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Developing a Comprehensive Management Program to Accommodate a Gorilla with Glaucoma and Diabetes

The Bronx Zoo's Congo Gorilla forest exhibit opened in 1999 and currently holds 55 species indigenous to the Congo basin. Among the mammal species exhibited in Congo, the largest collection is 9.11 Western lowland gorillas (*Gorilla gorilla gorilla*) housed in two mixed sex troops and one all-male bachelor troop.

One of our silverbacks, "N'tondo", was transferred to the Bronx Zoo in 2014 from the Kansas City Zoo to lead a mixed sex group. Upon arrival at the Bronx Zoo, 21-year-old N'tondo was in good health with the exception of a chronic gastrointestinal issue for which he was treated and still receives daily medication. His introduction to his female group went smoothly and all members of the troop exhibited appropriate behavior toward one another.

In January 2016, N'tondo's keepers noticed that he was unresponsive to visual cues for established behaviors during training sessions. He seemed unable to see close objects, or appeared cross-eyed when trying to do so, and he was challenged in pinpointing the location of small food items when foraging. These initial signs of N'tondo's compromised vision corresponded with the rupture and treatment of a facial abscess. N'tondo also exhibited signs of discomfort that accompanied his vision loss, including holding his head, squinting his eyes, and general lethargy. His deteriorating condition resulted in concurrent changes in the social dynamics of his troop and his role as silverback. Without a clear diagnosis, veterinarians started him on treatment for potential toxoplasmosis, amoebic encephalitis, fungal infection, and general inflammation.

In February 2016, N'tondo was observed by a consulting neurologist, who assessed the problem was ocular rather than neurologic or a central nervous system issue. The following week, he was immobilized and examined by a consulting ophthalmologist, who diagnosed N'tondo with glaucoma. Glaucoma is a disease caused by increased pressure within the eye that compromises ocular function and vision. In addition to causing blindness, glaucoma can be painful. N'tondo was prescribed a diuretic and a calcium channel blocker to treat the glaucoma. During this time, he was also trained to accept eye drops. His calm demeanor and trusting nature allowed this behavior to be quickly and easily trained.

In March 2016, N'tondo was immobilized for laser ciliary body ablation, conducted by the consulting ophthalmologist. The goal of the surgery was the destruction of tissue creating the fluid that causes pressure and discomfort in the eyes, stopping the progression of vision loss and alleviating pain. N'tondo was prescribed two kinds of eye drops: a steroid to reduce post-surgery inflammation and a beta blocker used to reduce eye pressure. His condition worsened following surgery, with a perceived increase in pain and decrease in vision. In addition, N'tondo

exhibited hyphema in both eyes. Hyphema is the collection of blood inside the space between the cornea and the iris, which may further impair vision. This condition is usually painful. As a result, Ntondo was prescribed antibiotic and steroid eye drops.

Through the end of April 2016, N'tondo seemed to be in less pain and was better navigating his surroundings, indicating a possible improvement in his vision. Hyphema appeared to have resolved in both eyes and the diuretic and antibiotic/steroid eye drop treatments were discontinued. On May 4, a follow-up immobilization was conducted to re-check Ntondo's intraocular pressure, which was assessed as normal. Thus, the laser surgery was deemed successful. However, the following week, N'tondo began showing signs of confusion and disorientation again, especially when navigating or shifting to familiar areas. With the onset of these symptoms, methods to specialize his husbandry program were investigated and implemented. While he was encouraged to forage with the rest of his group, he received additional, individual feeding opportunities. More verbal and tactile cues were incorporated into his training program, and the location where N'tondo's group was housed overnight and during the day was kept consistent. N'tondo was asked to shift to and through the same rooms and transfers daily where previously the troops were rotated through different holding areas to create a more dynamic and enriching environment. N'tondo's troop members began to assist N'tondo with navigating his surroundings. One female in particular would stay close to N'tondo and vocalize when the troop was asked to shift from one area to another. Given the many challenges of managing N'tondo's medical condition, our focus as keepers was to continue to evolve our husbandry techniques to ensure the best possible care by balancing his medical and social needs. In doing so, N'tondo's shifting and other navigational abilities normalized and social dynamics within his troop stabilized as N'tondo regained the leadership skills of an effective silverback. N'tondo's high blood pressure medication and remaining eye drop treatments were discontinued based on his behavioral improvements.

Unfortunately, throughout the following year, N'tondo's health began slowly deteriorating despite our husbandry modifications. He became lethargic and had decreased activity levels, lost muscle tone and weight, although he appeared to be consuming the appropriate amount of food. N'tondo also developed dermatitis, resulting in hair loss on his legs, arms and back. On November 29, 2017, Ntondo was immobilized for a general health exam and was diagnosed with diabetes. He was started on oral medications and a low-sugar diet to manage the diabetes. Shortly thereafter, we began testing his urine glucose by collecting voluntary urine samples. Additionally, we began training voluntary blood glucose monitoring with a glucometer. Toes were chosen as the optimal blood collection site due to safety and cleanliness. A toe presentation behavior was previously established, so focus was shifted to increasing the duration of the behavior and manipulating his toes for cleaning. A shoulder injection behavior

was also previously established so we were able to easily transfer the injection training to his toes. Five weeks after N'tondo's diabetes diagnosis, we obtained our first blood glucose reading with the glucometer. We have since established a daily routine that includes urine and blood glucose testing without regression in either behavior.

After further research into N'tondo's treatment regimen given his diabetes diagnosis, veterinarians became concerned about systemic effects from a drug he was on to manage his pre-existing irritable bowel disease (IBD) called budesonide. Previous attempts to manage the IBD with other oral medications had not been successful. Veterinarians started N'tondo on an alternative drug, mesalamine, which was slowly incorporated to his regimen while the budesonide was decreased. During the transition to the new combination of IBD medications keeper staff were closely monitoring his stool quality, appetite, glucose levels, and weight. After modifying the IBD medications, N'tondo's blood glucose levels stabilized, his hair-loss reversed, he gained weight, and his activity levels returned to normal. On July 19, 2018, N'tondo was immobilized for an overall health exam. Veterinarians concluded that his diabetes was under control, the glaucoma had not progressed further, and his body condition had returned to that of a healthy 25-year-old silverback gorilla.

The social dynamics within the troop have stabilized and N'tondo has regained his role as an effective silverback. He still receives his supplemental diet and has maintained a healthy appetite. He seems to enjoy interaction with the keeper staff who have supported N'tondo through the many health challenges he has faced over the past two years; he will even make happy vocalizations at his keepers during his daily blood glucose testing. N'tondo is now utilizing more of the enrichment items offered to his troop and is exhibiting more play behavior. As keepers, this experience has taught us a great deal about the importance of adapting our husbandry techniques to the individual needs of the animals in our care and, despite the challenges of this case, it has been extremely rewarding to watch N'tondo work through these challenges and regain his health and role as a silverback.