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Survey of Wet Land Macrophytes from Wetlands of Haliyal Taluk

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ABSTRACT

The present investigation resulted in the documentation of forty nine aquatic macrophytes from eight wetlands of Haliyal taluk. Dicotyledons were predominant in the study areas, from the diversity point of view Cyperaceae was the dominant family, followed by Commelinaceae, Lentibularaceae and Scropulariaceae. Azollabipinnata was the most common taxa in the studied areas. Eight species documented, have medicinal value. Among the morpho-ecological groups, emergent anchored were the dominant and the least were submerged rooted group. Shannon diversity index revealed comparatively high diversity in the riparian wetland of Bomanahalli dam. WMI scores reveals Yadoga and Murukwad in fairly goodcondition, whereas Sambrani and Ajgaoh are highly polluted and not suitable for fishing. The qualitative survey data when subjected to CCA revealed larger water spread area and conductivity as environmental gradient for the occurrence of emergent anchored and submerged rooted forms respectively. Hence in the present paper, the authors emphasize the usefulness of WMI and CCA in the interpretations of qualitative survey data, which may be helpful in wetland conservation and restoration strategies.

Key words: *Macrophyte, CCA, WMI, Environmental gradients.*

INTRODUCTION

Wetland macrophytes are the class of vascular plants that are normally found growing in wetlands, i.e., in or on the water, or where soils are flooded or saturated long enough for anaerobic conditions to develop in the root zone, and so evolving some specialized adaptations to the anaerobic environment. Wetland plants are primary producers and hence at the base of the food chain. Some herbaceous wetlands have extremely high levels of productivity, rivaling those of tropical rain forests[8]. They are often used to help organize environmental inventories and research programs, and to set goals for management programs or restoration projects[6, 5, 4, 8]. Although the benefits of macrophytes for aquatic systems are recognized[13, 12, 20], when growing in high abundance these plants interfere with the utilization of water resources[15], blocking water flow, depleting oxygen in the water, and causing problems for fisheries and hydropower generation. Due to these issues (both benefits and nuisance) the study of aquatic macrophyte communities and the factors which drive their distribution are important for water resource management of reservoir systems[3].

Surveys of biological diversity in aquatic ecosystems are essential protective measures because they identify areas of major conservation value[19]. Rao *et al.*, 2009, documented the wetland flora of Uttara Kannada[16], their work does not include survey in the Haliyal taluk. Hence the documentation of wetland macrophytes from the former region was a scope for the authors.

The taxonomic compositions of the aquatic macrophytes are directly influenced by wetland quality, mainly the human disturbance. From the economic point of view, impairment of wetland quality negatively affects fish habitats. According to Croft and Fraser, wetland macrophyte index (WMI), a costeffective and sensitive biotic assessment tool, can be utilized, to detect the impact of anthropogenic activities on fish habitats[7].

Prediction of the occurrence and abundance of macrophytes species is a major issue in ecological studies of these plants, so establishing what factors determine their growth and distribution is essential[14].According to Ter-Braak and Verdonschot, 1995, multivariate statistical methods such as Canonical correspondence analysis (CCA) can help aquatic ecologists unravel how a multitude of species simultaneously respond to external factors, such as environmental variables, pollutants and management regime, using data either from observational studies or from designed experiments[18].

The objective of this study was to investigate aquatic vegetation in Haliyal taluk and to emphasize the importance of WMI and CCA in the qualitative survey data.

MATERIAL AND METHODS

Description of the study area

Haliyal taluk (15^0 5' - 15^0 25' N, 74^0 34' - 74^0 55'), though having a geographical area of 84,960 Hectares[10], the water spread area of wetlands is only 439.82[1]. Among the eleven Taluks of Uttara Kannada, Haliyal Taluk receives low rainfall. Seasonal fishing and agriculture is mainly dependent on the shallow open wetlands. Hence the study areas represent scope for the wetland conservation and restoration managements.

Collection of samples

The study conducted was a random opportunistic seasonal survey, visiting eight wetland localities in Haliyal taluk of Uttara Kannada district over a period of two years-2013 and 2014. Wetland macrophytes were collected from seven perennial shallow open wetlands and one Riparian wetland. Details of the studied wetlands are provided in Table 1.

Analysis of physical environmental parameters

During the survey; pH, Conductivity and Temperature was recorded on the spot, except for the riparian wetland, using field pH and conductivity meter (Eutech, Germany)

Taxonomy and classification

Fresh specimens were identified following regional and other floras[2, 11, 16]. The species data were classified according to morpho-ecological groups as follows: Emergent anchored, floating leaved, submerged, and free floating types[9].

Statistical Indices

Macrophyte diversity was calculated using the Shannon-Wiener diversity index[17], following the formula;

H'= $\sum_{i=0}^{s} Pi \ln Pi$

Where pi = ni/N, ni = no. of individuals in the i^{th} species; N = Total number of individuals of all species.The calculations were carried in Biodiversity-Pro. Software[21]

"Wetland macrophyte index[7]" was calculated to access the impact of human disturbance on fish habitats in selected wetlands, following the formula

$$\text{WMI} = \left[\frac{\sum_{i=1}^{n} YiTiUi}{\sum_{i=1}^{n} YiTi}\right]$$

Where Y_i = if the species is present, this value is 1; if absent, it is 0, T_i = value from 1–3 or niche breadth of species i,U_i = value from 1–5, tolerance of species $i$to degradation. The WMI calculations were carried out in Microsoft Office Excel 2007. Wetlands with WMI scores < 2.5can be considered impaired (moderately to highly degraded conditions), scores > 2.5 can be considered in "good" to "excellent" conditions.

Direct gradient analysis (CCA)

To summarize the relationships between multiple response (morpho-ecological groups) and physical environmental variables (pH, Temp., Cond. and water spread area) variables, a method of direct gradient analysis known as CCA was employed. XLSTAT-2014 (statistical software) was used to construct the CCA 2-d ordination diagram (Bi-plot).

RESULTS AND DISCUSSION

A total of forty nine plant species were documented in the present investigation (Table 2). The contribution of the dicotyledons was 67.3%, Monocotyledons 24.5%, Pteridophytes and Macro-algae 4%. Table 2 reveals that Cyperaceae (4 genera and 5 species) was the most dominant family, followed by Commelinaceae (3 genera and 4 species), Lentibulariaceae (1 genera, 3 species) and Scrophulariaceae (3 genera, 3 species). *Azollabipinnata* was the most commonly occurring taxa among the studied areas. *Hygrophil aschulli*, *Alternanthera sessilis*, *Eclipta alba*, *Coldenia procumbens*, *Murdannia nudiflora*, *Cyperus iria* and *Nymphaea nouchali*, are the macrophytes having medicinal value, as recorded by Rao et al, 2009 in the aquatic flora of Uttar Kannada[16]. Based on the morpho-ecological groups, emergent anchored was the dominant group among the study areas; the least was submerged rooted.

Shannon diversity index (Table 3) reveals that highest comparative diversity (1.15) has been observed in the Riparian wetland of Bomanahalli dam. Among the shallow open wetland types, Sambrani is the highest (1.041), followed by Bhagavathi (1.07), least diversity is observed in Ajgaoh (0.69), followed by Gundolli (0.77.)

The scores calculated from Wetland macrophyte index (Table 3), reveal Yadoga (4.2), followed by Murukwad (3.8) is in good condition and not affected by human disturbance. Whereas Sambrani (1.25), followed by Ajgaoh (1.5) and Gundolli (1.8), indicates highly degraded condition and not suitable for fish spawning and nursery. The value of Bhagavathi (2.71) indicates that the wetland is moderately degraded and is in dire need of restoration to prevent further degradation. From the above results we can ascertain that Kalaginakoppa is suitable for fishing activity, though Gundolli has fishing activity, the WMI scores clearly suggests, further activity of habitat degradation will lead to decrease in fish population.

The qualitative survey data of seven lentic open wetlands (Table 4),when subjected for CCA (Canonical correspondence analysis), produced an ordination, where the p-value (0.490) is greater than the significance level alpha= 0.05. Hence we can say that the occurrence data of morpho-ecological groups are not linearly related to thephysical variables, this also indicates the resulting interpretations of the qualitative data are significant.Total inertia was highest in F1axis (60.38) followed by F2 (12.36). Hence the first two axis, F1 and F2 were chosen for constructing the CCA bi-plot. The CCA bi-plot explains the following results:

The occurrences of emergent anchored groups are closely associated to wetland of larger water spread area. The bi-plot indicates high occurrence of emergent macrophytes in Murukwad and Bhagavathi which are shallow open wetlands of larger area (Table 1). The occurrence of submerged types are closely associated with conductivity and higher pH (8.3-8.9), this is clearly indicated in the Yadoga tank. Hence the water spread area and higher pH can be considered as environmental gradients on the occurrence of emergent anchored and submerged types respectively.

Table 1: Details of the Study area

Locality ID	Wetland	Type of wetland	Water spread area	Location	Activities Observed
1	Yadoga	Shallow open wetland	0.05	15°,20’,24.6’’ N 74°,43’ ,49.7’’ E Elevation- 534m	Irrigation Domestic
2	Ajgaoh	Shallow open wetland	3.00	15°, 18’, 05.3’’ N 074°,42’,46.7’’ E Elevation- 493m	Cattle washing Irrigation Domestic
3	Sambrani	Shallow open wetland	5.00	15°,14’,32.9’’ N 074°,45’,55.8’’ E Elevation- 526m	Cattle washing Irrigation Domestic
4	Bhagavathi	Shallow open wetland	1.50	15°,09’,10.0’’ N 074°,45’,38.1’’ E Elevation- 494m	Cattle washing Irrigation Domestic
5	Murukwad	Shallow open wetland	6.00	15°,16’,55.8’’ N 074°,49’,46.3’’ E Elevation- 518m	Irrigation Domestic

6	Gundoli	Shallow open wetland	2.4	15^0, 15', 03.92" N 074^0, 46', 49.80" E Elevation: 516m	Fishing Irrigation Domestic
7	Kalaginakoppa	Shallow open wetland	3.4	15^o,15',23.5'' N 074^o,48',10.4'' E Elevation- 512m	Fishing Irrigation Domestic
8	Bomanahalli stream	Riparian wetland	-----	15^0, $09^'$, 57.9" N 074^0, 42', 37.3" E Elevation- 426m	Wild life Domestic

Table2: Wetland Macrophytes from the study areas

S. No.	Macrophyte	Family	Ecological group	Occurrence	Location ID
1	*Alternantherasessilis* (L.) R. Br. ex DC.	Amaranthaceae	Emergent Anchored	Monsoon	3
2	*Azollabipinnata* R. Br.	Azollaceae	Floating	Monsoon, winter	2 ,3, 4, 8
3	*Bacopamonnieri* (L.) Pen.	Scrophulariaceae	Emergent anchored	Monsoon, winter	8
4	*Ceratophyllumdemersum* L.	Ceratophyllaceae	Submerged	winter, summer	2, 7, 6, 3
5	*Chara vulgaris* L.	Characeae	Submerged	winter, summer	1
6	*Coldeniaprocumbens* L.	Boraginaceae	Emergent Anchored	Winter	4
7	*Commelinabengalensis* L.	Commelinaceae	Emergent Anchored	Monsoon	8, 7
8	*Murdannianudiflora*(L.) Bron.	Commelinaceae	Emergent Anchored	Monsoon	3
9	*Commelinadiffusa*Burm. f.	Commelinaceae	Emergent Anchored	Monsoon	8, 3
10	*Cyanotisaxillaris* (L.) D. Don	Commelinaceae	Emergent Anchored	Monsoon, winter	8
11	*Cyperuscompressus* L.	Cyperaceae	Emergent Anchored	winter, summer	4 , 8
12	*Cyperusiria* L.	Cyperaceae	Emergent Anchored	Winter, summer	8
13	*Echinochloa sp.* P Beauv.	Poaceae	Emergent Anchored	winter, summer	8
14	*Eclipta alba* (L.) Hassk.	Asteraceae	Emergent Anchored	winter, summer	8
15	*Eichorniacrassipes* (Mart.) Solmsc	Pontederiaceae	Floating	winter, summer	8
16	*Eleocharisequisetoides* (Ell). Torr	Cyperaceae	Emergent Anchored	Throughout	1, 4, 5,
17	*Hedyotis sp.* L.	Rubiaceae	Emergent Anchored	winter, summer	8
18	*Hydrillaverticillata* (L.f.) Royle	Hydrocharitaceae	Submerged	Throughout	1, 3, 5
19	*Hygrophila schulli* (Buch.-Ham.) M.R. & S.N.	Acanthaceae	Emergent Anchored	winter, summer	4, 5, 6, 8
20	*Ipomeaaquatica*Forrsk	Convolvulaceae	Floating leaved	Throughout	1, 3, 4, 6
21	*Kylinga nemoralis* (Forst.) Dan. ex Hutch.	Cyperaceae	Emergent Anchored	Winter	8
22	*Lemna* sp. L.	Lemnaceae	Floating	Throughout	8
23	*Limnophilaaquatica* (Rox.) Als.	Scrophulariaceae	Emergent anchored	winter, summer	7, 8
24	*Linderniaviscosa* (Hornem.) Boldingh	Scrophulariaceae	Emergent Anchored	winter, summer	8
25	*Ludwigiaadscendens* (L.) Hara	Onagraceae	Emergent	Throughout	4

			Anchored		
26	*Ludwigiaperennis* L.	Onagraceae	Emergent Anchored	Throughout	8,
27	*Marsileaquadrangularis* L.	Marsileaceae	Floating leaved	Winter	8
28	*Monochoriavaginalis* (Burm. F.) Presl ex. Kunth	Pontederiaceae	Floating leaved	Winter, summer	3
29	*Nelumbonucifera*Gaertn.	Nelumbonaceae	Floating leaved	Throughout	3,4, 5,6, 7
30	*Neptuniaaquatica*	Mimosceae	Emergent Anchored	monsoon, winter	7
31	*Nitellahyalina* L.	Characeae	Submerged	monsoon, winter	7
32	*Nymphaeanouchali*Burm. f.	Nymphaeceae	Floating leaved	Monsoon, winter	7, 3
33	*Nymphoidescristata* (Roxb.) Kuntze	Menyanthaceae	Floating leaved	Monsoon	1, 7, 8
34	*Nymphoideshydrophylla* (Lour.) Kuntze	Menyanthaceae	Floating leaved	Monsoon	5, 8
35	*Nymphoidesindica* (L.) Kun.	Menyanthaceae	Floating leaved	Monsoon	1, 8
36	*Oryza sativa* L.	Poaceae	Emergent Anchored	Monsoon	8
37	*Otteliaallismoides* (L.) Pers.	Hydrocharitaceae	Floating leaved	Monsoon	8
38	*Pandanussp.* Park.	Pandanaceae	Emergent Anchored	Throughout	8
39	*Pistiastratiotes* L.	Araceae	Emergent Anchored	winter, summer	4
40	*Polygonumglabrum*Willd.	Polygonaceae	Emergent Anchored	Summer	3, 4, 8
41	*Rotala*sp Lo.	Boraginaceae	Submerged	Monsoon	8
42	*Sagittariaguayanensis* H. B. & K.	Allismataceae	Emergent Anchored	throughout	4, 8
43	*Schoenoplectus articulates* L.	Cyperaceae	Emergent Anchored	throughout	8
44	*Spirodellapolyrhiza* (L.) Schleid	Lemnaceae	Floating	Monsoon, winter	8,
45	*Trapanatans* L.	Lythraceae	Floating leaved	winter, summer	2, 5, 6, 7
46	*Typhaangustata*Bory&Chaub.	Typhaceae	Emergent Anchored	Throughout	8
47	*Utriculariagibba* L.	Lentibulariaceae	Emergent Anchored	winter	5
48	*Utriculariastellaris* L. F.	Lentibulariaceae	Floating	winter	6
49	*Utricularia vulgaris* L.	Lentibulariaceae	Emergent Anchored	Winter	8

Table 3: Diversity and Wetland degradation Indices

Indices	Shannon index	WMI
Sambrani	1.041	1.25
Murukwad	0.903	3.8
Kalaginakoppa	0.987	3.1
Gundolli	0.778	1.8
Bhagavathi	1.079	2.71
Ajgaoh	0.699	1.5
Yadoga	0.828	4.2
Bommi	1.157	Not applicable

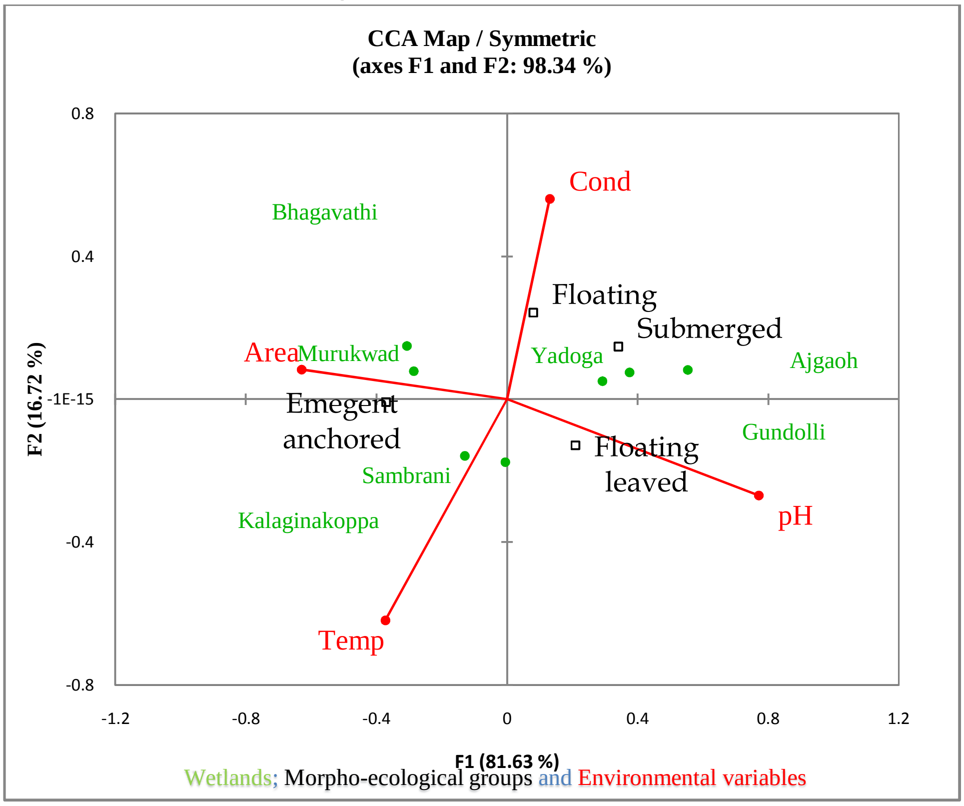
WMI- Wetland Macrophyte Index

Table 4: Qualitative Survey data for CCA

Wetlands	Morpho-ecological groups				Physical variables			
	Emergent anchored	Floating	Floating leaved	Submerged	pH	Temp (^{0}C)	Cond (µS)	Area (hect.)
Sambrani	4	1	4	1	8.5	33.4	430	5
Murukwad	3	1	3	1	7.9	30.6	360	6
Kalaginakoppa	5	1	5	1	8.2	29.8	340	2.3
Gundolli	1	1	3	1	8.9	28.7	580	3.4
Bhagavathi	7	2	2	1	7.9	27.1	510	4.1
Ajgaoh	1	1	2	1	8.6	27.8	370	3
Yadoga	1	1	4	2	8.3	23.9	490	0.05
Bommanahalli	20	2	3	4	**not included in CCA**			

Temp- Temperature; Cond- Conductivity; CCA:Canonical correspondence analysis; 0C: degree Celsius; µS: micro siemens; hect: hectares

Fig. 1: CCA ordination bi-plot



CONCLUSION

The above results clearly indicate, that the qualitative survey data when subjected to CCA and WMI analysis can reveal useful interpretation which may be helpful for wetland restoration and management strategies.

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REFERENCES

1. Anonymous., Details of Minor Irrigation Tanks, Bandharas LI Schemes and Kharland schemes, as on 1-4-2010 in Uttar Kannada District. Government of Karnataka (Minor Irrigation). Ms excel document (2010).
2. Bhat, K.G., Flora of Udupi. Indian Naturalist (R), Udupi, 150pp (2003).
3. Bottino, F. Calijuri, M.D.C. and Murphy, K.J., Temporal and spatial variation of limnological variables and biomass of different macrophyte species in Neotropical reservoir. Acta. Limno. Bras. **25(4):** 387-397 (2013).
4. Brinson, M., A Hydrogeomorphic Classification for Wetlands. Technical Report WRP-DE-4, US Army Corps of Engineers, Wetlands Research Program, Washington DC. Pp: 1-79 (1993).
5. Britton, R.H. and Crivelli, A.J., Wetlands of southern Europe and North Africa: Mediterranean wetlands. In: Wetlands of the world I: Inventory, Ecology and management. Eds. Whigham, D.F. Dykyjova, D. and Hejny, S. Kluwer Academic Publishers. Dordrecht. Pp: 129-194 (1993).
6. Cowardin, L.M. Carter, V. Golet, F.C. and LaRoe, E.T., Classification of wetlands and deep water habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31. Washington, DC. Pp: 131 (1979).
7. Croft, M.V. and Fraser, P.C., Use and Development of the wetland macrophyte index to detect water quality impairment in fish habitat of Great lakes Coastal marshes. J. Great Lakes Res. **33(3)**: 172-197 (2007).
8. Cronk, J.K. and Fennessy, M.S., Wetland Plants: Biology and Ecology. CRC Press/Lewis Publishers. Boca Raton, FL. Pp: 440 (2001).
9. Esteves, F.A., Fundamentos de Limnologia. Ed. Interciência /FINEP, Rio de Janeiro. Pp: 575 (1998)
10. Ganapathy, S. and Ramachandra, T.V., Vegetation analysis using GIS and Remote Sensing using GIS and Remote Sensing Techniques. ENVIS Technical Report 24. Ministry of Environment and Forests. Government of India. (2008).
11. Gupta, O.P., Weedy aquatic plants: their utility, menace and management. Agro bios, Jodhpur, India. Pp: 273 (2001).
12. Hassan, S. Schmieder, K. and Böcker, R., Spatial patterns of submerged macrophytes and heavy metals in the hypertrophic, contaminated, shallow reservoir Lake Qattieneh/Syria. Lim., **40:** 54-60 (2010).
13. Kouki, S. M'Hiri, F. Saidi, N. Belaïd, S. and Hassen, A., Performances of a constructed wetland treating domestic wastewaters during a macrophytes life cycle. Des., **246:** 452- 467 (2009).
14. Lacoul, P. and Freedman, B., Environmental influences on aquatic plants in freshwater ecosystems. Environ. Rev., **136:** 89-136 (2006).
15. Pieterse, A.H. and Murphy, K.J., Aquatic weeds: the ecology and management of nuisance aquatic vegetation. Oxford University Press, Oxford, UK., Pp: 593 (1993).
16. Rao, G.R. Divakar, K.M. Subash, C. and Ramachadran, T.V., Wetland flora of Uttara Kannada. In: Environment education for ecosystem conservation. Ed. Ramachandra, T.V. Capital Publishing Company, Bangalore, India. Pp: 153-159 (2009).
17. Shannon, C.E. and Weaver, V., The Mathematical Theory of Communication, University of Illinois Press, Urbana, Ill, USA. Pp: 117 (1963).
18. TerBraak, C.J.F. and Verdonschot, P.F.M., Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aq. Sci. **57(3)**: 1015-1621 (1995).
19. Thomas, S.M. and Bini, L.M., Análisecrítica dos estudossobremacrófitasaquáticasdesenvolvidos no Brasil. In: Ecologia e manejo de macrófitasaquáticas. Eds. Thomas, S.M. and Bini, L. M. EDUEM, Maringá., Pp:19-38 (2003).
20. Vymazal, J., Long-term performance of constructed wetlands with horizontal sub-surface flow: Ten case studies from the Czech Republic. Eco. Eng.,**37:** 54-63 (2011)
21. McAleece, N. Gage, J.D.G. Lambshead, P.J.D. and Paterson, G.L.J., Biodiversity Professional statistics analysis software (1997).