Diversity and Phytosociology of Herbaceous Flora in the Wetland Area of the University of Ibadan Integrated Fish Farm, Nigeria

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Abstract

University of Ibadan Integrated Fish Farm was assessed using stratified random survey of 108 randomly laid quadrats within 18 plots of 900 m² each. Floral identification, species diversity, relative importance value (RIV), ordination and classification analyses followed standard procedures. Presence of invasive plants were determined. Routine soil analyses conducted followed standard procedures. Soil data were analysed using ANOVA (P=0.05). Significantly different means were separated with least significant difference at p=0.05. The site contained 144 plant species distributed within 38 families. Species richness was high across all plots except plot two. Species dominance ranged from 0.03 to 0.1. RIV ranged from 0.15 to 6.3; Amaranthus viridis had the highest and Aspilia bussei, lowest. Multivariate analyses indicated two ecosystem structures comprising a small densely vegetated near-pristine wetland and a large sparsely vegetated perturbed area. Floral dichotomy included 12 positive preferential groups of 86 stands and 6 negative preferential groups of 22 stands. The soil was Silty-clay. Invasive plants species with high RIVs were Althernanthera brazilensis (1.33) and Bidens pilosa (0.15). pH (6.60), potassium (0.58), sodium (2.23), calcium (11.57), total carbon (38.04), total nitrogen (2.68), and phosphorus (50.63) were higher for soils collected from under forest plots than in non-forested plots (5.85, 0.15, 0.16, 5.42, 5.1, 1.15 and 16.42 respectively). The vegetation of University of Ibadan Integrated Fish Farm was moderately high and stable. The wetland is not pristine, and prone to degradation. Construction activities for aquacultural purposes should maintain the wetland for sustainable biological productivity. The flora should be assessed periodically.

Keywords: *Invasive species, Wetland development, Fish pond, Ecosystem monitoring, Deforestation, Floral assessment*

Introduction

Wetland is one of the most biologically diverse ecosystems in the world (Wilson, 1992), second only to rainforests (Keddy, 2000). A wetland ecosystem arises when inundation by water produces soils dominated by anaerobic processes and forces the biota, particularly rooted plants, to exhibit adaptations to tolerate flooding (Keddy, 2000). The Ramsar Convention on wetlands define the term wetland as an area of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters (Smart, 1997; Ramsar convention bureau, 2000; Akosim *et al.* 2007). Among many valuable functions of wetlands includes improving water quality, balancing water regime in other to serve as flood storage, and providing habitats for plants and animals, sustaining biogeochemical cycles that can be explored for ecosystem management (Hruby, 1999; Clairain, 2002; Adamus *et al.* 2001; Sheldon *et al.* 2005). Further, wetlands provide clean water, wildlife viewing opportunity and other outdoor recreation activities. They also conserve soil and control erosion, retain sediments, absorb nutrients, degrade pesticides, store water and moderate impacts of floods and droughts, recharge aquifers and help to moderate climate change. These wetland benefits apply to landowners as well as to society as a whole (Alberta Environment, 2007).

However, agriculture and construction activities have been implicated as some of the causes of wetland loss, especially when adequate planning is lacking (Okali and Ewah, 2004). The degradation of wetlands thatcould be brought about by these anthropogenic disturbances are easily indicated in the structure of vegetation of wetland's ecosystems. Wetland vegetation is commonly defined as plants growing in water or on a substrate that is at least periodically deficient in oxygen as a result of its excess water content (Cowardin *et al.* 1979). This vegetation includes both herbaceous (vascular and nonvascular) and woody species. Wetland plants may be floating, floating-leaved, submerged, or emergent, and may complete their life cycles in still or flowing water, or on inundated or non-inundated hydric soils (Cronk and Fennessy, 2001). According to Bedford (1996), one key to understanding why plants are considered one of the best indicators that shape wetlands within their landscape is the contributions they make to wetland ecosystems. Another indicator is the presence of invasive alien species in the ecosystem. Alien species are likely to drive indigenous plant species to extinction. Although only a small percentage of these alien species will become invasive, when they do their impacts are immense, insidious and usually irreversible, and they may be as damaging to native species and ecosystems on a global scale as the loss and degradation of habitats (IUCN/SSG/ISSG, 2000). Lack of adequate information on species composition, ecosystem resilience and dynamics of wetlands is a bane of mismanagement and loss of crucial wetlands and their functions in many developing countries. Institutionalized wetlands, such as wetlands of international importance and well protected wetlands that are located within governmental institutions are potential sources for gathering information, not only to manage them, but also to guide other resource managers and decision makers on possible use of wetlands in a region. When such institutions are committed to socio-economic development and poverty alleviation, they must work towards environmental sustainability of their activities in line with Goal number 7 of the Millennium Development (MWO, 2012).

Aquatic plants play very important roles in a wetland. They are the most conspicuous feature of wetland ecosystems and have been used extensively as an indicator of changes in structure and function of wetlands, which are usually brought about by human influences and natural phenomena. This study considered the presence, diversity and richness of the flora of the University of Ibadan Fish Farm as a basis for baseline data gathering for determination of state, function and health of the wetland for future monitoring purposes. The floristic assessment to collect and document baseline data on vegetation followed standard procedural considerations in line with Kent and Coker (1992) and Keddy (2000) for wetland vegetation. For instance, the stratification of the University of Ibadan Fish Farm was done to unify the variations of the site for random sampling of the study site.

Adekola and Mitchell (2011) observed that wetlands' ecosystem advantages can be eroded through invasive plant infestation and wetland reclamation. At some points in their existence, wetlands located within institutions are used for targeted purposes. Some of these are impounded without proper pre-assessment of species composition, diversity and status. This research was carried out with the general goal to exploring the spatial distribution of herbaceous plant species, their abundance, richness and diversity on the wetland area of the University of Ibadan Integrated Fish farm in Ibadan. Specifically it documented the composition and diversity of herbaceous plants in the pre-construction stage of the Integrated Fish Farm and investigated the presence or otherwise of invasive alien plant species in the study site.

Materials and Method

Study site

The study was carried out at the Integrated Fish Farm located on a wetland section of the University of Ibadan, Ibadan, Oyo state, Nigeria. It is located between latitude $3^0$53`N and longitude $7^0$ 26`E. The elevation ranges from 208 – 216 m ASL (Above sea level). The geographical location of the Fish Farm comprises of forest cover with a river flowing through to Awba dam. The University of Ibadan Integrated Fish farm covers an area of 9.99 hectares of land with a perimeter of 16,888.28 m^2. The vegetation of the University of Ibadan is typical of the humid tropical vegetation pattern A small part of the wetland is covered with water all year round, and as such a good location for fish farming.

Mean annual rainfall for the year 2013 was 1,154 mm while mean monthly temperature, relative humidity and sunshine hours, were 27^0C, 75% and 4.97 respectively.

Sampling processes

The Integrated Fish Farm was divided into 18 plots of 900 sq. m each. The layout of the plots was such that nine plots were located on either side of the river (north and south) that runs east-west of the study site which roughly corresponded to regions of highly and sparsely forested areas as recommended by Kent and Coker (1992) and Yallop *et al.* (2003). The layout of the plots was achieved with the use of a Garmin^{TM} *12 etrex* Vista H model Geographic Positioning System (GPS) and a Silva plastic model Compass (SPMC) to mark each point. Wooden pegs sharpened at one end with yellow ribbon tags were used to mark the 30m x 30mboundary. Six (6) rectangular wooden quadrat of 50 cm X 50 cm quadrats were randomly laid to assess the herbaceous flora of each plot. Buildings and areas under construction were omitted in the layout. A total of 108 quadrats were laid to describe the flora of the University of Ibadan Fish Farm. Herbaceous plant species occurring in each quadrat were identified in-situ following Akobundu and Agyakwa (1998), Johnson (1997), Etukudo (1997), and Obot and Ayeni (1987). All sampling were done during the raining season.

Three soil samples were randomly collected from the top soil of the two sides of the dichotomy defined by the river within the upper 0 - 15 cm of the soil surface. The samples were collected in three replicates and later bulked per side of the river. The soil was air-dried, separated into three coded replicates for each stratum for routine analysis (for the determination of nitrogen, physic- chemical properties and major nutrient elements in the soil). The analysis were conducted at the Department of Agronomy, Faculty of Agriculture and Forestry, University of Ibadan, using standard procedures described by AOAC (1996).

Data analyses
The data on species enumerated in the study area were recorded in a quadrat-by-species raw-data matrix for quantitative values of species composition density and frequency for quadrat. The data were analyzed for relative importance values (RIV) (Curtis and McIntosh, 1950; Kent and Coker, 1992; and Olubode *et al.,* 2011).

The data collected were further analysed following multivariate procedures for Ordination and Classification (Hill, 1994) using DECORANA© 2012 software for stand ordination; and TWINSPAN© 2012 software for Two-Way Indicator Species Analyses for classification.

RESULTS
A total of 130 plant species belonging to 38 families were enumerated in the 108 quadrats laid (Table 1).

Table 1 Floristic composition, Relative Importance Values and habitat type of the University of Ibadan Fish Farm in 2013.

SPECIES	Family	Habitat	RIV
Saccioleptis africana Hubb. & Snowden	Poaceae	Hydromorphic	6.3647
Ludwiga decurrens Walt. Syn.	Onagraceae	Hydromorphic	5.3033
Boerhavia diffusa L.	Nyctaginaceae	Cultivated	2.8340
Ageratum conyzoides Linn.	Asteraceae	Crop weed	2.5683
Cynodon dactylon (Linn.)	Cyperaceae	Hydromorphic	2.5217
Cyperus longibracteatus Cherm.	Cyperaceae	Cultivated	2.4062
Commelina benghalensis L.	Commelinaceae	Waste area	1.7719
Musa paradisiaca L.	Musaceae	Cultivated	1.7202
Pentodon pentandrus Vatke	Rubiaceae	Hydromorphic	1.6912
Gomphrena celosiodes Mart.	Amaranthaceae	Waste area	1.6565
Althernanthera sessilis L.	Amaranthaceae	Cultivated	1.5871
Ischaemun rugosum Salisb.	Poaceae	Hydromorphic	1.5467
Kyllinga erecta Schumach. Var. erecta	Cyperaceae	Hydromorphic	1.5120
Panicum laxum Sw.	Poaceae	Waste area	1.5006
Chromolaena odorata King & Robinson	Asteraceae	Cultivated	1.4488
Musa sapientum L.	Musaceae	Cultivated	1.4431
Althernanthera brazilensilis L.	Amaranthaceae	Cultivated	1.3390
Cyperus difformis L.	Cyperaceae	Hydromorphic	1.2583
Paspalum conjugatum Berg.	Poaceae	Hydromorphic	1.2526
Centrosenma pubescens Benth.	Leguminosae	Upland	1.1718
Amaranthus viridis L.	Amaranthaceae	Cultivated	1.1371
Oldenlandia corymbosa Linn.	Rubiaceae	Cultivated	1.0620
Andropogon gayanus L.	Poaceae	Wetlands	1.0273
Kyllinga bulbosa Beauv.	Cyperaceae	Hydromorphic	0.9869
Clome viscosa L.	Clomaceae	Cultivated	0.9812
Lapotea aestuans Chew	Urticaceae	Waste area	0.9812
Fiscus exasperata Vahl	Moraceae	Dry secondary forest	0.9465

Cassia obtusifolia L.	Fabaceae	Roadside, cultivated	0.9352
Peperoma pellucida H. B. & K.	Piperaceae	Hydromorphic	0.9062
Physalis angulata L.	Solanaceae	Hydromorphic	0.9062
Panicum maximum Sw.	Poaceae	Waste area	0.8658
Euphorbia hyssopifolia Linn.	Euphorbiaceae	Waste area	0.8601
Desmodium scorpiurus (Sw.) Desv.	Fabaceae	Cultivated	0.8254
Phyllanthus amarus Schum. & Thonn.	Euphorbiaceae	Waste area	0.8254
Gliricidia sepium Wall	Fabaceae		0.8197
Manihot esculentus Crantz	Euphorbiaceae	Waste area	0.8197
Sida acuta Burm. F.	Malvaceae	Cultivated	0.8197
Cyperus bulbosa L.	Cyperaceae	Hydromorphic	0.8021
Alchornea cordiifolia Mull. Arg.	Euphorbiaceae	Cultivated	0.7793
Ipomea aquatica L.	Convolvulaceae	Hydromorphic	0.7793
Senna obtusifolia Irwin & Barneby	Leguminosae-Caesalpinioideae	Cultivated	0.7793
Mitracarpus villosus DC	Rubiaceae	Waste area	0.7617
Pennisetum purpureum L.	Poaceae	Hydromorphic	0.7560
Acroceras zizanioides Dandy	Poaceae	Wetlands	0.7446
commelina diffusa L.	Commelinaceae	Waste area	0.7099
Acalypha fimbriata Linn.	Euphorbiaceae	Cultivated	0.7042
Monechma ciliatum Milne-Redhead	Acanthaceae	Cultivated	0.7042
Chloris pilosa Schum.	Poaceae	Crop weed	0.6752
Cyperus esculentus L.	Cyperaceae	Hydromorphic	0.6752
Eragistis tenella Beauv	Poaceae	Cultivated	0.6752
Cyperus distans L.	Cyperaceae	Hydromorphic	0.6695
Spermacoce ocymoides Burm. f.	Poaceae	Hydromorphic	0.6638
Euphorbia hirta Linn.	Euphorbiaceae	Cultivated	0.6638
Luffa cylinderica L.	Cucurbitaceae	Waste area	0.6638
Ocimum grattissimum L.	Lamiaceae	Cultivated	0.6234
Rafia hookeri Mann & Wenland	Arecaeae	Cultivated	0.6234
Digitaria horizontalis Willd.	Poaceae	Cultivated	0.5597
Calopogonium mucunoides Desv.	Leguminosae	Hydromorphic	0.5484
Celosia leptostachya Linn.	Amaranthaceae	Cultivated	0.5484
Paspalum vaginatum Berg.	Poaceae	Hydromorphic	0.5484
Portlaca oleracea L.	Portulacaeae	Cultivated	0.5484
Rhynchospora corymbosa Britton	Scrophulariaceae	Cultivated	0.4733
Acalpha ciliata Forsk.	Euphorbiaceae	Cultivated	0.4676
Amaranthus spinosus L.	Amaranthaceae	Cultivated	0.4676
Spermacoce ocymoides Burm. f.	Asteraceae	Crop weed	0.4676
Marantochloa cuspidata L.	Maranthaceae	Waste area	0.4676
Mimosa pigra var. inermis Adelb	Fabaceae	Cultivated	0.4676
Momordica charantia Linn.	Cucurbitaceae	Waste area	0.4676
Newbouldia laevis Seemann ex Bureau	Bignoniaceae	Waste area	0.4676
Pentaclethra macrophylla L.		Hydromorphic	0.4676

Spermacoce ocymoides Burm. f.	Rubiaceae	Cultivated	0.4386
Boerhavia erecta L.	Nyctaginaceae	Amaranthaceae	0.4329
Cyclosurus striatus(Schum.) Ching	Thelypteridaceae	Hydromorphic	0.4329
Cyperus iria Linn.	Cyperaceae	Hydromorphic	0.3925
Ipomea triloba Linn.	Convolvulaceae	Cultivated	0.3521
Mimosa invisa var. inermis Adelb	Fabaceae	Cultivated	0.3521
Eragrostis tremula Hochst. Ex Steud	Poaceae	Cultivated	0.3174
Daniellia oliveri Hutch & Dalz	Leguminosae/Caesalpinioideae	Waste area	0.3117
Echinocloa obtusiflora Stapf	Poaceae	Hydromorphic	0.3117
Elaeis guineensis	Arecacea/Palmae	Cultivated	0.3117
Mangifera indica L.	Anacardiaceae	Cultivated	0.3117
Rhamphicarpa fistulosa L.	Scrophulariaceae	Cultivated	0.2770
Boerhavia coccinea L	Nyctaginaceae	Cultivated	0.2366
Celosia isertii C. C. Townsend	Amaranthaceae	Cultivated	0.2366
Pteridium aquilinum Kuhn	Dennstaedtiaceae	Waste area	0.2366
Setaria barbata Kunth	Poaceae	Hydromorphic	0.2366
Sorghum arundinaceum Stapf	Poaceae	Crop weed	0.2366
Andropogon gayanus Kunth var. gayanus	Poaceae	Wetlands	0.1962
Echinochloa pyramidalis Limk	Poaceae	Hydromorphic	0.1962
*Elusine indica*Gaertn	Poaceae	Waste area	0.1962
Ipomea involucrata Linn.	Convolvulaceae	Cultivated	0.1962
Lapotea ovalifolia Chew	Urticaceae	Cultivated	0.1962
Setaria longiseta Beauv	Poaceae	Hydromorphic	0.1962
Achyranthes aspera L.	Amaranthaceae	Shade tolerant	0.1559
Aspilia bussei Hoffm. & Muschler	Asteraceae	Crop weed	0.1559
Bidens pilosa Linn.	Asteraceae	Crop weed	0.1559
Ceratopteris cornuta Lepr.	Parkeriaceae	Hydromorphic	0.1559
Corchorus olitorius L.	Poaceae	Cultivated	0.1559
Combretum hispidium Laws.	Combretaceae	Cultivated	0.1559
Conyza sumatrensis L.	Asteraceae	Cultivated	0.1559
Echinochloa crus-pavvonis Schult	Poaceae	Hydromorphic	0.1559
Eclipta alba Hassk	Asteraceae	Hydromorphic	0.1559
Eclipta prostrata Hassk	Asteraceae	Hydromorphic	0.1559
Heterotis rotundifolia Jac. Del	Melastomaceae	Dampy	0.1559
Hewittia sublobata L.	Convolvulaceae	Cultivated	0.1559
Ipomea eriocarpa Linn.	Convolvulaceae	Cultivated	0.1559
Lindernia numulariifolia Wettst.	Scrophulariaceae	Hydromorphic	0.1559
Ludwiga abyssinica Walt. Syn	Onagraceae	Hydromorphic	0.1559
Mallotus oppositifolius Geisel	Euphorbiaceae	Cultivated	0.1559
Melanthera scandens	Asteraceae	Hydromorphic	0.1559
Merremia aegyptia Urban	Convolvulaceae	Cultivated	0.1559
Pennisetum polystachion L.	Poaceae	Hydromorphic	0.1559
Pouzolzia guineensis Benth.	Urticaceae	Cultivated	0.1559
Sclerocarpus africanus L.	Poaceae	Hydromorphic	0.1559
Setaria pumilar Schult	Poaceae	Hydromorphic	0.1559

Solanum torvum Linn.	Solanaceae	Cultivated	0.1559
Spilanthes filicaulis C. D. Adams	Asteraceae	Hydromorphic	0.1559
Spilanthes uliginosa L.	Asteraceae	Hydromorphic	0.5080
spigelia anthelmia L.	Asteraceae	Hydromorphic	0.2366
Sphenoclea zeylanica Gaertn	Sphenocleaceae	Hydromorphic	0.5540
Stachytarpheta cayensis Schau	Verbenaceae	Cultivated	0.6234
Stolenostemon monostachyus Briq	Lamiaceae	Hydromorphic	0.1559
Syndrella nodiflora Gaertn	Asteraceae	Cultivated	1.8584
Talinum fruticosum (Jacq.)	Portulacaceae	Cultivated	0.4733
Tieghemella heckelii Pierre ex A. Chev.	Sapotaceae	Cultivated	0.7793
Tithonia diversifolia	Asteraceae	Cultivated	0.4329
Trianthema portulacastrum Linn.	Aizoaceae	Hydromorphic	1.4255
Tridax procumbens Linn.	Asteraceae	Cultivated	2.2970
Vernonia amygdalina L	Asteraceae	Cultivated	0.6638
Veronia cinerea Less	Asteraceae	Cultivated	0.6234

*RIV- Relative Importance Value

They were found growing in hydromorphic/wetlands, cultivated and waste lands of the study area. Their Relative Importance Values narrowly ranged from 0.394 - 6.365. The flora on the north side of the river of the farm contained higher diversity of plants (Table 2) than that of the flora of the south side (Table 3).

Table 2: Diversity indices of flora north side of river at the University of Ibadan Integrated Fish Farm in 2013

INDEX	PLT 1	PLT 2	PLT 3	PLT 4	PLT 5	PLT 6	PLT 7	PLT 8	PLT 9
Taxa (S)	43	33	36	57	45	28	31	41	35
Abundance	101.333	59.667	66	60.667	34.667	48.333	30.667	19.333	25
Dominance (D)	0.065	0.102	0.074	0.045	0.042	0.481	0.059	0.034	0.046
Simpson (1-D)	0.935	0.898	0.926	0.955	0.958	0.519	0.941	0.966	0.954
Shannon(H)	3.2	2.779	2.974	3.555	3.486	1.591	3.09	3.57	3.309
Equitability (J)	0.851	0.795	0.83	0.879	0.916	0.478	0.9	0.961	0.931

* PLT - Plot

Table 3: Diversity indices of flora south side of river at the University of Ibadan Integrated Fish Farm in 2013

INDICES	PLT 10	PLT 11	PLT 12	PLT 13	PLT 14	PLT 15	PLT 16	PLT 17	PLT 18
Taxa_S	20	19	28	30	32	26	24	21	31
Abundance	27.333	14.333	14.667	25	27.333	28.667	20	24.667	52.667
Dominance_D	0.088	0.076	0.0475	0.0613	0.0482	0.169	0.06	0.0657	0.05961
Simpson_1-D	0.9123	0.9237	0.9525	0.939	0.952	0.831	0.94	0.9343	0.9404
Shannon_H	2.661	2.736	3.193	3.096	3.239	2.539	2.997	2.865	3.123
Equitability_J	0.8881	0.9293	0.958	0.910	0.9347	0.779	0.943	0.9411	0.9094

* PLT - Plot

The north side contained species that ranged from 28 in Plot 6 to 57 in Plot 4. The Dominance was generally low, ranging from 0.034 to 0.102. The Simpson index indicated very high species richness in all plots, with Plots 8, 5, 4 and 9 having 0.966, 0.958, 0.955 and 0.954 respectively. The species richness on the other side of the river however ranged from 0.831 to 0.952.

Among the alien/invasive plant species enumerated on the study site as identified by (Dogra *et al.*, 2010) included: *Panicum laxum, Imperata cylindrical, Andropogon gayanus* and *Panicum maximum* of poacea family; *Ageratum conyzoides, Bidens pilosa, Chromolaena odorata, Syndrella nodiflora, Aspilia Africana* of Asteraceae family; *Althernanthera brazilensilis* and *Althernanthera sessilis* of Amaranthaceae family and *Mimosa pigra* and *Mimosa invisa,* both belonging to the Fabaceae family (Table 4).

Table 4: List of Alien/ Invasive Species with their Relative Important Values (RIV) in the University of Ibadan Fish Farm in 2013.

Invasive species	Family	Habbitat	RIV North	RIV South
Panicum laxum Sw.	Poaceae	waste area	1.5	0
Panicum maximum Sw.	Poaceae	waste area	0.87	2.93
Ageratum conyzoides Linn.	Asteraceae	crop weed	2.57	4.92
Althernanthera brazilensilis L.	Amaranthaceae	Cultivated	1.34	0.64
Althernanthera sessilis L.	Amaranthaceae	Cultivated	1.59	0.64
Andropogon gayanus Kunth s Mart	Poaceae	wetlands	1.02	0.45
Bidens pilosa Linn.	Asteraceae	crop weed	0.16	0
Chromolaena odorata King & Robinson	Asteraceae	Cultivated	1.45	3.41
Imperata cylindrical Raeuschel var.	Poaceae	hydromorphic	0	0.75
Mimosa pigra var. inermis Adelb	Leguminosae-Mimosoideae	Cultivated	0.47	0
Mimosa invisa var. inermis Adelb	Leguminosae/ Mimosoideae	Cultivated	0.35	0
Syndrella nodiflora Gaertn	Asteraceae	Cultivated	1.86	3.41
Aspilia africana C. D. Adams	Asteraceae	crop weed	0	0.57

*RIV – Relative Importance Value

The key effect on the diversity of the University of Ibadan Fish Farm is wetland. There is a wide range of diversity ranging from 57 in plot 4 to 19 in plot 11. Plot 2 and plot 15 had higher dominant values of 0.102 and 0.169 respectively. From the Shannon-index values, species diversity is high in random distribution fashion.

Two dimensional quadrat ordinations were obtained from the DE - trended Correspondence Ordination Analysis (DECORANA/DCA) for the survey as shown in Figure 1 variability respectively. The axes of definition for the study sites were axes 1 and 2 with percentage contributions of 83.6% and 74.6%. The different points on the scattergram correspond to individual quadrats, the designations of which are represented by the corresponding labels as quadrats numbers. The major cluster shows most of the quadrats falls within wetland (the inner circle), indicating most of the enumerated flora species have characteristics of hydromorphic habitats, while the remaining species were located in either cultivated ecosystems or spaces being opened up for pond construction (Figure 1).

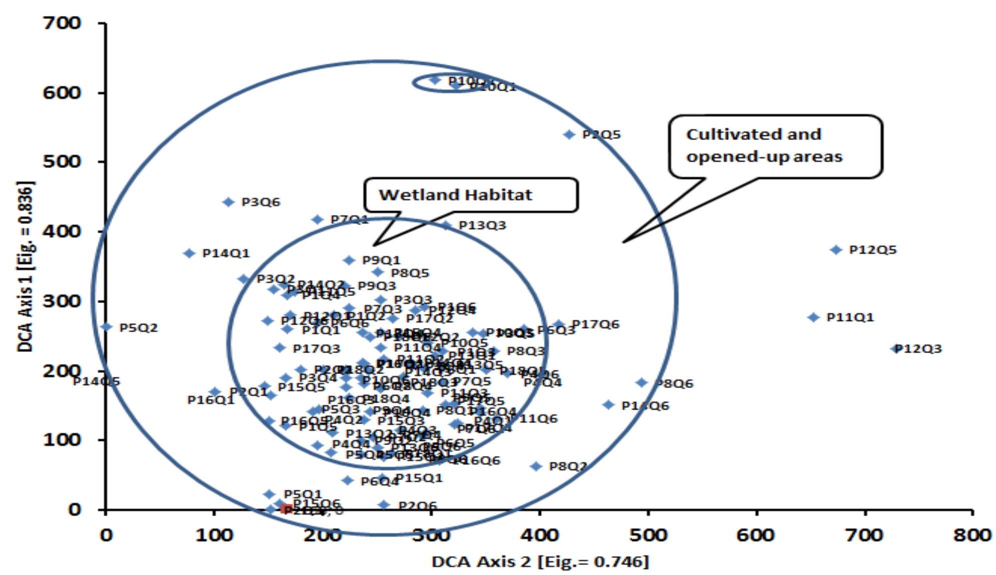

FIGURE 1: DCA biplot of stands defining the herbaceous flora of the U. I. fish farm in 2013

The classification of this species is according to their ecological preferences of species in relation to one another. One hundred of and eight quadrats (stands) fed into TWINSPAN software yielded eighteen divisively classified phytosociological groupings at the sixth hierarchy (level) of association. The original 108 quadrats were divided into phyto groups of 105 and 3 quadrats. Further classification yielded two groups of positive and negative differentials of 8 and 97 respectively. At the third hierarchy for groups of 6, 56, 42, 30, and 11 produced and two dichotomies each for the group of 56 (14 and 42) and 41 group (30 and 11) respectively. At the next lower level (5th), there were sub-groups for the 42, 30 and 11 phyto-groups, whereas the group of 6 and 14 at the 3rd and 4th levels respectively did nit divide further. The 6th and the last phyto-class comprises of 18 sub-groups of 2, 2, 4, 2, 3, 9, 4, 27, 9, 2, 13, 16, 1, 5, 1, 4, 1, and 3 groups of pairs of positive and negative preferential for wetlands, and open cultivated well drained ecosystems respectively (Figure 2).

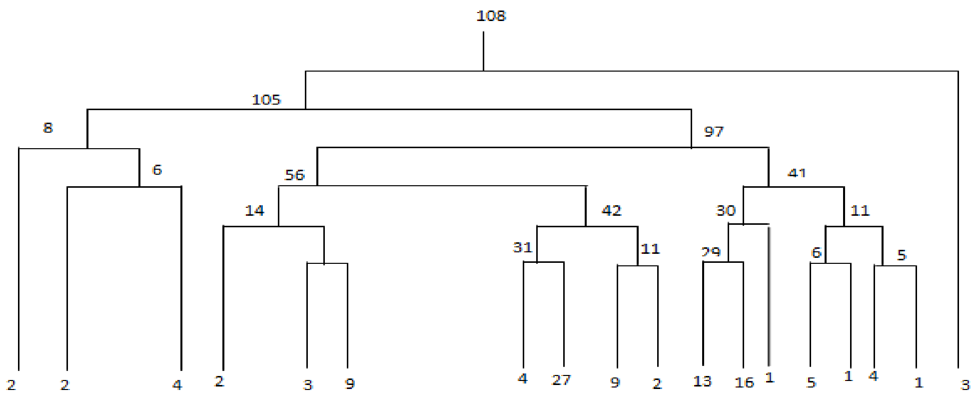

Figure 2: Phytosociological classification of herbaceous flora in the University of Ibadan Integrated Fish Farm in 2013

From Figure 2, the laid quadrats are grouped based on their similarities especially ecological preferences and habitats. The major dominant species are those peculiar to wetlands with the highest value of 27 stands.

Discussion

The flora of the two strata were similar, conforming to what Olubode *et al.* (2011) reported on the wetlands located in the same locality in his work on the wetland communities of Old Oyo National Park.

This study discovered, in accordance to the study conducted by Sheldon *et al.* 2005 that removal of vegetation reduces the diversity of native plants, and which may affect their regulatory functions, such as uptake and transformation of nutrients and toxic compounds in a wetland, flood control and survival of other life forms. Among the numerous function of the wetland in the present site of the University of Ibadan fish Farm is that it serves as a reservoir for excess water that may cause flood within the locality. The herbaceous species diversity is currently high with 144 plants in 38 families. Many of the species enumerated are typical wetland plants with robust rooting systems that can serve as barrier to excessive flooding, reduce soil erosion and retain nutrients in the soil, apart from their extensive shoot (especially leaves) with which they can mop up excess CO2 being generated in the densely populated University environment, mitigating adverse effects of climate change (Adamus *et al.* 2001) Some of these plants (with high relative importance values) include *Echinocloa obtusifolia, Lugwigia spp., Ipomoea spp, Cyeprus difformis, and Paspalum spp.*

Therefore, the deforestation and vegetation removal which is always associated with construction and developmental activities can have negative impacts on the components of wetlands. Adamus *et al.* (2001) reported that the removal of vegetation can have a significant impact on the aquatic organisms present in a wetland as a result of increased water temperature that may go above the tolerance limits of certain species; decreased cover and thereby increased susceptibility to predation; and changes in foods and their availability. Also, other functions they perform would be lost as well (Keddy, 2000). Although, the development of an integrated fish farm is a desirable, initiative from the viewpoint of meeting the food demands (Millennium Development Goal, 2015), caution should be exercised in removal of native plant populations because of the dramatic chain of cataclysmic ecosystem events. For instance, according to Martin *et al.* (1992), in wetlands along the fringes of lakes, submerged plants are particularly important and their removal can alter fish population often by making them change their habitat.

Floristic erosion is a major challenge that can cause extinction of mostly through anthropogenic activities. The wetland of the Fish Farm seems to be fragile. This is because, at the present low level of disturbance of the ecosystem at the current state of the farm at the pre-construction stage, there was a significant level of a few plants known to thrive in cultivated and perturbed ecosystems. Plants in this category that were identified and enumerated with high relative importance values (usually higher than those of native plants) include *Ageratum conyzoides, Chronmolaena odorata, Panicum spp. Althernanthera spp., Sida acuta, Amaranthus spinosus,* and *Cleome viscosa.* Some of these plants, like *Ageratum conyzoides, Chronmolaena odorata,* and *Panicum spp. Althernanthera spp.,* are alien invasive plants (Dogra *et al.* 2010). Invasive plants, according to UNEP (2000) are one the emerging environmental issue of the 21st century whose significance is still largely unrecognized or misunderstood but which contributes to ecosystem change, especially in Africa. Their presence in the University of Ibadan Fish Farm is of grave biodiversity importance, especially considering the fact that invasive species are now second only to habitat destruction as a major cause of extinction. Anthropogenic activities are indicated by presence of cultivated plants like *Musa spp, Zea mays, Amaranthus viridis, Telfaria occidentalis, Occimum grattissimum* and *Manihot esculenta.*

The ecological impacts and loss of soil stabilizing effects from roots of herbaceous plants may contribute to prevent soil erosion, leaching and run-off. Therefore, the high diversity (typical of wetland ecosystems) is an indication of good health for soil biota as it is present in the fish the farm (Keddy, 2000). The soils collected from under forest cover, especially, south of the river had the highest value of pH as this may be due to high amount of organic matter occurring from leaf litters that drop off from trees or shrubs and die-back of herbaceous plants. The presence of other essential plant nutrients which occur in high concentrations, may also be attributable to the fact that the south of the river is flood-prone, a situation which Ogunyemi (2001) acknowledged as assisting in the transport of nutrients in flood-prone ecosystems. This may be a reason some resident of the locality prefer to cultivate crops in the flood plains of the fish farm, and may be a reason for the choosing of the site was for integrated fish farming. Other portions, including the northern section and other units of the farm were being prepared for concrete fish pond and farm houses.

Based on the findings of this study, it can be recommended that the flora data generated should be used as a baseline for periodic monitoring for ecological relevance of the University of Ibadan Fish Farm site. Intensive monitoring should be carried out at regular intervals on the herbaceous composition so as to detect significant changes in composition, diversity and cover over a five to ten year interval. In addition to the monitoring, a qualitative inventory - carried out at frequent interval could yield useful data on local immigration or extinction of species. List of herbaceous plants can be identified for utilization in further research areas of special interest for actions. Fauna erosion is directly related to floral composition and erosion, thus, instance of floral erosion should be given adequate remedial considerations otherwise, the larger ecological functions of the wetland of the fish farm site might be lost. This corresponds to the findings of (LaBaugh *et al.*

1996) that the loss of small wetlands will cause a direct linkage and loss among the remaining species.

Since construction poses a threat to diversity which will have a negative effect on the ecosystem, it is therefore recommended that the construction activities should be planned and executed in as much as it is done with environmentally friendly manner as possible, especially in the area of ecosystem impoundment, retention of some native species on site, introduction of non-invasive ornamental plants, maintenance of non-injurious level of air quality and avoidance of soil pollution.

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