Water quality and wildlife: A case study in Kisumu, Kenya

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ABSTRACT

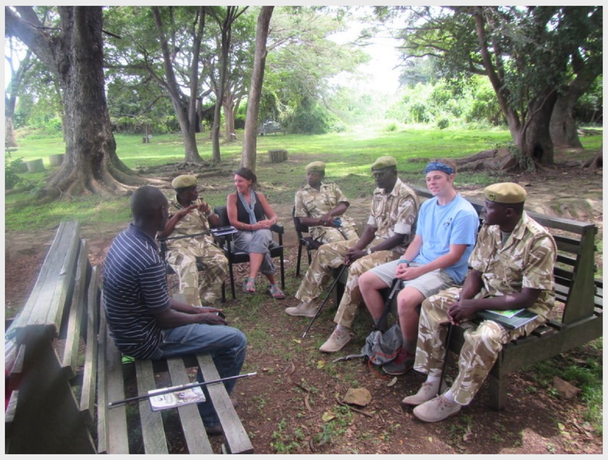
LA population of endangered Sitatunga antelope live in a free-range environment at the Impala Sanctuary in Kisumu, Kenya. The park, gazetted in 1992 by the Kenya Wildlife Service (KWS), continues to be negatively impacted by population growth and the building of luxury hotels adjacent to park boundaries. KWS park officials suspected that increased demands on outdated sewage infrastructure have caused animal drinking water sources to become contaminated Through three consecutive years of site assessments, data collection, and analysis we determined that most of the open water sources for the endangered Sitatunga antelopes are severely contaminated. Field testing for eight physical and chemical parameters (pH. dissolved oxygen, nitrates, phosphates, fecal coliform, biological oxygen on demand, turbidity, and temperature) allowed us to calculate a water quality index value for each of the sample sites (Mitchell and Williams, 2000; Brown et al., 1970). The WQI is a unit less number ranging from 1 to 100 that reflects the overall health of a system by assigning weighted values to the aforementioned parameters. A higher WQI number is indicative of better water quality (100-90 is deemed excellent water quality, for example). We found that the water quality ranked from 46 to 57% (bad to medium). Moreover, only two of the six sample sites met the minimum criteria determined by numerous livestock researchers (Adams et al., 1995; Beede, D.K. 2006; Linn and Raeth-Knight, 2010) for fecal coliforms, nitrates, phosphates, and turbidity. The remaining four sites were exponentially contaminated with some levels reaching 10X recommended values for water health. Temporary changes have been made within the park to supply clean drinking water options for free roaming animals within the park boundaries.

RESULTS

1. Through several months of site assessments, data collection, and analysis we determined that most of the open water sources for the endangered Sitatunga antelopes are severely contaminated. Field testing for eight physical and chemical parameters (pH. dissolved oxygen, nitrates, phosphates, fecal coliform, biological oxygen on demand, turbidity, and temperature) allowed us to calculate a water quality index value for each of the sample sites (Mitchell and Williams, 2000; Brown et al., 1970). After quality (100-90 is deemed excellent water quality, for example). After three-months of continual monitoring, a baseline WQI (that represents seasonal variability) was established for each sample site in Impala Sanctuary. We found that the water quality ranked from 46 to 57% (bad to medium). Moreover, only two of the six sample sites met the minimum criteria determined by numerous livestock researchers (Adams et al., 1995; Beede, D.K. 2006; Linn and Raeth-Knight, 2010) for fecal coliforms, nitrates, phosphates, and turbidity. The remaining four sites were exponentially contaminated with some levels reaching 10X recommended values for water health. Although water quality testing will continue for the next year we have already substantiated that contamination is coming from up gradient sources including luxury hotels and residential complexes.

2. With help from the animal keepers, and approval by the senior warden, we were able to fence off a major watering hole for the Sitatunga antelopes that was found extremely contaminated with nitrates, phosphates, and fecal coliform.

3. A key component to this project was to train KWS scientists, wardens, and staff how to both use the field instrumentation and to have a thorough understanding of how to interpret results. This was done through a series of workshops, demonstrations, and field experiences. Additionally, I used a tiered-teaching approach whereby I taught the KWS park scientist who then taught the senior warden. The senior warden then taught the park warden. With several people now comfortable with the instrumentation I am confident that together they can trouble shoot problems and have discussions about their results.



Photograph 1. Dr. Jovanelly talks to Kenyan Wildlife Service Senior Warden, Christine Boit (left), and other KWS wardens about the project in Impala Sanctuary at the opening of the research launch gathering.

Photograph 2. Free-roaming impalas also share similar habitat to the Sitatunga antelope, however, the Sitatunga antelope are way more camera shy and difficult to capture in the wild.

Photograph 3. Dr. Jovanelly introduces the field equipment purchased by the Rufford Foundation for the water quality assessment at Impala Sanctuary. The equipment remained at KWS for weekly sampling throughout the 2015/2016 year.

OUTCOMES

The arching goal of this project is to protect and conserve the free-roaming habitat of the endangered Sitatunga antelope. As documented by our pilot study, the available drinking water sources record water quality at damaging levels of contamination. After three-months of continual monitoring, a baseline WQI (that represents seasonal variability) was established for each sample site in Impala Sanctuary. We found that the water quality index ranked from 46 to 57% (bad to medium). Moreover, only two of the six sample sites met the minimum criteria determined by numerous livestock researchers (Adams et al., 1995; Beede, D.K. 2006; Linn and Raeth-Knight, 2010) for fecal coliforms, nitrates, phosphates, and turbidity. The remaining four sites were exponentially contaminated with some levels reaching 10X recommended values for water health. Although water quality testing will continue for the next year (through May 2016) we have already validated that contamination is coming from up-gradient sources including luxury hotels and residential complexes. Our research team has agreed that large-scale changes to broken sewage lines, leaking septic tank systems, and waste disposal will take community effort that will be encouraged through the aforementioned stakeholders meeting. At this meeting the stakeholders will be made aware of the environmental regulations enforced by the Natural Environmental Management Authority (NEMA) for waste water disposal. With funding, however, Impala Sanctuary can make landscape alterations within park boundaries to improve dire conditions. In discussions with Impala Sanctuary KWS scientists, wardens, animal keepers, and staff, we have concluded that the installation of a French-drain (see methodology) will mitigate and control immediate pollution problems. Through the channelization of the waste water the sanctuary will be able to secure clean surface water viable for the Sitatunga antelope and other free-roaming park animals.

DISCUSSION

In achieving our pilot project goals we were able to scientifically corroborate the detrimental water quality suspected at all of the Sitatunga antelope water holes and subsequent living habitat. In following the US Environmental Protection Agency guidelines for an Environmental Phase I Site Assessment we outlined both point source and non-point source contamination entering the park. Parallel and up-gradient to park boundaries we flagged numerous leaking sewage pipes, drains, and overflows being deposited directly into critical Sitatunga ecosystems from hotels, residential neighborhoods, and sewage treatment facilities. With the 2nd Rufford Small Grant we plan to focus on both short-term (immediate, yet temporary) and long-term changes that will result in ecosystem improvement. . With the already gathered support from Kenyan Wildlife Service staff and animal keepers, we intend to create a French-drainage system that parallels approximately 600 m of the park boundary as a temporary means of channelizing waste water away from Sitatunga antelope habitat. Next, we will use the calculated monthly water quality index (WQI) which combines physical (e.g. temperature, turbidity) and chemical parameters (e.g. dissolved oxygen, pH, nitrates, phosphates, E. coli) into a single rank value (poor, moderate, etc.) to serve as a straightforward way of communicating changes in watershed health to communities adjacent to park boundaries. Culturally, in Kenya, infrastructure change must include the participation, and input, of all relevant stake holders. Next summer (2016), we hope to host a workshop to present our water quality data, the challenges with water pollution at Impala Sanctuary, the threat poor water quality has on the Sitatunga antelopes, and potential long-term solutions to infrastructure.