Alternate methodology for eco-restoration of limestone quarries- Giving back to nature and community

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Abstract

Today almost all our development needs centre around cement and concrete – whether buildings, bridges or roads. This large quantity of cement requires equally large raw material in the form of limestone.

The limestone when extracted in the form of open cast mining creates large quarries which are stripped of all their living material. What remains after the extraction is a large sterile landmass not supporting any life. The loss of agricultural and grazing lands to mining, have always given rise to local antagonism towards the cement companies.

The mining norms of the Ministry of Environment and Forests, Government of India, require the mining company's quarried areas to be restored to a form that may resemble its original ecosystem. However, because of the sterile soil strata, flora and fauna taking over this area naturally is almost impossible.

The present restoration in most cases has meant just taking up of monoculture plantations of exotic species of trees. Such plantations have never formed ecosystems and the study of insects and birds in these "so called" restored areas shows a poor diversity. The objective of replicating nature is thus never achieved.

a. ***b.*** ***c.***

Figure 1. **a. Surface mining excavator in a limestone quarry**
b. Large tracts of sterile landscapes created by quarrying
b. Old plantation with wide spaced exotic trees.

This had called for "an alternative approach" towards restoration which would be based on the principle of restoring the excavation completed mines for return to nature - Lands that could not only resemble local ecosystems but also be useful to the community.

This ***New Restoration Process*** *developed by Anirudh Chaoji of Pugmarks Ecologix in association with Gujarat Ambuja Cements Ltd. at Kodinar, Gujarat, India,* ***converted the excavation completed mines into the following useful areas:***

- ***Sustainable Ecosystems and Habitats*** *that replicate the local environment in the floral content. The local fauna almost automatically stepped in. This is against all the monoculture plantations that only add to the statistics.*

- ***Fodder Plots for the local cattle,*** *where the fodder cropping, irrigation, protection, harvesting and distribution is all taken up by the neighbouring community. This is in stark contrast to the 'normal' mined areas that remain useless.*

- ***Agriculture and Horticulture plots of Fruiting trees.*** *Fruiting trees provide regular income for many years along with supportive agriculture as an intercrop. Many of the old mined areas are now bearing fruits of restoration.*

- ***Water from Living Water Bodies*** *has been utilised extensively by the neighbouring villagers – who have almost tripled their farm productivity. The large numbers of resident and migratory water birds that have accepted these water bodies, confirm the life sustaining ecosystem that has been established in the once sterile and alkaline water-bodies.*

1. Introduction

Large scale open cast limestone mining has left denuded landscapes, devoid of plants and soil, and of little use to surrounding agricultural communities. And because of sterile soil strata, flora and fauna taking over this area naturally is almost impossible. These factors have resulted in a strong antagonism against the cement companies.

All mining completed areas are required to be restored according to the norms of Ministry of Environment & Forests – Government of India. However, almost everyone involved, only undertakes typical plantations of exotic trees (trees typically planted include *Glyricidia sapium, Cassia siamea, Peltophorum ferrugineum, Acacia auriculiformis, Leucaena leucocephala, Eucalyptus sp.* etc.) in straight rows and columns. Such a plantation can never create habitats or restore biodiversities and the outcomes are of little use to the local communities too.

A new approach was developed by Pugmarks Ecologix, an ecological organisation. The long term goal was set to return these mining completed lands– back to nature and to the community. The cement company in picture, **Gujarat Ambuja Cement Ltd, Kodinar, Gujarat, India** was an industry with an excellent track record in fields of resources conservation and social responsibility. It was hence the appropriate host for undertaking such a project.

a. **b.**

Figure 2. **a. Students take up plantation of local species. The cement company is in the background.**

b. Demoiselle cranes at a restored mine. This project has used birds as indicators.

2. Restoration Path

The restoration of the limestone quarries of Gujarat Ambuja Cement Ltd. started in April 2002. The approach used the large voids formed by open cast mining to create bird friendly habitats, areas suitable for cultivating fodder for cattle, reviving agriculture in some areas, storing rain water for agriculture and taking up fruiting tree plantations.

3. Project Details

3.1 Project site location

City/ town: Kodinar; State : Gujarat; Country : India Coordinates: 20.46 N and 70.46 E

3.2 Type of ecosystem being restored

The area is comprised mainly of agricultural lands with interspersed scrub Acacia woodlands.

3.3 Stake holders involved: Approach to partnership

Designing organisation: Planning, Design and Evaluation

Pugmarks Ecologix, An ecological organisation based at Pune, Maharashtra, India

Local organisation: Implementation and Overseeing.

Ambuja Cement Ltd. One of the leading Cement industries in India,

Ambuja Cement Foundation, Public Charitable Trust based at Kodinar, Gujarat, India.

3.4 Project site size

At Ambuja, there are 4 mining areas (with areas under mining and population in the surrounding villages)

Table 1: Villages surrounding the lease area

Village	Area	Population
Vadnagar	366 ha	16,439
Solaj	200 ha	7,628
Rampara	131 ha	9.927
Sugala	417 ha	5,611
TOTAL	**1,114 ha**	**39,605**

3.5 Project description

The Gujarat Ambuja Cement Ltd. limestone quarry restoration project exemplifies an integrated approach to landscape regeneration that uses the new post-mining landscape as a resource to improve local biodiversity, provide local communities with enhanced and sustainable livelihoods and offers the extraction company a viable exit strategy.

Rainfall here is reasonably good (average 900 mm). However, the area suffers from prolonged summer droughts owing to the highly seasonal nature of the rainfall. A high proportion of the population is farmers whose productivity is constrained by the harsh climate. They are also adversely affected by the loss of their farming land due to limestone extraction.

Voids left by limestone extraction, underlain by the impermeable marl bed enables the development of significant water storage areas. These capture water during the intense rainy seasons, ensuring on-going supply for ecological and economic activities during the prolonged drought periods of the Indian summer. This water today is used to irrigate agricultural land up to a distance of one kilometre from the quarries.

a. **b.**

Figure 3. a. The excavation completed mines become large storages of water. These water-bodies are restored into living ones as a part of the project.

b. The neighbouring farmers use water from this "restored" water-body for irrigating their fields.

4. The restoration process

An alternative approach to restoration was developed, using the opportunities existing in the post-mining landscape, while recognising the limitations posed by such sites. In particular, the restoration aim was changed to creating sustainable habitats in closed extraction areas that could resemble local ecosystems, but also be of value to the local communities.

The first step in the restoration process was **determining the base-line data**; these included studies of:

- Local flora surrounding the mines – i.e. the vegetation best suited to the local environmental conditions;
- Local fauna – in particular, their relation to food plants;
- Local land-use patterns – typical crops, fodder requirements, availability of water for irrigation;
- Substrate conditions in the excavated areas – pH, substrate hardness etc., to determine the thickness of soil to be re-spread (the top soil that was earlier removed before the mining began) to ensure sufficient planting material
- Detailed land use patterns- Most of the population in this area is dependent on agriculture. Requirements mainly cantered on water requirement post monsoons and fodder for their cattle.

The initial plan for restoration took very long – 9 months to formulate. There were no guidelines or examples to follow. Many had to do with what was possible in that area and what was of interest to the cement company and the neighbouring community.

The result was a restoration plan for each area of excavation. During the development of the plans, considerations were taken into account, in particularly to the proximity of the local community, agricultural land and scrub forest. In areas where excavation was still underway, the restoration plan for that area influenced the extraction work – to decide the final landscape with respect to side wall slopes and creation of low-lying areas for water bodies.

4.1 The process of restoring of a mine would therefore take one of the following paths

- Creation of an eco-friendly habitat – replicating the nearby natural woodlands
- Creation of "living" water-bodies – for supporting local agriculture
- Creation of fodder plot for providing for the numerous cattle
- Creation of plots for revival of agricultural practices

- Taking up Horticultural and medicinal plantations. These would serve as model for replication by the community

4.1.1 Creation of ecosystems and habitats.

In the absence of any guidelines, the restoration process till now mainly comprised of taking up monoculture plantations of exotic species in straight rows and columns, separated by a distance of 8 meters. This had to be changed to become more natural, to incorporate weeds, shrubs, insects and all other elements of biodiversity to establish food chains. Thus all the new plantations were based on the following principles.

- Saplings were planted randomly - instead of straight row and column pits.
- Large number of native species were selected to ensure that no monoculture plantations would be taken up (for the year 2003-2004, total of over 30,000 plants belonging to 96 species were planted).
- Bird attracting trees were preferred to attract more birds – which also helped in dispersal of the seeds. Ficus trees (*Ficus benghalensis*, *Ficus religiosa*, *Ficus racemosa*) being keystone species trees were planted in significant numbers. They support a large number of insects that come to feed on the fruit as well as birds that come to feed on these insects and fruits. Thus these trees provide habitats for a very large diversity of organisms – almost as a complete ecosystem.

a. **b.** **c.**

Figure 4. **a. Extensive Ficus stumps plantation has been undertaken. Ficus is a keystone species.**

b. Ficus saplings prepared in the nursery
c. New plantation design: mixed plantation of local tree species.

- The inter plant distance was reduced to 2 ½ meters. Earlier the plants were spaced over 8 meters. So if one of the plants perished, it would create a gap of over 16 meters.
- Fifteen centimetres of the original soil was also spread between the saplings to enable the development of local herbaceous vegetation from the seed bank, and the local insect fauna from the “egg bank”. This was necessary to form the food chain in the restored area.
- People from the local community have been given the plantation plots for care and maintenance on a monthly retainer ship basis. This has provided them incentive for participation.

Table 2: **Areas under ‘ecosystem & habitat’ plantation**

Village	**Area under plantation**
Vadnagar	89 ha (includes Pasture land)
Solaj	2 ha

Rampara	2ha
Sugala	1ha
Eco-park	22.5 ha

(The plantation at Rampara, Sugala, Ecopark are totally and some areas of Vadnagar are according to the new design)

4.1.2 Creation of 'living' water bodies

Although average rainfall is high, it is not evenly spread throughout the year leading to long droughts in the hot Indian summer. This has affected the agriculture, as it is mainly rain fed. The fodder available for the cattle was also always in short supply.

One of the key aspects of the mine restoration scheme has been the creation of rain water holding reservoirs. Low-lying areas were converted into water bodies. The impermeable marl layer beneath extracted limestone ensured that water retained for long periods – extending over 12 months. Only evaporation losses reduced the water levels and even this helped cooling the surrounding areas.

Table 3: Areas under water-bodies & their capacities

Mining area	**Present area (ha)**	**Present capacity (m^3)**	**Future area (ha)**	**Future capacity (m^3)**
Vadnagar	22	700000	88.2	4300976
Solaj	28	791810	58.7	3271043
Rampara	15	368410	33.0	1159093
Sugala	Active Mining area			

- This water has been used extensively by local villagers who have almost tripled their agricultural production. Earlier their agriculture was purely rain-fed.
- The water bodies have also acted as focal points of the re-establishment of biodiversity. Life was introduced from nearby water bodies. Introduction of organic matter like cowdung has also helped jumpstart life in these restored waterbodies. Aquatic and semi-aquatic plants species were planted, appropriate for the local area.
- **Today, as a result of life formation and decomposition of organic matter, there has been significantly lowering of pH. The sterile water bodies reported pH around 10.5. Today, about two years of restoration later, <u>the pH is around 8.5 and the water is certified as potable</u>. (Report attached in the annex 1)**
- These new lakes have become heavens for resident and migratory water birds– key indicators of the health of the ecosystem. (Detailed bird list in annex. 2)

4.1.3 Creation of fodder plots

The long hot and dry summers have always made the availability of sufficient fodder for cattle a problem for local communities. These cattle invariably ended up in the plantation areas. Thus a solution was designed to

involve these cattle owners to grow fodder on a restored mine – by providing them with black soil re-spread on the floor of the mine and also providing them water for irrigating their crop.

This has enabled significant increase in the availability of wet and dry fodder grown on restored mine area. This new system of fodder cropping, irrigation and protection, harvesting and distribution is all taken up by the community on 8 restored mines. Today there are far fewer stray cattle now – ensuring better results in the plantation areas.

Table 4: Areas under fodder and agriculture

The areas under fodder and agriculture	12Ha (mainly jowar, bajara, maize & lucerne grass)

a. **b.**

Figure 5. a. Fodder crop taken up on a restored mine. Cultivation, protection and harvesting is undertaken by the community.
b. Fodder areas protected by a local.

4.1.4 Creation of Agricultural plots

A soil layer almost 2 feet thick was spread over the excavated layer. Waste rock was removed and the floor of the pit was levelled to create areas for growing crops. Initially the area was used to grow crops only for fodder. However sound agricultural practices like crop rotation and nitrogen fixing legumes will ensure improving the soil conditions. Mainly jowar, bajara and maize were initially taken up and eventually land is improving to suit wheat, groundnuts and barley. The initial moderate results have inspired more farmers to participate.

4.1.5 Creation of Horticulture plots

Apart form fodder and agriculture crops, many restored areas have also been brought under fruiting orchard. The success of these plantations has also served an important role in communicating with the local community to undertake plantations on their lands as well. In suitable areas, inter-cropped fruit trees have been planted, providing regular income for local farmers. Most of these plantations were taken up prior to year 2002.

Table 5: Areas under fruit trees plantation:

Vadnagar:	10 Hectares	(Mango, coconut, sapota, guava)
Solaj:	3.00 Hectares	(Coconut, guava)
Rampara:	0.50	(Mango, coconut, chiku)
Sugala:	2.00	(Guava, mango)

Areas under medicinal plants at Vadnagar Mines: 1.4 ha

5.0 Lessons learnt

- **Simply planting trees does not restore sustainable landscapes. The prerequisite is to establish ecosystems with living water-bodies and food chains.**

- **Any restoration programme, will succeed only if the organisation concerned follows a good neighbour policy – involving the local community in the process - they need to be incentivised to motivate their long-term involvement.**

- **The host organisation must be committed to the process- as the restoration process is slow and involves on-going financial inputs.**

6.0 Legislative / policy framework

This project illustrates the limitations of the existing legislations in India regarding post-extraction habitat restoration.

The Government of India's Ministry of Environment and Forests has a policy for the restoration of mined areas, which required the landscape to be restored to a form resembling the pre-existing ecosystem. However, the post-mining edaphic conditions precluded this, so a system of monocultural exotic tree plantations has been practiced to bring areas under "quick" green tree cover.

7.0 Results

Some areas in which PUGMARKS Ecologix has been able to contribute at Ambujanagar are:

- Creation of bird friendly habitat: Construction of shallow water baths & containers for grains to attract birds has made Ambuja a bird habitat. Large number of birds has also used the Bird boxes that have been installed for nesting. Spreading of grains near large water-bodies has been successful in attracting birds.

- Better understanding for Birds: Sign boards that have been displaying images of birds have become very popular amongst the residents of Ambujanagar. Also painting of buses with images of birds and butterflies have ensured a better understanding amongst the local communities - as the buses travel through the neighbouring villages and towns. It also helps in spreading the message of the Ambuja's commitment towards a good environment.

- Planting pattern has become more "natural": Random plantation of local trees has replaced the straight line style of plantations. Plantations now lay stress on multi species and bird attracting trees.

- Plantation of ficus species: Since Lord Krishna's times, the importance of ficus trees has been understood by our civilisation. Ficus trees in themselves form an ecosystem by creating habitats for insects, animals and birds and hence are called keystone species.

- Water-body restoration: Introduction of life & aquatic plants have brought life in otherwise sterile water-bodies. We have used birds as indicators to determine the health of the water-body. The presence of the highest predator birds like osprey and kingfisher on the water-body indicates its good health.

- Planting babool (*Acacia nilotica*) trees in the water-bodies as bird roosting. The backbone of the Indian economy and one of the favourite trees for the birds to nest is unfortunately neglected in most plantation schemes. It is hoped that the birds will start nesting on these trees - once they grow up.

- Preparation of pasture lands for local cattle to graze: In order to prevent the entry of local cattle into our plantation areas, some of the restored mines were converted into pasture lands. Today, the local community grows, protects, harvests and distributes the fodder grown on the restored mines. (However this programme has partially been a failure - because all the pasture lands on restored mines are being used by the *Grampanchayat (village administration)*. Individual grazers have no grazing areas and hence their cattle still damage our plantations. Some areas need to be reserved for them.)

- Reducing the alkaline pH: The highly alkaline water in the limestone quarries was not used much. We have been able to reduce the pH by ensuring decomposition and establishment of life - now this water is tested to be potable. It is now extensively used for agriculture by the local communities- who have almost tripled their crop yield.

- Preparation of a Eco-Park in oil room pit. Today, this large excavation completed mine is fast becoming a self sustaining habitat. The concept behind developing the Eco-Park was to replicate the neighbouring Gir National Park full fledged with a living water-body.

- Plantation of trees by school students: Students have been involved in plantations in the Eco-Park and in areas surrounding the school premise. This has been a popular activity because the student's name is displayed on a board next to the plant he has planted.

- Study of Flora & Fauna. The study of the local flora and fauna has created a base data of the biodiversity of the area.

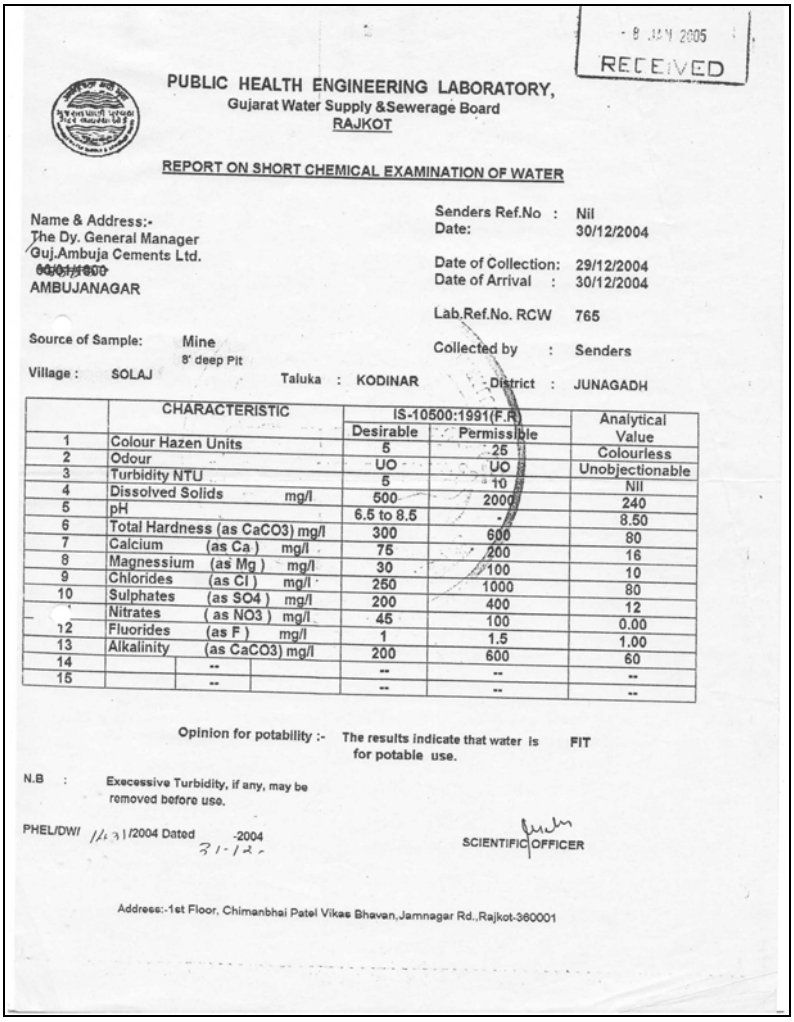
Acknowledgements

The restoration of the excavation completed mines at Ambujanagar was possible mainly due to the wholehearted support and a sincere desire of the erstwhile management under Mr. Narottam Sekhsaria. However, now the company is under a new management.

- Mr. Narottam Sekhsaria, Managing Director, whose personal involvement drove this process,
- Mr. Pulkit Sekhsaria, Director,
- Mr. Patel, Jt. President,
- Mr. Jalpota, Sr. Vice President - Commercial,
- Mr. Parik, General Manager - Mines,
- Mr. Rajashekhar. General Manager - Geology
- Mr. Pawar, Sr. Manager, Horticulture
- Mr. Mori, Sr. Manager, Ambuja Cement Foundation.
- Staff of Ambuja Cement Ltd. Horticulture, Environment and Mines departments.
- Mr. Rahul Marathe, Lecturer in Zoology, Sinhagad College of Science.
- Mr. Vivek Gaur Broome, Botanist.

Annex 1. Water analysis report

The rain water stored in limestone mines becomes highly alkaline with pH of about 10.5. This water neither supports life nor is useful for agriculture. The restoration process of mines aims at making these water-bodies "living" with a reduced pH of around 6.5 to 8.5 and establishing life cycles.



- 8 JAN 2005
RECEIVED

PUBLIC HEALTH ENGINEERING LABORATORY,
Gujarat Water Supply &Sewerage Board
RAJKOT

REPORT ON SHORT CHEMICAL EXAMINATION OF WATER

Name & Address:-
The Dy. General Manager
Guj.Ambuja Cements Ltd.
AMBUJANAGAR

Senders Ref.No : Nil
Date: 30/12/2004

Date of Collection: 29/12/2004
Date of Arrival : 30/12/2004

Lab.Ref.No. RCW 765

Source of Sample: Mine
8' deep Pit

Collected by : Senders

Village : SOLAJ Taluka : KODINAR District : JUNAGADH

	CHARACTERISTIC	IS-10500:1991(F.R)		Analytical Value
		Desirable	Permissible	
1	Colour Hazen Units	5	25	Colourless
2	Odour	UO	UO	Unobjectionable
3	Turbidity NTU	5	10	Nil
4	Dissolved Solids mg/l	500	2000	240
5	pH	6.5 to 8.5	-	8.50
6	Total Hardness (as CaCO3) mg/l	300	600	80
7	Calcium (as Ca) mg/l	75	200	16
8	Magnessium (as Mg) mg/l	30	100	10
9	Chlorides (as Cl) mg/l	250	1000	80
10	Sulphates (as SO4) mg/l	200	400	12
	Nitrates (as NO3) mg/l	45	100	0.00
12	Fluorides (as F) mg/l	1	1.5	1.00
13	Alkalinity (as CaCO3) mg/l	200	600	60
14	--	--	--	--
15	--	--	--	--

Opinion for potability :- The results indicate that water is FIT for potable use.

N.B : Excessive Turbidity, if any, may be removed before use.

PHEL/DW/ /2004 Dated 31-12-2004

SCIENTIFIC OFFICER

Address:-1st Floor, Chimanbhai Patel Vikas Bhavan,Jamnagar Rd.,Rajkot-360001

Figure 6: Government laboratory report showing water in one such restored mine, at Solaz, having an acceptable pH and fit for Potable use.

Annex 2. BIRDS of AMBUJANAGAR

This restoration process involving taking up of "ecosystem" plantations and creating "living" water-bodies cannot be gauged by any mechanical device. However, using birds as indicators gives fairly good idea of an established eco-system. For example, an Osprey on a water-body is likened to the tiger indicating a healthy forest.

Sr.	Area	English Name	Scientific name
1.	Mines	Little Grebe	*Podiceps ruficollis*
2.	Mines	Little Cormorant	*Phalacrocorax niger*
3.	Mines	Little Egret	*Egretta garzetta*
4.	Mines	Grey Heron	*Ardea cinerea*
5.	Mines	Purple Heron	*Ardea purpurea*
6.	Mines	Great Egret	*Ardea insignis*
7.	Mines	Intermediate Egret	*Egretta intermedia*

8.	Mines	Cattle Egret	*Bulbulcus ibis*
9.	Mines	Indian Pond Heron	*Ardeola grayii*
10.	Mines	Black-crowned Night Heron	*Nycticorax nicticorax*
11.	Mines	Painted Stork	*Mycteria leucocephala*
12.	Mines	Asian Openbill Stork	*Anastomus oscitans*
13.	Mines	Woolly-necked Stork	*Ciconia ciconia*
14.	Mines	White Ibis	*Threskiornis aethiopica*
15.	Mines	Black Ibis	*Pseudibis papillosa*

a. ***b.***

Figure 7: Birds habitat: a. Comb Ducks b. Little Cormorants feeding gregariously.

16.	Mines	Eurasian Spoonbill	*Platalea leucorodia*
17.	Mines	Lesser Flamingo	*Phoeniconaias minor*
18.	Mines	Lesser Whistling Duck	*Dendrocygna javanica*
19.	Mines	Comb Duck	*Sarkidiornis melanotos*
20.	Mines	Eurasian Wigeon	*Anas Penelope*
21.	Mines	Gadwall	*Anas strepera*
22.	Mines	Common Teal	*Anas crecca*
23.	Mines	Spot-billed Duck	*Anas poecilorhyncha*
24.	Mines	Northern Pintail	*Anas acuta*
25.	Mines	Garganey Teal	*Anas querquedula*
26.	Mines	Northern Shoveler	*Anas clypeate*
27.	Mines	Common Pochard	*Eythya farina*
28.	Mines	Indian White-backed Vulture	*Gyps bengalensis*
29.	Mines	Long-billed Vulture	*Gyps indicus*
30.	Mines	Eurasian Marsh Harrier	*Circus aeruginosus*
31.	Mines	Common Moorhen	*Gallinula chloropus*
32.	Mines	Eurasian Coot	*Fulica atra*
33.	Mines	Demoiselle Crane	*Anthropoides virgo*
34.	Mines	Common Crane	*Grus grus*
35.	Mines	Black-winged Stilt	*Himantopus himantopus*
36.	Mines	Little Ringed Plover	*Charadrius dubius*
37.	Mines	Kentish Plover	*Charadrius alexandrinus*
38.	Mines	Common Snipe	*Gallinago stenura*
39.	Mines	Black-tailed Godwit	*Limosa limosa*
40.	Mines	Eurasian Curlew	*Numenius arquata*
41.	Mines	Common Redshank	*Tringa tetanus*
42.	Mines	Marsh Sandpiper	*Tringa stagnatilis*
43.	Mines	Common Greenshank	*Tringa nebularia*
44.	Mines	Green Sandpiper	*Tringa ochropus*
45.	Mines	Common Sandpiper	*Tringa hypoleucos*
46.	Mines	Brown-headed Gull	*Larus brunnicephalus*
47.	Mines	Gull-billed Tern	*Gelochelidon nilotica*
48.	Mines	Indian River Tern	*Strena aurantia*
49.	Mines	White-throated Kingfisher	*Halcyon smyrensis*

a. ***b.***

Figure 8: a. Artificial bird boxes b. Nesting population of Peafowl

50.	Mines	Baya Weaver bird	*Ploceus manyar*
51.	Mines	Wire-tailed Swallow	*Hirundo smithii*
52.	Mines	White Wagtail	*Motacilla alba*
53.	Mines	Large Pied Wagtail	*Motacilla maderaspatensis*
54.	Mines	Grey Wagtail	*Motacilla cinerea*
55.	Mines	Yellow Wagtail	*Motacilla flava*
56.	Mines	Pied Bush Chat	*Saxicola ferrea*
57.	Mines	Desert Wheatear	*Oenanthe deserti*
58.	Mines	Bay-backed Shrike	*Lanius vittatus*
59.	Mines	Indian Silverbill	*Lonchura malabarica*
60.	Res	Green Bee-eater	*Merops orientalis*
61.	Res	Indian Roller	*Coracias benghalensis*
62.	Res	Eurasian Hoopoe	*Upupa epops*
63.	Res	Coppersmith Barbet	*Megalaima haemacephala*
64.	Res	Blue Rock Pigeon	*Columba livia*
65.	Res	Shikra	*Accipiter badius*
66.	Res	Honey Buzzard	*Pernis ptilorhyncus*
67.	Mines	Osprey	Pandion haliaetus
68.	Res	Common Peafowl	*Pavo cristatus*
69.	Res	White-breasted Waterhen	*Amaurornis phoenicurus*
70.	Res	Spotted Dove	*Strptopelia chinensis*
71.	Res	Little Brown Dove	*Strptopelia senegalensis*
72.	Res	Indian Ring Dove	*Strptopelia decaocto*
73.	Res	Rose-ringed Parakeet	*Psittacula alexandri*
74.	Res	Asian Koel	*Eudynamys scolopacea*
75.	Res	Greater Coucal	*Centropus chlororhynchus*
76.	Res	Spotted Owlet	*Athene brama*
77.	Res	House Swift	*Apus affinis*
78.	Res	Red-vented Bulbul	*Pycnonotus cafer*
79.	Res	Common Iora	*Aegithina tiphia*
80.	Res	Magpie-Robin	*Copsychs saularis*
81.	Res	Indian Robin	*Saxicoloides fulicata*
82.	Res	Black Redstart	*Phoenicurus ochruros*
83.	Res	Ashy Wren Warbler	*Prinia socialis*
84.	Res	Common Tailorbird	*Orthotomus sutorius*
85.	Res	Tickell's Blue Flycatcher	*Muscicapa tickelliae*
86.	Res	White-browed Fantail	*Rhipidura aureola*
87.	Res	Large Grey Babbler	*Turdoides malcomi*
88.	Res	Grey Tit	*Parus major*
89.	Res	Purple Sunbird	*Nectarinia asiatica*
90.	Res	Purple Rumped Sunbird	*Nectarinia zeylonica*
91.	Res	Oriental White-eye	*Zosterops palpebrosa*
92.	Res	Black Drongo	*Dicrusus adsimilis*
93.	Res	Indian Treepie	*Dendrocitta vagabunda*
94.	Res	House Crow	*Corvus splendens*

95.	Res	Jungle Crow	*Corvus macrorhynchos*
96.	Res	Brahminy Myna	*Sturnus pagodarum*
97.	Res	Common Myna	*Acridotheres tristis*
98.	Res	Tickell's Flowerpecker	*Dicaeum erythrorhynchos*
99.	Res	House Sparrow	*Passer domesticus*
100.	Res	Whitebacked Munia	*Lonchura striata*
101.	Neigh	Indian Sandgrouse	*Pterocles exustus*
102.	Neigh	Palm Swift	*Cypsiurus parvus*
103.	Neigh	Tawny Eagle	*Aquila rapax vindhiana*
104.	Neigh	Black-shouldered Kite	*Elanus caeruleus*
105.	Neigh	Pariah Kite	Milvus migrans govinda
106.	Neigh	Pied Kingfisher	*Ceryle rudis*
107.	Neigh	Egyptian Vulture	*Neophron percnopterus*
108.	Neigh	Yellow-wattled Lapwing	*Vanellus malbaricus*
109.	Neigh	Red-wattled Lapwing	*Vanellus indicus*
110.	Neigh	Alexandrine Parakeet	*Psittacula eupatria*
111.	Neigh	Indian Nightjar	*Caprimulgus indicus*
112.	Neigh	Ashy-crowned Sparrow-lark	*Eremoprerix grisea*
113.	Neigh	Rufous-tailed Finch Lark	*Ammomanes phoenicurus*
114.	Neigh	Crested Lark	*Galerida cristata*
115.	Neigh	Dusky Crag Martin	*Hirundo concolor*
116.	Neigh	Rufous-backed Shrike	*Lanius schach*
117.	Neigh	Bank Myna	*Acridotheres ginginianus*
118.	Res	Grey Partridge	*Francolinus pondicerianus*