**Recent studies on Indian primates show declining population trends, even in protected areas**

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Supplementary Table 1 Search queries used in search engines (Web of Science, ResearchGate, Google Scholar) for identifying the studies to be included in our analysis. An asterisk (\*) at the end of a search term is a wildcard of an undetermined number of characters, which we used to ensure that all potentially relevant publications were captured by our search.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Keyword category 1 | Boolean operator | Keyword category 2 | Boolean operator | Keyword category 3 | Boolean operator | Keyword category 4 |
| Population\* OR  spatial\*  OR geographic\* | AND | Survey\* OR  distribut\* OR  status\* OR  estimat\* OR  abundan\* OR  asses\* OR  census\* OR  monitor\* | AND | Stumptail or bear NEAR/1 macaque OR Eastern NEAR/1 Assamense NEAR/1macaque OR Western NEAR/1 Assamense NEAR/1 macaque OR Nicobar NEAR/1  long-tailed NEAR/1 macaque OR Northern NEAR/1 pigtail NEAR/1 macaque OR  Western NEAR/1 hoolock NEAR/1 gibbon OR Indian NEAR/1 rhesus macaque OR  Arunachal NEAR/1 macaque OR Light-bellied NEAR/1 bonnet NEAR/1 macaque OR  Deccan NEAR/1 langur OR Dark-armed NEAR/1 Himalayan NEAR/1 langur OR  Bengal NEAR/1 Hanuman NEAR/1 langur OR Plains NEAR/1 langur ORTerai NEAR/1 langur OR Malabar NEAR/1 langur OR Tenebrous NEAR/1capped NEAR/1 leaf NEAR/1 monkey OR Pale-armed NEAR/1Himalayan NEAR/1 langur OR White-handed NEAR/1 crested NEAR/1langur OR Mysore NEAR/1 slender NEAR/1 loris OR Malabar NEAR/1slender NEAR/1 loris OR Northern NEAR/1 slow NEAR/1 loris ORBlond-bellied NEAR/1 capped NEAR/1 leaf NEAR/1 monkey ORGrey-handed NEAR/1 crested NEAR/1 langur OR Buff-bellied NEAR/1capped NEAR/1 leaf NEAR/1 monkey OR Orange-bellied NEAR/1capped NEAR/1 leaf NEAR/1 monkey OR Phayre's NEAR/1 leaf NEAR/1monkey OR Golden NEAR/1 leaf NEAR/1 monkey OR Lion-tailed NEAR/1  macaque OR Nilgiri NEAR/1 black NEAR/1 langur OR Dark-bellied NEAR/1bonnet NEAR/1 macaque | OR | Macaca NEAR/1 arctoides OR Macaca NEAR/1 assamensis NEAR/1 assamensis OR Macaca NEAR/1assamensis NEAR/1 pelops OR Macaca NEAR/1 fascicularis NEAR/1 umbrosa OR Macaca NEAR/1 leonina OR Macaca NEAR/1 mulatta NEAR/1 mulatta OR Macaca NEAR/1 munzala OR Macaca NEAR/1 radiata NEAR/1 diluta OR Macaca NEAR/1 radiata NEAR/1 radiata OR Macaca NEAR/1 Silenus OR Semnopithecus NEAR/1 entellus NEAR/1 Achates ORSemnopithecus NEAR/1 entellus NEAR/1 ajax OR Semnopithecus NEAR/1 entellus NEAR/1 Anchises OR Semnopithecus NEAR/1 entellus NEAR/1 entellus OR Semnopithecus NEAR/1 entellus NEAR/1 hector OR Semnopithecus NEAR/1 entellus NEAR/1 hypoleucos OR Semnopithecus NEAR/1 entellus NEAR/1 schistaceus OR Semnopithecus NEAR/1 priampriam OR Semnopithecus NEAR/1 priam NEAR/1 thersites OR Semnopithecus NEAR/1 johnii OR Trachypithecus NEAR/1 geei OR Loris /1 lydekkerianus NEAR/1 lydekkerianus OR Loris NEAR/1 lydekkerianus NEAR/1 malabaricus OR Nycticebus NEAR/1 bengalensis OR Trachypithecus NEAR/1 obscurus NEAR/1 phayrei OR Trachypithecus NEAR/1 pileatus NEAR/1 brahma OR Trachypithecus NEAR/1 pileatus NEAR/1 durga OR Trachypithecuspileatus NEAR/1 pileatus OR Trachypithecus NEAR/1 pileatus OR Trachypithecus NEAR/1 tenebricus OR Hoolock NEAR/1 hoolock |

Supplementary Table 2 Information on the Population status (increasing, decreasing or stable), year of survey, main threats reported, study area location, protection status of the study area (PA, protected area; NPA, non-protected area), and the survey methods used in the research articles that met our inclusion criteria.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study (by species) | Study area status | Location/ State | Year of survey | Purpose of study | Method/statistics | Threats reported | IUCN–CMP Unified Classification of Direct Threats | Population status inference | IUCN Red List status1 |
| **Western hoolock gibbon *Hoolock hoolock*** | | | | | | | | | EN |
| Islam et al., 2013 | PA/NPA | Assam | 2010–2011 | Demography, population structure | Line transects | Habitat fragmentation | Natural system modifications | Declining |  |
| Sharma et al., 2012 | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |
| Sharma et al., 2014 | NP | Assam | 2006–2007 | Distribution & persistence | Random sampling | Habitat loss | Natural system modifications | Declining |
| Srivastava et al., 2001 | PA | Assam | 1995, 1997, 1988 | Population status | Line transects | Habitat loss | Natural system modifications | Declining |
| Sati, 2011 | PA/NPA | Meghalaya | 2007 | Population status | Call count & all count | Anthropogenic pressures | Human intrusion & disturbance | Declining |
| ***Eastern hoolock gibbon Hoolock leuconedys*** | | | | | | | | | VU |
| Chetry et al., 2021 | PA | Assam | 2019 | Demography, population structure | Line transects | Habitat modification | Natural system modifications | Declining |  |
| Chetry et al., 2012 | PA | Assam | 2010 | Status & conservation | Line transects & call count | Anthropogenic pressures | Human intrusion & disturbance | Declining |  |
| Sarma et al., 2015 | NPA | Arunachal Pradesh | 2010–2011 | Population status | Line transects | Habitat degradation | Natural system modifications | Declining |  |
| Chetry et al., 2010 | PA | Arunachal Pradesh | 2008–2009 | Status & distribution | Line transects & calls | Habitat loss | Natural system modifications | Declining |  |
| **Assamese macaque *Macaca assamensis*** | | | | | | | | | NT |
| Biswas et al., 2011 | NPA | Arunachal Pradesh. | 2005–2006 | Biogeography, biology & taxonomy | Line transects | Habitat loss | Natural system modifications | Small |  |
| Srivastava et al., 2001 | PA | Assam | 1995, 1997, 1988 | Population status | Line transects | Habitat loss | Natural system modifications | Declining |  |
| Sharma et al., 2012 | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |  |
| Sharma et al., 2014 | NPA | Assam | 2006–2007 | Distribution & persistence | Random sampling | Habitat loss | Natural system modifications | Declining |  |
| **Nicobar long-tailed macaque *Macaca fascicularis umbrosa*** | | | | | | | | | VU |
| Narasimmarajan & Raghunathan, 2012 | NP | Great Nicobar Island | 2011–2012 | Population status | Distance sampling | Habitat modification | Natural system modifications | Recovering after tsunami |  |
| Rajeshkumar & Raghunathan, 2014 | PA/NPA | Andaman & Nicobar Islands | 2011–2013 | Population status & demography | Line transects | Anthropogenic activities | Human intrusion & disturbance | Recovering (stable; recovery attributed to regrowth of native vegetation after the area has been vacated by people) |  |
| Velankar et al., 2016 | NPA | Great Nicobar Island | 2013–2014 | Population status | Line transects | Habitat modification | Natural system modifications | Recovering after tsunami; increasing |  |
| Saren et al., 2019 | NPA | Nicobar Islands | 2015–2016 | Population status & distribution | Line transects | Habitat fragmentation | Natural system modifications | Increasing |  |
| **Northern pig-tailed macaque *Macaca leonine*** | | | | | | | | | VU |
| Sharma et al., 2014 | NPA | Assam | 2006–2007 | Distribution & persistence | Random sampling | Habitat loss | Natural system modifications | Declining |  |
| Sharma et al., 2012 | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |  |

*Supplementary Table 2, cont.*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study (by species) | Study area status | Location/ State | Year of survey | Purpose of study | Method/statistics | Threats reported | IUCN–CMP Unified Classification of Direct Threats | Population status inference | IUCN Red List status1 |
| **Strepsirrhine Bengal slow loris *Nycticebus bengalensis*** | | | | | | | | | VU |
| Sharma et al., 2012) | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |  |
| **Pig-tailed macaque *Macaca nemestrina*** | | | | | | | | | VU |
| Srivastava et al., 2001 | PA | Assam | 1995, 1997, 1988 | Population status | Line transects | Habitat loss | Natural system modifications | Declining |  |
| **Black-footed grey langur *Semnopithecus hypoleucos*** | | | | | | | | |  |
| Kumar et al., 2018 | PA | Karnataka | 2014–2015 | Population status | Line transects | Habitat fragmentation | Natural system modifications | Increasing because of greater spatial coverage |  |
| **Bonnet macaque *Macaca radiata*** | | | | | | | | | VU |
| Kumar et al., 2013 | PA/NPA | Maharashtra, Andhra Pradesh, Gujarat, Goa & Karnataka | 2004–2008 | Demography & population status | Line transects | Habitat Degradation | Natural system modifications | Declining |  |
| Erinjery et al., 2017 | PA/NPA | Karnataka, Tamil  Nadu & Kerala | 2009–2015 | Population status | All count | Habitat Loss | Natural system modifications | Declining (declined by 50% during 2003–2015) |  |
| Sengupta & Radhakrishna, 2013 | NPA | Goa | 2012 | Distribution & conservation status | Random sampling & direct sighting | Human–wildlife conflict | Biological resource use | Declining (sighted in less than 40% of their previously recorded locations) |  |
| Kumara et al., 2010 | PA/NPA | Karnataka | 2001–2004 | Distribution & conservation status | Line transects | Hunting & habitat loss | Biological resource use | Declining |  |
| Kumar et al., 2018 | PA | Karnataka | 2014–2015 | Population status | Line transects | Habitat fragmentation | Natural system modifications | Increasing because of greater spatial coverage |  |
| **Rhesus macaque *Macaca mulatta*** | | | | | | | | | LC |
| Imam & Ahmad, 2013 | NPA | Uttar Pradesh | 2010 | Population status | Line transects | Habitat degradation | Natural system modifications | Increasing |  |
| Kumara et al., 2010 | PA/NPA | Karnataka | 2001-04 | Distribution  & conservation status | Line transects | Hunting & habitat loss | Biological resource use | Declining |  |
| Sharma et al., 2012 | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |  |
| Kumar et al., 2013 | PA/NPA | Maharashtra, Andhra Pradesh, Gujarat, Goa & Karnataka | 2004–2008 | Demography & population status | Line transects | Habitat degradation | Natural system modifications | Declining |  |
| Chaudhuri et al., 2007 | NPA | Odisha | 2005 | Population status | All count | Habitat loss | Natural system modifications | Increasing because of religious/cultural protection |  |
| Srivastava et al., 2001 | PA | Assam | 1995, 1997, 1988 | Population status | Line transects | Habitat loss | Natural system modifications | Declining |  |
| Sharma et al., 2014 | NPA | Assam | 2006–2007 | Distribution & persistence | Random sampling | Habitat loss | Natural system modifications | Declining |  |

*Supplementary Table 2, cont.*

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study (by species) | Study area status | Location/ State | Year of survey | Purpose of study | Method/statistics | Threats reported | IUCN–CMP Unified Classification of Direct Threats | Population status inference | IUCN Red List status1 |
| **Arunachal macaque *Macaca munzala*** | | | | | | | | | EN |
| Sinha et al., 2005 | NPA | Arunachal Pradesh. | 2003–2004 | Distribution | Random sampling & direct sighting | Human–wildlife conflict | Biological resource use | Small |  |
| Sarania et al., 2017 | NPA | Arunachal Pradesh | 2013–2014 | Distribution modeling & population status | Random sampling & direct sighting | Habitat degradation | Natural system modifications | Increasing |  |
| Sinha et al., 2006 | NPA | Arunachal Pradesh | 2004–2005 | Distribution & conservation status | Random sampling & direct sighting | Human–wildlife conflict | Biological resource use | Small |  |
| Kumar et al., 2008 | NPA | Arunachal Pradesh | 2004–2005 | Distribution & conservation status | Random sampling & direct sighting | Human–wildlife conflict | Biological resource use | Small |  |
| **Himalayan grey langur *Semnopithecus ajax*** | | | | | | | | | EN |
| Singh, 2020 | PA/NPA | Himachal Pradesh | 2015–2018 | Distribution | Line transects | Habitat degradation | Natural system modifications | Good/stable population size (no prior study to compare) |  |
| Mir et al., 2015 | PA | Kashmir | 2011–2013 | Population density | Distance sampling | Habitat loss | Natural system modifications | Good/stable population size (no prior study to compare) |  |
| **Hanuman langurs *Semnopithecus entellus*** | | | | | | | | | LC |
| Narasimmarajan et al., 2012 | PA | Maharashtra | 2010–2011 | Population density, group size & abundance | Line transects | Habitat degradation | Natural system modifications | Good/stable population size (no prior study to compare) |  |
| Chaudhuri et al., 2007 | NPA | Odisha | 2005 | Population status | All count | Habitat loss | Natural system modifications | Increasing because of religious/cultural protection |  |
| Mishra et al., 2020 | NPA | Rajasthan | 2020 | Distribution & demography | Line transects | Habitat loss | Natural system modifications | Good/stable |  |
| Kumara et al., 2010 | PA/NPA | Karnataka | 2001–2004 | Distribution & conservation status | Line transects | Hunting & habitat loss | Biological resource use | Declining |  |
| **Phayre’s langur *Trachypithecus phayrei*** | | | | | | | | | EN |
| Adimallaiah et al., 2014 | PA | Tripura | 2009–2010 | Population status | Line transects | Anthropogenic activities | Human intrusion & disturbance | Declining |  |
| **Capped langur *Trachypithecus pileatus*** | | | | | | | | | VU |
| Kumar & Solanki, 2008 | PA | Arunachal Pradesh | 2001–2003 | Population status & conservation | Line transects & all count | Hunting & habitat loss | Biological resource use | Declining |  |
| Sharma et al., 2012 | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |  |
| Srivastava et al., 2001 | PA | Assam | 1995, 1997, 1988 | Population status | Line transects | Habitat loss | Natural system modifications | Declining |  |
| Sharma et al., 2014 | NPA | Assam | 2006–2007 | Distribution & persistence | Random sampling | Habitat loss | Natural system modifications | Declining |  |
| Choudhury, 2014 | PA | Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland & Tripura | 2011–2012 | Population status & distribution | Various | Hunting & habitat loss | Biological resource use | Declining |  |

*Supplementary Table 2, cont.*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study (by species) | Study area status | Location/ State | Year of survey | Purpose of study | Method/statistics | Threats reported | IUCN–CMP Unified Classification of Direct Threats | Population status inference | IUCN Red List status1 |
| **Golden langur *Trachypithecus geei*** | | | | | | | | | EN |
| Chetry et al., 2020 | PA | Assam | 2016–2017 | Conservation status | Line transects | Habitat loss | Natural system modifications | Increasing (sole protected area designated for the protection of this species) |  |
| Chakravarty et al., 2020 | PA | Assam | 2017 | Population status, demography & conservation | All count | Habitat loss | Natural system modifications | Declining (declined by 3% during 2012–2017) |  |
| **Lion-tailed macaque *Macaca Silenus*** | | | | | | | | | EN |
| Panner & Kalaivanan, 2021 | PA | Tamil Nadu | 2012–2013 | Population status & distribution | All count | Habitat fragmentation | Natural system modifications | Declining |  |
| Kumara et al., 2014 | PA | Karnataka | 2005–2006 | Population status | All count | Hunting & habitat loss | Biological resource use | Declining |  |
| Kumar et al., 2018 | PA | Karnataka | 2014–2015 | Population status | Line transects | Habitat fragmentation | Natural system modifications | Increasing because of greater spatial coverage |  |
| Kumara et al., 2014 | PA/NPA | Kerala | 2010–2012 | Distribution, demography & conservation status | All count | Habitat fragmentation | Natural system modifications | Good/stable population size  (1/3 of total estimated population) |  |
| **Tufted grey langur *Semnopithecus priam*** | | | | | | | | | NT |
| Ganapathy et al., 2020 | PA | Tamil Nadu | 2018 | Population status & distribution | All count | Habitat fragmentation | Natural system modifications | Good population size |  |
| **Dark-bellied bonnet macaque *Macaca radiata radiata*** | | | | | | | | | VU |
| Kumara et al., 2010 | PA/NPA | Karnataka | 2001–2007 | Distribution, abundance, group size  & demography | Line transects | Anthropogenic pressures | Human intrusion & disturbance | Declining |  |
| Singh et al., 2011 | NPA | Karnataka | 2009 | Population status & conservation | Line transects | Habitat loss | Natural system modifications | Declining |  |
| **Stump-tailed *Macaque macaca arctoides*** | | | | | | | | | VU |
| Sharma et al., 2021 | PA | Assam | 2016 | Population status | All count | Habitat fragmentation | Natural system modifications | Good/stable population size |  |
| Sharma et al., 2012 | PA | Assam | 2002, 2005, 2009 | Extinction & persistence | All count | Habitat fragmentation | Natural system modifications | Declining |  |
| Sharma et al., 2014 | NPA | Assam | 2006–2007 | Distribution & persistence | Random sampling | Habitat loss | Natural system modifications | Declining |  |

1IUCN Red List status: LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered.

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