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Length-Weight Relationship of Some Selected Fish Species of Lekan-Are Lake, Ogun State, Nigeria

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Abstract: The length-weight relationships of selected 25 species of fish belonging to 10 families inhabiting Lekan Are Lake, a man-made Lake in Ogun State, Nigeria are presented. The parameters a (intercept) and b (slope) of the length-weight equation ($W = a * L^b$) were estimated. The b value indicated that only *Alestes leuciscus* and *Hemichromis bimaculatious* have b values above 3 (3.129 and 3.256 respectively) while the other 23 species exhibited b values less than 3. The values of regression analysis (r) ranges from 0.107 in *Bagrus bayad* to 0.935 *in Tilapia zillii* with all regression highly significant ($P<0.05$). The mean b value for the 25 species was 1.31 (n=25, SD=1.20) and was significantly different from b = 3 (t-test; degree of freedom (df) = 24, p = 0.05).

Key words: Length-weight · Fish species · Lekan-Are · Lake · Ogun State

INTRODUCTION

Length-weight relationship (LWR) is of great importance in fishery assessments [1, 2]. King [3] noted that, only a few estimates of species-specific length-weight relationship parameters are available for Nigerian fishes.

Lekan-Are dam is the second medium earth dam constructed by the Ogun-Osun River Basin Development Authority [4] in 1982, after the Eniosa dam Ojoo, Ibadan, Oyo state, Nigeria. The dam is a multi-purpose earth dam constructed across a small stream flowing through the headquarters site. This dam was for training and demonstration purpose at the headquarters of Ogun-Osun River Basin Development Authority for portable water supply for the headquarters' staff consumption, commercial water bottling and for fisheries.

It has been stocked with fish species at different periods from its completion in 1982 and fishing activities at the shallow parts have been done yearly (during the dry season) by professional fishermen with the authorities providing the boats and fishing gears while the fishermen use their expertise; and the capture is shared equally between the fishermen and the authorities at the end of the exercise. Fish production from the dam in 2004 and 2005 were 214.8 kg and 108 kg respectively. However there still exist huge stocks waiting to be exploited as the fishing activities that have been done in the reservoir has been at few selected shallow areas.

The relationship between the length and the weight of fishes are related with the metabolism in each species and the environment where they live [5]. The length-weight relationships of fishes are important in fisheries biology because they are useful tools for assessing the relative well being of the fish population [6].

Like any other morphometric characters, the length-weight relationship can be used as a character for the differentiation of taxonomic units and this relationship is seen to change with various developmental events in life such as metamorphosis, growth and the onset of maturity. Apart from this, the length-weight relationship can also be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time. The empirical relationship between the length and the weight of the fish thus enhances the knowledge of the natural history of the fisheries of Lekan-Are Lake about which studies are scanty.

The fact that not much quantitative information is available on the length-weight relationship of the fishes of this lake is a pointer to the invaluable scientific contribution this study will have on later works that might involve the fauna of Lekan-Are Lake.

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MATERIALS AND METHODS

Fish Sampling Procedure: Experimental gill nets with graded stretched mesh sizes 1″, 1.5″, 2″, 2.5″, 3″, 3.5″, 4″, 5″ and 7″ inches which are equivalent to 25.4, 38.1, 50.8, 63.5, 76.0, 88.5, 101.6, 126.4 and 177.2 mm, respectively were set to collect fish specimens. The nets were mounted at 50% hanging ratio. Net setting was carried out three evenings at each of the sampling stations between 7.00 pm and 10.00 pm. Nets were lifted (retrieved) for fish catch checking in the mornings (7.00 and 10.00 hours). Fishes were identified to the lowest taxonomic levels according to Olaosebikan and Raji [7].

The total length and standard length of each fish caught was measured using fish meter rule to the nearest centimeters. The weight was measured using Ohaus weighing scale and weighed to the nearest 0.5 g. The parameter **a** and **b** of the L-W relationship of the form W = **a***L^b - - - (1) and were estimated through a logarithmic transformation, i.e. In W = In **a** + b lnL - - - (2) by ordinary least square regression.

RESULTS

Results of the length-weight relationship analysis of 25 fish species representing 11 families are summarized in table (1). Sample size of species studied ranged from 4 to 24 individuals.

Apart from gill net sizes ranging from 1 inch to 2.5 inches which successfully picked all the fish species in this study, other larger sizes from 3 inches and above did not record any catch. The fact that the smaller nets were successful in catching fish sample for this research may imply the possibility of sparse population or depletion in the availability of large fishes in Lekan-Are Lake indicating the possibility of over-fishing by the fisher folks.

Data recorded from table (1) on the **b** value estimator indicates that only *Alestes leuciscus* and *Hemichromis bimaculatus* have **b** values of 3.129 and 3.256 while the remaining others (i.e. 5 species) have their b values close to 3. It can be deduced that the 5 species showed isometric growth. The value **b** = 3 indicates that the fish grows symmetrically or isometrically (provided its

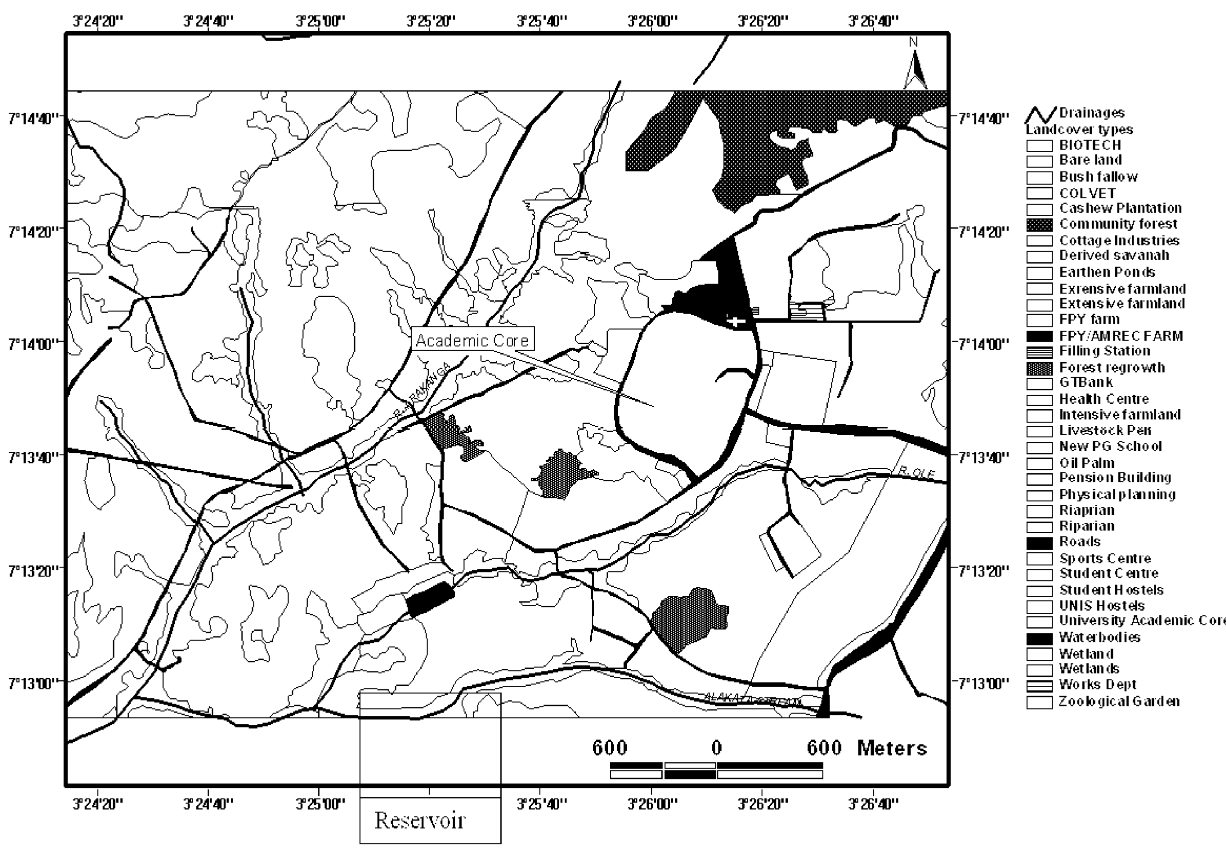

Fig. 1: Map of the study area showing the reservoir

Table 1: Length-weight relationships and related statistics for 25 fish species population occurring in Lekan Are Lake of Nigeria

			Standard length		Weight		Regression Parameters		
Family	Species	No. of fish	Minimum	Maximum	Minimum	Maximum	A	b	R
Bagridae	*Bagrus bayad*	5	6	10	6	7.5	0.62	0.22	0.107
	Chrysichthys nigrodigitatus	24	6	18	5	117	-12.221	2.455	0.718
	Clarotes laticeps	4	20	23`	8.5	10	-0.052	0.764	0.622
Schilbeidae	*Schlbe mystus*	17	9.5	15	10	53	-1.528	2.637	0.803
	Physalia pellucid	23	8.5	37	5	38	0.472	0.448	0.562
Centropomidae	*Lates niloticus*	5	22	30	19	24	0.68	0.469	0.746
Characidae	*Alestes spp.*	11	5	7	3	10	-1.645	3.129	1.685
Cyprinidae	*Barbus spp*	10	6.5	7.5	6	11	-0.938	2.25	0.737
	Labeo spp	8	38	45	15	18	-0.295	1.585	0.967
Distichodontidae	*Phagos loricatus*	7	11	56	11	20	0.766	0.328	0.847
Mormyridae	*Petracephalus bovei*	13	6	15.5	5	71	0.633	0.719	0.879
	Marcusenius spp.	10	6	20	4	18	0.105	0.962	0.772
	Mormyrus rume	4	6	9	7	7.5	0.749	0.118	0.528
	Mormyrus hasselquitis	6	10.5	13	20	30	-0.349	1.62	0.874
Cichlidae	*Hemichromis fasiatus*	12	5.5	8	4	18	-.148	2.94	0.693
	Sarotherodon galilaeus	12	7	12	14	85	-1.119	2.71	0.909
	Hemichromis niloticus	6	4	21	5	8	0.527	0.307	0.917
	Hemichromis binaculatus	10	5.5	8	5	23	-1.69	3.256	0.917
	Tilapia zilli	5	20	94	7.5	12	0.691	0.19	0.935
Clariidae	*Heterobranchus bidorsalis*	6	14	20	10	13	0.331	0.59	0.764
	Hepsetus odoe	17	7	21	10	127	0.576	0.672	0.728
	Channa obscura	3	14	16	35	75	0.632	0.956	0.242
	Eutopius niloticus	6	20	36	12	15	0.49	0.446	0.808
	Auchenoglosa occidentalis	6	4	9	7.5	9	0.736	0.24	0.718
	Pelmatrochmis spp.	6	4	14	5	7.5	0.509	0.306	0.915

Table 2: Mean monthly temperature (°C) readings for the sample stations in the Lekan-Are

	Months						Stations		
Reservoir. Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	Mean	*SD	*SE
1	26.85	27.10	27.55	28.45	23.85	29.35	27.19[a]	1.72	0.70
2	26.80	27.10	27.55	28.50	23.85	29.28	27.18[a]	1.71	0.70
3	27.15	27.70	27.85	28.55	23.96	30.25	27.58[a]	1.89	0.77
4	27.25	27.83	28.10	30.25	24.86	30.50	28.13[a]	1.90	078
5	27.25	27.79	27.79	28.65	24.45	29.88	27.64[a]	1.65	0.68
Monthlymean	27.06	27.50	27.77	28.88	24.19	29.85			
*SD	0.20	0.33	0.21	0.69	0.40	0.48			
*SE	±0.09	±0.15	±0.09	±0.31	±0.18	±0.22			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant
*SD = Standard deviation
*SE = Standard error

Table 3: Mean monthly dissolved oxygen (DO) (mg/l) readings for the sample stations in the Lekan-Are Reservoir

	Months						Stations		
Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	mean	*SD	*SE
1	6.65	7.30	7.30	8.00	8.20	6.30	7.29[a]	0.67	±0.27
2	6.50	7.35	7.30	8.90	6.20	7.00	7.21[a]	0.86	±0.35
3	7.50	7.45	7.50	7.90	6.90	7.05	7.38[a]	0.33	± 0.13
4	6.70	7.25	7.15	7.50	7.90	8.75	7.54[a]	0.65	± 0.27
5	6.80	7.20	7.15	8.08	7.30	7.28	7.30[a]	0.39	± 0.16
Monthlymean	6.83	7.31	7.28	8.08	7.30	7.28			
*SD	0.35	0.09	0.13	0.46	0.71	0.81			
*SE	±0.16	±0.04	±0.06	±0.20	±0.32	±0.36			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant
*SD = Standard deviation
*SE = Standard error

Table 4: Mean monthly Secchi disc transparency (m) readings for the sample stations in the Lekan-Are Reservoir

	Months						Stations		
Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	mean	*SD	*SE
1	0.36	0.38	0.38	0.35	0.60	1.20	0.55^{a}	0.31	± 0.12
2	0.50	0.60	0.60	0.52	0.62	1.20	0.67^{a}	0.24	±0.10
3	0.63	0.65	0.60	0.56	0.65	1.25	0.72^{a}	0.24	±0.10
4	0.45	0.47	0.45	0.40	0.45	0.80	0.50^{a}	0.13	±0.05
5	0.46	0.47	0.47	0.38	0.50	1.00	0.55^{a}	0.21	±0.08
Monthlymean	0.48	0.51	0.50	0.44	0.56	1.09			
*SD	0.09	0.10	0.09	0.08	0.08	0.17			
*SE	±0.04	±0.04	±0.04	±0.04	±0.03	±0.08			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant
*SD = Standard deviation
*SE = Standard error.

Table 5: Mean monthly pH readings for the sample stations in the Lekan-Are Reservoir

	Months						Stations		
Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	mean	*SD	*SE
1	6.85	7.10	7.85	7.15	6.75	6.95	7.11^{a}	0.36	±0.15
2	7.10	7.25	7.55	7.30	6.66	7.15	7.17^{a}	0.27	±0.11
3	7.30	7.30	7.40	7.40	6.10	6.55	7.01^{a}	0.50	± 0.20
4	7.15	7.25	7.15	7.15	6.60	7.10	7.07^{a}	0.21	± 0.09
5	7.20	7.25	7.51	7.25	6.53	6.94	7.11^{a}	0.31	± 0.13
Monthlymean	7.12	7.23	7.49	7.25	6.53	6.94			
*SD	0.15	0.07	0.23	0.09	0.23	0.21			
*SE	±0.07	±0.03	±0.10	±0.04	±0.10	±0.09			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant
*SD = Standard deviation
*SE = Standard error

Table 6: Mean monthly total alkalinity readings for the sample stations in the Lekan-Are Reservoir

	Months						Stations		
Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	mean	*SD	*SE
1	60.00	73.50	52.50	57.00	70.50	80.00	65.58d	9.75	3.98
2	60.25	73.50	63.00	63.50	78.00	80.00	69.71b	7.77	3.17
3	67.50	78.00	75.00	75.00	91.50	90.00	79.50^{a}	8.57	3.50
4	57.00	68.00	60.00	60.00	78.00	78.00	66.83c	8.57	3.50
5	61.25	70.00	62.50	63.50	79.50	80.50	69.54b	7.90	3.22
Monthlymean	61.20	72.60	62.60	68.80	79.50	81.70			
*SD	3.45	3.43	7.25	6.10	6.77	4.24			
*SE	1.54	1.53	3.24	2.73	3.03	1.90			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant
*SD= Standard deviation
*SE= Standard error

Table 7: Mean monthly Conductivity (S/cm) readings for the sample stations in the Lekan- Are Reservoir

	Months								
Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	mean	*SD	*SE
1	125.00	130.00	180.00	130.00	150.00	150.00	144.17^{a}	18.80	7.68
2	130.00	162.00	180.00	135.00	175.00	180.00	160.33^{a}	20.63	8.42
3	160.00	170.00	200.00	180.00	240.00	260.00	201.67^{a}	36.70	14.98
4	155.00	106.00	155.00	110.00	185.00	200.00	151.83^{a}	34.86	14.23
5	155.00	125.00	160.00	110.00	180.00	202.00	155.33^{a}	31.05	12.67
MonthlyMean	145.00	138.60	175.00	133.00	186.00	198.40			
*SD	14.49	23.90	16.12	25.61	29.56	36.03			
*SE	6.48	10.69	7.21	11.45	13.22	16.11			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant
*SD= Standard deviation
*SE= Standard error

Table 8: Mean monthly dissolved solids (TDS) (mg/l) readings for the sample stations in the Lekan-Are Reservoir

	Months								
Stations	Sept.'06	Oct.'06	Nov.'06	Dec.'06	Jan.'06	Feb.'06	Mean	*SD	*SE
1	75.00	75.00	80.00	70.00	75.00	70.00	74.17b	3.44	1.40
2	80.00	85.00	80.00	70.00	90.00	112.00	86.17b	13.04	5.33
3	93.00	90.00	110.00	100.00	115.00	130.00	106.33a	13.74	5.61
4	80.00	75.00	60.00	55.00	78.00	115.00	77.17b	19.28	7.87
5	78.00	75.00	65.00	58.00	75.00	115.00	77.67b	18.05	7.37
MonthlyMean	81.20	80.00	79.00	76.60	86.60	108.40			
*SD	6.18	6.32	17.44	15.92	15.24	20.20			
*SE	2.76	2.83	7.80	7.12	6.82	9.04			

Significance level at 95% ($p<0.05$), values with same subscript are statistically not significant

*SD= Standard deviation

*SE= Standard error

specific gravity remains constant). Values other than 3 as demonstrated by *Alestes spp* (3.129) and *Hemichromis bimaculatus* (3.256) indicate allometric growth i.e. if **b** is greater than 3, the growth is positive allometric and if **b** is less than 3, it is called negative allometric as observed in 17 species with their **b** values ranging between 0.11 (*Mormyrus rume*) and (2.25) *Barbus* spp (Family: Cyprinidae).

The mean **b** value for the 25 species was 1.31 (n = 25, SD =1.20) and was significantly different from **b** = 3 (t-test, df = 24, p = 0.05). Only 2 of the fish species (8%) had **b** within ranges of 3. The values of calculated **r**, ranges from 0.107 in *Bagrus bayad* to 0.935 in *Tilapia zillii*; with all regression highly significant ($P<0.05$).

Most of the physico-chemical parameters assessed showed similar relationships with the seasons, while water temperature, transparency, conductivity, total alkalinity and total dissolved solids exhibited increasing trends in the dry season months, pH was relatively low in the dry season and highest in the wet season months, with dissolved oxygen exhibiting fluctuations with implications of decreasing tendencies in the dry season, though the least values recorded occurred in the wet season month of September. There is no significant difference between the mean temperature, dissolved oxygen, transparency, pH and conductivity observed across the stations. Significant difference was observed in the mean total alkalinity and mean total dissolved solids observed across the stations.

DISCUSSION

Pauly [8] reported that **b** values must be equal to 3 if fishes have to maintain their shape as they grow, but there is no theory that says in which case the estimated **b** values can be expected to be negatively or positively allometric. Garcia [1] reported that biological interpretation of the numerical values of the parameters **a** and **b** is not straight forward, except that when growth is isometric, **a** can be interpreted as a condition factor. When growth is allometric, the role of **a** as the condition factor is questionable.

Nine fish species exhibited slightly negative isometric growth (**b** values <1). Seven species exhibited acute negative isometric growth (values of **b** < 0.5). For an ideal fish which maintains dimensional equality, the isometric value of **b** would be 3; this has been occasionally observed [9]. The slope (**b)** value of less than 3 indicates that a fish becomes more slender as it increases in length. A slope value greater than 3 denotes stoutness or allometric growth [10]. However, from isometric growth it is often observed, that most fish change their body shape as they grow.

Chrysichthys nigrodigitatus which was second in abundance in Lagos Lagoon Epe [11] was found to thrive well in the reservoir with the highest number of individuals. This may be attributed to the difference in the aquatic environment.

The lowest water temperature readings in January 2007 was due to the late rains in December 2006 and the cold air temperature characteristics of the dry North East trade wind effect (harmattan) in January 2007. While warmer atmospheric temperature of the dry season was responsible for the highest water temperature readings recorded in February 2007. Similar effects have been observed by [12] in Jos Plateau water reservoir, Ovie and Adeniji [13] in the Shiroro Lake and Egborge [14] in the Lake Asejire. The water temperature for the entire reservoir ranged between 24.45°C and 29.88°C. This range compares well with the ranges reported for other tropical lakes [13, 15, 16] and the fall within the recommended tolerance range for tropical fish growth and survival [17-19].

Similar to the mean dissolved oxygen value in September, studies have shown the low dissolved oxygen values observed during the high water period which coincide with wet season could be attributed to the chemical oxidation of humic compounds in addition to higher and larger amount of organic materials available for decomposition as a result of inundation of lands and forest areas, also the wind velocity seem to be lower at this period of the year thus reducing the movement of the waters by wind action [20-22]. The dissolved oxygen exhibited tendencies of further decrease in the later dry season months of March (not assessed), this may be due to the argument of Boyd [21] that the density of oxygen decrease with increasing temperature and that a 10°C rise in temperature often doubles leading to lowered dissolved oxygen content of water bodies in periods of high temperature [19, 21].

The lower water transparency observed in the months of September to November and the higher transparency values in January and February have been associated with the rainy season and dry season impact on water transparency and turbidity, similar to the reports of Boyd [22], Adeniji and Adeniji, [23, 24] on Jebba Lake, Adeniji *et al.*, Adeniji and NIFFR [25-27] on Oyan Lake. December's value being the lowest could be as a result of the late rains resurfacing after about two weeks break.

The highest mean pH recorded in November could be due to the greater water retention period during the wet season is reported by Ikenweiwe [28] on the Shiroro Lake, agrees with those of Sidinei [21] in his sediment pH studies and also in his study of mini lakes. However the pH range obtained in this study fall well within the recommended range of 6.5-7.5 by Sidinei *et al.* [21] and 6.5 and 9.0 at day break according to Kolo [29], as most suitable for fish and other aquatic lives.

The wet season means for total dissolved solids were observed to be lower than those in dry season, suggesting richer concentrations of nutrients due to the increasing draw down caused by the dry season similar to the findings of [14, 22, 27, 30].

The relatively higher conductivity values obtained in January and February (dry season) was in agreement with the findings of Heide [31] on Brokopondo Lake as reported by Ikenweiwe [28]; and Ovie and Adeniji [13] on Jebba Lake confirming increase in conductivity values with increasing temperature characteristics of the dry season.

Higher mean values of total alkalinity were observed in the dry season as against the lower values of the rainy season showing similarity with the findings of Kolo [29] and Ovie and Adeniji [13] on the Lake Shiroro and is supported by the argument of Boyd and Lichtkoppler and Arce and Boyd [17, 32] that lower volumes of water bodies increase the concentration of bases in the water bodies and the alkalinity increase with increase in temperature due to availability of carbon dioxide for photosynthesis.

The effects of temperature change on the other physico-chemical parameters were obviously seen in the various trends exhibited in the wet and dry seasons.

CONCLUSION AND RECOMMENDATIONS

The results from the current study will be useful source of information for anyone studying any of the 25 species for comparative and validation purposes. Despite the numbers of species for which Length-weight relationship are now available, much needs to be known about the other species that are probably not major contributors to total biomass and stocks, but may play a significant role in ecosystem processes and fish production. The species under investigation in this research definitely fall within this status and thus need more extensive works to maximize their.

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