

Research Article

Impact of plastic pollution on fresh water biota of water streams around the picnic spots of Hilly region in the Swat Valley Pakistan

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Received: 09-03-2026

Accepted: 22-03-2026

Published online: 30-03-2026

DOI: <https://doi.org/10.33687/ricosbiol.04.03.110>

Abstract

The presence of Blue water Ecosystem in the upper region of Swat has a diverse biomass of different species at different trophic levels. Among species involved in the food chain of these freshwater systems are *Navicula subtilissima*, *Zygnema Cruciatum* (Producer), *Lathocerus americanus* and other aquatic insects (Primary Consumer) of low temperature and *Schizothorax plagiostomus* (Secondary consumer). There is a drastic imbalance and disturbance in their communities due to water pollution. Plastic bottles are on top among the pollutants which are thrown by visitors especially at the picnic spots around these water bodies. Fish species have been observed to emigrate from the picnic spots towards deep, speedy and clean habitats in these aquatic ecosystems. Decomposition rate of these bottles is negligible and hence affecting aquatic fauna and flora Food in a very negative manner. Heavy metal concentrations in pristine, unpolluted waters of this region are typically below detectable levels (0%). However, in winter 2019-2020, following the accumulation of plastic waste, this figure was recorded at 13%, indicating a significant increase. Due to such pollution this figure recorded in winter 2019-2020 was 13 % with an increasing trend. Regulatory authorities must pay attention to this issue on priority base and initiate remedial as well as preventive measures for the water of uphill beautiful streams and lakes.

Keywords: Plastic Bottles, Pollution, Swat Valley, Freshwater Ecosystem.

Introduction

Plastics are used extensively for a wide range of applications, with approximately 280 million tons produced annually worldwide for products such as food packaging and other materials (Shaw & Sahni, 2014; Sigler, 2014). The occurrence of plastic trashes has become a well-researched “hot topic” in the marine environment, but is ignored in freshwater environments (Wagner et al., 2014 and Eerkes-Medrano et al., 2015). Plastics in different form found in already sufficient quantities to be considered as one of the most important types of “techno fossil” that can form a permanent record of human presence on Earth (Zalasiewicz et al. 2016). From the last century, humans have been muddling near water resources, causing plastic pollution alarmingly (Faure et al. 2015). In the List of Crucial environmental problems Plastic pollution are numbered (UNEP 2014), and it is notorious alongside climate change as an evolving issue that influence human health in long and biological diversity in the short term future (Sutherl, et al. 2010).

Studies have shown plastic absorption by wild freshwater organisms (e.g. Sanchez et al., 2014, Faure et al., 2015, Biginagwa et al., 2016; Pazos et al., 2017). Plastic concentrations have been reported in different water bodies i-e rivers (e.g. Lechner et al., 2014; Klein et al., 2015), lakes (e.g. Fischer et al., 2016; Blettler et al., 2017), estuaries (e.g. Peng et al., 2017) and even on wastewater as well (Mintenig et al., 2017; Correia Prata, 2018). Moreover, freshwater plastic research seems to be inherently partial towards a country's state of development and disconnected as each study was considered and conducted with its specific aims in mind (Blettler et al. 2018).

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Water quality problems are a major challenge that humanity is facing in the twenty-first century as it directly and indirectly emphasizes them (Schwarzenbach et al., 2010). It was noticed that microplastics is more likely to infiltrate food webs (Browne et al. 2008). Studies have shown that freshwater invertebrates and vertebrates can ingest plastic particles, causing serious illness from cellular to all systems of the body that compel them for migration (e.g., Rosenkranz et al. 2009, Imhof et al. 2013, Sanchez et al. 2014; Biginagwa et al. 2016). As many plastics are chemically harmful, either because they are harmful or because they absorb other pollutants that are harmful for the Producers (Algae) of the Area (Teuten et al. 2009; Rochman et al. 2013).



Figure 2a: Stable Ecosystem 2018(autumn)



Figure 1b: Stable Ecosystem 2018(autumn)



Figure (1c): Disturbed Ecosystem April (2020) After Plastic Bottle Pollution

Material and method

STUDY AREA:

The river swat with all of its Cascades and others originates from Hindukush Mountains above Kalam (Mahoodand) and empties in River Kabul near Charsadda district, and is 240 Km long. It is also stated in Rig Veda 8.19.37 as the Suvastu River (Swat River) (Lal, 2005).. A large number of peoples in different way are dependent on the river for their maintenance and many societies use its water for drinking, for field and in last for generating power. It is also the prime source for fishing, construction material and irrigation (Shah et al., 2016).

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Figure (2): Study Area Map (River Swat)

Sampling and Identification

Due to diversity of organisms (Algae, Insect and Fishes) in the research so different methods applied in different spots.

Algal collection

Algae (Producer) collection was made by planktonic net, scooping Vegetation of the Ecosystem and by water collection from that spot.

Algal identification

The Algal members were identified from available literature (G.W Prescott 1954) and Seamer D 2017.

Insects Collection

Insects were collected from the samples collection randomly from the water in the ecosystem by collecting water after Shaking in particular water part

Insect Identification

Insect were identified from available Literature (Pond Life) by George K. Reid Paperback

Fishes Collection

Fishes were collected by Fishery net and by locale people using method by showing a little piece of breed in Pot and collect fishes.

Fishes Identification

The Species were identified from the available literature for Fishes (Heckel 1838; Leidy, 1847) for Insects in chain.

RESULT AND DISCUSSION

Water a basic source of life , important from cellular Level to Habitat of all kind of Flora and Fauna on the earth. The Assurance of water is actually the surety of Life.

The classification of life in Aquatic environment is all because of the Nature of that water weather it is Fresh, Marine or Brackish water. The equilibrium of the cell is a Primary need for every life. Life on the earth is not in isolated form, All the organisms are linked in any form with in an ecosystem. Fresh water also have an ecosystem of different water the current studies was conducted in the Hilly region picnic spot of the Swat.

Before the exploring of the study area and before the arrival of the plastic pollutants (Water bottles, soft drink bottles and some others) The Algal Member *Zygnema Cruciatum* dominating the Lentic water with Blooms appearance and the greenery of the place presenting the water status visually.

The slippery nature of the rocks and stones present the presence of the *Navicula subtilissima*.

The fly(Primery consumer) surrounding this fresh water ecosystem is dominating by *Lathocerus americanus*. present there in rocks and Blooms there.

The (Secondary consumer) *Schizothorax plagiostomus* were collected by Fishery Net use by the Local Fisher mans . All the above statements were collected in Spring 2018, after a gap of two years and the arrival of pollutant there a abrupt change in trophic level was observed, the bloom were totally disturbed with no regular body , instead they were collected in different corners of the ecosystem.

The White fly was collected approximately 200 meter away from the ecosystem with a small water fall presenting the absence of Plastic water bottles.

No single species of *Schizothorax plagiostomus* was collected in that Lentic Ecosystem and were collected in the deep water of River swat away 400metre away.

The data, numbers, colonies, members, and status of the ecosystem present the pollutants function there negatively and show how this 16000 square feet ecosystem was disturbed by polluting only with plastics bottles.

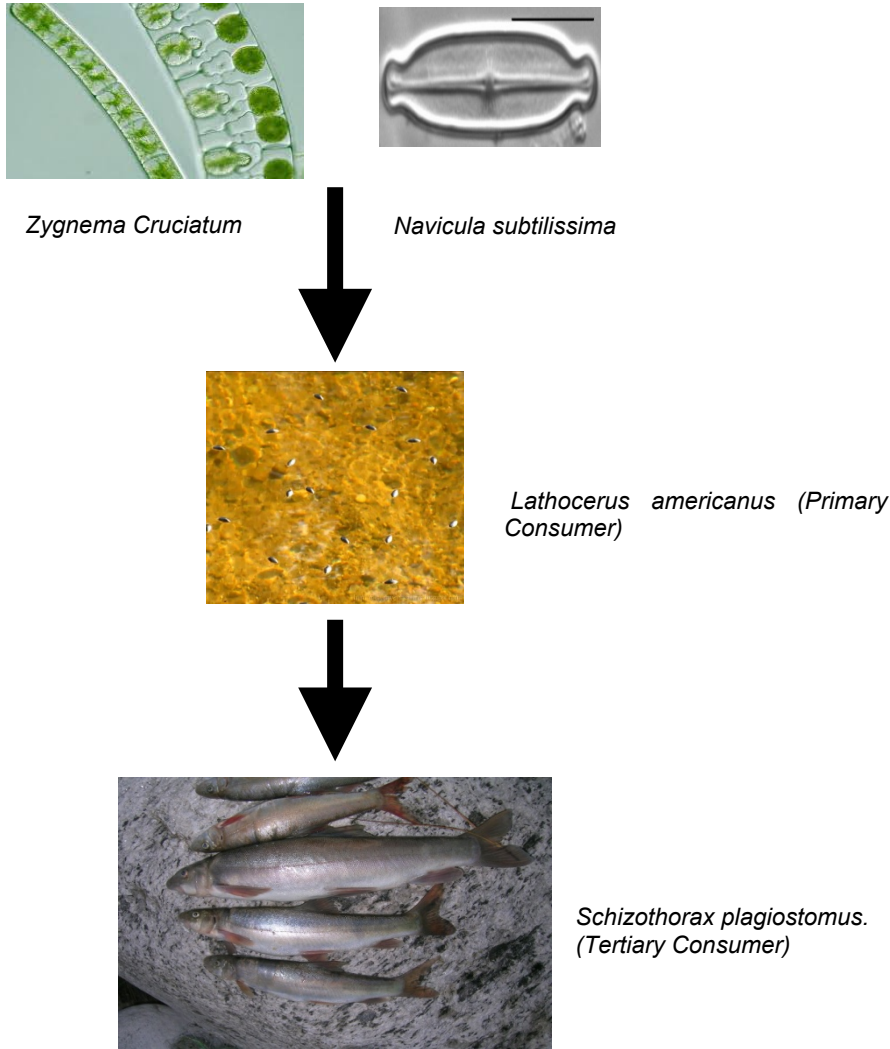


Figure (3): Plastic degradation process

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Table (1): Water quality difference between the migrated habitats.

Abiotic Factor	Natural Habitat(Before Pollutant)	Natural Habitat(After Pollutant)
Temperature	9-12	13
PH	7.2	7
Electric conductivity	402.4	407
Salinity	0.2	0.3
Dissolved oxygen	43.2	42.2
Light intensity	1127	1022
Depth of Water (Max)	3 -4 ft	8- 11+

Table (2): Collection of Fishes in different time of the day in picnic spot before pollution(2018)

Collection time	Maximum	Minimum	Average
4:00Am	7/fishing net	5/fishing net	6/fishing net
10:00Am	4/fishing net	2/fishing net	3/fishing net
2:00Pm	2/fishing net	0/fishing net	1/fishing net
4:00Pm	1/fishing net	1/fishing net	1/fishing net

Table (3): Collection of Fishes in different time of the day in picnic spot after pollution (2020)

Collection time	Maximum	Minimum	Average
4:00Am	2/fishing net	1/fishing net	1.5/fishing net
10:00Am	1/fishing net	0/fishing net	.5/fishing net
2:00Pm	0/fishing net	0/fishing net	0/fishing net
4:00Pm	0/fishing net	0/fishing net	0/fishing net

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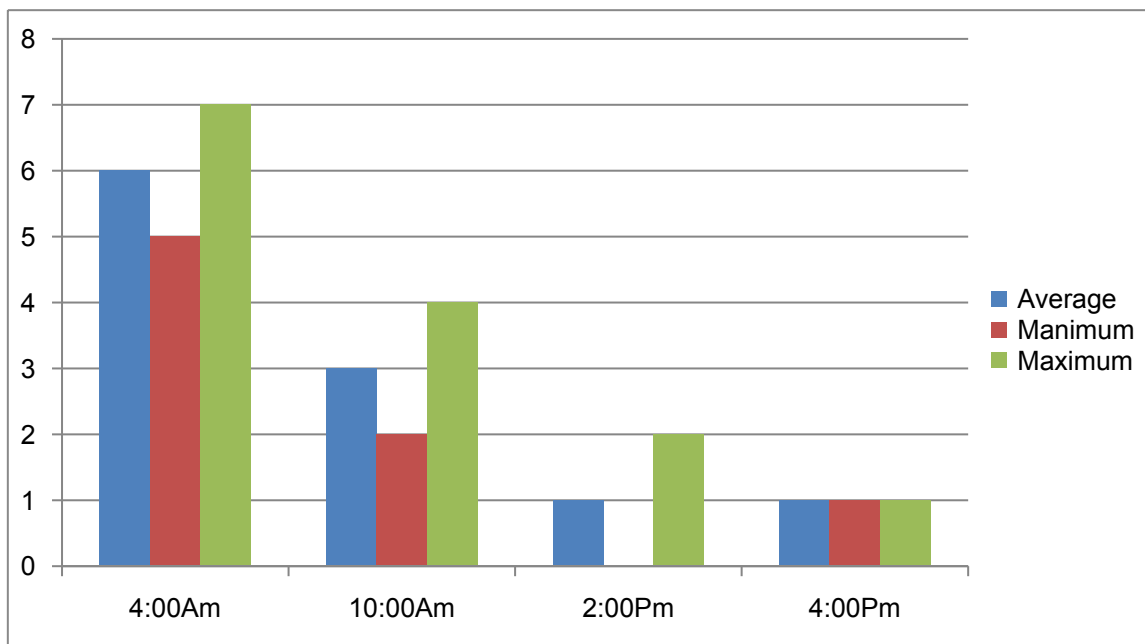


Fig 04: Collection of Fishes in different time of the day in picnic spot before pollution (2018)

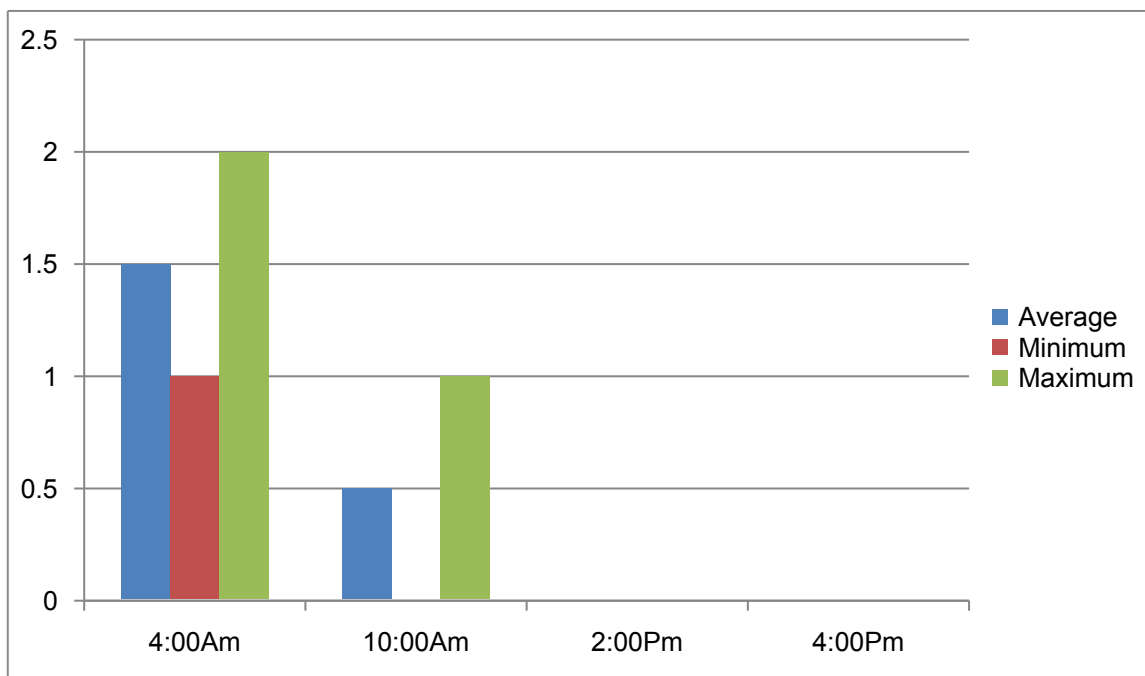


Fig (5): Collection of Fishes in different time of the day in picnic spot after pollution (2020)

Results and Discussion

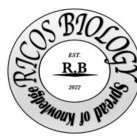
The current study aimed to assess the impact of plastic bottle pollution on a freshwater ecosystem in the Swat Valley by comparing the biotic community structure and key abiotic parameters before (2018) and after

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(2020) the significant accumulation of plastic waste at a popular picnic spot. The results revealed a marked disturbance in the ecosystem, with observable negative effects across all trophic levels.

1. Changes in Biotic Community Structure

The most conspicuous change was the dramatic alteration of the producer and consumer communities within the 16,000 square feet study area.

Producers: In 2018, the ecosystem was characterized by a healthy and stable community of producers. The presence of *Zygnema cruciatum* in bloom-forming colonies and the dominant coverage of *Navicula subtilissima* indicated a productive and balanced aquatic environment. The "greenery" and "slippery nature of the rocks" noted in the methods were visual confirmations of this robust algal growth. In contrast, the 2020 survey showed that these blooms were "totally disturbed with no regular body." The algal colonies were fragmented and relegated to "different corners of the ecosystem," signifying a collapse of the primary producer community. This decline can be attributed to several factors associated with plastic pollution. The physical presence of plastic bottles can shade the benthos, reducing light penetration essential for photosynthesis (Fig. 07 shows a decrease in light intensity from 1127 to 1022 Lux). Furthermore, plastics can leach harmful chemical additives or act as vectors for other pollutants (Teuten et al., 2009 and Rochman et al., 2013), creating a toxic environment for sensitive algal species.

Primary Consumers (Aquatic Insects): The dominant primary consumer, *Lathocerus americanus*, was observed to have emigrated from the polluted site. The study notes that these white flies were found approximately 200 meters away, near a small waterfall with no plastic bottles. This displacement suggests that the presence of plastic pollution rendered the original habitat unsuitable. The reasons for this are likely twofold: the loss of their algal food source and the direct toxicological effects of plastic leachates, which are known to cause sub-lethal effects and avoidance behavior in aquatic insects (Imhof et al., 2013).

Secondary Consumer (Fish): The most compelling evidence of ecological disruption was the complete absence of *Schizothorax plagiostomus* from the polluted lentic ecosystem in 2020. The study reported that no individuals were collected in the picnic spot area, and they were only found in deeper, faster-flowing sections of the main Swat River, approximately 400 meters away. This is a stark contrast to the 2018 survey where the species was readily collected using a fishery net. This migration is a clear behavioral response to avoid the polluted area. Fish often emigrate from areas with degraded water quality, reduced food availability (due to the loss of algae and insects), and the stress of chemical contaminants. The quantitative fish collection data (Figs. 09 & 10) further supports this trend, showing a drastic decline in catch rates at all times of the day in 2020 compared to 2018.

Table (4): Summary of observed changes in biotic communities between 2018 and 2020.

Parameter	Natural Habitat (Before Pollutant, 2018)	Natural Habitat (After Pollutant, 2020)
<i>Zygnema cruciatum</i>	Dominant, forming blooms	Totally disturbed, no regular colonies
<i>Navicula subtilissima</i>	Present on rocks	Presence and dominance diminished
<i>Lathocerus americanus</i>	Dominant in the area	Emigrated ~200m away to a non-polluted site
<i>Schizothorax plagiostomus</i>	Readily collected in the lentic ecosystem	Absent from the area, found ~400m away in deep, fast water

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Analysis of Abiotic Factors

While the primary focus was on biotic communities, changes in abiotic factors were also recorded (Fig. 07). While parameters like pH, electrical conductivity, and salinity remained relatively stable, notable changes were observed in temperature, depth, and light intensity. The temperature range shifted from 9-12°C to a higher minimum of 13°C, which could be a result of reduced shading from algal cover and changes in water flow. The maximum depth increased from 3-4 feet to 8-11 feet, potentially altering the habitat structure. Light intensity also decreased, likely due to the accumulation of plastic debris on the water surface or bottom, further impacting primary production.

Discussion of Findings

The findings of this study provide a clear, multi-trophic level case study of the negative impacts of plastic pollution on a freshwater ecosystem. The observed emigration of insects and fish, coupled with the collapse of the algal community, demonstrates a fundamental disruption to the food web. The initial observation from the abstract, regarding the count of heavy metals increasing from 0% to 13% in the winter of 2019-2020, is a critical piece of evidence, even though its methodology is not detailed in the current section. This increase strongly suggests that plastics, by acting as a vector for heavy metals or through the leaching of their own chemical components, are contributing to chemical contamination. This aligns with the findings of Rochman et al. (2013), who demonstrated that plastic can transfer hazardous chemicals to fish.

The study's results confirm the growing body of evidence that freshwater ecosystems are not immune to the threats of plastic pollution, a concern previously highlighted by Wagner et al. (2014) and Eerkes-Medrano et al. (2015). The specific and localized impact observed at a picnic spot underscores the role of human recreational activity as a direct source of pollution, as visitors discard plastic bottles. This on-the-ground observation validates the concerns raised by Faure et al. (2015) about human activity near water resources.

Furthermore, the study illustrates the cascading effects of such pollution. The primary impact of plastic bottles—physical smothering, chemical leaching, and light reduction—first affected the base of the food web (the producers). This, in turn, led to a loss of habitat and food for primary consumers (insects), which ultimately forced the secondary consumers (fish) to migrate to find suitable conditions. This cascading disruption highlights how plastic pollution threatens not only individual species but also the integrity and stability of the entire aquatic ecosystem.

The significant decline in fish catch rates from an average of 6/net at 4:00 AM in 2018 to 1.5/net in 2020, and to zero catches during daytime hours, has severe implications for local communities. As noted in the introduction, the Swat River is a prime source for fishing, irrigation, and drinking water (Shah et al., 2016). The degradation of this resource directly threatens the livelihoods and well-being of the people dependent on it. The almost negligible decomposition rate of plastic bottles mentioned in the abstract means that without intervention, this pollution and its associated impacts will persist for decades, potentially creating a permanent "technofossil" record of this disturbance (Zalasiewicz et al., 2016).

Conclusion

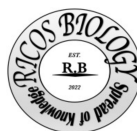
The results of this study provide clear evidence that plastic bottle pollution is causing significant and negative changes to the freshwater biota of the Swat Valley. The observed disruption of algal blooms, emigration of aquatic insects and fish, and changes in water quality parameters demonstrate a severe impact across trophic levels. The study reinforces the urgent need for regulatory authorities to address this issue. Preventive measures, such as enforcing bans on single-use plastics in protected picnic areas and installing proper waste management infrastructure, are critical. Remedial measures, including clean-up drives, are also necessary to restore the health of these beautiful and ecologically important uphill streams and lakes. Future research should focus on quantifying the heavy metal concentrations directly linked to the plastics and further investigating the sub-lethal physiological effects on the affected species.

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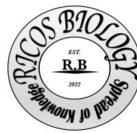
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Ricos Biology Journal ISSN 2959-3751(E), 2959-3743(P)
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