2nd International Conference - Water resources and wetlands. 11-13 September, 2014 Tulcea (Romania); Available online at http://www.limnology.ro/water2014/proceedings.html
Editors: Petre Gâştescu ; Włodzimierz Marszelewski ; Petre Bretcan; ISSN: 2285-7923; Pages: 102-109;

FLOATING AQUATIC PLANTS AND THEIR IMPACT ON WETLANDS IN TURKEY

Birsen Kırım, Deniz Çoban, Mehmet Güler
[1] Adnan Menderes University, Faculty of Agriculture, Department of Fisheries Engineering, South Campus Aydın/Türkiye * Email*: birkirim@hotmail.com*

Abstract
Aquatic plants play an important role in wetlands because they provide many benefits to fish, birds and other wildlife animals. They ensure food, habitat and oxygen to wildlife, aquatic organisms and even people. During the history, humans have used these plants as a food source, and medicine. They can also soak up pollutants from contaminated water. Aquatic plants are classified according to properties such as their habitats, form, size, development properties and etc. in wetlands. The most common floating aquatic plants in wetlands are *Lemna, Spirodela, Salvinia* and *Azolla*. There are also aquatic plants such as *Potamogeton, Nymphaea* and *Trapa* which are rooted in the soil at the base of the water but have leaves floating on the surface. The aim of this study is to mention the role of the floating aquatic plants in wetlands in the world and Turkey which are also known as invasive aquatic plants. Literature knowledge on floating aquatic plants are examined and the importance of these plants are evaluated and discussed.

Keywords: Floating aquatic plants, invasive aquatic plants, wetlands

1 INTRODUCTION

Wetlands, which are of great importance with regards to their features and host of species richness for the sustainability of the ecological balance, are not given enough importance even they are underestimated as swamps or marshes.

Wetland ecosystems are adapted to the hydrological regime and are vulnerable to change. They perform many functions on local, regional and global scales from providing wildlife habitat and basic necessities for humans to regulating atmospheric processes and geochemical cycles. While these benefits are not always obvious or measurable, they are nevertheless critical (Alexander & Mclnnes, 2012).

The Ramsar Convention recognizes that the designation of Wetlands of International Importance (Ramsar Sites) provides just the starting point for securing the sustainability of wetlands. Wetlands are dynamic areas, open to influence from natural and human factors. The Convention also recognizes the interdependence of humans and wetlands and the irreplaceable resources they provide to society. In all of their myriad forms, wetlands are collectons of plants, animals and microorganisms (biotic components) that interact with the nonliving environment (abiotic components) and exist within and form an integral part of the larger landscape, i.e., watersheds, catchments and river basins (Handbook 18: Managing wetlands, 2010; Alexander & Mclnnes, 2012; STRP, 2012).

Turkey has included in 1994 to Ramsar Convention signed at Ramsar City of İran in 1971 and aimed in the conservation and wise use of wetlands.

According to the World Wildlife Fund Turkey report, 2011; Turkey has lost half of its 2.5 million hectares of wetlands over the last 40 years due to poor water-management practices and water pollution. The report emphasized that the country's largest body of freshwater, Lake Eğirdir, is among those threatened by pollution. Other threatened wetlands include those around Lake Beyşehir, Lake Bafa (Figure 1), the "Büyük Menderes Delta", the "Gediz Delta", "Göksu Delta", the "İğneada Su Basar Forests and Lakes", "Lake İznik", "Lake Sapanca" and "Lake Ulubat". "Lake Tuz", formerly Turkey's second-largest lake, has diminished by 60 percent due to unsustainable consumption of both aboveground and underground water sources (Hürriyet Daily News, 2011).

Under the Ramsar Convention, 13 sites in Turkey have been listed as Ramsar Sites: Sultan Marshes in Kayseri, Kuş Lake in Balıkesir, Seyfe Lake in Kırşehir, Göksu Delta in Mersin, Burdur Lake in Isparta in 1994; Kızılırmak Delta in Samsun, Uluabat Lake in Bursa, Gediz Delta in İzmir, Akyatan Lagoon in Adana in 1998; Yumurtalık Lagoons in Adana, Meke Maar in Konya in 2005; Kızören Obruk in Konya in 2006; Kuyucuk Lake in Kars in 2009; adding up to a total of 179.898 hectares. Therefore, 14th Ramsar Site of Turkey, namely Nemrut Caldera will be announced by 2013 (Turkey's Important Wetlands, 2013).

Floating aquatic plants provide sheltering, protection, nutrition and reproduction habitat for the other aquatic life. They produce oxygen and by purifying the water they decrease the effect of pollutants. They uptake the nutrients and use for the food chain. They are also used by people for different usages and

activities such as pool decoration, cosmetic products etc. However, there are also negative impacts. As the result of their rapid growth over the water surface, the other living organisms, which are hanging on their bodies, increase in number, which prevent the transmission of light and cause oxygen decrease in water. As a result of this, in periods when the dissolved oxygen decreases there could be seen a great amount of loss in invertebrates and fish.

In this context, the aim of this study is to emphasize the importance of the wetlands and particularly the floating aquatic plants, which are not well known and taken into considerence.

Acccording to this aim, as the aqutic plants have great importance but do not see the value they deserve, it is decided to dwell on this subject and literature knowledge on aquatic plants particulary the floating aquatic plants in Turkey and in the world are examined and discussed due to the literature review.

Figure 1. Lake Bafa, Aydin, Turkey

2 MATERIAL AND METHOD

Material of this study is the literature knowledge on Wetlands specific to free-floating aquatic plants. The method used in this study depends on analyzing of literature from different sources. The method is developed mainly in three stages:

1. Determining the subject of the study,
2. **Collecting Data**: Literature on floating aquatic plants in Wetlands in the world and some of the important floating aquatic plants in Turkey are examined.
3. **Evaluation**: Floating aquatic plants in Turkey are evaluated and discussed according to the literature review.

3 LITERATUR REVİEW

3.1 Wetlands, Functions, Values and Benefits

In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The word wetland is used to describe areas where the soil is saturated or covered by water for some part of the year. Many wetlands have been lost, and most remaining wetlands are embedded within highly modified landscapes where basic ecosystem functions have been compromised by anthropogenic disturbance (Mıshra & Naraın, 2010; Euliss Jr, et al., 2014).

Wetlands have many important functions and value. To a wide range of wildlife species, they offer critically important habitats. They also act to mitigate flooding, regulate micro and macro climate changes, degrade pollutants and control erosion etc. Wetland ecosystem functions include the transfer and storage of water, biochemical transformation and storage, the production of living plants and animals, the decomposition of organic materials, and the communities and habitats for living creatures. Wetland ecosystem functions include the transfer and storage of water, biochemical transformation and storage, the

production of living plants and animals, the decomposition of organic materials, and the communities and habitats for living creatures (Minga, et al., 2007).

Based on these and other ecological functions, wetlands provide "values" to humans and naturally functioning ecosystems. Important values include, but are not limited to, flood control, filtering and cleansing water, erosion control, food production (shrimp, ducks, fish, etc.), timber production, recreation (boating, fishing, bird watching, etc.), winter deer yards, and habitat for plants and animals, including many rare or endangered species (Mitsch & Gosselink, 2000; EPA, 2001).

Benefits provided by wetlands include water supply and control, mining, use of plants, wild-life, integrated systems and aquaculture, erosion control, education and training, recreation and reclamation (Dordio, et al., 2008; USEPA, 2000).

Wetlands are considered valuable because they clean the water, recharge water supplies, reduce flood risks, and provide fish and wildlife habitat. In addition, wetlands provide recreational opportunities, aesthetic benefits, sites for research and education, and commercial fishery benefits.

Wetland functions include water quality improvement, floodwater storage, fish and wildlife habitat, aesthetics, and biological productivity (EPA, 2001)

3.2 Wetlands Aquatic Plants (Macrophytes) and Types

Wetlands (marshes, swamps, bayous, and bogs) generally are shallow, low-lying areas (near the water table) with fluctuating water levels. The soils are wet most of the year and they support an abundance of aquatic plants (Helfrich & Parkhurst, 2009).

Wetland plants or hydrophytes, are adapted for life in these wet, oxygen poor soils. There are many different types of wetlands. They occur in both fresh and saltwater. Each can be identified by its dominant or common plants. Wetlands provide habitat for hydrophytes or aquatic plants, that are adapted to living in saturated soil all or part of the year. Aquatic and wetland plants come in a variety of shapes and sizes and fill many ecological habitat (Mıshra & Naraın, 2010).

Aquatic plants grow partially or completely in water. Macrophytic plants are large enough to be seen with the naked eye (as compared to phytoplankton, which are tiny and can only be identified with a microscope) and are found in the shallow zones of lakes or rivers. This shallow zone is called the littoral zone and is the area where sufficient light penetrates to the bottom to support the growth of plants. The types of aquatic and wetland plants (macrophytes) of interest to most aquatic plant management programs can be classified into four groups: Emergent, Floating-leaved, Submersed, and Free floating (sometimes can be included in algae; algae are photosynthetic plants and unlike the majority, but not close relatives of the plant kingdom is a group of a group of aquatic organisms), (Figure 2). Aquatic macrophytes, by definition, are the macroscopic (large enough to be observed by the naked eye) forms of aquatic and wetland plants found in water bodies. The term aquatic macrophytes refers to a diverse group of aquatic plants and encompasses flowering vascular plants, mosses, ferns, and macroalgae (Gettys, et.al., 2009).

Floating plants, two types develop. One part, with their roots hold the soil and their leaves float on the surface of the water. A portion also hold anywhere freely float on the surface of the water. These plants are plants drifting freely with wind and wave movements on the water surface and that are not associated soils. Generally, in the colonies thrive.

In these plants, as there are extremely rugged (*Azolla caroliniana*, *Lemna trisulca*, ect.) which are highly sensitive (*Salvinia auriculata*, *S. natans* etc.) to environmental conditions are also available (Söğüt, 1996).

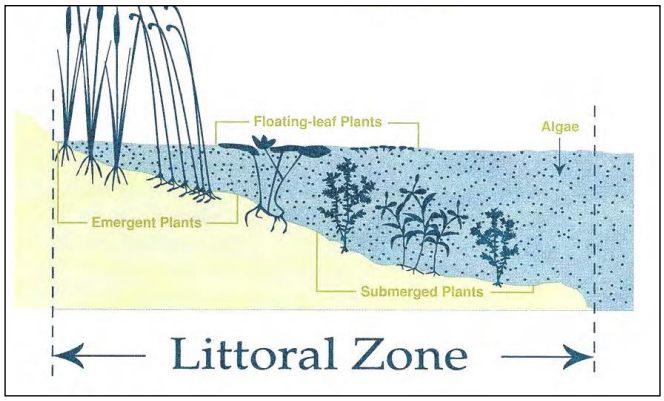

Figure 2. (Gettys et.all., 2009)

Floating-leaved plants grow at intermediate depths. Some floating-leaved species are rooted in the sediment, but others are freefloating with roots that hang unanchored in the water column. The leaves of floating-leaved plants float more or less flat on the surface of the water. Waterlily and spatterdock are floating-leaved species, whereas waterhyacinth and waterlettuce are free-floating plants. Submersed plants are rooted in the sediment and inhabit the deepest fringe of the littoral zone where light penetration is sufficient to support growth of the plant (Gettys, et.al., 2009).

Algae also grow in lakes and provide the basis of the food chain. The smallest algae are called phytoplankton and are microscopic cells that grow suspended in the water column throughout the lake. Dense growth of phytoplankton may make water appear green, but even the "cleanest" lake with no green coloration has phytoplankton suspended in the water (Gettys, et.al., 2009).

In aquatic plants, the most intense interference may be expected to occur between species of similar growth forms occupying a similar position in the water column. Despite apparent similarities, these species may differ substantially when facing interference competition (Gettys, et.al., 2009).

In the aquatic environment, the availabilities of light, dissolved inorganic carbon and nutrients are critical for the photosynthesis and growth of floating-leaved plants. In competition for light, floating-leaved plants have the advantage of being unshaded by any lightreducing component of the water (Gettys, et.al., 2009). When conditions permit water plants can multiply very quickly in the environment (Figure 3).

Figure 3. Bozdoğan, Aydin, Turkey.

3.2.1 Some aquatic plants in Turkey

In the wetlands of Turkey, about 50 families and 500 species live among aquatic plants. Some aquatic plants which are reported in Turkey are: *Apium, Alisma plantago-aquatica, Azolla filiculoides, Butomus umbellatus, Callitrichaea (4 species), Carex, Ceratophyllum demersum, C. submersum, Eleocharis, Elodea Canadensis, Fontinalis antipyretica, Juncus, Lemnaceae (5 species), Lotus, Mentha aquatic, Menyanthes trifoliate, Myriophyllum, Nuphar lutea, Nymphae alba, Nymphoides peltata, Phragmites, Polypogon, Potamogeton Pectinatus, P. natas, P. perfoliatus, Ricciocarpos natans, Rumex, Sagittaria sagittifilia, Salviniaceae -Salvinia natas-, Schoenoplectus lacutris, S. littoralis, Scirpus, Sparganium, Trapa natans, Typha (6 species), Ultricularia (3 species), Vallisneria spiralis, Veronica* (Environment Foundation of Turkey, 1993).

3.2.2 Some free-floating aquatic plants in Turkey

Water hyacinth, Duckweed and *Azolla, Salvinia, P. Stratiotes* are some of the most common and important floating macrophytes. Freely floating plants, such as water grass (*Ricciocarpos natans*), red fern (*Azolla filiculoides*), floating fern (*Salvina natans*), duckweeds (*Lemna* species*)*, big duckweed (*Spirodela polyrrhiza*), frogsbit (*Hydrocharis morsus-ranae*) can be seen in Turkey.

Freely floating plants (e.g., *Salvinia*, *Azolla*, *Lemna*, *Wolffia* and *Spirodela*) cover the water surface and reduce the evaporation losses while on the other hand by transpiration; they cause the losses of water (DSI, 2009; Söğüt, 1996).

Water hyacinth *Water hyacinth* is a floating plant that has clusters of leaves with spongy stalks arising from a base of dark purple feathery roots. *Water hyacinth* is a free-floating perennial aquatic plant native to tropical and is now widespread in all tropic climates. The genus Eichhornia comprises seven species of *Water hyacinth* among which *E. crassipes* is the most common and have been reported to grow very first. However, its enormous biomass production rate, high tolerance to pollution and absorption capacity of heavy-metal and nutrient qualify it for use in wastewater treatment (Florida Department of Environmental Protection, 2014).

Duckweed The rapidly growing and small floating aquatic plants of the botanical family of *Lemnaceae* are capable of accumulating nutrients and minerals from wastewater. *Duckweeds* are small free-floating aquatic angiosperm plants which do not have distinct stems and leaves. The whole plant body is reduced to form a flat small leaf-like structure called frond. *Duckweed* family comprises of four genera, *Lemna, Spirodela, Wolffia*, and *Wolfiella*, and of 34 species (Iqbal, S., 1999).

Azolla Species of mosquito/water fern (*Azolla*) is a small, free-floating fern, and is widely distributed in paddy fields, rivers, ponds and lakes. Floating aquatic macrophytes are defined as plants that float on the water surface, usually with submerged roots. Floating species are generally not dependent on soil or water depth. It can fix nitrogen by its symbiotic partnership with Anabaena which resides in the dorsal cavity of *Azolla* fronds; for this reason Azolla has been used as a green manure to improve soil fertility and rice production (Invasive Species Action Plan, 2010; FAO, 2014).

Salvinia All species of *Salvinia* are free-floating aquatic ferns, with small, spongy, green leaves positioned in pairs along a common stem. The surface of each leaf is covered with long, stiff, water-repellent hairs. When the plant matures, the leaves become thick and fold at the mid-rib. *Salvinia* is a free-floating aquatic macrophyte of *Salviniaceae*. Its wide distribution, faster growth rate and close relation with other water ferns, including *Azolla* and *Lemna*, make it potential for phytoremediation (Fisheries and Forestry Biosecurity Queensland, 2013a).

Water lettuce (P. stratiotes) Pistia is a genus of aquatic plant in the family *Araceae*, comprising a single species, *P. stratiotes*, often called water cabbage or water lettuce. It floats on the surface of the water, and its roots hanging submersed beneath floating leaves. Although *P. stratiotes* mats degrade water quality by blocking the air–water interface, reducing oxygen levels in the water, and thus threatening aquatic life, it has been tested for metal remediation, metal detoxification, and treatment of urban sewage (Fisheries and Forestry Biosecurity Queensland, 2013b).

Hydrocharis morsus-ranae is a miniature floating plant with smooth shiny green heart-shaped leaves 1-2" across. Leaves are deeply notched at the base with thick spongy tissue in the center and on undersides. Frogbit looks similar to a small water lily, although, the name comes from how it resembles the chin of a frog in the water. Tiny cup shaped white flowers with a pale yellow center in July and August. Frogbit does best in still water with full sun to shade. Can be very aggressive with fast coverage and require periodic thinning. Frogbit will root where ever possible. Remove dead or dying foliage and flowers as they appear. Hardy to zone 7 or higher, winterizing is only possible indoors (Pond Plants, 2014; Söğüt, 1996).

3.3 Impact of Floating Plants on Wetlands

Wetlands free-floating plants serve many functions, including (Villamagna, 2009; Wetlands Ecology, 2005; Fisheries and Forestry Biosecurity Queensland, 2013a and b):

- Free floating wetland plants (*Duckweeds*, *Azolla* spp., *Spirodela* spp., *Wolffia* spp.) are important food sources for waterbirds and provide food and shelter for small molluscs, crustaceans and insect larvae,
- The structure of a macrophyte assemblage plays a large role in determining composition of phytoplankton, zooplankton, fish, and birds in freshwater ecosystems,
- Soaking up water that would otherwise cause rivers and lakes to flood,
- Slowing the flow of water,
- Lessening the effects of coastal erosion,
- Filtering excess nutrients, sediment, and pollutants out of water. They can change water quality by altering water clarity and decreasing phytoplankton production, dissolved oxygen, nitrogen, phosphorous, heavy metals, and other contaminant concentrations,
- Providing protection, breeding grounds, and food for fish and aquatic wildlife and nesting areas for migratory birds,

- The socio-economic effects of floating plants are dependent on the extent of the invasion,the uses of the impacted water body, control methods, and the response to control efforts,
- Wetland floating plants are important food source for a variety of waterfowl. Studies that evaluate the relationship between waterfowl and aquatic plants (native or nonnative) usually focus on the food habits and feeding ecology of waterfowl. For example, waterfowl require large amounts of protein during migration, nesting and molting and they fulfill this requirement by consuming aquatic invertebrates,
- They are also eaten by some wildlife and fish and their prey (insects, frogs, etc.). Studies suggest that the structure provided by plant beds is important to fish reproduction. Fish use the shade from mats of aquatic plants for cover. Aquatic plants can change water temperatures and available oxygen in habitats, thus indirectly influencing growth and survival of fish. The amount of oxygen a fish uses during the course of a day is referred to as daily oxygen consumption rate (Figure 4).
- Birds that live at least part of their lives in or around water are referred to as aquatic birds and/or water birds. Each species has specific requirements that must be met in order to reproduce, survive, grow and reproduce again. Aquatic birds rely on aquatic plants to meet a large variety of needs during their life cycles. Some birds nest directly in aquatic plants, whereas others use plants as nesting material, foraging platforms, for resting and for refuge from predators. Aquatic plants are eaten by some bird species; in addition, some plants support attached invertebrates that are used as a food source by some aquatic birds.
- They have also been reported to reduce mosquito reproduction in ponds. Some water plants (Water lily, etc.) are also a favorite of honeybees. Some aquatic plants leaves make a great landing spot for insects (e.g., Watershield).

Figure 4 Fish from aquatic habitat, Aydin, Turkey.

4 DISCUSSION AND CONCLUSION

The wetlands are important in terms of conservation of biological diversity and ecological balance. Wetlands in Turkey continue to exist despite various problems such as water pollution, drying of wetlands, exceeding hunting etc.

Turkey is rich in terms of aquatic plants. Literature studies show that floating aquatic plants have important functions such as being food source and shelter for other organisms (fish, waterfowl, etc.). As they are source of production of oxygen, we breathe, they decrease the negative impacts of climate change and used for purification. Wetlands support also recreational and touristical activities and in this context, they support the economy. As a natural component of wetlands, aquatic plants have also importance for economy while they are used as food and for reed harvesting.

In Turkey, the importance of wetlands consequently the aquatic plants and floating aquatic plants are not taken into considerence although they have such great properties, which are mentioned above. This shows that there is a big dilemma as they are even considered as a problem and they are destroyed. Most of the time, problems arise when floating aquatic plants are so numerous and impede water transport and recreational activities such as boating and swimming. When the plants grow exceedingly, they also harm some fisheries, particularly juvenile salmon and trout habitat. The excess nutrients cause the natural process

of lake aging (eutrophication) to proceed at an accelerated rate, and increased plant and algal growth is part of this process because of agricultural or domestic waste in the water. As they create a habitat for the waterborne disease carriers such as mosquitoes they are found hazardous and they are dried.

As a result, wetlands and all the inhabitans of the wetlands have to be protected and sustainability and management of the wetlands should be obtained. Laws are important but they have to have a senction. On the other hand, people have to learn the importance of the wetlands and the awareness of protection of wetlands for future generations have to be given. As it is mentioned before, floating aquatic plants have economic and recreational properties. They are used for pharmaceutical industry, and they are used as food and reed harvesting etc. These properties should be evaluated and in this context instead of destroying these plants advantages of these plants should be taken into consideration.

REFERENCES

Alexander, S. & Mclnnes, R., 2012. Ramsar Convention on Wetlands, Briefing Note Number 4, May, STRP (Scientific and Technical Review Panel), Online Available from www.ramsar.org/bn/bn1.pdf, Access Date: 12.04.2014.

Gettys, L. A., Haller, W.T. and Bellaud, M. 2009. Biology and Control of Aquatic Plants: A Best Management Practices Handbook, 2009. First published in the United States of America in 2009 by Aquatic Ecosystem Restoration Foundation, Marietta, Georgia, Printed in Gainesville, Florida, USA, ISBN 978-0-615-32646-7.

STRP, 2012. STRP, Scientific and Technical Review PanelBriefing Note, Scientific and Technical, Review Panel, Number 4, May. Ramsar Convention on Wetlands, http://www.ramsar.org/bn/bn1.pdf, Access Date: 21.05.2014.

DSI, 2009. Water Weeds Distribution Areas, Life, Environmental Relations, Issues and Prevention Methods, Ministry of Environment and Forestry General Directorate of State Water Works Operation and Maintenance Department, Ankara.

Dordio, A., Carvalho, A.J. P., Pinto, A. P., 2008. Wetlands: Water "living filters"? (http://dspace.uevora.pt/rdpc/bitstream/10174/6485/1/Dordio%20-%20Wetlands%20Water%20%20%20%20%20%20living%20filters.pdf), Access Date: 17.05.2014.

Environment Foundation of Turkey, 1993. Wetlands of Turkey, Kenedy Cd. 33/3 06660 Kavaklıdere, Ankara, 398 p.

EPA, 2001. Functions and Values of Wetlands, EPA 843-F-01-002c, September, (http://water.epa.gov/type/wetlands/outreach/upload/functions-values.pdf), Access Date: 15.05.2014.

Euliss Jr., N. H., Mushet, D. M., Newton, W. E., Otto, C. R.V., Nelson, R. D., LaBaugh, J. W., Scherff, E. J., Rosenberry, D. O., 2014. Placing prairie pothole wetlands along spatial and temporal continua to improve integration of wetland function in ecological investigations, Journal of Hydrology 513 (2014) 490–503.

FAO, 2014. Floating Aquatic Macrophytes– Azolla, Use of Algae and Aquatic Macrophytes as feed in small-scale aquaculture – A review, Online Available from http://www.fao.org/docrep/012/i1141e/i1141e02.pdf, Access Date: 28.05.2014.

Fisheries and Forestry Biosecurity Queensland, 2013a. Salvinia, Salvinia molesta, Department of Agriculture, Fisheries and Forestry Biosecurity Queensland, Fact Sheet Declared Class 2 Pest Plant PP12 April, Online Available from http://www.daff.qld.gov.au/__data/assets/pdf_file/0003/65964/IPA-Salvinia-PP12.pdf, Access Date: 05.06.2014.

Fisheries and Forestry Biosecurity Queensland, 2013b. Salvinia, Water-Lettuce, Pistia stratiotes, Department of Agriculture, Fisheries and Forestry Biosecurity Queensland, Fact Sheet Declared Class 2 Pest Plant PP12 April 2013. Online Available from http://www.daff.qld.gov.au/__data/assets/pdf_file/0007/70954/IPA-Water-Lettuce-PP19.pdf, Access Date: 03.05.2014.

Florida Department of Environmental Protection, 2014. Florida Department of Environmental Protection, Bureau of Invasive Plant Management, 3900 Commonwealth Blvd., MS 705, Tallahassee, FL 32399 (850) 245-2809. Website: http://www.dep.state.fl.us/lands/invaspec; Online Available from http://myfwc.com/media/226468/InvasivePlants_Hyacinth.pdf, Access Date: 06.06.2014.

Gettys, L. A., Haller W. T. and Bellaud M., 2009. Biology and Control of Aquatic Plants: A Best Management Practices Handbook, First published in the United States of America in 2009 by Aquatic Ecosystem Restoration Foundation, Marietta, Georgia, ISBN 978-0-615-32646-7, Printed in Gainesville, Florida, USA.

Handbook 18: Managing wetlands, 2010. Ramsar handbooks for the wise use of wetlands 4th edition, Online Available from http://www.ramsar.org/pdf/lib/hbk4-18.pdf, Access Date: 11.04.2014.

Helfrich, L. A.& Parkhurst, J.,2009. Sustaining America's Aquatic Biodiversity Aquatic Habitats: Homes for Aquatic Animals, Virginia Cooperative Extension, Publication 420-522. Online Available from http://pubs.ext.vt.edu/420/420-522/420-522_pdf.pdf, Access Date: 26.05.2014.

Hürriyet Daily News, 2011. Half of Turkey's wetlands lost in last 40 years, report says. (2/6/2011 12:00:00 AM). (http://www.hurriyetdailynews.com/default.aspx?pageid=438&n=turkey8217s-wetlands-gives-s.o.s-report-says-2011-02-06) Access Date: 02/06/2014.

Iqbal, S., 1999. Duckweed Aquaculture, Potentials, Possibilities and Limitations for Combined Wastewater Treatment and Animal Feed Production in Developing Countries, March, SANDEC Report No. 6/99, http://www.protilemna.com/docs/Duckweed%20Aquaculture%20Potential%20Possibilities%20and%20Limitations%20SANDEC.PDF, Access Date: 02/05/2014.

Invasive Species Action Plan, 2010. Water Fern (Azolla filiculoides), The Invasive Species Ireland Project is undertaken, in partnership, by EnviroCentre and Quercus. Online Available from http://invasivespeciesireland.com/wpcontent/uploads/2010/10/Azolla_filiculoides_ISAP.pdf, Access Date: 03.06.2014.

Minga, J., Xian-guo, L., Lin-shu, X., Li-juan, C., Shouzheng, T., 2007. Flood mitigation benefit of wetland soil — A case study in Momoge National Nature Reserve in China, EcologıcalEconomics 61, 217-223.

Mitsch WJ & Gosselink JG. 2000. Special Issue, the Values of Wetlands: Landscapes and Institutional Perspectives, The Value of Wetlands: Importance of Scale and Landscape Setting, Ecological Economics 35 (200) 25–33

Mıshra, S. And Naraın S., 2010. Florıstıc and Ecologıcal studıes of Bakhıra Wetland, Uttar Pradesh, Indıa. Duthie Herbarium, Department of Botany, University of Allahabad, Allahabad (U.P.) http://re.indiaenvironmentportal.org.in/files/Bakhira%20wetland.pdf, Access Date: 08.04.2014.

Pond Plants, 2014. Online Available from http://www.pondplants1.com/floating/floating_pond_plants.htm, Access Date: 18.05. 2014.

Söğüt, Z., Aquatic Plants and The use of Landscape Architecture. Cukurova University, Faculty of Agriculture, Executive Editor, No: 122, Textbooks, Publication No. 35, 204 p., Adana.

Turkey's Important Wetlands, 2013. Turkey's Important Wetlands, Our Ramsar, Department of Water Affairs and Forestry, General Directorate of Nature Conservation and National Parks, Department of Sensitive Areas, Wetlands Branch, Sögütözü cad. No:14/E Beştepe, Ankara, Türkiye, Ocak/January (www.milliparklar.gov.tr).1996.

USEPA, 2000. Constructed Wetlands Treatment of Municipal Wastewaters; EPA/625/R-99/010; Office of Research and Development: Cincinnati, OH, USA.

Villamagna, A. M., 2009. Ecological effects of water hyacinth (Eichhornia crassipes) on Lake Chapala, Mexico, Dissertation Submitted to the Faculty of the Virginia Polytechnic Institute and State University in Partial Fulfillment of The Requirements for The Degree of Doctor of Philosophy in Fisheries and Wildlife Sciences, 1-180 p, April 1, Blacksburg, Virginia.

Wetlands Ecology, 2005. Wetlands Institute 1075 Stone Harbor Blvd. Stone Harbor, NJ 08247 (609)368-1211 (www.wetlandsinstitute.org), Online Available from http://wetlandsinstitute.org/wp-content/uploads/2010/06/Wetlands_Ecology.pdf, Access Date: 12.04.2014.