FIELD NOTES

Preliminary indications of the effect of infrastructure development on ecosystem connectivity in Tsavo National Parks, Kenya

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Balancing conservation and infrastructure development

Conserving land and ecosystem connectivity for wildlife is increasingly a global challenge as demand for infrastructure development to meet growing human population needs encroaches in many traditional wildlife areas. The survival of wildlife species in arid and semi-arid systems requires interconnected landscapes, and limiting animal movement greatly reduces the system's ability to sustain viable wildlife populations (Vasudev et al. 2015). Major infrastructural developments such as multi-lane highways and railways can sever wildlife movement often with negative consequences (Clevenger and Waltho 2005; van-der-Ree et al. 2011; Xia et al. 2007). Wildlife crossing structures, underpasses and "fauna passages" are, therefore, critical tools for maintaining landscape connectivity in areas affected by these developments and their capacity to sustain wildlife populations. However, there is limited information available on optimal designs and locations for African species. Here we report on a research project that aims to contribute to optimizing the design and manage the existing wildlife crossing structures by monitoring the movement of elephants in a conservation area of global significance that is affected by major–ongoing and planned–rail and road construction projects.

The infrastructure

In 2014 the Kenyan government initiated construction of the 500 km Standard Gauge Railway (SGR) from Mombasa to Nairobi, due for completion in 2017. This is a flagship project under Kenya's blue print Vision 2030, whose goal is to transform Kenya into a middle-income industrialized economy by 2030. It is the most important transport project in Kenya since the building of the first railway in the early 20th century. The SGR will bisect the 23,000 km^2 Tsavo National Parks comprising Tsavo East and Tsavo West NPs, and is home to the largest single elephant population in Kenya, numbering approximately

12,000 to 14,000 animals (Chase et al. 2014; Kyale et al. 2014) as well as other mammalian species. The SGR will be elevated (up to 10 metres in some sections) and fenced including sections that cross the conservation area; construction of the elevated railway line is already complete in many areas. In addition, the Mombasa–Nairobi highway that runs alongside the SGR has been earmarked for expansion in the near future, as has the Voi–Taveta highway that passes through Tsavo West National Park. Landscape connectivity between and within these national parks will be entirely dependent on the wildlife-crossing structures once these infrastructural projects are completed.

Wildlife crossing structures/ underpasses

The contractor of the SGR, the China Communications Construction Company Limited, constructed six wildlife crossing structures in the form of underpasses each measuring around 70 m long x 6 m high The placements, designs and sizes of these underpasses were guided by inputs from conservation organizations working in Tsavo Conservation Area through Kenya Wildlife Service (KWS et al. 2014) and references to literature on best practices from elsewhere (FHWA 2011). Other potential underpasses along the SGR are the 1,980 m long Tsavo river bridge, the 520 m long inter-crossing between the old railway and the new SGR at Kenani and 30 drainage culverts over seasonal dry riverbeds (luggas) greater than 5 m high and ranging from 6 m to 210 m long. An example of the underpasses and culverts is shown in (Figure 1, see colour pages vii). Speed bumps and speed limit signage for wildlife-crossings have been provided at 4 sites along the Voi–Taveta highway (Figure 2, see colour pages vii).

Collaring and planning

Satellite radio tracking collars were fitted on five adult males and five adult female elephants. The animals were captured and collared within 20 km on either side of the SGR and the Voi–Taveta highway between 15th and 17th March 2016. Selection of target animals, ranging distance and period of capture, aimed at maximizing opportunities for behavioral study of elephants crossing the SGR and highways and the influence of food and water resources on elephant movements following a rainy season.

Females were immobilized remotely by 15 mg of etorphine hydrochloride (M99®, Norvartis South Africa (Pty) Ltd) while the males by 18 mg of the same drug shot using Dan-Inject dart gun (Dan-Inject APS) from the Kenya Wildlife Service's Bell 206 helicopter. The effect of immobilization drug was reversed by the intravenous injection of diprenorphine hydrochloride (Norvatis South Africa (Pty) Ltd/(Edms) Bpk) through the superficial ear veins. Capture and general handling of the animal followed procedures described in Okita-Ouma et al. (2008), Mijele et al. (2013), KWS (2015), and KWS (2016).

The movement data will be analyzed to; (1) assess the effectiveness and utility of the underpasses along the SGR and speed bumps along the Voi–Taveta highway, (2) discern the SGR, the highway and landscape properties associated with different elephant behaviors, (3) understand potential impact of the SGR and the Voi–Taveta highway on the use of space and vital resources by elephants. (4) provide quantifiable data to inform decision-making in future infrastructural developments. Analyses of the elephant movement patterns and behavior will be fed back into the management to enhance conservation efforts.

Preliminary elephant movements

Within four weeks of collaring, we observed crossings by six out of the ten collared elephants; two females and their families and two males crossed the SGR, while the male and female captured along the Voi–Taveta highway had crossed that highway multiple times at some sections identified for speed bumps by Kenya Wildlife Service. One female and one male seemed to have difficulty in crossing the SGR between Kenani and Mtito Andei mainly due to the exposed oil pipe line under construction. One female and one male, both collared south of Voi town, had not attempted to cross the SGR (Figure 2).

In some situations, where a barrier has been created in a wildlife conservation area, (see http://corridordesign.org/designing_corridors/linkage_designs/mitigating_barriers) impacts have resulted in fatalities for wildlife and people. Instead of seeking a way around, i.e. through an underpass and, facing the barrier, the animals then try to re-cross the main highway and are killed by traffic. The casualties could be significant here in the Tsavo ecosystem as it takes many years for wildlife to learn new behavior patterns.

Immediate and future use of movement data

The analyzed movement data will provide critical information to improve the design of the planned fence line and the channeling structures along the SGR, and to help maintain wildlife access to vital resources such as water, food and mates. Immediate actions needed include the burial of the oil pipeline and integration of active crossing points in the design of the overpasses for wildlife along the Nairobi-Mombasa and the Voi–Taveta highways by the Kenya National Highways Authority.

This collaborative exercise is the first tracking project that we know of that seeks to understand how elephant movements are influenced by a major infrastructural project. This elephant tracking project is an excellent precursor of similar initiatives that will be required for future planning of development projects in wildlife rich areas, such as in the Lamu Port Southern Sudan Ethiopia Transport corridor (LAPSSET) that will cut through pristine wildlife habitats in Northern Kenya.

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