Restoration of Natural Grassland Habitat at Lakhpat Region, Gujarat

Second Annual Report

Sponsored by

ADANI PORTS AND SPECIAL ECONOMIC ZONE LIMITED

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ACHIEVEMENT (SUMMARY)

SUMMARY

- Guneri village is situated north of Lakhpat Fort with a population of 967 as per the 2011 census. Being located in the western part of Kachchh the region experiences extreme arid climatic conditions with scanty rainfall of about 400 mm.
- Around 59 percent of the village area is barren land dominantly hilly rocky terrain (34 percent) followed by saline waste (25 percent). About 21 percent of the area is under agriculture and 3 percent forms pasture land.
- The area for restoration includes 40 ha of gauchar land. The restoration process is spread over three years, starting initially with 10 ha and slowly moving up to 40 ha by the third year.
- The major objective of the restoration are i) Restoring the grasslands in the gauchar lands (under panchayat) .ii) Documentation of biodiversity and ecological process iii) Capacity building of the locals in the ecological monitoring process of documentation of changes.

Bhatagadh Area

- To prevent soil erosion, plugging was done using locally available rocks and other materials from the site itself.
- In the first round of plantation efforts in July end, around 150 plants of Desi Guggal and other species like Karanj, Limbdo, and Mithi Amli were undertaken. The Guggal, a threatened species, the nursery was raised at Bhuj plantations undertaken at the plot.
- The first survival count was taken on 30th November 2022 and the second round of counting was done in May 2023. The survival rate of Desi Guggal was high as compared to other species and indicates its suitability and high level of adaptation at the site.
- Biofencing of cactus was initiated to prevent damage to the barbed wire fencing.
- The long-term monitoring of soil indicated a reduction in pH from 2021 to 2023, indicative of the enhancement of OH^- ions, which improve the absorption capacity of the other nutrients at the root zones.

- Heavy metal analysis results indicate a higher percentage of Aluminium and Iron in the form of ferric oxide. Aluminum in higher concentrations limits the growth of the plants due to high acidity.
- Monitoring of ground vegetation showed that the ground flora diversity increased from 18 number in 1st year to 30 in 2nd year, clearly indicating the species enhancement in the area. The results are attributed to the seeding programme and control of cattle grazing.
- An increase in the density of *Aristida*, a grass species will help to retain moisture and improve the fertility of the soils by the addition of biomass. The *Indigofera* species (*leguminoceae)* appearance in the second year with root nodule is important species that assist in nitrogen-fixing and thereby improve soil fertility.
- About 50 avifaunal species were reported from the restoration site in the three months of winter observation. Two threatened species viz., Desert Wheatear (Vulnerable) and Painted stork (Near Threatened) is reported from the restoration site.
- Among the mammals, one Schedule I species (Chinkara) and three Schedule IV species viz., Indian crested porcupine, Indian Desert jird, and Indian hare reported from the Bhatadagadh area. The hunting of these species is prohibited under the Wildlife Protection Act (WPA) 1972, and the presence of these species indicates the presence of habitat and food base for these species.

Chachh Area –I

- In the beginning, soil analysis was carried out in June 2022, and based on the soil salinity the area was mapped.
- Piludi (*Salvadora* spp) and Unt morad plantations were undertaken in the first round in September 2022 and the second round of plantations was undertaken in October 2022. During this phase, mangrove (*cheriya)* saplings were planted on an experimental basis in an area with high salinity.
- The monitoring was done in November 2022 and the survival rate of the piludi was relatively higher as compared to other species.
- The soil quality was monitored indicating that the pH of the soil did not differ much. However, a significant reduction in soil salinity was observed. This

alteration is good for the vegetation as the harsh conditions seem to have become mild and will be confirmed in the vegetation growth of 2023.

- The heavy metal analysis indicates the presence of higher concentrations of Aluminium, Iron, and calcium. The presence of aluminum retards the absorption of essential elements into the roots and affects the growth of the plants. Calcium indicates the presence of high soil alkalinity which again restricts the growth of the plants.
- Ground vegetation dynamics revealed an increase in the diversity from 10 species at the beginning to 32 after the end of the first year of soil treatment.
- The number of migratory birds was reported high in the January recording. Grey francolin, Grey heron, and laughing were reported throughout the winters and are the resident birds of the areas. The important RET species reported from the Chachh area include 2 Near threatened species and 2 Vulnerable species.
- Direct sightings of Bengal fox, Chinkara, and Indian hare were reported from the study area. The presence of Chinkara indicates the presence of grass for grazing in the area and Bengal fox is the top predator in the food chain.

Chahchh Area – II (Planning).

- In the third year of the project restoration of the last 10 Ha will be undertaken. The terrain is generally flat with sparse *Prosopis juliflora* vegetation.
- The soil analysis of 10 locations indicates pH in the range of 8.27 and the salinity is reported in the range of 1.89 ppt. The salinity is low compared to the previous Chachh I site.

Capacity Building Activities

- The locals participated in various activities right from pit digging, to manure collection and application.
- The youth of the village were trained on how to count the grass species and maintain records, identify the local species, and the soil sampling process.
- The locals and the school children were oriented on the presence of rare and engendered species in their area. In this regards GES's old publication on the identification of rare and endangered species was distributed among the

locals, BMC members, and school children in September as a part of the capacity building.

- **A Rare and Threatened species *Limonium stocksii* was spotted by the field assistant growing in the Bhatagadh plot.**
- The locals were involved in the grass seeds collection in January 2023. These are stored and will be used for the preparation of seed balls and spraying in the new locations during monsoons.
- After the first spell of rainfall in 2022, the seeds balls prepared by mixing cow dung and grass seeds were spread over the Chachh area. In this process, the school children were involved in the preparation of seed balls and dispersal.
- SMC structures were erected in the Bhatadagadh area to prevent soil in June 2022. The site location was undertaken with the assistance of the locals and their ideas were used in the construction of these structures.

Innovations In The Project

- Fencing of cactus and dead Prosopis stems were done to support barbed wire fencing at Bhatadagadh.
- In the first year, the cactus cutting was planted at a distance of 3 m and thereafter gap filling was undertaken after the rains of 2022.
- The mangrove nursery was raised and transplantation was undertaken after 6 months. The mortality rate of the seedlings was very high and it is learned that the transplantation need to be undertaken after the mangroves have attained a height of about 1 m.
- Biochar improves the soil porosity and thereby assists in better root growth. Considering this an onsite experiment was done, where biochar was applied to plants. The growth will be monitored in the coming months and if found encouraging will be an important tool of restoration for the Guneri soils, especially the Bhatagadh soils.
- To create awareness of the species present in the Guneri village with special emphasis on the restoration site identification manual of birds and butterflies comprising of photographs and a short description in the local language about the species is being conceptualized.

SDG Goals Achieved Under The Project

- SDG 13 Focuses to combat climate change and its impacts.
- SDG 14 States conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
- SDG 15 Focuses to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combating desertification, and halt and reverse degradation and halt biodiversity loss.

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CONTENTS

1 INTRODUCTION

INTRODUCTION

The concept of restoration in many of these initiatives and agreements is very broad and includes many approaches to ecosystem management and nature-based solutions, all of which are valuable. The standards address the relationship between ecological restoration and other ecosystem management and nature-based solutions and clarify the specific role of ecological restoration in contributing to the goals of conserving biodiversity and improving human well-being worldwide.

Grasslands are among the most widely distributed terrestrial biomes globally (White et al. 2000; Dixon et al. 2014). Grasslands harbor a high diversity of plant and animal species, including endemic and endangered ones (Dengler et al. 2014). Grassland landscape elements act directly or indirectly on ecosystem structure and dynamics, which in turn affects ecosystem products and services Figure 2.

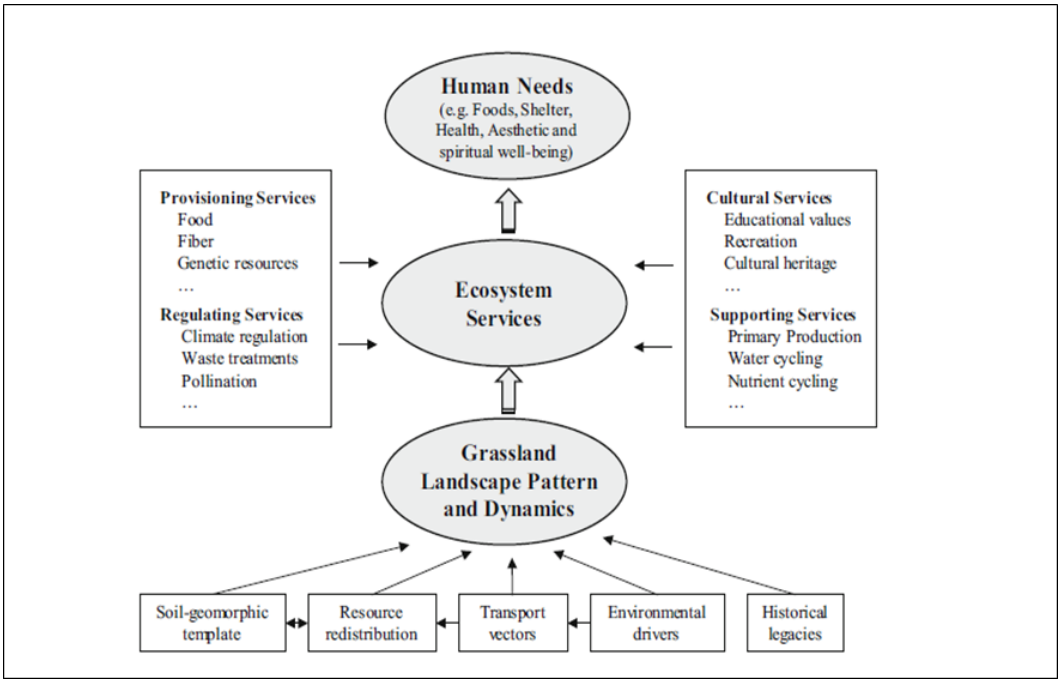


Figure 2: Main ecosystem services of grasslands and their interactions with the grassland landscape and human needs (Source: Zhao et al. 2020)

Guneri village located in Lakhpat Taluka of Kachchh has unique ecosystems like Savanna grasslands, thorny forests, wetlands, and creeks. In addition, the village has a unique pocket of biodiversity in inland mangroves. The Guneri's inland mangroves are rare, maybe three-four, recorded in the world disconnected from the sea, still sustaining a unique ecosystem.

Around 59 percent of the village area is barren land dominantly hilly rocky terrain (34 percent) followed by saline waste (25 percent). About 21 percent of the area is under agriculture and 3 percent forms pasture land.

The region supports many rare and threatened species including *Helichrysum cutchicum* (endemic species), *Cistanche tubulosa*, *Campylanthus ramoissimus*, and *Sida tiagii*. Studies carried out by GES (2013), Patel et al. (2018), and Das et al.(2019) enlist the threatened species of Lakhpat and Guneri, which includes *Anhingame lanogaster, Mycteria leucocephala, Platalealeu corodia, Circusae ruginosus, Pavov cristatus, Gazella bennettii, Limonium stocksii, Dipcadi erythraeum, Talinum portulacifolium, Indigofera caerulea var. monosperma,* and *Ipomoea kotschyana.*

A Biodiversity Management Committee (BMC) exists and hence it becomes easy to undertake grassland restoration with the help of committee members. The area for restoration includes gauchar land and about 40ha of the area is considered. The restoration process is spread for three years, starting initially with 10ha and slowly moving up to 40ha by the third year

The current project focus on grassland restoration for 40ha area along Guneri village with the following aims:

1) Restoring the grasslands in the gauchar lands.
2) Documentation of ecological process and the success of grassland development.
3) Capacity building of the locals in the ecological monitoring process and process of documentation and observation of changes.

A Brief on the First-Year Progress

- For the first few months interaction with the community and discussions were conducted at regular intervals to understand the issues and problems faced by the locals and introduction of the restoration project and its importance. Before the intervention is undertaken, an environmental assessment was done for hydrogeology, drainage, soil types, etc. The baseline soil surveys indicate salinity was in the range of 800 ppt to 7000 ppt.
- The baseline survey for vegetation was also done, to understand grass, shrub, and tree layers. Drone videography was done with the support from APSEZ team for the selected restoration sites to document the phase-wise restoration process.

- Six educated youths from the villages were interviewed by the GES team and Mansingh Jadeja was appointed as a project assistant on 17/6/2021.
- PRA with locals was carried out during the field visit by the GES team. Based on the area survey and discussion with the villagers and local communities are decided for the restoration. On 19/8/2021 and a resolution was passed where the aforesaid agreed upon coordinating and carrying out the restoration work in the village.
- Based on the discussion with the villagers, the restoration activity was initiated from Bhatadagadh (rocky area) for the first year followed by the subsequent area. For the second year, the Chhachh area was taken for restoration.
- In the initial phase of restoration, *Prosopis juliflora* was removed from the plot which would otherwise hamper the restoration process. Grass seeds were procured mixed with desi khattar and dispersed in the form of seed balls during the first monsoon. Saplings of Salvadora, Paraspimpal, Desi babul, and Neem were procured from the forest department and plantations undertaken in the fringes.
- Barbed fencing was undertaken to restrict cattle movement in the plot area. Based on the demand of the locals and grass availability in the plot the fencing was kept open from one side.
- To conserve rare and threatened species seeds of *Campylanthus ramossius* and *Helichrysum kutchicum* from nearby locations and other parts of Kachchh were collected for propagation in the grass plot.
- The faunal survey was undertaken in the winter from December 2021 to February 2022.
- To assess the impact of restoration, monitoring of the soil at regular intervals was undertaken at regular interval.
- To strengthen the environmental monitoring process a training manual in Gujarati language is developed. Field training on the species diversity present at Bhatdagadh and Chhach village was given.
- Celebrations were done for World Soil Day on 5th December and International wetland day on 2nd February.
- A small competition was conducted on embroidery and the best ones were given prizes on World Environment Day 5th June.
- For the restoration process, the area in Chachh area was marked out and SMC structures and other plantation schemes were drawn based on the soil conditions.

- Due to conservation efforts and protection, the region provided fodder even in the late summer, while the grass was dried in outside regions. This is one of the achievements of the project in the first year apart from training and create generate awareness on the conservation of grass plots and rare and threatened species.

2 BHATAGADH AREA (Progress)

BHATADAGADH AREA

Challenges in the site as observed in the first year

- Low soil cover and grass cover
- Less retention of rainfall water
- Grazing pressure

2.1 Plugging of Gullies

In the first year, it was observed that the terrain has channels that tend to erode and water quickly passed out from these channels. At the beginning of the second year, plugging was done using locally available rocks and other materials from the site itself. The sequence of photographs below shows the plugging process.

After the rains, ceased soil was found retained at the plugging sites and the grass developed at the site. The moisture retention was good and resulted in better growth of the ground vegetation.

2.2 Plantations

Guneri received heavy rainfall in the first week of July and the process of the plantation programme was delayed. In the first round of plantation efforts in July end, around 150 plants of Desi Guggal and other species like Karanj, Limbdo, and Mithi Amli were undertaken. The Guggal nursery was raised at Bhuj and plantations, transported at Guneri, and plantations were undertaken. However, due

to good rainfall and prolonged rainfall that continued until August end, some of the plantations withered due to excess rainfall. In the second round gap filling and replantation were undertaken and plants were procured from the Forest department nursery. Around seven species were planted as indicated in the **table below**.

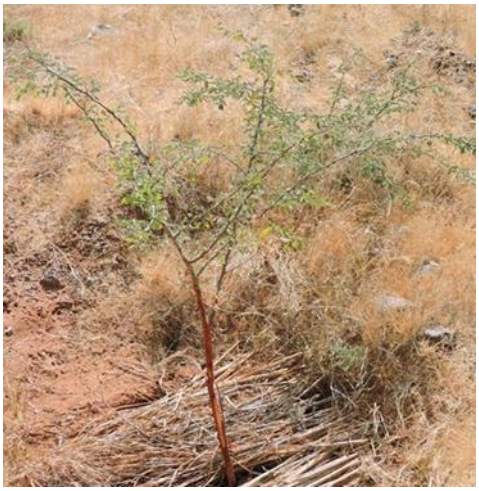
The first survival count was taken on 30th November 2022 and species like Karanj, Limbdo, Kharek, and Unt Morad showed low survival rates. The temperature again rose in November and as suggested by Adani team, mulching was dry leaves were spread at the root zone to retain moisture. The watering is undertaken periodically so that the plants acclimatize to the harsh conditions. In January cuttings of plantation by porcupine were reported high Mithi Amli.

The second round of counting was done in May 2023. The survival rate of Desi Guggal was high as compared to other species. Desi Guggal is a threatened species and its survival and establishment in the Bhatagadh area indicated its suitability and high level of adaptation. The guggal population is in decline and its conservation will add to the population of the region.

Table 1: Plantation Survival Rate.

Plant species name	**First round (July 2022)**	**as on 30/11/2022**	**as on 5/5/2023**
Karanj	50	20	5
Limbdo	50	22	8
Mithi amli	100	33	15
Desi Guggal	150	135	110
	Second round (September 2022)		
Mithi amli	100	81	70
Bengali baval	100	54	28
Limdo	100	28	7
Karanj	100	57	33
Unt morad	100	17	16
Kharek	50	20	5
Dalam	50	35	30

Nibbling of saplings (Hares or Rodents)

In the first year fencing was done which got damaged due to the entry of cattle for grazing and it was decided to initiate bio-fencing through the plantation of cactus. The cactus plantation was done at a distance of 3 m initially and thereafter gap filling was done to reduce the gap.


2.3 Soil Monitoring

Soil remediation involved the addition of Desi Khatar to improve the soil fertility and this in turn helped to reduce the salinity of the area. The table indicates the improvement in soil quality after the application of Desi Khatar. The soil pH reduced in March 2023 sampling is indicative of the enhancement of OH^- ions, which will improve the absorption capacity of the other nutrients at the root zones. The availability of nutrients will enhance the growth of the plants.

Table 2: The soil quality analysis undertaken during the second year

	Initial (June 2021)	Pre-monsoon (April 2022)	Monsoon (September 2022)	post monsoon (March 2023)
pH	8	8.08	8.13	7.77
EC	368	115.83	137.22	283.33
Salinity	1.97	0.65	1.3	0.88
OC	12.35	19.19	18.97	17.39
OM	8.82	33.08	35.29	26.11
TN	0.34	1.29	1.37	1.01

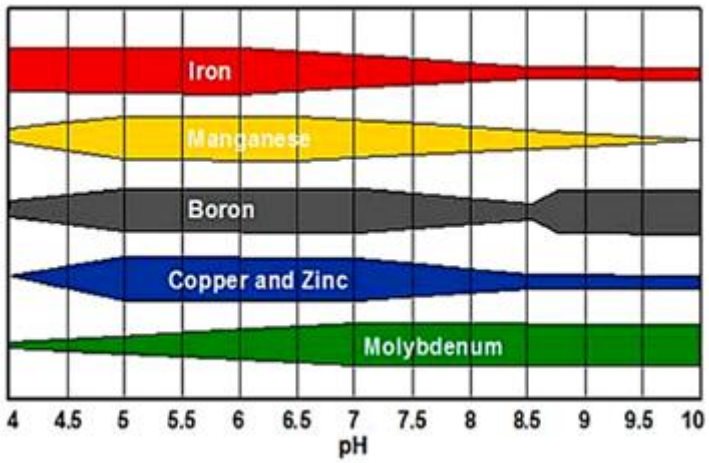
Heavy metal analysis was undertaken to understand the soil quality from the Indian Institute of Semiology, Gandhinagar. The results indicate a higher percentage of Aluminium and Iron in the form of ferric oxide. Aluminum in higher concentrations limits the growth of the plants due to high acidity. Iron in the ferric oxide form is not available to the plants and is an essential component required for the plants. In this case, plants that secrete acid from the roots can dissolve and uptake iron recommended.

Table 3: Heavy metal analysis of the Bhatagadh soils

Element		in %	Element		In µg/g
Silica	SiO2	47.522	Zirconium	ZrO2	375.18
Aluminium	Al2O3	**18.816**	Barium	BaO	337.26
Iron	Fe2O3	**18.204**	Chromium	Cr2O3	214.16
Magnesium	MgO	2.094	Strontium	SrO	145.82
Sodium	Na2O	1.969	Rubidium	Rb2O	47.62
Calcium	CaO	1.832	Thorium	Th	11.82
Titanium	TiO2	1.240	Uranium	U	4.06
Potassium	K2O	1.073	Sulphur	S	752.40
Phosphorus	P2O5	0.110	Copper	Cu	93.52
Scandium	Sc	0.004	Manganese	Mn	3621.60
Calcium	Ca	1.83	Molybdenum	Mo	2.18
Magnesium	Mg	2.09	Nickel	NI	157.32
			Zinc	Zn	179.84

The micronutrients are best absorbed in the acidic soils and soil pH plays key characteristics that affect the solubility and availability of the plant nutrients. In the present study, the soil pH reported was lowest at 7.7 in March 2023. This is also not sufficient for the nutrients to get absorbed. Thus, lowering of pH is to be done through additions of organic manures and crop residues.

Figure 1: showing the uptake of nutrients at various pH



2.4 Floral Diversity

In the second year, a total of 30 species were reported growing in the restoration plot. The three species viz., *Aristida adscensionis, Indigofera cordifolia* and *Indigoferea linnifolia* showed dominance. The two species of *Indigofera* are nitrogen-fixing plants and will help to improve fertility through the growth of the root nodules. This will benefit the soil in terms of reducing the pH and better nutrient availability. *Aristida* on the other hand forms thick tufts and retain the moisture of the soils along with forming good biomass.

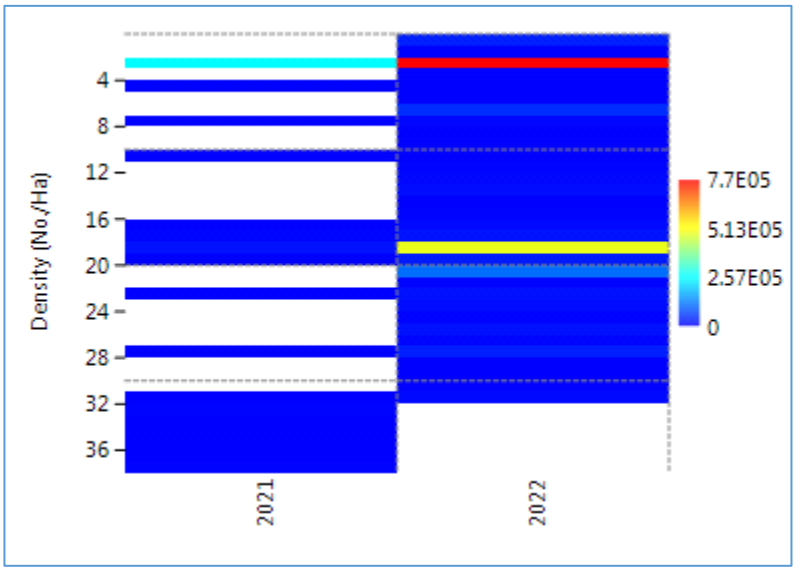
Table 4: The density of different herbaceous vegetation in the soils

S No.	Name of species	Density/ha
1.	*Aristida adscensionis*	770000.00
2.	*Indigofera cordifolia*	485714.29
3.	*Indigoferea linnifolia*	107142.86
4.	*Cenchrus biflorus*	45000.00
5.	*Abutilon indicum*	31428.57
6.	*Pulicaria wightiana*	30714.29
7.	*Indigofera linnaei*	27142.86
8.	*Goniogyna hirta*	19285.71
9.	*Melanocenchrus jaqumontii*	17142.86
10.	*Polygala erioptera*	17142.86
11.	*Pentatropis spirallis*	12857.14
12.	*Enicostemma hyssopifolium*	12142.86
13.	*Fagonia schweinfurthii*	8571.43
14.	*Zyzyphus nummularia*	8571.43
15.	*Eleucine indica*	7142.86
16.	*Chrysopogon fulvus*	6428.57
17.	*Prosopis cineraria*	5714.29
18.	*Evolvulus alsinoides*	5000.00

19.	*Dactyloctenium sindicum*	4285.71
20.	*Ipomoea pestigridis*	4285.71
21.	*Phaseolus munga*	3571.43
22.	*Cucumis callosus*	2857.14
23.	*Blainvillea camlea*	2142.86
24.	*Vernonia cineris*	2142.86
25.	*Commelina diffusa*	1428.57
26.	*Cymbopogon sp.*	1428.57
27.	*Alysicarpus longifolius*	714.29
28.	*Boehravia diffusa*	714.29
29.	*Rhynchosia minima*	714.29
30.	*Solanum indicum*	714.29

The ground flora diversity increased from 18 number in year 1 to 30 in year 2, clearly indicating the species enhancement in the area. In the restoration project, the number of species increases is a positive sign of improvement in the restoration site in terms of species enrichment. The density of the herbaceous vegetation has increased many folds, largely due to control of grazing and seeding through seed balls.

Figure 2: Diversity and density of ground vegetation for the first and second year



The significance of this vegetation change is that palatable good grass has reappeared in the land. Further, the higher density of *Aristida* will help to retain moisture and improve the fertility of the soils by the addition of biomass. The higher herbaceous layer will also aid in carbon sequestration. Two *Indigofera* species appeared in the second year and these species belong to the *leguminoceae* family with root nodule which helps in nitrogen-fixing and helps to improve soil fertility.

Table 5: Vegetation species naturalised in the area.

Species established in second year	
3	*Aristida adscensionis*
12	*Dactyloctenium sindicum*
13	*Eleucine indica*
14	*Enicostemma hyssopifolium*
19	*Indigofera cordifolia*
21	*Indigoferea linnifolia*
23	*Melanocenchrus jaqumontii*
28	*Pulicaria wightiana*

Species disappeared in the second year	
33	*Triumfetta rotundifolia*
34	*Eragrostis pilosa*
35	*Corchorus depressus*
36	*Dichanthium annulatum*
37	*Tephrosia uniflora*
38	*Eleusine compressa*

2.5 Faunal Diversity

About 50 avifaunal species were reported from the restoration site in the three months of winter observation. December and March showed the presence of maximum bird species. In January, around 9 migratory bird species were sighted as the region lies in the Central Asian flyway migratory pathway. The restoration site had grass seeds present at this time of the year that attracted migratory birds. Two threatened species viz., Desert Wheatear (Vulnerable) and Painted stork (Near Threatened) is reported from the restoration site.

Common babbler, Grey francolin, Indian robin, Red-vented bulbul, and White-eared bulbul common species were reported in all the sampling seasons.

Table 6: List of avifaunal species reported during the survey

S No.	Common name	Scientific name	Dec_22	23-Jan	23-Mar
1	Ashy-crowned sparrow-lark	*Eremopterix griseus*			√
2	Asian green bee-eater	*Merops orientalis*			√
3	Barn swallow	*Hirundo rustica*	√	√	
4	Bay-backed shrike	*Lanius vittatus*		√	
5	Black francolin	*Francolinus francolinus*			√
6	Blackwinged kite	*Elanus caeruleus*	√		
7	Booted eagle	*Hieraaetus pennatus*		√	
8	Brahminy kite	*(Haliastur indus*	√		
9	Chestnut-bellied sandgrouse	*Pterocles exustus*			√
10	Common babbler	*Turdoides caudata*	√	√	√
11	Common crane	*Grus grus*		√	
12	Common kestrel	*Falco tinnunculus*	√		
13	Common myna	*Acridotheres tristis*	√		
14	Common tailor bird	*Orthotomus sutorius*	√		
15	Desert wheater	*Oenanthe deserti*	√		
16	Great white pelican	*Pelecanus onocrotalus*		√	
17	Greater short-toed lark	*Calandrella brachydactyla*		√	
18	Green bea-eater	*Merops orientalis*	√		
19	Grey francolin	*Francolinus pondicerianus*	√	√	√
20	Grey-breasted prinia	*Prinia hodgsonii*			√
21	House crow	*Corvus splendens*	√		
22	House sparrow	*Passer domesticus*	√		
23	Indian bush lark	*Mirafra erythroptera*			√
24	Indian robin	*Saxicoloides fulicatus*	√	√	√
25	Indian Roller	*Coracias benghalensis*	√		
26	Indian silver bill	*Euodice malabarica*			√
27	Indian thick knee	*Burhinus indicus*	√		
28	Isabelline shrike	*Lanius isabellinus*	√	√	
29	Jungle Prinia	*Prinia sylvatica*			√
30	Laughing dove	*Spilopelia senegalensis*	√		√
31	Lesser whitethroat	*Sylvia curruca*		√	
32	Long-tailed Shrike	*Lanius schach*	√		
33	Montagu's harrier	*Circus pygargus*			√
34	Painted stork	*Mycteria leucocephala*		√	√
35	Pallid harrier	*Circus macrourus*			√
36	Pied bush chat	*Saxicola caprata*	√		
37	Purple sunbird	*Cinnyris asiaticus*			√
38	Red-vented bulbul	*Pycnonotus cafer*	√	√	√
39	Rock pigeon	*Columba guinea*	√		
40	Rufous-fronted prinia	*Prinia buchanani*		√	√

41	Rufous-tailed lark	*Ammomanes phoenicura*		√	
42	Siberian stonechat	*Saxicola maurus*		√	
43	Spotted flycatcher	*Muscicapa striata*	√		
44	Sykes's warbler	*Iduna rama*			√
45	Tawny pipit	*Anthus campestris*		√	√
46	Variable wheatear	*Oenanthe picata*	√	√	
47	White-eared bulbul	*Pycnonotus leucotis*	√	√	√
48	White-tailed iora	*Aegithina nigrolutea*			√
49	Yellow-throated sparrow	*Petronia xanthocollis*			√
50	Yellow-wattle lapwing	*Vanellus malabaricus*			√
			24	**19**	**24**
				Resident = 10 Migratory =9	**Resident = 21 Migratory =3**

Around six mammalian species were recorded in the site both indirect and direct evidence. The site includes the presence of Chinkara, Schedule I species and three Schedule IV species viz., Indian crested porcupine, Indian Desert jird and Indian hare. The hunting of these species is prohibited under the Wildlife Protection Act (WPA) 1972, and the presence of these species indicates the presence of habitat and food base for these species.

Table 7: List of mammals reported from the Bhatdagadh area

Sr. No.	**Common Name**	**Scientific Name**	**Observed No.**	**Remarks**	**As per 2022 notification**
1	Canid sp.	*	*	Indirect sign (Pugmarks)	
2	Cat sp.	*	*	Indirect sign (Pugmarks)	
3	Chinkara	*Gazella bennettii*	*	Indirect signs (Pugmarks and Scat)	Schedule I
4	Indian crested porcupine	*Hystrix indica*	*	Indirect signs (Quills and Scat)	Schedule IV
5	Indian desert jird	*Meriones hurrianae*	2	observed near it's burrow	Schedule IV
6	Indian hare	*Lepus nigricollis*	1	Direct & Indirect signs (Pugmarks and Scat)	Schedule IV

Chinkara pellets

Canid pugmark

Felid pugmark

Porcupine quills

Snake skin

Hare burrow

About ten buffer fly species was reported from the restoration site. December was the peak time when maximum butterfly species wad recorded which coincided with the flowering of grass species. The number of butterfly species visiting the plot declined in the preceding months and only three species was recorded in the month of March. One Daniad eggfly, a Schedule II species that requires higher degree of conservation was recorded from the site.

Table 8: List of butterfly species reported from the Bhatdagadh area

S No.	Common name	Scientific name	Dec 22	Jan 23	March 23	As per 2022 notification
1	Common castor	*Ariadne merione*	√	√		
2	lemon pansy	*Junonia lemonias*	√			
3	White orange tip	*Ixias marianne*	√	√	√	
4	Common grass yellow	*Eurema brigitta*	√	√		
5	Daniad eggfly	*Hypolimnas misippus*	√			Schedule II
6	Plain tiger	*Danaus chrysippus*	√	√	√	
7	Small salmon Arab	*Colotis amata*	√	√		
8	Pioneer	*Belenois aurota*	√			
9	Crimson tip	*Colotis danae*	√		√	
10	Gram blue	*Euchrysops cnejus*	√	√		

Daniad eggfly

Lemon Pansy

Plain tiger

Black Francolin

White tailed Iora

Rufous–fronted prinia

Ashy crowned sparrow lark

Great Grey Shrike