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Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

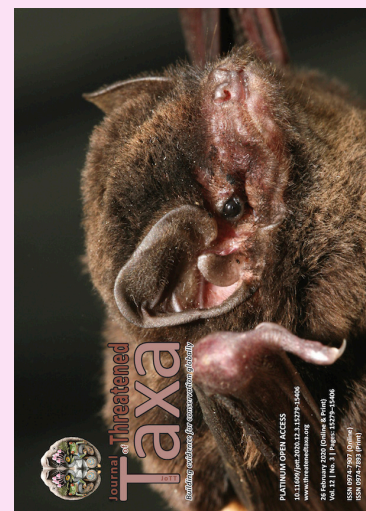
COMMUNICATION

BUILDING WALLS AROUND OPEN WELLS PREVENT ASIATIC LION *PANTHERA LEO PERSICA* (MAMMALIA: CARNIVORA: FELIDAE) MORTALITY IN THE GIR LION LANDSCAPE, GUJARAT, INDIA

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26 February 2020 | Vol. 12 | No. 3 | Pages: 15301–15310

DOI: 10.11609/jott.5025.12.3.15301-15310



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Building walls around open wells prevent Asiatic Lion *Panthera leo persica* (Mammalia: Carnivora: Felidae) mortality in the Gir Lion Landscape, Gujarat, India

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Abstract: The Asiatic Lion population has increased in the last three decades, which now occupies a large regional spread with six or more identified satellite populations in eight districts of Gujarat. An overlap of lion habitat with human-dominated landscape elements leads to an increase in lion-human interactions in these growing satellite populations. A high rate of lion mortality has been observed in the periphery of Gir in the last decade due to falls into open dug wells. These wells have been excavated for irrigation in the agricultural landscape of Gir. About 145 wild animals including lions have died due to accidental falls into open wells in past 10 years. It has been observed that construction of parapet walls around wells in some of the peripheral areas of Gir Sanctuary have prevented this accidental mortality at very low cost. To assess the efficiency of these measures we did a survey of 20 random villages in the Gir Lion Landscape to collect data on the types of wells that cause this uncalled-for mortality. The paper explores the reasons for the lions falling into wells in the agricultural areas outside the Gir Sanctuary. The survey has shown that the corridors used by lions and in the satellite population areas are high risk sites where more parapet walls should be built on a priority basis. From the year 2007 to 2018 more than 48,000 parapet walls have already been randomly built in the periphery of the Gir Sanctuary. Out of 130 identified wells, 90 were protected with parapet wall or iron net while, 32 were without parapet wall and rest eight were with unfinished parapet wall. Providing a scheme for building more parapet walls around prioritized open wells would be an effective step towards Asiatic Lion conservation in the Gir Lion Landscape. Our survey indicates that there has been no mortality of lions in those wells where parapet walls have been built.

Keywords: Conservation, lion-human interactions, mortality, parapet wall, satellite population.

Editor: L.A.K. Singh, Bhubaneswar, Odisha, India.

Date of publication: 26 February 2020 (online & print)

Citation: Kagathara, T. & E. Bharucha (2020). Building walls around open wells prevent Asiatic Lion *Panthera leo persica* (Mammalia: Carnivora: Felidae) mortality in the Gir Lion Landscape, Gujarat, India. *Journal of Threatened Taxa* 12(3): 15301–15310. <https://doi.org/10.11609/jott.5025.12.3.15301-15310>

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Funding: Self-funded.

Competing interests: The authors declare no competing interests.

Author details: MS. TITHI KAGATHARA is a fellow at 'Youth for India fellowship'- SBI Foundation and working on the project with M S Swaminathan Foundation (MSSRF) titled 'NTFPs as a source of sustainable livelihood of tribal people of Koraput, Odisha'. DR. ERACH BHARUCHA has worked in wildlife and biodiversity conservation for over 40 years, has held several prestigious positions in the wildlife sector both government and non-government organisations and has many publications to his credit.

Author contribution: This study was a part of the MSc dissertation of Tithi Kagathara under guidance of Dr. Erach Bharucha. She has collected secondary data with the help of Division officials of Gujarat Forest Department and with help of local people. The primary data was collected personally by visiting the 20 villages of Gir Lion Landscape. EB conceptualized, designed the research methodology and personally supervised the work and interacted with local forest officials in the Gir landscape on the value of this study, which was requested by the forest department of Gujarat.

For Gujarati abstract see end of this article.

Acknowledgements: The author would like to thank the Gujarat Forest Department, especially the officers and staff of Junagarh Wildlife Circle of Gir-East and Gir-West divisions. Authors appreciate the help of Dr. A.P. Singh (IFS) and Mr. Sanjaysingh P. Sisodiya (IFS). Authors are also thankful to all the local people who helped during the data collection in the field.



INTRODUCTION

The population of Asiatic Lions in India saw a decline in Gir Sanctuary before 1990s (Singh 2017). Effective conservation, however, saw an increase in numbers in the last 20 odd years. This was accompanied by a dispersal of their population in more recent times. The present home-range of the Asiatic Lion has spread across eight districts of the Saurashtra region of Gujarat which is known as the Asiatic Lion Landscape or Gir Lion Landscape Gir Lion Landscape (GLL) (Kumar & Pathan 2015). The growing population is now expanding into suitable sub-optimal pockets of habitats in the agricultural landscape and in river corridors (Jhala et al. 2009; Basu et al. 2012). The patches of satellite population of Asiatic Lions are Girnar, Mitiyala, Lilia-Krankach-Savarkundala, Shetrunji-Jesor-Hippavadli, southwestern coast, and southeastern coast of southern Saurashtra (Singh 2000; Gujarat Forest Department 2015; Singh 2017) (Figure 3). As lion population in satellite areas increase, the human-lion interactions and their habitat conditions is getting altered. Falling into wells, getting hit by trains/vehicles, and accidental electrocution lead to mortality of lions and other wild animals in the surrounding cultural landscape (Banerjee & Jhala 2012). According to the statistics of the Gujarat Forest Department (GFD), 30 lions have had accidental deaths due to falling into open wells in the last 10 years. There is a great need to prevent this unnecessary mortality through tested conservation measures that should be implemented in high risk areas where lions disperse outside the protected area (PA).

In 2007, the GFD began to construct a few low-cost parapet walls around the wells for local farmers to see if the innovative measure would prevent high level of accidental mortality of lions and other wild animals. For several years, however, the GFD continued to rescue a large number of lions at very high cost. If the scheme could be shown to be effective as a preventive measure this would be of great conservation importance. Our study has indicated that parapet wall construction around wells is a possible measure to prevent lion mortality. A public-private partnership (PPP) under the eco-development program could be extended to such potentially hazardous areas. In the periphery of Gir, there are more than 30,000 wells that have been protected with parapet walls between 2007 and 2018. No careful study was done on the causes that led to these accidents in unprotected wells, nor was a comprehensive survey done on the benefits from this simple intervention.

The GFD provided INR 8,000 to build each parapet wall

under the eco-development program. For an estimated 30,000 wells in the larger human dominated landscape, the total cost of parapet walls could be approximately INR 240 million (Rs. 24 crore). It is impractical and costly to build a wall around every well in the GLL by the forest department. Thus, the support of local people, GFD, Gram-Panchayats, Biodiversity Management Committees under the Biodiversity Act 2002, and CSR funds from industry, would have to be generated. It would, however, be cost effective if sites for building walls around open wells are focused on high risk areas. This should focus on lion movement corridors and the identified resident or temporary satellite populations of lions outside the Gir PA. The entire initiative would be a preventive strategy in the agricultural landscape outside the Gir Sanctuary to minimize accidental mortality.

STUDY AREA

The study area lies across the peripheral areas of the Gir Sanctuary (Figure 1), mainly to the east where satellite populations have taken residence and in the west where lion dispersal has also been recorded. The study includes 20 villages outside the Gir PA. All the 130 visited farms to study the wells were in revenue land. Direct visits to these randomly selected agricultural farms in known satellite areas and interviews with 102 farmers for data collection were undertaken in this study in the high dispersal zone of lions.

The four major districts of Gir Lion Landscape are Amreli, Junagadh, Gir-somnath, and Bhavnagar (Figure 1). The lions had already occupied the visited villages in the study area 30 years back and the seasonal rivers of the study area are frequently used as a corridors for lion movement across the landscape (Figure 2).

METHODS

Gir East and West divisions outside the Gir PA were used for data collection. Twenty villages of the GLL were randomly identified for survey in known satellite area. The primary data collection was based on questionnaire and interviews in villages that comprised 14 villages in 10km periphery of Gir Sanctuary and six villages from different known areas of satellite population of lions in GLL were selected. The survey included 120 respondents from the local farmers and other stakeholders of rural society.

Data on lion dispersal and accidental mortality in

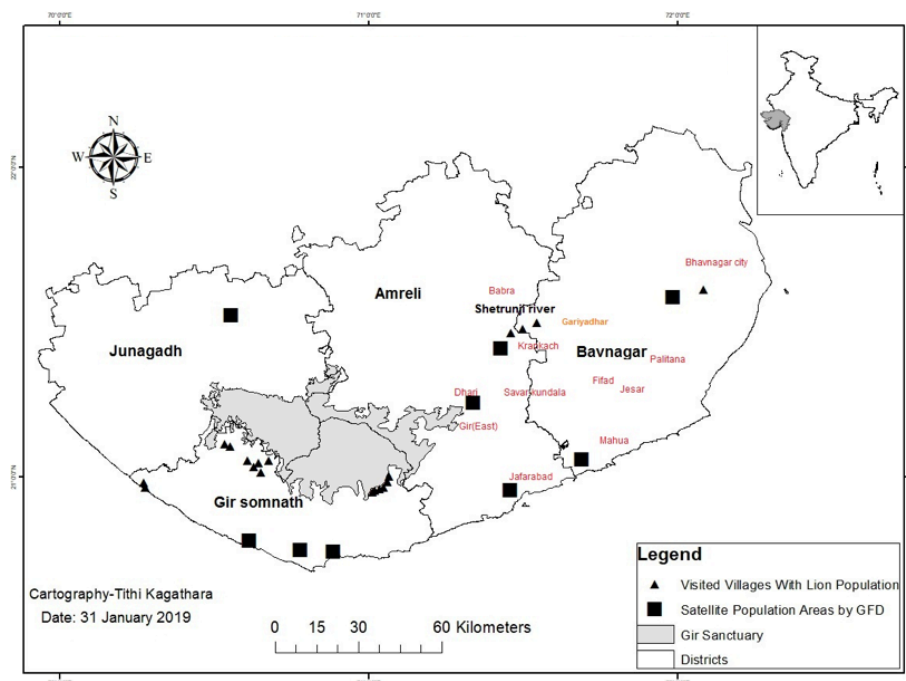


Figure 1. Study area–Gir Lion Landscape, Gujarat.

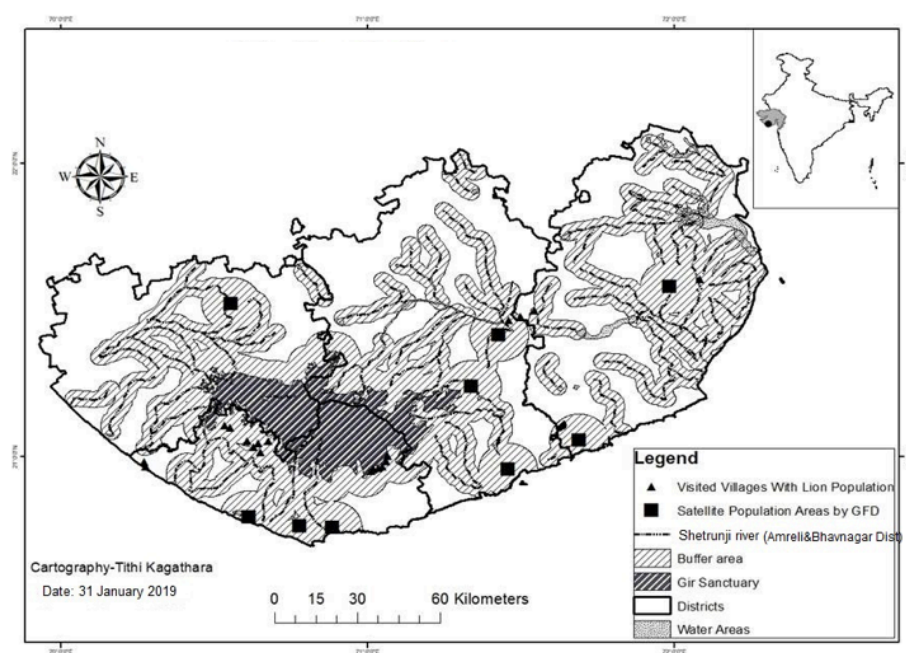


Figure 2. Prioritized buffer areas in the Gir Lion Landscape.

the study area was collected through semi-structured questionnaires with the farmers. The 130 wells in these villages were identified and studied to observe their site and local typological features. GPS reading and photo documentation of wells were done to appreciate their visibility and other features which contribute to the risk of accidental fall of the lions. The data on the number of parapet walls built and the wild animal mortality due to

open wells was provided by the division office of Dhari and Junagadh which are under wildlife wing of the GFD.

Interviews of local stakeholders

The survey was conducted in all randomly selected 20 villages. The semi-structured interviews of local people in the villages ascertained people's views on the presence of lions and the reasons that they could

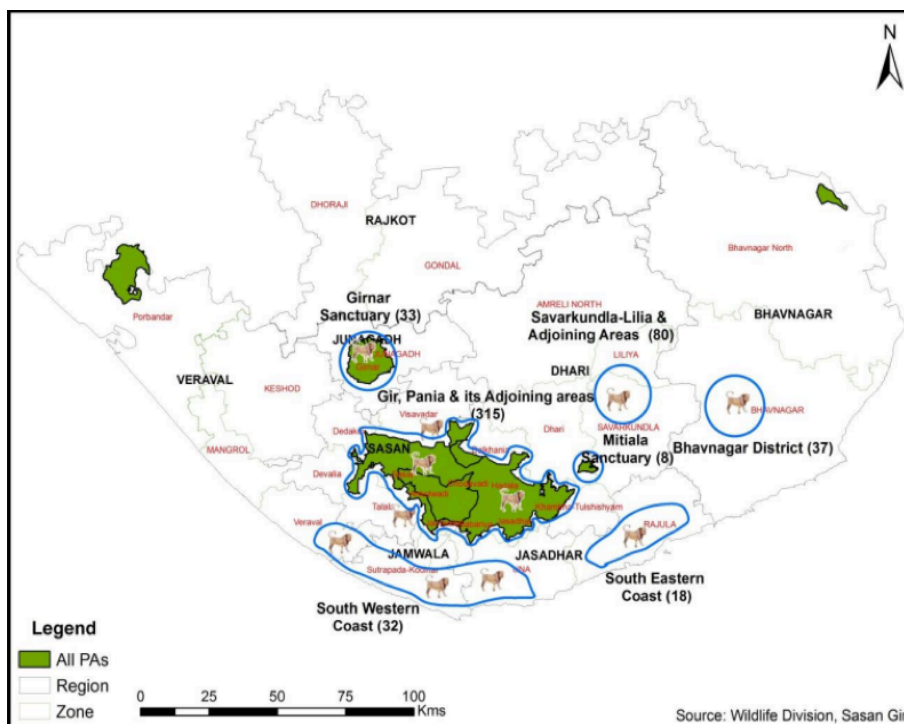


Figure 3. Habitat map of satellite population of Asiatic Lions.

Table 1. Relevant questions for assessing the parapet efficiency (number of respondents = 130).

	Indicator questions	Answers	
1	Why are lions falling into open well?	Chasing after prey (90%)	Do not know the answer (10%)
2	What is the land use where a majority of the wells are situated?	Agricultural farm land (98%)	Inside forest (2%)
3	After building a wall, were there any incidences of lions or other wild animals falling into wells?	No (95%)	Do not know the answer (5%)
4	Do you think more parapet walls would help to protect the lions?	Yes (95%)	Answer was not given (5%)

attribute for lions falling into the wells (Table 1). Snowball technique was used for choosing respondents in each village. A minimum number of five respondents and a maximum of 15 stakeholders were interviewed per village in high risk areas. Questions related to the success of the scheme through which parapet walls were built, the typology of wells, the lion presence and frequency of occurrence of prey species was documented. The views of respondents on how and why lions fall into wells was documented through a citizen science approach, as they were conversant with lion behavior over a long period of time.

The views of respondents on how the mortality occurs was also done through open ended informal interactions along with the brief questionnaire, which provided qualitative opinions that revealed that the people have clear views on their observations of lions that have fallen into wells in their area.

Field observation of well typology

The wells in agricultural lands which were visited were photographed and classified into specific risk related typologies. The typology has different implications for lion mortality prevention.

Well typology: classification and analysis

The types of wells were classified on the visual and photographic appearance documented during these field visits. A total of 130 photographs of wells were taken with their GPS locations. The vegetation and accessibility of the surroundings of the wells were documented to identify possible causes of lion mortality in the open wells. The parapet walls around wells were either square or circular with an average height of one meter. Of the 130 wells 29 were covered with concrete or wire mesh. There were 32 open wells, of these 24 were surrounded by thick growth of plants and were thus obscured from view.

According to the well typology (Figure 4), out of the 130 wells 90 were protected wells, 32 were unprotected open wells and eight were inadequately maintained and classified as others. The 90 protected wells are surrounded by one-meter high parapet walls or covered with different materials like a cement slab, nylon or iron net, which are included in the protected wells category. Parapet walls have been built around 61 wells observed in the survey. The 32 unprotected or open wells do not have any protective cover around the well. There is a high possibility of a wild animal including the lions falling into these wells. In these 32 wells, 24 were difficult to see as they were heavily surrounded by shrubs, grasses, herbs and trees which hide the well from view. There were eight wells which could be identified from a far distance (about seven meter) which are categorized as noticeable open wells. There were eight wells with one side open while the other three sides were surrounded by a parapet wall that means the walls were damaged, so are categorized as “other” types of wells (Figure 4).

RESULTS

A major finding of the survey of local residents shows that they have observed that lions fall into open wells while chasing prey. This was observed by 10% of respondents who reported that accidental falls into the wells happens mostly at night. They observed that lions fall into wells particularly while chasing after blue bull or wild boar. As the visibility of wells during the night is relatively poor due to the surrounding thick vegetation there is a high possibility that the prey jumps over the well while the lion suffers a misadventure. According to farmers in the periphery of the Gir, Blue Bull and Wild Boars feed on and ruin their crops. These species also fall into the open wells during crop raiding. According to the respondents, the Blue Bull *Boselaphus tragocamelus* population has increased in the Gir in the past 10 years due to the absence of ‘naar’ (Gujarati: Wolf), which used to prey on the calves and effectively controlled the herbivore population. There are, however, no wolves *Canis lupus* recorded in Gir at present and the population of Blue Bull continues to increase. The Blue Bull population in agricultural land is thus an indirect reason for lion mortality resulting from falls into open wells while stalking their prey.

The periphery of the Gir PA is divided into four divisions. The construction of parapet walls around open wells has been implemented in two divisions which are Gir West and Gir East divisions. The data

collection of 14 ranges of the study area is within the immediate periphery of the Gir Sanctuary. Building parapet walls around open wells has been initiated since 2007 in different ranges (Table 2). Talala Taluka has the highest number of wells with parapet walls. According to the GFD, the villages of Gir West division have more protected wells compared to Gir East.

Data on wild fauna mortality provided by the GFD was analyzed which shows that there is a high accidental mortality of lions over the past six years 2011–2017 (Figure 5). The data includes mortality of several other wild species due to open wells.

Open wells are a risk not only for lions but also other wild animals such as Leopard, wild ungulates especially Blue Bulls. Blue Bulls formed 48% of the mortality, Leopards (28%) and lions (16%) (Figure 5).

During the survey 90% of the farmers have reported that lions fall into wells while chasing Blue Bull as the ungulate can jump over the well successfully whereas the lion may not be able to do so as easily. This locally known observation has, however, not been substantiated.

The sudden increase of lion mortality due to falls into open wells after 2015 can be explained by the increase in range of the lions outside the PA into agricultural landscapes where there are a large number of open wells, and many of which are hidden by vegetation (Figures 6 & 8). After 2010, the lion population started increasing

Table 2. Number of protected wells surrounding Gir PA (2007–2017)
(Data source: Gir West Division Office, Junagadh).

		Range name	Taluka name	No. of protected wells
GIR (West)	1	Jsadhar	Una	1418
	2	Dalkhaniya	Dhari	1700
	3	Tulsishyam	Una	1469
	4	Savarkundla	Savarkundla	1758
	5	Pania	Dhari	205
	6	Sarasiya	Dhari	466
GIR (East)	7	Sasan	Talala	5413
	8	Dedkdi	Mendarda	5760
	9	Babariya	Una	3579
	10	Jamvala	Kodinar	6439
	11	Visavadar	Visavadar	4649
	12	Devaliya	Maliya-hatina	3846
	13	Talala	Talala	6854
	14	Ankolvadi	Talala	5307
Total				48863

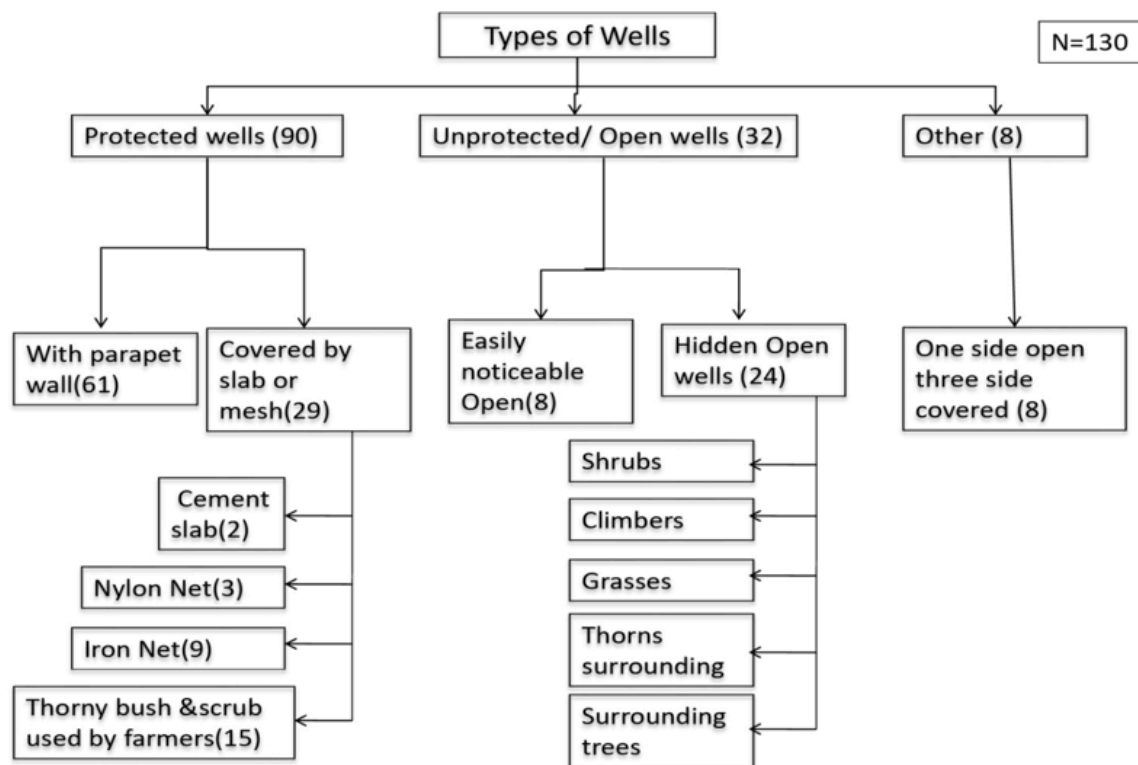


Figure 4. Types of wells (number of wells that were visited during data collection = 130).

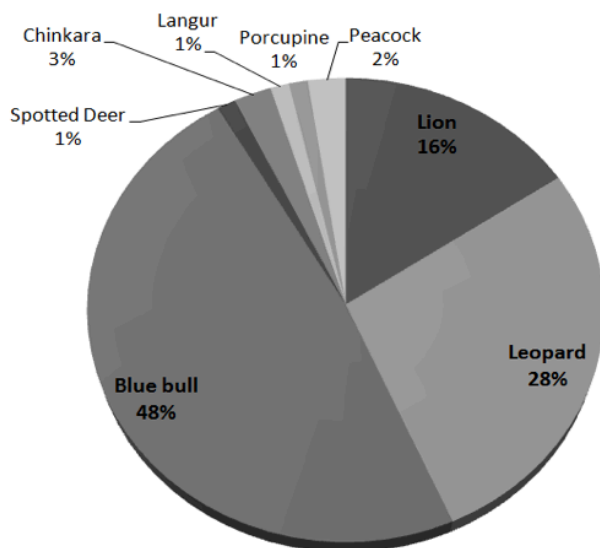


Figure 5. Wild animal mortality due to falls into wells in Gir Lion Landscape (2011–2017). (Data source: Wildlife Circle-Junagarh, Gujarat Forest Department).

outside the PA. In the last 25 years the number of lions inside Gir PA increased by 89 individuals or 1.3 times, while outside the PA the increase was by 150 or 9.8 times (Figure 7). Although the number of unprotected or open well in the periphery of Gir Sanctuary have decreased

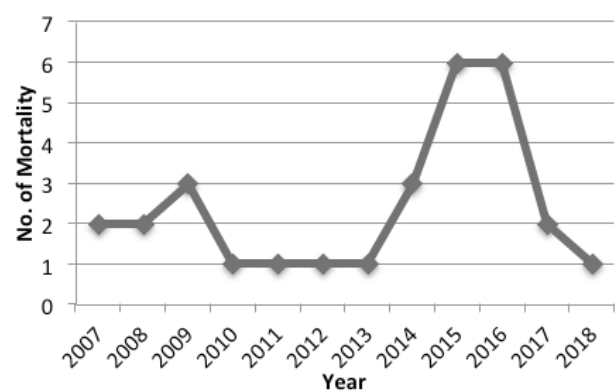


Figure 6. Lion mortality reported due to open wells around Gir Sanctuary (2007–2018).

gradually (Figure 8), lion mortalities outside Gir PA have continued due to higher spill over of lion population out of the PA, and continued existence of unprotected live wells. The number of protected wells reflect fluctuating trend, that may be due to addition of new constructions or disintegration due to lack of maintenance. Ultimately, the number of protected wells have remained almost the same in 2016–17 as it was in 2007–8 (Figure 9).

The locations of frequent lion movements as suggested by local people during survey includes

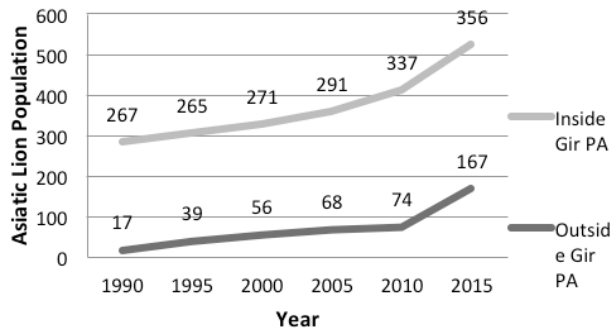


Figure 7. Asiatic Lion population inside and outside the Gir Protected Area (1995–2015).

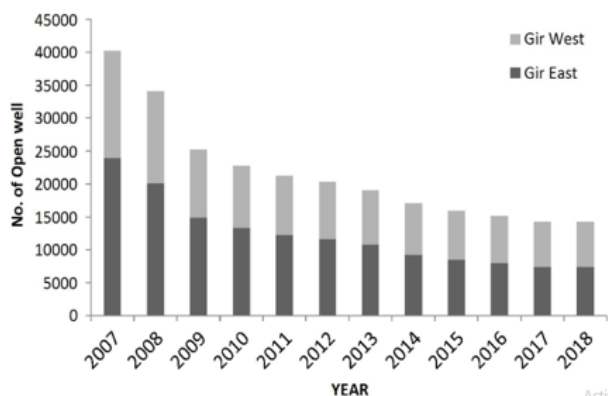


Figure 8. Unprotected or open well in the periphery of Gir Sanctuary.

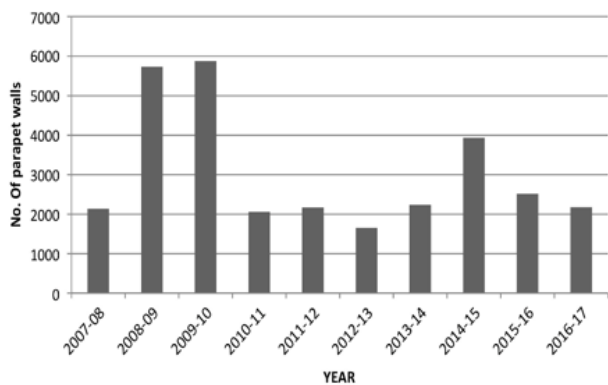


Figure 9. Number of protected wells in the periphery of Gir Sanctuary.

following areas (Figure 3):

1. Babara (Amreli) → Gagadiyo River (tributary of Shetrunji River) → Shetrunji River → Sarmda Village → Fifad (Bhavnagar) → Palitana Dam → Bhavnagar Coast
2. Gir East border → Dhai → Savar kundala → Liliya → Krankach (Greater Gir) → Gariyadhar
3. Gir (East) border → Coastal region of Rajula and Jafrabad → Mahua → Jesar (Bhavnagar) → Palitana Hills.

Local people have suggested the names of the villages and rivers which lions frequently use as movement corridors. These are potentially high-risk areas where building parapet walls would be more beneficial to limit accidental mortality.

The GLL comes under the semi-arid biogeography zone 4B- The Gujarat-Rajwara Biotic Province (Rodgers & Panwar 1988). The rivers are mainly seasonal except those inside the sanctuary. According to a recent study, lions use rivers as corridors (MoEFCC 2017). Green belts alongside the rivers are ideal isolated forest patches for the lions (MoEFCC 2017) (Basu et al. 2012). There are six known patches where satellite populations of lions are now resident (Figure 3). These are situated in agricultural land, river and tributaries, coastal areas, and foot hills in scrublands, which are concentrated in satellite populations (Meena et al. 2014).

DISCUSSION

Lions have been moving outside the sanctuary and establishing their territories (Basu et al. 2012). The fragmented suboptimal habitat patches in the matrix of cultural landscape elements where lions are frequently observed by local people is an important aspect to be recognized and managed appropriately (Dolrenry et al. 2014). The wells that have been provided with parapet walls over the years are now beginning to age. Of the 90 wells with parapet walls studied during the survey, eight require urgent repairs. As lions are moving further away from the sanctuary, the GFD needs to build parapet walls in those areas where the satellite populations have been recorded on a priority bases outside the Gir PA (Shankar 2017). A better appreciation of movement corridors, reported by local residents are other important areas for building parapets for wells.

The wells in the satellite population areas have different vegetation patterns and geographic features (Images 1–4). Even though they are situated in the overall semi-arid biogeography zone they are hidden from view by *Prosopis juliflora* and shrubs (Image 1). This is furthered due to changes in the cultural landscape which is linked to agricultural practices such as irrigation, human access, roads, and neo-urbanization (Bharucha 2017). The increasing population of Blue Bulls and invasion of *Prosopis juliflora* needs to be controlled as this hides the wells from view. The grassland of Bhavnagar (near Palitana) currently has less *Prosopis juliflora* compared to Krankach of Amreli. Controlling the spread of *Prosopis* and scrub around wells would



Image 1. Hidden open well.



Image 2. A well with the parapet wall.



Image 3. A well in a mango orchard.



Image 4. Asiatic Lion in mango orchard.

reduce the risk of accidental falls of lions into these hidden wells.

Cost analysis

The cost of building a parapet wall is about INR 8,000–10,000 according to local respondents. The GFD had helped farmers and owners of land to build parapet walls under the eco-development project after 2007. The excavation of a well costs about INR 150,000 (Rs. 1.5 lakh) depending on the site. Building a parapet wall around a well thus requires a relatively low investment to be added to the cost of the well. This amount is approximately 5% of the total cost. This must become a policy for all new wells while sanctioning wells.

Saving a lion that has fallen into a well is cost intensive, time consuming, and an important untoward event. It often requires middle term rehabilitation, or even life time care. An unnecessary preventable mortality of even a single lion is a serious biodiversity loss. People living in the cultural landscape outside the wildlife sanctuary where lions have now begun to spread spontaneously may be involved through local Biodiversity Management Committees at the Panchayat level as an outcome of the Biodiversity Act, 2002. Communication, education, and public awareness campaigns in the GLL may be initiated for lion conservation to comply with Aichi Target 1. Supporting lion conservation by building protected walls around the wells is now a proven and tested measure (Pathak & Kothari 2013). This would prevent the potential risk to lions and other wild animals from accidental mortality for one particular noticeable cause. It may also prevent accidental death of children and adults as several wells are not visible due to thick growth of vegetation around them especially during the monsoon. Steps may also be taken for keeping the surrounding of wells clear of weed growth and obstruction of visibility round the year. The removal of the obstruction from observing the edge of the wells may prevent lion mortality to some extent.

Prevention of lion mortality

Proper maintenance of wells in the agricultural landscape prevents lions and other wild animal from accidental mortality around the Gir PA. Clearing of vegetation surrounding the wells after the monsoon period to improve visibility of the wells must be done through the local Panchayat and the Biodiversity Management Committees. Removal of the obstruction from observing the edge of the wells may prevent lion mortality to some extent. Building of parapets or covering wells with a cement slab should be mandatory

in the GLL as a part of rural development. No new wells should be permitted without parapet walls or a concrete covering slab. The walls should be built during excavation of the wells itself and inspected periodically for breaches.

Rescue and rehabilitation aspects

A rescued lion loses its territory to other lions without an aggressive fight because the rescued lion has been kept in captivity before release and has lost hold over its territory. Thus, after release it is unable to take over its own territory (Kumar & Pathan 2018). This has been known to occur with both male and female lions. If a lioness has cubs and she is moved to a rescue center after falling into a well, the mortality of her cubs is likely to be high. The mortality of cubs in Gir is reported to be higher in the first six months of their life if their mother is dead. Her cubs die because of hunger. Mortality is also observed due to in-fights between the released and resident lions (Pati & Vijayan 2002). It is reported that a rehabilitated mother cannot produce milk for the cubs, if the captivity period time has been over two weeks (Singh 2000). Thus, even if lions are rescued from the wells, there are serious concerns about their rehabilitation in the wild.

CONCLUSION

Interactions with local observers have suggested that the priority to build protective parapet walls should include:

- Peripheral area of the PA for about 10km mainly in the southern fringe.

- Known movement corridors of lions which use tributaries of Shetrunji River where wells are adjacent to villages in agricultural land.

- Known pockets of satellite populations which are 40 to 100 km away from the edge of the PA such as southwestern Coast, southeastern Coast, Pania and its adjoining areas, Savarkundala-Lilia and adjoining areas, Bhavnagar District and Girnar Sanctuary to northern side of Gir.

The buffer has been identified around the Gir Sanctuary, rivers and satellite population areas of lions by the Gujarat Forest department. Ten kilometer buffer around the Gir Sanctuary as well as the satellite population areas of lions; while for the rivers, three kilometer buffer was identified with help of Arc MAP. Two kilometer buffer area around the Gir sanctuary should be prioritized for building parapet walls around

wells due to frequent movement of lions (Figure 2).

Reducing the risk of mortality of an endangered species is a key to its long term survival. A simple measure to prevent mortality of the lions in Gir which has been highly successful has been to build parapet walls around open wells into which lions were frequently suffering accidental deaths. The positive attitude of local people towards the scheme of building these parapet walls has also contributed towards preventing accidental mortality of other wild fauna. This mitigation measure for addressing lion-human interaction may be prioritized in high risk areas where satellite populations of lions are present. The completeness of information on risks identified and on current movement patterns of lions across the GLL will need to be addressed with all local stakeholders and the GFD. The citizen science approaches of eliciting this information can be used to appreciate where the wells should be developed in these prioritized situations.

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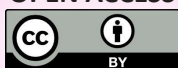
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Gujarati abstract: છેલ્લા ત્રણ દાયકામાં એશિયાઈ સહિની વસ્તીમાં વધારો થયો છે જે હવે ગુજરાતના આઠ જિલ્લાના અલગ અલગ વસિતારમાં વસવાટ કરે છે. ગીરમાં સહિનો વસવાટ મનુષ્ય સમાન હોવાથી તેઓ એકસાથે જોવા મળે છે. છેલ્લા 10 વર્ષમાં સહિનો મૃત્યુ આંક ખુલ્લા કુવાને લીધે ઘણો વધ્યો છે જે ગીર અભયારણ્યની ફરતે આવેલ છે. આ કુવાઓ ખેતીલાયક જમીનની પાણીની જરૂરિયાત માટે ખોદવામાં આવેલ છે. છેલ્લા 10 વર્ષમાં અંદાજીત 145 જંગલી પરાણીઓના ખુલ્લા કુવામાં પડી જવાથી મૃત્યુ નીપજ્યા છે. અધ્યયન પરથી જાણવા મળ્યું છે કે ખુલ્લા કુવાને ફરતે પાળ/દવાલ બાંધવાથી સહિના મૃત્યુદરમાં કેટલાંક અંશે ઘટાડો લાવી શકાય છે. આ સંભાવના ચકાસવા માટે અમે ગીર અભયારણ્યની આસપાસ આવેલ 20 ગામોમાં રેન્ડમલી સર્વે કર્યો હતો અને આ પેપરમાં સહિના ખુલ્લા કુવામાં પડવાના કારણો પર ચર્ચા કરી છે. સર્વે પરથી જાણવા મળ્યું છે કે લાયન કોરીડોર અને સેટેલાઇટ પોપ્યુલેશન વસિતારોમાં સૌ પ્રથમ કુવા ફરતે પાળ બનાવવી જોઈએ. ગીર લાયન લેન્ડસ્કેપમાં 2007 થી 2018 સુધીમાં અંદાજીત 48000 કુવાઓને ફરતે દવાલ બનાવાઈ છે. ડોક્યુમેન્ટેશન કરેલા કુલ 130 કુવાઓમાંથી 90 કુવાઓમાં દવાલ હતી અને 32 કુવામાં કોઇપણ પ્રકારની દવાલ ન હતી બાકીના 8 કુવાઓની દવાલ અધુરી બનાવેલ હતી. “ ખુલ્લા કુવા ફરતે દવાલ બનાવી” યોજના અંતર્ગત જો પરાયોરીટાઇઝ્ડ વસિતારોમાં અમલ કરવામાં આવે તો એ સહિના સંરક્ષણ માટે ખુબ જ મહત્વનો સાબિત થાય. અમારા સર્વે મુજબ કોઇ સહિનુ મૃત્યુ એવા વસિતારમાં નથી થયું જ્યાં કુવા ફરતે દવાલ બનાવેલ છે.



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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

February 2020 | Vol. 12 | No. 3 | Pages: 15279–15406

Date of Publication: 26 February 2020 (Online & Print)

DOI: 10.11609/jott.2020.12.3.15279-15406

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