

Application of novel estimating methodologies to monitor lion abundance within source populations and large carnivore occupancy at a National scale

Solomon Kyalo- KWS

Fredrick Lala- WRTI



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Introduction



- To effectively manage and conserve wildlife populations, it is essential to establish their abundance and distribution reliably and regularly.
- Between 2018 and 2020 we conducted field surveys within ten of Kenya's most important source populations of lions, and analysed these data using spatially-explicit capture-recapture models.
- Kenya has adopted the SECR method and applied it at a national scale.

Recent Publication on the Methodology

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SCIENTIFIC IMPACT PAPER

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The emergence of a robust and inclusive framework for a nationwide assessment of African lions

Shadrack Ngene¹  | Femke Broekhuis²  | Nicholas B. Elliot³  |
Joseph Mukeka¹ | Monica Chege¹ | Daniel Muteti¹ | Bernard Ngoru¹ |
Fredrick Lala¹ | Stephen Mwiu¹ | Irene Amoke⁴ | Guy Western⁵ |
Yussuf Wato⁶ | Stephanie Dolrenry⁷ | Arjun M. Gopaldaswamy⁸ 

¹Wildlife Research and Training Institute, Naivasha, Kenya

²Wildlife Ecology and Conservation Group, Wageningen University and Research, Wageningen, PB, The Netherlands

³Wildlife Counts, Nairobi, Kenya

⁴Kenya Wildlife Trust, Nairobi, Kenya

⁵South Rift Association of Landowners, Nairobi, Kenya

⁶WWF-Kenya, Nairobi, Kenya

⁷Lion Guardians U.S, Washington, DC, USA

⁸Carnassials Global, Bengaluru, India

Survey Goal

To conduct the first ever national survey of lions to provide decision makers with essential information and to catalyse support for large carnivore conservation

Objectives

1. Estimate the number of lions over the age of one year in all potential source populations.
2. Estimate occupancy of all large carnivores throughout Kenya.
3. Build capacity to ensure long-term monitoring of lion populations.



Methods to estimate lion numbers

1) Expert opinion

- Educated guess – This method is highly subjective and may not be reliable or repeatable

2) Whole counts

- Direct observations – mostly applied in small ecosystems

3) Track surveys

- Spoor surveys – uses index calibration techniques to estimate the density based on lion tracks sighted

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Methods to estimate lion numbers

4) Call-in/ playback surveys

- Different sounds (e.g. Buffalo calf in distress) are broadcast using a loudspeaker to attract lions to a fixed area so as to count them.
- Lions are directly observed but not individually identified

5) SECR (spatially-explicit capture-recapture)

- Accurate, precise, comparable and repeatable method of estimating lion numbers
- Reliant on identifying individuals. Lions are not physically captured but information on where individuals were sighted and re-sighted is modelled.

Methods to estimate lion numbers

		SECR	Track surveys	Call-in surveys	Whole counts	Expert opinion
Data collection	Direct observation of lions needed	Yes	No	Yes	Yes	No
	Individual identification of lions	Yes	No	No	Usually	No
	Possibility of double counting	No	Yes	Yes	No	Yes
Data analysis	Data needed	Yes	Yes	Yes	Yes	No
	Statistical analysis involved	Yes	Yes	Yes	No	No
	Fieldwork effort accounted for	Yes	Yes	Yes	No	No
	Analysis accounts for variation in the probability of detection	Yes	No	No	No	No
	Confidence intervals (measure of precision)	Narrow	Wide	Wide	None	None
Overview	Precise and accurate	Yes	No	No	No	No
	Monitoring population trends and dynamics	Yes	No	No	No	No
	Costs (e.g. resources)	High	Medium	Medium	Medium	Low

Survey Design

Participatory mapping exercise

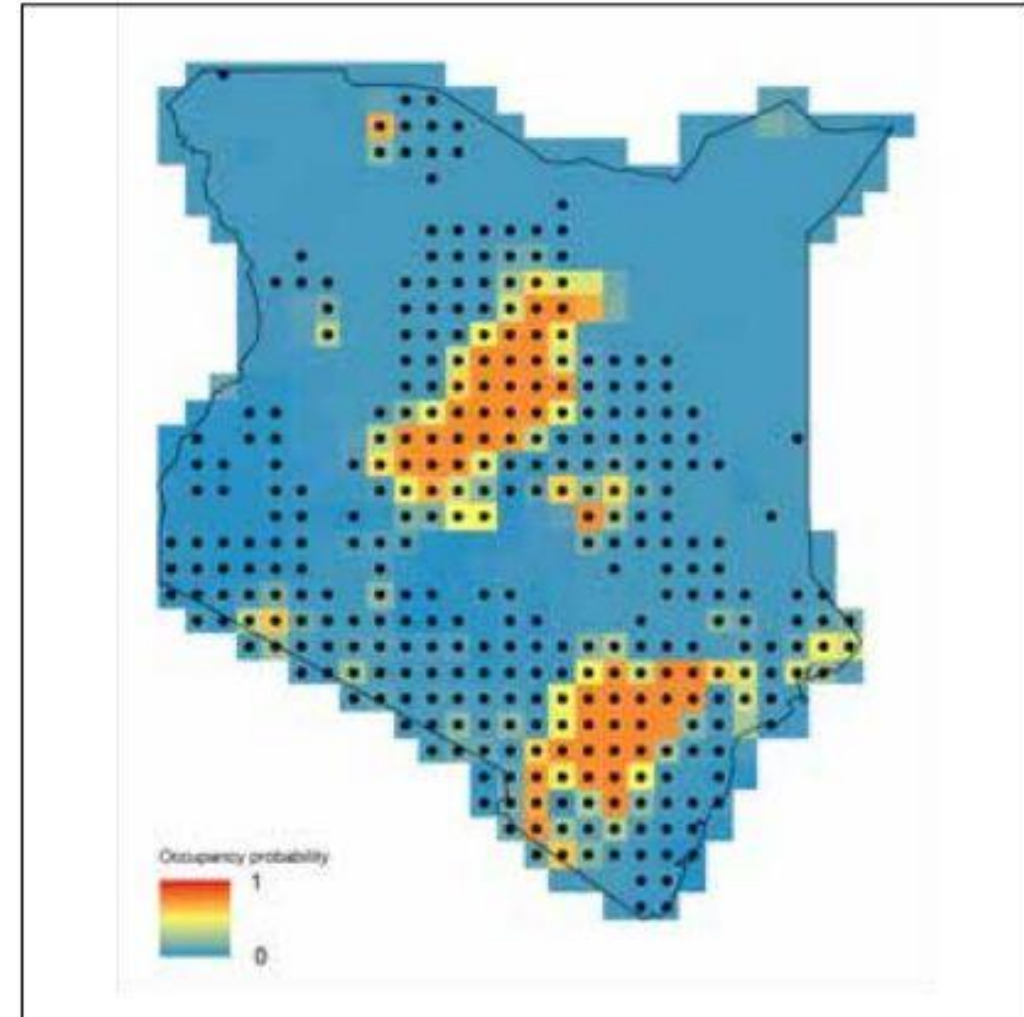
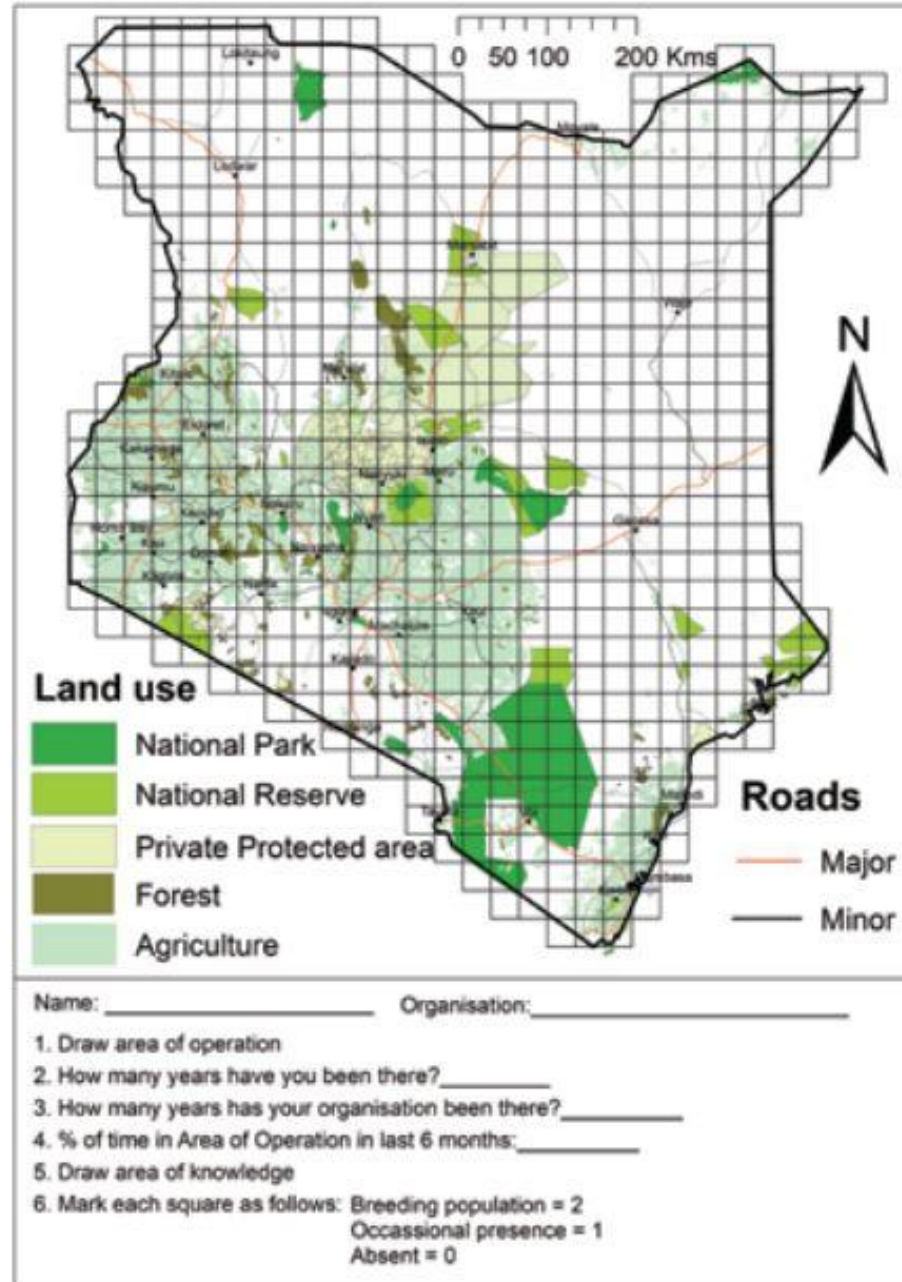
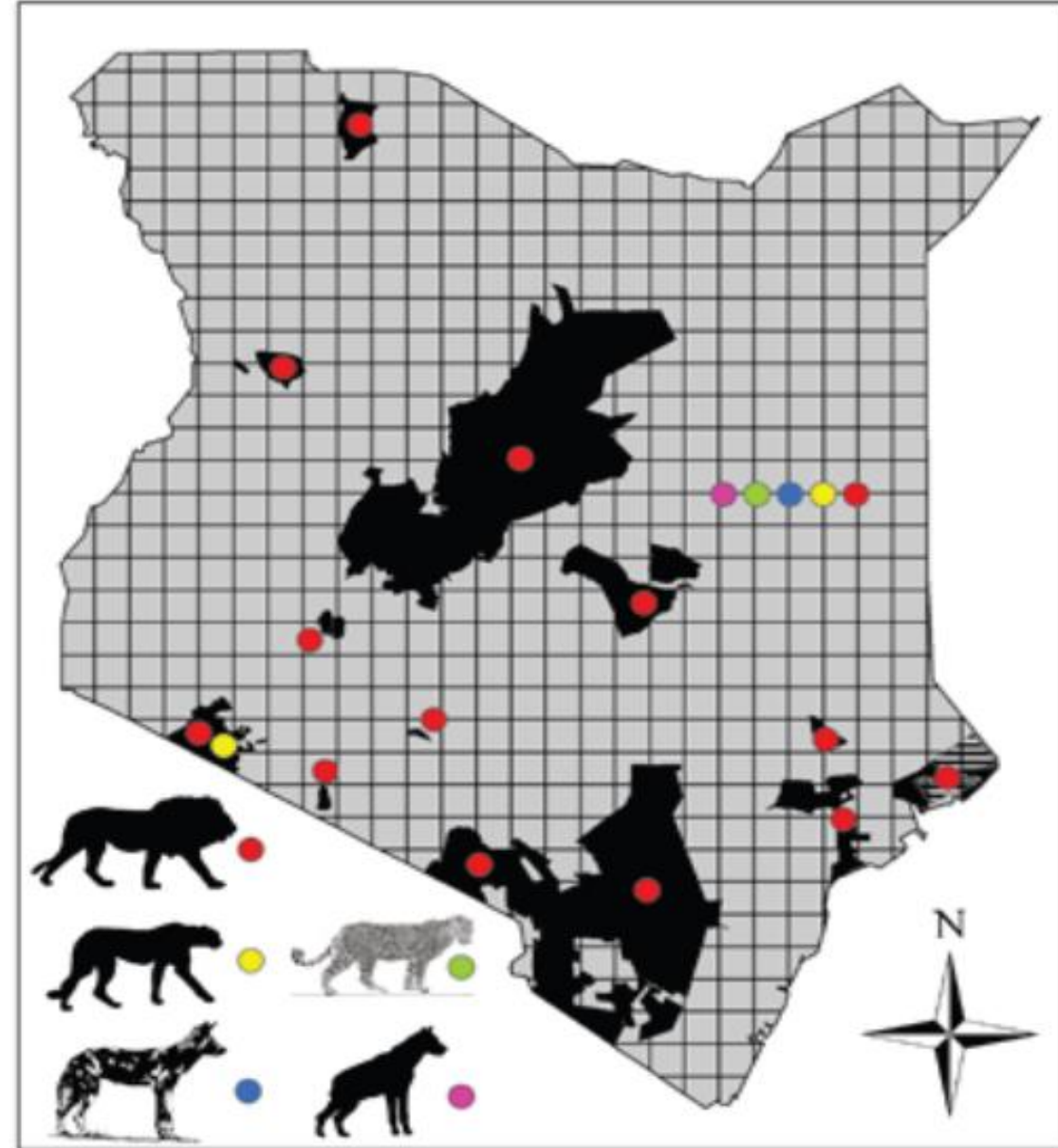



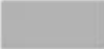
Figure 1.3: Outputs from the participatory mapping exercise during the planning workshop. This map shows the probability of occupancy for source populations of lions based on the expert opinion of key stakeholders. This map was used to inform the national survey plan (see Figure 2.1).

Survey Design

A group of experts identified a total of 77,595km² (black areas) as potentially holding source population of lions. For each of these areas, follow-ups were done with local stakeholders to assess (a) whether resident lions occurred and (b) whether security was a concern. Areas that were deemed not to have a source population and/or have security concerns were later shifted to the **occupancy-based survey** that was conducted throughout Kenya (grey areas).



Survey Method

-  SECR: Estimate densities of lions & selected predators
-  Occupancy: Provide a range map for all large predators

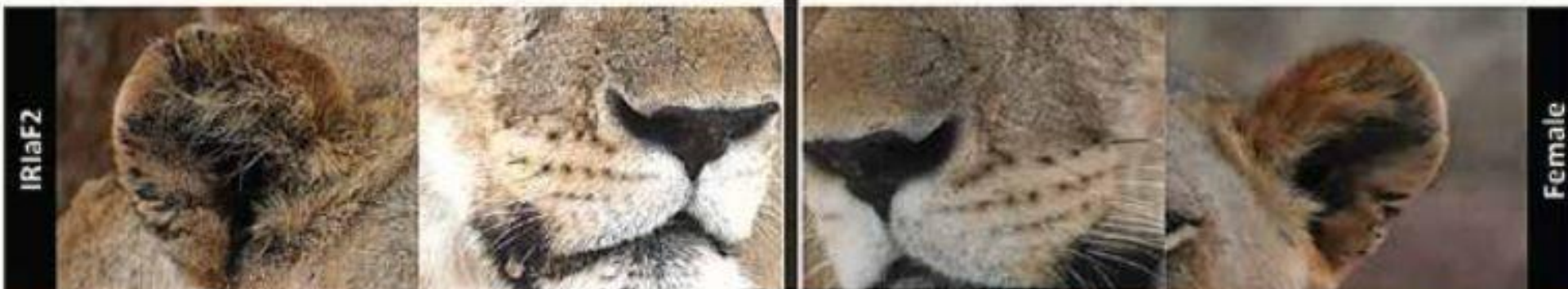
Survey Implementation

Overseen by the technical team

Stakeholder meeting	A planning meeting with all relevant stakeholders to (a) define the exact area to be surveyed, (b) develop appropriate site-specific field protocols (c) decide upon what data would be collected, (d) identify data collectors.
Training	Each survey began with all participants attending a four-day workshop: the first day focused on theory and sampling considerations, followed by three days of fieldwork wherein the field protocols were taught.
Data collection	Data collection was aimed at finding and identifying as many individual lions as possible while following the site-specific protocols and keeping a careful record of field effort using customised smartphone applications.
Data management	Photographs were collected regularly by members of the technical team. All other data was sent remotely via mobile data to a central database, which was validated daily to ensure high quality data collection was consistently being collected.
Individual identification of lions	Data collected via smartphone automatically synced to a database. Technical team members (sometimes with assistance from interested local stakeholders) were responsible for sorting and identifying individual lions and inputting those identities according to each sighting.
Data validation	Classification of individual identity at each detection were validated by a second member of the technical team to ensure accuracy. A conservative approach of 'when in doubt, leave it out' was adopted to any ambiguous detections.
Data analysis	Input files were prepared and validated for analysis. A set of candidate models were defined <i>a priori</i> and analysis was conducted on advanced computing facilities.
Model diagnostics	A series of model diagnostics were used to assess the MCMC convergence and mixing of chains in addition to model specification.
Model inference	Inference on model choice was informed assessing model adequacy (Bayesian P-value), visual inspection of pair-wise correlation plots between estimated parameters and the harmonic mean estimator of the marginal likelihood.

Logistics overseen by KWS area managers, senior scientists and local stakeholders

SECR



Pride: Irima
Name:
Location: Irima, Tsavo East
Date of Birth: 01/01/2013
Distinguishing features: Eye spot, missing lower incisors



ID: SQRF1



Female

Pride: Square Tank

Name:

Location: Square Tank, Inge Dam

Age class: Over 1 year

**Distinguishing features: Both ear
tears, top right canine broken**



SECR - Conceptual Underpinnings

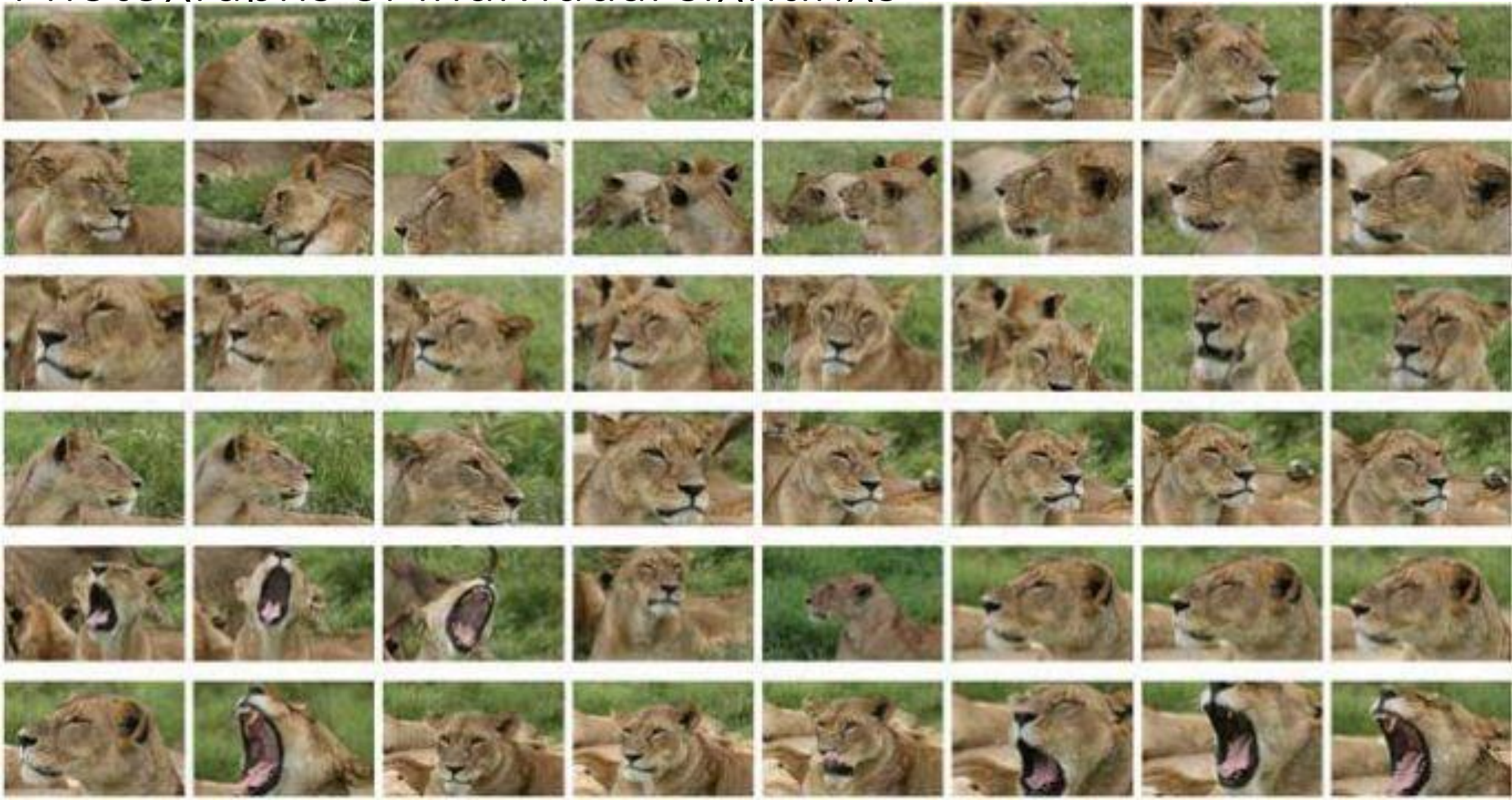
1. Population closure population does not change during the survey period

2. Detection probability

$$\hat{N} = \frac{C}{\hat{p}}$$

3. Capture-recapture

Photographs of Individual sightings



Results

	Area surveyed	Area size (km ²)	Survey Method	Number of lions	Year of Estimate	Source
1	Maasai Mara Ecosystem	3,000	SECR	556 (24)	2018	Elliot et al., 2020a
2	Shompole and Olkiramatian	409	SECR	25 (4)	2018	Elliot et al., 2020a
3	Amboseli Ecosystem	4,512	SECR	141 (24)	2018	Elliot et al., 2020a
4	Tsavo Conservation Area	28,419	SECR	459 (40)	2019	Elliot et al., 2020a
5	Nairobi National Park	147	SECR	25 (6)	2018	Elliot et al., 2020a
6	Lake Nakuru National Park	135	SECR	11 (1.5)	2017	Elliot et al., 2020b
7	Laikipia & Meru Ranches	3,752	SECR	184 (8.3)	2019	Elliot et al., 2020a
8	Ol Pejeta	365	SECR	49 (10.5)	2019	Elliot et al., 2020a
9	Solio Ranch	161	SECR	66 (8.3)	2019	Elliot et al., 2020a
10	Sections of Samburu, Isiolo, Laikipia and Meru Counties	3,204	SECR	17 (2.8)	2019	Elliot et al., 2020a
11	Meru Conservation Area	1,016	SECR	55 (8)	2019	Elliot et al., 2020a
	Total estimated by systematic SECR surveys			1,588 (56)		

Total
estimated
population
in Kenya

~2,489

13	Soysambu Ranch	190	IndID	~5	2020	KWS Database, 2020
14	Southern Rift Region	1,200	Guess	~45	2020	Guy Pers. Comm., 2020
15	Kuku Ranch	960	Guess	~60	2020	Muller Pers. Comm., 2020
16	Machakos Ranches	280	Guess	~10	2020	Mbithi Pers. Comm., 2020
17	Greater Nairobi National Park Ecosystem	401	Guess	~20	2020	KWS Database, 2020
18	South Turkana –Nasalot Ecosystem	2,191	Guess	~5	2020	KWS Database, 2020
19	Garissa County	44,753	Guess	~150	2020	HCP Database, 2020; Ali Pers. Comm., 2020; NRT, Database 2020
20	Wajir County	55,841	Guess	~200	2020	HCP Database, 2020; Ali Pers. Comm., 2020; Sharmake Mohamed Pers. Comm., 2020
21	Mandera County	25,798	Guess	~130	2020	Hussein Ahmed Mahat Pers. Comm., 2020 (Honary Warden, Mandera)
22	North Horr Sub-County	38,953	Guess	~10	2020	Lesilau Pers. Comm., 2020
23	Moyale Sub-County	9,390	Guess	~15	2020	Lesilau Pers. Comm., 2020
24	Lamu County	6,273	Guess	~40	2020	NRT, Database 2020 & KWS Database, 2020
38	Kiunga/ Awer conservancies, Lamu	1,869	Guess	~20	2020	NRT, Database 2020
26	Tana River County	35,000	Guess	~15	2020	NRT, Database 2020 & KWS Database, 2020
25	Tana River Conservancies & Tana River Primates Reserve	376	Guess	~25	2020	NRT, Database 2020 & KWS Database, 2020
27	West of Marsabit	14,775	Guess	~10	2020	Lesilau Pers. Comm., 2020
28	Nairobi Ranch, Lamu	47	Guess	~9	2020	Raabia Hawa of Ulinzi Africa Foundation, 2020
29	Hanshak-Nyongoro Community Conservancy, Lamu	779	Guess	~17	2020	Raabia Hawa of Ulinzi Africa Foundation, 2020
30	Shaba National Reserve/ Nakuprat Gotu	130	Guess	~10	2020	NRT, Database 2020; Ewaso Lions 2020
31	Biliqo Bulesa Conservancy	3,773	Guess	~20	2020	NRT, Database 2020; Ewaso Lion, 2020
32	Sera and Melako conservancy	8,896	Guess	~10	2020	NRT, Database 2020
33	Songa, Shurr and Jaldesa conservancies	6,329	Guess	~15	2020	NRT, Database 2020
34	Greater Namunyak conservancy	8,500	Guess	~30	2020	NRT, Database 2020; Ewaso Lions, 2020
35	Meibae/ Nkotieya conservancies	1,171	Guess	~5	2020	NRT, Database 2020
36	Naibunga conservancy	466	Guess	~15	2020	NRT, Database 2020
37	Ishaqbini conservancy	899	Guess	~10	2020	NRT, Database 2020
	Total estimated by guesses			~901		

Acknowledgements



Lion
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Asante Sana

