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Effect of Kashmiri willow (*Salix integra*) on the fish biodiversity of Wullar Lake and conservational measures for sustainable fish production

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Abstract
Wullar Lake is one of the largest fresh water lakes of Asia. It plays a significant role in the livelihoods of the people of adjacent areas by boosting their economy and is a source of nutritious food, tourism, and has got aesthetic value. It is a treasure of genetic pool as it harbours different species of fishes and other biodiversity. But unfortunately the threat is being posed to the existence and survival of the fish biodiversity of this lake by different factors like willow trees of the surrounding social forestry plantations, sewage and garbage disposed off by the local population into the water of the inlet tributaries. The need of the hour is that different projects and schemes may be implemented on a war footing basis to restore the original glory and fish biodiversity of this famous lake.

Keywords: Wullar Lake, economy, biodiversity, genetic pool, existance, projects

1. Introduction
Wullar lake being one of the largest fresh water lakes of Asia is situated in the district Bandipora- the Northern part of the Jammu and Kashmir, India [1, 2]. The geographical location of this lake is 34º 20N′74º 36′, E [3]. This lake is largely surrounded by the willow plantations of the social forestry department. The primary inflow and outflow of Wullar lake is the River Jhelum. The maximum length and breadth of this lake is 16 km and 9.6 km respectively [4]. Its surface area is 30 to 189 km^2 with a maximum depth of 14m. Wullar lake has been designated as a Ramsar Wetland Site on 23 March 1990 [5]. In the present study, the focus has been laid on the factors like surrounding willow plantations, sewage and nutrients, which pose a threat to the existence of Wullar Lake, and the remedial measures to be taken for the effective management of this prestigious lake and its fish biodiversity.

2. Materials and Methods
In the present study, four different sites were choosen to assess the concentrations of the nutrients present in the lake from 15th May, 2021 to 06th June 2021.

- Site 1 Banyari inlet: It is located at a distance of aout 30 kilometres from the BandIpora district headquarters.
- Site 2 Banyari 11: It is located at a distance of about 1 kilometre from the site on the Western side of the Wullar Lake from where the waterflows downwards.
- Site 3 Makhdoomyari: It is located at a distance of aout 1 Kilometre from the site ll.
- Site 4 Ningli: It is located at a distance of about 8 kilometres from the site lll.

Wullar Lake being the main habitat of fishes harbours Common carp (*Cyprinus carpio*), Rosy barb (*Barbus conchonius*), Mosquito fish (*Gamusia affinis*), *Nemacheilus* species, *Crossocheilus latius* and different snow trout species of the genus *Schizopyge* and *Schizothorax*. The different snow trout species identified in the lake are Sattar snow trout (*Schizopyge curvifrons*), Chirruh snow trout (*Schizopyge esocinus*), *Schizothorax planifrons, Schizothorax macropogon, Schizothorax longipinus* and Chush snow trout (*Schizopyge niger*) [6]. The wullar Lake is also a favourable place for the survival of the populations of different migratory birds like Black- eared kite, Eurasian sparrowhawk, short- toed eagle, Himalayan Golden eagle, Himalayan monal Chukar patridge, Koklass pheasant, Rock dove,

common cuckoo, alpine swift, Indian roller, Himalayan woodpecker, hoopoe, barn swallow, golden oriole and others [6].

2.1 Effect of nutrients

The growth of plants in any waterbody depends on the concentrations of the nutrients like Total nitrogen (TN) and Total phosphorus (TP). These nutrients therefore indicate the extent to which any waterbody is polluted or eutrophicated. Wullar Lake is surrounded by the dense vegetational areas of social forestry with abundant willow strees (*Salix alba*). The greater influx of organic matter from the willow trees into the aquatic systems can have a significant impact on the quantity of nutrients in aquatic environments [7]. Willow leaves rapidly leach simple organic compounds like reducing sugars, amino acids and phenolic componds on entering any water body. As much as 25%, 50% and 85% of the nitrogen, phosphorus and potassium in the leaf is rapidly released into the water column respectively [8]. Willow leaves have comparatively higher Nitrogen concentrations (1.8% litter dry mass [DM]) as compared to grey alder (Alnus sp.) leaves that have N-fixings symbionts (2-3% DM) [9], and had higher initial N and P concentrations than Populus and Platanus species [10]. Willow leaves sumerged in a stream for 56 days possessed about three times as much Nitrogen and Carbohydrate, twice as much protein, and similar quantity of chlorophyll a as periphyton [11].

Table 1: Quantity of dissolved nutrients in Wullar Lake at selected sites

Parameters	Ammonolical Nitrogen µg/l	Nitrate Nitrogen µg/l	Total Phosphorus µg/l	Ortho-Phosphorus µg/l	Sulphate mg/l	Sodium mg/l	Potassium mg/l
Banyari inlet	108	231	183	85	10.0	7	3.0
Banyari 11	133	244	328	130	23.0	8	4.0
Makhdoom Yari	262	805	293	104	28.0	6	4.5
Ningli	264	287	358	128	26.0	11	5.0

2.2 Suggestions to safeguard the fish bio- diversity of the Wullar Lake

- Cutting down of the surrounding Willow plantations of the Wullar Lake.
- Strict implementation of the laws related to wild life and fisheries.
- Monitoring of pollution of the Wullar Lake and its inlet water bodies.
- Protection and conservation of the endemic species.
- Dredging and construction of fencing walls surrounding the Wullar Lake.
- Mobility and functioning of Wullar Conservation and Management Authority (WUCMA).
- Public awareness programmes should be conducted to check the point sources of pollution from the surrounding inlet water bodies.

3. Result and discussion

All the above discussed facts suggest that willow leaf litter while decomposing can contribute to the increased concentrations of nutrients in lakes and wetlands. The decomposition rates of leaf litter are regulated by temperature [12], nutrient availability, oxygen availability, current velocity, hyphomycete diversity, invertebrate presence and litter chemistry [13]. Because of physical abrasion, leaching and biological aspects like mineralisation and modification, willow leaves possess rapid decomposition rate. These activities result in the formation of CO_2 and inorganic compounds, dissolved and fine particulate organic matter and decomposer biomass [14]. Thus the nutrient leaching rates within a system can increase with studies showing that the amount of soluble nutrients (630 g/g) which is three times as can be leached from physically abraded leaves compared to intact leaves [15] and there is a further enhancement in this volume during floods [16].

The analysis of data clearly indicates that the concentrations of nitrogen, phosphorus, sulphate sodium and potassium in the Wullar water at Banyari is 108, 231, 183, 85, 10.0, 7, 3.0 respectively which goes on increasing as the water moves down into the lake at Banyari ll with the concentration of the mentioned nutrients upto 133, 244, 328, 130, 23.0, 8, 4.0 respectively. The increase in the concentrations of the nutrients from Banyari inlet to Banyari ll upto Ningli is due to the accumulation of the willow leaves from the surrounding plantations down into the lake water. This has lead to the tremendous growth of the algal bloom and other aquatic plants over the water surface of this area of the Wullar Lake. So the quantity of nutrients accumulating in the Wullar Lake due to leaf litter annually from the willow plantations will decrease by the removal of willow trees in the future and in addition to it the implementation of the mentioned suggestions to safeguard the fish bio- diversity of the Wullar Lake will definitely help to restore the lost glory of the Wullar Lake and will help to get rid from the eutrophication of the lake water.

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