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Celebration of Wild life Week- 2019
(Life Below Water: For People and Planet)

Microsite Specific Biodiversity Along River Kosi, Kumaun Himalaya

The animals and plants that live in the wild have an intrinsic value and contribute to the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic aspects of human well-being and sustainable development. Wildlife week is celebrated all over the country from 2nd to 7th October every year with the view to protect the fauna and make common people aware of its importance. Wild life week was conceptualized in 1952 with the vision of saving animals by taking some critical steps. In addition, the Indian Government established an Indian Board of Wild life which works to raise awareness towards the protection of wildlife and it involves the planning to save extinction of animals in India. The theme for World Wild life Day 2019 is *"Life below water: For people and planet"*, which aligns with the SDG 14- Life below water. Unlike previous years, where wildlife weeks were primarily celebrated on themes pertaining to terrestrial ecosystems and its biodiversity elements, this years theme attempted to focus on relatively a new domain of aquatic sphere. To celebrate this occasion, Centre for Biodiversity Conservation & Management (CBCM), GBPNIHESD decided to organize a transect walk (Padyatra) of nearly 5 km along the river Kosi (Distt. Almora). The walking stretch along the river was deliberately selected to encompass a range of microhabitats along the riverine ecosystem and its biodiversity elements. Over 30 participants (including CBCM scientists/ researchers/subject experts) took part in this Padyatra on 3 October 2019. The event was started with a brief about the World Wild life week objectives and significance of its theme for 2019 by Dr. G.C.S. Negi Head, CBCM.

Fig.1. Delibirtion at barrage site about the riverine ecosystem

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The "ENVIS Centre on Himalayan Ecology" collects, collates, compiles and builds quantitative and qualitative databases of information in the fields related to the Himalayan Ecology. The information is disseminated regulary via online as well as hardcopies to several valuable stakeholders and various users such as DICs, universities, institutions along with other ENVIS Centres across India to support overall Environmental Information System in India.

Editorial Note

Wild life (both flora and fauna) make an essential component of our earth. Every one of us appreciates wild life in one way or the other. However, most of us are more familiar with the terrestrial forms of life; but the "Life Below Water" is often undermined barring a few important species such as fish, crocodiles, octopus etc. In fact, life in water performs many useful functions for the mankind. Sea food has grown a huge Industry by in the recent decades worldwide. Often due to pollution of our water sources and over exploitation of the aquatic animals diversity below water is also being depleted. Also, in many localities biodiversity contained in our ponds, rivers and other water bodies is yet to be identified (floral/ fauna). The theme of Wildlife Week has been aptly chosen this year to make us aware about the importance of life below water and need for its conservation. To celebrate this event our Institute faculty researchers tracked along a section of Kosi river, which is a life river of this region. This Newsletter contains the diversity of life found by the researchers during this day-long trekking, and have highlighted the need for conservation of life below water through various articles.

GCS Negi
Excutive editor

General Description of the Kosi River

The Kosi river originates from the reserve forest Dharpanidhar hill which lies in the North West of the Kausani town (Kumaun Himalaya). It is a non-glacial perennial river and fed by nearly 11 tributaries along its course. According to Hindu scriptures it is also known as Kauski and Kosila. It is the lifeline of the heavily populated Almora town and for thousands of people living along its bank. Besides being critical for the survival of people around, the river embodies significant agriculture, religious, cultural, mythological and historical importance. The river not only benefits people but also supports unique biodiversity elements in its riverine ecosystem. Amid the changing scenario of increasing demand, land use intensification, climate, effluents and others, the river is under tremendous pressure and it is compared now often with connotations like, Blind or Dying river. The perennial stream is gradually transforming into seasonal stream with reduced summer flow and dumping of waste in the river by the locals and tourists. We selected following three characteristically different sites for detailed study on fauna and flora present along the 5 km stretch of Kosi river (Table 1).

Table 1. Characteristics of micro-sites selected along Kosi river

Site-1 (Barrage site)	Site-2 (Near RTC) Kosi Town	Site-3 (Near Devashthal Temple)
Stagnant water in the Kosi dam. River edge (Marshy ecotone area along the river) was studied. Itsless bouldary habitat, one side of river dominated by *Pinus roxburghii* forest, *Polygonum* sp. dominant in area at marshy land, sunny/ exposed habitat.	Mixing of two water channels Kosi river and Khankal gadhera (that drains a watershed dominated by agriculture) makes river confluence turbid. Shady moist and unexposed conditions. Less bouldary and sandy habitat. Shady areas were dominated by Ferns, grasses and Bryophytes.	River edge (Marshy ecotone area along the river at one side). Rocky at another side of river. Sunny and exposed habitat, marshy area dominated by *Polygonum* sp. and grasses. Water flow was not so turbulent due to flat terrain.

Site 1- Barrage site

Considering the impact of embankment on river ecology and flow, the site was selected to provide characteristic details of lentic ecosystem, where water is relatively calm, deep, and the bottom surface is not exposed to light. The deliberations on lentic water system included, different light zones (photic and aphotic), thermal stratification across different depth zone (epilimnion, thermocline and hypolimnion) and impact of abiotic factors like turbidity, dissolved oxygen on productivity of a lentic ecosystem. Furthering the deliberations, the experts explained about some basic abiotic factors such as pH, DO (Dissolved Oxygen), turbidity, hardness, alkalinity, and temperature of water which determine the quality of water, which in turn, influences the productivity of the system. Explaining about the prime food stuffs of the fishes, it was explained that zooplankton and phytoplankton constitute the staple food of the fishes. While phytoplankton are the main producers and usually occupies the water surface where there is sufficient light, zooplanktons are small aquatic animals and

Fig. 2. Identification of flora and fauna of river ecosystem

consumers prefer darker places that feed on other plankton.

Site 2- Near Rural Technology Centre (Kosi Town)

The participants observed that contrary to the lentic conditions at barrage site (site-1), the conditions are entirely different as the river flows naturally but not calm, the depth is shallow and river bottom is prominently visible. Secondly, the site is confluence area, where a small stream merges with river Kosi and drains an intensively cultivated and densely populated watershed. Comparing the conditions with the barrage site, the expert explained about lotic ecosystems and delineated a clear distinction between lentic vs. lotic ecosystems. It was noted by the participants that the change in conditions within visibly alike ecosystems attributed to different biodiversity assemblages, therefore required keen and careful observations. It was also explained that because of the fast flow of Kosi river, fish usually spawns in adjoining streams with relatively low flow and conducive abiotic conditions by adhering their eggs on small pebbles and gravel. The potamodromous migration thus, ensure high survival rates of eggs, fries and fingerlings of fish, which usually are incapable to withstand the fast current of the main river. The interactions between abiotic (light) and biotic components is crucial to lotic systems, because it provides the energy necessary to drive primary production via photosynthesis. Generally lotic systems are shallow, therefore can easily be heated or cooled through radiation at the surface. Such shallow streams are typically well mixed (aerated) and maintain a relatively uniform temperature within the river.

Site 3 - Devsthal Temple

This site was characterized by relatively slow flow of river Kosi and was moreover similar to the lotic water system, but had boulders and reed along its bank. Emphasizing the importance of this zone i.e. the riparian zone, the experts deliberated on its critical role in river ecology. Such sites, being an interface between terrestrial biome and river system represent a zone crucial for maintaining a healthy river system by facilitating energy flow as well as checking the flow of sedimentation, contaminants and waste, thus acting as natural biofilters. Such zones also support different reed and emergent plants, thus creating a niche for egg laying insects (Odonates- Dragonflies, Damselflies; Lepidoptera- Butterflies), crabs, fish, amphibian, reptiles and birds. Elaborating further, the experts told that the functions of riparian zone in terms providing a shield to terrestrial perturbations by creating a buffer and creating a interesting place of aquatic and terrestrial life that makes it a curious area of scientific investigation. During the above deliberations and site visits the flora and fauna encountered by the participants was listed out and identified with the help of resource

Table 2. Ichthyofaunal (Fish) diversity of river Kosi, Almora

S. No.	Name of the species	Local name	Habit and Habitat
1.	*Tor putitora*	Mahasheer	An omnivorous species found near the surface in water that ranges from 13 to 30 °C (55–86 °F) in rapid streams, riverine pools, and lakes
2.	*Tor tor*	Mahasheer	Fast-flowing rivers and streams with rocky bottoms
3.	*Puntius chelynoides*	Karnchula	Potamodromous. Migrating within streams, migratory in rivers
4.	*P. ticto*	Dumrua	Shallow, marginal waters of lakes and rivers, usually with muddy bottoms: spawn among a course gravel bed.
5.	*Crossocheilus latius latius*	Saknera	Freshwater; brackish; benthopelagic; potamodromous; Found over gravel and stony bottom of mountain streams
6.	*Schizothorax richardsonii*	Asela	Freshwater; demersal; potamodromous; preferring to live among rocks; herbivores feeding mainly on algae, aquatic plants and detritus; Mature individuals breed during April and May
7.	*S. plagiostomus*	Trout	Freshwater; benthopelagic; potamodromous; Feed on detritus material; Breed in streams
8.	*Barilius bendelisis*	Dhaur	Freshwater; benthopelagic; potamodromous; streams and rivers along the base of hills with pebbly and rocky bottom
9.	*B.varga*	Dhaur	Freshwater; benthopelagic; streams with gravelly and rocky bottom
10.	*B. barna*	Dhaur	Freshwater; benthopelagic; clear hill streams with gravelly bottom
11.	*Garra gotyla*	Bhagnera	Freshwater; benthopelagic; streams and lakes ; feed on algae, plants and detritus
12.	*G. lamta*	Bhagnera	Freshwater; benthopelagic; streams and lakes
13.	*Labeo dyocheilus*	Unera	Freshwater; benthopelagic; potamodromous; adults live in clear active currents
14.	*L. dero*	Unera	Freshwater; benthopelagic; potamodromous; Adults inhabit torrential hill-streams in shallow waters; migrate to warmer regions of lakes and streams during winter; herbivorous
15.	*Noemacheilus beavani*	Gadhera	Adults are found in fast flowing, clear streams with a pebbly substrate
16.	*N. rupicola*	Gadhera	Found in shallow, gently flowing clear streams/creeks and riffles, over gravel or pebbles
17.	*N. botia*	Gadhera	Freshwater; demersal; adults inhabit clear water, swift flowing streams with rocky, pebbly and sandy bottoms
18.	*N. multifasciatus*	Gadhera	Freshwater; benthopelagic; found in rapid streams and rivers with gravelly bottom

Source: *Pant MC 1964, Selakoti B. 2018, www.fishbase.se and others*

Outcomes of the Padyatra

During this day-long event a total of 71 species of fauna were recorded from the targeted sites along theKosi river. As per the experts, along the river Kosi one can find 22 species of fishes, followed by birds (18 species), butterflies (17 species), insect and moths (8 species) and dragonflies (6 species). The floral diversity along these three sites of Kosi river consisted of 17 herbs and 7 grass species at Site-1, 17 herbs, 6 grasses, 3 ferns, 1 species of Equisetum, 2 liverworts and 5 species of mosses at site-2, and 15 herbs and 7 grasses at site-3. On the basis of recorded floral diversity site-2 represents the maximum richness of life forms and plant groups as compared to the other two sites high lighting the microsite characteristict of confluence zone.

Table 4. Checklist of Butterflies, Dragonfly, Insects and Moths encountered along the Kosi river at all three study sites

Local Name	Scientific Name
Common grass yellow	*Eurema hecabe*
Small grass yellow	*Eurema brigitta*
Tree yellow	*Gandaca harina*
Indian cabbage white	*Pieris canidia*
Common rose	*Pachliopta aristolochiae*
Common four ring	*Ypthima huebneri*
Plain tiger	*Danaus chrysippus*

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Table 3. Checklist of bird diversity encountered along the Kosi river at all three study sites

S. No.	Local Name	Scientific Name
1.	White wagtail	*Motacilla alba*
2.	White browed wagtail	*Motacilla maderaspatensis*
3.	Grey wagtail	*Motacilla cinerea*
4.	House sparrow	*Passer domesticus*
5.	Vertider flycatcher	*Eumyias* sp.
6.	Common stone chet	*Saxicola torguatus*
7.	White capped red star	*Chaimarrornis leucocephalus*
8.	Plumbeous water red star	*Rhyacornis fuliginosa*
9.	Blue whistling thrush	*Myophonus caeruleus*
10.	Brown dipper	*Cinclus pallasii*
11.	Red vented bulbul	*Pycnonotu scafer*
12.	Great tit	*Parus major*
13.	Red billed blue magpie	*Urocissa erythroryncha*
14.	White bellied drongo	*Dicrurus caerulescens*
15.	Crested kingfisher	*Megaceryle lugubris*
16.	Common kingfisher	*Alcedoatthis*
17.	Common pigeon	*Columba livia*
18.	Black kite	*Milvus migrans*

Table 5. Quantitative details of flora found along the Kosi river in three study sites

Life From	Site-1 (Near barrage)	Site-2 (Near RTC)	Site-3 (Near Temple)
Herbs	17	17	15
Grass	7	6	7
Ferns	-	3	-
Pteridophytes	-	1	-
Bryophytes (Liverworts)	-	2	-
Bryophytes (Mosses)	-	5	-
Total	24	34	22

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The Golden Mahseer: A Native Endangered Fish of Himachal Pradesh

The state of Himachal Pradesh is known for its geographical beauty as well as its biological diversity. It covers an area of 55,673km^2, with elevation ranging from 450 to 7025 meters amsl (i.e. Shilla peak). Due to the presence of this altitudinal range, there is presence of different climatic and mountainous regions in the area. In this region availability of water bodies like rivers, wetlands, ponds, groundwater sources and lakes provide a huge choice for the development of the number of aquatic floral and faunal species in the regional aquatic ecosystem. There are nearly 800 glaciers in the regions with an aerial extent of 3124.71km^2 which currently fed the 7 major streams of the Himachal Pradesh. Also, there are 3 Ramsar wetland sites in Himachal Pradesh which are Chandratal Wetland (0.49km^2), Pong Dam lake (156.62km^2) and Renuka Wetland (0.2km^2) (MoEF, 2019). Due to these water bodies, there are numerous varieties of aquatic organisms available in the region.

The Golden Mahseer

Golden Mahseer (*Tor putitora*) is also known Himalayan Mahseer, is listed as endangered in the IUCN Red List. It belongs to large-bodied species of Cyprinidae family (Fig. 1). This species can attain weight up to 50kg and length up to 2.74m, hence considered as premier sport fish. It also has a religious and cultural value in the Southeast Asian region. The fish Mahseer got its name from mahi-fish and sher-tiger and therefore it is known as tiger among fish. Its color is generally golden-yellow and is mainly carnivorous in natural conditions. They can be found in the temperature range of 5°C to 25°C. Various anthropogenic activities such as hydropower dam construction, drainage basin alteration and over-exploitation has led to a decrease in the population of the Golden Mahseer. It is distributed throughout India, Sri Lanka, Nepal, Bhutan, Myanmar and Bangladesh. Since the population of these species has not been assessed, so there is a dire need to assess the population and create baseline data to check the impact of climate change on the species.

Status in Himachal Pradesh

The state of Himachal Pradesh is home to 85 species of fish, including Rohu, Catla, Mringal, Trout and many others. The population of Golden Mahseer was affected by the construction of a series of dams and over-exploitation. The construction of the numerous dams in the state is acting as a physical barrier to these migratory species. The diminishing population of Mahseer in the river of Satluj, Giri, Beas, Chenab and their tributaries directly speaks the effects of the dam constructed like Pandoh, Bhakra, and Giri Barrages. The changes in the slope of the river-bed profile, submersion of gravel zones, destruction of vegetation and other changes in the climatic conditions have also led to the decrease in the population of this species. On July 21st, 2016 for the first-time breeding of the Golden Mahseer was done by the state department of fisheries in Himachal Pradesh successfully. In 4-5 days after breeding nearly 7000 hatchlings were recovered from the hatchery at Machial in Mandi district of Himachal Pradesh. Golden Mahseer is considered as an angler's delight like the Trout fish in the state of Himachal Pradesh. Himachal Pradesh is collecting the fries of the Golden Mahseer from nature since 2012. This species can sustain the temperature as low as 5°C. In Himachal Pradesh nearly 6,000 families directly depend upon the fishing, so this Golden Mahseer can help in providing a new dimension to the pisciculture in the state. The Pong Dam reservoir supports a large population of Golden Mahseer, but with climate change and upstream disturbances, it is on decline. This depleting fish stocks can be increased using hatchery juveniles into the water bodies. One such hatchery site is recommended for the same at Naggar village in the Sunni area of Shimla district and one at Deoli in (Bilaspur). In the year 2016, total fish production increased by 9.2 % in the state which generated the revenue of Rs. 109.80 Crore for a total of 11,798 tonnes of fish.

Way Forward

In India, the sector of fisheries is most neglected of all-natural resources. The fisheries sector has grown from 4.9% in 2012-13 to 11.9% in 2017-18. Fish and its allied activities earned revenue of Rs 47,620 Crore in 2018-19 providing income and employment to more than 14.5 million people. The techniques to develop the hatcheries should be the priority of the government to boost the fisheries sector. Since the Himachal Pradesh and other Himalayan states have the voluminous amount of water reservoirs fisheries can play a big role in the income generation of the people. Also, varieties of fishes enlisted in the IUCN red list must be considered for protection using the breeding techniques concerning their climatic conditions. With the efforts of Himachal government for the breeding of Mahseer, Government of India has approved a state proposal of setting up a 'National Mahseer Fish Farm' with the assistance of Rs 2.00 crore. Such initiatives can help in giving a boost to fisheries sector of the agricultural economy in the country.

Source: *Keeveneo.com*

Fig.1. Golden Mahseer Endangered Fish of Himachal Pradesh

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Fresh Water Fish: Facts and Information

River: An Important Freshwater Ecosystem

The fresh water ecology refers to the relationships that living organisms have with each other in their instinctive environment, thus forming a well balanced ecosystem. Though occupy a relatively small portion of earth's surface as compared to other marine and the terrestrial habitats, but are of much importance to a variety of life forms on the earth. Fresh water ecology; based on habitat condition is categorized into two types: (i) Standing water or lentic: example ponds, swamps and bogs etc., and (ii) Flowing water or lotic: classical examples being river, streams, springs etc. Based on the distance from the shore the fresh water bodies are divided into three categories (i) littoral zone- one closest to the shore, that host wide variety of rooted plants species due to its warm and shallow environment, (ii) limnetic zone- is the open water farther from shore and dominated by planktons, and (iii) profundal zone- deeper region of a lake or pond, that consists

Fig.1. Example of lotic (river) ecosystem

of only heterotrophs. The species composition in the above mentioned zones differs from each other; they are autotrophs (producer), phagotrophs (macroconsumers), and saprotrophs (decomposers). On the basis of their fundamental niche, they are classified as benthos (bottom dwellers), periphyton (attached to other life forms), planktons (free floating), and nekton (swimming). Rivers a lotic fresh water body have their importance from hydrological, geomorphological, ecological as well as environmental points of view. As, compared with the lentic ecosystem, river ecosystem are explored to a lesser extent. Ecological factors like temperature, light, pH, dissolved gases and salts of water, turbidity, alkalinity, salinity, depth and areal distribution play major controlling and limiting factors in a feshwater ecosystem. The most obvious characteristic of river ecosystems is flowing water that is mostly unidirectional. River ecosystem which is an 'open ecosystem' is interdigitated with terrestrial and lentic system. It is home to wide variety of species including the phytoplankton, zooplankton, aquatic plants, insects, fish, birds, mammals, and others. The chief primary producers are green algae, encrusting diatoms and aquatic mosses that are permanently attached to a firm substance. Within the consumers certain peculiar features such as presence of hooks and suckers, sticky undersurfaces, streamline bodies, flattened bodies, positive rheotaxis (rheo= current; taxis = arrangement) and positive thigmotaxis (thigmo= touch, contact) is seen, so as to catch its pray at ease. The top tropic level within this ecosystem is occupied by a variety of miniature to large animals i.e. water sponges, larvae of snails and flatworms, fishes, and stonefly that feed on subsequent tropic levels. In addition to these, river along its bank harbours many species of trees and shrubs that serve as food source, shelter and nesting site mainly for mammals and birds especially migratory birds. Thus, provides a range of ecosystem services, independent of the community structure.

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Twelve Hill Stream Fishes from Kosi Watershed, Almora

Fishes are the important part of our planet and several countries depend on the production of fish for their economy. Growth and survival of fish fauna depends on the food availability in the water. Zooplankton and phytoplankton are the prime food stuffs for the fishes and physico-chemical conditions of the water also play role in survival of fish faunal diversity. There are several physio-chemical parameters of water such as pH, hardness, conductivity, alkalinity, temperature, etc., those influence the productivity of fish fauna, richness and diversity of aquatic ecosystem. The river of Kosi is like the life line of Almora district, Uttarakhand. The 11 streams draining in Kosi river represents a rich diversity of fishes namely *Tor putitora; Tor tor; Schizothorax richardsonii; Schizothorax plagiostomus; Barilius bendelisis; Barilius varga; Garra gotyla; Labio dyocheilus; Labio dero; Noemacheilus beavani; Noemacheilus rupicola; Noemacheilus montanus.*

Fig.1. Diverse life forms in Kosi watershed Almora

Now days, environmental factors like overfishing, deterioration of water quality, plastic disposal, construction on riverside, use of chemical fertilizers, pesticides, bleaching powder, industrial waste, sewage and wastewater, mining activities, growth of ichthyotoxic plants etc., have caused the alteration of ecology of the rivers of mountains region and degradation of aquatic ecosystem.

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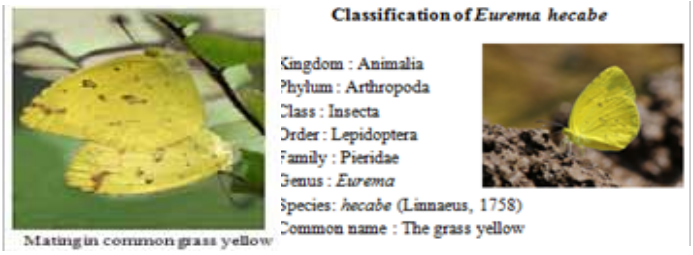
Grass yellow (*Eurema hecabe*)- A Common River Side Butterfly of Kosi, Almora

The flora and fauna that form today's biodiversity are a snapshot of the earth's 3.8 billion year history of life, representing just 0.1% of all the species that have lived on earth. Thus 99.9% or virtually all of life that has existed on earth has gone extinct (Gouyon, 1993). Butterflies are generally regarded as one of the best taxonomically studied groups of insects (Robbins et al., 1997), yet even in genera containing very common and widespread species, our understanding of true species diversity may prove to be startlingly below common expectation (Ackery 1987; Tiple et al., 2009). Butterflies have been studied systematically since the early 18th century and about 19,238 species are documented worldwide (Heppner 1998, Kunte 2000) and the Indian subcontinent hosts about 1,504 species of butterflies of which peninsular India and the Western Ghats host 351 and 334 species respectively (Tiple 2011). In Madhya Pradesh and Vidarbha of central India 177 species of butterfly species have been documented (D'Abreu 1931). Our institute GBPNIHESD, Kosi-Katarmal Almora celebrated World Wild Life Week. The theme of World Wild Life Week is "Life below water: for People and Planet". A team of scientist and researchers about more than forty from the institute and three experts from outsides the institute were visited from Kosi barrage to Ram- Mandir Almora for knowledge sharing and documentation of riverine fauna. We have visited total four sides (Kosi-barrage, River near by Rural Technology Centre of GBPNIHESD, Vanshthali and Ram-Mandir, Almora) seen many species of butterflies, fishes, birds and fauna across the river also recorded by our team during that visit. In this article we have studied about common grass yellow which were commonly seen across the river near by the Vanshthali Tample.



Habitats

The common grass yellow was found all over India and was abundant in many places. It occurs in large open patches in the evergreen, semi-evergreen and deciduous forests and in scrub and grasslands near human habitations in urban and rural areas. It was among most common butterflies. It was widespread species and occurs mostly in the tropical and subtropical areas of Asia, Africa and all over India.

Larval host plants

The common grass yellow was among the stages. Its hosts are leguminous plants mostly belonging to the families – Mimosaceae (acacias, touch-me-not and their relatives), Caesalpiniaceae (Cassia mimosoides) and Fabaceae. New host plants are constantly being added to the list of known host plants and it seems as the list will continue to grow.

Description

The common grass yellow exhibits seasonal polyphenism. The lepidopteran has a darker summer morph, triggered by a long day exceeding 13 hours in duration, while the shorter diurnal period of 12 hours or less induces a fairer morph in the post-monsoon period

Male

Common grass yellow has yellow color in upper side and slightly paler yellow shade in underside with reddish-brown marking. Forewing are apex and deep black, this color continued narrowly along the costal margin to base of wing with a square spot which occupies the whole of the tornal angle; the inner margin of this dilatation is variable in upper side and two small spots or specks in basal half of cell and a reniform (kidney-shaped) spot or ring on the discocellulars in underside.

Female

The female is very similar to the male grass yellow but the upper sides of both wings are larger and a paler yellow, with broader black but diffused.

Fig.1. Life cycle of *Eurema hecabe*

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Life Below Water for People and Planet

The Himalayan region owing to its unique biogeography has peculiar identity in the world. It supports a large number of ecosystems terrestrial or land ecosystem and aquatic or water ecosystem (forest ecosystem, grassland ecosystem, desert ecosystem, pond ecosystem, and lake ecosystem, etc.) including rich flora and fauna across its diverse habitats. Himalaya is the world's sixth largest bioregion and is recognized as one of the global biodiversity hotspot. It harbours a large number of identified species of marine life.The Wildlife Week is celebrated all over the country every year between 2nd October and 8th October. This year celebration of Wildlife week focused on "*Life below water for people and planet*". The theme aims to enhance knowledge and spread awareness to preserve animal life in India.Water is very important in our life. Nothing is possible without water so without water, man's life cannot be imagined. Water is found on earth, that's why it is called a unique planet. Water is a priceless gift of nature to the whole living ones. The chemical name of water is H_2O. Water is essential for humans, animals, plants and all living forms. Plants take water from their roots and all the branches carry water to the leaves. Life inside the water is known as aquatic or marine life. Marine life includes those plants, animals and other living organisms that live in water of the ocean or the sea. Each animal inside water has different respiratory system; few animals respire through their gills while few respire directly through their skins. Marine plants mostly algae produce much of the oxygen which mainly is the basic need of living organisms. The ocean covers one third part of the earth's surface. For centuries people have regarded the oceans, rivers, lakes and coasts as a source of an infinite supply of food, an appropriate transport route, and a suitable ground for dumping. More than 3 billion people depend on marine and coastal biodiversity for their livelihoods. People depend on fish as a source of protein. Most life forms evolved initially in marine habitats. The most primitive vertebrate appeared in the form of fish, which live exclusively in water. Some of these evolved into amphibians which spend some portions of their lives in water and some portions on land. Other fish evolved into land mammals and subsequently returned to the ocean as seals, dolphins or whales. Many plant forms such as kelps and algae grow in the water and are the basis for some underwater ecosystems. Algae can be found residing in oceans, lakes, rivers, ponds. Algae and cyanobacteria are tiny organisms that occur naturally in saltwater and freshwater. Algae, specifically the type of algae that exists in a specific water source can also be beneficial in another manner. Algae are good indicators of the atrophic status of a water body, that is, the degree of pollution and nutrients in that water. A lake dominated by green algae and diatoms is relatively "clean" oligotrophic water, whereas dominance by bloom-forming blue-green algae indicates a more polluted or eutrophic condition, typically caused by the troublesome Cyanobacteria. A macrophyte is a plant that grows in or near water and is emergent, submergent, or floating. In lakes and rivers macrophytes provide cover for fish, substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife. Macrophytes are primary producers and are the basis of the food web for many organisms. They has a significant effect on soil chemistry and light levels as they slow down the flow of water and capture pollutants and trap sediments. Macrophytes perform many ecosystem functions in aquatic ecosystems and provide services to human society. One of the important functions performed by macrophyte is uptake of dissolve nutrients (N and P) from water. Macrophytes are widely used in constructed wetlands around the world to remove excess N and P from polluted water. Beside direct nutrient uptake, macrophytes indirectly influence nutrient cycling. Some aquatic plants are used by humans as a food source. Examples include wild rice (Zizania), water caltrop (*Trapa natans*), Chinese water chestnut (*Eleocharis dulcis*), Indian lotus (*Nelumbo nucifera*), water spinach (*Ipomoea aquatica*), and watercress (*Rorippa nasturtium-aquaticum*).The marine life is used for determining will have harmful effects on the aquatic life. Many aquatic animals can face death because of the polluted water, as they have only water as the source of oxygen. If aquatic life is disturbed then the beauty of this nature may get worsen. "It is a curious situation that the sea, from which life first arose, should now be threatened by the activities of one form of that life that are humans". It is responsibility of every human being to take care of aquatic animals and their lives. These species are depleting day by day. If this decline is not stopped right away, soon they will disappear completely.

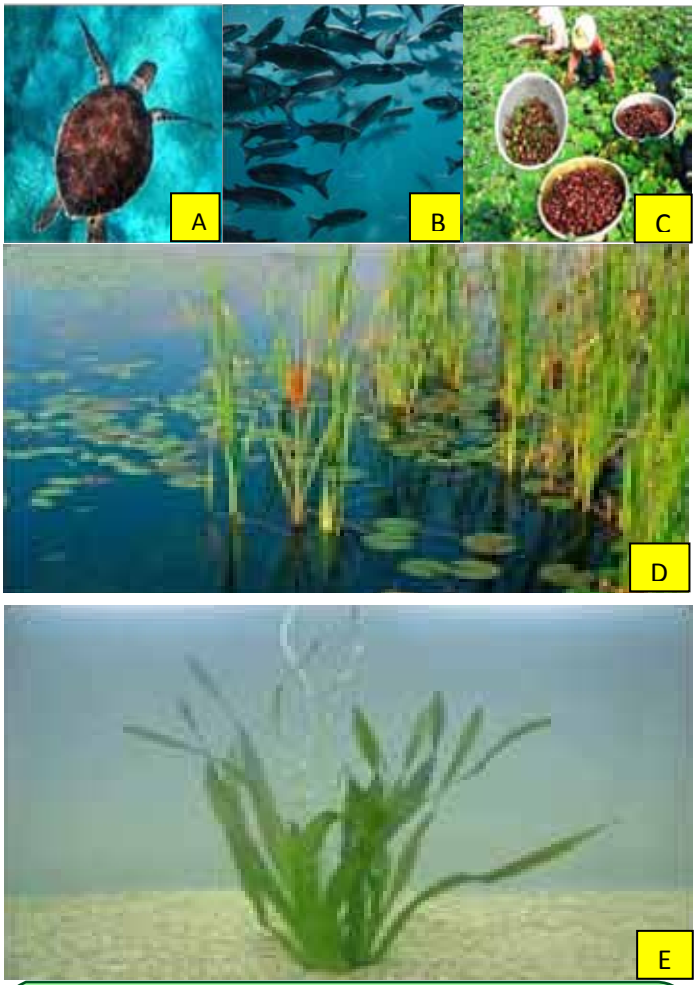

Fig.1. Diversity found in water: A. Turtle B. Fishes C. Water chestnut D. Cattail plant E. Vallisneria (Tape grass or eelgrass)

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Water Quality Guidelines (WQGs) for the Freshwater Aquatic Ecosystem

Water is the second most important component of the earth after air and its quality is critical for all the living beings. Aquatic ecosystems consist of interactions between biotic and abiotic components. Biotic components include producers, consumers, decomposers while abiotic components include physical and chemical parameters. Anthropogenic interferences such as the introduction of chemicals into water, may adversely affect many species of aquatic flora and fauna, which are dependent on both abiotic conditions (e.g., temperature, flow conditions, pH, concentration of dissolved oxygen, concentration of heavy metals and organic micropollutants) and biotic conditions (e.g., species composition). So, the proper guidelines for maintaining water quality of aquatic ecosystem is essential. The water quality guidelines (WQGs) recommend minimum concentration levels of contaminants/ nutrients or dissolved oxygen to ensure negligible risk to living being. Based on the use of water, worldwide, different types of guidelines are available e.g., WQG for drinking water, WQG for irrigation water, WQG for aquatic life/ aquatic ecosystem, WQG for recreation, WQG for aquaculture/ fish farming etc (Nugegoda *et al.,* 2013). These guidelines can be voluntary or regulatory. WQGs, for the protection of aquatic life and aquatic ecosystems, are the recommended concentration levels that should result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems and the designated resource uses they support (ANZECC and ARMCANZ 2000). In India, the Central Pollution Control Board (CPCB) has developed a concept of designated best use, through which five designated best uses have been identified (Box 1).

Classification of surface water based on usage	
Class	**Type of use**
A	Drinking water source without conventional treatment but after disinfection
B	Outdoor bathing
C	Drinking water source with conventional treatment followed by disinfection
D	Fish culture and wildlife propagation
E	Irrigation, industrial cooling or controlled waste disposal

Class D covers the propagation of wildlife and fisheries (Guidelines for water quality monitoring, CPCB (MINARS/27/2007–08) where the main quality parameters are dissolved Oxygen, pH, Ammonia Nitrogen, electrical conductance, oil and grease, alpha emitters, beta emitters and free carbon dioxide. Water-quality guidelines for the protection of aquatic life mainly consists of physico-chemical parameters which mainly define the water quality which can protect and maintains aquatic life, ideally in all its forms and life stages, or they may consider the whole aquatic ecosystem. Nutrients present in water, supports the primary production in food web of aquatic ecosystem, but in excess it can cause its degradation which can create algal bloom, increasing aquatic plant growth and their decay. Physiological activities of aquatic plants vary the concentration of nitrogenous and phosphorous nutrients, pH, carbonates, dissolved oxygen, and other chemicals sensitive to oxidation/reduction conditions. So, these aquatic plants can vary the chemistry of water where they are growing, although the impact varies with the type of water resources e.g., the lake ecosystem is impacted more in comparison to the flowing river water. Decaying process depletes the oxygen concentration in water which affects the fishes and other aquatic organisms. Dissolved oxygen concentration is also affected by density stratification, precipitation, temperature of water etc which may affect activities in aquatic ecosystem (Kundzewicz *et al.,* 2010). This gas also influences inorganic chemical reactions. Therefore, knowledge of the solubility and dynamics of oxygen distribution is essential to interpreting bothbiological and chemical processes within water bodies. Main concerns for the aquatic life, related to water-quality parameters, are dissolved oxygen (which can cause fish kills at low concentrations) as well as phosphates, ammonium, and nitrate (can cause significant changes in community structure if released in excessive amounts into aquatic ecosystems). Heavy metals and many synthetic chemicals can enter organisms, which cannot be metabolized or excreted by the aquatic life, and thus bio-accumulate. If the organism continues to be exposed to chemicals which it cannot adequately excrete or detoxify, then their concentrations can with in the organisms can increase to toxic levels. Some pollutants can also cause carcinogenic, reproductive, and developmental effects. Many chemical reactions inside aquatic organisms (cellular metabolism) that are necessary for survival and growth of organisms require a narrow pH range. At the extreme ends of the pH scale (2 or 13) physical damage to gills, exoskeleton, fins, occurs. Changes in pH may alter the concentrations of other substances in water to a more toxic form e.g. the conversion of nontoxic ammonia (ammonium ion) to a toxic form of ammonia (un-ionized ammonia) above pH 8.5 which is harmful for aquatic life.Disturbances in dissolved oxygen concentration in water can cause death of adults and juveniles, reduction in growth, failure of eggs/larvae to survive, change of species present in waterbody. Observing this, CPCB has provided the water quality norms for aquatic ecosystems where the dissolved oxygen, pH, ammonia nitrogen, electrical conductance, oil and grease, Alpha emitters, beta emitters and free carbon dioxide should be maintained at 4 mg/L, 6.5-8.5, 1.2 mg/L, 1000 µS/cm, 0.1 mg/L, 10-9µc/ml, 10-8µc/ml and 6 mg/L respectively. Worldwide WQGs for aquatic life are mainly prepared based on the forms of aquatic life and all aquatic stages of life cycles. Data relevant to fate and behaviour, bioaccumulation, Kow values (octanol/ water partition coefficient), acute andchronic toxicity to aquatic life, for example, fish and invertebrates (e.g., crustaceans, molluscs, algae and macrophytes) and environmental concentrations are collected and collated from published texts and journals, as well as commercial data bases (e.g., US EPA Ecotox database; http://cfpub.epa.gov/ecotox) which provide single chemicaltoxicity information for aquatic and terrestrial lifeetc (Nugegoda *et al.,* 2013). Water quality Data are generated following acceptable experimental procedures e.g., American Society for Testing andMaterials (ASTM), Organization for Economic Co-operation and Development (OECD) or by following acceptable good laboratory procedures and along with quality testing, appropriate species are also tested for toxicity level, toxicity endpoints, dose–response relationships, lethal concentration (to 50% of testorganisms) or LC50, and chronic studies threshold concentrationsetc. Such guidelines can provide the area specific solutions for aquatic ecosystem based on the present aquatic life.

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Natural Vegetation Pattern Along with the Kosi-Watershed, Almora

Kumaun is a mountainous region of Uttarakhand in India. Many rivers and their tributaries orginate from here. Four major rivers Kali, Western Ramganga, Kosi and Gaula make the surface drainage of Kumaun Himalaya. Kosi is the main river of Almora and Nainital Districts. Which descended from the hills to the plains. These rivers are spring-fed (except Kali is glacier fed) as a result the water of Kosi River is comparatively warmer than the glacier Rivers. The word Kosi refers to "river". Kosi river which originates from Koshimool near Kausani and flows in the central part of Almora and the western part of Nainital District. Kosi River leaves hills of Kumaun at the plains of Ramnagar and confluences with river Ramganga near village Chamraul Tehsil Shahabad of District Rampur (U.P.). River Kosi has the total catchment area of 3,420 sq. km. The climatic conditions of this region are most important elements in their natural setting as they practically influence the entire mix of physical and cultural phenomena. Here elevation and aspects of slope are the important factors that give rise to great variations in the climatic conditions even at the micro and local level (Maithani,1986). The temperature changes are associated with changes in altitude and every continuous ridge diminishes the supply of rain to the region lying in the north. By combining differences in rainfall with differences in temperature and humidity, a single mountain range can produce a bewildering

variety of climates (Mani,1981). The Kosi watershed lies in the temperate latitudes, remote from the marine influence, at a high elevation and diversified configuration and suffers from vagaries of sub-mountain to mountain cold climate with marked anomalies. As climate is regarded as a controlling factor for land use, the complexities of the landscape promote variations in micro- climatic phenomena and influence the soil and vegetation. Notable amongst the climatic factors, which ultimately affect the growth and development of plants and crop production, are temperature and rainfall. The Central Himalayan forest vegetation ranges from tropical. Once of the pristine forest of Kosi watershed have been also showing signs of deteroration of biodiversity, regeneration, loss in biomass productivity and varieties of wild edibles and non-timber forest products due to a number of anthropogenic (wood cutting, grazing, forest fire etc.) and natural drivers (eg. climate change). This decline in forest wealth of the watershed is also reflected in the water flows regine of Kosi river (eg. flash floods and low flow cycles) that has certain undesirable implications on the diversity and species richness of aquatic life of the river.

Natural Vegetation

The Kosi watershed can be considered to be a vast storehouse of natural vegetation. A greater degree of variation in the environmental condition created a complex vegetational pattern in the region. Due to variations in gradient, temperature and rainfall the watershed has varied altitudinal belts and variety of vegetation. As a consequence, the region though agriculturally sub marginal and industrially almost untouched possesses rich vegetation which is essentially arboreal (Jhonson, 1993). The natural vegetation of the Upper Kosi watershed may be classified into: I. Temperate Moist Broad Leaved Forests and II. Himalayan Sub Tropical Pine Forest.

(I) Himalayan Sub Tropical Pine Forest

Chirpine forests ordinarily extend on the southern slope from 1100 to 2300 meters and on the northern slope from 1100 to 2200 meters elevation and are well distributed in the watershed. Chirpine is found on almost all geological formations which occur in this zone on the hot exposed southern slopes with shallow soil. It is often entirely replaced by low level miscellaneous scrubs and other broad leaved species tend to take its place along water courses and in moist sheltered places, particularly in the northern aspects (Palo,1990). Chir pine forests are seldom very dense. The ground is covered with grass, sometimes dense, whatever the aspect of covered canopy, and there is almost a discontinuous undergrowth of scrubs often so widely scattered is noticeable. In the upper transitional limits of Chir pine, it is associated with Banj Oak (*Quarcus leucotrichophora*), Buransh (*Rhodendron arboreum*), Kaphal (*Myrica esculenta*), and Mehal (*Pyrus pashia*) etc. in the lower limits.

(II) Temperate Moist Broad Leaved Forests

These forests are scattered in the southern, east and northern pockets of the watershed where the elevation is above 1820 meters. The temperate moist broad leaved forests of the watershed can further be divided into the following:

(a) Temperate Moist Deciduous Forests

The temperate moist deciduous forests found in the deeper moist soils areas in the north eastern part of the watershed. The undergrowth is usually thin in the undistributed forests owing to the heavy shade of the trees. Pangar (*Aesculus indica*), Maples (*Wallichiana* ap.), Walnut (*Jhglans regia*) and Angu (*Fraxinus micrantha*) are the main species forming part of this forest type. This forest type very rarely forms an extensive forest of its

(b) Banj Oak (*Quercus leucotrichophora*) Forests

Banj Oak is the predominating species existing from the highest point in the basin to the Chir zone. The dividing line between Banj Oak and Chir pine is vague, but towards its lower limits Oak follows ravines and watercourses particularly in the northern aspect down to 1800 meters. The soil of the oak zone is usually moist, though towards the southern aspect often forms a marked exception and there is a high degree of atmospheric humidity throughout the monsoons, irrespective of aspect. Rich flora, of mosses, ferns and linches drape on Oak trees indicate humidity. The undergrowth is usually of more or less extensive cover of herbaceous plants which die after the rains. Three distinctive types of Oaks are recognized in the watershed namely, Tilonj, and Kharsu occupying distinctive altitudinal zones. Moru or Tilonj Oak (*Quercus floribunda*) occupy the intermediary zone between Banj Oak and Kharsu Oak (*Q. semecarpifolia*). It attaints its optimum development on moist deep soils especially where the sub soil is limestone. The Kharsu Oak occupies the highest elevation zones amongst the Oaks occurring mainly on the northern and southern slopes. Horse Chestnut, Maples and Walnut trees are associated with it. Ringal is often a marked feature of the undergrowth of these forests and is almost impenetrable. At its lower limits it often passes into Banj forests though on northern slope it frequently gives way to Tilonj Oak.

Banj Oak forest

Chir Pine forest

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