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## Establishing Integrated Aquatic Habitats for Bees, Birds and Fishes

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Aquatic habitats are important constituents of natural ecosystems whether they are freshwater, estuarine or marine in nature. A wide diversity of vertebrates and invertebrates along with several plant species from algae to angiosperms are common biodiverse constituents of any dynamic aquatic ecosystem model. However, due to exponential rise of human populations, environmental pollution, climate change and global warming, destruction of forests and other natural ecosystems, expansion of industry and agriculture into highly fragile and vulnerable ecosystems; aquatic habitats across the planet are facing serious challenges for their virtual existence. It is quite unfortunate to note that several ecologically fragile aquatic habitats from the Arctic and Antarctic to the temperate, sub temperate, tropical and sub tropical biomes have been impacted drastically; often in an irreversible manner with little or no expectation(s) for them to come back again over time even when applying sustainable environmental engineering approaches. Several such aquatic habitats across the planet have been damaged beyond any possible ecological repairing or restoration.

Not only different aquatic habitats are vanishing rapidly across the planet; but, also a huge diversity of biological species along with them in terms of important microbes, flora and fauna directly or indirectly dependent on those aquatic ecosystems. The biological species are disappearing faster than they are actually scientifically

recorded or documented. The situation is grave across the planet; however, developing and under developed nations are the worst impacted. It is therefore important to save these aquatic habitats to the best of our ability to protect the fragile local ecosystems, biodiversity and the nature.

Marine and estuarine ecosystems certainly will need much bigger initiatives for the purpose of conservation; however, fresh water aquatic habitats could be protected through organized as well as individual efforts across Federal, Provincial/State and Territorial (FPT) areas of a nation. What is needed is a highly integrated, effective, efficient and comprehensive Multiple Tier Conservation Model (MTCM) to broadly cover multiple tiers of trophic levels within a single aquatic ecosystem to save a larger number of species either directly or indirectly dependent on the aquatic habitats; or directly inhabiting these unique aquatic ecosystems within the Federal, Provincial/State and Territorial (FPT) boundaries of a nation.

An important environment-friendly as well as sustainable (green) approach or model for protecting freshwater aquatic habitats could be through Establishing Integrated Aquatic Habitats for Bees, Birds and Fishes (IAH-BBF). This is an Integrated Ecosystem Development Model (IEDM) in which conservation of species from various trophic levels existing within an aquatic ecosystem could be targeted simultaneously. Different natural as well as artificial freshwater aquatic habitats like ponds, pools, lakes, swamps, bogs, ditches, low lying inundated areas, low salt pans, meandering streams, slow moving sections of tributaries and distributaries; all could be very easily and successfully targeted for IAH-BBF.

The integrated Bees, Birds and Fishes Conservation Model (BBFCM) is a new, excellent and innovative approach for successful

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conservation of both natural and artificial aquatic habitats targeting multiple species at various trophic levels simultaneously. An aquatic habitat can be utilized therefore for targeting the successful conservation of various terrestrial insects such as natural pollinators like native bees, honey bees, moths, butterflies, some pollinator species beetles and flies; as well as several aquatic insects. A wide diversity of insects in and around aquatic habitats will certainly attract both large and small land birds to forage on them. At the same time a well protected and well fish stocked aquatic habitat is bound to attract a wide diversity of freshwater aquatic birds for both foraging as well as nesting. Aquatic vegetation, bird droppings, leaf litter, insect larvae as well as adult insects together with some artificial fish food added to the water will help both the indigenous and introduced fish populations in the aquatic habitats to thrive together with the birds and bees.

It will be however important to build the plant populations along such natural or artificial water bodies by introducing or planting some pollinator friendly annual and/or perennial legume-grass mixes to attract pollinator insects and other land birds to forage and nest in these attractive and dynamic ecosystem. The legumes used in the mixes can provide diverse shape, sizes, and colored flowers that are good pollinators and attract bees and other insects along with land birds for nectar foraging. Some of these birds will also predate on bees and other insects as part of a natural dynamic ecosystem as their natural food sources. Care must be taken to avoid spraying toxic pesticides, fungicides, algacides in such ecosystem models to avoid chemical contamination and accidental or deliberate pollution of these natural or artificial aquatic habitats.

Legumes incorporated in the Pollinator Mix will help building the pollinator insect populations around the aquatic habitats; and at the

same time help in enriching the soil in natural nitrogen without the application of synthetic nitrogen fertilizers. The grasses in the mix on the other hand will help in creating bird habitats and will also prevent soil erosion along the edges of the aquatic habitat. Short and tall grasses and even native grasses and wildflowers could also be incorporated in the mix depending upon the agro-climatic conditions of the FPT. For areas impacted with salinity related issues; salt tolerant grasses could be incorporated in the Pollinator mix for the purpose of phytoremediation. A diverse Pollinator mix with varied flowering regime (early-, mid- and late-) will be more attractive to a widely divergent species of pollinator insects like bees and will also attract land birds in significant numbers over time.

A grassy and well protected aquatic habitat with rich food source is always a favorite for aquatic birds to colonize the habitat; thereby successfully developing into an Integrated Ecosystem Development Model (IEDM). Furthermore, as these aquatic habitats get well established over the years and suitably protected; both small and medium sized aquatic as well as terrestrial mammals will be attracted to such sites for breeding, nesting and hunting purposes on their suitable target prey species in that ecosystem. Hence there is a huge opportunity for the integrated Bees, Birds and Fishes Conservation Model (BBFCM) to be successful at multiple levels; if executed properly and managed scientifically. It will be important to explain the concept to people and popularize through various demonstrations at appropriate model aquatic habitat sites.

Photo credit: S. K. Basu

Sources: CIJ, Shillong Times, Technology Times, COABC, Sikkim Express



## Ecotourism Opportunities

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Ecological tourism or ecotourism has been a very popular catch phrase around the globe among ecologically sensitive travelers and tourists. People who are highly respectful towards ecosystem and environment; but, at the same time wish to travel and explore new exotic habitats and ecosystems within a country or overseas; are hugely supportive of the ecological tourism or ecotourism concept. The International Ecotourism Society (TIES), in 1990 defined ecotourism as "*Responsible travel to natural areas that conserves the environment and improves the well-being of local people.*" Ecotourism is about bringing the triad of conservation, communities and sustainable tourism on a common platform.

According to TIES, ecotourism activities should follow some specific guidelines, such as: 1. reduced impact on the local ecosystems and environment that are being explored or visited, 2. building eco-environmental as well as socio-cultural awareness and mutual respect during ecotourism in the host nation, ecosystem or habitat, 3. develop positive relationship, cooperation and coordination between the host and the visitors 4. assist directly in supporting local conservation and ecological restoration efforts, 5. economically help local communities, making them self-reliant, independent, sustainable and both ecologically and economically empowered, lastly, and 6. sensitize the socio-political and eco-environmental awareness level of the visiting country to the best of one's ability.

Modern ecotourism is changing rapidly both in its form and dynamics. A paradigm shift has been noticed across the globe with respect to ecotourism; and it has demonstrated both long term positive as well as negative impacts on local ecosystems and in conservation efforts. Often the environmentally and ecologically sensitive nature and sustainable philosophy have been compromised in several host countries, and in the process of ecosystems and habitats restoration and conservation efforts. The money received through ecotourism has gone into infrastructural developments, in paying staff salaries, wasted through useless conference and workshops or siphoned into secret and untraceable coffers.

The ecological costs have been quite detrimental too. The basic concept behind ecotourism has been that the money generated through ecological tourism was to be directed towards conservation of sensitive ecosystems in the host country (mostly biodiverse developing and under developed nations). A part of the profit generated through ecotourism was to be allocated for the socio-economic development of neglected, poor, local rural communities leaving in close proximity of the forests, forest fringe residents and forest dependent communities to reduce their dependence on local forests for sustainability; and to provide them with alternate livelihood.

The coherent idea was that as forest dependent communities will realize the benefits of the unique forest ecosystems and wildlife due to ecotourism and thereby help in protecting and conserving the local ecosystems and forest resources. Although the model did work and has helped in supporting conservation effort in some



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parts of the world; but at the same time, it did backfire in other places, suggesting that same model will not work at each and every host country promoted under ecotourism initiatives.

Over exposure of sensitive ecosystems and habitats to insensitive, so called ecotourists have damaged and degraded fragile ecosystems and disturbed sensitive forest environment and local wildlife. Indiscriminate tourist footprints due to overcrowding and lack of proper monitoring, irresponsible waste disposal, sound pollution, transportation pressures, infringement into sensitive forests to accommodate tourists have gone against the conservation and ecological restoration of the same habits that was in urgent need of protective measures. Constant flow of tourists has disturbed wildlife and premier nesting, breeding, foraging and hunting habitats of several endangered species. Furthermore, fire hazards and bringing pets as well as pests into sensitive wildlife habitats have negatively impacted local flora and fauna.

India representing a modern global democracy, an ancient civilization with divergent ethnic cultures as well as being a megabiodiverse nation with different agro-climatic regions attracts millions of foreign tourists every year. A small chunk of them do visit India as ecotourists; but the ecological tourism industry in India is still at infancy compared to many other countries across Asia, Africa and Latin America. India will need substantial investment to promote and develop sensitive areas of the country into ecotourist hub; but this will take some time. However, while the industry takes shape over next few years; India still has some simpler and viable options to develop soft ecotourism sectors within the nation rapidly.

India is a megabiodiverse nation with huge resident, indigenous avian (bird) population; and is an important transit point for several migratory bird species from Europe, Africa, Central Asia, Siberia and SE Asia during the winter months. Thus India has the capability to develop into a premier avitourism (bird tourism) destination allowing enthusiastic ecotourists to catch glimpses of divergent avian species in different selected habitats throughout the country spread across different states. Each state could develop their own bird watching ecotourism centers through comprehensive planning, investments and developing necessary eco-friendly infrastructure around such spots that will attract tourist and help in conservation as well proving socio-economic benefits to the poor, local resident communities.

Another viable option could be integrating recreational fishery with ecotourism with some broad long term environment friendly commercialization plan. Recreational fishery is still at its infancy in India; although this is a huge industry in western nations. Although allowing fishing in sensitive wild aquatic habitats in India will be a catastrophe and is not advisable. However, developing well stocked commercial ponds with commercial, edible species of fishes; and opening them for recreational fishery for both indigenous and overseas as well as ecotourists can easily help initiating another potential revenue generating opportunity. Both options, namely avitourism and recreational fishing tourism can be looked upon as advanced form of ecotourism with modifications that can help generating funds for conservation efforts as well as provide some seed money for the socio-economic benefits and development of the local indigenous and rural communities.

*Photo credit: S. K. Basu, S. Ghosh, H. El asmer & R. Ray*  
*Sources: Nagaland Post, Sikkim Express, ENVIS-COE*



## Phenology of Species with Apicultural Potential at Xmabén, Hopelchén, Campeche, México

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Beekeeping is one of the main economic activities conducted in the Xmabén community, located in Hopelchén, Campeche State, Mexico. Hence, the objectives of this study has been to identify the local melliferous flora with high apiculture potential (AP), the contribution of nectar and pollen they can provide, their flowering patterns (phenology); and the necessary parameters for the vegetation to be established adjacent to local apiaries for high quality honey production in the Xmabén community of Hopelchén, Campeche State, Mexico. An exhaustive interview based survey was therefore conducted during 2017; on 40 local beekeepers to collect the necessary information on local melliferous flora with AP as described above.

The survey contained a total of 14 open and close-ended questions related to the local AP flora; and the activities of local beekeepers to counteract periods of acute food shortage for their honeybees (*Apis mellifera* L.). An exhaustive list of local melliferous AP flora provided by interviewing the local beekeepers was thus prepared that includes 56 taxa, spread across 26 families, 51 genera, 50 species, three

subspecies and three varieties. Among the AP melliferous flora from Xmabén community; trees were the most frequent growth form with 39 species; followed by shrubs (6), herbs (5), climbers (4) and vines (2). From the phenological perspective, 19 taxa were recorded that bloom exclusively in the dry season, 6 in the rainy season and 8 in nortes season. Two flowering peaks were also recorded: Phase 1. January to June, and Phase 2. October to November. The first phase corresponds to dry season when local beekeepers get maximum honey production; and the second peak corresponds to the beginning of the rainy season. The rainy season has the lowest number of plants flowering in the region; and this is the period when the local honeybees face acute shortage of food resources, pushing them to migrate or swarm to other localities for survival. However, a number of herbs and climbers, particularly in the Convolvulaceae family; do flower during the rainy season and could serve as an excellent forage resource for the starving local honeybees if propagated adjacent to local apiaries as melliferous flora with AP.

The information provided by the interviewed beekeepers indicated that species with AP are either nectariferous (31) or polleniferous (15) or both (17). Local beekeepers depend on 18 species with AP for stable quality honey production. The AP flora of the Xmabén community as used by the beekeepers has a high selection for tree species that flower during the dry season; a favorable time for maximum high quality honey production. However, as mentioned above there is a high demand for additional resources like herbs and climbers during the rainy season, when there is a shortage of food for the local honeybees. The diversity of melliferous flora of Xmabén community, Hopelchén, Campeche State, Mexico therefore constitutes a valuable resource for successful beekeeping in the region and adjacent areas. The data generated can help in further expansion of the local apiaries, beekeeping business and in building future opportunities for the local apiculture industry.





## Apiculture Potential of Convolvulaceae Family in the Yucatán Peninsula, Mexico

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The Convolvulaceae family globally represents around 1200 species with 55 genera, distributed across the tropics and temperate latitudes, with highest diversity reported from the continents of the Americas and Africa. In Mexico, the Convolvulaceae family is represented by 251 species under 17 genera. Majority of the local species are herbaceous climbers, herbs and shrubs are also reported to occur. The plants predominantly grow on secondary vegetation; and on different types of vegetation along the side of rural and urban roads. The objective of this study has been to determine geographic distribution pattern of Convolvulaceae family in the Yucatan Peninsula (YP), Mexico; and to investigate the ecological perspective and areas of greater diversity for their conservation and their potential uses for their use in local beekeeping industry. Based on field collections and a review of specimens of herbaria



(CICY, ECOSUR, UCAM and MEXU), 1250 collections were projected on a base map of the vegetation types of the YP to determine the growth of the number of species for each vegetation type, through the ArcGIS program. In addition, based on the material studied their growth habits, flowering patterns and distribution frequency in each state covering YP; namely, Campeche, Quintana Roo and Yucatán was also determined. Finally, data was collected on potential application of the local Convolvulaceae members by reviewing relevant literature sources; and by collecting information described on the herbarium labels.

We reported 76 Convolvulaceae species from the YP distributed across 12 genera. Our results indicate that the state with the highest number of species is Yucatán (63), followed by Campeche (53) and Quintana Roo (47). The species of Convolvulaceae were registered in 20 types of vegetation. We reported the highest number of species from the low deciduous forest (53), secondary forest (52) and medium stature tropical forest (36). When comparing the number of species with apicultural potential within botanical families in the YP, our results also indicate that Convolvulaceae (56%) along with Fabaceae (52%), Asteraceae (57%), Malvaceae (72%) and Euphorbiaceae (54%) are the most diverse with apicultural potential plants. Although, principal use of Convolvulaceae is melliferous; however, some species are reported to have multiple uses, for e.g. forage (22 species, such as *Ipomoea criniticalyx* S. Moore, *I. nil* (L.) Roth), medicinal (15 species, antispasmodic or anti-inflammatory, *Jacquemontia tamnifolia* (L.) Griseb.), ornamental (9 species, several species of *Convolvulus*, *Ipomoea*, *Jacquemontia*, etc), religious magic (4 species, *Turbina corymbosa* (L.) Raf. from which an alcoholic beverage is prepared that is used in the celebration of good harvests of the milpa), food (3 species, sweet potato, *Ipomoea batatas* (L.) Lam.), and for handicrafts (2 species, *Merremia tuberosa* (L.) Rendle).



The Convolvulaceae members in the YP are mostly climbers with multiple flowers; and flowering period spread across major part of the year. The peak flowering corresponds to the half of the rainy season. The rainy season has the lowest number of plants flowering in the region; and this is the period

when the local honeybees face acute shortage of food resources, pushing them to migrate or swarm to other localities for survival. Hence, Convolvulaceae could serve as an excellent forage resource for the starving local honeybees if propagated adjacent to local apiaries as a melliferous flora. Therefore, Convolvulaceae species represent an important alternative as a stable source of nectar and pollen for bees during critical periods of flowering in the different types of natural ecosystems; where local apiaries are located.



## Zoo Gardens as Window of Exploration, Education and Knowledge for the Public

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Zoological gardens or zoo gardens has a nostalgic connection to most of our lives. There are hardly any kids these days where the family has not made stop at the zoo for exploring the vibrant and divergent animal life at some point of his/her life. Zoos have strong impacts on all school going kids in knowing about mysterious animal life and behavior; and also to appreciate the diversity of our natural world. Several schools have programs to take students to the zoos to introduce them to the spectacular diversity of animal life, to connect the kids to the natural world outside the four walls of the classroom in a practical nature based laboratory as well as an eye opener with opportunities of supervised exploration and gathering knowledge about our diverse natural world. Several countries include visit to zoos with various objectives at the primary, secondary and tertiary levels of education. The basic idea however is the same; and that is to respect and appreciate the diversity of life that we often forget in the din and bustle of our busy daily life.

Private zoos across different continents were in fact first established by the existing monarchy of the land, aristocrats, noblemen, influential courtesans and rich social elites as a part of their proud and exquisite collection of wild animals, birds and reptiles. Hence credit must be given to the monarchy and other elites of the society in establishing and maintaining the first of its kind of private zoos. With democratic reforms hitting various societies; private zoos slowly transformed into public zoos keeping in pace with the evolution of human social history and the rise and popularity of democratic values. When the need and importance of modern electorate and ordinary citizens started getting recognized; private zoos slowly started transforming into public zoos.

The process was initiated in Europe and then spread to the rest of the world over time during the post colonial era. Many of these zoos were stocked with animals from different continents either by explorers and travelers or through armed campaigns during pre colonial era; and through army personnel, adventurers, explorers, hunters and researchers during the colonial and post colonial period. The collection of live and dead animals and birds from distant continents thus started rapidly filling in the shelves and galleries of natural history museums and cages of the zoos respectively. Such global collections enriched premier zoos with spectacular diversity of life from around the planet during the classical age of exploration, adventurism and post industrial revolution era.

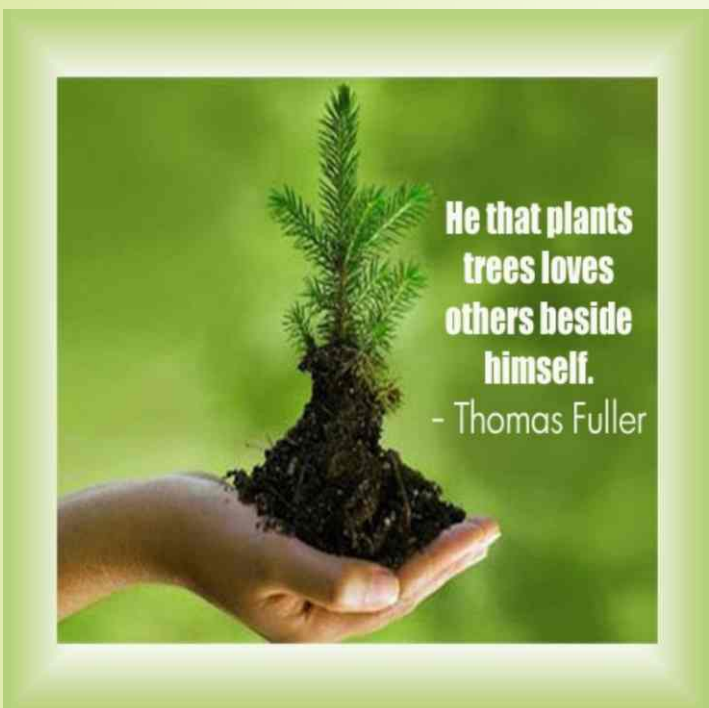
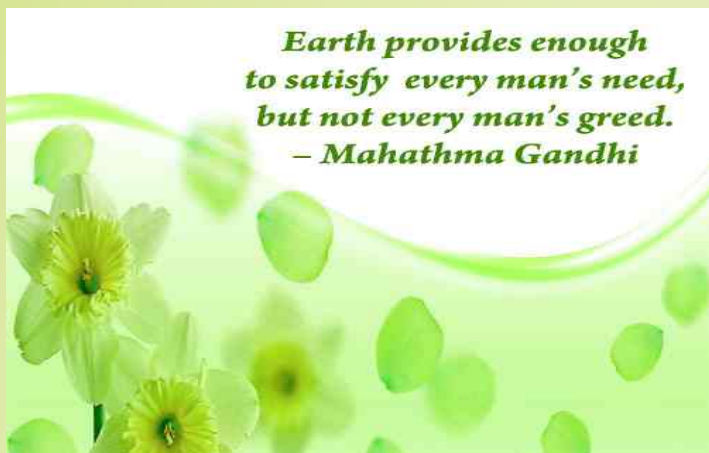
However, it is important to remember that most zoos however started with a single point agenda; and that has been entertainment of the public primarily. The display of animals in the age old conventional or traditional zoos have been guided by the notion of capturing the interest of the public, to provide visiting families with an opportunity to have an enjoyable or memorable day out with their kids watching spectacular wildlife outside the confines of their homes without having the trouble to visit natural ecosystems or forests in far off lands and continents.

Zoo management has been at its infancy with very little or almost no proper care for the animals housed in congested and over crowded cages. Appropriate veterinary diagnostics and treatments as well as modern vet medications were not available for the inmates. Many precious animals, birds and reptiles died during transportation and due to lack of suitable care, proper diet and nutrition or any facilities for modern animal care. Furthermore, unhygienic condition of the cages, cross contamination, injury and diseases also took a number of animal lives in the traditional zoos of the past.

But out of this chaos and confusion, modern zoo gardens got their basic foundation laid and established over few centuries to transform into world class public zoos from their initial humble beginning as private zoos for the aristocrats. Today, modern zoos around the world have evolved into different specialized forms such as zoological parks or gardens, fresh water and marine aquariums, eco parks, animal theme parks, vivarium, reptile houses, snake parks, animal laboratories for study of animal physiology and animal behavior, aviaries, animal nurseries and hatcheries, nature interpretation centers, animal rescue and rehabilitation centers, butterfly gardens, insect gardens, open air zoo, captive breeding centers, animal education and interpretation centers to mention only a handful.

The zoos and aquariums around the world are now governed by the World Association of Zoos and Aquariums (WAZA). The Padmaja Naidu Himalayan Zoological Park in Darjeeling, West Bengal is a member of WAZA. Otherwise, nodal central administrative units in individual country like the Central Zoo Authority (CZA) in India manage the zoo at the national level; following stringent international guidelines, protocol and procedures for zoos across the country. Zoo management has reached a new height now across the globe with respect to the management of zoo animals like housing them in artificial natural habitat like enclosures, better treatment for animals under captivity, zoo based breeding, modern veterinary treatment for sick or injured animals, catering to animal specific diet and nutrition, paying special attention to research on zoo animal physiology and behavior; and attempting to make zoo as an effective and efficient tool for public education and awareness rather than simple entertainment as in the past.

Zoos around the planet have now developed more into education and interpretation centers for wildlife, human-animal interaction platform; and for showcasing the spectacular global biodiversity. Zoos have travelled a long distance from the traditional agenda as showbiz into nature based education hub for the public to explore and educate themselves about nature, wildlife and biodiversity; and the value of natural world in our social and economic life. Such institutions and organizations have big funding with support from the government and public to conduct captive breeding for many endangered species to be able to replenish the natural ecosystems which they represent. The evolution of modern zoos from their traditional humble beginning is an inspirational story in itself. They have slowly undergone transformation from exhibitionism into knowledge centers with high focus on conservation.



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