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ARTIGO ORIGINAL

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Length-weight relationship of fishes species from the tributaries of Machado River, located in pasture lands (Rondônia State - Brazil)

Relação peso-comprimento de peixes dos tributários do rio Machado localizados em áreas de pastagens (estado de Rondônia-Brasil)

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Abstract The knowledge of a length-weight relationship supports important information which can help for a reasonable handling of fish species, especially those species belonging to the base of food chains found in basins. Thus, the present paper aims to identify the fish species existing in streams on pasture lands in the basin of Rio Machado, in order to determine the length-weight parameters of these individuals. Data collection occurred in the period from September, 2014, to June, 2015, in five streams belonging to first order, by using fishing nets; cast nets, and nylon sieves. A total of 6,012 fishes belonging to 21 species and 7 families (Characidae, Cichlidae, Curimatidae, Loricariidae, Gymnotidae, Anostomidae, Erythrinidae) were collected. The results showed that 57% (N=12) of the species had positive allometry (b>3) whereas 43% (N=9) had negative ones. Also presented values of *a* and *b* belonging to length-weight relationship similar to several studies, which indicates that landscape did not interfere with the allometry values of the length-weight curve, even though the abundance of the species in the present study has been relatively smaller. Thus, it is necessary to take proper handling measures so as to guarantee the permanence of this natural resource, since it is the base of food chain, which prevents the fish species from pasture lands from extinction.

Keywords: allometric coefficient, Ichthyofauna, streams, growth pattern.

Resumo O conhecimento da relação peso-comprimento subsidia informações importantes que podem auxiliar para um manejo racional das espécies de peixes, principalmente aquelas espécies da base da cadeia alimentar encontrada em microbacias. Sendo assim, o presente estudo teve como finalidade identificar as espécies de peixes existentes em igarapés de áreas de pastagens na bacia do rio Machado, para determinar os parâmetros da relação peso-comprimento desses indivíduos. A coleta dos dados ocorreram no período de setembro de 2014 a junho de 2015, em cinco canais de igarapés de primeira ordem, utilizando redes de pesca, tarrafa e peneira de nylon. Foram coletados 6,012 peixes pertencentes a 21 espécies e 7 famílias (Characidae, Cichlidae, Curimatidae, Loricariidae, Gymnotidae, Anostomidae e Erythrinidae). Os resultados mostraram que 57% (N=12) das espécies exibiram alométria positiva (b > 3) e 43% (N=9) alométria negativa (b < 3). Ainda os valores de *a* e *b* da relação peso-comprimento foram semelhantes a diversos estudos, indicando que a paisagem em que as espécies se encontravam não interferiu nos valores alométricos da curva peso-comprimento, embora a abundância das espécies do presente estudo tenha sido relativamente menor. Nesse sentido, se faz necessário medidas adequadas de manejo para assegurar a permanência desse recurso natural, uma vez que é base da cadeia alimentar, evitando assim a extinção local das espécies de peixes de áreas de pastagens.

Palavras-chave: coeficiente alométrico, Ictiofauna, igarapés, padrão de crescimento.

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Introduction

The Amazon basin stands out in world scenario, especially because in its territory, it comprises the largest tropical forest, the longest fresh water river and the greatest diversity of mammals and fish on the planet (Reis, Kullander & Ferraris, 2003; Buckup, Menezes & Ghazzi, 2007). The latter, with more than 2,400 catalogued species (Lévêque, Oberdorff, Paugy, Stiassny & Tedesco, 2008). However, in the last decades, the growth of agricultural enterprises, especially those related to grain production (Ferreira & Coelho, 2015) and bovines (Rivero, Almeida, Ávila & Oliveira, 2009), has encouraged the deforestation of forest areas (Ferreira, Venticinque & Almeida, 2005) causing irreversible damage to nature and the biodiversity in it. These deforested areas are favorable to leaching caused by weather conditions, which causes siltation and degradation in river beds and streams (Tundisi, 1999).

The current scenario of environmental destruction has been increasing throughout the country, especially in Rondônia state, whose part of territory is included in "Deforestation Arch" (Cohen, Beltrão, Gandu & Silva, 2007), and most of these areas are located along or around Machado River basin (Fernandes & Guimarães, 2002), in a way as to impact the local ichthyofauna, causing a reduction of food supply for the local fish species and causing changes in water quality (Claro-Jr, Ferreira, Zuanon & Araujo-Lima, 2004; Tundisi & Tundisi, 2010).

In this region, there are numberless small streams which are sensitive to anthropogenic actions, especially those which are located in deforested areas for grazing and cattle raising. They are small tributaries which have low flow (Luiz, Agostinho, Gomes & Hahn, 1998) and in turn, they have been facing erosions and siltation in their canals, sometimes causing them to skim and dry. These aquatic environments shelter 50% of diversity of small-sized fish species already described (Castro et al., 2003). On the other hand, the destruction of these aquatic environments, directly affect the community of resident fish, providing the decrease and even the extinction of those species, at a local level (Miranda, 2012).

The researches about fishing biology, such as the identification of species (Casatti, Langeani & Castro, 2001; Corrêa, Gerhard & Figueiredo, 2012), population dynamics (Sant'Anna, Doria & Freitas, 2014), ecology (Torrente-Vilara, Zuanon, Leprieur, Oberdorff & Tedesco, 2011) and length-weight relationship (Silva, Castro & Gubiani, 2005), provide important information which can help in reasonable handling of the ichthyofauna in those environments (Lizama & Ambrósio, 1999),especially related to the species belonging to the base of food chain (Lizama & Ambrósio, 2002), such as those small-sized and forage crops (Lizama & Ambrósio, 2003). The awareness of the level of the environmental balance and its interaction with the life cycle of a certain population are essential for the researches on fishing ecology (Silva-Júnior, Castro, Soares, & França, 2007), in a way that they strengthen the background related to this theme in the region, which is still very little (Tribuzy-Neto, Conceição, Siqueira-Souza & Freitas, 2015).

The information on the length-weight of the fish species can be used to estimate the weight of a certain species through the survey on the length of group of individuals, vice-versa (Lemos et al., 2015), and this makes it easier to describe the growth of the analyzed individuals, without considering their age (Gomiero, Villares-Junior & Braga, 2010). The length-weight curve of a population is ruled by the parameters "a" which is the linear coefficient of the relationship, and this is the intercept in a logarithmic way, whereas "b" is the angular coefficient in the arithmetic way, performing the inclination of the regression line in the logarithmic way (Araújo, Flynn & Pereira, 2011).

The use of this length-weight information of the populations may help in the comparison of the growth rate among different species (Joyeux, Giarrizzo, Macieira, Spach & Vaske-Jr., 2009). Thus, the present study focuses on identifying the existing fish species in small streams in the pasture lands in the basin of Machado River in order to assess the indexes "a" and "b" in the length-weight curve of these individuals, so as to make this information available for the environment managers and researchers, before these communities and assemblages become extinct due to man's disorderly action upon the environment.

Material and Methods

Research Environment

The basin of Machado River (Presidente Médici - Rondônia) comprises a drainage area around 75,000 sq km (Casatti, Pérez-Mayorga, Carvalho, Brejão & Costa, 2013), where the equatorial climate prevails, with temperatures ranging from 19 to 33 ºC (Krusche et al., 2005), forming a rainfall regime with two different seasons: a dry season (from May to September) and rainy season (from October to April) (Fernandes & Guimarães, 2002). In this region, five streams were selected for data collection. They are all located in the pasture lands of Machado River (Figure 1).

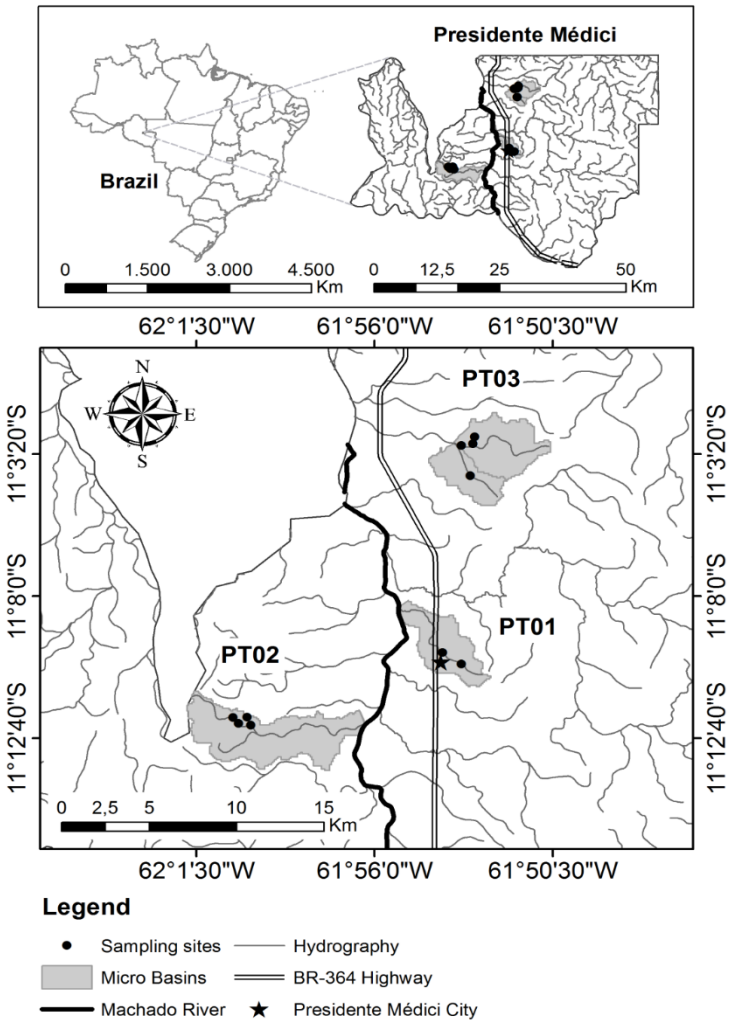

Figure 1 Location of the research environment with corresponding sample places (Geografic Coordinates: Sirgas 2000 - Data source: IBGE).

Data Collection

The individuals collected belong to the ichthyofauna in small streams of the Machado River basin, during the period from September, 2014 to June, 2015. The samplings were performed in five creek canals, where there were two sections of 150 meters in each main canal. Two fishing nets were used for fish collection. The nets were made of nylon, with 20 mm between the adjoining nodes, 5 m long and 2 m high. Also, a cast-net with 2 m diameter and 2 mm mesh size was used. The nets were set for a period of two hours, along the creek canals, day and night times. The nets, in turn, were checked at every 20 minutes. The other fishing gears were used for two hours along the selected sections.

The collected fish were stored in plastic bags, labeled and packaged with ice, for a posterior taxonomic identification in the Aquaculture and Fishing Laboratory of Rondônia Federal University. The scientific names of each species were verified with the help of the key proposed by Queiroz et al. (2013), and also, by specialists. At the same time, the data on weight (g) and the standard length (cm) of each individual was collected, organized in electronic spreadsheets for later statistical analysis.

Statistical Analyses

The length-weight relationship was estimated by the non-linear regression, using the algorithm of Levenberg-Marquardt (Myers, 1990) in the equation: $W=a.L^b$ (Len Cren, 1951), where W is the individual's total weight (g), L is the standard length, *a* is the intercept and *b* is the allometric gradient of growth (Froese, 2006). The Student's "t" test was used to verify the existence of significant differences among the *b* values, when close to isometrics (*b*=3), respecting the confidence interval of 95% (α=0.05) (Giarrizzo et al., 2015). The correlation between W and L was verified by Pearson analysis through r-squared (r^2) (Schmidt et al., 2015). All the statistical analysis were performed by using software Statistica 9.0 (Statsoft, 2009).

Results

The weight and length data of 6,012 fishes belonging to seven families and 21 species were evaluated in the study area (Table 1).

Table 1 Number of individuals (N) of the studied species, with their corresponding maximum weight (Wmax) and minimum weight (Wmin); maximum length (Lmax) and minimum length (Lmin).

Taxonomy	N	Wmin (g)	Wmax (g)	Lmin (cm)	Lmax (cm)
Anostomidae					
Leporinus friderici	50	0.100	81	2.2	15
Characidae					
Astyanax aff. *bimaculatus*	407	0.122	26	1.8	9.3
Bryconops cf. *giacopinii*	165	0.086	31	2.0	11.5
Serrapinus aff. *notomelas*	892	0.049	9	1.4	7.0
Serrapinus cff. *microdon*	874	0.056	2	1.5	4.3
Knodus cf. *hetesthes*	95	0.076	2	1.7	4.5
Moenkhausia oligolepis	64	0.100	9	1.5	6.3
Serrasalmus altispinis	115	0.334	575	2.3	25
Cichlidae					
Aequidens tetramerus	1017	0.065	137	1.0	14.0
Satanoperca jurupari	739	0.138	135	1.7	16
Crenicichla lepidota	56	0.150	47	2.5	13.3
Crenicichla sp. "juvenil"	66	0.033	0.553	1.4	3.8
Curimatidae					
Curimatella dorsalis	227	1.533	63	4.2	12.5
Steindachnerina fasciata	795	3	83	4.6	13.5
Erythrinidade					
Hoplias cf. *malabaricus*	92	0.158	306	2.2	24.5
Gymnotidae					
Gymnotus carapo	110	0.193	26	3.5	19.5
Eigenmannia sp. nov.	62	0.291	18	3.1	23
Sternopygus macrurus	38	0.174	105	3.0	35
Loricariidae					
Ancistrus cf. *dubius*	38	0.205	31	2.3	9.5
Hypostomus pyrineusi	73	0.021	165	1.2	19.0
Reneloricaria sp. "juruema"	43	0.100	8.2	1.8	11.0

Of the 21 analyzed species, 57% showed positive allometry and 43% negative ones. The estimates on the length-weight relationship showed different pattern according to analyzed species (Table 2).

Discussion

In the present study, the species with positive allometric growth was superior to the ones with negative allometry, with 12 and 9 species, respectively. The main representatives were species from family Characidae with five groups of fish, followed by families Curimatidae, Loricariidae, Gymnotidae, Anostomidae and Erythrinidae. This data matches the research reported by Abdon **Table 2** Intercept values (a) and the values of allometric growth gradient (b) in the length-weight relationship of the studied fish species, indicating their limits and r^2 values.

Species	"a"	Lower limit "a"	Upper limit "a"	"b"	Lower limit "b"	Upper limit "b"	r^2
Leporinus friderici	0.016	0.011	0.022	3.158	3.028	3.288	0.990
Astyanax aff. *bimaculatus*	0.024	0.018	0.029	3.094	2.978	3.210	0.953
Bryconops cf. *giacopinii*	0.028	0.020	0.035	2.852	2.734	2.971	0.990
Serrapinus aff. *notomelas*	0.016	0.015	0.017	3.230	3.189	3.271	0.942
Serrapinus cff. *microdon*	0.010	0.008	0.011	3.588	3.441	3.736	0.868
Knodus cf. *hetesthes*	0.005	0.003	0.006	4.028	3.808	4.248	0.961
Moenkhausia oligolepis	0.045	0.023	0.067	2.843	2.555	3.131	0.965
Serrasalmus altispinis	0.010	0.008	0.013	3.374	3.302	3.445	0.998
Aequidens tetramerus	0.070	0.065	0.075	2.852	2.820	2.884	0.979
Satanoperca jurupari	0.040	0.037	0.044	2.936	2.902	2.971	0.985
Crenicichla lepidota	0.020	0.014	0.025	2.992	2.872	3.112	0.990
Crenicichla sp. "juvenil"	0.016	0.011	0.020	2.724	2.434	3.013	0.912
Curimatella dorsalis	0.020	0.017	0.023	3.191	3.117	3.265	0.975
Steindachnerina fasciata	0.017	0.015	0.019	3.286	3.233	3.339	0.976
Hoplias cf. *malabaricus*	0.018	0.012	0.024	3.017	2.907	3.127	0.984
Gymnotus carapo	0.015	0.004	0.025	2.437	2.192	2.682	0.929
Eigenmannia sp.	0.122	0.044	0.199	1.574	1.354	1.795	0.931
Sternopygus macrurus	0.000	0.000	0.001	3.567	3.351	3.783	0.987
Ancistrus cf. *dubius*	0.022	0.004	0.040	3.157	2.787	3.528	0.972
Hypostomus pyrineusi	0.150	0.081	0.220	2.401	2.235	2.567	0.986
Reneloricaria sp. "juruema"	0.002	0.000	0.005	3.428	2.904	3.951	0.950

Silva, Oliveira, Florentino and Tavares-Dias (2015) performed in Amapá's region, where most of the fishes which were found to present positive allometry belonged to family Characidae.

In the research performed by Giarrizzo, Bastos and Andrade (2011) on six species from family Characidae collected from one tributary of Amazon River, only one of them did not show positive allometry. On the other hand, Giarrizzo et al. (2015) reported that, in Xingu River (Amazon basin), the estimated length-weight relationship for 135 fish species belonging to 27 families, the families Characidae and Loricariidae have stood out for prevailing with positive allometry species. In another research performed by Lizama and Ambrósio (1999), the length-weight relationship of nine species from family Characidae was estimated, on the flooded plain up Paraná River, where they reported that most of the collected individuals presented an isometric growth.

The existing differences in the allometry values of the mentioned studies maybe related to the environmental and food variation of the studied individuals, since they were collected from different places and environments. Also, the *a* and *b* coefficients from the length-weight relationship may differ, not only due to environmental factors, but also among the fish species and among the stocks belonging to the same species (Nahara, Godinho, Fenirich-Verani & Romagosa, 1985), as well as the type of analysis used in the different researches, or if during these studies, the distinction between males and females was considered (Hauser & Benedito, 2012).

Le Cren (1951) points out that the *b* values for fish may range from 2.5 to 4.0, but they usually show an isometric growth around 3.0 (Rocha et al., 2005). The length-weight relationship describes the ways of growth in the different stages of the life cycle of the fish species, which becomes a good indicative of the food and reproductive activities (Silva Júnior, Castro, Soares & França, 2007). Besides, this relationship can be used as a base to compare the stress degree or different environmental conditions among fish populations with a big geographic distribution (Bolger & Connolly, 1989). Therefore, when $b = 3$, the species has an isometric growth, where the weight increases proportionally with the length. However, when $b < 3$, the growth is negative allometric, which indicates that the increment occurs due to the weight, and when $b > 3$, the growth is positive allometric, and the increment in the length is higher than the weight. These differences which occur around the allometric

coefficient may be related to the biological aspects which characterize each species, as well as the different environmental conditions which took place in the environment where they reside (Silva, Castro & Gubiani, 2005).

In the present study, it was observed that the sample number of the collected individuals (n = 6,012 and 21 species) was lower than the ones shown in other researches which were about the topic for ichthyofauna in the Machado River basin, as reported by the Casatti, Pérez-Mayorga, Carvalho, Brejão and Costa (2013), which collected fish in this region counting 22,875 individuals and 140 species, by Costa and Nogueira (2006) which quantified 8,058 individuals and 88 species. In the other hand, the present results exhibited a number of individuals bigger than the ones presented by Costa, Rocha, Albuquerque, Nogueira, Pereira and Ribeiro Filho (2015), which showed 1,320 individuals with 56 species sampled from the east of the Rondônia State. Similarly, Costa, Ohara and Almeida (2017) also found 1,482 individuals and 74 from Tarumã River a tributary of Machado River.

However, most of the studied species showed a positive allometric growth, which is proven in the several researches performed in the studied region and in different locations, as reported by the Schmid, Andrade, Jesus, Souza, Santos and Giarrizzo (2015) which presented a total of 14 species with positive allometry (100% of the sample). Also, Loureiro, Mourão Júnior and Giarrizzo (2017), shown the dominance of positive allometry in their research, exhibiting 4 species with positive allometry, 2 with negative allometry and one specie with isometric growth.

These differences in the sample size and in the allometric coefficients may be related to the conservation condition of the streams shown, since the ones mentioned in the present study have no riparian vegetation, and this strongly contributes for the reduction of the abundance of the species in those places.

Thus, the present study provides essential information on the length-weight relationship of the fish species mentioned herein, once its brought primaries dataset from the fish communities from the streams of the Machado River basin, and this information can be used in management of the local fishing resources, pointing out the conservation condition of the fish assemblages, providing data for future proposals on recovery of the streams' riparian forests located in the studied environment, which would help in the reduction of erosions and entry of allochthonous matter in the creek canals, allowing for the permanence and maintenance of the fish assemblages which inhabit the region.

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References

Abdon, S., Oliveira, L.M.B., Florentino, A.C. & Tavares-Dias, M. (2015). Length-weight relationship of 11 fish species from a tributary of the Amazon River system in northern Brazil. *J. Appl. Ichthyol.*, 31(4): 816-817.

Anjos, M.R., Manzatto, A.G., & Machado, N.G. (2015). Assembleias de peixes em igarapés de terra firme em duas sub-bacias do médio rio madeira, *Brasil. Evolução e Conservação da Biodiversidade*, 6(1): 1-12.

Araújo, C., Flynn, M. & Pereira, W. (2011). Indicadores de qualidade da água e biodiversidade do Rio Jaguari-Mirim no trecho entre as pequenas centrais hidrelétricas de São José e São Joaquim, São João da Boa Vista, São Paulo. *Rev. Intertox de Toxicologia, Risco Ambiental e Sociedade*, 4(2): 51-64.

Bolger, T. & Connolly, P.L. (1989). The selection of suitable indices for the measurement and analysis of fish condition. *J. Fish Biol.,* 34(2): 171-182.

Buckup, P.A., Menezes, N.A. & Ghazzi. M.S.A. (2007). *Catálogo das espécies de peixes de água doce do Brasil*. Rio de Janeiro: Museu Nacional.

Costa, I.D., Ohara, W.M., & Almeida, M. (2017). Fishes from the Jaru Biological Reserve, Machado River drainage, Madeira River basin, Rondônia State, northern Brazil. *Biota Neotropica*, 17(1): 1-9.

Costa, I.D., & Nogueira, W.V. (2016). Diel variation in the structure of fish assemblages in south western Amazon streams. *Acta Limnol. Brasiliensia*, 28.

Costa, I.D., Rocha, V.M., Albuquerque, P.D.T.F., Nogueira, W.V., Pereira, J.M.A., & Ribeiro- Filho, R.A.R. (2015). Variação nictemeral na assembleia de peixes de um trecho de rio na Amazônia ocidental brasileira. *Biotemas*, 28(3): 79-92.

Casatti, L., Langeani, F. & Castro, R. (2001). Peixes de riacho do Parque Estadual Morro do Diabo, bacia do alto rio Paraná, SP. *Biota Neotropica*, 1(1): 1-15.

Casatti, L., Pérez-Mayorga, M.A., Carvalho, F.R., Brejão, G.L. & Costa, I.D. (2013). *The stream fish fauna from the rio Machado basin, Rondônia State, Brazil*. Check List 9(6): 1496-1504.

Castro, R., Casatti, L., Santos, H.F., Ferreira, K.M., Ribeiro, A.C., Benine, R.C., Dardis, G.Z.P., Melo, A.L.A., Stopiglia, R., Abreu, T.X., Bockmann, F.A., Carvalho, M., Gibran,F.Z. & Lima, F.C.T. (2003). Estrutura e composição da ictiofauna de riachos do rio Paranapanema, sudeste e sul do Brasil. *Biota Neotropica*, 3(1): 1-31.

Claro-Jr, L., Ferreira, E., Zuanon,J. & Araujo-Lima, C. (2004). O efeito da floresta alagada na alimentação de três espécies de peixes onívoros em lagos de várzea da Amazônia Central, Brasil. *Acta Amazonica*, 34(1): 133-137.

Cohen, J.C.P., Beltrão, J.D.C., Gandu, A.W.& Silva, R.R.D. (2007). Influência do desmatamento sobre o ciclo hidrológico na Amazônia. *Ciência e Cultura*, 59(3): 36-39.

Corrêa, F., Oliveira, E.F., Pouey,J. & Piedras, S. (2016). Length-weight relationship of trahira *Hoplias aff. malabaricus* (Bloch, 1794) in a regulated stream of southern Brazil. *Revista Biotemas*, 29:169-174.

Corrêa, J.M., Gerhard, P. & Figueiredo, R.O. (2012). Ictiofauna de igarapés de pequenas bacias de drenagem em área agrícola do Nordeste Paraense, Amazônia Oriental. *Rev. Ambiente & Água*, 7(2): 214-230.

Ferreira, L.V., Venticinque,E. & Almeida, S. (2005). O desmatamento na Amazônia e a importância das áreas protegidas. *Estudos avançados*, 19(53): 157-166.

Ferreira, M.D.P. & Coelho, A.B. (2015). Desmatamento Recente nos Estados da Amazônia Legal: uma análise da contribuição dos preços agrícolas e das políticas governamentais. *Rev. Econ. Sociol. Rural*, 53(1): 91-108.

Fernandes, L.C. & Guimarães, S.C.P. (2002). *Atlas geoambiental de Rondônia*. Porto Velho: Sedam.

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *J. Appl. Ichthyol.*, 22(4): 241–253.

Giarrizzo, T., Bastos, D. & Andrade, M. (2011). Length–weight relationships for selected fish species of Rio Trombetas Biological Reserve: a reference study for the Amazonian basin. *J. Appl. Ichthyol.*, 27(6): 1422-1424.

Giarrizzo, T., Oliveira, R.R.S., Andrade, M.C., Gonçalves, A.P., Barbosa, T.A.P., Martins, A.R., Marques, D.K., Santos, J.L.B., Frois, R.P.S., Albuquerque, T.P.O., Montag, L.F.A., Camargo M. & Sousa, L.M. (2015). Weight and length length relationships for 135 species of fish from the Xingu River (Amazon Basin, Brazil). *J. Appl. Ichthyol.*, 31(2): 415-424.

Gomiero, L.M., Villares-Junior, G.A. & Braga, F.M.S. (2010). Relação peso-comprimento e fator de condição de *Oligosarcus hepsetus* (Cuvier, 1829) no Parque Estadual da Serra do Mar-Núcleo Santa Virgínia, Mata Atlântica, estado de São Paulo, Brasil. *Biota Neotropica*, 10(1): 101-105.

Hauser, M. & Benedito, E. (2012). Species of the *Hoplias aff. malabaricus* complex (Characiformes: Erythrinidae): An investigation of coexistence in a Neotropical floodplain. *Zoologia*, 29(1): 59-69.

Joyeux, J.C., Giarrizzo, T., Macieira, R.M., Spach, H.L. & Vaske-Jr., T. (2009). Length-weight relationships for Brazilian estuarine fish along a latitudinal gradient. *J. Appl. Ichthyol.*, 25(3): 350-355.

Krusche, A.V., Ballester, M.V.R., Victoria, R.L., Bernardes, M.C., Leite, N.K., Hanada, L., Victoria, D.C., Toledo, A.M., Ometto, J.P., Moreira, M.Z., Gomes, B.M., Bolson, M.A., Gouveia- Neto, S., Bonelli, N., Deegan, L., Neill, C., Thomas, S., Aufdenkampe, A.K. & Richey, J.E. (2005). Efeitos das mudanças do uso da terra na biogeoquímica dos corpos d'água da bacia do Rio Ji-Paraná, Rondônia. *Acta Amazonica*, 35(2): 197-205.

Loureiro, S.N., Mourão-Júnior, M., & Giarrizzo, T. (2017). Length–weight relationships for seven fish species from Marajó Bay, Amazon estuary, northern Brazil. *J. Appl. Ichthyol.* 00:1-3.

Le Cren, E.D. (1951). The length-weight relationship and seasonal cycle in gonadal weight and condition in the perch (*Perca fluviatilis*). *J. An. Ecol.*, 20(2): 201-219

Lemos, J.R.G., Oliveira. A.T., Santos, M.Q.C., Pereira, C.N., Nascimento, R.B. & Tavares-Dias, M. (2015). Influência do transporte na relação peso-comprimento e fator de condição de *Paracheirodon axelrodi* (Characidae). *Biota Amazonia*, 5(4): 22-26.

Lévêque, C., Oberdorff, T., Paugy, D., Stiassny,M.L.J. & Tedesco, P.A. (2008). Global diversity of fish (Pisces) in freshwater. *Hydrobiologia*, 595(1): 545-567.

Lizama, M.L.A.P. & Ambrósio, A.M. (1999). Relação peso-comprimento e estrutura da população de nove espécies da família Characidae na planície de inundação do alto rio Paraná, Brasil. *Revista Brasileira de Zoologia***,** 16(3): 779-788.

Lizama, M.L.A.P. & Ambrósio, A.M. (2002). Condition factor in nine species of fish of the Characidae family in the upper Paraná River floodplain, Brazil. *Braz. J. Biol.*, 62(1): 113-124.

Lizama, M.L.A.P. & Ambrósio, A.M. (2003). Crescimento, recrutamento e mortalidade do pequi *Moenkhausia intermédia* (Osteichthyes, Characidae) na planície de inundação do alto rio Paraná, Brasil. *Acta Scientiarum, Biol. Sc.*, 25(2): 329-333.

Luiz, E.A, Agostinho, A.A., Gomes, L.C. & Hahn, N.S. (1998). Ecologia trófica de peixes em dois riachos da bacia do rio Paraná. *Braz. J. Biol.*, 58(2): 273-285.

Miranda, J.C. (2012). Ameaças aos peixes de riachos da Mata Atlântica. *Natureza On Line*, 10(3):136-139.

Nahara, M.Y., Godinho, H.M., Fenerich-Verani, N. & Romagosa, E. (1985). Relação Peso-comprimento e fator de condição de *Rhamdia hilarii* (Valenciennes, 1840) (Osteichthyes, Siluriformes, Pimelodidae). *Bol. Inst. Pesca*, 12(4): 13-22.

Queiroz, L.J., Torrente-Vilara, G., Ohara, W.M., Pires, T.H.S., Zuanon, J.& Doria, C.R.C. (2013). *Peixes do Rio Madeira*. São Paulo: Dialeto Latin American Documentary.

Reis, R.E., Kullander, S.O. & Ferraris, C.J. (2003). *Check list of the freshwater fishes of South and Central America*. Porto Alegre: Edipucrs.

Rivero, S., Almeida, O., Ávila S. & Oliveira, W. (2009). Pecuária e desmatamento: uma análise das principais causas diretas do desmatamento na Amazônia. *Nova economia*, 19(1): 41-66.

Rocha, M.A., Ribeiro, E.L.A., Mizubuti, I.Y., Silva, L.D.D.F. Borosky J.C. & Rubin, K.C.P. (2005). Uso do fator de condição alométrico e de fulton na comparação de carpa (*Cyprinus carpio*), considerando os sexos e idade. *Semina: Ciências Agrárias*, 26(3): 429-434.

Sant'Anna, I.R.A., Doria,C.R.C. & Freitas, C.E.C. (2014). Pre-impoundment stock assessment of two Pimelodidae species caught by small-scale fisheries in the Madeira River (Amazon Basin–Brazil). *Fish. Manag. Ecol.*, 21(4): 322-329.

Silva Júnior, M.G., Castro, A.C.L., Soares, L.S. & França, V.L. (2007). Relação peso-comprimento de espécies de peixes do estuário do rio Paciência da ilha do Maranhão, Brasil. *Bol. Lab. Hidrobiol.*, 20(1): 31-38.

Schmidt, K., Andrade, M.C., Jesus, A.J.S., Araujo, J.S., Santos,P.R.B. & Giarrizzo, T. (2015).Length-weight relationships for fish fauna from water bodies in the upper Tapajós river basin of Palito Mountain ridge, Brazilian Amazon region. *Biota Amazônia*, 5(3): 112-114.

Silva, G.C., Castro, A.C.L. & Gubiani, E.A. (2005). Estrutura populacional e indicadores reprodutivos de *Scomberomorus brasiliensis* Collette, Russo e Zavala-Camin, 1978 (Perciformes: Scombridae) no litoral ocidental maranhense. *Acta Scientiarum Biol. Sc.*, 27(4): 383-389.

Silva-Júnior, M.G., Castro, A.C.L., Soares, L.S. & França, V.L. (2007). Relação peso-comprimento de espécies de peixes do estuário do rio Paciência da ilha do Maranhão, Brasil. *Bol. Lab. Hidrobiol.*, 20(1): 31-38.

Statsoft, Inc. (2009).*Statistica (data analysis software systems), version 9.0*. www.statsoft.com

Torrente-Vilara, G., Zuanon, J., Leprieur, F., Oberdorff, T. & Tedesco, P.A. (2011). Effects of natural rapids and waterfalls on fish assemblage structure in the Madeira River (Amazon Basin). *Ecol. Freshwat. Fish*, 20(4): 588-597.

Tribuzy-Neto, I.A., Conceição, K.G., Siqueira-Souza, F.K. & Freitas, C.E.C. (2015). Length-weight relationship of eleven fish species of the Amazonian floodplain lakes. *Rev. Colombiana de Ciencia Animal*, 7: 77-79.

Tundisi, J.G. (1999). Theoretical basis for reservoirmanagement. *In:* Tundisi, J.G. & Straskraba, M. (Eds.).*Theoretical reservoir ecology and its applications* (pp.505-528). BAS, Backhuys Publications.

Tundisi, J.G. & Tundisi, T.M. (2010). Potencial impacts of changes in the Forest Law in relation to water resources. *Biota Neotropica*, 10(4): 67-75.