classifications that were used in the habitat mapping conducted during the second phase of the study. Standard criteria were established for each habitat classification to ensure consistent habitat mapping within and among reservoirs. The habitat classifications and associated criteria were: (1) bedrock - greater than 50% solid rock outcrops for a distance of 100 linear feet, (2) clay/weathered rock -

greater than 50% clay or a combination of clay and weathered rock (e.g., gneiss and schist) for a distance of 100 linear feet, (3) fractured rock - greater than 50% medium to large broken boulders for a distance of 100 linear feet, (4) riprap/stacked rock - man-induced structures within the project boundary for a distance of 100 linear feet, (5) sand/cobble - greater than 50% sand or sand and cobble for a distance of 100 linear feet, (6) silt - greater than 50% silt (primarily organic in origin) for a distance of 100 linear feet, (7) woody debris - four or more felled trees (>10 inches in diameter at breast height) extending from the shoreline within a distance of 100 linear feet and (8) vegetated areas/coves with stream confluences - greater than 50% of the area composed of stable, emergent vegetation (minimum width of 5 feet) for a minimum distance of 100 linear feet or where intermittent or permanent streams enter the upper ends of coves (may or may not contain vegetation).

The delineation of the shallow water habitats developed on Glenville and Wolf Creek reservoirs was conducted in Wolf Creek, Tennessee Creek, Bear Creek, Cedar Cliff, Glenville and Nantahala reservoirs during the summer 2002. Habitat mapping of most of the reservoirs was conducted at water elevations that generally ranged from two to three feet below full pool. The habitat delineations were made by two observers and were conducted in all areas of the reservoirs that were accessible by boat. Some shoreline areas on Nantahala Lake and Tennessee Creek Lake were inaccessible for mapping, and those areas were classified and reported as “Not Surveyed”. The observers classified the habitat by type and noted its location and extent on field maps. In addition to habitat types, the location of piers was also recorded.

The field maps and data were provided to Orbis GIS, Inc., Charlotte, NC, for incorporation into a GIS database for each reservoir. The databases were then used to produce habitat distribution maps for each reservoir. Additionally, a tabular summary of habitat types and respective percentages of overall lake shoreline (in feet and miles) was prepared for each reservoir. For those reservoirs whose project boundary line (PBL) or full pool elevation is contiguous with United States Forest Service (USFS) property (i.e., Nantahala Lake, Tennessee Creek Lake, Wolf Creek Lake and Bear Creek Lake), the habitat summary also included a separate habitat table for that portion of shoreline bordering the USFS property boundary.

At the request of the resource agencies, a breakdown of the field data relative to habitat segments and segment lengths was also provided in tabular format. These data were summarized by lake and habitat type for the total number of habitat segments, total lake habitat distance (feet) and segment length statistics (i.e., minimum segment length, maximum segment length and mean segment length in feet).

#### Slope and Elevation Evaluations of Lake Glenville and Nantahala Lake

In addition to identifying and mapping the shallow water habitat of each reservoir, the resource agencies were interested in lakebed slope as a function of habitat changes with lake elevation changes. The agencies were concerned about the potential loss of shoreline habitat as reservoir elevation decreased. The reservoirs of primary concern

were Lake Glenville and Nantahala Lake. To address this concern, a subsample of each of the shoreline habitats within Lake Glenville and Nantahala Lake was selected for evaluation of lakebed slope and elevation during the fall 2002.

Generally, five transects were selected from each of the habitat types in each reservoir; bedrock, clay/weathered rock, fractured rock, riprap, sand, woody debris, and vegetated/stream confluence. Transects were selected to be representative of that habitat type and were distributed throughout the reservoir. Each transect was perpendicular to the shoreline and extended along the lakebed from the normal pool elevation (i.e., about one foot below maximum full pool elevation) to the water level at the time of the field survey. Due to limited or absent habitat, a limited number of sand habitat transects and no riprap habitat transects were evaluated in Nantahala Lake, and no silt habitat transects were evaluated in either reservoir. The slope determinations were conducted at lake levels that were at or near the lowest annual lake level target for Lake Glenville and Nantahala Lake. The lower water elevations afforded excellent visual observation of the vertical distribution of the various habitat types.

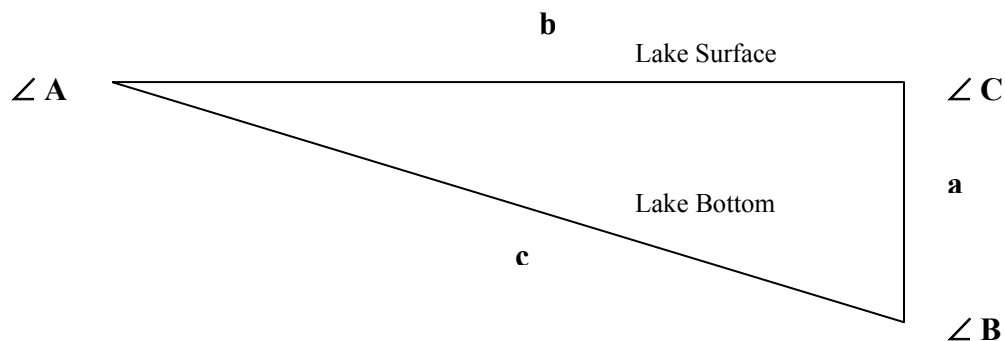
An Abney™ level and surveyor's stadia rod were used to measure the range in elevation and overall slope of the habitats along each transect. All measurements began at the elevation of the reservoir on the day of the survey and ranged up to the normal pool elevation. Data were summarized by habitat type and transect as the elevation range and overall transect slope. Additionally, mean elevation range and slope were calculated for each habitat type in each of the two reservoirs.

To address concerns about habitat losses associated with lake level decreases, the slope and elevation data for Lake Glenville and Nantahala Lake were used to calculate the approximate lakewide habitat losses (both shoreline distance and acreage) associated with 5-foot incremental decreases in lake elevation. The lowest lake elevation evaluated for this phase of the study was the lowest operational lake level target for Nantahala Lake (lake elevation 70 feet). Although the lowest lake elevation observed on Lake Glenville during this study was elevation 86 feet (Lake Glenville minimum lake elevation target), the habitat loss evaluation for Lake Glenville was conducted for lake elevations down to elevation 70 feet. This decision was based on observations of habitat on Nantahala Lake, where clay/weathered rock, fractured rock and bedrock habitat were observed to extend down to and, in some cases, well below elevation 70 feet. On Lake Glenville, these same habitat types were observed to extend below elevation 86 feet, but limited visibility prohibited the direct observation of the full extent of these habitats. Accordingly, for the habitat loss evaluation on Lake Glenville, it was assumed that these habitats in Lake Glenville exhibited vertical distributions similar to those in Nantahala Lake.

To estimate shoreline distance and habitat area at lake elevations less than full pool, it was necessary to assume that Lake Glenville and Nantahala Lake were essentially cone-shaped basins and exhibited uniform changes in shoreline distance and lakebed area with decreasing lake elevations. A direct relationship between lake elevation and shoreline distance was not available; however, equations relating lake elevation and lake storage volume were available. These equations were used to calculate the storage volumes of

the two reservoirs at 5-foot increment lake elevations, from the full pool elevation, 100 feet, to elevation 70 feet. Since shoreline distances and corresponding storage volumes at full pool elevation were available for both reservoirs, those values were used to establish a simple ratio between shoreline distance and storage volume. Those ratios were then applied to the respective reservoir's storage volumes calculated from the lake elevation/storage volume equations mentioned above, to estimate the shoreline distances associated with storage volumes at each of the 5-foot increment lake elevations (i.e., 95 feet, 90 feet, 85 feet, etc.)

The next step was to calculate, for each habitat type, the maximum lakebed distance. This is the distance that a habitat type extended within the 30-foot fluctuation range between full pool elevation 100 feet and elevation 70 feet (i.e., the length of a straight line perpendicular to the shoreline, parallel to the lakebed and terminating at the end of the habitat type). The maximum lakebed distance represents the maximum habitat available at that transect at full pool elevation. For example, since bedrock substrate extended over the entire 30-foot range of fluctuation, the maximum lakebed distance for bedrock habitat would be the entire lakebed distance between full pool elevation and elevation 70 feet. To calculate this maximum lakebed distance, the lakebed slope (measured during field survey) and maximum depth of habitat (determined based on habitat elevation range from field survey) were used to construct a right triangle (see figure below), in which the right angle ( $\angle C$ ) was formed by the intersection of the lake surface (side **b**) with a perpendicular line extending from the lake surface to the lakebed (side **a**) at the point of maximum habitat depth. The hypotenuse of this right triangle (side **c**) was the unknown maximum lakebed distance. Since the angle formed by the intersection of the lake surface with the lakebed ( $\angle A$ ) was known (the measured lakebed slope) and the vertical distance from the lake surface to the maximum habitat depth (side **a**) was known (the difference between the elevations at which a habitat type began and ended), the maximum lakebed distance (side **c**) could be calculated using the sine function for  $\angle A$ , where  $\sin A = a/c$ .



Since decreases in lake elevation result in dewatering of a portion of the lakebed, habitats in the dewatered zone are eliminated. To account for those habitat losses and to estimate

the remaining habitat at the lower lake elevations, the lakebed habitat distances had to be recalculated for each 5-foot decrease in lake elevation. These calculations were performed using the same sine function and equation described above, but decreasing the maximum habitat depth (side **a**) by 5 feet for each successive 5-foot drop in lake elevation. The resulting dataset contained lakebed habitat in linear feet for each habitat type at full pool elevation and at every 5-foot decrease in lake elevation down to elevation 70 feet.

With estimates of shoreline distances and lakebed habitat for all lake elevations from full pool to elevation 70 feet, the next step was to determine shoreline mileages and total lake acreages for each habitat type at each lake elevation. To determine the shoreline mileage for each habitat type at each lake elevation, the habitat percentages determined from the field surveys were applied to the recalculated shoreline distances for each of the elevations below full pool (i.e., 95 feet, 90 feet, 85 feet, 80 feet, 75 feet and 70 feet) to yield the total lake shoreline distance for each habitat type at each lake elevation. To determine the total acreage for each habitat type at each lake elevation, the shoreline mileages calculated above were converted to distances in feet. Those shoreline distances were then multiplied by the corresponding lakebed habitat distances in feet to yield habitat areas in square feet. Those areas were then converted to acreages by dividing by 43,560, the number of square feet in one acre. The resulting shoreline miles and lake acreages for each habitat type at each lake elevation were tabulated for easy comparison and evaluation of habitat changes associated with lake elevation changes.

## **RESULTS AND DISCUSSION**

The composition and relative abundance of shoreline habitats varied by reservoir (Table 1 and Figures 1 - 6). Within each reservoir, the number of habitat segments and segment length statistics varied by habitat type (Table 2).

Overall, the shoreline habitat surveys revealed that the majority of habitat in most of the Nantahala Area reservoirs is clay/weathered rock, fractured rock and bedrock. With the exception of Cedar Cliff Lake, of those three “rock” habitat types, clay/weathered rock is the most prevalent habitat and comprises from 39.0% of the total shoreline on Bear Creek Lake (Figure 5) to 68.1% of the total shoreline on Wolf Creek Lake (Figure 4). Of the natural habitat types, silt, sand/cobble and woody debris are the least abundant habitats. Silt habitat is the least abundant of those three habitats and is only present in Nantahala Lake, Tennessee Creek Lake and Wolf Creek Lake, where it comprises only 0.5% to 1.2% of the total shoreline (Figures 1, 3 and 4). The vegetated/stream confluence habitat type is present in all reservoirs; however, it comprises a relatively small percentage of the total habitat in each reservoir. The percentages of vegetated/stream confluence habitat in the reservoirs range from 1.5% in Cedar Cliff Lake (Figure 6) to 5.2% in Nantahala Lake (Figure 1). The riprap/stacked rock habitat type, indicative of development, is found in all six reservoirs, but is most abundant in Lake Glenville, the most developed of the six reservoirs (Figures 1 - 6). The percentages of riprap/stacked rock habitat range from 1.0% of the shoreline in Nantahala Lake (Figure 1) to 12.4% of the shoreline in Lake Glenville (Figure 2).

### Nantahala Lake

Almost 83% of the shoreline habitat in Nantahala Lake is either clay/weathered rock or fractured rock (Table 1 and Figure 1). Although vegetated/stream confluence habitat comprised only 5.2% of the Nantahala Lake shoreline, this was the highest percentage of the six reservoirs surveyed. The least abundant shoreline habitat was silt (0.5%), followed by bedrock and riprap, each of which comprised 1.0% of the shoreline.

Nantahala Lake is one of four Nantahala Area reservoirs whose full pool elevation or PBL borders USFS property. Of the 30.7 total miles of shoreline, 15.7 miles, or 51% of the shoreline falls into this category (Table 1). As such, the habitats associated with that shoreline are essentially protected from development. For most of the surveyed habitat types, a high percentage of the total lake habitat is within this “protected” area: 50.0% of the vegetated/stream confluence, 66.7% of the woody debris, 46.7% of the clay/weathered rock, 66.7% of the bedrock and 64.7% of the fractured rock.

### Lake Glenville

The most abundant habitat type in Lake Glenville is clay/fractured rock, which comprises 56.8% of the shoreline habitat (Table 1 and Figure 2). The majority of the remaining habitat consists of the other three “rock” habitats (riprap/stacked rock, fractured rock and bedrock), which, collectively, comprise 31.4% of the shoreline habitat. Woody debris (1.6%), sand/cobble (6.1%) and vegetated/stream confluence (4.2%) habitats collectively comprise only 11.9% of the Lake Glenville shoreline habitat.

### Wolf Creek Lake

Similar to the observed habitat in Lake Glenville, the majority of the shoreline habitat in Wolf Creek Lake is “rock” habitat (92.3%) (Table 1 and Figure 4). The most abundant “rock” habitat is clay/fractured rock, which comprises 68.1% of the total lake habitat. The next most abundant habitat is bedrock, which comprises 13.7% of the shoreline habitat. Woody debris (0.3%), sand/cobble (2.6%) and vegetated/stream confluence (3.6%) habitats collectively comprise only 6.5% of the Wolf Creek Lake shoreline habitat.

Wolf Creek Lake is another Nantahala Area reservoir where the PBL borders USFS property. Of the 7.6 miles of shoreline, 3.2 miles or 42% of the shoreline borders USFS property (Table 1). Almost half (41%) of the Wolf Creek Lake “rock” habitat is bordered by USFS property, while 33.3% of the vegetated/stream confluence habitat and 18.4% of the sand/cobble habitat is bordered by USFS property.

### Tennessee Creek Lake

On Tennessee Creek Lake, 83.1% of the shoreline habitat is comprised of clay/weathered rock and bedrock (Table 1 and Figure 3). Silt (1.2%) and fractured rock (1.1%) are

minor components of the overall shoreline habitat. Riprap/stacked rock (3.7%) and vegetated/stream confluence (3.4%) habitats are about equally represented.

Tennessee Creek Lake is another of the Nantahala Area reservoirs whose PBL borders USFS property. About a third (31%) of this reservoir's shoreline is associated with USFS property. For the predominant habitat types, clay/weathered rock and bedrock, about a third of that habitat is located along project shoreline associated with USFS property (Table 1).

### Bear Creek Lake

The majority of shoreline habitat on Bear Creek Lake (77.9%) is comprised of about equal percentages of clay/weathered rock (39.0%) and fractured rock (38.9%) (Table 1 and Figure 5). As with most of the Nantahala Area reservoirs, "rock" habitat types are the predominant habitats, and collectively comprise 88.9% of the Bear Creek Lake shoreline habitat. Vegetated/stream confluence, sand/cobble and woody debris are minor habitat components comprising only 3.5%, 3.3% and 2.5%, respectively, of the overall Bear Creek Lake shoreline.

Bear Creek Lake is the last of the four Nantahala Area reservoirs whose PBL borders USFS property. The percentage of Bear Creek Lake shoreline associated with USFS property (18%) is the least of the four reservoirs (Table 1). For the two most abundant habitats in Bear Creek Lake, clay/weathered rock and fractured rock, only 17% of that total habitat is associated with USFS property.

### Cedar Cliff Lake

Consistent with the other Nantahala Area reservoirs, the majority of shoreline habitat in Cedar Cliff Lake (87.6%) is comprised of "rock" habitat types, with fractured rock being the most abundant habitat (43.8%) and clay/weathered rock being the second most abundant habitat (28.8%) (Table 1 and Figure 6). Of the six reservoirs surveyed, Cedar Cliff Lake has the highest percentage of sand/cobble habitat (9.7%). Similar to the other reservoirs, vegetated/stream confluence (1.5%) and woody debris (1.3%) habitats are minor components of the Cedar Cliff Lake shoreline.

### Effect of Reservoir Level Decreases on Shoreline Habitat

Lakebed slopes and elevations in Nantahala Lake and Lake Glenville varied by habitat type (Tables 3 and 4). For most habitats, the average lakebed slopes in Nantahala Lake are steeper than those in Lake Glenville, however, the vertical distributions of habitats are similar for the two reservoirs. This similarity is especially true for the natural "rock" habitat types, which tend to be uniformly distributed over the range of reservoir level fluctuation in each reservoir. The habitat type in both reservoirs with the most limited vertical distribution is the vegetated/stream confluence habitat. Because this habitat is typically associated with the lower gradient, shallower portions of the reservoirs, it is the habitat that is most susceptible to impacts resulting from reservoir level decreases.

## Nantahala Lake

Due to maintenance activities at the Nantahala powerhouse, the surface elevation of Nantahala Lake at the time of the survey was approximately ten feet lower than the normal, minimum elevation target for the reservoir (elevation 70 feet). As a result of this abnormally low reservoir level ( $\approx$  elevation 60 feet), a more detailed evaluation of the extent of vertical distribution of the various habitat types in Nantahala Lake was possible.

Average lakebed slopes and elevation ranges varied by habitat type (Table 3). The habitat types associated with the steepest average lakebed slopes are bedrock ( $33^\circ$  slope), fractured rock ( $29^\circ$  slope) and woody debris ( $23^\circ$  slope). The habitat types associated with moderate lakebed slopes are clay/weathered rock ( $16^\circ$  slope) and sand ( $10^\circ$  slope). The vegetated/stream confluence habitat type is found in areas of the reservoir with very little lakebed gradient ( $5^\circ$  slope).

All habitat types except the vegetated/stream confluence and woody debris habitats extend over the entire normal operating range of target reservoir levels (elevation 100 feet to elevation 70 feet). The woody debris habitat extends to within two vertical feet of the normal minimum target level. The vegetated/stream confluence habitat is limited to the upper ten feet of the reservoir.

The effect of reservoir level decreases on habitat in Nantahala Lake varies by habitat type and is a function of the vertical distribution of a particular habitat. A comparison of the estimated total lake habitat area (acres) at full pool to the total lake habitat area (acres) at various lower elevations (Table 5) shows the relative changes in habitat with changes in reservoir elevation. It should be noted, however, that the habitat estimates used for this comparison do not represent absolute lake-wide habitat quantities, since the estimates are based on an average of lakebed slopes and elevation ranges measured/observed at the time of the field survey. These estimates of available habitat at various reservoir elevations only represent lakebed habitat observable at and above the reservoir level on the day of the survey. The most abundant habitat types, the natural "rock" habitats, extended below the reservoir level at the time of the survey, but the depth of their distribution could not be determined. Accordingly, the habitat estimates should be viewed as conservative estimates of the actual habitat present.

The percentages of shoreline habitat reductions resulting from reservoir level decreases in Nantahala Lake vary by habitat type (Table 7). Although substantially reduced in total area, four of the six identified habitats in Nantahala Lake (sand/cobble, clay/weathered rock, bedrock and fractured rock) are still available at reservoir elevations down to and below the normal minimum reservoir level target of elevation 70 feet (Table 8). Woody debris habitat disappears at reservoir levels one to two feet above the minimum target. Because of its association with very low gradient shoreline, vegetated/stream confluence habitat is the most severely impacted habitat and generally disappears at reservoir elevations between 95 and 90 feet.

Concerning any potential adverse impacts of reservoir level decreases and associated habitat reductions on the Nantahala Lake fishery, the period of the year when reservoir levels are the lowest (November - February) is generally the period when fish are the least active. As fish activity increases in the early spring, reservoir levels are rising. One of the potentially important fish habitats for spring/summer spawning and nursery functions, vegetated/stream confluence habitat, is only present at reservoir elevations at or above elevation 93 feet. Although reservoir elevations begin to rise during February, they typically won't reach elevation 93 feet until sometime between April and May. This could result in vegetated/stream confluence habitat being unavailable during a portion of the spring spawning period.

Whether the potential unavailability of this one type of spawning/nursery habitat in early spring has an overall adverse impact on fish production in Nantahala Lake is unknown; however, since this habitat type comprises such a small percentage of the total shoreline in Nantahala Lake (5.2 %), it is likely that the spawning/nursery habitat function is being provided by other more abundant and more widely available habitats. In considering potential impacts to fish spawning, reservoir level changes after spawning activities have begun can be critically important, especially for nest-building fish species. If reservoir levels decrease appreciably after nests have been constructed and eggs deposited, nests and eggs can be dewatered. Since the reservoir level targets and operating guidelines for Nantahala Lake provide for rising reservoir levels from early spring through early summer, the risk of reservoir level decreases during the spring/early summer spawning season are minimal.

## Lake Glenville

Average lakebed slopes and elevation ranges in Lake Glenville varied by habitat type (Table 4) and exhibited trends similar to those in Nantahala Lake. The habitat types associated with the steepest average lakebed slopes are the natural "rock" habitats, bedrock (22° slope) and fractured rock (21° slope), and the man-made "rock" habitat riprap (27° slope). The habitat types associated with moderate lakebed slopes are woody debris (14° slope) and clay/weathered rock (10° slope). The sand (8° slope) and vegetated/stream confluence (4° slope) habitat types are found in areas of the reservoir with marginal lakebed slopes.

All habitat types except the vegetated/stream confluence and riprap habitats extend over the entire normal operating range of target reservoir levels (elevation 100 feet to elevation 86 feet). The riprap habitat is generally limited to the upper ten feet of the reservoir, while the vegetated/stream confluence habitat is limited to the upper five feet of the reservoir.

The effect of reservoir level decreases on habitat in Lake Glenville varies by habitat type and is a function of the vertical distribution of a particular habitat. A comparison of the estimated total lake habitat area (acres) at full pool to the total lake habitat area (acres) at various lower elevations (Table 6) shows the relative changes in habitat with changes in reservoir elevation. The same precautions noted for Nantahala Lake, concerning

comparative habitat estimates not representing absolute lake-wide habitat quantities, also apply to Lake Glenville. Additionally, the estimates of available habitat in Lake Glenville at various reservoir elevations are the result of extrapolating beyond the surveyed reservoir elevation 86 feet, based on the distribution of the same habitat types in Nantahala Lake. As with Nantahala Lake, the most abundant habitat types, the natural “rock” habitats, were distributed from full pool elevation to below the minimum reservoir level target (elevation 86 feet).

The percentages of shoreline habitat reductions resulting from reservoir level decreases in Lake Glenville vary by habitat type (Table 9). Although substantially reduced in total area, four of the six identified natural habitats in Lake Glenville (woody debris, clay/weathered rock, bedrock and fractured rock) are still available at reservoir elevations down to and below the normal minimum reservoir target elevation 86 feet (Table 8). Sand habitat disappears at the minimum reservoir target elevation. As was the case in Nantahala Lake, because of its association with very low gradient shoreline, vegetated/stream confluence habitat is the most severely impacted habitat and generally disappears at reservoir elevations between 100 and 95 feet.

The discussions of potential adverse impacts of reservoir level decreases and associated habitat reductions on the Nantahala Lake fishery, also apply to the Lake Glenville fishery. As was previously notes, the period of the year when reservoir levels are the lowest (November - February) is generally the period when fish are the least active. The late winter/early spring is also the period of the year when Lake Glenville reservoir levels are rising. On Lake Glenville, the vegetated/stream confluence habitat is only present at reservoir elevations at or above elevation 95 feet. Reservoir elevations in Lake Glenville generally reach this level around the first of April, so the vegetated/stream confluence habitat is available for most of the spawning season. Even if the vegetated/stream confluence habitat was unavailable during a portion of the spawning season, similar to Nantahala Lake, this habitat type comprises a small percentage of the total shoreline in Lake Glenville (4.2 %), and it is likely that the spawning/nursery habitat function in Lake Glenville is also being provided by other more abundant and more widely available habitats.

In considering potential impacts to fish spawning, reservoir level changes after spawning activities have begun can be critically important, especially for nest-building fish species. If reservoir levels decrease appreciably after nests have been constructed and eggs deposited, nests and eggs can be dewatered. Since the reservoir level targets and operating guidelines for Lake Glenville provide for rising reservoir levels from early spring through mid summer, the risk of reservoir level decreases during the spring/early summer spawning season are minimal.

Table 1. Shoreline habitat survey results by habitat type for Nantahala Lake, Lake Glenville, Tennessee Creek Lake, Wolf Creek Lake, Bear Creek Lake and Cedar Cliff Lake.

### Nantahala Lake Summary

<b>Entire Lake</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	1.6	8,380.7	5.2%
Sand/Cobble	0.5	2,562.5	1.6%
Woody Debris	0.9	4,925.3	3.0%
Clay/Weathered Rock	15.2	80,424.3	49.6%
Bedrock	0.3	1,575.1	1.0%
Fractured Rock	10.2	53,630.3	33.1%
Riprap/Stacked Rock	0.3	1,637.5	1.0%
Silt	0.2	850.4	0.5%
Not Surveyed	1.5	8,172.4	5.0%
<b>Total</b>	<b>30.7</b>	<b>162,158.3</b>	<b>100.0%</b>

<b>USFS Boundary touching Full Pond*</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.5	2,552.8	7.9%
Sand/Cobble	0.0	235.3	0.7%
Woody Debris	0.4	2,158.5	6.6%
Clay/Weathered Rock	3.5	18,557.4	57.1%
Bedrock	0.0	179.4	0.6%
Fractured Rock	1.7	8,794.8	27.1%
Riprap/Stacked Rock	0.0	0.0	0.0%
Silt	0.0	0.0	0.0%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>6.2</b>	<b>32,478.1</b>	<b>100.0%</b>

\* 20% of the Full Pond boundary is touched by Forest Service Land

<b>USFS Boundary touching PBL*</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.4	1,883.4	3.7%
Sand/Cobble	0.0	0.0	0.0%
Woody Debris	0.2	1,077.4	2.1%
Clay/Weathered Rock	3.5	18,667.9	36.9%
Bedrock	0.2	989.8	2.0%
Fractured Rock	4.9	25,795.0	51.1%
Riprap/Stacked Rock	0.0	161.3	0.3%
Silt	0.0	125.9	0.2%
Not Surveyed	0.3	1,827.8	3.6%
<b>Total</b>	<b>9.6</b>	<b>50,528.5</b>	<b>100.0%</b>

\* 31% of the Project Boundary Line is touched by Forest Service Land

Table 1. Continued.

**Nantahala Lake Summary (continued)**

<b>USFS Boundary touching PBL or Full Pond*</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.8	4,436.1	5.3%
Sand/Cobble	0.0	235.3	0.3%
Woody Debris	0.6	3,235.8	3.9%
Clay/Weathered Rock	7.1	37,225.4	44.8%
Bedrock	0.2	1,169.2	1.4%
Fractured Rock	6.6	34,589.7	41.7%
Riprap/Stacked Rock	0.0	161.3	0.2%
Silt	0.0	125.9	0.2%
Not Surveyed	0.3	1,827.8	2.2%
<b>Total</b>	<b>15.7</b>	<b>83,006.6</b>	<b>100.0%</b>

\* 51% of the Project Boundary Line or Full Pond is touched by Forest Service Land

**Lake Glenville Summary**

<b>Entire Lake</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	1.2	6,119.7	4.2%
Sand/Cobble	1.7	8,900.8	6.1%
Woody Debris	0.4	2,372.6	1.6%
Clay/Weathered Rock	15.8	83,204.6	56.8%
Bedrock	2.1	10,853.4	7.4%
Fractured Rock	3.2	16,958.7	11.6%
Riprap/Stacked Rock	3.4	18,103.9	12.4%
Silt	0.0	0.0	0.0%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>27.7</b>	<b>146,513.7</b>	<b>100.0%</b>

**Wolf Creek Lake Summary**

<b>Entire Lake</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.3	1,450.8	3.6%
Sand/Cobble	0.2	1,022.4	2.6%
Woody Debris	0.0	114.5	0.3%
Clay/Weathered Rock	5.1	27,160.6	68.1%
Bedrock	1.0	5,456.7	13.7%
Fractured Rock	0.5	2,848.6	7.1%
Riprap/Stacked Rock	0.3	1,369.8	3.4%
Silt	0.1	464.5	1.2%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>7.6</b>	<b>39,888.1</b>	<b>100.0%</b>

Table 1. Continued.

**Wolf Creek Lake Summary (continued)**

<b>Forest Service Boundary touching PBL*</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.1	677.7	4.1%
Sand/Cobble	0.0	194.7	1.2%
Woody Debris	0.0	41.5	0.2%
Clay/Weathered Rock	2.0	10,375.1	62.1%
Bedrock	0.5	2,829.1	16.9%
Fractured Rock	0.4	2,276.0	13.6%
Riprap/Stacked Rock	0.0	0.0	0.0%
Silt	0.1	303.8	1.8%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>3.2</b>	<b>16,697.9</b>	<b>100.0%</b>

\* 42% of the Project Boundary Line is touched by Forest Service Land

**Tennessee Creek Lake Summary**

<b>Entire Lake</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.1	697.6	3.4%
Sand/Cobble	0.0	0.0	0.0%
Woody Debris	0.0	0.0	0.0%
Clay/Weathered Rock	1.8	9,563.5	46.5%
Bedrock	1.4	7,543.7	36.6%
Fractured Rock	0.0	220.6	1.1%
Riprap/Stacked Rock	0.1	757.6	3.7%
Silt	0.0	248.0	1.2%
Not Surveyed	0.3	1,555.3	7.6%
<b>Total</b>	<b>3.9</b>	<b>20,586.2</b>	<b>100.0%</b>

<b>Forest Service Boundary touching PBL*</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.0	83.1	1.3%
Sand/Cobble	0.0	0.0	0.0%
Woody Debris	0.0	0.0	0.0%
Clay/Weathered Rock	0.7	3,550.4	54.5%
Bedrock	0.3	1,615.2	24.8%
Fractured Rock	0.0	0.0	0.0%
Riprap/Stacked Rock	0.1	542.1	8.3%
Silt	0.0	0.0	0.0%
Not Surveyed	0.1	719.7	11.1%
<b>Total</b>	<b>1.2</b>	<b>6,510.5</b>	<b>100.0%</b>

\* 32% of the Project Boundary Line is touched by Forest Service Land

Table 1. Continued.

**Bear Creek Lake Summary**

<b>Entire Lake</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.6	2,989.3	3.5%
Sand/Cobble	0.5	2,788.4	3.3%
Woody Debris	0.4	2,105.3	2.5%
Clay/Weathered Rock	6.3	33,229.2	39.0%
Bedrock	1.8	9,375.9	11.0%
Fractured Rock	6.3	33,106.2	38.9%
Riprap/Stacked Rock	0.3	1,616.3	1.9%
Silt	0.0	0.0	0.0%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>16.1</b>	<b>85,210.6</b>	<b>100.0%</b>

<b>Forest Service Boundary touching PBL*</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.1	474.8	3.1%
Sand/Cobble	0.0	0.0	0.0%
Woody Debris	0.0	122.8	0.8%
Clay/Weathered Rock	1.0	5,367.5	35.5%
Bedrock	0.6	3,329.3	22.0%
Fractured Rock	1.1	5,829.5	38.5%
Riprap/Stacked Rock	0.0	0.0	0.0%
Silt	0.0	0.0	0.0%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>2.9</b>	<b>15,123.8</b>	<b>100.0%</b>

\* 18% of the Project Boundary Line is touched by Forest Service Land

**Cedar Cliff Lake Summary**

<b>Entire Lake</b>			
<b>Type</b>	<i>Miles</i>	<i>Feet</i>	<i>Percentage</i>
Vegetated/Stream Confluence	0.1	429.9	1.5%
Sand/Cobble	0.5	2,742.5	9.7%
Woody Debris	0.1	357.5	1.3%
Clay/Weathered Rock	1.5	8,173.5	28.8%
Bedrock	0.6	3,413.7	12.0%
Fractured Rock	2.4	12,453.9	43.8%
Riprap/Stacked Rock	0.2	842.1	3.0%
Silt	0.0	0.0	0.0%
Not Surveyed	0.0	0.0	0.0%
<b>Total</b>	<b>5.4</b>	<b>28,413.2</b>	<b>100.0%</b>

Table 2. Number of habitat segments and segment length statistics, by reservoir and habitat type, for shoreline habitat surveys of the Nantahala reservoirs.

Lake	Habitat Type	No. of Segments	Length Statistics by Habitat Type (ft)			
			Total	Minimum	Maximum	Mean
Nantahala	Bedrock	11	1,575.1	33.0	439.6	143.2
	Clay/Weathered Rock	137	80,424.2	18.8	5,004.1	587.0
	Fractured Rock	89	53,630.4	26.2	4,962.9	602.6
	Not Surveyed	4	8,172.4	1,827.8	2,193.1	2,043.1
	Riprap/Stacked Rock	4	1,637.5	123.0	1,113.7	409.4
	Sand/Cobble	5	2,562.5	148.9	1,280.1	512.5
	Silt	2	850.4	125.9	724.5	425.2
	Vegetated/Stream Confluence	48	8,380.7	24.8	1,798.3	174.6
	Woody Debris	40	4,925.3	32.3	963.3	123.1
	<b>Totals</b>	340	162,158.4			
Glenville	Bedrock	56	10,853.5	40.6	862.7	193.8
	Clay/Weathered Rock	209	83,204.6	46.9	2,760.9	398.1
	Fractured Rock	57	16,995.1	52.0	1,260.5	298.2
	Riprap/Stacked Rock	64	18,103.9	41.4	1,325.7	282.9
	Sand/Cobble	57	8,900.7	30.3	853.0	156.2
	Vegetated/Stream Confluence	54	6,119.7	26.0	552.4	113.3
	Woody Debris	24	2,372.5	31.4	387.3	98.9
		<b>Totals</b>	521	146,550.1		
Wolf Creek	Bedrock	13	5,456.7	64.1	1,020.6	419.7
	Clay/Weathered Rock	40	27,160.6	64.6	2,623.5	679.0
	Fractured Rock	12	2,848.6	43.8	739.5	237.4
	Riprap/Stacked Rock	3	1,369.8	58.9	1,176.3	456.6
	Sand/Cobble	8	1,022.4	37.1	277.1	127.8
	Silt	3	464.5	70.6	303.8	154.8
	Vegetated/Stream Confluence	19	1,450.8	18.2	228.6	76.4
	Woody Debris	2	114.5	41.5	73.1	57.3
	<b>Totals</b>	100	39,888.0			

Table 2. Continued.

Lake	Habitat Type	No. of Segments	Length Statistics by Habitat Type (ft)			
			Total	Minimum	Maximum	Mean
Tennessee Creek	Bedrock	16	7,543.7	44.0	1,660.4	471.5
	Clay/Weathered Rock	21	9,563.5	62.1	1,163.3	455.4
	Fractured Rock	2	220.6	73.3	147.3	110.3
	Not Surveyed	2	1,555.3	719.7	835.6	777.6
	Riprap/Stacked Rock	2	757.6	215.5	542.1	378.8
	Silt	2	248.0	89.8	158.1	124.0
	Vegetated/Stream Confluence	9	697.6	34.4	255.6	77.5
	<b>Totals</b>	<b>54</b>	<b>20,586.2</b>			
Bear Creek	Bedrock	38	9,375.9	57.5	832.9	246.7
	Clay/Weathered Rock	100	33,229.2	52.1	1,966.5	332.3
	Fractured Rock	93	33,106.2	58.3	2,292.7	356.0
	Riprap/Stacked Rock	4	1,616.3	111.2	1,233.8	404.1
	Sand/Cobble	18	2,788.4	60.1	489.9	154.9
	Vegetated/Stream Confluence	30	2,989.3	38.5	708.3	99.6
	Woody Debris	20	2,105.3	42.3	246.5	105.3
	<b>Totals</b>	<b>303</b>	<b>85,210.6</b>			
Cedar Cliff	Bedrock	16	3,413.7	64.0	398.1	213.4
	Clay/Weathered Rock	26	8,173.5	49.3	1,018.1	314.4
	Fractured Rock	28	12,453.8	59.4	1,539.3	444.8
	Riprap/Stacked Rock	1	842.2	842.2	842.2	842.2
	Sand/Cobble	11	2,742.5	55.2	569.9	249.3
	Vegetated/Stream Confluence	8	429.9	38.8	79.5	53.7
	Woody Debris	6	357.5	44.7	87.7	59.6
	<b>Totals</b>	<b>96</b>	<b>28,413.2</b>			

Table 3. Elevation (feet) and slope (°) associated with major littoral habitat types found in Nantahala Lake.

Transect	Bedrock		Clay/weathered rock		Fractured rock		Sand*		Woody debris		Vegetation	
	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope
1	99.0-59.4	27	99.0-59.4	22	99.0-67.8	24	99.0-59.4	13	99.0-73.0	23	99.0-90.7	3
2	99.0-59.4	27	99.0-59.4	21	99.0-59.4	29	99.0-59.4	8	99.0-81.0	16	99.0-92.3	4
3	99.0-76.3	28	99.0-59.4	16	99.0-81.0	23	99.0-58.9	10	99.0-74.4	20	99.0-93.3	3
4	99.0-58.9	27	99.0-59.4	8	99.0-59.4	31	99.0-58.9	8	99.0-75.3	27	99.0-96.6	4
5	99.0-80.3	56	99.0-59.4	15	99.0-59.4	40			99.0-71.7	31	99.0-94.3	10
Mean	99.0-66.9	33	99.0-59.4	16	99.0-65.5	29	99.0-59.2	10	99.0-71.7	23	99.0-93.4	5

\*Only four areas of sand habitat were identified

Table 4. Elevation (feet) and slope (°) associated with major littoral habitat types found in Lake Glenville.

Transect	Bedrock		Clay/weathered rock		Fractured rock		Riprap		Sand		Woody debris		Vegetation	
	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope	Elevation	Slope
1	99.0-86.1	16	99.0-86.1	7	99.0-86.1	24	99.0-88.9	27	99.0-86.1	8	99.0-78.2	14	99.0-94.1	2
2	99.0-86.1	13	99.0-86.1	12	99.0-86.1	17	99.0-94.0	38	99.0-86.1	6	99.0-80.1	12	99.0-94.1	2
3	99.0-86.1	23	99.0-85.9	10	99.0-86.1	24	99.0-93.0	20	99.0-85.9	9	99.0-78.9	13	99.0-97.5	6
4	99.0-86.1	39	99.0-89.1	15	99.0-85.9	19	99.0-96.3	32	99.0-85.9	7	99.0-78.9	16	99.0-96.5	7
5	99.0-85.9	21	99.0-85.9	8	99.0-85.9	20	99.0-93.2	18	99.0-85.9	8	99.0-80.4	15	99.0-93.9	1
Mean	99.0-86.0	22	99.0-86.6	10	99.0-86.0	21	99.0-93.1	27	99.0-86.0	8	99.0-79.3	14	99.0-95.2	4

Table 5. Nantahala Lake shoreline habitat distance (mi.) and area (ac.) at various lake levels below full pool.

**NANTAHALA LAKE SHORELINE HABITAT DISTANCE (MI.) AT VARIOUS LAKE LEVELS**

Habitat Type	Full Pool		Lake Level						
	Miles	Percentage	100	95	90	85	80	75	70
Vegetated/Stream Confluence	1.6	5.2%	1.6	1.5	0.0	0.0	0.0	0.0	0.0
Sand/Cobble	0.5	1.6%	0.5	0.5	0.4	0.4	0.4	0.4	0.3
Woody Debris	0.9	3.0%	0.9	0.9	0.8	0.8	0.7	0.7	0.0
Clay/Weathered Rock	15.2	49.6%	15.2	14.3	13.5	12.7	12.0	11.2	10.5
Bedrock	0.3	1.0%	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Fractured Rock	10.2	33.1%	10.2	9.6	9.0	8.5	8.0	7.5	7.0
Riprap/Stacked Rock	0.3	1.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silt	0.2	0.5%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Not Surveyed	1.5	5.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>	<b>30.7</b>	<b>100.0%</b>	<b>28.7</b>	<b>27.0</b>	<b>24.0</b>	<b>22.6</b>	<b>21.3</b>	<b>19.9</b>	<b>18.0</b>

**NANTAHALA LAKE SHORELINE HABITAT AREA (AC.) AT VARIOUS LAKE LEVELS**

Habitat Type	Full Pool		Lake Level						
	Feet	Percentage	100	95	90	85	80	75	70
Vegetated/Stream Confluence	8,381	5.2%	14.6	3.3	0.0	0.0	0.0	0.0	0.0
Sand/Cobble	2,562	1.6%	13.8	11.4	9.2	7.3	5.5	3.9	2.5
Woody Debris	4,925	3.0%	8.2	6.3	4.7	3.2	1.9	0.7	0.0
Clay/Weathered Rock	80,424	49.6%	272.0	224.5	182.5	143.0	110.0	76.9	48.8
Bedrock	1,575	1.0%	2.2	1.8	1.4	1.0	0.7	0.4	0.1
Fractured Rock	53,630	33.1%	87.7	70.4	55.1	41.3	28.9	17.8	7.9
Riprap/Stacked Rock	1,638	1.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silt	850	0.5%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Not Surveyed	8,172	5.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>	<b>162,158</b>	<b>100.0%</b>	<b>398.4</b>	<b>317.7</b>	<b>252.8</b>	<b>195.7</b>	<b>146.9</b>	<b>99.7</b>	<b>59.4</b>

Table 6. Lake Glenville shoreline habitat distance (mi.) and area (ac.) at various lake levels below full pool.

**LAKE GLENVILLE SHORELINE HABITAT DISTANCE (MI.) AT VARIOUS LAKE LEVELS**

Habitat Type	Full Pool		Lake Level						
	Miles	Percentage	100	95	90	85	80	75	70
Vegetated/Stream Confluence	1.2	4.2%	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Sand/Cobble	1.7	6.1%	1.7	1.5	1.4	0.0	0.0	0.0	0.0
Woody Debris	0.4	1.6%	0.4	0.4	0.4	0.3	0.3	0.0	0.0
Clay/Weathered Rock	15.8	56.8%	15.8	14.1	12.7	11.3	9.9	8.7	7.6
Bedrock	2.1	7.4%	2.1	1.8	1.7	1.5	1.3	1.1	1.0
Fractured Rock	3.2	11.6%	3.2	2.9	2.6	2.3	2.0	1.8	1.5
Riprap/Stacked Rock	3.4	12.4%	3.4	3.1	0.0	0.0	0.0	0.0	0.0
Silt	0.0	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>	<b>27.7</b>	<b>100.0%</b>	<b>27.7</b>	<b>23.9</b>	<b>18.6</b>	<b>15.4</b>	<b>13.5</b>	<b>11.7</b>	<b>10.1</b>

**LAKE GLENVILLE SHORELINE HABITAT AREA (AC.) AT VARIOUS LAKE LEVELS**

Habitat Type	Full Pool		Lake Level						
	Feet	Percentage	100	95	90	85	80	75	70
Vegetated/Stream Confluence	6,120	4.2%	9.7	0.0	0.0	0.0	0.0	0.0	0.0
Sand/Cobble	8,901	6.1%	20.6	11.8	4.7	0.0	0.0	0.0	0.0
Woody Debris	2,373	1.6%	4.7	3.2	1.9	0.9	0.1	0.0	0.0
Clay/Weathered Rock	83,205	56.8%	446.6	351.4	270.2	201.9	142.9	95.2	55.9*
Bedrock	10,853	7.4%	22.0	16.8	12.4	8.6	5.5	3.0	1.0*
Fractured Rock	16,959	11.6%	37.5	28.8	21.4	15.2	9.9	5.7	2.4*
Riprap/Stacked Rock	18,104	12.4%	6.3	1.6	0.0	0.0	0.0	0.0	0.0
Silt	0	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>	<b>146,514</b>	<b>100.0%</b>	<b>547.3</b>	<b>413.5</b>	<b>310.6</b>	<b>226.7</b>	<b>158.4</b>	<b>103.9</b>	<b>59.2</b>

\* Assumes habitat extends beyond surveyed lake level of 86.0, based on Nantahala Lake

Table 7. Percent reduction of total habitat acreage, by habitat type, associated with each 5-foot incremental decrease in reservoir level on Nantahala Lake.

<b>Habitat Type</b>	<b>Percent Habitat Reduction for Reservoir Level Decreases</b>					
	<b>100 to 95</b>	<b>95 to 90</b>	<b>90 to 85</b>	<b>85 to 80</b>	<b>80 to 75</b>	<b>75 to 70</b>
Vegetated/Stream Confluence	77.1%	100.0%	-	-	-	-
Sand/Cobble	17.3%	33.0%	47.2%	59.9%	71.5%	81.8%
Woody Debris	22.8%	42.8%	60.9%	77.1%	91.5%	100.0%
Clay/Weathered Rock	17.5%	32.9%	47.4%	59.6%	71.7%	82.0%
Bedrock	20.2%	38.4%	54.4%	68.9%	82.0%	93.6%
Fractured Rock	19.7%	37.2%	53.0%	67.1%	79.8%	91.0%
Riprap/Stacked Rock	N/A	N/A	N/A	N/A	N/A	N/A
Silt	N/A	N/A	N/A	N/A	N/A	N/A
Not Surveyed	N/A	N/A	N/A	N/A	N/A	N/A

Table 8. Reservoir target levels by month for Nantahala Lake and Lake Glenville.

MONTH	RESERVOIR TARGET LEVELS	
	Lake Glenville	Nantahala Lake
January 1	86	70
February 1	86	70
March 1	89	75
April 1	94	85
May 1	96	93
June 1	98	98
July 1	98	98
August 1	96	93
September 1	92	85
October 1	88	78
November 1	88	70
December 1	87	70

Table 9. Percent reduction of total habitat acreage, by habitat type, associated with each 5-foot incremental decrease in reservoir level on Lake Glenville.

Habitat Type	Percent Habitat Reduction for Reservoir Level Decreases					
	100 to 95	95 to 90	90 to 85	85 to 80	80 to 75	75 to 70
Vegetated/Stream Confluence	100.0%	-	-	-	-	-
Sand/Cobble	42.5%	77.0%	100.0%	-	-	-
Woody Debris	32.5%	58.8%	80.4%	97.9%	100.0%	-
Clay/Weathered Rock	21.3%	39.5%	54.8%	68.0%	78.7%	87.5%*
Bedrock	23.8%	43.8%	60.8%	75.0%	86.4%	95.5%*
Fractured Rock	23.2%	42.9%	59.5%	73.5%	84.7%	93.7%*
Riprap/Stacked Rock	75.1%	100.0%	-	-	-	-
Silt	N/A	N/A	N/A	N/A	N/A	N/A

\* Assumes habitat extends beyond surveyed lake level of 86.0, based on Nantahala Lake

Figure 1. Percentage composition of shoreline habitat for Nantahala Lake.

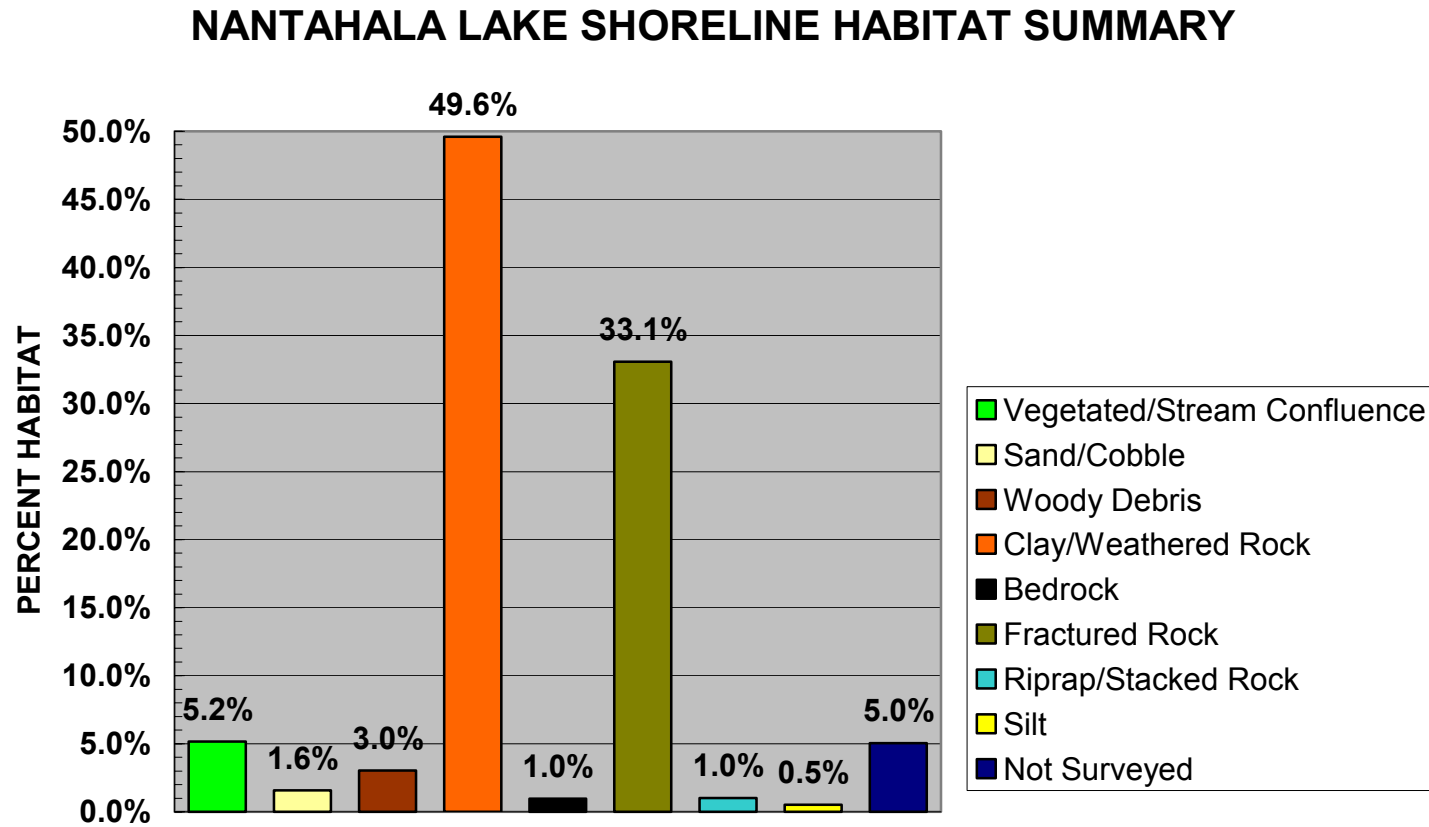


Figure 2. Percentage composition of shoreline habitat for Lake Glenville.

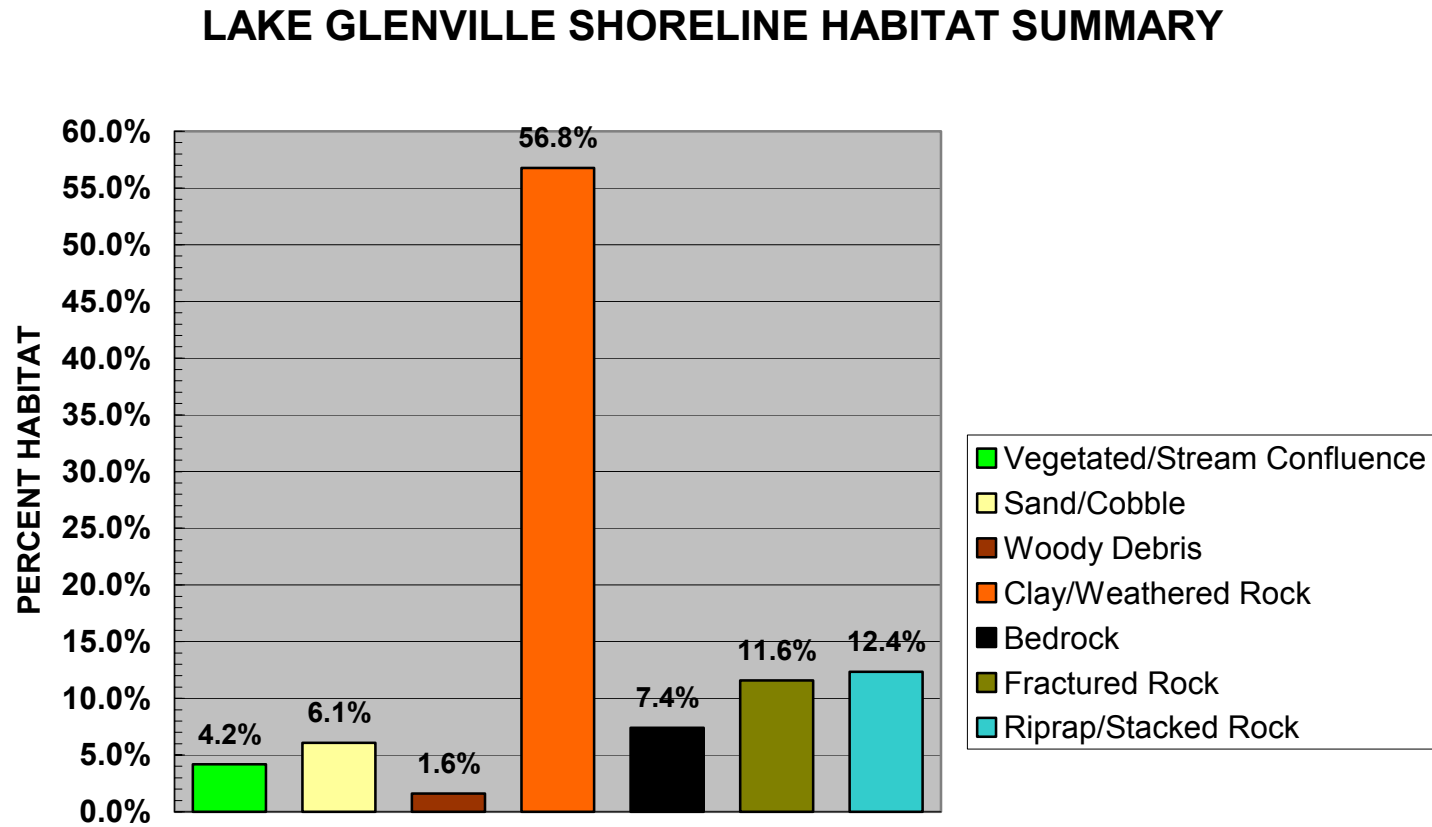


Figure 3. Percentage composition of shoreline habitat for Tennessee Creek Lake.

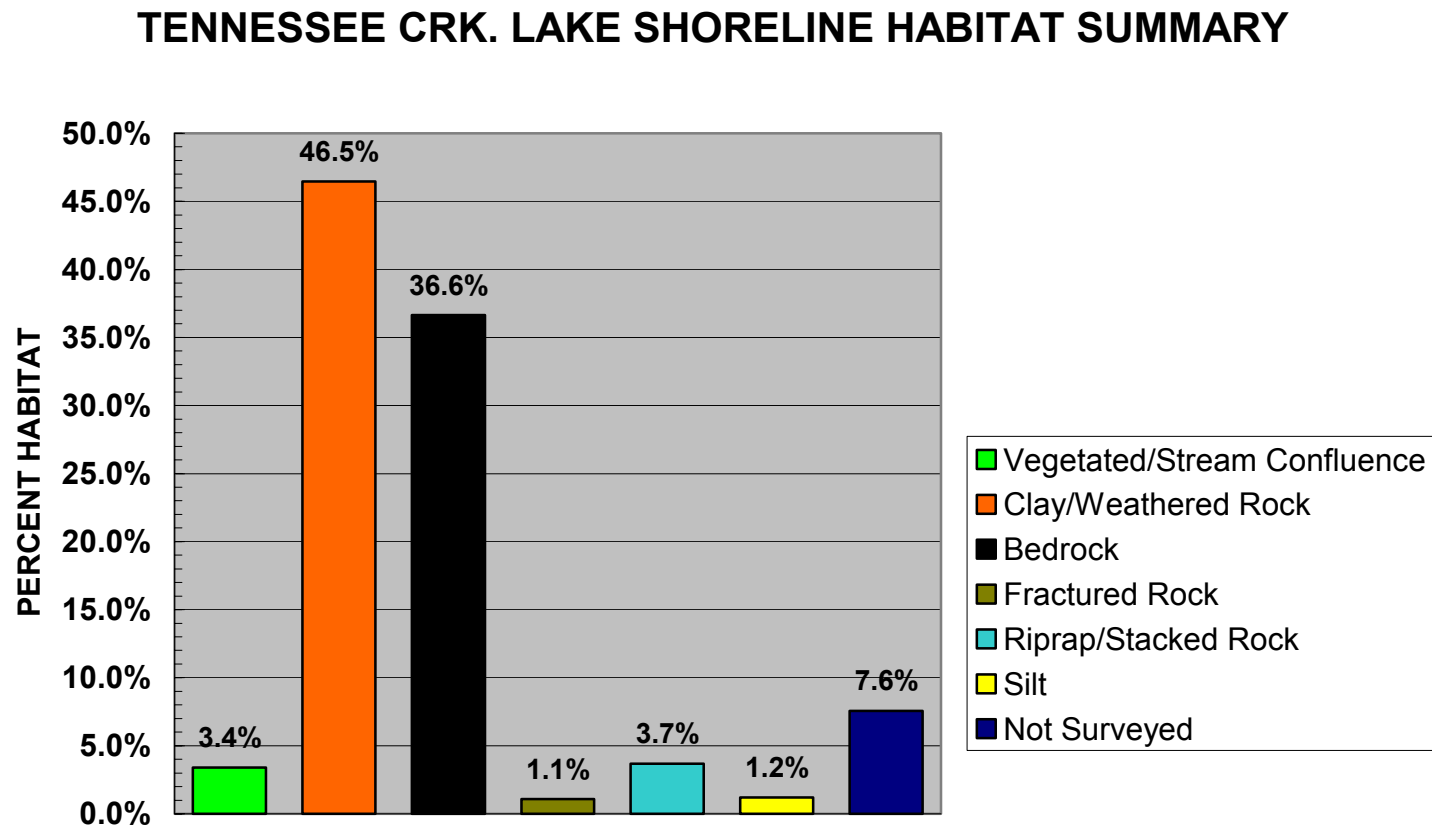


Figure 4. Percentage composition of shoreline habitat for Wolf Creek Lake.

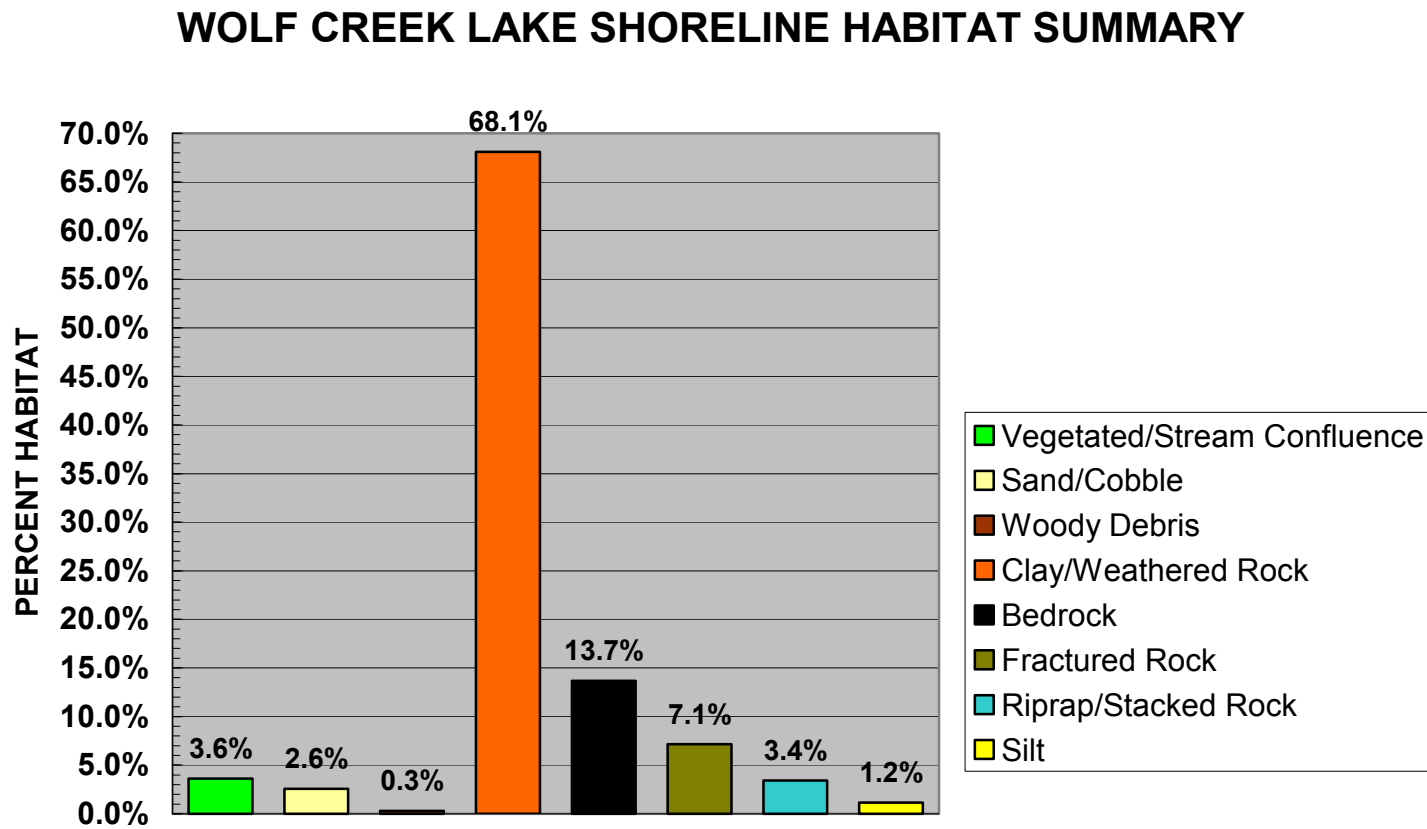


Figure 5. Percentage composition of shoreline habitat for Bear Creek Lake.

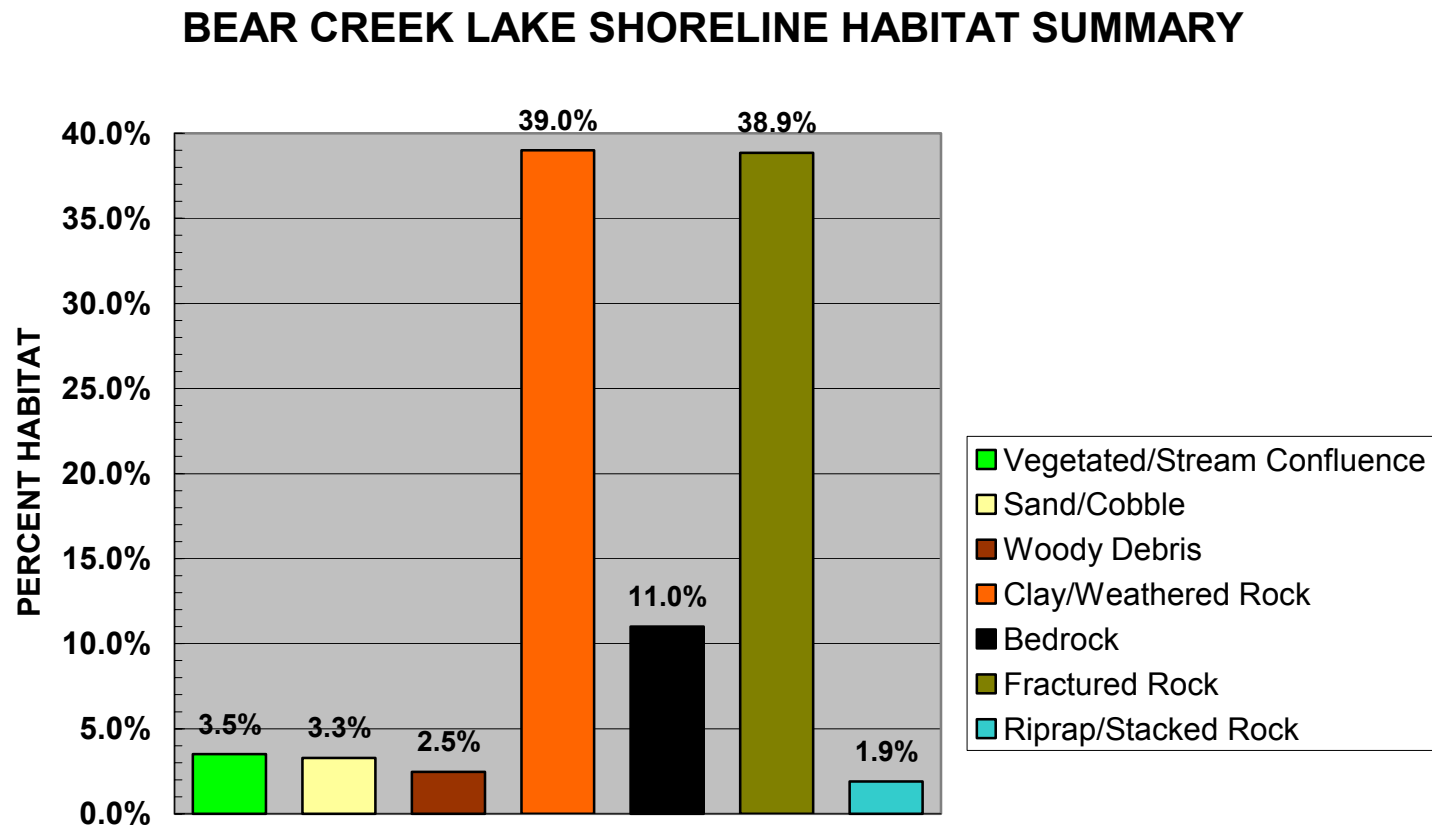


Figure 6. Percentage composition of shoreline habitat for Cedar Cliff Lake.

