



A tiger and her cubs leave India's Bandhavgarh National Park in search of prey, which is scarce inside the reserve.

TIGER TROUBLE



Central India – The Maruti Gypsy 4×4 sped along a jungle track, jolting us out of our seats. We had signed up for a wolf safari, but the trip leader had another quarry in mind. The vehicle barrelled towards a pungent smell on a hillside – a fresh tiger kill.

The forest guide spoke to one of his colleagues in a different vehicle and then barked at our driver to rush towards a nearby meadow. A tigress and four cubs are at a watering hole just beyond our sights, he said.

A full Moon rose, and revealed an ink-blue landscape. Handheld lights were banned, so visibility was at 3 metres. The phone rang, and the guide instructed the driver, who raced on a rollercoaster route back to the kill site. No tiger. We dashed back to the meadow, a second vehicle in hot pursuit. It felt ugly, like a hunt.

Two circuits later, the Moon was high over the meadow when we were beckoned once more back to the kill site. We raced there to find four Gypsies, the drivers using their headlights to sweep the hillside. Another vehicle banged into ours. Our guide cursed. Then silence, as the drivers shut off the engines. Tourists stood on seats, peering through telephoto lenses.

Footsteps rustled dead leaves, and the drivers switched on the high beams. There sat two tigers, larger than life as wild tigers are. These were no cubs; they were male adolescents. Camera shutters clicked. Minutes later, the animals got up and disappeared into the darkness.

Two hundred years ago, tens of thousands of tigers (*Panthera tigris*) roamed India and 29 other nations, from the Indonesian swamps to the Russian taiga. There were once Balinese, Caspian and Javanese subspecies, all now considered extinct. Today, only six subspecies remain. The International Union for Conservation of Nature (IUCN) estimated in 2014 that there are only about 2,200 to 3,200 individuals in the wild, placing the animal on the organization's endangered list. About 93% of the tiger's historic range has emptied owing to habitat loss, poaching and depletion of prey.

The spectre of a world without tigers led 13 nations to meet in 2010 in St Petersburg, Russia, where they declared that they would double their wild tiger numbers by 2022. But all except India, Nepal and Bhutan are struggling to save their tigers, even in protected reserves.

Against this backdrop, India is the beacon. It has roughly two-thirds of the world's tigers in less than one-quarter of their global range. In 2019, it has invested 3.5 billion rupees (US\$49.4 million) in tiger conservation, including relocating villages outside protected areas. And it has built the world's largest animal underpass to funnel tigers safely beneath a highway.

About 3% of the spending on tigers is flowing to government-sponsored science. Government scientists are studying all aspects of the animal, and are heading a large tracking study to understand tiger behaviour.

STEVE WINDER/NATIONAL GEOGRAPHIC

India is trying to save its tiger population, but researchers question the country's long-term plans to protect this endangered species.
By Gayathri Vaidyanathan

Feature

The efforts have paid off, according to the government. It announced in July that the number of wild tigers in the country had doubled from 1,411 in 2006 to 2,967 today – meaning that India has met the St Petersburg target. Indian Prime Minister Narendra Modi declared that tiger conservation could go hand in hand with building roads, railways and homes.

But parse the country's tiger data, and the story becomes murky. The animals are increasingly becoming isolated in small reserves that prioritize tourism. If the cats leave the parks, the risks are rising that they will encounter humans and infrastructure, with tragic results for both the animals and people. Some scientists question whether tiger numbers in India have truly increased and are attempting to get a more accurate count of populations in specific areas. Other researchers are studying how to get people and the carnivores to coexist.

Saving tigers is difficult enough, but research efforts in India are made more challenging by an apparent antagonism between the actors involved. Some experts charge that government scientists sometimes present questionable evidence in support of state policies and hamper efforts by independent investigators. Such conflicts are routine in tiger conservation globally, says John Goodrich, who heads the tiger programme at Panthera, a conservation organization in New York City.

"It's something that I've been incredibly frustrated with," he says. "We all have all this data, all this knowledge that we need to be sharing."

The national animal

Two hundred years ago, an estimated 58,000 tigers roamed India's lush, unbroken forests¹. But centuries of hunting and

habitat destruction left fewer than 2,000 wild individuals by the 1970s. In 1973, the government declared the tiger India's national animal, banned hunting and set up a conservation scheme called Project Tiger. There are 50 reserves today under the programme, and about half are well managed, according to a government assessment. But the reserves are small, averaging less than 1,500 square kilometres – much smaller than many protected areas in Africa.

These are unfavourable conditions for the solitary tiger. Male Bengal tigers need a home range of about 60–150 km², whereas females use about 20–60 km². And tigers do not share easily, even with siblings or kids. So when a cub hits adolescence at about one and a half years, it begins roaming to find territory in which to live and hunt. If the tiger reserve is already full, it has two options: either push out an old or weak tiger and take over the space, or keep moving well outside the reserve until it finds unoccupied territory. It is thought that 70–85% of India's tigers are inside reserves.

These numbers are from India's tiger census. Every four years, an army of forest guards, conservationists and volunteers fans out over an area roughly the size of Japan and carries out a comprehensive census. It's a difficult task because tigers are elusive. The workers place camera traps in some parts of tiger reserves for about 35 days. Then they walk on foot, collecting sightings of tiger tracks, scat and signs of prey and human disturbance. This is called a sign survey. They send the data to scientists at the government-run Wildlife Institute of India (WII) in Dehradun, who identify individual tigers in photos from their unique stripe patterns and then estimate local tiger densities in reserves. They create a calibration model that

links the tiger densities to the collected signs, then input the sign-survey data into this model to derive nationwide numbers.

"Unless you know what you have and where you have it, you can't manage it," says Yadvendra Jhala, who heads the tiger team at the WII and is responsible for the survey.

The latest census suggests that tigers are rebounding, and Modi celebrated a 33% increase in numbers since 2014.

But many scientists are sceptical. Ullas Karanth, director of the Centre for Wildlife Studies in Bengaluru, questions the sign surveys, which he says are collected by ill-trained workers who don't know how to do accurate counts – an accusation he based on his own experiences with the field workers. "The field protocols are deeply flawed," Karanth says. When I walked with forest guards doing surveys in a reserve in May, they said they felt pressured by local officials to record positive tiger signs and ignore signs of human disturbance.

Critics also argue that Jhala's team varies the census coverage every time. In 2018, they added 90 survey sites and 17,000 extra cameras. These types of differences make it difficult to compare census years and to say how India's tigers are faring, says Abishek Harihar, a population ecologist with Panthera in Bengaluru.

Another point of contention is the data analysis, particularly the calibration model used to arrive at pan-India numbers. The description of the methodology and models used is "vague", and the resulting numbers have "higher uncertainties than are currently reported", says Arjun Gopalaswamy, a statistical ecologist and science adviser at the Wildlife Conservation Society in New York City. He has authored two studies critiquing the census method^{2,3}.

Jhala refutes the criticisms about the accuracy of the census. He says there are safeguards to protect against bad data. Although the coverage has increased, he says the census is based on estimates of tiger density, so increasing the extent of the survey does not affect the trend calculations. He has published a study refuting the accusations⁴.

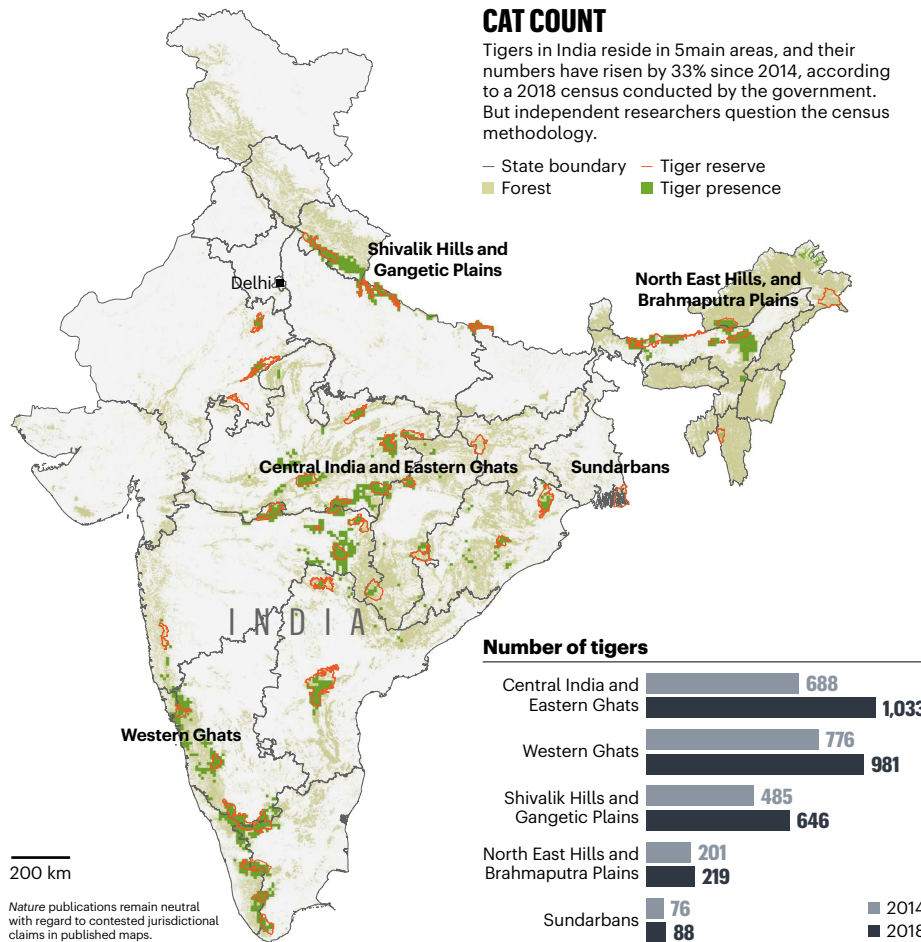
The best way to resolve the disagreement, argue scientists, would be if the WII released raw data and model information to ecologists for independent analysis. But Jhala says that releasing the geo-tagged data, even to scientists, could make the animals vulnerable to poaching – a claim that others dispute.

The result is that there is little consensus on India's tiger population and, more importantly, whether it is rebounding or has remained steady for many years. For now, scientists can say only that the animals are thriving in some places, but doing poorly elsewhere.

The biggest known conservation success is in central India, an area with 19 tiger reserves across 8 states. I travelled there in May with researchers from the Mumbai-based Wildlife Conservation Trust to see how India's best-kept



A tiger was killed trying to cross a train track near Jaldapara National Park, India.



tigers are faring.

The central Indian forests in Maharashtra state were brown and crackly under the 45 °C heat. Most trees had dropped their leaves for the dry season, reservoirs had dipped low and everyone was waiting for the monsoons.

The government says there are 1,033 tigers in central India, up 50% since 2014 (see 'Cat count'). That's more than one-third of India's tigers. The region attracts a proportionally high number of India's tiger scientists.

They have found that historically, tigers here have moved unhindered through forest corridors in search of territory, carrying precious new genes into distant populations. The central Indian tigers have high genetic variation, which should help them to adapt to environmental crises such as drought or disease⁵.

But the forest corridors in central India are fragmenting rapidly. Without roaming tigers, none of India's small reserve populations would be demographically viable in the long run, says Aditya Joshi, head of conservation research at the Wildlife Conservation Trust. Uma Ramakrishnan, an ecologist at the National Centre for Biological Sciences in Bengaluru, says that if infrastructure development in rural areas continues unabated, the genetic diversity of small populations could fall within a century.

The government might then have to shuttle tigers between reserves to maintain the gene

flow necessary for a population to stay healthy. "That will be pretty much like a zoo," she says.

In the worst-case scenario, tigers might get marooned in reserves and relatives might start breeding. These aren't vague fears. In the Ranthambore tiger reserve, a popular tourist attraction in northwest India, some 62 individuals, half of them descended from one matriarch, live in genetic isolation in a 1,115 km² area. Villages surround the reserve, and there are no other tiger populations nearby to seed new genes. Ramakrishnan and her colleagues have seen markers of inbreeding in the genomes of Ranthambore tigers⁶. In an unpublished study, they have detected regions of over a million base pairs of DNA without variation. In an average tiger, there are 500 variations in every million or so base pairs. If these stretches harbour deleterious alleles, the offspring could have reduced fitness, increasing the risk of local extinction, she says.

Deadly highways

The day before the frenzied night-time chase in Pench tiger reserve, Milind Pariwakam, a road ecologist with the Wildlife Conservation Trust, and I drove there on a four-lane motorway called National Highway 44, or NH44 (also known as NH7). In a nation full of potholes, I appreciated the smooth road connecting two major cities and reducing travel time. But

Pariwakam says the road comes at a high cost.

A 65-kilometre section of the NH44 cuts through the tiger park, separating the core reserve from a forest corridor. Some 40 mammalian species, including tigers, use this landscape. So do 6,151 trucks, cars and motorcycles that race down the NH44 every day. And this is not the only road through Pench; there are 24 smaller roads and another highway – the NH6.

Roads kill millions of animals globally every year. And over time, busy roads become barriers to movement as some species learn to avoid them. Tigers, which prefer to stroll on paths rather than skulk through undergrowth, are attracted to roads and exhibit little fear of traffic. In the Russian Far East, home of the Siberian tiger, scientists looked at the impact of roads on 15 resident individuals. The roads carried 250 vehicles a day, a fraction of the traffic through Pench. The researchers found that tigers living in the area died sooner and had fewer offspring than did animals living in road-free areas⁷.

In 2008, Pariwakam and a group of non-governmental organizations sued the government to stop the expansion of the NH44 to four lanes. The fight lasted eight acrimonious years before WII scientists and the conservationists came to a compromise: underpasses that animals could use to walk safely beneath.

"What we always say is that conservation has to be affordable, it has to be sustainable," says Bilal Habib, a carnivore biologist who heads the central India tiger programme at the WII. "We are a developing nation."

Finished in 2018, the NH44 has 9 specially built underpasses, ranging in length from 50 to 750 metres, designed to allow animals to pass beneath the roads. These are the longest animal underpasses in the world, and the first in India. If evidence suggests they are effective, the government might deploy them in some of the 20,000 km of roads through wild spaces, Habib says.

But although the underpasses are excellent on paper, Pariwakam questions their efficacy. Since 2018, two leopards and one tiger have walked across the road rather than using an underpass and were hit and injured. As we inspected one structure, a 4×4 careened into view from a village access road and drove through the underpass to a service ramp leading to the highway. Pariwakam whipped out his phone and filmed the intrusion. "The villagers are using the shortcut to save a quarter kilometre," he said, seething. He has been urging the forest department to close off all access roads.

Mistaken identity

This year, news about tiger deaths and fatal attacks on humans has popped up almost every week. As reserves have filled up, tigers are moving into the forest corridors that connect them – which are also used by people.

Tigress T49 was born in the corridor enclosing the Chandrapur district, outside the Tadoba Andhari tiger reserve, not too far from Pench. There are 155 people per square kilometre here, living in 600 villages that are slowly encroaching into forests. There are also 41 tigers, which is more than in half of India's protected reserves.

In December 2016, T49 had four cubs, named E1 to E4, in a culvert under a bridge. Villagers thronged on tractors and motorbikes to see the newborns.

Habib of the WII and his graduate student Zahidul Hussain were also interested in the cubs. Since 2013, Habib's team has radio-collared adolescents to understand the behaviour of tigers inside and outside reserves and to learn about the drivers of human–tiger conflict. They have collared 23 individuals so far, a small sample size. But this is still the largest telemetry, or tracking, study of tigers in the world. Their preliminary data are troubling. They suggest that non-reserve tigers move longer distances daily, perhaps to avoid humans and get around infrastructure. Consequently, they need 22% more food in an area already depleted by humans of wild prey. Habib says that of five tigers that left a reserve the team was monitoring, four died from walking into electrified wires.

In March 2019, the scientists collared E1, E3 and E4; E2 was shy and escaped, a trait that might serve her well amid humans. E1 was special. "As soon as you take your vehicle towards them, E1 is the first one to come to you," Hussain says. "She comes, sits there, curious about what is happening."

The adolescents were looking for territory, but roads, villages and the summer's sparse tree cover restricted their movement. E1 favoured a forest fringing a village.

On 6 April, an older woman went into the forest to collect flowers of the mahua tree, used to make liquor. As she crouched down, her posture made her look like small prey, researchers suspect. A tiger emerged without a sound and pounced. It dragged the woman 3 metres, then dropped her and disappeared.

There were two more human kills in three weeks. Hussain's data showed that E1 had been at all three kill sites, but none of the people was eaten, suggesting they were victims of mistaken identity; tigers generally don't eat humans. Scientists and the forest department are racing to understand ways to minimize such human–animal encounters. Some are using camera traps to warn villagers when tigers are in their vicinity. Others are exploring ways to train locals in alternative livelihoods so that they don't need to enter forests. Their efforts are urgent because the death toll is rising. Across central India, villagers have killed 21 tigers through electrocution, traps or poisoning since 2015. In Chandrapur alone, tigers have killed 24 people in the past 4 years.

In June, the forest department captured the tiger E1 and moved her to a wildlife rehabilitation centre, making her the ninth individual to be relocated since 2015. But it might be a temporary reprieve, as another tiger will probably take E1's territory.

Scientific battles

Much like the animals they study, tiger scientists are fiercely territorial. Everyone except Karanth at the Centre for Wildlife Studies requested anonymity while speaking about politics because it could hinder their ability to do research.

Several scientists say there is a conflict of interest because government managers fund and oversee science as well as set policies regarding reserves. Karanth says managers

"IT'S A NIGHTMARE WORKING IN WILDLIFE IN THIS COUNTRY."

grant research permits more easily to scientists from the government-run WII than to independent scientists, unless the latter join government-led studies as junior partners. Independent observers also charge that government scientists sometimes rubber stamp government actions, whether or not they are scientifically sound.

"[The WII] seems to have completely bought in, they seem very biased," one scientist says. An example is the NH44 road project: although the WII initially recommended much larger overpasses to the government, it reworked its assessment to reduce costs and make it more palatable under pressure from government officials, according to a government report.

Most independent field initiatives have shut down, says Karanth. His 30-year-long study of tigers in southern India ended in 2017 because the local forest officials had been repeatedly interrupting or delaying his work – for example, by not allowing his assistants access to field sites. The union and state government officials ignored his complaints. "To get the permits was becoming very impossible," Karanth says.

"Sadly, I've realized I don't think I can impact policy," another scientist notes.

Government officials and researchers challenge those criticisms. Anup Kumar Nayak, member secretary of the National Tiger Conservation Authority (NTCA), India's tiger conservation and research coordinating body, says that his agency has permitted several research projects by non-government scientists and non-profit organizations. "Most

of the research projects are given to [the WII] because they are the technical wing of NTCA, and they've been doing research work on wildlife for a long time," he says. "In southeast Asian countries, they're a very reputed organization."

Nitin Kakodkar, who is the chief wildlife warden of Maharashtra and signs off on research permits in his state, disagrees that WII scientists are favoured or that the managers influence research. WII scientists, he says, are more knowledgeable about the permit requirement procedures than are independent scientists. And he contends that there is no favouritism in Maharashtra. "There are people who've been doing research in Maharashtra who are not from the Wildlife Institute of India."

Jhala of the WII says his team finds it easier to get permits because they work for the government, but not by much. The bureaucracy is difficult even for WII scientists, he says. "It's a nightmare working in wildlife in this country."

The government maintains a tight grip because the tiger is a symbol of national pride, researchers say. That exalted status – and rising revenues from the tourism industry around tiger safaris and luxury resorts – might be what eventually saves the tiger from extinction.

The Indian government has plans to expand tiger conservation. For example, India is going to increase the number of tiger reserves in coming years, says Nayak.

Although numbers are stagnating in other countries, the 'wild' tiger will probably survive in India, at least inside reserves, researchers say. The animal's fate outside reserves is more questionable. Older villagers don't mind the large carnivores in their midst, but the younger generation is more circumspect.

In Kurwahi, a village near Pench, a 'fat' tiger snatched away a calf tied outside an elderly woman's house in March. Hers was one of 17 village cattle killed by the animal. I asked her whether she was angry. She put her palms together, laughed and shook her head. "How can I be angry with a tiger?" she said.

Her son glanced hesitantly at the forest-department guard, who was standing nearby. Then he gathered up courage and said what other villagers had been demanding – that there needs to be a more permanent solution. "The authorities should remove the tiger."

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