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Spatial distribution, biometrics and volumetric estimation of *Dicksonia sellowiana* (Presl.) Hook (Dicksoniaceae) in an araucaria forest fragment

Distribuição espacial, biometria e estimativa volumétrica de Dicksonia sellowiana *(Presl.) Hook (Dicksoniaceae) em um fragmento de floresta ombrófila mista*

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ABSTRACT
Dicksonia sellowiana is the only Brazilian tree fern in the Dicksoniaceae family. Due to the exploitation of its caudex for the manufacture of pots for plants, the species is endangered. The objective of this research was to analyze the spatial distribution of *D. sellowiana* in the araucaria forest. To obtain data, 37 sample units with 10 × 50 m each were evaluated and systematically distributed in 25-hectar permanent plots installed in the Irati National Forest. All tree ferns above 1.30 m in total height were identified and measured. To analyze the spatial distribution, three aggregation indices were used, while the total volume and the commercial volume were estimated using volumetric models. The density and population structure in height classes were calculated. The species has an average density of 83 individuals per hectare. Through the evaluation of the indices, it was verified that the species has an aggregated pattern. The estimates were 19.87 $m^3.ha^{-1}$ for total volume and 11.82 m^3 ha^{-1} for commercial volume, with more than 60% of these volumes concentrated in heights of 3.30 m to 6.30 m, which is about 40% of the population.
Keywords: non-timber forest resource; tree fern; *xaxim-verdadeiro*.

RESUMO
Dicksonia sellowiana é a única samambaia arborescente brasileira da família Dicksoniaceae. Por causa da exploração de seu cáudice para a fabricação de vasos para plantas, consta da lista da flora ameaçada de extinção. O objetivo desta pesquisa foi analisar a distribuição espacial, a biometria e a volumetria de *D. sellowiana* em floresta ombrófila mista. Para a obtenção de dados, foram avaliadas 37 unidades amostrais de 10 × 50 m cada uma, distribuídas sistematicamente em parcelas permanentes de 25 hectares instaladas na Floresta Nacional de Irati. Foram identificadas e mensuradas todas as samambaias arborescentes acima de 1,30 m de altura total. Para analisar a distribuição espacial, utilizaram-se três índices de agregação, enquanto o volume total e o volume comercial foram estimados empregando-se modelos volumétricos. A densidade e a estrutura populacional em classes de altura foram calculadas. A espécie tem densidade média de 83 indivíduos ha^{-1}. Com a avaliação dos índices, verificou-se que a espécie tem comportamento agregado. As estimativas foram de 19,87 m^3 ha^{-1} para volume total e 11,82 m^3 ha^{-1} para volume comercial, com mais de 60% desses volumes concentrados nas classes de altura de 3,30 m a 6,30 m, ou seja, cerca de 40% da população.
Palavras-chave: recurso florestal não madeireiro; samambaia arborescente; xaxim-verdadeiro.

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INTRODUCTION

Brazil is composed of several biomes, that are: *caatinga*, Amazonia, *cerrado*, *pampa*, Pantanal and Atlantic forest, forming the largest biodiversity on the planet. It is necessary to protect this biodiversity, especially the floristic one, and the best way to do this is through research that allows knowing this flora, particularly the rare or endangered species. Among the Brazilian biomes, the most threatened, as a consequence of the anthropic action, is the Atlantic forest, which is characterized by several forest formations, and the araucaria forest stands out in the middle of them (IBGE, 2012).

The dominant species of araucaria forest is *Araucaria angustifolia* (Bertol.) Ktze., popularly known as Parana pine. Associated with this species, several species of trees occur, in addition to many species of tree ferns (TEIXEIRA & LINSKER, 2010). The tree ferns are commonly listed in phytosociological works in southern Brazil, showing the great importance of the species in the natural populations studied. The tree ferns have considerable ecological relevance, due to an expressive amount of organic matter that they can add to the soil, besides housing many species of epiphytes, some of them exclusive in tree ferns (GASPER *et al.*, 2011). Despite of this, a great part of the research carried out in araucaria forest refers to tree species, and research directed at non tree species, such as tree ferns, are scarce.

In Parana state, there are 13 species of tree ferns, among which stands out *Dicksonia sellowiana* (Presl.) Hook (KAEHLER *et al*., 2014), a Dicksoniaceae that is distributed from Mexico to Uruguay at altitudes between 60 and 3,800 m. It can measure up to 10 m total high and has fronds up to 4 m long, which, when they grow old, cover the caudex as a moisture protection strategy (ALFONSO-MORENO *et al*., 2011). The individuals of this species are distinguished from the other tree ferns by presenting the upright portion of the caudex with many adventitious roots (GASPER *et al*., 2011)—the main characteristic for its identification in the field.

In Brazil, *D. sellowiana* is known by several popular names, such as *xaxim*, *xaxim-bugio*, *xaxim-verdadeiro* and *xaxim-sem-espinho*. It is the only species representative of the Dicksoniaceae family in the country, being one of the most notable species among the plants that characterize the forests of southern Brazil, especially the araucaria one. The species grows at altitudes ranging from 60 m in Rio Grande do Sul state to 2,200 m in Serra do Itatiaia, Rio de Janeiro state (FERNANDES, 2000). Due to the economic value, this species was widely exploited, because of its caudex, which was very used for the production of pots and substrates used in the cultivation of ornamental plants (MONTAGNA *et al*., 2012), leading the species to the Brazilian list of endangered flora species (GASPER *et al*., 2011).

Although *D. sellowiana* is protected by law, further information is needed about its biology. The scientific literature lacks information on the population structure of this species in forest formations, as well as aspects related to its autecology, synecology and soil characteristics in its natural habitats (MANTOVANI, 2004). The species has ornamental use and also other potential uses, such as medicinal. According to Malucelli *et al*. (2018), the indigenous population uses some parts of this species to treat scabies, itching, parasitic diseases and asthma, but its use in medicine is still quite recent.

About the spatial distribution of tree ferns, it is known that the main limiting factor is the dispersion of the propagules, and about that, on a local scale, the physical factors have strong influence, beyond the structure of the vegetation. However, the knowledge of the spatial distribution pattern of the populations and the factors that influence it are still unknown for the great majority of Brazilian tree fern species (MALLMANN *et al*., 2013).

In order to manage a given species, it is necessary to know its biometry, volume, among other factors that make up its biology. The measurement of biometric variables is a primary and essential activity in forest inventory work. This information serves as a basis for implementing management plans, as well as formulating forest policies (PÉLLICO-NETO & BRENA, 1997).

The biometric variables that can be obtained directly and indirectly are the diameter at breast height (DBH), measured at 1.30 m from the ground, and the total and commercial height. Later, with this information, it becomes possible to calculate cross-sectional area in m^2 and, by volume equations, the individual and the total volume (GOMES *et al*., 2009).

Machado & Figueiredo Filho (2003) emphasize that, in native forest inventories, it is generally not allowed to log trees for cubing. An alternative would be to perform the cubage of the tree standing. After the cubage, volume equations are adjusted to allow the estimation of the volume. The use of such functions facilitates and decreases the cost of forest inventories (THORNLEY, 1999). It is noteworthy that tree ferns are not trees. However, as there are no specific cubing methods for this group of plants, the cubing method is applied to the tree ferns due to the similarity of the stem form.

Despite their great ecological importance, studies on the spatial distribution, biometrics and volume of tree ferns in literature are scarce. Thus, it is relevant to understand their pattern and, consequently, the subsidiary forms for the species preservation. In this way, the objectives of the present study were to analyze the spatial distribution, to describe the biometrics variables and to estimate the volume of *D. sellowiana* to improve the knowledge about this species in Irati National Forest, located in the state of Paraná, Brazil.

MATERIAL AND METHODS

Irati National Forest (Flona of Irati) is located between the municipalities of Fernandes Pinheiro and Teixeira Soares, in Parana state, with the geographical coordinates of 50°33'44.889" W and 25°20'24.818" S (figure 1). It has an area of 3,495 hectares, with high concentration of native forest. The climate is humid, subtropical and mesothermal, with fresh summers, severe and frequent frosts and no dry season (ICMBIO, 2013).

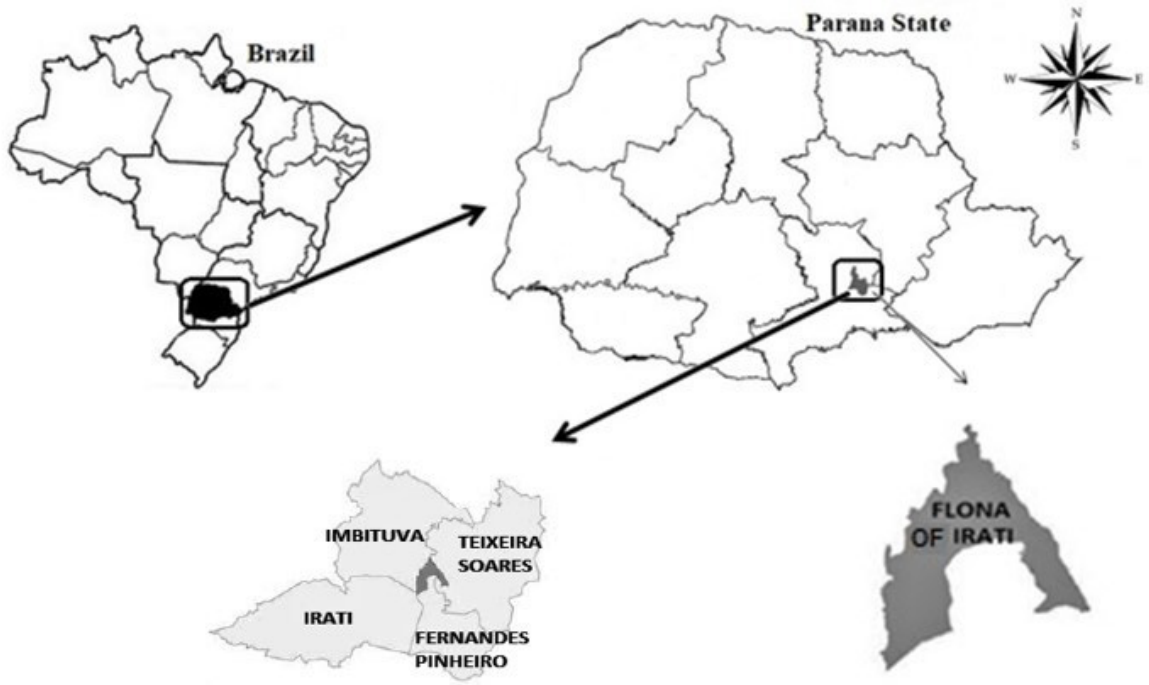


Figure 1 – Location of Irati National Forest (Flona of Irati), Parana state, Brazil. Source: adapted from Mazza (2006).

In Flona of Irati, 25 ha of permanent plots were installed in 2002, divided into 25 blocks of 1 ha (100 × 100 m) each, and subdivided into four plots of 0.25 ha (50 × 50 m), which, in order to facilitate the continuous forest inventory of this area, were divided into five control bands (or lines) of 0.05 ha (10 × 50 m) (figure 2). Of these, 37 sample units (10 × 50 m) were evaluated and systematically distributed in 25 permanent plots—bands 1 are represented in red, and bands 2 in blue, according to figure 2. It is worth mentioning that this area has not had human intervention since the 1940s.

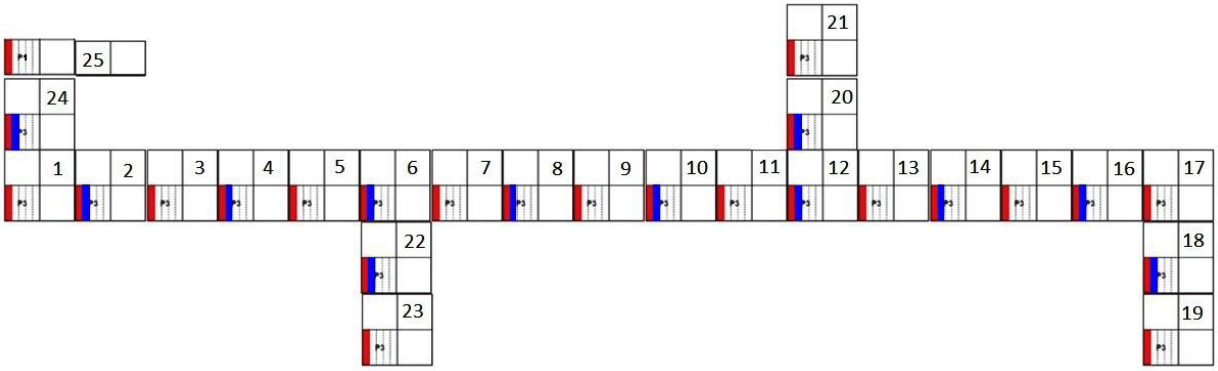


Figure 2 – Design of the 25 hectares of permanent plots in Irati National Forest, Parana state, Brazil. In red, there are the sample units of lane 1, and, in blue, the sample units of lane 2. Source: primary.

To facilitate the field work, the inclusion limit was adopted, according to the literature (MANTOVANI, 2004), so all individuals of *D. sellowiana* above 1.3 m in total height were identified and measured (figure 3). The variables measured in the forest inventory were: number of individuals, DBH (1.3 m) and total and commercial height (m). With these measurements, the transversal area (m^2), the basal area ($m^2.ha^{-1}$), the density (number of individuals per hectare) and also the volumetric estimate ($m^3.ha^{-1}$) were obtained.

Figure 3 – Individuals of *Dicksonia sellowiana* in (A) araucaria forest, (B) caudex details and (C) frond detail. Source: primary.

To analyze the spatial distribution, three aggregation indices were used: Morisita, Payandeh and Hazen, deliberated according to the literature (SOUZA & SOARES, 2013).

The Morisita index is very little influenced by the size of the sample units and it considers that values less than 1 indicate a regular distribution, meanwhile values equal to 1 denote a random distribution, and values greater than 1 represent populations with aggregated distribution. In addition, the significance for the F statistic, in this case 5%, with positive statement, is needed (SOUZA & SOARES, 2013).

For the Payandeh index, it is necessary to obtain the relation between the variation in the number of individuals per plot and the average number of individuals, with values less than or equal to 1 suggesting a random pattern, while values between 1 and 1.5 point out clustering tendency, and values greater than 1.5 indicate clustering (SOUZA & SOARES, 2013).

The Hazen index uses the relationship between the variance and the average number of individuals per plot and is analyzed by the X^2 test, in which values below 75% level indicate non-aggregated distribution, while values between 75 and 99% reveal clustering tendency, and values greater than 99% denote grouped distribution (SOUZA & SOARES, 2013).

To estimate the total volume, the model adjusted and evaluated by Lerner (2016) was used, represented by equation 1, which obtained the coefficient of determination (R^2_{adj}) of 0.96 and standard error of estimation (S_{yx}) of 16.33%.

$$v = -0{,}1048 + 0{,}002889 * (DBH * h) + 0{,}154971 * \left(\frac{1}{h}\right) \quad (1)$$

In which:
v = total volume (m^3);
b1 = -0.1048;
b2 = 0.002889;
DBH = diameter at breast height (cm);
h = height (m);
b3 = 0.154971.

To estimate the commercial volume, the model proposed by Lerner (2016) was also used, represented by equation 2, which obtained the coefficient of determination (R^2_{adj}) of 0.97 and standard error of estimation (S_{yx}) of 16.31%.

$$v = 0{,}001606 * (D_{base} * h_{com}) + 0{,}000001 * (D_{base} * h_{com})^2 \quad (2)$$

In which:
v = the commercial volume (m^3);
b1 = 0,001606;
b2 = 0,000001;
D_{base} = base diameter (cm);
h_{com} = commercial height (m).

Commercial height was measured according to Mantovani (2004), considering the height of the caudex from the soil up to the first dead leaf scars. Crown height was obtained by subtracting the commercial height from the total height.

In addition to the total and commercial volume calculated, the following variables were obtained: data on base diameter (D_{base}), DBH, total height, density, basal area, diameter classes using a range of 10 cm and height classes with a range of 1 m, adapted by Mantovani (2004).

Differently from the methods used for tree species, for tree ferns, it is necessary to distribute the caudex height classes to characterize the population, making it possible to infer age by height, using a method developed by Tanner (1983). This method is justified, according to Pérez-Paredes *et al*. (2014), taking into account the relationship between fertility and age of several species of tree ferns is still controversial, making the height of the caudex still widely used to define the population structure of the ferns.

RESULTS AND DISCUSSION

Dicksonia sellowiana was found in 27 of 37 sample units, totaling 152 individuals, with the average of 83 individuals per hectare. In table 1, the minimum, the average and the maximum values of the descriptive variables are shown. The amplitude for the D_{base} was 57.2 cm, for the DBH was 46.8 cm and for the height was 6.19 m (total), 5.32 m (commercial) and 4.45 m (of the crown).

Table 1 – Minimum, mean and maximum values of the descriptive variables of the tree fern *Dicksonia sellowiana* in Irati National Forest, Parana state, Brazil.

Variables / Values	Minimum	Mean	Maximum
D_{base} (cm)	15.2	35.3	69.4
DBH (cm)	11.6	26.9	58.4
Transversal area (m^2)	0.0106	0.0649	0.2680
Basal area SU (m^2)	0.1064	0.2702	3.0487
Basal area ($m^2.ha^{-1}$)	2.1281	5.4060	48.0224
Total height (m)	1.30	3.22	7.49
Commercial height (m)	0	1.97	5.32
Crown height (m)	0.25	1.22	4.70
Density SU (n)	1	4.16	29
Density ($n.ha^{-1}$)	20	83.24	460
Individual total volume (m^3)	0.0394	0.2386	0.9988
Total volume SU (m^3)	0.4156	0.9934	11.2151
Total volume ($m^3.ha^{-1}$)	8.3136	19.8680	180.1069
Individual commercial volume (m^3)	0	0.1420	0.6850
Commercial volume SU (m^3)	0.1821	0.5912	7.0799
Commercial volume ($m^3.ha^{-1}$)	3.6428	11.8243	111.3937

D_{base}: base diameter; DBH: diameter at breast height; SU: sample units—plots of 10 × 50 m.

To better understand the results, table 2 was elaborated, presenting the results obtained for the aggregation indices of the present study and of other studies on the same species.

To complement the information exhibited in table 2, it must be pointed out that, for the Hazen index, the χ^2 values were 41.30 for the probability level of 75% and 58.61 for the probability level of 99%. For the Morisita index, the value of F_{calc} was 8.08 and of F_{tab} was 1.80. Therefore, Morisita index was validated.

The results of the indexes indicate that *D. sellowiana* has an aggregated spatial distribution pattern, in agreement with other studies already performed with this species. In a more detailed study about Ronda Municipal Natural Park, São Francisco de Paula, Rio Grande do Sul state, Brazil, 16 species of terrestrial ferns were found, among them *D. sellowiana*, all of them presenting spatial grouped distribution (BLUME *et al*., 2010).

In a floristic composition study involving species of trees and also of tree ferns from Municipal Park of Lages, Parana state, 46 species were found in total (trees and tree ferns), and the spatial distribution of 15 species with high density was verified. One of these species was *D. sellowiana* (KLAUBERG *et al*., 2010). The mentioned spatial distribution data corroborate those found in the present study for Flona of Irati, although the absolute density (224.61 individuals per hectare) and the basal area (7.19 m^2) in Lages were higher than the one found in Flona of Irati (83.24 and 5.40, respectively).

In the forest floristic inventory of Santa Catarina (IFFSC), one of the results was that the focused species has an aggregated spatial distribution for the fragments of Santa Catarina state, Brazil, even when measuring individuals with a height greater than 1.5 m (GASPER *et al*., 2011). Although with different methodology, the results found by the IFFSC corroborate the results of the present study, even though there are sites in Santa Catarina state where the density of *D. sellowiana* is close to 1,000 individuals per hectare, which is almost 12 times larger than the one found in Flona of Irati.

It is possible to note that, regardless the area sampled, the density, the inclusion criteria and the index used, the aggregated spatial distribution does not change. This corroborates the data

found in a study carried out with fragments of different sizes in the araucaria forest in Rio Grande do Sul state (MALLMANN *et al*., 2018). It has been reported that environmental factors, such as soil moisture, canopy openness, among others, along with fragmentation and anthropization or not, have effects on the distribution and population structure of *D. sellowiana*, but this influence is not a variable of easy measurement (MALLMANN *et al*., 2018). In this case, in addition to a database on the physical and chemical characteristics of the soil, for example, it is also necessary to exercise caution in choosing the statistical analysis to aid in the interpretation of the facts.

Correlating the presence of *D. sellowiana* with some environmental characteristics is quite interesting, because it is not only possible to know the spatial distribution pattern of the species, but also, mainly, to understand the causes of this pattern. As the equation for estimating the total volume used has an error of 16.33%, the estimated 19.8680 $m^3.ha^{-1}$ has an error of 3.2445 $m^3.ha^{-1}$. Thus, the amplitude of *D. sellowiana* in Flona of Irati varies from 16.6235 to 23.1125 $m^3.ha^{-1}$. In the equation to estimate the commercial volume, there is an error of 16.31%, so for the 11.8243 $m^3.ha^{-1}$ the error is 1.9285 $m^3.ha^{-1}$, reaching an amplitude of 9.8958 to 13.7528 $m^3.ha^{-1}$.

Table 2 – Aggregation indices for the species *Dicksonia sellowiana* in works developed in the araucaria forest in the Southern region of Brazil.

Authors	Research location	Municipality (state, country)	Sample area	Inclusion criteria	Index of aggregation	Values obtained	Pattern
Araújo *et al*. (2009)	National Forest of São Francisco de Paula	São Francisco de Paula (Rio Grande do Sul, Brazil)	100,000 m^2	CBH ≥ 30 cm	Payandeh	1.63[B]	Aggregate
Blume *et al*. (2010)	Ronda Natural Park	São Francisco de Paula (Rio Grande do Sul, Brazil)	1,000 m^2	Total height ≥ 0 m	Morisita Variance/ mean *ratio*	1.6 2.04 (103.4)[A]	Aggregate
Klauberg *et al*. (2010)	João José Theodoro da Costa Neto Paula Natural Park	Lages (Santa Catarina, Brazil)	6,400 m^2	DBH ≥ 5 cm	Morisita	2.262	Aggregate
Marques & Krupek (2014)	Breyer's Resort/Cave Site*	União da Vitória (Parana, Brazil)	1,000 m^2	Total height ≥ 0 m	Morisita Variance/ mean *ratio*	1.24 4.17 (37.5)[A]	Aggregate
Mallmann *et al*. (2018)	Aparados da Serra National Park	Cambará do Sul (Rio Grande do Sul, Brazil)	6,000 m^2	Total height ≥ 0 m	Variance/ mean *ratio*	7.71[C] (146.51)[C]	Aggregate
Present study	Irati National Forest	Fernandes Pinheiro (Parana, Brazil)	18,500 m^2	Total height ≥ 1.3 m	Morisita Payandeh Hazen	2.69 8.08 291.03	Aggregate

*Private area; [A]respective values of χ^2; [B]mean value of the sample units; [C]mean value of the three indexes and χ^2 values, respectively; CBH: circumference at breast height; DBH: diameter at breast height.

Of the ten sample units that had no individuals of the focused species, three of them (blocks 9, 24 and 25, figure 2) contain *Merostachys multiramea* Hack., a species of the Poaceae family, popularly known as *taquara*, which has an aggressive behavior, inhibiting the growth of other species, which may justify the absence of *D. sellowiana*, since individuals of tree species are also low in the mentioned sample units, mainly in blocks 24 and 25, where the presence of *M. multiramea* is more expressive.

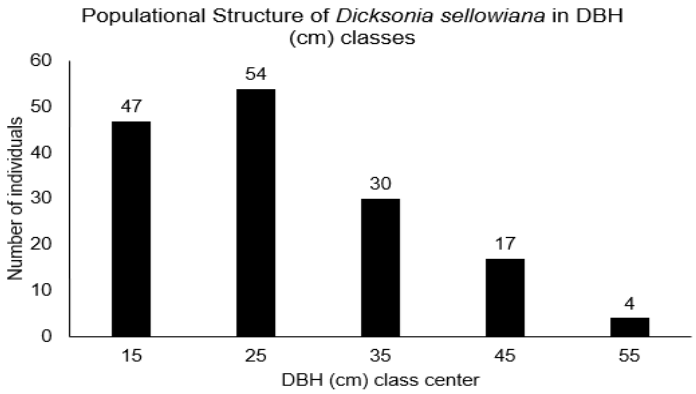
Although it is known that height represents more adequately the age variable for tree ferns, the population structure by diameter class was analyzed (table 3) to enable possible comparisons with tree species.

Table 3 – Diametric classes for number of individuals (N), basal area (G) and volume of the tree fern *Dicksonia sellowiana* in Irati National Forest, Parana state, Brazil.

DBH class center (cm)	N	G-SU (m^2)	G ($m^2.ha^{-1}$)	Total volume-SU (m^3)	Total volume ($m^3.ha^{-1}$)	Commercial volume SU (m^3)	Commercial volume ($m^3.ha^{-1}$)
15	47	1.1022	0.5958	3.8514	2.0819	1.8501	1.0000
25	54	2.6453	1.4299	9.5968	5.1875	5.7259	3.0951
35	30	2.6694	1.4429	10.2465	5.5387	6.3552	3.4352
45	17	2.5767	1.3928	9.7137	5.2507	5.9638	3.2237
55	4	1.0074	0.5446	3.3474	1.8094	1.9801	1.0703
Total	152	10.0011	5.4060	36.7559	19.8680	21.8750	11.8243

DBH: diameter at breast height; SU: sample unit—plots of 10 × 50 m.

The largest diameter class was 35 cm central class (28%, total = 5.53 $m^3.ha^{-1}$ and commercial volume = 3.43 $m^3.ha^{-1}$), which also had the largest basal area sampled. The diameter classes with center class of 15 and 25 cm had the largest number of sampled individuals, about 30 and 35%, respectively (figure 4).



DBH: diameter at breast height.

Figure 4 – Population structure of *Dicksonia sellowiana* in DBH classes in Irati National Forest, Parana state, Brazil. Source: primary.

As the assessed area is a fragment of native forest under monitoring since 2002, the diameter structure was expected to be in inverted J, since younger individuals tend to be more numerous. In this case, when analyzing the population structure by height classes, it was possible to notice this decrease of individuals as height increases (table 4).

Table 4 – Height classes for number of individuals (N), basal area (G) and volume for the tree fern *Dicksonia sellowiana* in Irati National Forest, Parana state, Brazil.

Height classes (m)	N	G-SU (m^2)	G ($m^2.ha^{-1}$)	Total volume-SU (m^3)	Total volume ($m^3.ha^{-1}$)	Commercial volume SU (m^3)	Commercial volume ($m^3.ha^{-1}$)
1.3–2.29	52	1.4355	0.7760	4.1955	2.2678	2.0726	1.1203
2.3–3.29	34	1.7830	0.9638	5.2844	2.8564	3.5045	1.8944
3.3–4.29	30	2.5495	1.3781	8.6816	4.6928	5.1089	2.7615
4.3–5.29	21	1.7228	0.9312	7.5027	4.0555	4.5673	2.4688
5.3–6.29	11	1.7469	0.9443	7.5702	4.0920	4.6780	2.5287
6.3–7.29	3	0.5995	0.3240	2.6171	1.4147	1.4278	0.7718
7.3–8.29	1	0.1639	0.0886	0.9043	0.4888	0.5158	0.2788
Total	**152**	**10.0011**	**5.4060**	**36.7559**	**19.8680**	**21.8750**	**11.8243**

SU: sample unit—plots of 10 × 50 m.

The height class of 3.3 to 4.3 m had the largest amount of total volume (about 25%), although the class that had the largest number of individuals was the class of 1.3 to 2.3 m, with 34% of the individuals (figure 5).

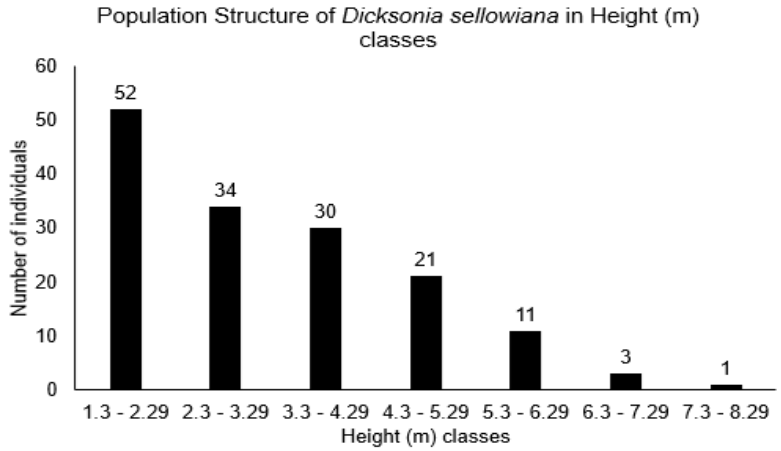


Figure 5 – Population structure of *Dicksonia sellowia*na in height (m) classes in Irati National Forest, Parana state, Brazil. Source: primary.

The two height classes, from 4.3 to 6.3 m, had similar values, despite the difference in heights and number of representative individuals, in which case the greater number of one was offset by the higher height of the other class.

For the commercial volume, it was noticed that the height class of 3.3 to 4.3 m had greater quantity (23%) of individuals than the following classes of height, and the height classes of 4.3 to 6.3 m had values close to each other (with 21% of the commercial volume each).

Mantovani (2004) found, in Santa Catarina state, a *D. sellowiana* specimen with a diameter range of 12.3 to 56 cm and a maximum height of 7 m. Gasper *et al*. (2011) found, in *D. sellowiana* inventory in Santa Catarina state, individuals with DBH between 10 and 77 cm with average of 67.5 cm and median height for samples of 3 m with minimum height of 1.5 m, and also reported that, from the six height classes, classes 1 and 2 had 76% of the sampled tree ferns up to 3.5 m in height, suggesting regeneration potential.

Chini *et al*. (2012), in Urubici, Santa Catarina state, sampled 107 individuals of *D. sellowiana* with DBH greater than or equal to 5 cm distributed in a diametric amplitude of 12 to 62 cm, with a

hypsometric amplitude of 1.4 to 8 m divided into 10 classes. The first five classes (1.4–5.07 m) had 96 individuals, showing regeneration potential.

Mantovani (2004) and Lerner (2016), even using different methods for the elaboration of height classes, found corroborative data with the present study, that is, the height class better represented the population structure of tree ferns, as well as data from Gasper *et al*. (2011) and Chini *et al*. (2012) did. In more details, lower height classes had the greatest number of individuals, as they represent younger individuals. In the case of the present study, the first class represented 34%, the second 22% and the third 20%, what is close to 75% of the population of *D. sellowiana* of Flona of Irati.

CONCLUSIONS

Dicksonia sellowiana presents an aggregated distribution pattern in Irati National Forest. The species has 83.24 individuals per hectare, totaling an estimated of 19.8680 $m^3.ha^{-1}$ for the total volume and of 11.8243 $m^3.ha^{-1}$ for the commercial volume, and more than 60% of these volumes are concentrated in classes of heights of 3.3 to 6.3 m, representing approximately 40% of the population.

Thus, genetic studies are suggested to be performed to verify the genetic similarity, rare alleles, among other information about the gene pool, to better know and preserve the species under study. It is also advisable to check if there is any environmental variable that may help to better understand the aggregated pattern presented by this species. This knowledge would be fundamental to elaborate, with more consistency, future management and conservation plans for *D. sellowiana*.

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