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How the Wallace line explains the difference in species across continents

In the 19th century, Alfred Wallace noticed a shift in the composition of organisms as he moved from Asia to Australia. He posited an invisible barrier in the ocean running between the islands of Bali and Lombok, striking north between Borneo and Sulawesi before curving south of Mindanao

Rupsy Khurana

Kangaroos and cockatoos are synonymous with Australia and tigers and orangutans with Asia. Both these continents boast rich biodiversity that is also very unique. A simple yet popular way to understand these 'separate greatnesses' has taken the shape of the Wallace line.

What is the Wallace line?

In the late 19th century, the English naturalist Alfred Russel Wallace noticed a dramatic shift in the composition of organisms as he moved from Asia to Australia, New Guinea, and other islands nearby. He posited an invisible barrier in the ocean, later called the Wallace line, running between the islands of Bali and Lombok, striking north between Borneo and Sulawesi before curving south of Mindanao. To him this line was like a fence between the different kinds of animals on the two sides.

Wallace and others conducted eight years of fieldwork to carefully plot the line across many kilometres, in the process laying the foundations of modern biogeography: the study of how species are distributed and how they got there.

Over the years, the line has attracted considerable research interest. "The Wallace line ... ties partly into the theory of evolution. Nowhere else on the earth do you see such a dramatic shift over such a narrow distance. Organisms are not just scattered randomly," Jason R. Ali, honorary associate researcher at the Senckenberg Society for Nature Research, Germany, said.

What did Wallace find on Sulawesi?

At their closest, the islands of Borneo and Sulawesi are just over 20 km apart yet they support very distinct plants, mammals, and birds. Wallace was more baffled by Sulawesi. It's one of the largest islands in the archipelago and home to species found nowhere else on the planet, including tarsiers (family Tarsiidae), the lowland anoa (Bubalus depressicornis), and the mountain anoa (Bubalus quarlesi), which are both of Asian origin. Yet Sulawesi is also home to Australian marsupials like the dwarf cuscus (Strigocuscus celebensis).

The island frustrated Wallace, who repeatedly redrew his line because he was unsure whether it belonged to Asia or Australia. He wrote in 1876 that the animals here showed "affinities" to Africa, India, Java, the Maluku Islands, New Guinea, and the Philippines.

Why do Sulawesi have species from both sides of the line while most others didn't? Wallace had deduced the essential answer all those years ago but it has accrued greater depth with more research over time.

What does the ancient past say?

The line is part of the Malay archipelago, a geologically complex region with more than 25,000 islands.

Wallace figured that Sulawesi's animal distribution could be explained if some of these islands had been joined with the Asian mainland in the past. As the islands broke off and drifted apart, the ancestral species on each island would have become isolated and evolved independently, creating the distribution Wallace saw in the 19th century. Since then, researchers have expanded this understanding by going further back in time. Millions of years ago, Australia broke off and drifted away from Antarctica. An ocean emerged in the growing gap and the water currents in its depths cooled the planet.

Meanwhile, Australia drifted north into Asia, creating the volcanic islands of Indonesia. Various studies found that variations in monsoons, aridity, and sea levels between these islands spurred island species to adapt to their new conditions and diversify, until as recently as four million years ago.

The movement of continents was one part of the puzzle. A study published in 2023 revealed another when scientists took a closer look at how species across the Wallace line were related. They analysed data of 20,000 species of birds, mammals, reptiles, and amphibians. Despite global cooling, they found, Malay's tropical islands stayed warmer and wetter than Australia. Thus, Asian fauna used these islands as stepping stones to Australia whereas Australian species, having evolved in cooler climes, struggled to make their way across the islands to Asia. "Species from Asia can migrate through the rainforest-rich northern route, as the ecosystems are similar to their origins," Ali said. "Australian species can only move into Asia along the southern route, around Timor and nearby islands. This path emerged much later – only a few million years ago – making migration more challenging for Australian species."

Does the line matter?

By combining insights from multiple disciplines, the aforementioned studies helped explain Wallace's findings to a degree that revealed the line to be a mirage: it was visible but the real reasons why it exists are rooted in the deeper facts of nature.

Today, even newer tools have joined older ones to further clarify the region's biogeography. "We are learning more about which adaptations allow species to move throughout the region by using advanced evolutionary modelling and computer simulations," Alexander Skeels, a postdoctoral research fellow at Australian National University, Canberra, said.

The factors that influenced species dispersal and settlement in the past are still relevant today.

The Indo-Malayan archipelago faces one of the world's highest rates of habitat destruction. Understanding its biography will be crucial for ecologists to predict how species will respond to the loss of their homes, compounded by the effects of climate change.

"New technologies are helping us understand that 'lines' that separate Asia and Australia may be simplifying the story," Skeels said. Ali echoed him, saying redrawing the Wallace line or any other line like it is "futile".

"Different datasets and methods will reveal different results. These boundaries will always be fuzzy. Instead of redrawing lines, it is more valuable to focus on how these species will be affected by habitat destruction in future," Ali added.

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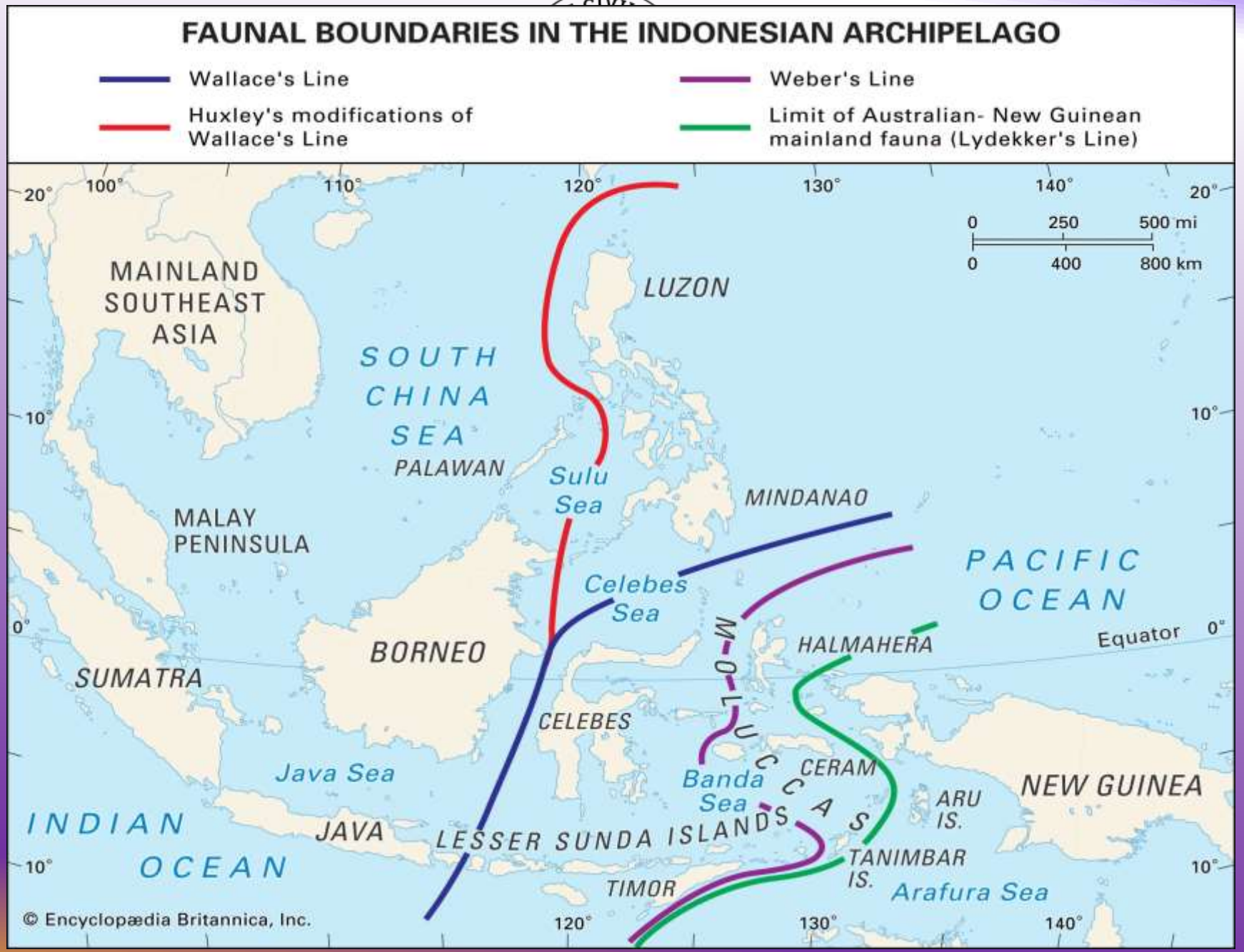
FAUNAL BOUNDARIES IN THE INDONESIAN ARCHIPELAGO
Wallace's Line
Weber's Line
Huxley's modifications of Wallace's Line
Limit of Australian- New Guinean mainland fauna (Lydekker's Line)
0 250 500 mi
0 400 800 km
MAINLAND SOUTHEAST ASIA
LUZON
SOUTH CHINA SEA
PALAWAN
Sulu Sea
MINDANAO
MALAY PENINSULA
Celebes Sea
PACIFIC OCEAN
BORNEO
HALMAHERA
Equator
SUMATRA
CELEBES
MOLUCCAS
Java Sea
Banda Sea
CERAM
NEW GUINEA
ARU IS.
INDIAN OCEAN
JAVA
LESSER SUNDA ISLANDS
TANIMBAR IS.
TIMOR
Arafura Sea
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Why has India got another tiger reserve?

Where is Madhav National Park located? What is its tiger population? What are the factors under consideration before a national park can become a designated tiger reserve? What is the tiger population in the country according to the 2023 tiger census?

Jacob Koshy

The story so far:

On March 9, Environment Minister Bhupender Yadav announced that the Centre had declared the Madhav National Park in Madhya Pradesh as the country's 58th tiger reserve. This is the ninth tiger reserve in the State, the highest among the States. Maharashtra has six; Rajasthan, Tamil Nadu, and Karnataka have five each.

The Madhav National Park is an important connecting corridor to Ranthambore tiger reserve in Rajasthan

What is the rationale behind setting up tiger reserves?

While tigers were historically abundant in India, hunting, poaching and the colonial exploitation of forests for timber started a precipitous decline in their numbers in the early 20th century. It was estimated in 1964 that there would have been around 40,000 tigers in the country at the turn of the 20th century. By the 1960s, these numbers were down to between 2,000 and 4,000, attributed to wanton hunting aided by a proliferation of gun licences issued in the years following 1947, improved access to the forest, clearing of large tracts of forests for various purposes, mushrooming of the new businesses of "Shikar Companies" and fur trade.

Following an alarm raised by naturalists, the Indian Board for Wild Life (IBWL) — the earlier avatar of the National Board for Wild Life — in a meeting in New Delhi in July, 1969 recommended a total ban on the export of all wild cat skins, including tigers. The same year, the 10th Assembly of International Union for Conservation of Nature met in Delhi and included the tiger in its "Red Data Book" as an endangered species and adopted a resolution calling for a ban on the killing of tigers. When numbers further dwindled to nearly 1,863, then Prime Minister Indira Gandhi commissioned an 11-member Task Force to investigate the problem and prepare a project to preserve the tiger in the wild in India. In August 1972, the Task Force recommended eight tiger forests spread across India to be brought under the purview of 'Project Tiger,' as this mission came to be called. On April 1, 1973, Project Tiger was inaugurated at Corbett tiger reserve with nine tiger reserves announced across India — Corbett (then in Uttar Pradesh, now in Uttarakhand), Palamau (then in Bihar, now in Jharkhand), Simlipal (Odisha), Sundarbans (West Bengal), Manas (Assam), Ranthambore (Rajasthan), Kanha (Madhya Pradesh), Melghat (Maharashtra) and Bandipur (Karnataka) – which were representative of the various tiger habitats in the country.

What does establishing a tiger reserve entail?

The Project Tiger (replaced by the National Tiger Conservation Authority (NTCA) since 2006) guidelines made it mandatory for every tiger reserve to be managed in accordance with a site-specific management plan. Project Tiger established a template for scientific management of protected areas in India. It laid down the concept of establishing a 'core zone' and a 'buffer zone', prescribed interventions for protection, habitat improvement, field data collection relating to change in the composition of flora and fauna on account of protection, animal estimation and other aspects. The guidelines also established Tiger Conservation Plans to ensure: i) Protection and site specific habitat managements for viable population of tigers, prey and co-predators, ii) ecologically compatible land uses in the tiger reserves and areas linking one protected area or tiger reserve to another for addressing the livelihood concerns of local people. The NTCA guidelines for preparing Tiger Conservation Plans, cognizant of constraints imposed by small reserves embedded in human land uses, aimed to create source populations within tiger reserves with corridor links between sources and to sink habitats. Sources are places where animal numbers are growing, and sinks are where they are dwindling, and must be supplemented by bringing in animals to boost numbers to sustainable numbers. To establish a reserve, the Centre gets a proposal from the State, the NTCA recommends the proposal to the State after due diligence, the State government notifies the area as a Tiger Reserve.

How are tiger reserves funded?

Under Project Tiger guidelines, 60% of the funds for conservation are provided by the Centre, while the rest is borne by the concerned State. In the case of Northeastern and Himalayan States, the Centre covers 90% of the funds. These activities include anti-poaching initiatives, habitat improvement and water development, addressing human-animal conflicts, designating inviolate spaces, and relocating villages from critical tiger habitats within a timeframe by offering a better relocation package. It also supports States in settling the rights of displaced people, rehabilitating traditional hunting tribes living in and around tiger reserves, conducting independent monitoring, and evaluating tiger reserves.

Why is the Madhav National Park important?

With an estimated area of 165.32 sq km, it was first notified as a National Park in Madhya Pradesh in 1956 under the MP National Parks Act, 1955. Now, the Madhav National Park and tiger reserve has a core area of 355 sq km, with a buffer zone of 4-6 sq km. It did not have a tiger population till 2023, when a male tiger and two females were relocated there. Today, the population has grown to seven. However, the Madhav reserve is an important connecting corridor to the Ranthambore Tiger Reserve in Rajasthan. It is also connected to Kuno National Park, which now has a captive cheetah population. Experts speculate that there could be competition among these predators for the prey base of deer, leading to its complex dynamics.

Madhya Pradesh boasts several prominent tiger reserves, such as Kanha, Panna, and Bandhavgarh. Due to successful conservation strategies, the State has the highest number of tigers (785). However, the Kuno-Madhav forest division, in the northern part of the State, has historically been relatively neglected. With Kuno gaining prominence as an emerging cheetah reserve, a more centralised management strategy is expected to oversee both cheetah and tiger populations, contributing to the region's long-term development as a wildlife spot.

There are plans to introduce lions from Gir in Gujarat into Kuno National Park, after the Supreme Court green-lit the project. In March 2023, the government told the Supreme Court that relocating lions to Kuno may create tensions between the pride and the cheetahs imported from Namibia and South Africa, and sought time to re-examine the issue. But if lions were to be relocated to Kuno, it would also mean more funds —central and international — for conservation.

As of the 2023 tiger census, India is estimated to have 3,682 tigers. About 30% of them are considered to be living outside tiger reserves.

Homes for the big cat

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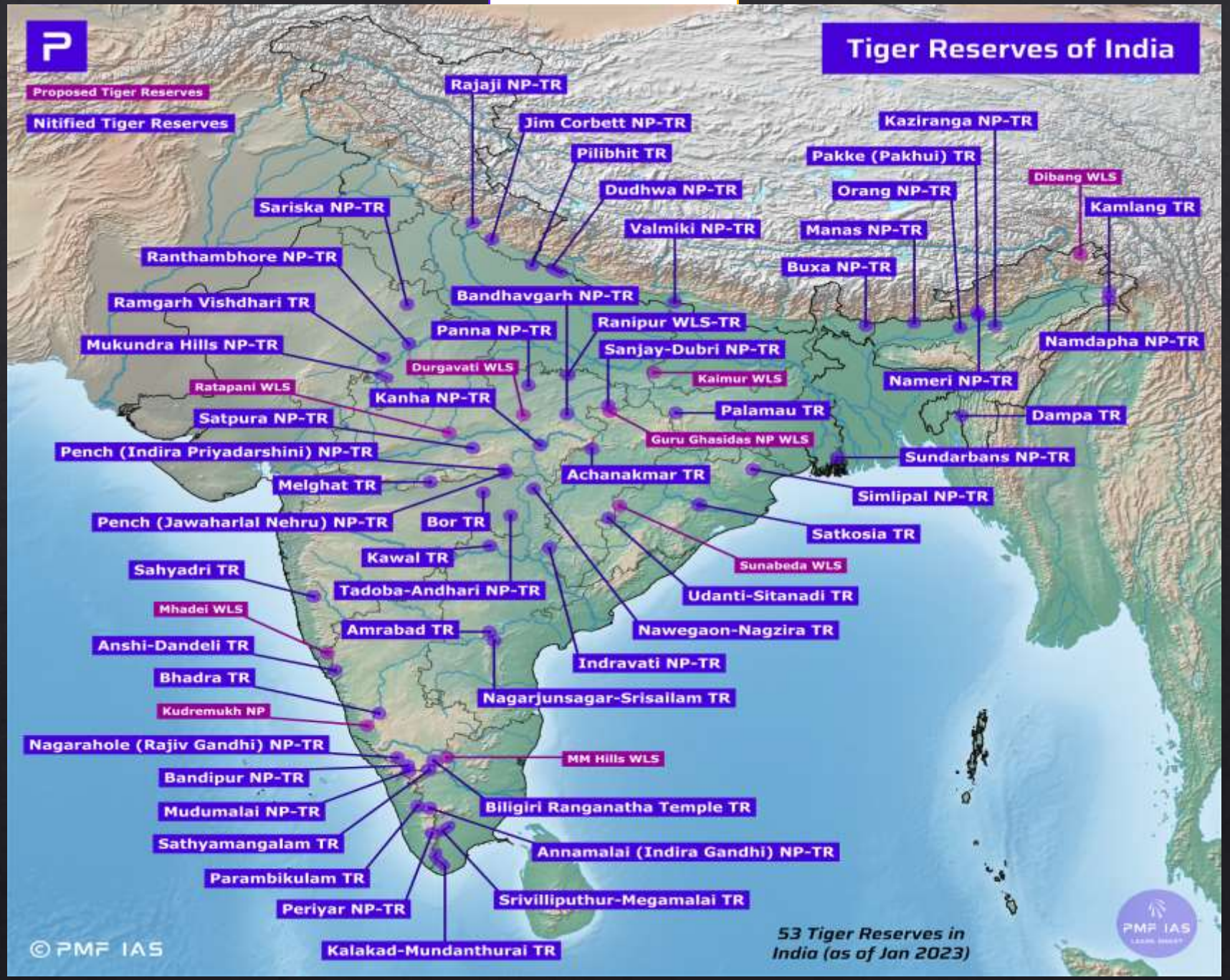
Protected Areas of India (Mar 2023)			
Protected Area Type	**Number**	**Total Area (Km^2)**	**% of India's Area**
National Parks (NPs)	**109**	**41,610**	**1.26**
Wildlife Sanctuaries (WLSs)	**572**	**~125,500**	**3.64**
Conservation Reserves (CnRs)	88	4,356	0.13
Community Reserves s (CmR)	127	525	0.02
Protected Areas (PAs)	**~900**	**~1,66,500 Km^2**	**~5.06**

Protected Area (PA) has been defined in the Wildlife (Protection) Act, 1972.
It includes national parks, sanctuaries, conservation reserves and community reserves.
Biosphere Reserve: A BR may consist of a few NPs, WLSs, PFs and RFs.
Tiger Reserve: A TR may consist of an NP, a few WLSs, PFs and RFs.
Bird Sanctuary: A BS is a WLS that conserves birds and their natural habitats.


Tiger Reserves of India
Proposed Tiger Reserves
Nitified Tiger Reserves
Rajaji NP-TR
Jim Corbett NP-TR
Pilibhit TR
Dudhwa NP-TR
Sariska NP-TR
Valmiki NP-TR
Ranthambhore NP-TR
Ramgarh Vishdhari TR
Bandhavgarh NP-TR
Panna NP-TR
Ranipur WLS-TR
Mukundra Hills NP-TR
Sanjay-Dubri NP-TR
Durgavati WLS
Kaimur WLS
Ratapani WLS
Kanha NP-TR
Satpura NP-TR
Palamau TR
Guru Ghasidas NP WLS
Pench (Indira Priyadarshini) NP-TR
Achanakmar TR
Melghat TR
Pench (Jawaharlal Nehru) NP-TR
Bor TR
Kawal TR
Sahyadri TR
Tadoba-Andhari NP-TR
Mhadei WLS
Amrabad TR
Anshi-Dandeli TR
Bhadra TR
Kudremukh NP
Nagarahole (Rajiv Gandhi) NP-TR
MM Hills WLS
Bandipur NP-TR
Mudumalai NP-TR
Biligiri Ranganatha Temple TR
Sathyamangalam TR
Annamalai (Indira Gandhi) NP-TR
Parambikulam TR
Srivilliputhur-Megamalai TR
Periyar NP-TR
Kalakad-Mundanthurai TR
Kaziranga NP-TR
Pakke (Pakhui) TR
Dibang WLS
Orang NP-TR
Kamlang TR
Manas NP-TR
Buxa NP-TR
Namdapha NP-TR
Nameri NP-TR
Dampa TR
Sundarbans NP-TR
Simlipal NP-TR
Satkosia TR
Sunabeda WLS
Udanti-Sitanadi TR
Nawegaon-Nagzira TR
Indravati NP-TR
Nagarjunsagar-Srisailam TR
53 Tiger Reserves in India (as of Jan 2023)
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Largest Tiger Reserves in India (by Total Area)

1	**Nagarjunsagar Srisailam TR**	**Andhra Pradesh**	**3296**
2	**Manas TR**	**Assam**	**3151**
3	Indravati TR	Chhattisgarh	2799

Smallest National Parks in India (by Total Area)

1	**Nameri TR**	**Assam**	**344**
2	Orang TR	Assam	492
3	Ranipur WLS-TR	Uttar Pradesh	529

Largest Tiger Reserves in India (by Core Area)

	Tiger Reserve	State/UT	Area (km^2)
1	**Nagarjunsagar Srisailam TR**	**Andhra Pradesh**	**2596**
2	**Amrabad TR**	**Telangana**	**2166**
3	Namdapha TR	Arunachal Pradesh	1808
4	Sunderbans TR	West Bengal	1700
5	Melghat TR	Maharashtra	1500

Smallest National Parks in India (by Core Area)

1	**Orang TR**	**Assam**	**79**
2	**Bor TR**	**Maharashtra**	**138**
3	Nameri TR	Assam	200