CHEMICAL CONTROL OF WATER HYACINTH (*Eichhornia crassipes*) AT ERE, OGUN STATE, NIGERIA: IMPLICATIONS FOR AQUATIC AND TERRESTRIAL BIODIVERSITY CONSERVATION

B.B. ADEKOYA

Ogun State Agricultural Development Programme,
PMB 2122, Abeokuta, Nigeria.

Abstract

The herbicidal treatment of water hyacinth in a lagoon channel at Ere, in Ado-Odo/Ota Local Government Area of Ogun State, Nigeria was undertaken with the use of glyphosate (in form of 480g/litre isopropylamine salt). Site assessments were undertaken for 6 months before and after the herbicidal treatment especially on physico-chemistry, plankton abundance, aquatic weed abundance; fish abundance and catch, fish pathology, visibility; ionic stability, and women-in-agriculture activities. Fish catch per unit effort was found to have improved from 5.13 kg (pre-treatment) to 75.13 kg (post-treatment) while residue analysis of the applied herbicide was found to be 37.0 μl/l (below internationally accepted levels). Women-in-Agriculture activities also progressed from 2% (pre-treatment) significantly ($p < 0.5$) to 55.4% (post treatment). Glyphosate had no adverse effect on fish and the human population at Ere.

INTRODUCTION

Water hyacinth, *Eichhornia crassipes* (Mart-Solms-Laubach, 1840) is easily the world's most noxious weed (Holm *et al,* 1977), being ahead of the eight worst waterweeds (Oso, 1996). It is a perennial freshwater aquatic plant that doubles its numbers within four weeks under favourable conditions (Akinyemiju and Imevbore, 1990). The individual plant has a potential of producing at least, 140 million others, hence the marked and incessant interest in its control (Botanouny and El-Fiky, 1975). It is known to have originated from the Amazon basin of Brazil in South America. This free-floating mono-cotyledous plant of the order Lilliales and family Pontederiacceae (Oso, 1996), obstructs fishing, water transportation, food processing, recreation, and other social uses for the many riverine, lacustrine, and estuarine communities

(Adekoya, 1987). It is capable of producing 3,3000 tons per hectare annually. Ten water hyacinth plants can thus produce 600,000 others covering 0.4 hectare within months (Oso, 1996). The individual plant starts to double its number in merely six days (Bennet, 1982).

Water hyacinth *Eichhornia crassipes* is one of the seven genera of *Eichhornia*, so-named in 1840 after J.A. Eichhorn, Prussia's Minister of Education who was an outstanding patron of horticulture. The weed grows luxuriantly in rivers, lakes, ponds, canals, drains, dams, ditches, channels, creeks, lagoons, estuaries and reservoirs (Oso, 1996).

It can assert severe economic impact on the host community when it can hinder navigation, lumbering, communal transportation, food processing, cage and pen aquaculture, recreation, batthing, regatta, irrigation, hydroelectricity, fishing, and other water-dependent activities. It can harbour insect vectors of human and animal diseases while providing refuge for snakes, crocodiles, monitor lizards that are predators of fish and other aquatic wildlife. The weed promotes greater evapotranspiration through its many leaves thus accelerating the drying up of rivers, lakes, reservoirs, canals, river basins, etc. It also promotes considerable ecological succession, creating islets and sandbars.

Water hyacinth was reported to have infested Nigeria's freshwater lagoons through Ogun and Lagos States (Badagry creeks) in 1984 and from the neighbouring Republic of Benin. By 1987, it had spread to the waterside fishing villages prompting the Ogun State government's financed manual clearing by the fisherfolk which was unsuccessful. This led to the desertion of some fishing villages eventually. Two successive diagnostic survey teams working for the Ogun State Agricultural Development Programme (OGADEP), Abeokuta in April and June 1991 (Akinyemiju, 1991; 1992) respectively found the encumbrance of water hyacinth at the Ere fishing channel to have attained severe proportions on the livelihood of the fisherfolk. A formal appeal for assistance through the use of the herbicidal (chemical) method of control came from the Ere fishing community to the OGADEP management in July 1991. The OGADEP management subsequently commissioned the Department of Plant Science, Obafemi Awolowo University, Ile-Ife to carry out an assessment survey of water hyacinth infestation in Ogun State (Akinyemiju, 1991; 1992).

After due consultation and considerations, the OGADEP management approved the constitution of a team of eleven (11) scientists under the coordination of the Department of Plant Science of the Obafemi Awolowo University, Ile-Ife to

undertake a pilot demonstration of the herbicidal control of water hyacinth at Ere, Ado-Odo/Ota LGA, Ogun State. Other resources, institutions involved were: State Ministry of Health, Abeokuta (which gave an ethical certificate for the use of herbicide at the Ere channel); Ogun State University (OSU), Ago-Iwoye; Ladoke Akintola University of Technology (LAUTECH), Ogbomosho; National Institute of Horticultural Research (NIHORT), Ibadan and OGADEP, Abeokuta itself.

The pilot demonstration also enjoyed collaboration from: Federal Environment Protection Agency (FEPA), Abuja; Federal Agricultural Coordinating Unit (FACU), Abuja; Ado-Odo/Ota Local Government, Ota; PMAS, Kaduna; Institute of Agriculture Research and Training IAR&T), Ibadan; Directorate for Food, Roads and Rural Infrastructure (DFRRI), Abeokuta; Ministry of Agriculture and Rural Development (Fisheries Department), Abeokuta; and Rhone-Poulene Ltd., Lagos.

METHODOLOGY

The pre-herbicidal application scientific assessments were carried out for baseline data derivation on the Ere fishing channel from July 17 – December 17, 1991 (Fig. 1) when Glyphosate (N-phospho-nomethyl glycine) containing 360/litre glyphosate in form of 480 g/litre isopropylamine salt was applied at the rate of 2.16kg a.i/ha (1.04g a.e/ha) by fixed winged AG-CAT Schweizer plane. Mopping-up application was done with a knapsack sprayer with special protusible lance. Post herbicidal application assessments were undertaken to detect possible changes in the ecosystem as from December 17 to June 5, 1992. Parameters assessed in all cases included: physico-chemistry, plankton, microbial and aquatic weed abundance in the Ere channel in addition to fish pathology, fish abundance and catch, fish breeding, visibility, percentage limuniscence, ionic stability in water and women-in agriculture activities.

RESULTS AND DISCUSSION

The presence of water hyacinth in the Ere fishing channel was found to have affected the parameters assessed. Glyphosate (Round-up) achieved a total mortality of water hyacinth within 14 days of application while the water surface became totally free of dead and decaying water hyacinth and associated aquatic weeds within 4 weeks of application (Table 1). Ionic mobility was found to have increased with the death of water hyacinth and release of hitherto-absorbed ions. Percentage luminescence, which was low in the post treatment period, increased significantly ($p < 0.5$). Dissolved oxygen which had reduced within the first 4 weeks of application owing largely to its use by the decaying water hyacinth and other aquatic weeds

improved as from between 4 – 6 weeks post treatment (Fig. 2). Women-in-Agriculture activities was low (2%) in the pre-treatment period but later increased significantly ($p < 0.5$) after herbicidal treatment (55.4%). Table 2 shows that the pH and temperature of the medium in the pre-treatment period: 6.2 – 7.8; 28.5C – 29.5°C respectively, increased to pH 7.3 to 7.9 and temperature of between 28.5°C – 33°C respectively. This favours greater fish production and breeding as a result of the absence of water hyacinth, reduced acidity, and increased insolation of the water; the primary productivity of which became greatly increased ($p < 0.5$) in the post-treatment period. Fish pathological instances (86%) decreased significantly ($p < 0.5$) in the post-treatment period (28%). Residue analysis of the glyphosate revealed that it was undetectable in the open water treated within only the first four (4) hours of application. Only traces (< 1.0 μl/l) were detectable in mud. Fish abundance (7 species) and catch (Catch Per Unit Effort – CPUE) which was 5.13kg in the pre-treatment period, increased significantly ($p < 0.5$) in the post-treatment period to 13 species and 75.13 kg respectively (Table 3). There was no mortality of fish or other forms of aquatic animals during the herbicidal treatment period (Fig. 3a & b). This attests to the fact that glyphosate as applied in this research work is safe and cost-effective when properly used under specialist scientific supervision. The public health (medical) assessments also revealed that glyphosate had no adverse effect on the Ere population throughout the period of the herbicidal treatment and afterwards.

The result of this study shows clearly that water hyacinth infestation doesn't have significantly adverse effect on the aquatic and terrestrial biodiversity of the affected location. Fishes, zooplankton, phytoplankton and other animal populations were drastically reduced by water hyacinth infestation. It also afforded the emergence of unprecedented levels of predators, snakes and crocodiles that were detrimental to aquatic bio-diversity conservation.

Table 1 Effect of Glyphostate at 2.16 kg a.i/ha Applied Aerially on Water Hyacinth at Ere Channel

Weed control treatment	Time after application (weeks)	Plant height (cm)	No. of leaves per plant	Fresh weight per plant (g)	Dry weight per plant (g)	Mortality (%)
Untreated control	0	48	9	410	40.8	0
	2	52	9	415	42.6	0
	4	52	11	415	42.6	0
	6	56	11	420	45.6	0
	8	58	11	422	45.8	0
	10	58	11	425	45.9	0
Glyphosate (2.16 kg a.i/ha)	0	48	4	410	42.1	0
	2	32	2	340	31.8	50
	4	24	1	300	25.6	70
	6	0	0	0	0	100
	8	0	0	0	0	100
	10	0	0	0	0	100

Table 2: Range of Concentration of Hydrochemical Parameters in Ere Channel beofre and after Herbicidal Treatment (all values are in mg/l)

Parameters	Staition 1		Station 2		Station 3	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Conductivity (S/cm)	85.9-114.5	107.2-38.4	90.3-103.0	91.0-562	103.7-106.0	90.30-164.5
pH (-logCH)+)	6.2-7.8	7.3-7.9	6.5-7.5	6.6-7.0	6.5-7.7	6.6-7.2
Sodium	4.2-9.7	9.1-11.7	8.7-76.8	8.0-47.8	8.8-9.0	12.0-76.8
Potassium	3.4-9.0	8.5-10.9	8.1-71.3	7.5-44.4	8.2-8.4	11.1-71.3
Calcium	4.7-7.2	6.8-24.2	6.5-56.9	6.2-35.4	6.5-6.7	8.9-56.9
Magnesium	3.2-5.8	5.5-19.6	5.3-46.1	5.4-25.0	5.3-5.4	7.2-46.1
Bicarbonate	24.4-36.6	24.4-32.6	24.5-45.7	24.4-25.0	42.7-48.0	18.3-24.4
Chloride	8.4-36.6	17.7-63.6	16.7-150.0	16.3-92.7	17.1-17.5	23.3-149.0
Sulfate	3.5-4.7	4.4-15.7	4.2-37.0	4.5-23.0	4.2-4.4	5.8-37.0
Nitrate	1.0-2.7	2.6-9.2	2.4-21.7	2.0-13.5	2.5-2.5	3.4-21.7
Dissolved Silica	15.0-17.0	25.7-96.0	25.5-220.0	26.2-140.5	25.9-26.5	35.3-335.7
Biochemical Oxygen Demand	2.50-3.65	1.10-3.90	2.0-4.62	2.30-4.45	1.10-3.50	2.30-3.40
Dissolved Oxygen	4.8-5.5	2.2-4.2	3.0-4.0	3.2-3.8	0.7-2.8	1.5-3.8
Chemical Oxygen Demand	1.4-3.2	0.8-4.8	3.0-4.02.0-3.2	2.4-4.6	2.0-3.5	2.3-3.3
Temperature (°C)	28.5-29.9	28.5-32.0	29.0-31.0	29.0-31.0	27.9-30.5	28.7-30.8

Station 1 is the Ere Channel full of water hyacinth and where glyphosate was applied on 17th December, 1991
Station 2 is the open Yewa Lagoon free of water hyacinth and untreated with herbicide
Station 3 is the Soki channel infested with water hyacinth; it is adjacent to Ere channel, but was untreated with herbicide

Table 3: Fisherfolk Activities in the Water Hyacinth-infested Ere Channel

No	Fish Species	Pre-Water Hyacinth Control Assessments				Post-Water Hyacinth Control Assessments			
		Total catch (kg)	Average wt (kg)	Average Length (mm)	Catch per unit effort (kg)	Total Catch (kg)	Average wt. (kg)	Average length (mm)	Catch/unit effort (kg)
1.	*Oreocrhomis niloticus*	166	0.40	202	5.53	1875	0.45	234	75.0
2.	*Tilapia guinensis*	183	0.43	228	6.56	1735	0.52	236	75.0
3.	*Tilapia melanopleura*	0	-	-	0	3605	0.25	200	75.1
4.	*Hemichromis fascianis*	297	0.21	176	5.20	3592	0.25	189	74.8
5.	*Hermichromis bimaculatus*	0	-	-	0	4500	0.20	101	75.0
6.	*Auchenoglanis occidentalis*	0	-	-	0	3197	0.28	24	74.6
7.	*Chrysichtys nigrodigitatus*	212	0.35	244	6.18	2343	0.38	258	74.2
8.	*Clarias gariepinus*	220	0.32	258	5.87	2186	0.41	281	74.7
9.	*Clarias anguillaris*	0	-	-	0	4090	0.22	206	75.0
10.	*Hepsetus odoe*	0	-	-	0	2308	0.39	264	75.0
11.	*Heterotis niloticus*	170	0.52	234	7.37	1599	0.56	240	76.6
12.	*Gymnarchus niloticus*	176	0.435	272	6.60	576	1.52	508	73.0
13.	*Mormyrus rume*	193	0.36	214	5.80	2029	0.42	262	71.0
14.	*Channa obscura*	153	0.44	257	5.61	1698	0.48	269	67.9
15.	*Gnathonemus tamandua*	186	0.38	238	5.90	2070	0.43	241	74.2
16.	*Schilbe mystus*	0	-	-	0	2875	0.28	203	67.1
17.	*Bagrus bayad*	0	-	-	0	2349	0.35	196	69.0
18.	*Notopterus afer*	0	-	-	0	2358	0.38	205	74.7
19.	*Polypterus senegalensis*	109	0.61	252	5.54	1261	0.67	259	70.4
20.	*Mugil cephalus*	188	0.35	206	5.48	1970	0.44	211	72.2
21.	*Synodontis clarias*	155	0.43	203	5.60	1724	0.51	209	73.3
22.	*Alestes nurse*	405	0.17	128	5.76	3739	0.23	136	71.7
23.	*Potrocephalus bane*	145	0.48	206	5.80	1686	0.50	212	70.3
24.	*Barbus nigeriensis*	2162	0.03	166	5.41	20050	0.04	169	56.8
25.	*Calamoichtys calabricus*	725	0.10	281	5.44	5367	0.15	288	67.1
26.	*Distichodus nostratus*	239	0.26	194	5.18	2161	0.38	2042	58.4

Station 1 is the Ere channel full of water hyacinth and where glyphosate was applied on 17 December, 1991
Station 2 is the open Yewa Lagoon free of water hyacinth and untreated with herbicide.
Station 3 is the Soki channel infested with water hyacinth; it is adjacent to Ere channel, but was untreated with herbicide.

Activities (%)	Pre-Hycinth Control Assessments						Post-Hyacinth Control Assessments					
	July	Aug.	Sept.	Oct	Nov.	Dec. 91	Jan.	Feb.	Mar.	Apr.	May	Jun. 92
1. Food processing	2.0	2.0	2.0	2.0	2.0	2.0	55.4	55.6	55.2	56.8	57.0	56.5
2. Fishing	14.0	16.0	14.0	16.0	16.0	18.0	58.0	58.2	58.8	59.0	59.5	61.5
3. Transportation	10.0	10.0	10.0	15.0	16.0	17.0	79.8	79.9	80.1	80.2	81.0	84.0
4. Other Uses	0.4	0.6	0.5	0.3	0.6	0.2	66.5	67.0	66.8	67.2	67.6	68.5

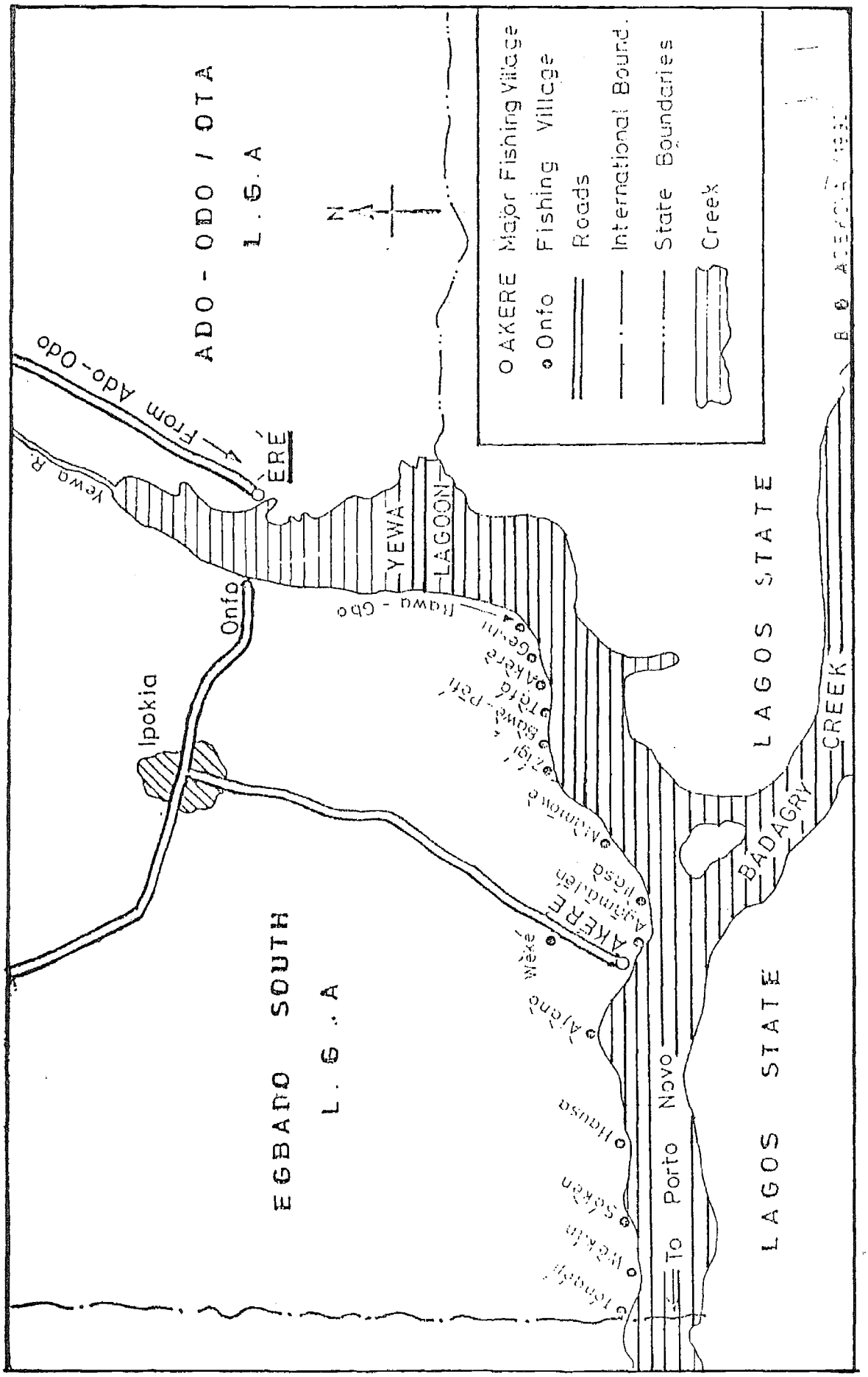

Fig. 1. Ere : Herbicidal Application Site

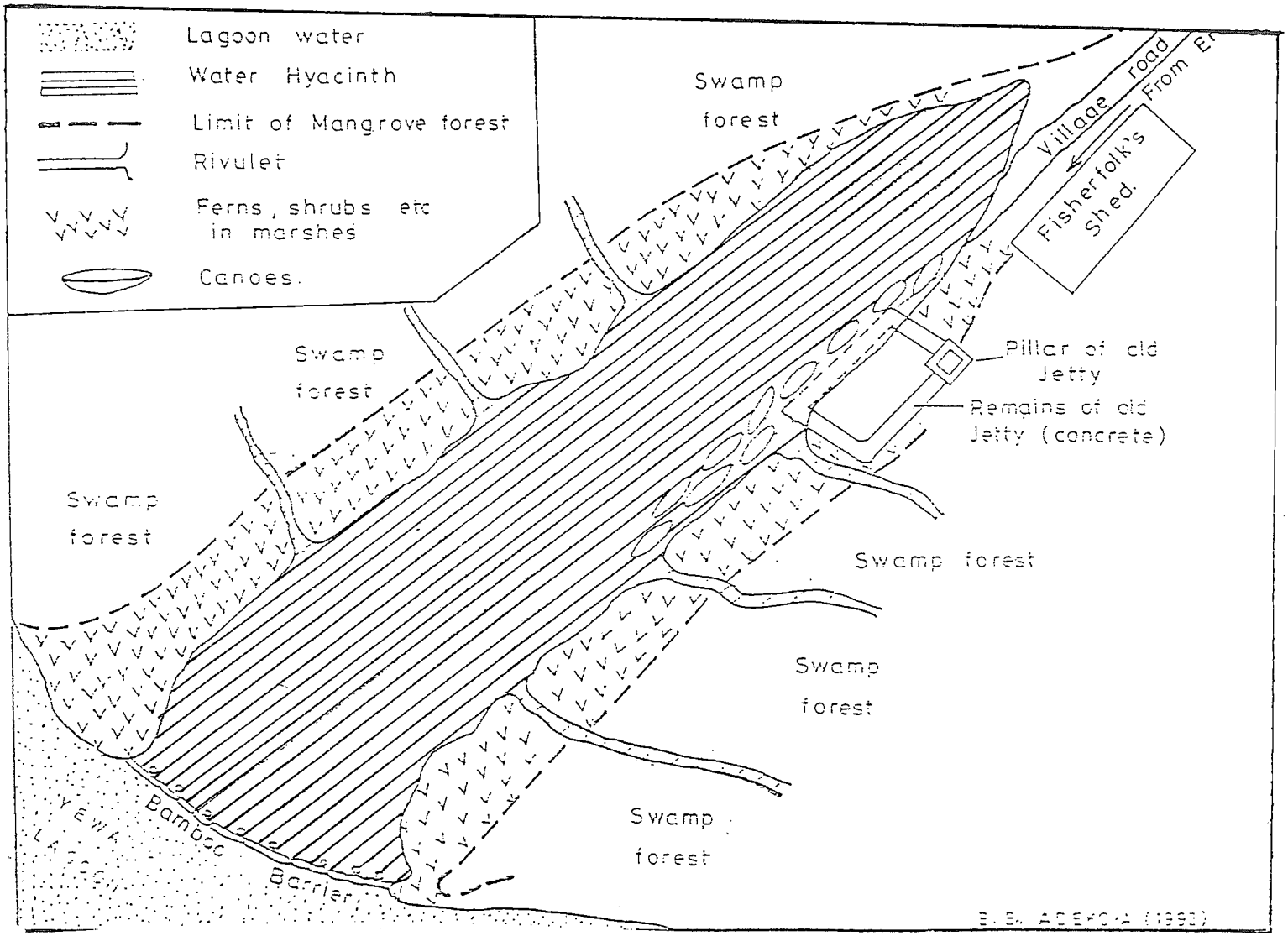

Fig. 2. Ere : Channel (Plan and Layout Details)

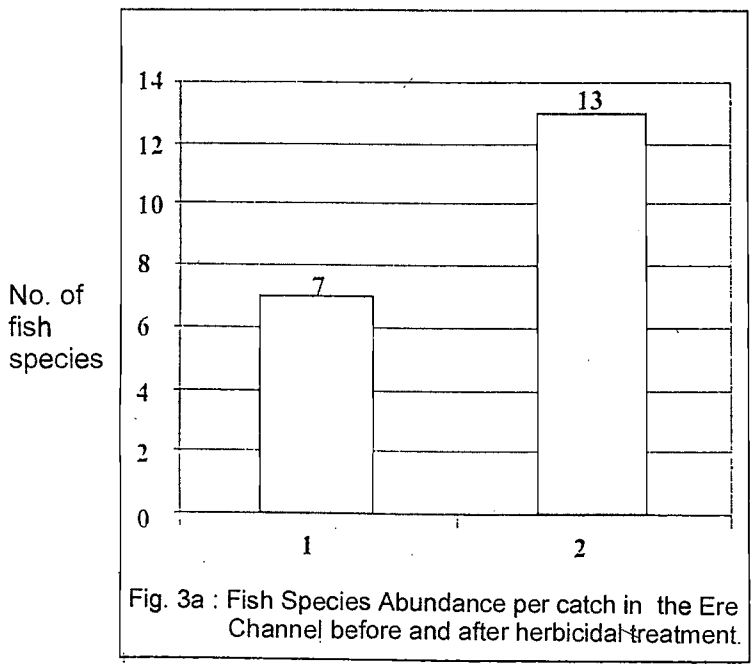

Fig. 3a : Fish Species Abundance per catch in the Ere Channel before and after herbicidal treatment.

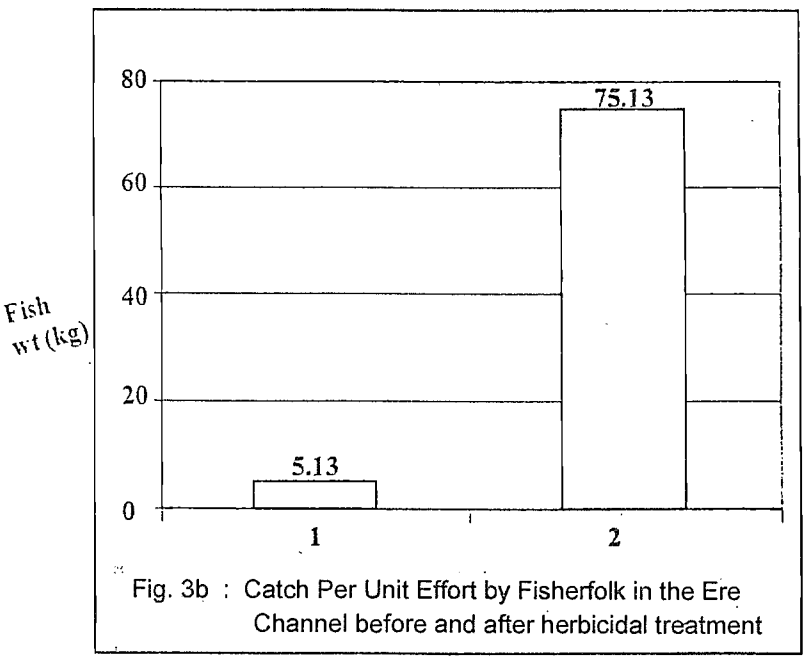

Fig. 3b : Catch Per Unit Effort by Fisherfolk in the Ere Channel before and after herbicidal treatment

Key

1. No. of Fish species before herbicidal treatment.
2. No. of Species after herbicidal

snakes, crocodiles, etc that were deterimental to aquatic biodiversity conservation.

The high levels of adaptability and proliferation of water hyacinth in water and on land has sometimes afforded the succession in waterfront wetlands thus smothering forest undergrowth flora and fauna with severe adverse effects on wetland biodiversity conservation. The implication of water hyacinth infestation is that it is detrimental to the conservation of aquatic and terrestrial biodiversity.

CONCLUSION

Conclusively, based on the pilot demonstration of the herbicidal control of water hyacinth at Ere, in Ado-Odo/Ota Local Government Area of Ogun State and similar ones conducted in Nigeria and elsewhere in the world, the principle of herbicidal control of water hyacinth in Nigeria is recommended on a nation-wide scale for managing heavy, obstructive infestations detrimental to the proper functioning of irrigation, fish pens (Akadja), hydroelectric systems, and other water dependent activities.

It is suggested that the "National Committee of Water Hyacinth Infested States (NACOWHIS)" will be valuable in supporting the Federal Government on its focus on water hyacinth management and articulate appropriate control strategies with the collaboration of States, Local Governments, affected communities, research institutes, universities, other relevant agencies, private companies and non-governmental organisations in order to successfully combat the menace of this noxious aquatic weed. A Regional Control Programme is also advisable for successfully combating water hyacinth within lagoon and river-linked ECOWAS countries for a holistic and cost-effective management of the obnoxious weed.

ACKNOWLEDGEMENTS

Special appreciation is hereby expressed to the various resource scientists involved in the chemical control of Water hyacinth at Ere, Ogun State.

REFERENCES

Adekoya, B.B. (1987). The mechanical (manual) clearing of water hyacinth by fisherfolk in the waterside. Report submitted to the Ministry of Agriculture and Natural Resources, Abeokuta, Ogun State.

Adekoya, B.B. (1992). Herbicidal control of Water hyacinth (Fisheries Adaptive Research): *Report presented to the World Bank Thematic Mission.* OGADEP, Abeokuta

Akinyemiju, O.A. (ed.) (1991). Water hyacinth infestation in Ogun State. A report submitted to OGADEP, Abeokuta. 15 pp.

Akinyemiju, O.A. (ed.) (1993). Hercidal control of water hyacinth. A pilot demonstration at Ere fishing channel, Ogun State, Nigeria. O.A.U (Dept of Plant Science, Ile-Ife.

Akinyemiju, O.A. and Imevbore, A.M.A. (1990). Herbicidal control of water hyacinth – A field pilot demonstration at Kofawei Creek,

Igbokoda, Ondo State, Nigeria. 181 pp. *A Final Report Submitted to the Presidency, Special Services, Tafawa Balewa Square, Lagos.*

Akinyemiju, O.A., Bewaji, F.A. and Imevbore, A.M.A. (1990). Chemical control of water hyacinth (*Eichhornia crassipes*). In: *Proceedings of the International Workshop on Water Hyacinth, Federal Mintstry of Science and Technology, Lagos, Nigeria.* pp 137 – 149

Akinyemiju, O.A. and Bewaji, F.A. (1990). Chemical control of Water hyacinth and associated aquatic weeds at Itoikin near Lagos. *Proceedings EWRS 8th Symposium on Aquatic Weeds, 1990.* pp 3 – 8.

Akobundu, I.O. (1987). Weed Science in the Tropics: Principles and Practices. John Wiley & Sons, N.Y. 522 pp.

Batanouny, K.A. and A.M. El-Fiky (1975). The Water hyacinth (*Eichhornia crassipes)* in the Nile System, Egypt. *Aquatic Botany.* 1: 243 – 252.

Holm, L.B. Pluehnet, D.L., Pancho, J.V. and Herberger, J.P. (1977). The World Worst Weeds: Distribution and biology. *University Press of Hawai.* 609 pp.

Word Bank (1990). Towards the Development of an Environmental Action Paln for Nigeria. *Report No.9002 –UNI.*

World Health Organisation (1971). International standards for drinking water. WHO (3rd Edition), Geneva.

World Health Organisation (1985). Safe use of pesticides: Ninth Report of the WHO Expert Committee on Vector Biology and Control Technical Report Series. No.720.

World Health Organisation (1991). Safe use of pesticides: Fourteenth Report of the WHO Expert Committee on Vector Biology and Control Technical Report Series. No.813.