Wetlands are considered as transitional areas between land and water. These ecosystems represent the transition between the two extreme diversifications, sustaining both amphibious as well as purely aquatic taxa, harbour a very complex taxonomic makeup of the macrophytic community (Smith, 1980; Banerjee and Venu, 1994). Wetlands are recognized for their high species diversity and productivity (Williams, 1990; Mitsch and Gosselink, 2000). They maintain ecological balance by performing four fundamental functions viz. hydrological, physico-chemical, biological and socioeconomic (Williams, 1990).

Wetlands are often described as “nature’s kidneys” for their ability to filter waste and pollutants, as well as “nature’s supermarket” for their high productivity and ability to act as a source of food to many organisms (Mitsch and Gosselink, 2000, 2007). The ecological significant services provided by the wetlands include climate regulation, turnover of organic matter, biomass accumulation, as well as substrate for phytophilous organisms and a source of food for aquatic as well as terrestrial organisms (Winter, 1989; Gorham, 1991; Cox, 1993). These ecological services are often considered in anthropocentric terms, because of their ability to ameliorate floods, stabilize shoreline, prevent erosion, as well as removal of contaminants from the water (Cox, 1993). Wetlands also play significant role in the biogeochemical cycling of nutrients by acting as nutrient source, as well as sink of nutrients (Schlesinger, 1991).

Wetlands, representing the last stage of lake succession, are heavily infested with macrophytes particularly emergents acting as nutrient pumps (Pandit, 1984; Cronk and Fennessy, 2001). Macrophytic infestation in aquatic ecosystems, like littorals and shorelines of lakes, marshes etc., determines the structure and functioning of these ecosystems in terms of their community architecture and distribution (Pandit, 1984). It has been emphasized that the aquatic plants occupy
great diversity of niches and display morphological plasticity. At the same they also occur in considerably wide range of forms and size though not as great as seen among the terrestrial plants (Pandit, 1984, 2008). It is true for our all aquatic ecosystems and more so for wetlands that all the three macrophyte types, representing different tiers: (a) submerged, floating leaf-types and free floating species, (b) low growing emergents and (c) tall emergents, are present influencing their physico-chemical environment as they form the basis of detritus food chains after their decay (Pandit, 1984, 2008).

Macrophytes, as a component of fresh water ecosystems, have diverse roles to play in the functioning of these ecosystems (Pandit, 1984; Wetzel, 2001). They are directly involved in modifying the nutrient chemistry within the water by acting as nutrient sinks as well as source of nutrients. (Carignan and Kalff, 1980; Pandit, 1984; Cronk and Fennessy, 2001). Besides, controlling the level of oxygen, macrophytes are also able to perform pivotal role in the biotic interactions of the littoral zone of shallow lakes and wetlands (Raspopov et al., 2002). The structural design of macrophytes within wetlands offers refuge for macroinvertebrate communities and periphyton (Pandit, 1984; Carpenter and Lodge, 1986; Cyr and Downing, 1988; Beckett et al., 1992). Herbivorous invertebrates such as crayfish obtain their food directly from aquatic plants (Lorman and Magnuson, 1978; Price et al., 1980; Rozas and Odum, 1988; Chambers et al., 1990; Hanson et al., 1990), and some fish (Pandit, 1984; Carpenter and Lodge, 1986). Macrophytes provide an efficient method for removing contaminants from the water, which has resulted in the successful implementation of treatment wetlands (Maine et al., 2006). Macrophytes offer significant regulating services through the stabilization of shoreline and at the same time prevent erosion with the help of root structure. Amelioration of flood effects by slowing incoming water flow, thereby acting as a sponge is also among the significant ecosystem services provided by macrophytes (Croft, 2007).

Macrophytes have pronounced impact on their abiotic environment (Kaul et al., 1980; Pandit, 1980; Makela et al., 2004). They slow down currents and thereby increase sedimentation (Spence, 1982; Carpenter and Lodge, 1986; James and Barko, 1990). The composition of the sediments beneath macrophyte beds differs considerably from other sediments. Sediments beneath the macrophytes are rich in nitrogen, phosphorus, calcium and organic compounds (James and Barko, 1990).
sediments below macrophytes also have increased proportion of decaying material from the plant bed (Carpenter and Lodge, 1986). Macrophytes alter the quantity and quality of light under them. The reduction in the amount of light causes the water under the macrophytes to be cooler than the surrounding water (Carpenter and Lodge, 1986). Macrophytes are having profound influence on chemical characteristics of wetland waters. Respiration and photosynthesis processes carried out by macrophytes influence the oxygen and carbon dioxide levels in littorals than the limnetic zone. Organic and inorganic carbon levels in the water are increased by macrophytes while inorganic nutrient levels are generally reduced (Carpenter and Lodge, 1986). Recent studies also suggest that macrophytes play a central role in shallow lakes which can have two possible stable equilibria: (i) a clear-water state that is dominated by aquatic macrophytes, and (ii) a turbid-water state that is dominated by phytoplankton (Scheffer et al., 1993; Moss et al., 1994; Hakanson and Boulion, 2002). In addition to these ecosystem services, macrophytes acts as potential source of food and fodder for humans and bovine population, besides serving as a base of aquatic foodchain (Pandit, 1984; Tardío et al., 2005; Rahman et al., 2007; Hasan and Chakrabarti, 2009; Smith, 2011; Swapna et al., 2011). This realization of multiple ecological and socio-economical importance of macrophytes has generated a great interest towards better understanding of their diversity and role in natural ecosystems, thus paving a way for scientific management of macrophytes dominated ecosystems-the wetlands (Pandit, 1999).

The shape of some macrophytes determines the environment that they may inhabit (Duarte and Roff, 1991). The aquatic macrophytes in the littoral zone of lakes are arranged in specific zones (Spence, 1982; Wetzel, 1983). Emergent macrophytes occur nearest the shore, the floating macrophytes occupy the intermediate zone, and the submersed macrophytes are farthest from shore towards the limnetic zone. The occurrence, density, distribution and growth of aquatic macrophytes depends on myriad of abiotic factors such as pH, water depth, transparency, bicarbonate alkalinity, dissolved organic matter, nitrate-nitrogen, phosphate etc. (Pip, 1979; Madsen et al., 2006; Vis et al., 2007; Dar et al., 2014). Composition and properties of sediments also seem to have considerable effect on the diversity and distribution of certain macrophytic species (Dawson and Krysztof, 1999; Heegard et al., 2001; Makela et al., 2004; Tamire and Mengistou, 2012; Sossey-Alaoui and Rosillon,
In addition to these factors the growth of macrophytes also depends on the number of growing days in the season (Wetzel, 1988) and accordingly different macrophyte species may exhibit seasonally variable growth patterns (Wetzel, 2001). Macrophytes act as important bioindicators of environmental conditions and long-term ecological changes in water quality (Pandit, 1984, 92; Solimini et al., 2006; Beck et al., 2010; Sondergaard et al., 2010). Because of their high rate of biomass production, macrophytes act as an important primary food resource for aquatic organisms (Pandit, 1980, 84). The complex tropic dynamics and primary productivity of wetlands is greatly influenced by the higher diversity and biomass of macrophytes (Kumar and Singh, 1987).

Phytoplankton and emergent, floating and submerged macrophytes which differ in terms of their productivity, consumption of different sources of nutrients and energy, are principal primary producers in shallow lakes and wetlands (Horne and Goldman, 1994; Nikolic et al., 2009). The abundance and productivity of macrophytes can vary within two orders of magnitude among lakes of different trophic levels. It has been well documented that maximum productivity of the biosphere occurs in the zone of emergent aquatic macrophytes and declines rapidly in case of submerged macrophytes (Westlake, 1963; Wetzel, 1990). Among macrophytes, emergents and rooted floating-leaf type are the most abundant and productive than submerged aquatic macrophytes and that are herbaceous perennial plants, developing highly dissected foliage and are not the rapidly growing surface canopy forming species under eutrophic conditions. The continuous turnover of organic matter with production of relatively resistant particulate organic matter in senescent tissues is mainly caused due to the continuous growth of perennial plants. However, annual plants do not exhibit such continuous growth and biomass turnover (Wetzel and Sondergaard, 1998). The productivity of perennials with thin, finely divided, reticulated foliage that increases surface area, enhances gas exchange and light harvesting is very much higher compared to productivity of rosette perennials such as the isoeetids and of most annual submerged plants (Sculthorpe, 1971). The higher productivity of aquatic macrophytes may hasten the process of eutrophication at the time of their decomposition (Nikolic et al., 2007, 2009; Dar et al., 2012). Therefore, for protecting the ecological balance in freshwater ecosystems, it becomes
imperative to monitor these ecosystems for growth and development of macrophytes with high biomass rates (Coops et al., 2002; Nikolic et al., 2009).

For the assessment of nutritional value and evaluation of food potential of aquatic plants, the knowledge of their ecological significance and chemical composition is essential (Chapman and Chapman, 1980; Hawkins and Hartnoll, 1983; Pandit, 1984, 1993; Pandit and Qadri, 1986; Abbott 1988). It is well known that seasonal variations in certain abiotic factors such as light, temperature, sediment composition and water chemistry can influence photosynthetic rates and biochemical composition of macrophytes (Koskimies and Nyberg, 1987; Roslin, 2001; Ordsuna-Rojas et al., 2002; Rajasulochana et al., 2002), thus necessitating the determination of their biochemical composition.

The biogeochemistry and trophic dynamics of wetlands is largely controlled by the distribution patterns of macrophytes and therefore, it becomes imperative to view wetlands as complex mosaic of habitats with distinct structural and functional attributes (Rose and Crompton, 1996). Considerable efforts have gone into the field studies to correlate the spatial distribution pattern of aquatic plants with major physico-chemical environment of their habitat. In India the studies on wetland ecosystems have attracted the attention of quite a few investigators in the last few decades (Gopal, 1968; Das and Gopal, 1969; Verma, 1979; Verma et al., 1982; Paliwal, 1984; Shardendu and Ambasht, 1991; Usha, 2002; Singh and Sharma, 2012) to mention a few, but most of them deal mainly with floristics composition, production and zonation in relation to water depth. There are only few reports regarding the distribution patterns and community characteristics of macrophytes including the studies pertaining to physiognomy of wetland vegetation in Kashmir (Handoo, 1978; Kak, 1978, 1981, 1990; Kumar and Pandit, 2005, 2008; Rather and Pandit, 2006; Mir, 2007; Mir and Pandit, 2008; Pandit, 2008; Kumar, 2009; Rather, 2009). Further, very little but preliminary published literature is available on Wular lake (Mir, 2007; Mir and Pandit, 2008) particularly on the very aspect of macrophytes. It is only very recently some work, yet to be published, has been conducted on the production and nutrient dynamics of macrophytes in Hokersar wetland (Kumar, 2009) which as such has remained untouched as far as the distribution patterns and biochemical composition of macrophytes is concerned. In this backdrop the present study on “Distribution, production and biochemical status of
dominant macrophytes in Wular lake, a Ramsar Site in Kashmir Himalaya” has been undertaken to work out a generalized relation between water and macro- vegetation distribution, production and biochemical composition. This study can later on in future help in determining the pattern in which distribution, production and biochemical composition of macrophytes change as the water quality deteriorates. The present study thus aims at fulfilling the following objectives:

1. To study the community features of macrophytes.
2. To assess the complex physiognomy of macrophytes in terms of species composition and various diversity indices.
3. To work out the primary productivity of dominant macrophytes.
4. To prepare vegetation map depicting the zonation and current status of the macrophytic community in respect of the diversity and distribution.
5. To assess the seasonal variations in the biochemical status of dominant macrophytes (carbohydrate, lipid, protein and chlorophyll (a, b and total) contents).
6. To study the seasonal variations in the physico-chemical characteristics of lake waters.
7. To study the relationship between macrophytes and physico-chemical characteristics of lake waters for determining the ecological distribution of macrophytes.