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RESEARCH ARTICLE

Influence of harvesting on associated macrofaunal community of Hazratbal basin of Dal lake in Kashmir Himalayas

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Abstract

Dal Lake is a shallow eutrophic lake, the effects of anthropogenic pressure and its subsequent impacts are evident in the lake. The influence of harvesting on macroinvertebrates was mainly due to habitat disturbance through the removal of vegetation. Harvesting was found to have an impact on some physico-chemical parameters such as a decrease in transparency and increase in dissolved oxygen and conductivity. All the three phyla were affected by harvesting. The impact was highest on Mollusca (planorbidae and lymnaidae) followed by Arthropoda (Chironomidae, coenagrionidae, gammaridae, pyralidae) and Annelida (glossiphoniidae, erpobdellidae). Species richness and composition of major macroinvertebrates in harvested and un-harvested areas of lake were dissimilar as portrayed by biotic indices via decrease in Shannon index from 1.7 to 2.1. On an average the weeded site (18 individuals/ kg dry wt. of macrophytes) had higher density of macroinvertebrates as compared to deweeded areas (2.8 individuals/ kg dry wt. of macrophytes).

Introduction

Dal lake restoration vis-à-vis harvesting was initiated after the recommendations by ENEX-1978, NLCP-1997 and AHEC-Roorke- 2000 reports. Since the nuisance was caused by exotic invasive species there was no controversy w.r.t. nature of conservation aims, as these species were a threat to the native biota. Mechanical harvesting is being carried out from 1984. Since then sophisticated machinery is being imported to restore the glory of the lake. These additions include- Classic Water Master III & Crawl cat (dredgers); Weed harvester and Truxors (harvesters).

For the present study the samples were procured from following two machines. *Mechanical Harvester (Aquarius Systems _ 1020 series)* cuts the vegetation usually at a depth of 3-6 ft. Swiss made *truxors* machines are being used as a part of spring- operation and for skimming off the floating leaved plants. It's carried only along the littoral areas of lake. It was observed that skimming primarily removed *Potamogeton crispus*, which was found to be one of the first plant that emerges with the onset of spring. The magnitude of habitat disturbance by them is much lesser then that of harvesters.

Till date no work has been done on the impact of harvesting on macrophytes associated macro-invertebrates. Lack of study in this field is perceived to be due their supposed insignificance as a commercial resource and primarily due to lack of standardized sampling method. However with the increasing awareness of macroinvertebrates as a primary link between macrophytes and fish considerable research is being initiated in this field. In this study an attempt was made to study the influence of harvesting on species composition and population densities of this important group of macroinvertebrates.

Study area

Dal Lake is situated in the east of Srinagar city. It is a Himalayan urban lake. Position and morphology of lake reveals that it has been derived from an enlarged oxbow in the flood plains of River Jehlum (Dianelle, 1922;

De and Paterson, 1939). The lake being an attractive tourist spot engrosses a large number residential areas and hotels in the catchment area besides being a hub of houseboats, floating gardens both in the littoral and inshore areas of the lake. This makes the problem of lake management multifaceted. The lake is severely infested with *Nymphoides peltata, Ceratophyllum demersum, Myriophyllum spicatum, Hydrilla verticillata* and *Potamogeton crispus, P. leucens, Nymphae Mexicana, Trapa natan, P. natans, Typha* sp., *Phragmites* sp. *Azolla* sp. and *Lemna* sp.

A preliminary survey was conducted in 15 sites covering major basins of Dal Lake. But out of these only three sites were selected in the Hazratbal basin for monthly data collection as there were expected chances of harvesting in these sites during the sampling period (Fig.1). A refernce site where no deweeding has been carried out from the last two decades was also selected for comparison purposes.

Fig. 1 Sampling sites in Hazratbal basin of Dal lake

Materials and method

Sampling was done from March to September, 2012 on monthly basis. However to assess the impact of harvesting, sometimes samples were also collected semimonthly. Important physico-chemical properties of overlying water such as pH, electrical conductivity, water temperature, transparency and dissolved oxygen in accordance with standard methods prescribed in A.P.H.A (1998). A gerking frame box sampler (Gerking 1957) and grappler was used for sample collection. The invertebrates were identified up to the lowest possible taxonomic level readily achievable for each taxon with the help of standard works of Edmondson (1959), McCafferty and Provonsha (1998), Wetzel and Likens (2000), and many other online published keys.

Results and discussion

A diverse phytophilous invertebrate fauna was found in the Dal Lake during the growing season (March to September, 2012). During this period a total of 22 macroinvertebrate genera in 15 families of 11 orders under 3 phyla were identified (Table 1). Insects and molluscs with 10 and 5 genera respectively were the most diverse groups. The most diverse insect group was Diptera (5 species) followed by Odonata (2 species). Other insect orders represented Hemiptera, Coleoptera and Lepidoptera. The non-insect group included crustaceans and spiders. All the five species of molluscs were gastropods (snails). Leeches and segmented worms represented the phylum Annelida. The high difference in abundance of species was observed between reference and deweeded sites (Fig.2). The mechanical harvester removes submerged macrophytes only. The macrofaunal community associated with *Ceratophylum demersum, Myriophyllum spicatum, Hydrilla verticillata* and *Potamogeton crispus* was investigated most thoroughly because of their profuse growth throughout the sampling period. These submerged plant with their characteristic finely dissected and densely packed leaves provided a better shelter and food source for invertebrates (Bogut *et al.,* 2007; Thorp *et al.,* 1997; Balci and Kennedy, 2003; Lillie and Budd, 1992).

Fig. 2. Abundance of macroinvertebrates per kg macrophyte dry weight for whole growing season per site (mean + standard error).

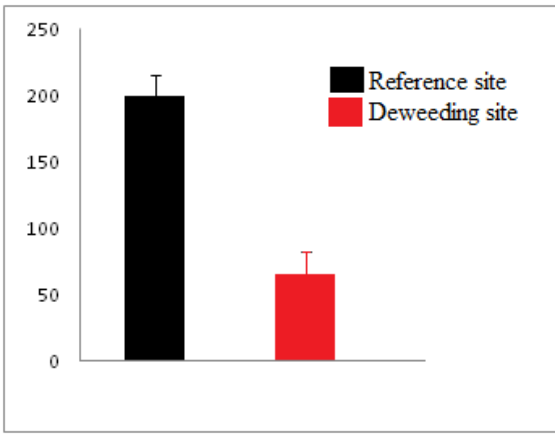


Table 1. Macroinvertebrate species composition in Dal Lake.

Phylum	Order	Family	Genus
Annelida	Rhynchobdellida	Glossiphoniidae	*Helobdella* sp.
			Glossiphonia sp.
	Pharyngobdellidae	Erpobdellidae	*Erpobdella* sp.
	Haplotaxidae	Tubificidae	*Limnodrilus* sp.
			Branchiura sp.
Molluca	Basommatophora	Planoribidae	*Gyraulus* sp.
			Promenetus sp.
			Parapholyx sp.
		Lymnaidae	*Lymnaea auricularia*
			Lymnaea columella
Arthopoda	Diptera	Chironomidae	*Chironomus* sp.
			Ablabesmyia sp.
			Procladius sp.
		Ceratopogonidae	*Bezzia* sp.
		Psychodida	*Psychoda* sp.
	Odonata	Coenagrionidae	*Enallagma* sp.
		Gomphidae	-
	Hemiptera	Corixidae	*Sigara* sp.
	Coleoptera	Dytiscidae	*Coptotomus* sp.
	Lepidoptera	Pyralidae	-
	Amphipoda	Gammaridae	*Gammarus* sp.
	Araneae	Pisauridae	-

Statically insignificant difference in the population densities of invertebrates was observed as a result of skimming (p value < 0.05). This was due to the fact that 2/3rd of the macrophyte standing crop was left behind, which along with the associated macrofauna recovered within 1-2 weeks, this was also reflected by subsequent rise in Shannon-Weiner index after 10 day (Fig. 3). However, some of the species belonging to families Glossiphonidae and Pyralidae were not recorded immediately after skimming, but these eventually established after 20 days.

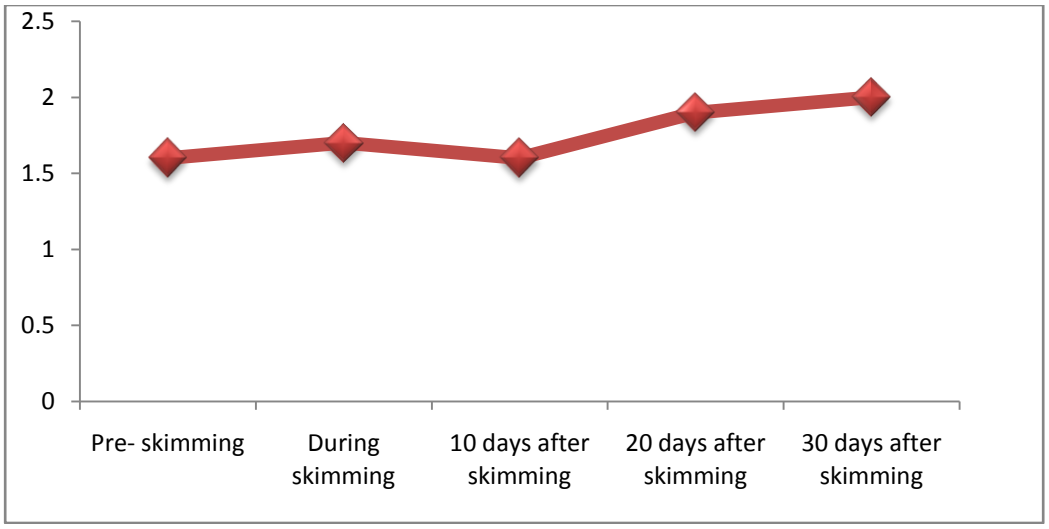


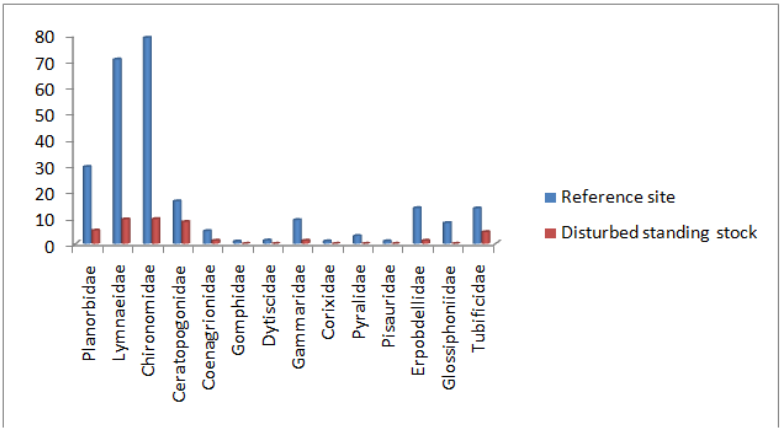
Fig. 3: Impact of skimming on diversity as shown by Shannon weiner index

An important observation after skimming/harvesting during early growing season was that the remaining macrophytic bed eventually became denser in the site compared to the reference site. The primary reason being the cutting of apical meristematic region of submerged plants during such operations, results in removal of shoot apex which in turn might have promoted the release of cytokinin plant hormone that leads to denser and accelerated growth of lateral branches (Cline, 1994). Besides, rapid recolonization of macrophytes occurred probably through vegetative fragments (Vari, 2012) that were dispersed during partial harvesting early in the season (Engel, 1990; Nichols and Lathrop, 1994).

During harvesting in summers the harvester induced vigorous turbulence in the water column, which led to perturbation in the area in terms of suspension of sediments as indicated by the decrease in secchi transparency (from 1.6 to 0.5 m). The physico-chemical parameters like temperature and pH remained almost same pre- and post-harvesting, however, an appreciable increase in dissolved oxygen (from 4.8 to 6.4 mg/l) was found which might be related to the vigorous churning activity of paddle wheels of mechanical harvester. A slight increase in conductivity (from 152 to 165 µS) was also observed, but this marginal fluctuation after harvesting can't be adjudged to determine any considerable change in ionic concentration of lake.

Habitat disturbance in the sites due to removal of plant biomass along with large-scale turbulence of water column results to dislodging and removal of invertebrates. This led to a decline in taxa number, diversity and specie richness which is attributable to lower abundance of macroinvertebrates in manipulated environment (Kaenel, *et al.*, 1998; Monahan and Caffery, 1996) as compared to reference site (Fig. 4). In other words, the loss of habitat by mechanical removal of macrophytes is considered as the cause of invertebrate decline in lake (Bryan, 1975). The decrease in invertebrate number is also shown by the reduced value of Shannon index in deweeded site (1.7) as compared to reference site (2.1).

Fig. 4. Comparison of Reference (Hazratbal site) and highly deweeded (standing macrophyte stock remaining after deweeding in Dockyard site) area of Dal lake from May to July, 2012



Dominance slightly decreased after harvesting but the evenness increased (Fig. 5). The plausible reason might be that prior to harvesting the richness of taxas to the total community was more or less uniform with lesser evenness, that is the group of organism having better competitive ability dominated over others, thereby numerically contributing more to the total community. Post-harvesting only those few species survived that were able to colonize and complete their life cycle during such perturbations (Fig. 4) leading to an increased evenness among species and decreasing dominance.

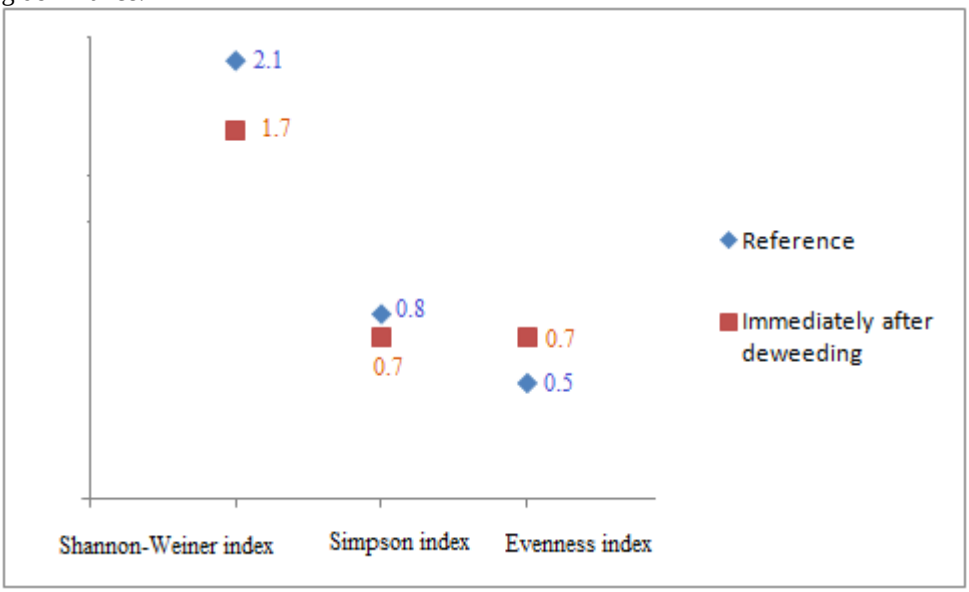


Fig. 5. Impact of harvesting as shown by biotic indices.

Hence, this study provides a preliminary understanding of the impact of deweeding on macroinvertebrate community associated with the macrophytes. Nevertheless allelopathy by macrophytes – their subsequent impact on invertebrates and feeding behavior of macroinvertebrates – needs to be investigated in detail in future studies to provide an elaborate information on the role of harvesting regime in favoring not only the long term dominance of some animal species over others but also the growth of mono-specific macrophytic beds.

Conclusion

Dal Lake is a shallow eutrophic lake, the effects of anthropogenic pressure and its subsequent impacts are evident in the lake. Apparent changes in the lake ecosystem can be related to anthropogenic activities and management problems. The influence of harvesting on macroinvertebrates was mainly due to habitat disturbance through the removal of vegetation. Harvesting does not uproot the submerged plants but simply trims the vegetation that is what is responsible primarily for recovery of invasive macrophyte species and corresponding macroinvertebrate fauna after harvesting. Harvesting was found to have an impact on some physico-chemical parameters such as a decrease in transparency and increase in dissolved oxygen and conductivity. All the three phyla were affected by harvesting. The impact was highest on Mollusca (planorbidae and lymnaidae) followed by Arthropoda (Chironomidae, coenagrionidae, gammaridae, pyralidae) and Annelida (glossiphoniidae, erpobdellidae). However, at the end of growing season the ceratopogonidae, chironomidae and lymnaeidae reached to an appreciable number. Species richness and composition of major macroinvertebrates in harvested and un-harvested areas of lake were dissimilar as portrayed by biotic indices. On an average the weeded site had higher density of macroinvertebrates as compared to deweeded areas. However, interpretation of some of the observations was limited by lack of research in bio-chemical aspect of plants and feeding habits of invertebrates, this leaves scope for future research.

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