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Socio-Ecological Importance of Aquatic Macrophytes to Some Fishing Communities in the Northern Region of Ghana

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ABSTRACT

The research was conducted to identify types of aquatic macrophytes that grow in and around reservoirs, their uses, and the impacts of the macrophytes on fishing communities at Bontanga, Golinga, and Libga reservoirs, the Buipela dam, and the Black Volta at Buipe in the Northern Region of Ghana. The principal methods were ocular observation, photography and semi-structured interviews using questionnaires. The predominant macrophytes identified and their uses were: *Vossia cuspidata*, *Elodea canadensis*, and *Echinochloa stagnina* used as fodder for livestock; shoots of *Ipomea aquatica*, *Panicum hemitomon*, and *Phragmites karka* were used as roofing material, and for making hats, mats and necklaces; *Nymphoid indica*, *Nympheae lotus*, *Elodea canadensis*, *Alternanthera sessilis*, *Pistia stratiotes* and *Hydrocharitaceae spp* were being used to treat stomach ulcer, rheumatism, malaria, flu and boils; *Ludwgia stolonifera and Ludwigia peploids* were used as feed and as food for human consumption. *Eichhornia natan and Triglochin dubia* were identified without any known uses. It was also observed that the macrophytes impeded fishing operation at the study areas by entangling the fishing net of the fishermen. Exploding masses of macrophytes such as *Ludwgia stolonifera* were observed to redirect paddling, making fishing operation tedious. Nevertheless, some of the macrophytes were being used as bait to catch fish and as soap (*Ludwigia peploid*) to wash fishing gears. Sustainable use of the reservoirs require active mechanical, chemical, biological, or integrated control methods and the commercial exploitation of the macrophytes for production of useful products in local industries.

Introduction

Aquatic macrophytes are seen as plants that complete their life cycle in water and cause harm to the aquatic environment (Thomas and Compson, 1980). However, aquatic macrophytes are plants that may be adapted as hygrophytes or as hydrophytes (true aquatic plants which must always be in water) and should not necessarily be seen as plants that are invasive, nuisance and harmful to the aquatic environment. Aquatic macrophytes characteristically grow in water or in wet areas and are quite a diverse group. Some are rooted and anchored in the substratum while other aquatic macrophytes are emergent and some are also found floating on the water surface. Aquatic macrophytes are an important components of many watercourses, providing structure and habitat for fish and invertebrates, offering protection against currents and predators and forming a substrate for the deposition of eggs. As primary producers macrophytes represent an important food resource and they also play a significant role in the oxygen balance and nutrient cycle of many watercourses (Goeggel, 2007).

Aquatic plants are especially sensitive to changes (increases) in nutrient concentrations notably phosphorus and ammonium and to organic pollutants. Aquatic macrophytes are among those factors which a fisheries manager will try to understand and include in his strategies for optimizing capture fisheries in inland waters. Plant species composition, distribution and percentage cover of aquatic plants may determine the fish species composition, individual fish species production, access to fish stocks by fishermen, fishing gear selection and sometimes may also be an efficient indicator of water quality. Their presence may enhance water quality due to their ability to absorb excessive load of nutrients.

Aquatic macrophytes are present virtually in all fresh water bodies. The study of aquatic plants in a lake provides useful information about the productivity of a habitat (Kwarfo and Ipinjolu, 1995). Obligatory and non-obligatory plant spawners (phytophlis) stick adhesive egg envelopes to submerged live and dead macrophytes. In Africa, *Heterotis niloticus* build nest in flooded plants at the margins of flood plains, catfishes such as *Clarias* species scatter it eggs among submerged aquatic plants. Some other fish stick their eggs to submerged plants but other substrates are utilized in their absence (Welcomme, 1985).

Socio-economic importance of the macrophytes cannot be underestimated. Macrophytes are important sources of fodder for animal production. Some macrophytes are used as roofing materials. Aquatic macrophytes serve as food and as medicine herbs. Lately, some aquatic macrophytes are useful raw materials for industries (mature silky inflorescence of the spike of typha). Some aquatic macrophytes are used in making dressing accessories such as necklaces, handbags, and hat are

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being made from aquatic macrophytes. Aquatic macrophytes have potential use in fertiliser production.

A fish swims into a gill net and passes only part way through the mesh. When it struggles to free itself, the twine slips behind the gill cover and prevent escape. Gill nets are so effective that their use is closely monitored and regulated by fisheries management and enforcement agencies. Mesh size, twine strength, as well as net length and depth are closely regulated to reduce by-catch of non-target species. These nets sometimes indiscriminately and destructively kill an enormous amount of by-catch along with the targeted species. However, macrophytes can affect the use of gill net by clogging into the net making it difficult to pull after the fish has been caught by the net. Freshwater organisms use aquatic macrophytes for shelter and refuge as well as food sources either direct or indirect, in the form of periphyton and associated invertebrates, as a spawning and nursery sites. Crowx and Welcomme (1988) listed a number of characteristics of aquatic plant which make them important to fish:

1. Spawning areas and sites of oviposition for many cyprinid and percid fish.
2. Food source (living and dead).
3. They create discrete habitat which is as functional as physical structure.

Aquatic macrophytes have a great effect on physical environment, especially light penetration at the water column, water temperature, water flow and substrate.

The littoral zone of many nutrient-enriched water bodies, such as, Bontanga, Golinga, and Libga reservoirs, Buipela dam, and Buipe stretch of Black Volta, all in the Northern Region of Ghana are often clogged with excessive growth of aquatic macrophytes which directly or indirectly affect the inhabitants. They impair recreational and industrial activities, as well as altering the structure of the food web. The problems associated with them is of significant importance as the aquatic macrophytes impede fishing activities in those areas since some of the macrophytes trap and entangle fishing nets making fishing activities tedious and difficult. This could result in low harvest or catch in these water bodies even though much effort is applied. Exploding masses of aquatic macrophytes also affect the quality (taste and odour) and quantity (volume) of the water and reduce the volume and the flow of water in irrigation canals. Regardless of the problems and uses of aquatic macrophytes, little research has been conducted on the various waterbodies in the country except a few on the downstream of the Volta Lake, Weija and Owabi dams. No significant research on aquatic macrophytes has conducted on Bontanga, Golinga, and Libga reservoirs, the Buipela dam, and on the Black Volta at Buipe, all in the Northern Region of Ghana. The dearth of knowledge on socio-ecological importance of aquatic macrophytes to fishing communities in the Northern region of Ghana necessitated this research. Little research has been conducted on aquatic macrophytes on the various water bodies, regardless of these problems and uses. And none has been done on the Bulpiela dam. The research was conducted with the aim of identifying various types of macrophytes, and then assessing their social and ecological importance to the inhabitants of the fishing communities in the study areas.

Methodology

Study area

The study was conducted at Bontanga reservoir lies on the latitude 9°30' N and 1° 15' W; Golinga reservoir lies on the latitude 9°25 N and longitude 1° and 2' W in the Guinea Savanna zone of Ghana. Libga reservoir lies within latitude 9º45' and 10º8' N and on longitude 1º10´W. Buipela dam is within the Tamale metropolis which lies between latitude 9°15'30" N and longitude 0°15'10"W. The last study site is Black Volta stretch at Buipe. Buipe which is the Central Gonja District Capital in the Northern Region of Ghana. Buipe is about 104 km from Tamale (Northern regional capital) and lies within the latitude 08° 47'N 01° 32'W and 8.783° N 1.533° W. Buipe is located on the upper reaches of Black Volta.

Method of data collection

Observation

As part of the objectives to identify the various types of aquatic macrophytes, critical observation was adopted to identify the common aquatic macrophytes which were then compared to various macrophytes in a hand book (Encyclopaedia of medicinal plants). A publication titled ‘‘Aquatic Weeds & their Management’’ by Lidia Lancar and Kevin Krake (2002) also aided the identification of unfamiliar aquatic macrophytes.

Photography

Photographs of aquatic plants were taken by a Samsung smart digital camera (16MP) and compared with a hand book on various macrophytes.

Sampling and questionnaire administration

Semi-interviews were conducted using questionnaire. Thirty respondents were selected from each fishing community to know the uses of the macrophytes and the effects macrophytes on fishing operation. The sample size had fair representation of occupation, gender, age and educational level. Semi-structured questionnaire (Appendix 1) was used for the interviews.

Data analysis

The data obtained was analysed using Microsoft Excel 2013 and Statistical Package for Social Science (SPSS) and the results were presented in plates, pie chart and tables

Results

Aquatic Macrophytes Identified at the Buipe stretch of the Black Volta River

A total of seventeen (17) aquatic macrophytes belonging to twelve (12) families were identified from the Bontanga, Golinga, and Libga reservoirs, Buipela dam, and the Black Volta at Buipe during the study periods. A floating-leaved macrophytes *Nympheae lotus* (commonly called water lily) from the family Nymphaeaceae was the only aquatic macrophyte identified in all the five study areas. Emergent macrophytes *Vossia cuspidata* (belongs to the family Poaceae. *Ludwgia stolonifera* (belongs to the family Onagraceae and a Floating leaved macrophyte *Ipomea aquatica* (Convolvulaceae) were observed in three of the five study areas.

The following aquatic macrophytes occurred in only one of the five study areas: *Elodea canadensis, Echinochloa stagnina, Nymphoid indica, Pistia stratiotes, Hydrocharitaceae spp., Ludwigia peploids, Triglochin dubia, Neptunia oleracea and Nymphaea micrantha.* Table 1 shows a summary of the aquatic macrophytes identified from the study areas.

Social importance of the aquatic macrophytes to the fishing communities

Fig. 1 presents the responses obtained on the uses of aquatic macrophytes in the study area. Forty one percent of the respondents reported that aquatic macrophytes were used as fodder for animal production while 22% of the respondents interviewed indicated that aquatic macrophytes were used as food. Another 21% of the respondents reported that aquatic macrophytes were used as roofing materials for mud houses.

Table 1: Aquatic macrophytes identified in the study areas

Type of Macrophytes	Species	Family	Common Name	Location				
				Bontanga Reservoir	Golinga reservoir	Libga reservoir	Buipela dam	Black Volta
Emergent	*Vossia cuspidata*	Poaceae	Hippo grass	x	x	x		
Submerged	*Elodea canadensis*	Hydrocharitaceae	Water weed					x
Emergent	*Echinochloa stagnina*	Poaceae	Burgu Millet					x
Floating leaved	*Ipomea aquatica*	Convolvulaceae	Water spinach	x	x		x	
Emergent	*Panicum hemitomon*	Poaceae	Maidencane	x				
Emergent	*Phragmites karka*	Poaceae	Common reed	x	x			
Floating-leaved	*Nymphoid indica*	Menyanthaceae						x
Floating-leaved	*Nympheae lotus*	Nymphaeaceae	Water lily	x	x	x	x	x
Occasionally Floating-leaved/Emergent	*Alternanthera sessilis*	Amaranthaceae		x			x	
Free Floating	*Pistia stratiotes*	Araceae	Water lettuce		x			
Emergent	*Hydrocharitaceae spp*	*Hydrocharitaceae*						x
Emergent	*Ludwgia stolonifera*	Onagraceae			x	x	x	
Emergent	*Ludwigia peploids*	Onagraceae						x
Emergent	*Eichhornia natan*	Pontenderiaceae			x		x	
Emergent	*Triglochin dubia*	*Juncaginaceae*						x
Free Floating	*Neptunia oleracea*	Fabaceae	Water mimosa		x			
Floating-leaved	*Nymphaea micrantha*	Nymphaeaceae			x			

Table 2: Comparison of the uses of the aquatic macrophytes

	This Study		Similar Findings by Other Authors			
Species of macrophytes	Part used	Uses	Place	Part used	Uses	Reference
Vossia cuspidata	Shoots	Fodder for livestock	Nigeria	Leaves, stem/bark	Fodder for livestock; Thatching	Burkill (1985); Ita (1994)
Elodea canadensis	Leaves	Used by fish as food	-	-	It used extensively by insects and invertebrates	Department of Wildlife & Fisheries Sciences
Echinochloa stagnina	Leaves and stem	Fodder for livestock	Kainji lake, Nigeria		Serve as fodder and spawning grounds for different classes of economically important fish	Balogun et al. (1995)
Ipomea aquatica	Leaves	Fodder for livestock	Nigeria	Whole plant	Medicine, Food	Ita (1994)
Panicum hemitomon	Shoots	Roofing materials Fodder for livestock	United State	Leaves	Fodder for livestock	U.S. Department of Agriculture
Phragmites karka	Shoots	Roofing materials Fodder for livestock	India	-	Compost/fettiliser	Sushil (2012)
Nymphoid indica	Whole	Treat stomach ulcer and rheumatism				
Nympheae lotus	Fresh stalk and inflorescence	As part of concoction for treating fever and food.	Nigeria	Stem, bark, floral parts and roots	Curing urethral discharges and fever; food	Ita (1993); Ita (1994); Kwarfo-Apegyah and Ipinjolu (1995)
Alternanthera sessilis	-	-	Nigeria		Medicinal: Headaches and dizziness	Hellesvig-Gaskell (2013)
Pistia stratiotes	Leaves	As part of concoction for the treatment of flu.	Nigeria	Whole plant, Leaves	Food; Fish feed; fodder;	Ita (1994)
Hydrocharitaceae spp	Whole	Use to treat boils				
Ludwgia stolonifera	Leaves	Rooting material and as fodder for livestock	Nigeria	-	Food	Ita (1994)
Ludwigia peploids	Leaves	As soap to wash fishing gears				
Eichhornia natan	-	-	West Africa	-	Medicinal uses	West African Plant (200)
Triglochin dubia	-	-				
Neptunia oleracea	Leaves	Fodder for livestock			Medicine	Nakamura et al. (1996)
Nymphaea micrantha	Fresh stalk	As part of concoction for treating fever.				

About 13% of the respondents said that aquatic macrophytes were used as medicinal herbs while the remaining 4% indicated that aquatic macrophytes were used as accessories (necklaces, bags, etc.).

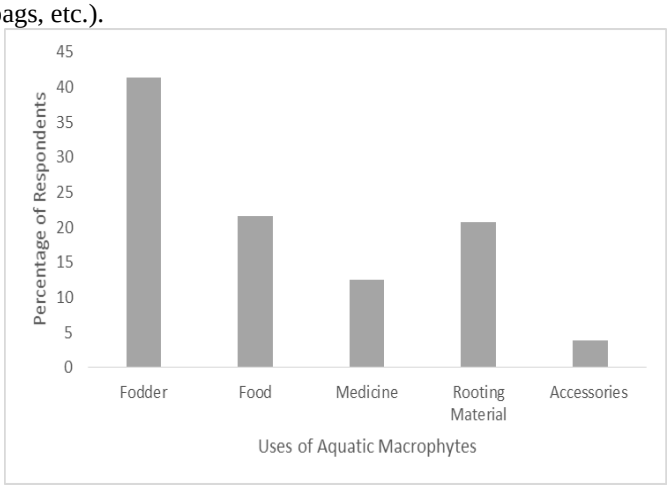

Figure 1: Uses of Aquatic Macrophytes from the Bontanga, Golinga, and Libga reservoirs, Buipela dam, and the Black Volta at Buipe

Macrophytes and fishing operation

Fishing gears

Fig. 2 illustrates the survey responses on types of fishing gear in the study areas. Forty six percent of the fishermen indicated that they used gill nets as their main fishing gear. This was followed by 29% of the respondents who reported that they used cast nets. Survey results also indicate that 13% of the respondents used baskets while 12% of the respondents used hook and line as fishing gears.

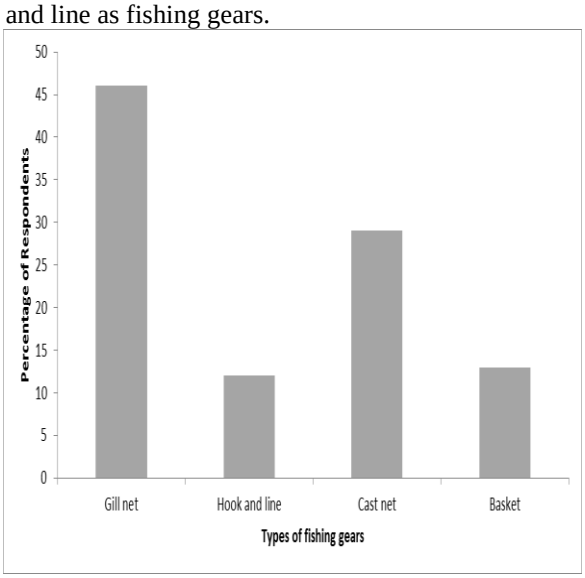

Figure 2: Types of fishing gears

Macrophytes on fishing operation and practices

Figure 3 depicts the responses from the fishermen in the study areas. Thirty percent of the fishermen indicated that aquatic macrophytes affected their fishing operation and practices by entangling their nets when the nets were thrown while 17% said that macrophytes affected their fishing operation and practices by re-directing their paddling. About 13% of the respondents reported that macrophytes destroyed their nets in the course of pulling the nets. Another 13% of the fishermen reported that they used macrophytes as bait to catch fish while 28% of the fishermen indicated that they used macrophytes as soap to wash fishing gears.

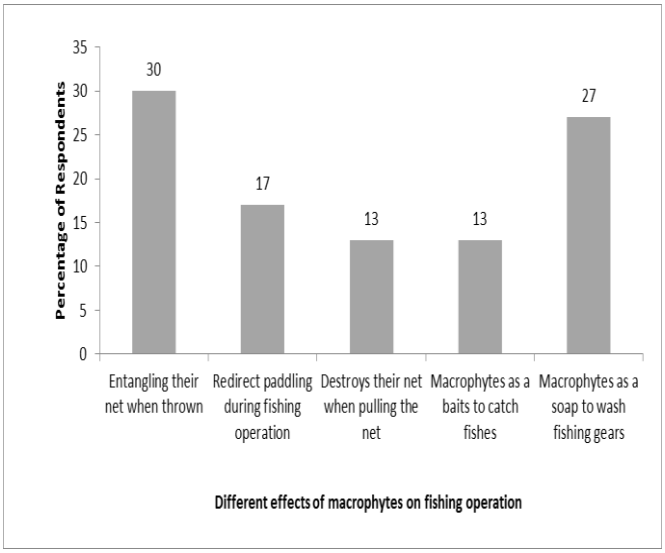

Figure 3: Macrophytes and fishing operation and practices

Identification of aquatic fauna

Table 3 shows the aquatic fauna identified in the macrophytes at the Golinga Reservoir. Five fish species and five invertebrates were observed at the Golinga Reservoir.

Table 3. Aquatic fauna found in the macrophytes in Golinga Reservoir

Fish species	Invertebrates
Tilapia zillii	Moths
Sarotherodon galilaeus	Weevils
Hemichromis fasciatus	Yola tuberculata
Malapterurus electricus	The great diving beetle (*Dytiscus marginalis*)
Oreochromis niloticus	*Neptosternus guignotum*

Discussion

The results from this study indicate that aquatic macrophytes exist in and around the Bontanga, Golinga, and Libga reservoirs, Buipela dam, and the Buipe stretch of the Black Volta.

Carfrey (1974) reported a variety of macrophytes in aquatic environments which included *Pistia stratiote*, *Nymphae lotus*, *Impomea aquatica*, *Hydrilla* species among others. The findings of Carfrey (1974) are similar to this study since *Pistia stratiotes* and *Nymphae lotus* were also observed in this study. The Volta (including the Buipe stretch of the Black Volta) has been reported to be an eco-region which supports extensive floodplains containing relatively diverse levels of aquatic and semi-aquatic flora. Typical species reported by the authors included *Nymphaea lotus*, *Vossiacuspidata*, *Aeschynomenenilotica*, *A. indica*, *Oryzabarthii*, *O. longistaminata*, *Nymphoidesezannoi*, *Cyperusdigitatus*, *Panicumsubalbidum*, *Cynodondactylon* and *Acacia nilotica* (Hughes and Hughes 1992; Guyot *et al*., 1994; Sally *et al*., 1994). In ponds, species such as *Echinochloa stagnina*, *Oryza barthii*, *O. longistamina*, *Vetivera nigritana* are found (Claude *et al*., 1991). Flooded meadows are dominated by *Echinochloa spp*., *Oryza barthii* and *Vossia cuspidata*, whereas *Pistia stratiotes*, *Ceratophyllum demersum*, *Nymphaea spp*. and *Ludwigia spp*. are common on the edges of Lake Volta (Davies and Walker, 1986). Five of the species the authors reported; namely *Nymphaea lotus*, *Vossiacuspidata*, *Echinochloastagnina*, *Pistiastratiotes* and *Ludwigiaspp* were also observed in this study. It is indicative that some of the macrophytes species may have been in existence for decades yet no comprehensive studies were done about their social and ecological importance until this research was carried out.

Macrophyte clogging the net of fishermen in the Bontanga, Golinga, and Libga reservoirs, Buipela dam, and the Buipe stretch of the Black Volta (Appendix 1) is major impediment to the fishing operation as indicated by sixty percent (60%) of the respondents. It conforms to what Smith (1991) reported, that a gradual or fast increase of aquatic macrophytes of an invasive character can results in threat to commercial or recreational fishery. Furthermore, it costs fishermen a lot of money to repair or replace their damaged nets. This can make their fishing occupation unprofitable. When macrophytes entangle the fishing nets, the nets sometimes become damaged in the course of pulling. Fast increase in macrophytes may become a major problem to fishing with net in the Bontanga, Golinga, and Libga reservoirs, Buipela dam, and the Buipe stretch of the Black Volta. Fish caught is released back to the river when an entangled net is torn in the course of pulling and thereby reducing fish catches. Plate 5 shows fishermen struggling to pull an entangled net at the Buipe stretch of the Black Volta.

Macrophytes directing the paddling of canoes lead to a lot of time being wasted during fishing operation and practices. Durocher *et al.* (1984) observed that fish production increase with an increase in aquatic plants density up to a certain point, after which further increase in plants density results in decline in fish production. It is therefore likely that a continuous increase in aquatic macrophytes density at the Bontanga, Golinga, and Libga reservoirs, Buipela dam and the Buipe stretch of the Black Volta may bring about an increase in fish production to a certain level, after which a further increase in the macrophytes density may lead to decline in the fish population. It is therefore important to look at a balance of control of these aquatic macrophytes in order to maintain the macrophytes' provision of socio-economic benefits to the fishing communities while preserving the ecological functions of the aquatic macrophytes.

The observation by respondents that some fishes hide in macrophytes during the day time is similar to what Crowx and Welcomme (1988) observed that aquatic plants are important to fishes since they serve as spawning areas, oviposition sites and sources of food. Reduced fish catches during the dry season as reported by fishermen could be an indication that fishes hides under the macrophytes for shelter or as breeding grounds or for food, or for protection against bad weather or for protection from predators. Shell *et al.* (1993) stated that aquatic vegetation provides breeding substrates for numerous fish and invertebrates and serves as fish feed which is comparable to the observations of this study. Shell *et al* (1993) observed that herbivorous fishes like *Tilapia zilli* and *Tilapia rendalli* feed on aquatic macrophytes. Moreover, it agrees with Lambert and Moore (1984) that Cichlids use aquatic vegetation directly for feeding and spawning of their sticky eggs.

Furthermore, aquatic macrophytes are used as bait to catch fishes. Respondents indicated that some species of fish feed on *Elodea canadensis*. Similarly, Mbaugwu and Adeniji (1998) reported that some species of fish feed on *Lemna pausiacota* which is similar to fish feeding on *Elodea canadensis* as observed in this study. It was realised that macrophytes were being used as soap to wash fishing gears. Using macrophytes as soap implies that the use of inorganic soap to wash fishing gears at landing sites is significantly reduced or eliminated. This will subsequently help in maintaining the aquatic ecosystem integrity as inorganic soaps have a lot of effects on the physiochemical properties of the river.

From interviews and observations, fishermen practice hand pulling to reduce the abundance of aquatic macrophytes. In practicing hand pulling to control the abundance of macrophytes, the fishermen waste a lot of time and energy controlling the macrophytes instead of fishing. It is nevertheless, in accordance with the findings of Okezie (1984), who stated that despite the adverse effects of the macrophytes, they can still be controlled. Cafrey (1974) reported that mechanical control of aquatic macrophytes is an importance and effective method of aquatic macrophytes management especially for surface floating macrophytes. Subsequently, the manual removal of aquatic macrophytes in and around Bontanga, Golinga, and Libga reservoirs, Buipela dam, and the Buipe stretch of the Black Volta can be regarded as an effective and efficient mode of the aquatic macrophytes control.

Notwithstanding the adverse effects of macrophytes on fishing activities, it was realized that the inhabitants of the fishing communities use some of the macrophytes as medicinal herbs to cure ailments such as malaria, fever, rheumatism, boils and stomach ulcer. The findings of this study is similar to that of Imevbore (1971) who indicated that most of the fifty two (52) macrophytes he identified including *Pistia stratiotes* and *Nymphoid indica* can be used for ulcerative conditions of the mouth and tongue. The use of macrophytes as alternative medicine is of great importance to the rural people of Bontanga, Golinga, Libga, Buipela and Buipe since the readily available macrophytes are relatively cheaper than manufactured drugs/medicine. Macrophytes are also used as fodder to feed animals (ruminants) especifically for cattle, sheep and goats. The use of *Echinochloa stagnina* as fodder for goat and sheep as observed in this study was not surprising as Imevbore (1971) reported that fourteen of the fifty two (52) macrophytes identified in aquatic environments in Nigeria were used as fodder and *Echinochloa stagnina* was one of the fourteen (14) species the author mentioned as being used as fodder. Most livestock farmers in the study area feed their animals mainly cattle, sheep and goats with dried *Phragmite* sp and *Ipomea* sp especially in the dry season when annual vegetation is dry and burnt. As reported by Boyd (1969) certain aquatic plants have significant levels of protein and can be used as livestock feed or soil amendment.

The use of *Phragmites karka* (Appendix 2) as roofing material for the thatch of mud houses makes it an important raw to the rural fishing communities. *Phragmiteskarka* and *Panicum hemitomon* are readily available from reservoirs for use as roofing materials. *Phragmites* when used for roofing is as effective as aluminum roofing sheets except for rain water harvesting.

Conclusion

Seventeen species of aquatic macrophytes were observed at the five study areas. Nine of the species namely *Vossia cuspidata, Echinochloa stagnina, Panicum hemitomon, Phragmites karka, Hydrocharitaceae spp, Ludwgia stolonifera, Ludwigia peploids, Eichhornia natan, Triglochin dubia* were emergent macrophytes. Four of the species namely *Ipomea aquatic, Nymphoid indica, Nympheae lotus* and *Nymphaea micrantha* were floating-leaved macrophytes. Free-floating macrophytes were *Pistia stratiotes* and *Neptunia oleracea.* The only submerged aquatic macrophyte observed from the study areas was *Elodea canadensis. An* Occasionally floating-leaved/emergent aquatic macrophytes *Alternanthera sessilis* was also encountered at the study area.

Aquatic macrophytes at Bontanga reservoir, Golinga reservoir and the Buipe stretch of the Black Volta affect fishing operation and practices by entangling fishing nets and sometimes the nets get torn in the course of pulling. The macrophytes at those locations direct the paddling of the

fishermen's canoes which subsequently lead to loss of energy and time. Notwithstanding, they serve as bait to catch fishes and as soap to wash fishing gears.

Moreover, macrophytes at the Buipe stretch of the Black Volta River are used as fodder to feed sheep and goat, medicine to treat malaria, stomach ulcer, rheumatism and boils.

The socio-economic importance of the predominant macrophytes found in the study areas is a great indication of the potential source of livelihood improvement in the fishing communities. The use of some of the aquatic macrophytes as a roofing material to thatch houses, as mulching material and for making necklaces and other dressing accessories presents new opportunities for the macrophytes industrial use and exploitation.

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Appendices

Appendix 1: Fishermen dragging their cast net entangled by macrophytes at the Buipe stretch of the Black Volta, Ghana

Appendix 2: A building roofed with *Phragmites karka* at Bontanga, Ghana