Abstract

Large cats are vulnerable to local extinction in fragmented landscapes mainly due to large scope developmental and anthropogenic activities. Present study highlights the mortality of protected leopard’s population in Uttarakhand state, north-west India. In between January 2009 to October 2010, 78 leopards have died due to various reasons accounted primarily for unnatural deaths. Maximum deaths occurred in between February 2009 & April 2010 and notably 37 leopards died since January, 2010. The mortality rate for females was significantly higher than for males. Notably, 11 leopards were found dead scrambled in trap and some deaths occurred while providing treatment after rescuing the animal. In addition, 21 cases of leopard’s poaching (illegal wildlife trade) were also documented in between January 2009 to March 2010 in which 35 leopard’s skins were recovered, which highlighted that poaching is also ongoing in some remote areas. Status of man-animal conflict in Uttarakhand is severely increasing; in between November 2000 to December 2008, 180 people died in leopard’s attack, whereas 343 were injured during encounters and leopard’s attacks. On the other hand, 394 leopards died due to other reasons during the said period and 50 were declared as man-eater, which were shot dead or translocated to other protected habitat. Here, we report on the mortality in protected leopard population of Uttarakhand state and conservation status. Such reports are highly required to know the status and our competence in illustrating success and failures of wildlife rescue operations besides in conservation of an endangered wildlife.

Keywords

Conservation, Leopard, Mortality, Protected Habitat, Threat, Uttarakhand

1. Introduction

Leopard (Panthera pardus) is widely distributed wild big cat and listed as an endangered species in IUCN Red List of Threatened Mammals and categorized under Schedule 1 of “Wildlife Protection Act 1972”. In between January 2009 to October 2010, this species has dwindled drastically in Uttarakhand state and its existing populations are at high risk (Figure 1). One of the main reasons for this decline is the degradation of the habitat and loss of connectivity among different protected habitats. In Uttarakhand, Rajaji–Corbett wildlife corridor is the strong hold of leopards with a population of 608 (census 2005, Figure 5 A&B), which also includes the population in Rajaji National Park, Corbett Tiger Reserve (including Sonanadi Wildlife Sanctuary and Kalagarh Tiger Reserve), Lansdowne, Dehradun, Haridwar, Ramnagar, Terai East, Terai West, Terai Central and Haldwani forests divisions. Remarkably, in between January 2009 and April 11, 2010, 78 leopards have died at different locations of Uttarakhand state and most of the deaths occurred in protected habitats (Table 1).

2. Causes of Mortality

The specific reason of maximum number of leopard’s deaths was not clearly known because of old carcass found. This has accounted for 30 leopards (38.4 %), which were found dead at different locations of the state (Figure 5 C&D). Ground data revealed that 24.3 % (19) leopards died due to poaching / captured in trap (in some cases died during care after rescued from trap, Figure 5 E) whereas 20.5% (16) leopards were declared as man-eater and had been shot dead. Road accidental deaths accounted for 6.4 % (05), killed by villager in self-defense accounted for 3.9 % (03) and train accidental deaths accounted for 1.3 % (01). A total of 3.9 % (03) animal had been died in internal fight whereas 1.3 % (01) killed in wildfires (Table 1, Figure 2, 5 F&G). However, it was said in some cases that leopard died because of disease/illness, but we assumed all these cases under unknown
category. It is quite difficult to find out accurate reason of death especially when any old carcass is found, even after the post-mortem; it is very difficult to trace accurate death reasons. However, exact death reason could be known tentatively by investigating the field evidences.

**Table 1.** Leopard’s mortality in Uttarakhand since January 2009

| Date          | Location                                      | Cause of Death                                      |
|---------------|-----------------------------------------------|-----------------------------------------------------|
| January 01, 2009 | Terai West Forest Division                     | Found injured, died during care                     |
| January 22, 2009 | Pokhaal, Kotdwar, Lansdowne Forest Division    | Female, 03 years Shot-dead, declared as man-eater   |
| February 03, 2009 | Rajawala, Selaqui, Dehradun Forest Division    | -                                                   |
| February 06, 2009 | Almora Forest Division                         | -                                                   |
| February 08, 2009 | Almora Forest Division                         | Male, Found dead                                   |
| February 13, 2009 | Gopeshwar-Chamoli Route, Nanda Devi Biosphere Reserve | - Trapped in clutch wire, rescued, died during care |
| February 16, 2009 | Almora Forest Division                         | -, Cub Found Dead, Unknown                          |
| February 16, 2009 | Nainital Forest Division                       | -, Cub Found Dead, Unknown                          |
| February 17, 2009 | Ghamandpur, Ranipokhri, Barkot Range, Dehradun, Forest Division | Male, Found dead                                   |
| February 18, 2009 | Paathisain area, Dhumakot, Pauri Forest Division | Male, Found dead                                   |
| February 19, 2009 | Pokhaal, Pauri Forest                          | -                                                   |
| February 19, 2009 | Gairsain, Chamoli Forest                       | -                                                   |
| February 19, 2009 | Khatima-Banbasa Route, Banbasa Forest          | Female, - Road accident                             |
| March 05, 2009  | Kholiagaon, Bageshwar Forest                   | -                                                   |
| April 12, 2009  | Gairsain, Chamoli Forest                       | Female, - Shot-dead, declared as man-eater          |
| April 26, 2009  | Gadgadia Range, Haldwani Forest Division       | -                                                   |
| May 13, 2009    | Chopra, Raipur Range, Mussoorie Forest Division | Female, - Shot-dead by shooter, declared as man-eater |
| May 20, 2009    | Haridwarp-Roorkee route, near to Pethri rau, Haridwar Forest Division | Female, - Road accident                             |
| June 09, 2009   | Tol village, Devprayag                         | Female, 08 years Shot dead, declared as man-eater   |
| June 28, 2009   | Devprayag                                      | -                                                   |
| June 26, 2009   | Sikroda, Khanpur Range, Haridwar Forest Division | -                                                   |
| July 01, 2009   | Premnagar, Dehradun Forest Division            | Female, - Shot dead, declared as man-eater          |
| July 14, 2009   | Bharpur patti, Devprayag, Tehri               | -                                                   |
| July 15, 2009   | Kudkawala, Haridwarp Forest Division          | Male, 05 years Found dead, Poaching (bullets were found over to body) |
| July 16, 2009   | Kumrada village, Chinyalisaur, Uttarkashi      | Female, 04 years Killed by villager during attack/self-defence |
| No. | Date               | Location/Details                                      | Age | Status/Details                                                                 |
|-----|--------------------|-------------------------------------------------------|-----|--------------------------------------------------------------------------------|
| 27. | July 17, 2009      | Khandah, Pauri                                        |     | Brutally killed by villagers                                                   |
| 28. | July 23, 2009      | Nainital Zoo                                          | Female, 04 years | Shifted from Birla Forest, rescued, finally died                               |
| 29. | July 27, 2009      | Gairsain area, Chamoli Forest                         |     | Shot dead, declared as man-eater                                               |
| 30. | August 16, 2009    | East Jhandi chaar, Kotdwar Forest                     |     | Found injured, died during care                                                |
| 31. | August 19, 2009    | Chiniyalisaur, Uttarkashi                             |     | Found injured, died during rescue operation                                     |
| 32. | August 21, 2009    | Gopeshwar, Chamoli Forest Division                    |     | Found injured, died during rescue operation                                     |
| 33. | August 21, 2009    | Gairsain, Chamoli Forest                              | Male, 05 years | Shot dead, declared as man-eater                                               |
| 34. | October 07, 2009   | Motasaal are, Sonanadi Wildlife Sanctuary Kalagarth Tiger Reserve | Female, - | Found dead                                                                     |
| 35. | October 13, 2009   | Chaukhuatia Block, Almora Forest Division             |     | Shot dead, declared as man-eater                                               |
| 36. | October 15, 2009   | Yamkeshwar Block, Pauri Forest Division               | Male, - | Shot dead, declared as man-eater                                               |
| 37. | October 23, 2009   | Kaladhungi Range, Rammager Forest Division            |     | Found dead, internal fight                                                      |
| 38. | November 07, 2009  | Bhndaar are, Jakholi BL, Radraprayag Forest Division  | Female, - | Shot dead, declared as man-eater                                               |
| 39. | November 12, 2009  | Kansrao, Rajaji National Park                        | Female, - | Train accident                                                                 |
| 40. | November 20, 2009  | Chini Forest, Khatina Range, East, Forest Division    | Male, - | Found dead, carcass found in a nullah; Haemorrhage of intestine/bleeding?      |
| 41. | December 24, 2009  | Chauparura Range, Barwa village, Dehradun Forest Division |     | Found dead; 03 nails missing                                                    |
| 42. | January 06, 2010   | Chaukuni Forest, Champawat Forest Division            | Female, 02 years | Found dead, Unknown (post-mortem report - Disease)                            |
| 43. | January 07, 2010   | Rishikesh Forest, Dehradun Forest Division            | Female, 02 years | Road accident                                                                  |
| 44. | January 12, 2010   | Patampur, south Jaspur, Terai West Forest Division    | Female, 04 years | Found Dead, Unknown                                                             |
| 45. | January 15, 2010   | Forest near to Buggalwala village, Khanpur Forest, Haridwar Forest Division |     | Found Dead, Unknown (post-mortem report - Disease)                            |
| 46. | January 21, 2010   | Haldwani Forest, Terai Central Forest Division        | Male, - | Found dead, Internal fight                                                      |
| 47. | January 22, 2010   | Jhajra Forest, Dehradun Forest Division               |     | Shot dead [declared as man-eater]                                               |
| 48. | January 24, 2010   | Forest near to Bosaan village, Chakrata Forest Division |     | Found dead, unknown                                                            |
| 49. | January 27, 2010   | Kota Forest, Rammagar Forest Division (Patikot village) | Male, 06 years | Found dead, Internal fight                                                      |
| 50. | January 29, 2010   | Bakli village, Chaukhuatia, Almora                   | Male, - | Found dead, unknown                                                            |
| 51. | January 29, 2010   | Malsi Deer Park, Dehradun                            | Female, 01 year | Disease, Brutally rescued from Survey of India campus                          |
| 52. | February 07, 2010  | Gaulapara area, near to Kalichaurs river, Raghunath, Chakrata Forest Division | Male, 05 years | Found dead                                                                     |
| 53. | February 07, 2010  | Hemppur forest, Aamokhwa Range, Terai west Forest Division |     | Found dead, Captured in fencing, rescued during night of 06th but finally died; fencing of agriculture farm of Remount training school & depot [poacher has laid the trap of clutch wire] |
| 54. | February 11, 2010  | Kirada-Lava Route (near Lava village), Devprayag      |     | Found dead, Trapped in fence                                                   |
| Date       | Location                                      | Animal | Age | Condition                                         |
|------------|-----------------------------------------------|--------|-----|--------------------------------------------------|
| 55. Feb 12 | Jhajhira Forest (Majhaun), Dehradun Forest Division (200 meters away from Birodi village) | Male, 07 years | Found hanged in a tree in break-wire |
| 56. Feb 12 | Aasarodi Forest Range, Dehradun Forest Division Near to Badowala barrier (in private farm house) | Female, 06 years | Found dead, brutally captured in a trap (all four legs were detached from body) |
| 57. Feb 15 | Rausaal village, Bhilangna Range, Terai Forest Div. | Female, 02 years | Found dead; died two days before |
| 58. Feb 15 | Chaka, Ludiyanaam Tok, Ghansorapaka Forest | - | Found dead, unknown |
| 59. Feb 16 | Langha Forest, Kalsi Forest Division | Male, 05 years | Found dead; trap marks in neck portion, Nails missing from three feet |
| 60. Feb 17 | Beribara Forest, Rajaji National Park | Male, 01 year | Found dead |
| 61. Feb 19 | Back portion of IMA campus, Dehradun attached | Female, - | Captured in trap, rescued very late & bring To with Tons river Aasarodi but finally died [trap was placed for army training purpose] |
| 62. Feb 23 | Rikhrikhal Block, Pauri district | - | Found dead, Natural death? |
| 63. Feb 25 | Ganja village, Bhimtal, Nainital | Female, - | Found injured; rescued & shifted to Nai Natal Zoo but finally died |
| 64. Mar 01 | Kotdwar Range, Lansdowne Forest Division | - | Found dead; old carcass |
| 65. Mar 08 | Near to Gaula river by-pass bridge, Haldwani Forest Division | Male, 02 years | Found dead; three claws were missing & neck bone was found fractured [looking like snow leopard] |
| 66. Mar 12 | Belani, Near to Vidya Mandir, Rudraprayag | Female, 01 month | Found dead; masticated spots found over To lower neck portion |
| 67. Mar 16 | Mandal Range, Imeria Beat, Kalagarh Tiger | Female, 02 years | Found dead; Injured marks at neck, belly & head |
| 68. Mar 20 | Saterakkhal, Rudraprayag | Female, 02 years | Found dead; Poaching case [seriously Injured & nails missing] |
| 69. Mar 21 | Khanpur, Haridwar Forest Division | - | Found dead |
| 70. Mar 21 | Pantnagar Veterinary College, Pantnagar Shifted from Malsi Deer Park for treatment | Male, 05 years | Found trapped in a snare at Majri village, rescued & shifted to Malsi Deer Park, after that shifted to Pantnagar Veterinary Col Lege for treatment; serious injury in neck Portion and infection, finally died |
| 71. Mar 21 | Badowala, Dehradun Forest Division | - | Found trapped in snare at Badowala vil lege, Badowala village near Shimla bypass road Shimla bypass road; leopard was captured during day hours [chest portion was seriously injured] rescued & shifted; finally died |
| 72. Mar 27 | Kotwali forest, Chiriapur Range, Haridwar Forest Division | Female, 02 years | Road accident, Haridwar – Bijnor National Highway No. 74 |
| 73. Mar 28 | Nirada/Mathana village, Pithoragarh Forest Division | Male, 06 month | Found dead |
| 74. Mar 28 | Nirada/Mathana village, Pithoragarh Forest Division | Female, 08 months | Found dead |
| 75. Apr 05 | Bohra village, Near Bhujaan, Civil forest, Ranikhet Almora Forest Division | Female, - | Found dead |
| 76. Apr 10 | Ramgarh Range, Rajaji National Park | - | Found dead, burnt in fire |
| 77. Apr 10 | Sauni Forest, near to Pant gaon, Ranikhet, Almora | Male, - | Found Dead, Unknown |
| 78. Apr 11 | Almora Forest Division | - | Brutally killed by villagers |

Source: Self observations / news published in national level newspapers / official records.
Leopard’s mortality rate was significantly influenced by on-going poaching activities (trap knotting and poisoning for skin and body parts). During last two years, clutch-wire made snares were frequently found by the officials being used by the poachers, which also don’t enable the animal to liberate out from trap. Notably, maximum number of deaths occurred during February 2009 & 2010 (12) and March 2010 (11) followed by January 2010 (10). As most of the protected habitats are adjacent to villages and leopards used to move frequently in buffer zones and sometimes near to boundary of villages, therefore, instances of poaching cases are commonly observed from time to time (Figure 2).

3. Skin Recovery Cases

Despite mortality cases, 35 leopard’s skin were also recovered / seized by forest officials, civil police and special force at different locations of Uttarakhand during January 2009 to March 2010 (Table 2). Additionally, 04 other cases of recovering body parts (bones, nails & teeth) were noted during said period. To control this, state forest department is conducting extensive patrolling and joint raid operations in sensitive areas besides, Task Forces are being constituted to check the illegal wildlife trade. Based on available figures, it can be said that poaching activities in Uttarakhand is effective and still ongoing (Figure 5 H&I).
Table 2. Cases of leopard’s skin recovery in Uttarakhand since January 2009

| S.No. | Date       | Area               | Case details                                                                 |
|-------|------------|--------------------|------------------------------------------------------------------------------|
| 1.    | February 08, 2009 | Haldwani | Bones of leopard recovered by Forest staff from Nepali person               |
| 2.    | February 14, 2009 | Banbasa, Nepal Border | 03 skins were recovered by Seema Shastra Bal force from Nepal border; 03 people arrested |
| 3.    | February 23, 2009 | DakPathar are, Dehradun | A skin was recovered by Special Task Force and Wildlife Protection Society of India |
| 4.    | March 18, 2009 | Pokhri, Chamoli | 02 skins were recovered by Special Task Force and WPSI from Dehradun         |
| 5.    | March 23, 2009 | Haridwar | Bones and Teeth of leopard were recovered by Haridwar Forest Division        |
| 6.    | April 25, 2009 | Champawat | A skin was recovered by Special Operation Group at Champawat                 |
| 7.    | May 07, 2009 | Champawat | 02 skins were recovered by Champawat civil police                            |
| 8.    | June 20, 2009 | Badrinath area, Chamoli | A skin was recovered by Badrinath Forest staff                               |
| 9.    | June 29, 2009 | Haldwani | Bones recovered from Fatehpur, Haldwani/Ramnagar by Terai west forest staff & WPSI |
| 10.   | July 08, 2009 | Haridwar | 01 skin was recovered by Haridwar police & forest division at Haridwar       |
| 11.   | July 26, 2009 | Hailang, Birhi | 03 skins were recovered by Forest department in Chamoli district             |
| 12.   | September 04, 2009 | Nandprayag, Chamoli | 02 skins were recovered by Special Task Force & WPSI; Poison/Poaching case |
| 13.   | September 12, 2009 | Ghat, Chamoli | 01 skin was recovered by forest staff & WPSI                                 |
| 14.   | September 14, 2009 | Jakholi, Rudraprayag | 01 skin was recovered by forest staff                                         |
| 15.   | October 11, 2009 | Kalsi, Vikas nagar, Dehradun | 02 skins were recovered by STF & forest staff                               |
| 16.   | November 11, 2009 | Almora | 01 skin was recovered by Almora civil police                                |
| 17.   | December 21, 2009 | Haridwar | 05 skins were recovered by civil police of Haridwar                           |
| 18.   | January 07, 2010 | Rishikesh city area | 03 skins of leopard were recovered by Special Task Force of Rishikesh, Dehradun |
| 19.   | January 17, 2010 | Muni ki Reti (Tehri) | 01 skin of leopard was recovered by Special Operation Group, Rishikesh        |
| 20.   | February 03, 2010 | Lohaghat, Pithoragarh village (Rawatgarh). | Bones, tooth and nails of leopard were recovered by Seema Shastra Bal (SSB) near Sail Nicotine Ganja was also recovered by poachers. |
| 21.   | February 13, 2010 | Dineshpur More, Rudrapur | One leopard skin was recovered from poachers by SIDCUL Police & SOG, Rudrapur, U S Nagar [as per poachers they bring skin from Nepal and are going to Haldwani for selling skin] |

Source: self observations / news published in national newspapers / official records

Leopard’s deaths during January 2009 – April 2010

| Sex – ratio | Total |
|-------------|-------|
| Found dead, unknown cause | 30 |
| Poaching / captured in trap (died during rescue / care) | 19 |
| Road accident | 05 |
| Declared as man-eater | 16 |
| Killed by villager in self-defense | 03 |
| Train accident | 01 |
| Internal fight | 03 |
| Wildfire | 01 |

4. Status of Rescued Leopards

Rescuing wild animal is a very sensitive and challenging task and needs very responsive treatment. Wild animals are very sensitive to human beings and proximity with them makes animal unconscious and furious. Besides, our efforts to rescue the leopards are not based on scientific protocol and that is one of the reason, which prolong deaths after rescue operations or during treatment. Out of 78 deaths, 12 were found trapped in snare and injured and shifted to some other safe areas but eventually all the leopards finally died. In addition, against to this, we have two examples in which leopards have been successfully rescued and translocated to...
During January 2006, a male leopard was declared as man-eater in Badrinath forest division (Chamoli district) and after capturing him successfully from Budhadhang village, was released to Khara forest (Mithawali area) of the Rajaji National Park. One such case had happened during 2008 in which a male leopard was translocated to Malsi Deer Park after being rescued from Dehradun–Mussoorie highway (Figure 5 J). Man-eater leopards were captured from time to time through setting up of baited traps effectively but as far as on-spot rescue and treatment is concerned our efforts are unequipped to save wildlife.

5. Rescue Center

In an initiative to protect the state’s endangered wildlife; state government initiated a project for care of rescued wild animals during 2010 especially for man-eater leopards. Under this project a rescue center has been established over an area of 25 hectares in Kotawali forest of the Haridwar forest division. Just after establishment four problem leopards were shifted to this centre from different locations of Garhwal Himalaya and are being providing treatment under supervision of experts. This initiative can be considered as a favourable step in wildlife conservation in north India. However, translocation of big cats is a controversial subject among various workers. In the event of a leopard problem, the most common management strategy followed throughout India is the setting up of baited traps, capture of an individual (not necessarily the problem causing individual) and its subsequent translocation into the nearest suitable natural habitat[1,2]. This is also recommended by the Indian Wildlife Protection Act[3] through an amendment made in 2002. However, this strategy is not recommended by scientists for managing problem animals because of the strong homing instincts exhibited by a wide range of carnivore families and the potential for movement of conflict with the individuals [1-4].
6. Future of the Leopard’s Population in Uttarakhand State

Uttarakhand is rapidly losing its leopard wealth and therefore needs a very transparent attention and conservation actions. During November 2000 to December 2008, 180 people were killed by leopards and 343 were injured in leopard’s attack (Figure 3). Notably, 394 leopards died due to various causes (236–natural, 116–accident and 42–poaching; Figure 4). On the other hand 50 leopards were declared as man-eater during November 2000 to December 2008 and most of them were shot down while some were shifted to other protected habitat (zoo, protected habitat & zoological park). But maximum deaths accounted for shot due to fierce nature and demand of local people.

Maximum number of man-eaters were declared during 2009 (14) followed by 2006 and 2007 (11) and 2003 (09) whereas least number were declared during 2004 and 2005 (02). Historical literature revealed that 140 people succumbing to leopard attacks between 1988 and 2000 while 93 leopards were killed in the same period[5]. Since 2009, man-leopard conflict has been enhanced to two folds and today the situation in some places is very severe especially in rural areas.

Figures indicated that man–leopard conflict is increasing day-by-day mainly because of competition for resources and space. Most of the villages are situated in between the forest area and adjoining to protected habitats and wild animals (leopard, wild boar, bear, Himalayan yellow throated marten and several species of deer) used to move extensively near to these areas because of presence of water and palatable crops. Besides, traditionally villagers also used to enter nearby forests to collect fuel-wood and fodder year round and thus encounter rate is increasing. In this critical situation more effective action-oriented and scientific protocol based strategies are required for conservation of this endangered species, which should primarily involve the participation of local people at every level, like formulation of policies, government meetings, awareness programmes and research activities.

Uttarakhand has a long history of leopard problem especially man-eater, for which the world famous conservationist Jim Corbett is known. This problem is more common in hilly areas where leopard’s movement is commonly observed adjoining to villages and currently its population is only safe in protected areas that don’t consist of human habitation. Mammalian carnivores are vulnerable to local extinction in fragmented landscapes mainly due to their low densities, large ranges and inevitable conflict with humans[6,7].

Outside protected areas, accidental or intentional killing by people drives local extinction of large carnivores or reduces their numbers, and it is a matter of fact that many human-dominated landscapes will always be unsuitable for some large carnivores[8]. Animal-vehicle collisions have the potential to impact the viability of wildlife populations. Several studies have been carried out on mortality of wild animals[8-11].

Today, wildlife in several parts of India does not exist in isolation. Most wildlife populations live outside protected areas, often along side humans. Dogs, pigs and goats form an important part of leopards diet across many sites (Himachal
Pradesh, Uttarakhand, Gujarat and Maharashtra) indicating that the feral animals and livestock are probably important prey of leopards living outside protected areas in India [12,13].

In India, most of the national highways and railway tracks are also running across the potential protected wildlife habitats, which impede the frequent movement of animals within their home range. In this situation there is further need to conduct more scientific studies on the unnatural deaths of wildlife to address the requirements of both humans and wild fauna.

7. Recommendations

1. Proper census should be carried out at potential sites especially in buffer zones, where leopard’s movement is very common and at risk.

2. At some places locals use to place snare / trap during night near to boundaries of the protected areas, therefore night patrolling of adjoining villages will be beneficial to know the status of poaching activities.

3. As most of the villagers are living adjacent to the protected habitats traditionally and their indigenous knowledge about the forest resources and wildlife conservation is important to be addressed, therefore if we incorporate their opinions in making conservation policy that will be immensely helpful in conservation of wildlife wealth.

4. Community participation should be ensured besides; involvement of local people, government organisation, NGOs and subject experts is highly required.

5. Affected regions should be monitored sharply and movement of other wild animals (herbivores) should be ensured. It will be helpful in knowing the specific status of poaching of wildlife.

6. Death reason should be explored properly so that we should know the accurate death reason and be cautious in future about that.

7. Radio-telemetric studies are required on leopards, which were released / translocated to protected habitat. This will be helpful in knowing the adaptation status of species and on the basis of which some recommendations could be given.

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