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Habitat conservation through butterfly zone: A new approach to *in-situ* conservation of butterfly diversity

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Abstract

The conventional species level approach for biodiversity conservation has major limitations; hence a policy shift from conservation of a single species to their habitat is justified and is the need of the hour. In this line, a new approach for habitat conservation through setting up Butterfly Zone was conceptualized at a Chorgalia range of Nandhaur Wildlife Sanctuary. Butterfly zone was set up in a 1.0 ha area of moist deciduous teak forest patch in a Chorgalia range of Haldwani Forest Division. As a result of enrichment and conservation of habitat having multiple indigenous host plants, there was remarkable increase in butterfly population in the zone around the year. Altogether, 35 species of butterflies were recorded. The naturally landscaped butterfly zone with its rich butterfly fauna was an attraction to the visitors. Besides conserving the butterfly diversity *in situ*, the butterfly zone also conserves the entire habitat that encourages a community of native plants and insects to thrive in the zone.

Keywords: Butterfly Zone, Habitat Conservation, Biodiversity conservation, *in-situ* Conservation, Role of Butterfly Zone

1. Introduction

A habitat is built on a complex network of relationships which are delicately balanced and easily disrupted. Removing a species or even introducing just one foreign species to a given habitat can set off a chain reaction that endangers a whole ecosystem that was once perfectly in balance. Habitat alterations due to deforestation, forest fires, grazing, fodder and fuel wood extraction, over-harvesting, pollution, climate change; fragmentation and degradation are the primary causes responsible for the biodiversity diminution. The conventional species-level approach for biodiversity conservation has major limitations, and a major change in understanding the priorities of biological conservation and management has resulted in policy shift from conservation of a single species to their habitat^[1]. Species loss has tremendous implications on the sustenance of life forms in the universe. Like other living organisms, butterflies also suffer from a loss of habitat. For instance, conversion to agriculture might be the most destructive form of habitat loss, for Lepidoptera^[2-3]. Habitat destruction as a result of deforestation, pollution, land development, modern farming practices and indiscriminate use of pesticides etc. are the threats to the survival of many species of butterflies and plants. Further species with narrow ranges tend to be the most vulnerable to the impacts of habitat loss and usually require natural forest to persist^[4-5]. Governmental policy on forestry, farming and road planning has great effect on the abundance and distribution of butterflies^[6]. Several techniques have been run to reduce the extinction of biodiversity, in which *ex-situ* and *in-situ* are major one^[7]. *Ex-situ* conservation involves the transfer of target species away from its native and natural habitat to a safe place such as zoos and botanical gardens^[8] or butterfly parks, while *in-situ* conservation involves the conservation of species in its native and natural habitat. So there is a need to develop new approaches and strategies to conserve habitat of butterflies. In this line the paper introduces a new approach to *in-situ* Conservation of butterfly diversity through the concept of 'Butterfly Zone'.

1.1 'Butterfly zone' a novel concept for Biodiversity Conservation in Forest Area

The lives of plants and butterflies are exceptionally interlinked [9]. The butterflies are also considered to be an umbrella species for their conservation would lead to conservation of several life forms in the ecosystem such as birds, reptiles and even mammals. An environment that enhances the survival of butterflies would therefore, enhance the survival of not only the butterflies, but also a variety of organisms and ultimately human beings [10]. In a particular habitat if butterfly is endangered then the plants, insects and vertebrates live in that habitat are also at risk. Therefore endangered butterflies serve as barometer of natural conditions in that habitat [11]. Thus the distribution and abundance of butterflies decline due to the habitat destruction [12]. In this line a new approach for habitat conservation through setting up 'Butterfly Zone' was well thought and conceptualized. Butterfly zone encompasses natural patches of vegetation having butterfly host plants, usually found along streams, rivers etc. or near ponds, waterfalls etc. It is important to identify and conserve such zone as conserving these habitats will indirectly conserve a variety of native plants as well as number of organisms surviving on these plants. Setting up of 'Butterfly Zone' having naturally occurring indigenous butterfly host plants and food plants, would be a new approach to *in-situ* conservation of butterfly diversity.

2. Materials and Methods

2.1 Site description

The Butterfly Zone (BFZ) was identified in the Nandhaur beat of a Nandhaur range of Haldwani Forest Division. The Nandhaur region is a very important component of "Shiwalik and foot hills" landscape of the country which is popularly known as "Terai-arch" landscape. On account of its adequate ecological, faunal, floral, geomorphological, natural and zoological significance for the purpose of protecting, propagating and developing wildlife and its environment, Nandhaur wildlife sanctuary with an area of 269.956 Km² was notified in 2012, located in the Nainital, Champawat and partly in Udham Singh Nagar districts of Uttarakhand State.

1. **Location:** The Butterfly Zone (Plate 1,2) was set up in August, 2016 in one hector area of Maswari A block of the Nandhaur beat of a Nandhaur range of Haldwani Forest Division, lying at N 29°07'58.9" and E 79°42'15.8" at an altitude of 332 m. Haldwani Forest Division is situated in the districts of Nainital and Champawat. The Forests cover the lower foot-hill of the Himalaya and the sub mountain tracts of Kumaon from the Sharda River and Nepal in the east to the Sukhi and Gaula River in the west. Considerable areas extend southwards below the hills and occupy Bhabar region. Bhabar is characterized by vast beds of boulder detritus under a thin porous gravelly soil.

2. **Topography:** The highest point is Maharudar on the division boundary between Aligadh and Deota block (6,128 feet) and the peak in Lobchula East block (5,890 feet), while along the southern boundary the altitude varies between 650 and 800 feet. The hills usually rise abruptly from the Bhabar to some 2000-3000 feet on the first ridge.
3. **Geology, Rocks and soils:** The geological formations, occurring in this Division are almost entirely sedimentary deposits, consisting of conglomerate at upper Shiwalik, sand rock at middle Shiwalik and sand stone at lower Shiwalik. The soil is a loam of great depth, fertility and uniformity of texture, intercalated with narrow bands of stony or sandy materials.
4. **Aspect:** The area falls at southern aspect, ensuring a warmer and sunnier habitat for basking.
5. **Climate:** There are three distinct seasons cold weather, follows from October to February, hot weather from March to June and Rainy season from July to September. In December or January, winter rains may be expected for a week or so, while the wettest months are July and August.
6. **Temperature and Rainfall:** The temperature as recorded in the Pantnagar Observatory over the last decades varies from 28°C in January to 37°C in May and a rainfall of 1400 mm.
7. **Forest Types:** The different Forest types that occur in the division are- Dry Siwalik sal forests (4b. C2.), Moist western hill sal forests (3b. C1. B1.), Moist high level alluvial sal forests (3b. C1. B3.), Most high/low level alluvial sal (B3/B4. 3b. C1. B3/B4.), Moist high level/dry alluvial sal (A-2. 3b. C1. B3/B4. C2. A2.), West Tarai sal forests (3b. C1. B6.), Climax moist deciduous forests (E-4.), Northern dry mixed deciduous (4b. C2.), Cane brakes (E-8.), Dry Bamboo brakes (E-12.), Gangetic moist deciduous riverain forests {7(b)}, Alluvial Savannah type forests (2s. 7a and b.), Khair-Sissu forests (2), Sub tropical pine forests (8C1.)



Fig 1: Geographical map showing the location of Butterfly Zone at Chorgalia in Nandhaur Wildlife Sanctuary, Haldwani Forest Division, Haldwani.

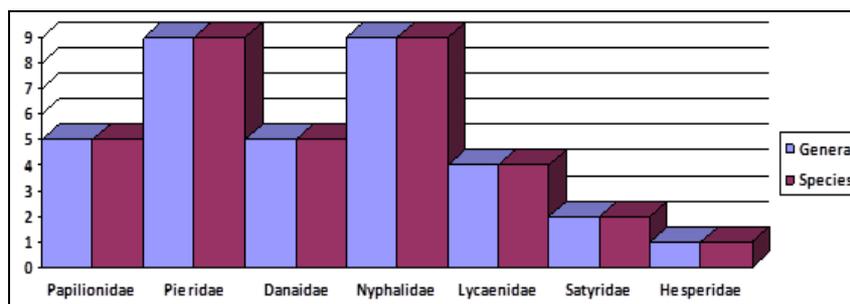


Fig 2: Number of genera and species of butterflies belonging to different families in Butterfly Zone.

2.2 Area

The site selected for establishing 'Butterfly Zone' was a patch of moist deciduous teak forest falling within the Chorgalia range of the Haldwani Forest Division. The zone is characterized by a dominant plant life with natural forests and relative wetness of the area. It is chosen to support the life cycle of a number of local species of butterflies. The zone is spread over an area of one hectare which was chosen by virtue of having many naturally occurring butterfly host plants dominated by *Asclepias* species, other bushes and ferns. The terrain is plain and undulating bound by streams on two sides of the zone. The entire existing vegetation was retained and the zone was also enriched by planting other native butterfly host plants that attract and support a more number of species compared to others. The experimental area was fenced from front roadside to avoid disturbances by cattle and outsiders after retaining entire wild vegetation connecting the forest area. A number of larval host plants of a number of butterflies which were already present in the area were *Cassia fistula*, *Syzygium cumini*, *Ficus racemosa*, *Lagerstroemia speciosa*, *Murraya koenigii* etc. No native vegetation was removed except invasive weeds etc while retaining local grasses like *Saccharum spontaneum*, *Thysanolea maxima*, *Dendrocalamus strictus* and native ferns. Butterflies exhibit important behaviours like mud puddling and basking in order to meet the demands of nutrients and maintain body temperature respectively. Suitable sites within the butterfly zone were identified and enriched by weeding, canopy clearing etc. to facilitate these behaviours.

2.3 Naturally occurring dominant host plant

Asclepias curassavica is a most common and dominant larval host plant naturally found here which is commonly known as Mexican butterfly weed or tropical milk weed. It is a flowering plant of species of the milkweed genus *Asclepias*. It

is an evergreen drought-tolerant perennial sub-shrub that grows up to 1 m in height and has gorgeous orange, red and yellow flowers. Like the other member of the genus, the sap of the plant is milky. Flowering occurs nearly year round. The flat seeds have silky hairs that allow the seeds to float on air currents when the pod like follicles split open. It is one of the best plants to attract butterflies as many butterflies sip its nectar (Plate 3). Monarch larvae love to feed on its leaves. Notably it attracts member of the Danainae sub family such as the Monarch and the Queen. Other native larval host plants were introduced in 2015 August, at the time of declaring of Butterfly Zone for attracting various butterflies found in the region. Common butterflies available in the zone which require conservation care or efforts for their establishment are listed in table 1.de

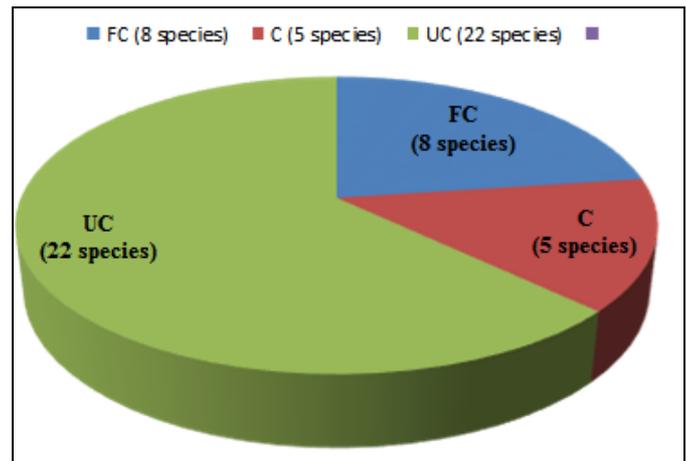


Fig 3: Status of different species of butterflies recorded from the study of Butterfly Zone.

Table 1: Species composition and status of butterflies recorded before and after the establishment of Butterfly Zone.

S. No.	Common Name	Zoological Name	Status	
			Before establishment of Butterfly Zone	After establishment of Butterfly Zone
Family- Papilionidae				
1.	Common Rose	<i>Pachliopta aristolochiae</i> (Fab.)	UC	C
2.	Lime Butterfly	<i>Papilio demoleus</i> (Lin.)	-	UC
3.	Common Mormon	<i>Papilio polytes</i> (Lin.)	UC	FC
4.	Common Jay	<i>Graphium doson</i> (Feldu Druly)	-	UC
5.	Common Jezebel	<i>Delias cucharis</i>	UC	C
Family- Pieridae				
6.	Common Emigrant	<i>Catopsilia crocale</i> (Cramer)	C	FC
7.	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Lin.)	-	UC
8.	One Spot Grass Yellow	<i>Eurema andersoni</i> (Moove)	-	UC
9.	Common Grass Yellow	<i>Eurema hecabe</i> (Lin.)	UC	C
10.	Three Spot Grass Yellow	<i>Eurema Blanda</i>	UC	C
11.	White Orange Tip	<i>Ixias arienne</i> (Cramer)	-	UC
12.	Plain Orange Tip	<i>Colotis eucharis</i> (Feb.)	-	UC
13.	Indian Cabbage White	<i>Pieris canidia</i> (sparrmon)	-	UC
14.	Indian Wanderer	<i>Pareronia hippia</i> (Febsicus)	-	UC
Family- Danaidae				
15.	Plain Tiger	<i>Danaus chrysippus</i> (Lin.)	C	FC
16.	Striped Tiger	<i>Danaus genutia</i> (Lin.)	C	FC
17.	Common Crow	<i>Euploea core</i> (Cramer)	UC	FC
18.	Glassy Tiger	<i>Parantica aglea</i> (Stoll)	C	FC
19.	Blue Tiger	<i>Tirumala Linniace</i> (Cramer)	C	FC
Family- Nymphalidae				
20.	Lemon Pansy	<i>Junonia lemonias</i> (Lin.)	-	UC
21.	Great Eggfly	<i>Hypolimnas bolina</i> (Lin.)	UC	UC

22.	Danaid Eggfly	Hypolimnas missipus (Lin.)	-	UC
23.	Blue Pansy	Precis orithya (Lin.)	-	UC
24.	Common Leopard	Phalanta phalantha (Drury)	UC	UC
25.	Common Map	Cyrestis Thyodamas	-	UC
26.	Rustic	Cupha erymanthis (Dvrry)	-	UC
27.	Striped Blue Crow	Euploea mulciber	UC	C
28.	Lemon pansy	Junonia lemonias (Li)	-	UC
Family- Lycaenidae (Blue Family)				
29.	Grass Jewel	Freyeria trochilus (Forster)	-	UC
30.	Common Cerulean	Jamides celeno (Cramer)	-	UC
31.	Quaker	Neopithecops zalmora (Butler)	-	UC
32.	Pea Blue	Lampides boeticus (linnaeus)	-	UC
Family- Satyridae				
33.	Common Evening Brown	Melanitis leda (Drury)	UC	UC
34.	Common Bush brown	Mycalesis perseus (Fab.)	-	UC
Family- Hesperidae				
35.	Indian Skipper	Spialia galba (Fabricius)	-	UC

2.4 Sampling and identification of butterflies

Sampling of butterflies was conducted from August, 2016 to July, 2017 on the basis of regular observations in the established Butterfly Zone. In order to sample the butterflies, net sweeping was adopted^[13]. The net used for sweeping was made up of thick cotton cloth with a diameter of 30 cm at mouth and a bag length of 60 cm. In addition to sweeping, photography of butterflies was also done to avert the loss of biodiversity. The butterflies were identified with suitable literature and butterfly identification guides^[14-16].

2.5 Species composition and status of butterflies

In order to determine the species composition of butterflies, identified species were placed according to their families and an inventory was prepared. Status of butterflies was determined on the basis of a number of the sightings in the study area and butterflies were placed in three categories namely fairly common (FC= more than 25 sightings), common (C=10-20 sightings) and uncommon (UC= less than 10 sightings), respectively.

3. Results and discussion

The successful model of the butterfly zone first of its kind in the natural forest area was very clear from the number of butterflies visiting the area throughout the year from August, 2016 to July, 2017. The data in table 1 indicates more than double numbers of the visiting butterflies in the established butterfly zone when compared to the same area before establishment of the butterfly zone. The remarkable increase in the composition and status of butterflies might be due to the better protection of the area and the additional planting of other native host plant species of butterflies of the area like *Azadirachta indica*, *Michelia champaca*, *Aegle marmelos*, *Cinnamomum camphora*, *Acacia nilotica*, *Cassia glauca*, *Cassia siamea* etc. to enrich the habitat for butterflies. These plants species were observed to provide a better habitat for foraging, basking and breeding activities of many butterflies when compared to the other adjoining areas of the forest. For instance Pierid butterflies like a Common grass yellow (*Eurema hecabe*) and Danaid butterflies like common crow (*Euploea core*) were found almost throughout the year. Common Mormon (*Papilio polytes*) and Grass Jewel (*Freyeria trochilus*) were found to be the monsoon visitors from July to November. The winter visitors were enlisted as One spot grass yellow, Striped blue crow, Common jezebel, Indian wanderer, Lemon pansy (*Junonia lemonias*). The major factor was the site selection as most butterflies require

high atmospheric humidity and for this an area having naturally occurring streams with undulated land surface was chosen for setting up the butterfly zone. The entire existing vegetation naturally dominated by *Asclepias curassacica* was left undisturbed. Further the zone was strengthened by introducing other native butterfly host plants and by conserving and improving the quality of habitats as it attracted and supported a more number of species compared to others. As a result of enrichment and conservation of habitat having multiple indigenous host plants there was a remarkable increase in butterfly population in the zone around the year. Altogether, 35 species of butterflies frequently observed are enlisted in table 2. The naturally landscaped butterfly zone with its rich butterfly fauna was an attraction to the visitors. Besides conserving the butterfly fauna the zone also conserves the entire habitat that encourages a community of native plants and insects to thrive in the zone. As the number of various native host trees is expected to bloom followed by flowering in forthcoming years of their regeneration period more and the number of types of butterflies are expected to visit and breed in the Butterfly Zone. Presently setting up of butterfly Zone have fantastic experience through a heavily conserved setting here where visitors can find many hosts of colourful, freely flying butterflies with their host plants.

Table 2: Diversity in total number of genera, species and status of butterflies belonging to different family after establishment of Nandhaur Butterfly Zone.

S.no	Family	Genera	Species	Status		
				C	FC	UC
1.	Papilionidae	5	5	2	2	1
2.	Pieridae	9	9	2	1	6
3.	Danaidae	5	5	-	5	-
4.	Nymphalidae	9	9	1	0	8
5.	Lycaenidae	4	4	-	-	4
6.	Satyridae	2	2	-	-	2
7.	Hesperidae	1	1	-	-	1
Total		35	35	5	8	22

3.1 Role of Butterfly and Butterfly zone in habitat and biodiversity conservation

In many regions of the world Lepidoptera are accepted as the ecological indicators of the ecosystem health^[17-18]. As a wildlife indicator, butterflies tell us almost everything we need to know about the health of an ecosystem^[19]. Some

butterfly species are very sensitive to even light disturbance of natural forest. These species of butterflies are good indicators for natural forest^[20]. Butterflies also react quickly to minor changes in the environment, providing an alarming signal for other reductions in wildlife and making them good indicator of biodiversity. So, they are best monitored group of insects in the world^[19]. Stephen Dickie, explains, "Birds plan their whole breeding season around when caterpillars will be more abundant. If butterflies and caterpillar are depleted then there will be less food for developing chicks"^[19]. Some butterfly larvae feed on harmful insect for example Hoverfly larvae are Predators of aphids so, caterpillars are also used as biological pest control^[21].

Many butterfly species migrate over long distances as many as 3,000 miles. These migrations allow for pollination across long distances and have increased human interest in the species^[22]. Butterflies contribute to ecosystem restoration because they supply pollination and source of food. Increased butterfly populations may indicate an increase in plant diversity and other pollinator groups within restored areas. So by identifying butterfly zones it is possible to gain insight into the life history, behaviour and role of butterflies in sustaining natural ecosystems. Besides an additional step towards biodiversity conservation, the butterfly safari in 'Butterfly Zone' as ecotourism activity can give insights on butterfly conservation. Butterfly Zone is an attractive destination for children, school going students, nature lovers, researchers and other nature enthusiasts.

4. Conclusion

Butterflies maintain the ecosystem by acting as pollinator, prey, biological pest control, and induce genetic variation in plants. But human activities and global climate fluctuation destroy and affect the butterfly habitats. So butterfly population is declining rapidly and it is suggested that greater emphasis should be placed on management of habitat. Thus one needs to act to preserve existing habitats. Also there is a need to enrich the degraded existing habitats by integrating the disappearing native plants into the landscape for enhancing the diversity of the habitat. Butterfly zone when established, represents such a natural forestry system that encourages a community of native plants and insects to thrive in the zone. Thus creating "Butterfly Zone" will not only ensure the "in-situ Conservation of "Butterfly Diversity" but also the habitat conservation involving biodiversity conservation of the region.

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