believed to be affecting the species at present, it appears many of them were largely historical, were less significant than previously thought, have been mitigated, or could be managed to alleviate many of the effects on the species. The sicklefin redhorse sucker likely experienced substantial range contraction associated with dam construction, power generation, and historical habitat degradation early in the 20th century, but the remaining populations appear to have stabilized within the present conditions and are successfully spawning and recruiting in four primary river drainages accessible from Hiwassee and Fontana Reservoirs.

In the future, we expect human population growth and land development to be primary factors affecting habitat quality in the range of the sicklefin redhorse sucker. However, compared to historical land use effects, we expect the effect of these future activities to be minimized by more stringent State and local land quality regulations, such as are required by current regulations for land development and water quality, and a trend of diminishing agriculture in the area. Improvements in land use practices are likely attributable to the modern regulatory environment that provides protection to the stream environment. The Fish and Wildlife Coordination Act of 1934 (16 U.S.C. 661 et seq.), North Carolina Environmental Policy Act of 1971, Clean Water Act of 1972 (33 U.S.C. 1251 et seq.), North Carolina Sediment and Pollution Control Act of 1973, Georgia Erosion and Sedimentation Act of 1975, as well as other regulatory actions, were enacted to control the effects of land development and pollution on the aquatic environment. Historical records indicate that the existing populations of the sicklefin redhorse sucker have persisted through significant agricultural land disturbance that resulted in considerable sedimentation of its habitat, indicating that the sicklefin redhorse sucker is likely able to tolerate moderate land disturbance. Rural development and the growth of several small towns within the range of the sicklefin redhorse sucker appear to be the dominant forms of land use disturbance. Rural development is limited in certain areas due to large portions of the watershed that are permanently protected by inclusion in the Nantahala and Chattahoochee National Forests. The region is currently experiencing a trend of diminishing agricultural land use, indicating that widespread conversion to farmland is not likely. Commercial development is

likely to be limited by a lack of large metropolitan areas or interstate highways that would facilitate rapid growth. The trend of high suspended sediment yield in the range of the sicklefin redhorse sucker appears to have improved over the last few decades. Increasing environmental regulation, greater public awareness, and the actions of governmental and nongovernmental organizations to improve water quality conditions have resulted in considerable improvements in suspended sediment rates. Therefore, we expect existing regulations for land development and water quality to adequately maintain habitat quality, and we anticipate that the species is likely to persist into the future even with the expected increase in development.

The sicklefin redhorse sucker is provided additional protection by State endangered species regulations and association with other federally listed species. It is listed as threatened by the State of North Carolina and endangered by the State of Georgia. Both States prohibit direct take of the species and the collection of the fish for scientific purposes without a valid State collecting permit. In the unimpounded portions of the mainstems of the Little Tennessee River and Tuckasegee River where the sicklefin redhorse sucker occurs, the species' habitat is indirectly provided Federal protection through the Act, where the mainstem portions of both of these rivers are designated as critical habitat for the endangered Appalachian elktoe (Alasmidonta raveneliana) (a mussel). In addition to the Appalachian elktoe, the portion of the Little Tennessee River where the sicklefin redhorse sucker occurs also supports populations of the endangered little-wing pearlymussel (*Pegias fabula*) and the threatened spotfin chub (Erimonax monachus) and is also designated as critical habitat for the spotfin chub.

Substantial public land ownership in the watersheds occupied by the sicklefin redhorse sucker provides partial protection to the watershed. Approximately 43 percent of the land adjacent to waterways occupied this species is owned by State and Federal agencies or by nongovernmental conservation organizations. On these conserved properties, land development is prohibited, providing protection to buffers and potentially improving water quality throughout the watershed. Most of the land surrounding Hiwassee and Fontana Lakes is publicly owned, limiting shoreline development and protecting the near shore habitat used by juvenile sicklefin redhorse suckers. The Eastern Band of Cherokee Indians

has management jurisdiction over a portion of the lands within both the Hiwassee River and Tuckasegee River watersheds, and tribal water quality ordinances protect habitat and water quality. Approximately 65 percent of the occupied area of the Little Tennessee River is protected from development by inclusion in the Needmore Game Lands. Along the other three major spawning tributaries, most of the land is privately held and does not have any restriction on land development.

When the sicklefin redhorse sucker was elevated to candidate status in 2005, the blueback herring, an invasive predator species, had been inadvertently introduced into the Hiwassee Reservoir, a major waterbody supporting the sicklefin redhorse sucker. At the time, predation of young sicklefin redhorse sucker by blueback herring was an unassessed threat. However, a recent study examining the gut contents of blueback herring in the Valley River and Hiwassee Reservoir failed to find any sicklefin redhorse suckers among the samples. It appears that the sicklefin redhorse sucker may naturally avoid predation by blueback herring by spawning farther upstream than typical foraging habitat for blueback herring. In the spring of 2016, blueback herring were collected from Fontana Reservoir, the other reservoir important for sicklefin redhorse sucker recruitment. Further investigation is required to determine the degree of impact the presence of blueback herring in Fontana Reservoir poses to the sicklefin redhorse sucker, but the distance to spawning sites upstream of Fontana Reservoir is similar to the distance in the Hiwassee Reservoir, suggesting that blueback herring will be similarly separated from the hatching sicklefin redhorse sucker fry during the time when they are most likely to be present in the reservoir. Collections in the Hiwassee River system in 2014–2015 produced many young adult/late juvenile sicklefin redhorse suckers that have clearly recruited since the herring invasion, even while juvenile walleye and white bass steeply declined immediately after the invasion, suggesting the blueback herring is not preventing successful recruitment of sicklefin redhorse suckers. Therefore, recent observations indicate that blueback herring have not proven to be a threat to the sicklefin redhorse sucker as once feared.

Many of the stressors that may affect the sicklefin redhorse sucker in the future can be further minimized by conservation actions carried out under the recently signed CCA among the Service, North Carolina Wildlife