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Impact of different Harvesting Techniques on the Population of Macrophyte-associated-Invertebrate Community in an Urban Lake

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Abstract

From past few decades the water quality of Dal Lake has decreased considerably. The excessive nutrient input from catchment area has led to nuisance growth of macrophytes which impede the services provided by the ecosystem. In order to control the excessive macrophytic growth the state government initiated a weed harvesting programme which includes manual- and mechanical- deweeding. This paper evaluates the influence of weed removal technique on the density of invertebrates that are associated with macrophytes. It was found that maximum number of invertebrates were removed via mechanical harvester (49.4%) followed by truxors (26.6%) and manual deweeding (23.9%). The average density of removed invertebrates was highest for Arthropoda (43 ind.Kg^{-1}), followed by Mollusca (31 ind.Kg^{-1}) and Annelida (11 ind.Kg^{-1}).

Manual deweeding involves selective harvesting and complete removal of macrophytes as against harvesters which trim the vegetation. Thus, the former emerged as a better method of controlling growth of nuisance macrophytes and restoring the health of the ecosystem than the latter.

Keywords: Deweeding; Harvesting; Invertebrates; Macrophytes

Introduction

Freshwater is an important resource essential for endurance of life on earth. Despite of over-riding priority to conserve these ecosystems, they are among the world's most altered ecological unit in terms of chemical, physical and biological alterations due to large scale water diversions, introduction of invasive species, pollution, eutrophication and climate change [1,2].

The freshwater bodies that are in close proximity to human settles are greatly impacted due to constant input of nutrients and wastes from its catchment area. Dal Lake is one such Himalayan urban lake located in Srinagar city of Jammu and Kashmir, India. From past few decades its water quality has considerably deteriorated due to excessive nutrient enrichment which has in turn lead to profuse microbial activity, algal blooms and nuisance weed growth.

The imprudent growth of macrophytes have manifested adverse effects in the utilization of this important resource, thereby interfering with its use for legitimate purposes in economic, cultural, aesthetic, scientific and educational terms.

For controlling the luxuriant growth of invasive weeds the state government initiated a weed harvesting programme on the recommendations by ENEX, NLCP and AHEC [3-5]. The process of weed removal is referred to as deweeding or harvesting. Two major methods have been employed for this purpose mechanical- and manual-deweeding. While the former is less time consuming and removes bulk of vegetation at a time the latter is more time consuming and selective in nature (Figure 1). Some of the mechanical devises include Weed harvester (Aquarius systems, Wisconsin and Rolba-type, Switzerland) and Truxors (Aquarius Company, Switzerland). On the other hand, manual deweeding requires the use long-hooked poles that are plunged in water; the hook gets entangled with the weeds that are then removed.

Since the macrophytes serve as a direct or indirect food source to the invertebrate groups belonging to different functional feeding groups [6], so this work explores the influence of different weed removal methods on the invertebrates associated with macrophytes.

Study area

The Dal Lake is situated at an altitude of 1584 m.a.s.l. It is located between the north latitudes 34° 05'- 34° 09' and east longitudes 74° 50'- 75° 05' in the north-east of Srinagar city (Figure 2). The catchment of the lake is 321 sq.km. The lake is multi-basined with four distinct basins, viz., Hazratbal (Bod Dal), Lokut Dal, Gagribal and Nigeen. From the past many decades the lake has not only undergone cultural eutrophication but there has been continuous encroachment of its shallow areas with the result that the water spread has got reduced to just 11 km^2 from 25 km^2.

Materials and Method

The sampling was carried out during March-April, 2012. Fresh macrophyte samples were taken from head of mechanical harvester and truxor. In case of manual deweeding, sample were collected from freshly harvested biomass. In the laboratory the sample was segregated into batches. A single batch was taken at a time which was thoroughly diluted in water and invertebrates were removed. This process was repeated thrice for each batch so that all the associated organisms were detached from the plant. The macrophytes were later air dried and weighed.

Results and Discussion

While assessing the level of removal of associated macroinvertebrates using different deweeding techniques, it was found that maximum

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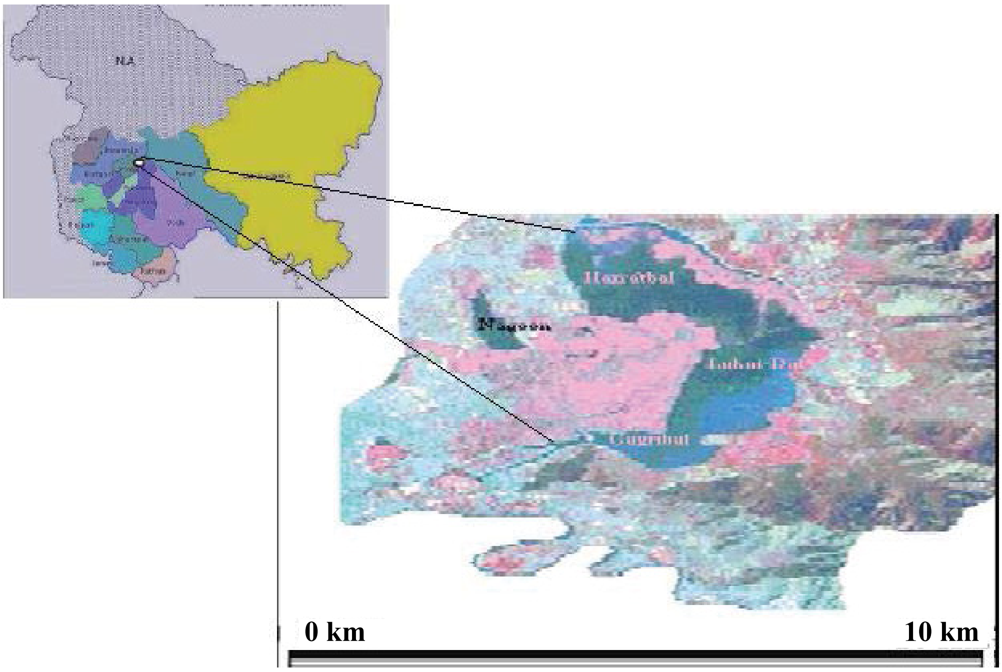

Figure 1: Location map of Dal Lake.

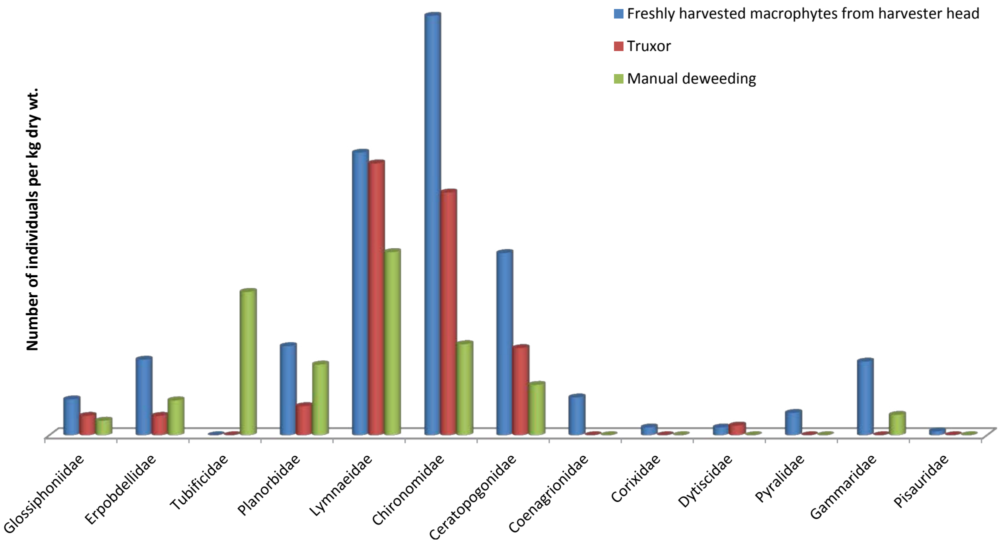

Figure 2: Level of invertebrate removal by different deweeding techniques.

number of invertebrates were removed by mechanical harvester (49.4%) followed by truxors (26.6%) and manual deweeding (23.9%).

The average density of removed invertebrates were as Arthropoda (43 ind.Kg^{-1}), Mollusca (31 ind.Kg^{-1}) and Annelida (11 ind.Kg^{-1}).

In phylum annelid manual deweeding removed three families which included Tubificidae (14.8 ind.Kg^{-1}), Erpobdellidae (3.6 ind.Kg^{-1}) and Glossiphoniidae (1.5 ind.Kg^{-1}). Truxors and harvesters removed only two of them, tubificidae which comprised of *Limnodrilus* sp. and *Branchiura* sp. were found absent as these are bottom dwelling organisms, during manual deweeding considerable amount of sediment is excavated out along with the plant biomass, however, truxors and harvesters only trim the vegetation without uprooting the underground part of macrophytes.

For mollusca only order basammatophora was recorded which comprised of taxas like *Promenetus* sp., *Lymnaea auricularia* and *Lymnaea columella*. These were recorded in considerable number in all the three techniques. Comparatively there was no significant difference in their percentage removal.

Lastly arthropod was most diverse phylum of all, being represented by a vast array of taxa. Harvesters were reported to remove maximum of organisms along with the harvested biomass. It followed the following trend: Diptera>Amphipoda>Hemiptera>Coleoptera>Araneae>Lepidoptera. Highest removal was observed for chironomidae (43.2 ind.Kg^{-1}), ceratopogonidae (18.8 ind.Kg^{-1}) and gammaridae (7.6 ind.Kg^{-1}). The diversity in the samples from other two techniques was no so pronounced.

In the initial stages of sampling it was found that the sample procured from storage deck barge of harvester (where the harvested biomass was stored for a long time till it reaches to its adequate capacity) contained no invertebrates except for some empty snail shells. The reason might be that with increasing air temperature the moisture content in harvested biomass decreases and the entangled organisms try to move in to deeper layers of the stored vegetation and eventually escape from the perforated plates of the barge and the loading vehicle (Figure 3) or they might have got desiccated which made their collection and identification impossible. To quantify the impact of deweeding and minimize the above drawback, fresh samples from harvesters head were taken, which showed a wide variety of animals being removed.

Truxors used for skimming (Figure 4) remove bulk of vegetation which mainly comprised of floating leaved plants and upper 1/3rd of submerged plants. The selective manual deweeding also removes appreciable number of invertebrates, the only difference being that sediment is removed along with the vegetation. This also removed a range of segmented worms including *Limnodrilus* sp., *Branchiura* sp. and *Nais* sp.

Figure 3: The perforated plates of harvester as well as loading vehicle provide an escape route for invertebrates and plant propagules like turion and buds. The macrophytes attached to harvester head aid in dispersion of viable propagules as the machine moves through water.

Figure 4: Lateral (left) and front view (right) of a Truxor harvester.

The harvesters are largely responsible for aiding in dispersion of viable propagules as the machine moves through water also since harvester trims the vegetation and does not uproot it the remaining macrophytic bed eventually became denser because of removing apical dominance which promotes accelerated growth of lateral branches [7]. Hence, manual deweeding because of selective harvesting and complete removal of macrophytes emerged out a better method of controlling growth of nuisance plants and restoring the health of the ecosystem.

Conclusion

Dal Lake, being a shallow eutrophic water body, is very productive due to high concentration of dissolved nutrients like nitrogen and phosphorus. This favors profuse growth of algae and other macrophytes. Apparent changes in the lake ecosystem can be related to anthropogenic activities and management problems. Mechanical deweeding disturbs the invertebrate populations which lead to destabilization of the community.

Deweeding through mechanical devices like harvesters and truxors does not involve proper selection of the weeds to be controlled. Instead, the harvester removes the weeds at random and in bulk amounts. This may also lead to some permanent changes in the biotic community structure of the lake in near future. As there is every possibility that some invasive macrophytic species get a chance to become more dominant in due course of time. Therefore, it's required that the present random type of harvesting is modified to a more scientific deweeding process where the population density and its distribution pattern are given centre-stage while deweeding in the lake areas. If this is done then simultaneous changes will be reflected that will help the lake ecosystem to restore to a great extent.

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