

CHAPTER-IV

Research and Conservation Efforts for Flora/ Fauna

A Snapshot

The Department had not prepared a consolidated State Wildlife Research Plan. There was lack of research activities and proper mechanism for ensuring timely submission of research findings to the State Authorities/ WII was yet to be established.

The Sanctuaries were invaded by invasive alien species. However, despite having management prescription regarding control of invasive species, fodder plantation, natural regeneration and plantation activity, its execution was not satisfactory in the test-checked Sanctuaries.

The Department did not conduct in-depth analysis of the estimated wildlife in terms of survival ratio/ pattern, seasonal patterns of movement, basic migratory routes and areas of high species density and diversity, etc. Special efforts were required for reintroduction/ conservation of the locally extinct species. However, measures taken by the test-checked Sanctuaries to stabilize/ improve such species were not commensurate with the requirements for conservation. Breeding Centre was required to be established at Jambughoda Sanctuary and the Centres in Ratanmahal and Shoolpaneshwar Sanctuaries were to be operationalised/ utilised as per the needs identified. Despite instances of human-wildlife conflicts; the Sanctuaries were not equipped to deal with such conflicts both in terms of human resources and equipment. Honorary Wildlife Wardens (HWW) were not being appointed on regular basis.

Introduction

Wildlife conservation refers to the protection, care, management and maintenance of ecosystems, habitats, wildlife species and populations, within or outside of their natural environments, in order to safeguard the natural conditions for their long-term permanence.

4.1 Research

Scientific Research is the backbone of conservation of wildlife and is crucial for better understanding of ecosystems, their functions, ecological status, threat perceptions of various species and their habitats. Research also helps in generating baseline information against which impacts of conservation and management efforts undertaken can be monitored which in-turn will help the field managers in taking appropriate actions.

4.1.1 State Wildlife Research Plan

NWAP-2 (2002-16) prescribes that each PA manager shall prepare research priorities for respective PA, which shall then be consolidated in a State Wildlife

Research Plan to be prepared every five years by the State Forest Department. The preparation of the first plan was to start in 2002 and was expected to be completed by 2004. NWAP-3 (2017-31) also provided for continued research/ studies to ascertain impact of developmental activities on wildlife habitats. Audit observed that the Department did not prepare Gujarat State Wildlife Research Plan till date (October 2022).

A State wildlife research plan would have ensured research in the identified areas for better habitat management and conservation and protection of wildlife.

4.1.2 Status of research

National Working Plan Code¹ 2014 stipulates that reference should be made to all research articles/ outputs/ findings during the preparation of the working plan. It also requires that while writing the working plan, all research gaps and challenges with respect to availability of data should be brought out clearly.

The Management Plans of the Sanctuaries identified various challenges such as poor and meaningless research; absence of systematic and scientific data, etc. Audit noticed that the Management Plans of the Sanctuaries and the working plans of the forests surrounding the Sanctuaries referred to research articles/ outputs/ findings published more than a decade ago which indicated lack of availability of current research. Audit noticed that 119 topics had been identified in the management plans of the six test-checked Sanctuaries. These included important research topics like reintroduction of locally extinct species, population study of various species, carrying capacity and appropriate interventions for formulation of eco-tourism plans etc. Research on these identified areas could be of immense use for better management of these Sanctuaries. However, in the test-checked Sanctuaries, no research was conducted in last 10 years (2010-11 to 2020-21).

The Department stated (November 2022) that research topics were being communicated to the Gujarat Forestry Research Foundation (GFRF) by the respective Sanctuaries. The Department further stated that research was being done by Gujarat Ecological Education and Research (GEER) Foundation and various Universities apart from GFRF. Moreover, it was informed that research on seven (out of 33) and two (out of 34) topics in respect of Jessore and Balaram Ambaji Sanctuaries respectively was either completed (seven topics) or was going on (two topics).

The reply, however, was silent on the research conducted on the topics identified in the Management Plans of the respective Sanctuaries. Furthermore, the concerns of the jurisdictional divisions regarding non-availability of latest research puts under doubt the co-ordination among different Department/ agencies regarding relevance, timeliness and availability of reports on research, if any conducted.

¹ was introduced to bring uniformity in forest management planning by the MoEF, GoI and aims to sustainably manage, conserve, and utilise the forest resources.

Recommendation 8: The Department may prepare and implement a State Wildlife Research Plan to ensure that research is conducted in an integrated and effective manner.

4.1.3 Submission and Availability of Research Reports

As per NWAP-2 (2002-16), it is the responsibility of the State to acquire, evaluate and disseminate available research reports and scientific findings and data to enable better management of wildlife species and habitats.

4.1.3.1 Submission of research reports

The Guidelines of 2006 issued by MoEF&CC provide that the final report and other scientific publications of the research project should be submitted to the Chief Wildlife Warden of the State within three to six months. As the submission of the research reports were not forthcoming, the Department came out with State specific Guidelines in March 2017.

Audit observed that the Guidelines *inter alia* detailed the procedure for processing of research proposals and general conditions for grant of permission. However, the condition regarding mandatory submission of final research report and other scientific publications to the Chief Wildlife Warden (PCCF (WL)) had not been incorporated in the State Guidelines. Moreover, though the State Guidelines mandated submission of data/ report/ findings/ thesis etc. to the WII, the Department did not put in place any mechanism to ensure the same.

Main objective of formulating these Guidelines was to ensure submission of research findings to the State Government so that useful findings are available to PA Managers for improved management of wildlife. Thus, not making it mandatory for the researchers to submit their findings to the State Government deprived PA Managers of relevant research material. Absence of such a provision in the Guidelines may result in continued non-submission of research reports by the researchers and consequent non-availability of research material for better management of PAs.

During the exit conference (October 2022) the Department acknowledged the need to revise the State Guidelines to make it binding on the researchers to submit their reports to the Department.

Conservation of Flora

Flora refer to all the plant life within a particular region. Native flora is the plant life that grows/ flourishes naturally in a particular region. Flora provides food not only for humans, but also for the wildlife who live in the area and those passing through. It also provides essential services to the environment like fertilizing soil and filtering water for drinking. Thus, conservation of flora is essential for the conservation of fauna in a particular region.

4.2 Invasive Alien Species

An alien species is a species of flora introduced outside its natural past or present distribution. If this species becomes problematic, it is termed an Invasive Alien Species. Unless control measures are adopted in a systematic and phased manner, their infestation may pose a serious threat to the wildlife.

The Sanctuary-wise details of alien species, their effects and remedial action required are given in **Appendix IV**. During joint site visit with the RFO (July 2021) of the Jessore Sanctuary, Audit observed that the Dantiwada range of the Sanctuary was invaded with *Prosopis Juliflora* which formed a monoculture, inhibiting growth of other plant and grass species, even in the rainy season. The Land Use and Land Cover analysis conducted by SAC, Ahmedabad (December 2021) on the request of Audit also brought out that around 51 *per cent* of the geographic area of Jessore Sanctuary and ESZ was dominated by *Prosopis Juliflora*. The photographs taken during joint site visit shows the prevalence of the invasive alien species:



Photograph 4.1: Large areas invaded by *Prosopis Juliflora*



Photograph 4.2: No undergrowth of other plants and grass species even in rainy season

Source: Photographs taken during joint site visit of Dantiwada range in July 2021.

Audit analysed efforts made by the authorities in the respective Sanctuaries for removal of invasive species, plantation of alternative species etc. to reduce the effects of these invasive species on the wildlife habitat as per prescriptions of Management Plan/ GEER Foundation/ MEE Reports. The observations are narrated in the following paragraphs:

- ***Jessore and Balaram Ambaji Sanctuary***

GEER Report and MEE Report 2017-18 for Jessore prescribed for total removal of invasive species. Similarly, MEE Report 2016-17 for Balaram Ambaji prescribed for removal of *Prosopis Juliflora* and *Lantana* and planting of native fruit-bearing trees.

However, Audit observed that in Jessore only a small patch (one Ha.) of the *Prosopis Juliflora* was removed and local tree species and fruit bearing species were planted (2020-21). In respect of Balaram Ambaji, the jurisdictional Division did not furnish records relating to invasive species removed and suitable plantation done to Audit (September 2022).

During the exit conference (October 2022), the Department agreed to prepare a five-year plan for the removal of invasive alien species in Balaram Ambaji and Jessore Sanctuaries.

- ***Jambughoda***

Management Plan (2012-22) prescribed for removal of 50 Ha of invasive species per year, plantation of edible species (50 Ha per year), gap plantation (50,000 plants per year in 445 Ha), fodder plot (124 Ha) and regeneration survey (775 Ha) during the years 2012-17.

Audit observed that as against the target of gap plantation in 445 Ha, plantation was done in 35 Ha in 2016-17 only during the five years' period from 2012-17. Thus, the target for gap plantation could not be achieved and fell short by 92 *per cent*. Further, no fodder development work and regeneration survey was carried out during the period 2012-17.

Regarding removal of invasive species, the Department stated (November 2022) that nearly 2,000 Ha *Lantana* has been removed in last five years. However, the Department did not furnish any evidence in support of their reply.

- ***Ratanmahal***

Management Plan (2014-24) prescribed for removal of 100 Ha of invasive species per year, promotion of rotational grazing and undertaking plantation of fodder species to fulfil the needs of Sloth Bear and habitat enrichment plantation in core zone (8 Ha per year), improvement of grasses (1 Ha per year) and regeneration of 250 Ha forest area per year.

However, the Department did not provide any information of the activities carried out in this regard (December 2022).

- ***Shoolpaneshwar***

Management Plan (2017-27) prescribed for cleaning of 170 Ha per year (totalling 850 Ha), planting grass (330 Ha), fruit/ fodder/ rare and endangered species (1,280 Ha), bamboo plantation (750 Ha) and browsable species improvement (852 Ha) during 2016-17 to 2020-21.

The jurisdictional Division stated (September 2021) that physical targets of plantation were not prescribed by the Department and therefore, it had not maintained any records and no monitoring was done regarding the same. The reply of the Division was indicative of the fact that the management Plan was not being referred in the management of the Sanctuary.

- ***Purna***

Management Plan (2014-24) prescribed for Ketki planting (125 Ha), fodder plots (400 Ha), miscellaneous plantation (120 Ha), silvi pasture development (100 Ha) during 2016-17 to 2020-21.

Audit observed that no Ketki planting, silvi pasture and other plantation was done during this period. Further, against the target of development of 400 Ha of fodder plots, only 125 Ha (31.25 per cent) was achieved during 2016-21.

Thus, despite having management prescription regarding control of invasive species, fodder plantation, natural regeneration and plantation activity, its execution was not satisfactory in the test-checked Sanctuaries during the period covered under the respective management plan, which was necessary for maintaining the ecological balance in the sanctuaries.

The Department stated (November 2022) that removal of invasive species and fodder plantation is done in the Sanctuaries as per budget availability.

Recommendation 9: The Department may undertake a phased programme for identification of areas invaded by invasive species and removal thereof, along with its replacement with the indigenous fruits, fodder and other suitable species.

Conservation of Fauna

4.3 Wildlife population estimation

Population estimation of wild animals is important as it contributes to improved management of wildlife habitats. It is important to record the type (species, age, male- female ratio, proportions of calves, yearlings, and sub-adults) of animals, their numbers, method adopted for counting (e.g. aerial or ground count), etc. Any programme for management and conservation of wildlife would require such information for deciding on management and conservation policies.

4.3.1 Estimation of wildlife in Gujarat

The estimation of Asiatic Lion, Sloth Bear, Leopard and other wildlife in Gujarat is to be conducted by the PCCF (WL) every five years. The estimation of wildlife in Gujarat during various years is shown in the table below:

Table 4.1: Estimation of wildlife in Gujarat

Sl. No.	Animal	2005	2006	2009	2010	2011	2014	2015	2016	2020
1	Asiatic Lion	359	-	-	411	-	-	523	-	-
2	Leopard	-	1070	-	-	1160	-	-	1395	-
3	Sloth bear	-	247	-	-	293	-	-	343	-
4	Wild Ass	-	-	4038	-	-	-	4451	-	6082
5	Blue Bull (Nilgai)	-	-	-	119546	-	-	186770	-	-
6	Crocodile	-	-	-	-	-	1098	-	-	-
7	Others ²	-	-	-	-	-	-	988269	-	-

Source: Website of the Forest Department, GoG.

As can be seen from the above table except for Asiatic Lion, Leopards, Sloth Bear and Wild Ass, estimation for other species of animals was not done on

² Black Buck, Spotted Deer, Sambhar, Chinkara, Chausinga, Barking Deer, Pea fowl, Monkey, Wild boar and Pig, etc.

regular basis during the 15 years' period (2005-2020). Since population estimation is the basis of management planning, it is essential to have updated data on various wildlife species. Management Plans, not based on updated data of wildlife species is fraught with risk of non-achievement of desired objectives.

4.3.2 Need for adoption of scientific method of wildlife estimation and analysis of estimates

National Bear Conservation and Welfare Action Plan, 2012 mentions that reports of very high densities of Sloth Bears in a few Protected Areas of Gujarat and Rajasthan have not been scientifically validated. Further, Gujarat Bear Conservation and Welfare Action Plan, 2012 prescribed development of protocol by 2013-14 for conducting scientific and systematic census of Sloth Bear in Gujarat. Scientific and systematic census/ estimation were also emphasized (1999) in 'Status Survey and Conservation Action Plan-Bears' of International Union for Conservation of Nature (IUCN)/ Species Survival Commission (SSC)- Bear specialist group (BSG).

Audit observed that the Department continued to use the traditional method of direct observance (direct sighting) and indirect observance (such as footprint, other marks and sound hearing) and the protocol for scientific and systematic census of Sloth Bear was not yet developed (November 2022).

The 'Status Survey and Conservation Action Plan-Bears' has also stated that unsubstantiated abundance estimates³ provide a false sense of assurance in population assessment, and may confer little or no warning for populations in jeopardy.

Review in Audit of the estimation figures for Sloth Bear and Leopards for 2006 and 2016 revealed that the Sloth Bear increased from 247 in 2006 to 343 in 2016. Similarly, the Leopard estimates increased from 1,070 in 2006 to 1,395 in 2016. The increase of both the species is an encouraging sign. However, out of 1,395 leopards⁴ in 2016, only 706 (51 per cent) were estimated based on direct observance whereas the remaining 689 (49 per cent) were estimated based on indirect observance, because of which 610 (44 per cent) Leopards could not be identified in terms of gender or age structure (matured or cubs).

Audit further observed that apart from statistical analysis, in-depth analysis of the estimated wildlife in terms of survival ratio/ pattern, seasonal patterns of movement, basic migratory routes and areas of high species density and diversity, etc., was not done by the Department. The absence of a detailed and in-depth analysis of the estimated wildlife may adversely affect the management of these wildlife in the protected areas.

4.4 Conservation of Fauna

Reintroductions/ conservation/ translocations have increasingly been recognised as a strategy to conserve threatened species and restore ecosystem

³ Abundance estimation comprises of all statistical methods used for estimating the number of individuals in a population.

⁴ Male: 330, Female: 278, Cubs: 177, Unidentified/ Uncertain: 610.

functions. As per the Management Plans of the six test-checked Sanctuaries, certain wildlife like Tiger, Cheetal, Chinkara, Four-horned Antelopes, Sambhars, Flying Squirrel, Wild Dogs etc. are locally extinct. Considering that certain wildlife had become locally extinct or were under threat of extinction, special efforts were required for reintroduction/ conservation of these species. However, measures taken by the test-checked Sanctuaries to stabilize/ improve such species were not commensurate with the requirements for conservation as discussed in the succeeding paragraphs.

4.4.1 Establishment of breeding centres

The herbivores serve as prey-base for the carnivores and thus are essential for conservation of the species placed in the upper levels of the food chain. The management plan of the four test-checked Sanctuaries (Jambughoda, Ratanmahal, Shoolpaneshwar and Purna) acknowledged that herbivores like Sambhar, Chital, Black Buck, Spotted Deer and Chinkara have locally ceased to exist. Accordingly, the Management Plans of these four Sanctuaries while recognizing need for preservation and reintroduction of the herbivores, recommended establishment of breeding centers. Audit analysed the establishment and results of the breeding centres, wherever established and observed the following:

Table 4.2: Establishment of Breeding Centre and results thereof

Sanctuary	No. of breeding centres required to be established as per Management Plan	Wildlife	Breeding Centre established and result thereof
Jessore Balaram Ambaji	No operational Management Plan during the period 2016-21.	NA	Breeding Centre for Chital and Red Jungle fowl was operational since 2019-20.
Jambughoda	Breeding Centre for the wildlife mentioned in column 3 were to be established.	Chital, Four-horned antelope, Grey jungle fowl, Indian hare & other suitable species	Not established (November 2022).
Ratanmahal	01	Chital/ spotted deer, Sambar and Common India hare	Though a Breeding Centre was established in 2012, it was lying idle as on August 2021 due to death of the animals brought for breeding.

Sanctuary	No. of breeding centres required to be established as per Management Plan	Wildlife	Breeding Centre established and result thereof
Shoolpaneshwar	Breeding Centre for the wildlife mentioned in column 3 were to be established.	Four horned Antelope, Barking Deer, Indian hare, Alexandrine Parakeet, Red Jungle Fowl, Spotted deer, Vulture, Peafowl.	<p>Breeding centre for Four Horned Antelope and spotted deer were established in 2014-15 and 2017-18 respectively.</p> <p>No breeding centre was established for other species (September 2022).</p> <p>Six spotted Deer were bred during 2019-21 and all the 10 Spotted Deer (including two breeding pairs) were released (2020-21) in the safari park.</p> <p>Though, 17 Four Horned Antelope were bred in between 2014-15 and 2020-21, these were yet to be released (October 2022).</p>
Purna	Breeding Centre for the wildlife mentioned in column 3 were to be established.	Barking Deer and Chital	One Deer Breeding Centre was operational (November 2022).

Audit observed that the release of Bred spotted Deer in the safari park instead of the Sanctuary area was not as per the intended purpose of breeding i.e. enhancing prey-base of the carnivores in the Shoolpaneshwar Sanctuary. Lack of prey base in the Sanctuary areas may adversely affect the sustenance of carnivores in these areas.

The Department stated (November 2022) that Director, Sakkarbaug Zoo, Junagadh would be requested to provide surplus animals for the Breeding Centre at Ratanmahal Sanctuary.

4.5 Human wildlife conflict and rescue

The destruction and disturbance in habitats of wild animals due to anthropogenic pressures have resulted in animals entering human settlements in

search of food and water, culminating in conflicts. Human-wildlife conflict occurs when wildlife requirements overlap with those of human population.

As per the latest wildlife estimates for the state of Gujarat (2016), 64 *per cent* of the leopards and 43 *per cent* of the sloth bears were found outside the Sanctuary areas. Further, the Department had acknowledged that in the five years' period from 2016-21, a total of 116 cases of human deaths, 679 cases of human injuries, and 21,273 cases of injuries or deaths of cattle had been reported. The six test-checked Sanctuaries during the period 2016-21 had reported a total of 50 human deaths and eight injuries. They had also reported 264 cases of cattle deaths.

In view of instances of human-wildlife conflict, it is essential that the concerned wildlife authorities (Division/ Range) are well-prepared to respond to such conflicts. Guidelines for Human-Leopard Conflict Management issued (April 2011) by the MoEF prescribe that each forest division should have a well-trained operational Emergency Response (ER) team⁵ equipped with chemical capture equipment, drugs, appropriate cages, etc., to manage conflict situations. Moreover, Animal Rescue Centre is also essential for the rescued/ injured animals/ birds.

Audit analysed preparedness of the Department with reference to availability of emergency response teams, required equipment and animal rescue centers.

4.5.1 Creation of emergency response teams and availability of required resources

Gujarat Bear Conservation and Welfare Action Plan had prescribed requirement of two separate rescue and emergency response teams for Gandhinagar Wildlife Circle (Balaram Ambaji and Jessore) and Vadodara Wildlife Circle (Jambughoda and Ratanmahal) by 2013. As against this, Gandhinagar Wildlife Circle had established a 'Rapid Response Team' in March 2021 while the Vadodara Wildlife Circle was yet to establish such a team (October 2022).

Similarly, the management Plan of Jambughoda Sanctuary had prescribed an emergency rescue team-cum-mobile squad⁶ with a pick-up van (wildlife rescue ambulance) and necessary equipment including cages. However, the squad was yet to be established (October 2022).

Thus, the Department did not establish rescue and response teams to effectively manage human-wildlife conflicts.

The status of required human resources/ equipment and animal rescue Centre, in the Sanctuaries is shown in the following table:

⁵ consisting of an officer not below the rank of Assistant Conservator of Forests (ACF), one qualified veterinarian, and a minimum of five trained support staff.

⁶ Comprising one forester, two guards and 3-5 labourers.

Table 4.3: Status of animal rescue preparedness as of September 2022

Sanctuary	Animal rescue Centre	Veterinary doctor	Tranquilizer Gun	Other equipment ⁷
Balaram Ambaji	Available	Hired on contract on yearly basis	Available	Available
Jessore	Not available	Hired on contract on yearly basis	Available	Available
Jambughoda	Available	Not available	Available	Not available
Ratanmahal	Not available	Not available	Not available	Not available
Shoolpaneshwar	Not available	Not available	Not available	Only cages/enclosures were available
Purna	Not available	Not available	Not available	Not available

Source: Information furnished by the jurisdictional divisions.

The Animal Rescue Centre at Balaram Ambaji Sanctuary was equipped with operation theatre, postmortem room, stretcher, sterilization, rescue vehicle, and medicines. However, the Centre at Jambughoda Sanctuary was found inoperative (August 2021). In Jambughoda (as of August 2021) and Shoolpaneshwar (September 2021) Sanctuaries, services of veterinary doctor of other Department/ District/ Taluka hospital, were being availed. In the case of Balaram Ambaji and Jessore Sanctuaries, though four tranquilizer guns were available, only one was in working condition. In Jambughoda, only one tranquilizer gun was available without anesthesia medicine. In Shoolpaneshwar, the cages and animal enclosures were old and rusted indicating lack of proper maintenance.

Thus, in spite of reported instances of human-wildlife conflicts, the Sanctuaries were not well equipped and prepared in terms of required human resources and equipment. This may affect the protection and conservation activities in and around the wildlife Sanctuaries.

Recommendation 10: The rescue centers may be provided with the required human resources including full-time veterinary doctors and equipment/gears, medicines, and other materials.

4.6 Appointment of Honorary Wildlife Wardens

People's participation and support is crucial for nature and wildlife conservation and protection which can be achieved by involving community leaders and other persons of standing. Such assistance can be particularly useful in control over poaching for the clandestine trade in wild animals or their articles, carrying the message of conservation to the people. Section 4 of the WPA allows appointment of suitable people from public as Honorary Wildlife Wardens (HWW). Appointment of HWW is made district-wise.

⁷ Specialised cage, dedicated vehicle for rescue, specialised safety gear.

The six test-checked Sanctuaries and their surrounding areas were spread in six Districts⁸. Audit observed that the tenure of the HWW appointed in 2008 for all the six Districts expired in 2010. State Government did not initiate any action for fresh appointment for seven years thereafter. Subsequently, HWW were re-appointed (January 2019) in only four Districts⁹ for a period of two years, which expired in January 2021. No further appointment has been made since then except in Narmada District (November 2022). It was also observed that Vadodara and Dang Districts did not submit recommendations for appointment of HWW despite instructions (July 2018) by the PCCF (WL). Thus, the post of HWW remained vacant in these two Districts since May 2010.

Thus, the Department did not ensure people's participation in conservation efforts, through the appointment of HWW, as envisaged in WPA.

4.7 Good practices

During joint site visits (July 2021 to September 2021) with the jurisdictional staff (DCFs/ ACFs/ RFOs/ Foresters) audit noticed certain good practices, however the same were found localized and could be replicated across Sanctuaries.

- Artificial termite mound at Jessore- The authorities in Jessore Sanctuary created artificial termite mounds for Sloth Bear¹⁰ as shown in the photograph below. Audit observed signs of Bear (claw marks and scat) frequenting the artificial termite mound. This was a good practice which could be replicated in other Sanctuaries having presence of Sloth Bear to further supplement conservation efforts.

Photograph 4.3: Artificial termite mounds in Jessore Sanctuary



Artificial termite mound: Holes indicating that termites were being sucked by Sloth Bear.
Source: Photograph taken during joint site visit of Dantiwada range on 21 July 2021.

⁸ (i) and (ii) Balaram Amabaji and Jessore: Banaskantha; (iii) and (iv) Ratanmahal and Jambughoda: Dahod, Panchmahal and Vadodara; (v) Shoolpaneshwar: Narmada; (vi) Purna: Dangs.

⁹ (i) Banaskantha (ii) Dahod (iii) Panchmahal (iv) Narmada.

¹⁰ Sloth Bears have a broad palate, protrusible lips, and they lack the upper two middle incisors, all specializations for eating ants and termites (Source: Bears 'Status survey and conservation action plan' brought out by IUCN).

- **Water recharge and soil erosion prevention structures at Ratanmahal and Jambughoda**

Check walls, trenches and soil erosion prevention structures were noticed inside Jambughoda and Ratanmahal Sanctuaries. The creation of such structures in remote and tough terrain of the Sanctuaries helps in arresting soil erosion.

- **Rainwater harvesting at Purna**

Rain water harvesting structure was constructed alongwith the watch-tower in Bardipada Range. Due to this, the rainwater could be channelized into an underground water tank constructed at the base of the watch-tower. As water was not normally available around the location, the rain water harvested could be used for fire control and human needs of staff during summer months, in addition to protective function of the watch tower. This was an innovative practice, which could be replicated at other locations.

Photograph 4.4: Rain water harvesting structure at Bardipada Range of Purna Sanctuary



Source: Photograph taken during joint site visit in September 2021.

- **Wind powered water pumps at Jessore, Ratanmahal and Jambughoda**

Wind powered water pumps were built in conjunction with artificial water storage structure created for use of animals at Jessore, Ratanmahal and Jambughoda Sanctuaries. Creation of such pumps is helpful in remote areas of the Sanctuaries where regular electric pumps cannot be used (due to non-availability of electric connection) for filling the water holes, guzzlers, water tanks etc. It would also reduce reliance on manual filling of these water sources.

Photograph 4.5: Wind powered water pump (Jambughoda WLS)



Source: Photograph taken during joint site visit in July/ August 2021.