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Assessment of amphibian population in the Water hyacinth infested village ponds with reference to pond length, width and depth in Cauvery delta districts of Tamil Nadu.

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Abstract

Populations of amphiasis are declining at rapid rate. There are several possible causes for the decline of amphibians. Existing agricultural field and village ponds have become not suitable habitats for amphibian population due to pollution Invasive plant species are widely recognized as a major threat to biodiversity and ecosystem stability. In the present study the length, width and depth were assessed to determine whether the exotic species has any negative impact on amphibian population. All the variables were found dependent on one another; The study was carried out in the selected village ponds of three districts viz., Nagapattinam, Thiruvarur and Thanjavur from June 2012 to June 2015 which were monitored monthly once to find out the diversity and density of amphibian. Visual Encounter Survey Method was adopted to estimate the amphibian population in various ponds. The biomass of the water hyacinth was employed by quadrate method. The study period was grouped into four different seasons. Among the three districts, thirty one village ponds were selected on the basis of the degrees of water hyacinth infestation. A total of 15.371, 6.598 and 7.071 acres of pond area were covered by GPS.The present article deals with the influence of area, length, width and depth of the pond and water hyacinth infestation on the amphibian density.

Key words: Amphibian, Cauvery delta regions, GPS, pond length, pond width, Water hyacinth

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INTRODUCTION

Amphibians are excellent “Bio indicator species” because they can provide information on the health of two habitats. Due to their biphasic lifestyle and permeable skins, amphibians are commonly used as “Bio indicators”. They are also considered as “Environmental sponges” because their semi-permeable skin allows environmental toxins to be easily absorbed (SERC, 2007). There are several possible causes such as agriculture, habitat destruction, exotic species, pollution, toxic substances. However information are backing to accurating assess the current status of the complibian. Scientists estimate that about 43% of amphibians or about 1,856 species are threatened and are declining at a rapid rate worldwide (Stuart *et al.,* 2004). The faunal diversity of amphibian in Tamil Nadu includes 76 species. Schedule IV includes 23 species of amphibians (Tamil Nadu Forest Deportment).In India, 342 species of amphibians are classified, in which 161 are still under the data deficient category which indicates the need of elaborative, systematic and coordinated efforts for estimating the population and to assess the factors delimiting the distribution of species. Dinesh *et al*. (2012) reported that the amphibians are the ecological indicator species in the environment. It has been estimated that one-third of 6,000 worldwide amphibian species are under threatened category. Besides habitat loss, over exploitation or introduced species, amphibians are affected due to the pollution of surface waters with fertilizers and pesticides. Katie Finlinson*et al*. (2002) reported that amphibians are integral components of many ecosystems and serve as excellent bio-indicators of the environment.

They are the important ecological component of both wetlands and dry land. Amphibians as a group are much more closely associated with water and wetlands than most reptiles, birds, or mammals. Both the aquatic and terrestrial environments are to be intact in order to protect the amphibian species. The amphibian larvae had to have either developed enough to leave the pond or to have perished as the pond dried up. Any change in dissolved oxygen due to the loss of leaf litter has its impact on the development of the larvae.

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In India, water hyawalts (Eichhornva crassipes) is a major problem in water bodies for aquatic diversity. They changes in the water quality due to changes in the physics chemical properties. This plant is turbulent in water, also occupying surface of pond and dominating the other aquatic plants. It blocks the water flowing in running water, rivers and canals. It is the major issue for disconnecting the linkage of water connection of local area and water bodies. The weeds in turn provide ideal breeding sites for mosquitoes by keeping the water surface placid and rendering it inaccessible to any methods of chemical control (Jayanth, 1987). Water hyacinth tolerates the high and low temperature limits, and causes in water quality changes in natural village ponds, canals and rivers, which in turn affects the aquatic biodiversity either directly or indirectly. Species like shells, fishes and amphibians were affected by changes in physio-chemical parameters of water. Because of its extremely high rate of development, *Eichhornia crassipes* is an excellent source of biomass. The ecological and socio-economic impacts of this invasive species are currently well understood (Villamagna and Murphy, 2010, Balasubramanianand Arunachalam, 2014).

Water hyacinth mats decrease concentration of dissolved oxygen, one of the most important water quality variables for aquatic fauna, by preventing the transfer of oxygen from the air to the water surface (Perna and Burrows, 2005). Although McVea and Boyd (1975) found a negative relationship between dissolved oxygen and water hyacinth coverage, a water hyacinth cover of 25% out of 400 m^2 experimental ponds did not show decreased level of dissolved oxygen. Water hyacinth infestations are also known to aggravate mosquito problems by hindering insecticide application (Seabrook, 1962). The socio-economic effects of water hyacinths are dependent on the extent of the invasion, the uses of the impacted water body, control methods and the response to control efforts (Villamagna and Murphy, 2010).

Study Area

The study was carried out in the selected village ponds of three districts viz., Nagapattinam, Thiruvarur and Thanjavur which were covered by various habitats of those districts.

METHODOLOGY

Mapping

The ponds were marked by GPS and GIS Program in Cauvery delta regions of Nagapattinam, Thanjavur and Thiruvarur districts, Tamil Nadu, India (Fig.1) Thirty one ponds were selected on the basis of the degree of water hyacinth infestations *i.e.* Dense, Medium and Low**.** A pond surface area could be estimated by walking the perimeter of the pond and stopping at various waypoint locations along the pond shoreline. The way points were stored at each location where the pond shape changes.

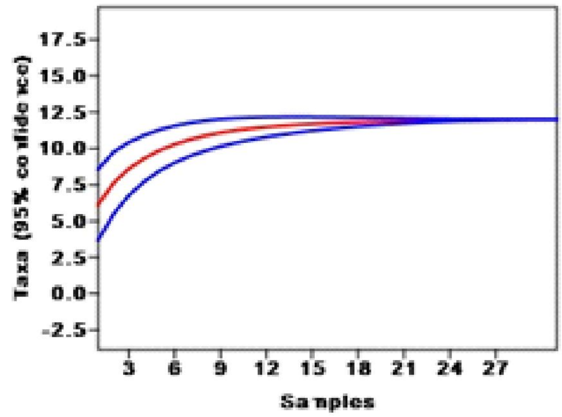

Fig.1. REGRESSION /MISSING LISTWISE / STATISTICS COEFF OUTS R ANOVA CHANGE / CRITERIA=PIN (.05) POUT(.10) /NOORIGIN / DEPENDENT *Eichhornia* /METHOD=ENTER PV / RESIDUALS NORMPROB(ZRESID).

Amphibian counting

Study was carried out from June 2012 to June 2015. The selected village ponds were monitored monthly once to find out the diversity and density of amphibian population. Visual Encounter Survey Method (VES) was carried out to estimate the amphibian population (Heyer, 1994) in various ponds and the diversity of frog species was recorded in the morning or evening time. Amphibians were thoroughly searched in the water bodies, edge of the water, grasses, bushes and over the surface of the water.

Biomass of the water hyacinth

Assessment of Biomars was made by quadrate method Madesen (1993), in which four quadrates were laid randomly. The height and weight of the plant was measured by using scales or measuring tap and Spring balance, respectively.

Seasons

The study period was grouped into four different seasons. The Pre-Monsoon season (PrM) includes the months of July, August and September. The Monsoon season (Mon) includes the months of October, November and December. The Post Monsoon (PoM) includes the months of January, February and March and the summer season (Sum) includes the months of April, May and June (Pandiyan *et al.,* 2006).

Pond Depth and Volume Measurement

Average pond depth was calculated by dividing the pond into at least four sub-areas. At least one depth within each of the sub-areas was taken which were used to calculate the overall average pond depth. This method is suitable when the pond bottom is irregular rather than bowl shaped. The volume of water in the pond (in acre-feet) was calculated by simply multiplying the pond area (in acres) by the average pond depth in feet. One acre-foot of water is equal to 325,851 gallons.

Statistical analysis

Statistical analyses were performed by using Windows based Statistical package viz., Microsoft Excel, SPSS (Statistical Package for Social Science: Nie*et al,* 1975)

RESULTS AND DISCUSSIONS

A total of 15.371, 6.598 and 7.071 acres of pond area in Nagapattinam, Thanjavur and Thiruvarur districts of Tamil Nadu in Cauvery delta region respectively were covered from June 2012 to June 2015 by using GPS. Among the three districts 31 village ponds were selected based on the degree of infestations of exotic plant *Eichhornia crassipes* fifteen village ponds covering an are aabout15.371 acres from ten villages were identified and measured from Nagapattinam district (Table 1). In Thanjavur district, only seven ponds from five villages were identified in which about 6.598 acres of pond area were sampled(Table 3). In Thiruvarur district, only nine ponds were identified from six villages in which about 7.071 acres of pond area(Table 2) were surveyed.

Table.1. Area, length and width measurements of 15 village ponds of Nagapattinam District

Sl. No.	Village Name	Pond Name	Area on Acres	Length (m)	Width (m)
Nagapattinam District Village Ponds					
1	Keezhaiyur	KeezhaiyurKulam	0.954	69.8	63.3
2	Karuvazhakarai	Periyakulam	3.19	142	106
3	Karuvazhakarai	Karuvazhakarai Pond1	0.389	50.4	30.9
4	Melayur	PalathanKulam	0.5	44.6	45.6
5	Melayur	PillaiyarKulam	0.291	41.2	31.6
6	Kanjanagaram	Puthukulam	0.989	69.7	64.6
7	Melakattalai(parasalur)	PillaiyarKulam	1.211	87.5	56.9
8	Parasalur	ThamaraiKulam	1.8	113.3	59.4
9	Parasalur (thiruparíyalur)	Thirukulam	0.211	36.9	28.2
10	Parasalur (thiruparíyalur)	AyyanarKulam	0.939	71	61
11	Thattamadam (Parasalur)	SammanKulam	1.719	87.5	88.3
12	Ilayalur	IlayalurKulam	0.48	46.2	42.3
13	Ilayalur	SivankoilKulam	0.439	48.2	36
14	Keelamangalam	Vannapadugaikulam	1.716	64.5	42.6
15	ChozhachakraNallur	Thamaraikulam	0.543	43.4	38

Table.2. Area, length and width measurements of 9 village ponds of Thiruvarur district

Sl. No.	Village Name	Pond Name	Area on Acres	Length (m)	Width (m)
Thiruvarur District Village Ponds					
1	Kunniyur	SathiramKulam	0.723	50.4	47.3
2	Kunniyur	Kunniyur kulam-2	0.831	60.1	47.8
3	Mavur	MavurKulam	0.678	44.3	43.5
4	ThiruthuraiPoondi	TherasaKulam	0.654	43.4	41.6
5	ThiruthuraiPoondi	Madathukulam	0.865	51.4	48.2
6	ThiruthuraiPoondi	Metupalayamkulam	1.2	61.5	56.4
7	Kachanam	MuthumariammanKoil kulam	0.468	38.6	35.8
8	SrinivasaPuram	SrinivasapuramKulam	0.863	59.7	56.8
9	Sannanallur	SannanallurKulam	0.789	50.9	48.6

Table.3. Area, length and width measurements of 7 village ponds of Thanjavur district

Sl. No.	Village Name	Pond Name	Area on Acres	Length (m)	Width (m)
Thanjavur District Village Ponds					
1	Narasinganpettai	Narasinganpettai Pond-1	0.231	32.1	29.5
2	Narasinganpettai	Narasinganpettai Pond-2	0.542	44.7	40.6
3	Thiruvalangadu	Thiruvalangadu	0.582	47.2	45.2
4	Kanjanur	KanjanurKulam	2.873	97.8	89.5
5	Mananjery	MananjeryKulam	0.456	56.6	49.3
6	Veppathur	Veppathur Pond-1	0.684	50.1	48.7
7	Veppathur	Veppathur Pond-2	1.23	61.6	49.2

The slope of the line (-2.654) indicates that the pond volume decrease due to infestation by *Eichhornia*. The pond volume *Vs Eichhornia* table of coefficients also reports some T-statistics and significance P= 0.000 levels (Fig. 1). The *Eichhornia Vs* volume of pond graph also re presents normal Probability Plot because of the residuals were normally distributed and lie along a 45º upward sloping diagonal line (Fig.2). The *Eichhornia Vs* pond area graph is called a normal Probability Plot because the residuals were normally distributed and lie along a 45º upward sloping diagonal line (Fig. 3). The amphibian density *Vs* pond area graph is called a normal Probability Plot because of the residuals were normally distributed and lie along a 45º upward sloping diagonal line (Fig.4). The amphibian density *Vs* pond volume graph is called a normal Probability Plot because the residuals were normally distributed and lie along a 45º upward sloping diagonal line (Fig.5).

The value of the test statistic for the slope is -0.375 and the associated P-value is approximately 0.708. As in all t tests there is a statistically significance between x and y (Table 8). The (Table10) area *Vs* density of the test statistic for the slope is -14.382, and the associated

Table.4. Amphibian species diversity, richness and evenness for each pond of study area for throughout the study period

Sl. No.	Pond Name	Taxa_S	Indv.	Dominance _D	Simpson _1-D	Shannon _H	Evenness_ e^H/S	Equit. _J
1	KeezhaiyurPond	5	21	0.2647	0.7353	1.449	0.8516	0.9002
2	Karuvazhakarai Pond	5	24	0.2387	0.7613	1.507	0.9027	0.9364
3	Periyakulam	9	31	0.1504	0.8496	2.014	0.8328	0.9167
4	Palathankulam	5	19	0.2339	0.7661	1.502	0.8982	0.9333
5	Pillayarkulam	9	33	0.1328	0.8672	2.092	0.8998	0.9519
6	Puthankulam	5	20	0.2136	0.7864	1.576	0.9675	0.9795
7	Pillayarkulam2	7	24	0.1843	0.8157	1.795	0.8601	0.9225
8	Thamaraikulam	4	15	0.2673	0.7327	1.353	0.9677	0.9763
9	Thirukulam	7	19	0.1648	0.8352	1.875	0.9312	0.9634
10	Ayyanarkulam	6	18	0.2351	0.7649	1.607	0.8314	0.897
11	SammanKulam	5	16	0.2255	0.7745	1.55	0.9419	0.9628
12	IlayalurKulam	6	24	0.1845	0.8155	1.741	0.9507	0.9718
13	SivankoilKulam	8	38	0.1798	0.8202	1.898	0.834	0.9127
14	Vannapadugaikulam	6	19	0.2208	0.7792	1.609	0.8332	0.8982
15	ThamaraiKulam	6	25	0.1882	0.8118	1.705	0.9167	0.9515
16	Kunniyur-1	10	29	0.1446	0.8554	2.092	0.8101	0.9086
17	Kunniyur-2	6	24	0.1971	0.8029	1.683	0.8969	0.9393
18	Mavur pond	6	30	0.2011	0.7989	1.698	0.9102	0.9475
19	Therasakulam	7	20	0.1753	0.8247	1.852	0.91	0.9515
20	Madathukulam	7	24	0.1865	0.8135	1.79	0.8554	0.9197
21	Mettpalayam pond	7	20	0.1732	0.8268	1.845	0.9043	0.9483
22	SirinivasapuramPond	5	17	0.2121	0.7879	1.58	0.9707	0.9815
23	Sannanallurpond	4	15	0.3103	0.6897	1.243	0.8662	0.8964
24	MuthumariyammanPond	5	17	0.2237	0.7763	1.541	0.9337	0.9574
25	Narasingapettai pond	3	12	0.3628	0.6372	1.056	0.958	0.961
26	Narasanpettaipond2	7	41	0.1712	0.8288	1.825	0.886	0.9378
27	Thiruvalangadu pond	6	26	0.2036	0.7964	1.664	0.88	0.9286
28	Kanjanurpond	6	22	0.1911	0.8089	1.702	0.9137	0.9496
29	Mananjerypond	5	23	0.2107	0.7893	1.583	0.9738	0.9835
30	Veppathurpond	8	32	0.1604	0.8396	1.915	0.8487	0.9211
31	Veppathurpond2	5	21	0.2185	0.7815	1.557	0.9493	0.9677

Table. 5. ANOVA table to show the relations between *Eichhornia* species and volume of pond

ANOVA [a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	194.513	1	194.513	1.25	0.265[b]
	Residual	69646.15	446	156.157		
	Total	69840.66	447			
a. Dependent Variable: Eichhornia ; b. Predictors:						

Table.6. Regression analysis to the relations between *Eichhornia* species with volume of pond.

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	28.713	0.675		42.565	0
	PV	-2.65E-07	0	-0.053	-1.116	0.265
a. Dependent Variable: Eichhornia						

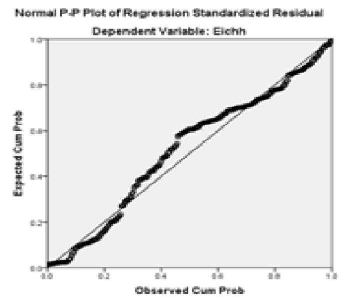

Fig.2. Regression analysis of Eichhornia *Vs* volume of pond

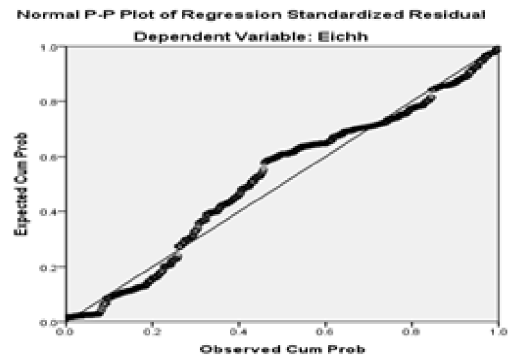

Fig.3. Regression analysis of *Eichhornia Vs* pond area

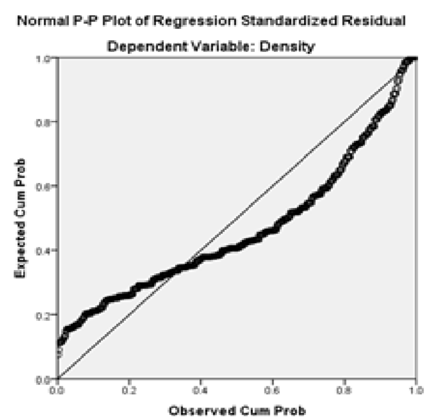

Fig.4. Regression analysis for amphibian density *Vs* pond area

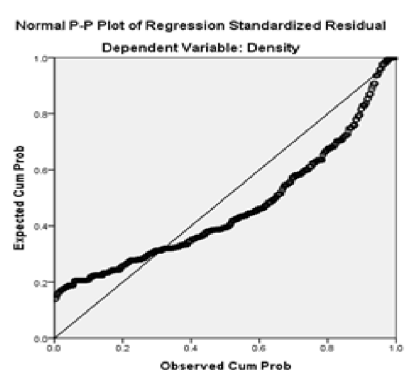

Fig.5. Regression analysis for amphibian density *Vs* pond volume

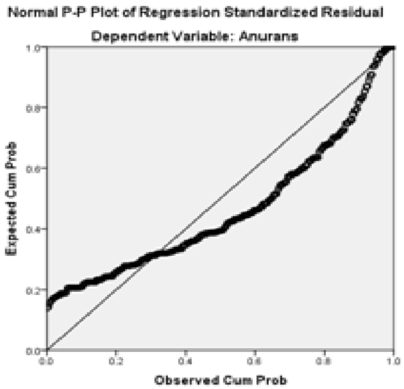

Fig.6. Regression analysis for amphibian population *VS* pond volume and area

Table. 7. Regression analysis of Coefficients between *Eichhornia Vs* area

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	28.68	1.052		27.265	0
	Area	-0.32	0.855	-0.018	-0.375	0.708

Table.8. ANOVA table for *Eichhornia Vs* surface area.

ANOVA[a]						
Model		SS	df	Mean Square	F	Sig.
1	Regression	14183.55	1	14183.6	206.8	0.000[b]
	Residual	37372.08	545	68.573		
	Total	51555.63	546			

a. Dependent Variable: Density
b. Predictors: (Constant), Area

Table.9. Regression analysis to compare *Eichhornia* with surface area.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	17.59	0.623		28.222	0
	Area	-7.071	0.492	-0.525	-14.38	0

Table.10. Regression analyses for amphibian density *Vs* pond volume

ANOVA[a]						
Model		SS	*Df*	Mean	F	Sig.
1	Regression	5357.131	1	5357.131	63.198	0.000[b]
	Residual	46198.5	545	84.768		
	Total	51555.63	546			

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.984	0.452		26.496	0
	PV	-1.20E-06	0	-0.322	-7.95	0

Table.11. Regression analyses for amphibian density *Vs* pond volume

ANOVA[a]						
Model		SS	*Df*	Mean Square	F	Sig.
1	Regression	5357.131	1	5357.131	63.198	0.00
	Residual	46198.5	545	84.768		
	Total	51555.63	546			

Coefficients[a]						
Model		Unstandardized		Standardize	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.984	0.452		26.496	0
	PV	-1.20E-06	0	-0.322	-7.95	0

P-value is approximately 0.000. As in all t tests there is a statistically significance between x and y. Both the volume and area of the pond are highly significant for density of amphibians. Thus, study clearly indicates that the water hyacinth influences the amphibian density and the physic-chemical environment of various pond ecosystems (Fig.6).

DISCUSSION

Oki and Ueki (1984) reported that the plants have more roots when they are floating in deep water than in shallow water, while the leaf area, and the summer growth of the plant are greater in the latter case. In the present study both the volume and area of the pond significantly influenced the density of amphibians. Semlitsch *et al.,* 2015 tested whether pond area was a significant predictor of density, species richness, and diversity of amphibians. They found that in all cases a quadratic model fit their data significantly better than a linear model. Because small ponds have a high probability of pond drying and large ponds have a high probability of fish colonization and accumulation of invertebrate predators. They also found that not all intermediate sized ponds produced low amphibian density, richness, and diversity. Their results indicated that hylid and chorus frogs are found predictably more often in ephemeral ponds whereas bullfrogs, green frogs, and cricket frogs are found most often in permanent ponds with fish. In the present study also it shows at significant level.

Management and control of the *E. crassipes* infestation

Today there is a global agreement among scientists and managers that there is no totally effective method to eradicate *E. crassipes,* and the best option is integrated management and control of the weed. Although,there has been little attention paid to the integration of chemical and biological control, Center *et al.* (1982) reported that weevils in combination with a growth retardant were more effective in controlling the weed. Great caution is needed for selecting combination of suitable herbicides to used together for biological control. Generally in countries where *E. crassipes* infestation affects hundreds of thousands of hectares, integrated control could include several different measures. It could be used as suitable feed for many animals, as a source of protein for man, could be recommended in farming as fertilizer and compost for mushroom culture.

CONCLUSION

It is concluded that the water hyacinth (*E. crassipes*) influencing the water quality, amphibian diversity and density in the study area. Several studies reported similar findings. Hence it in right time to evolve strategies for the control of water hyacinth in order to maintain the water quality and the associated biodiversity including the population of amphibians. Attempts should be made to convert the biomass of water hyacinth into organic manures, substractes formulation, cultivation, vermi composting, etc.

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