Entomology, Ornithology & Herpetology: Current Research
ISSN: 2161-0983
Mahendiran and Azeez, Entomol Ornithol Herpetol 2018, 7:2
DOI: 10.4172/2161-0983.1000209
Review Article
Open Access

Ecosystem Services of Birds: A Review of Market and Non-market Values

Mahendiran M* and Azeez PA
Department of Ornithology, Salim Ali Centre for Ornithology and Natural History, Coimbatore - 641108, Tamil Nadu, India

Abstract

Ecosystem provides direct and indirect benefits to humankind through numerous ways of resources and processes, which are collectively known as ecosystem services. The ecosystem services reflect the societal dependence on the ecological life supporting system. Interestingly, birds serve all four categories of ecosystem services; provisioning and cultural services are well known with market values while pest control, seed dispersal, pollination, and scavenging animal carcasses come under the regulating and supporting categories with potential non-market values. Here, in this article we examined the importance of ecosystem services, particularly habitat services, provided by birds; the need for research, appropriate documentation, and recognition of these services, whether monetised and appreciated by the market forces or not were examined. The aim is clearly to convey the message of conservation to policy makers and public at large, in easily comprehendible terms, so that the wrong and prevalent notion of conservation vs. development pertaining to avifauna and its importance of its habitat conservation does not persist.

Keywords: Birds; Pollination; Energy transfer; Ecosystem engineers; Market; Non-market values

Background

Recognition of the ecosystems services to humankind dates back to at least Plato (c. 400 BC) who realised that deforestation could lead to soil erosion and the drying of springs [1]. The concept long overlooked was revived during the last century some of them naming it 'natural capital'. The term 'environmental services' came in 1970, which eventually changed as 'ecosystem services', a term that later became standard in scientific literature [2]. The science of ecosystem service emerged as an attempt to tackle the mismatch of economy and ecology, the mounting conflict between the scale of global economic metabolism and the biophysical limits of the biosphere. The Millennium Ecosystem Assessment [3], involving almost 1360 experts and 80 review editors, identified four categories of ecosystem services; i) provisioning, ii) regulation, iii) supporting and iv) cultural, of which the supporting services regarded as the basis for the other three.

Recently, 'The Economics of Ecosystems and Biodiversity' (TEEB) replaced the term 'supporting services' with 'habitat services' [4]. These definitions are primarily anthropocentric, perhaps to communicate better with the decision/policy makers and the like, especially for the purpose of monetization and commodification of the ecosystem services, and for the purpose of environmental accounting [5]. Ecosystem provides direct and indirect benefits to humankind through numerous ways of resources and processes, which are collectively known as ecosystem services. The ecosystem services reflect the societal dependence on the ecological life supporting system [6]. The so-called ecosystem services, often rendered as interlinked bundles, are in fact the operational facets of the ecosystem functions served by the abiotic and biotic components through proximate as well distal factors [7]. Here in the article we examined the important ecosystem services, particularly habitat services, provided by birds, and the need for research, appropriate documentation, and recognition of these services, whether monetised and appreciated by the market forces or not were examined.

Birds' Ecosystem Services

Birds serve all the four categories of services (Tables 1 and 2). Pest control, seed dispersal, pollination, and scavenging animal carcasses come under the regulating and supporting categories. Meat, eggs, nests, feathers and fertilizer drawn from birds come under provisioning services, whereas the cultural services cover recreational, artistic and religious roles, bird watching, and photography.

The birds, from the view ecosystem services, could function as linkers (linking ecosystem functions /processes/ components), movers (transport of energy or materials), and/or makers (habitat making or engineering). However, it would not very apt to attempt delineating birds' roles (as linkers, movers and makers) since these services are highly integrated, an activity serving concurrently perhaps all the other functions. Nevertheless, for the purpose of discussion we have followed this grouping.

Birds as linkers

In all ecosystems birds act as crucial links in their respective ecologic circle, within and between systems [8]. Birds are being highly mobile, and they could quickly respond to irruptive or pulsed availability of resources, enabling them to be competent than other vertebrates in exploiting them. Therefore, they link, spatially and temporally, ecosystem process and fluxes separated by great distances and time [9]. Birds play as strong linkers across those systems while serving as movers of energy and materials across various ecosystems (such as rivers, wetlands, forests, coasts, and marine); meanwhile they also help modify, to various scales, each of the system taking the role of makers. The sustainability and biodiversity of ecosystem and the spread of species to other ecosystems is crucially dependent on such functions. However, the birds' services have been looked at reasonably well in hardly few ecosystems. Much more has to be done by tracing the linkages of birds with various ecosystem components and functions, and the services that they render for sustaining them.

***Corresponding author:** Mahendiran M, Department of Ornithology, Salim Ali Centre for Ornithology and Natural History, Coimbatore-641108, Tamil Nadu, India, Tel: +919787320901; E-mail: mahenrose@gmail.com

Received February 28, 2018; **Accepted** March 14, 2018; **Published** March 21, 2018

Citation: Mahendiran M, Azeez PA (2018) Ecosystem Services of Birds: A Review of Market and Non-market Values. Entomol Ornithol Herpetol 7: 209. doi: 10.4172/2161-0983.1000209

		Categories of Marketable Services						
Market Value[1]	**Provisioning services**	Meat (Poultry, Wild Ducks etc.)	Feathers (Ducks, Pheasants)	Integument (Hornbills)	Skin (Medicinal values-Pheasants)	Blood (Medicinal values-Doves, Pigeon)	Nests (Edible Nest Swiflets)	Nutrient / fertilizers (Guano – Seabirds)
	Cultural services	Customs / Religious / Cultural / Ethnic value	Entertainment	Photography	Aesthetics / Recreation	Bird Watching		
	Regulating services		Scavenging (Vultures)	Insect pest control (Passerines)	Nutrient transfer (Colonial Waterbirds)			
Note1: The exchange value or price of a commodity in the open market [a]; a (Gilipin, 2000;Kumar and Kumar, 2008)								

Table 1: Ecosystem services by birds that come under different categories of marketable services.

			Categories of Non-Market Services						
Non-market values* / Supporting / Habitat Services	**Intrinsic Value[2]**	**Species dispersal** (Pheasants, Ducks, Passerines), **Pollination** (Humming birds, Sunbirds, Flowerpecke, White eyes, Honey eaters, Lories, Hawaiian Honeycreepers, Warblers), **Big seeded tree disperser** (Bellbirds, Hornbills)	**Role of disease control** (Vultures), Obligate **Scavengers** (old world & new world Vultures), **Facultative Scavengers** (Herons, Rails, Skuas, Willet, Turnstone, Gulls, Plovers, Raptors, Woodpeckers, Crows, Tits, Starlings)	**Energy Transfer** Top level predators / Fish eating birds, **Nutrient Transfer** (Colonial Waterbirds, Seabirds), Bioturabation (Swans, Flamingoes)	**Colonization & Regeneration of forest lands** (Hornbills, Jays, Bellbirds, Cormorants), **Frugivores effect on forest biome** (Toucans, Manakins, Birds of paradise, Waxwings, Bulbuls, Thrushes, Tanagers & Bellbirds)	**Rodent control** (Owls & Hawks), **Insect control** (Sparrows, Cuckoos, Indigo buntings, Babblers, Warblers, Flycatchers)	**Maintenance of vegetation profile in waterbodies** (Grebes, Diving, Dabbling ducks), **Shoreline biomass** (Charadriiformes: Waders)	**Human bird interactions** (Honeyguidesetc)
	Intrinsic Value, Non Use[3]	**Seed disperser spatially & temporally** (Waterbirds, Shorebirds, Waders); **Plant, Animal dispersal**-endozoochory, epizoochory (Anseriformes)	**Primary cavity excavators** (Woodpeckers, Trogons), **Cavity Drillers** (Sapsuckers), Seed Catching (Jays & Nutcrackers)	**Bioperturbation** (Burrowing seabirds) **Soil burrowers, soil regeneration &enrichment** (Penguins, Seabirds, Parrots, Owls, Kingfishers, Song birds, Bee-eaters)	**Leaf litter gleaners** (Antbirds), Beaters & Followers (Waders, Kites, Kingfishers; Woodpecker, Grackles, Drangos) **Mixed flock foragers** (Drangos, Flycatchers, Bluebirds, Treepies, Bulbuls, etc)	**Feeding opportunities** (Antbird follows army ants which was followed by Lepidopteranfemalebutterfly) **Ship following birds** (Albatross, Gulls &Skuas), **Tractor following bird in Agricultural field** (Cattle Egrets, Mynas, Crows)	**Exclusive bird pollinating large seed plant taxas** (Burseraceae, Sapotaceae, Lauraceae	
	Existence Value[4]	**Taxonomic diversity**	**Ecological diversity**	**Genetic diversity**	**Natural History knowledge related to cultural identity, traditions etc**	**Knowledge value**		
	Bequest/ vicarious values[5]	**Bird Sanctuary**	**National Park, Forests**	**Important Bird Areas**	**Heronries, Rookeries**	**Wetlands, Ramsar sites**	**Migratory Bird flyways**	

Table 2: Ecosystem services by birds that come under different categories of non-marketable services.

Notes

1) The exchange value or price of a commodity in the open market[a] ;

2) The value of entities that may have little or no market value, but have use value [a];

3) The value attached to the environment & life forms for their own sake [a] ;

4)The value attached to the knowledge that species, natural environments & other ecosystem services exist, even if the individual does not contemplate ever making active use of them [a]

5) A willingness to pay to preserve the environment for the benefit of other people, intra &inter-generationally.

Common English names of the birds are used.

*Values which are yet to ascertained / recognized by the market.

a (Gilipin, 2000;Kumar and Kumar, 2008) b (TEEB, 2010).

Birds as movers

Birds indirectly or directly serves in genetic transfer (moving animals, plants, pollination etc), and transfer of materials and energy.

Plant dispersal: Seed dispersal is crucial for biodiversity, species distributions, population dynamics and gene flow. Birds take the propagules/seeds much longer than wind or other means of dispersal [10]. Zoochory, ecto/epizoochory, diplochory or endozoochory, carries the seeds/disseminules/propagules either externally on the body or internally in the guts of birds, aiding the movement of species to faraway places, at times across the continents [11]. These modes of transport require adaptations and mutualistic co-evolution with the carrier species. Such a process of directed dissemination of plants to reach most favorable habitats for survival has been documented [12].

Being important dispersers of plants (vascular, terrestrial, aquatic or otherwise), birds become an integral part of complex mutualistic network among the carriers and the carried; enhance and maintain the biodiversity and community structure of in several natural ecosystem [13]. Birds are one of the primary drivers of plant succession and recruitment in natural biomes, a service very valuable, but never given due seriousness. Nearly 48 families of birds, 1/3 of total, are frugivores, and of this 25% are extinction-prone. It is notable that birds alone disperse as many as 80,000 species of angiosperms, of which about 25,000 are trees, woody shrubs, lianas, vines, and herbaceous plants [14,15].

In many oceanic islands and tropics, the loss of avian seed dispersers and its consequence of plant dispersal are severe. Example-Dodo tree *Sideroxylon grandiflorum*, an endemic, was felt to be dying

out in Mauritius or several woody species in New Zealand, where their low recruitment is ascribed to the recent extinction or decline of frugivorous species such as moas, piopio, huia, and kokako [16].

Animal dispersal: Understood the importance of migratory waterbirds in the dispersal of aquatic invertebrates across areas separated by hundreds of miles [17]. There are records of metazoans particularly molluscs, resting eggs (ephippia) of Cladocera and statoblasts of Bryozoa attached to feathers and feet or in digestive tracts of ducks, grebes and mallards and other migratory species [18]. Multiple vectors are also seen to carry a given type of propagules and series of studies have demonstrated a variety of organisms surviving the gastric mill and digestive juices in waterbirds [19,20,21,22].

Birds in pollution: Role of wild pollinators in food production is reported to be very crucial for food production [23,24]. It has been found that preclusion of pollinators such as bees, birds and bats have differential role in fruit setting in several plants, both domesticated and wild [25]. Among birds, over 920 species are known to involve in pollination: E.g. hummingbirds (Americas), sunbirds (Africa and Asia), false-sunbirds (Madagascar), flowerpeckers and white-eyes (Southern Asia), honeyeaters and lories (Australasia), and Hawaiian honeycreepers (Hawaii).

In India studies on bird-pollination, although relatively rare, shows birds such as Black Drongo, mynas, crows, babblers, Rose ringed Parakeet, Golden backed Woodpecker, bulbuls, flower peckers, tits and lorikeets visiting the flowers, most of which carrying out pollination [26,27]. More than 290 bird species are said to be serving in pollination and seed dispersals, of which sunbirds, mynas, starlings, and Oriental White-eye are the frequent flower visitors and probably the prime avian pollinators [28,29,14]. Bird pollination could be considered under supporting services. Although there were a few attempts to value the service in economic terms, especially focussing crops and insect pollinators, not much attempt is known to have made focussing on birds [30].

Birds in nutrient transfer: Nesting colonies of birds contribute immensely to the nutrient influxes, an important provisioning service. The birds in effect move nutrients from rich to poorer areas, especially from aquatic to terrestrial habitats bridging the land-water interface. The nutrient input, which varies according to the species and its nesting/assemblage density, are known to influence the floral microbial and faunal composition and physico-chemical state of the recipient systems [31]. Several tons of nutrients are said to be transferred across ecosystems annually through birds' guano. However, such nutrient transfers through birds, as a service, demands relatively more attention from the researchers [32].

Birds in energy transfers: Scavenging birds live on carrions, help disposing dead bodies, re-reroute energy flows to higher food webs, help in nutrient cycling, and help control undesirable facultative mammalian / avian scavengers, and limit the spread of diseases [33,34,35]. It is said that a pack of vulture, an obligate scavenger, would clean up a full-grown buffalo in an hour's time leaving the skeletons, cleaned up of all meat/soft remnants, for drying and collection for trade/industry. No other facultative scavenger is known capable of such a clean and quick work. A break in the normal carrion food web have wide ranging implications, such as explosion in the population of other lesser efficient facultative scavengers, inadequate natural control of pathogens and disease transmissions, and ensuing human morbidity and mortality. The absence of obligate scavengers such as vultures increase the time taken for carcase decomposition considerably, leading to longer period available for pathogen proliferation and disease transmission. A recent study talks about the economic costs of the declining vultures (scavenging birds) in India in terms of human health impacts [36]. The absence of the chief obligate scavengers leads to rise in the abundance of other facultative scavenger species such as stray dogs and ensuing health impacts such as increasing likelihood for rabies infection.

Increasing evidences suggests that birds considerably control the populations, behaviour and evolution of invertebrate prey. Avian predation is an important factor that determines abundance of insects in wild or agro ecosystems [34], and in preventing explosion of certain insects. The birds extend a great deal of assistance, given them a chance, by feeding upon the prolific insect pests removing them in tonnes [37], for humans such removal of insects would cost millions.

Birds as makers

Ecosystem engineers are organisms that directly or in-directly modulate the availability of resources to other species, by causing physical state changes in biotic or abiotic materials: in doing so they modify, maintain and/or create habitats [38]. Changing the environment in which a species lives and change itself to fit the changing environment is an evolutionary function of all species and is more or less dialectical in relation. In fact, the organisms while modulating the availability of resources cause changes in the state of biotic or abiotic materials (ecosystem engineering), in the process frequently changing the selection pressures to which the species (the ecosystem engineer) and other organisms are exposed.

Almost all the functions birds serve such as seed dispersal, nutrient transport and predation are in effect engineering activities that modify ecosystems.

Birds in soil and water engineering: Swans and flamingos when foraging cause major bioturbation that radically change the distribution of sediments and nutrients. Bioturbation, the process of mixing-up the sediments in aquatic system benefits annelids, dipteran larvae and other organisms in the benthic environments. It affects the biological and physical nature of the substratum and the biogeochemical processes in the sediments [39].

Concluding Remarks

Few studies have quantified the importance of birds in developing and maintaining a community or an ecosystem, although their role is widely recognised. In effect, the birds facilitates i) wider distribution of certain plants and faunal elements to distant parts of the earth replenishing the biodiversity and richness of the recipient ecosystems, ii) adaptation of the species transported to distant locations according to the location specificities, an important diversification and evolutionary process, iii) effective recruitment of specific species in an ecosystem, iv) moves the offspring away from the parent, thus helping to reduce competition by being away from the parent, locally flourishing infectious fungi, pathogens and herbivores, v) helps a species to track conducive climatic conditions in the context of ensuing climate change, and vi) drive specific evolutionary changes.

Most of the activities carried out by birds are of economic and ecologic value (Tables 1 and 2). Valuing such supporting ecosystem services remains difficult and unaccounted for the lack of sufficient information. They also remain external to the market, perhaps, because these services are largely intangible and complex for valuation. Science driven policies that push for long-term conservation of bird

species, habitat conservation and restoration, forestry and landscape management, and control of trade in wild birds are crucial in this context. The efforts to conserve bird diversity and population would preserve diverse ecosystem services, would benefit several species and ultimately human well-being, the ultimate decision maker and the enforcer of the changes.

It is high time that the tangible and intangible servicesnby birds in the wild are quantified using robust scientific methodology and taken into account while reconciling developmental programs and conservation requirements. Appropriate accounting of these services, at least using surrogate or proxy values until more robust quantification (ecologic and economic) methods are very much required that would help by taking the message of conservation to policy makers and public at large, in easily comprehendible terms, so that the wrong and prevalent notion of conservation vs. development does not persist.

Acknowledgements

The paper is the spinoff from an interesting discussion we had during the International Conference on Ecosystem services of birds, on November 2013. MM acknowledge the financial support of DST- SERB grant (SR/FT/LS-12/2011). We thank Dr. Vijayakumar for critical comments.

References

1. Daily GC (1997) Nature's Services: Societal Dependence on Natural Ecosystems. Island Press: Washington DC.
2. Ehrlich PR, Ehrlich A (1981) Extinction: The Causes and Consequences of the Disappearance of Species. Random House New York.
3. Millennium Ecosystem Assessment (ME) (2005) Ecosystems and Human Well-Being: Synthesis, Island Press Washington p: 155.
4. TEEB (2010) The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations, Pushpam Kumar (Ed), Earthscan, London and Washington.
5. Kumar M, Kumar P (2008) Valuation of the ecosystem services: a psycho-cultural perspective. Ecological Economics 64: 808-819.
6. Gómez-Baggethun E (2010) To ecologize economics or to economize ecology-theoretical controversies and operational challenges in ecosystem services valuation. PhD Thesis, the Autonomous University of Madrid.
7. Alcamo J, Bennett EM, (Eds.), (2003) Ecosystems and Human well-being: A Framework for Assessment. Island Press.
8. Mehmet Ali Tabur (2010). Ecological Importance of Birds.
9. Whelan CJ, Wenny DG, Marquis RJ (2008). Ecosystem services provided by birds. Annals of the New York Academy of Sci 1134: 25-60.
10. Clark CJ, Poulsen JR, Bolker BM, Connor EF, Parker VT (2005). Comparative seed shadows of bird-, monkey-, and wind-dispersed trees. Ecology 86: 2684-2694.
11. Green AJ, Elmberg J (2014) Ecosystem services provided by waterbirds. Biological Reviews 89: 105-122.
12. Howe HF, Smallwood J (1982) Ecology of seed dispersal. Annual Review of Ecology and Systematics 13: 201-228.
13. Charalambidou I, Santamaría L (2005) Field evidence for the potential of waterbirds as dispersers of aquatic organisms. Wetlands 25: 252-258.
14. Mahendiran M, Azeez PA (2015) Birds, habitat services, unsung functional values National symposium on "Dryland Birds: Strategy for Conservation and Management' GUIDE, Bhuj, India Pp: 123-127.
15. Green AJ, Figuerola J (2005) Recent advances in the study of long-distance dispersal of aquatic invertebrates via birds. Diversity and Distributions 11: 149-156.
16. Temple SA (1977) Plant-animal mutualism: coevolution with dodo leads to near extinction of plant. Science 197: 885-886.
17. Darwin C (1859) On the origins of species by means of natural selection. Murray: London.
18. Brown CJ (1933) A limnological study of certain fresh-water Polyzoa with special reference to their statoblasts. Transactions of the American Microscopical Society 271-316.
19. Charalambidou I, Santamaría L (2002) Waterbirds as endozoochorous dispersers of aquatic organisms: a review of experimental evidence. Acta Oecologica 23: 165-176.
20. Figuerola J, Green AJ (2002) Dispersal of aquatic organisms by waterbirds: a review of past research and priorities for future studies. Freshwater Biology 47: 483-494.
21. Figuerola J, Green AJ, Santamaría L (2003). Passive internal transport of aquatic organisms by waterfowl in Doñana, south-west Spain. Global Ecology and Biogeography 12: 427-436.
22. Figuerola J, Green AJ, Black K, Okamura B (2004) Influence of gut morphology on passive transport of freshwater bryozoans by waterfowl in Donana (southwestern Spain). Canadian J Zoology 82: 835-840.
23. Mrill I, Nabhan GB, Buchmann S (1996) Impending pollination crisis threatens biodiversity and agriculture, The Forgotten Pollinators Campaign, Arizona-Sonora Desert Museum: 2021
24. Borges RM (2003) Conservation of pollinator services in rain forests. In: Conservation of Rainforests in India (Gupta AK, Kumar A, RamakanthaV, editors). ENVIS Publication, Wildlife Institute of India, Chapter 16; Pp: 229-242.
25. Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, et al. (2007) Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B: Biological Sciences 274: 303-313.
26. Rangaiah K, Raju AS, Rao SP (2004) Passerine bird-pollination in the Indian coral tree, *Erythrinavariegata* var. *orientalis* (Fabaceae). Current Science 87: 736-739.
27. Solomon RAJ, Rao SP (2006) Pollination by bees and passerine birds and seed dispersal by monkeys in the white teak *Gmelina arborea* Roxb., a commercially important timber tree species in the Eastern Ghats. Current Science 90: 232-236.
28. Subramanya S, Radhamani TR (1993) Pollination by birds and bats. Current Science 65: 201-209.
29. Balasubramanian P (2012) BOU Proceedings-Ecosystem services: do we need birds?
30. Kellermann JL (2008) Ecological and economic services provided by birds on Jamaican Blue Mountain Coffee Farms, Master of Science In Natural Resources thesis, The Faculty of Humboldt State University.
31. Craig EC, Elbin SB, Danoff-Burg JA, Palmer MI (2012) Impacts of Double-Crested Cormorants (*Phalacrocorax auritus*) and Other Colonial Waterbirds on Plant and Arthropod Communities on Islands in an Urban Estuary. Waterbirds 35: 4-12.
32. Ishizuka K (1966) Ecology of the ornithocoprophilous plant communities on breeding places of the black-tailed gull, *Larus crassirostris*, along the coast of Japan. Ecological Review 16: 229-244.
33. Prakash V, Pain DJ, Cunningham AA, Donald PF, Prakash N, et al. (2003) Catastrophic collapse of Indian white-backed (*Gyps bengalensis)* and long-billed (*Gyps indicus)* vulture populations. Biological Conservation 109: 381-390.
34. Sekercioglu CH (2012) Bird functional diversity and ecosystem services in tropical forests, agroforests and agricultural areas. J Ornithology 153: 153-161.
35. Dupont H, Mihoub JB, Bobbe S, Sarrazin F (2012) Modelling carcass disposal practices: implications for the management of an ecological service provided by vultures. J Applied Ecology 49: 404-411.
36. Markandya A, Taylor T, Longo A, Murty MN, Murty S, et al. (2008) Counting the cost of vulture decline - An appraisal of the human health and other benefits of vultures in India. Ecological Economics 67: 194-204.
37. Bird Life International (2008) Birds control insect pests in farmlands and forests.
38. Jones CG, Lawton JH, Shachak M (1994) Organisms as ecosystem engineers. Oikos 69: 373-386.
39. Odling-Smee FJ (1988) Niche-constructing phenotypes. In Plotkin HC (Ed), The Role of Behavior in Evolution, Cambridge (MA), MIT Press Pp: 73-132.