

**REPORT ON THE SURVEY OF THE DISTRIBUTION,
POPULATION DYNAMICS AND CONSERVATION STATUS OF
Pericopsis elata IN GHANA**



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EXECUTIVE SUMMARY

Pericopsis elata (Fabaceae) is a valuable timber species occurring in moist semi-deciduous forests with annual rainfall of 1250-1500 mm. In Ghana, it is threatened by excessive logging and it is estimated to have a resource life (the number of years that a species can be exploited commercially at the current rate of extraction) of zero. There is still some trading in the species even though harvest in any form is prohibited. The major problem with the management of *P. elata* is inadequate data on distribution, conservation and trade of the species in Ghana. The present study seeks to provide information on the distribution, population and conservation status of *Pericopsis elata* in Ghana for its sustainable management for improved trade in the species. The objectives of the study are to provide current data on the distribution, estimate plant density and wood volumes, determine the habitat conditions and describe the conservation status of the *Pericopsis elata* in Ghana. It is distributed in many forest reserves in the moist semi-deciduous vegetation zone in the Western, and Brong Ahafo regions of Ghana and particularly in the Juabeso, Goaso and Dormaa Ahenekro forest districts. Tree stock densities are quite low ranging between 0.013 -0.526. The diameter class (10-29 cm) contributes the least (0.05 %) to the volume of wood in the reserves studied which reveals few individuals in the smaller size classes and therefore confirm the view that natural regeneration in this species is unreliable and recruitment to the exploitable intermediate and larger size classes are often inadequate. Currently, the total wood harvest can reduce to a third when *Pericopsis elata* is harvested using the felling limit of 110 cm (DBH). It is also clear that in maintaining the legal felling diameter (110 cm DBH) the existing volume of wood at the estimated harvest level will only last for three years. This corroborates the finding that indicate its resource life (the number of years that a species can continue to be commercially utilized at the current rate of extraction) to be zero. The scenario at the moment is not different from the situation some three decades ago which suggests that the species is still under threat and may not be sustainably harvested. The reserves are not in any better condition than what has been reported in all management plans of these reserves. Asukese Forest Reserve had poor habitat condition and that could be the reason for the lowest estimated tree density. *P. elata* is a true pioneer species, stimulated to germinate by gaps in the canopy.

To conserve biodiversity in the forest reserves some forest management practices have been implemented. The Forest Service Division has set a felling limit of 110 cm (DBH) for *Pericopsis elata* thus delaying harvest for the species to recuperate naturally. A permit is also required prior to harvesting of the species. The export of logs and sawn timber of *Pericopsis elata* has been banned and to further restrain overexploitation there is an export levy of 30 percent on air-dried lumber exports for *Pericopsis elata*. There are several forest policies aimed at enhancing sustainable forest management that will improve and sustain the production of wood and wood products from the existing forest reserves and off-reserve areas. The Forestry Commission allocates Concessions, known as Timber Utilization Contracts and the Forestry Services Division of the Commission sets the total annual allowable cut for timber within the country. The 2012 Ghana Forest and Wildlife Policy noted a very high biodiversity loss of about 10 prime indigenous species including *Pericopsis elata* which may become extinct in less than a decade. Ghana has successfully established *Pericopsis elata* on a small scale in enrichment plantings (line and group methods) and in taungya and direct plantations and must be up-scaled. There is the need for more research in the phenological patterns and fertility, to help analyze the impact of logging on seed tree populations. In addition, there should be a study on the history of *P. elata* populations and why regeneration is dramatically lacking in its natural distribution area. A study must also investigate the genetic variation and spatial genetic structure of *P. elata*, to help us to understand the origins of its natural populations as well as their evolution. Plantation trials need to be conducted to identify affordable and effective enrichment methods (including pest identification and control techniques) that could be routinely applied by logging companies. Finally there should be regular monitoring of plant densities and estimates of wood volumes of the species. It has been reported that management through controlled exploitation benefits the natural regeneration and population dynamics of *Pericopsis elata* primarily by creating forest gaps. Consequently, more research is needed before a definitive decision can be made to allow harvesting of *P. elata*, in order to ensure that this action does not threaten the species with extinction.

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1.0 INTRODUCTION

1.1 Background

Pericopsis elata (Fabaceae) is a valuable timber species occurring in moist semi-deciduous forests with annual rainfall of 1250-1500 mm (Anglaaere, 2008; Dickson *et al.*, 2005; Swaine, 1996). In Ghana, it is currently threatened by excessive logging (Hawthorne, 1995). Alder (1989) estimated the resource life (the number of years that a species can be exploited commercially at the current rate of extraction) of *Pericopsis elata* as zero. It is a gregarious to semi-gregarious species with a limited but widely dispersed distribution. It is observed to occur along water courses and seasonally water-logged soils (Anglaaere, 2008; Dickson *et al.*, 2005; Swaine, 1996).

Swaine and Whitmore (1988) consider this species to be a true pioneer, stimulated to germinate by gaps in the canopy. *P. elata* is classified among either pioneer or non-pioneer light-demanders by various authors (Kyereh *et al.*, 1999; Hawthorne, 1995; Swaine *et al.*, 1988; Ampofo *et al.*, 1972). The lack of natural regeneration for this species has been widely noted (Hawthorne, 1995). The classical succession theory predicts that shade-intolerant species should eventually disappear from the forests and the forests could be composed of only shade-tolerant species. This theory generally assumed natural disturbance, like gap formation, as an unusual event. However, the 'gap dynamics theory' predicts an alternative scenario; shade-intolerant species can maintain their populations by regenerating within gaps in the mature or old-growth forests (Yamamoto, 2000).

The exportation of *P. elata* timber from Ghana to England started in 1948 (Bourland *et al.*, 2012; Howland, 1979) and has become a victim of over-exploitation and consumption mainly for its precious wood. The wood (trade names: afrormosia, assamela, kokrodua) is highly valued on the international market, mainly for furniture and as decorative veneer, and in traditional medicine as an anodyne. *Pericopsis elata* is classified by the World Alliance for Nature (IUCN) as endangered species, which led to its listing in the Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (Bourland *et al.*, 2012; Anon,

2003). The species is endangered and has become locally extinct in West African countries, including Côte d'Ivoire, where the exploitation and international trade in this species began seven decades ago (Betti, 2008).

Although there is no official trading information on the species in Ghana in recent times, a visit to and discussion with some timber companies and wood depots around the forest regions of Ghana indicate some level of trading in the species. Thus, the major problem with respect to the management of *P. elata* is inadequate data on distribution, conservation and trade of the species in Ghana (NDF, 2015). The present study seeks to provide information on the distribution, estimate of quantities and conservation status of *Pericopsis elata* in Ghana for its sustainable management for improved trade in the species.

1.2 Objectives

The specific objectives of this project are to

- 1) provide current data on the distribution of *Pericopsis elata*
- 2) estimate plant density and wood volumes of the species in the selected reserves
- 3) determine the habitat conditions of the selected reserves
- 4) describe the conservation status of the species in Ghana.

1.3 Limitations of the study

There is inadequate data on all aspects of *Pericopsis elata* in Ghana. The current information on the population status, distribution and composition and conservation status of *Pericopsis elata* are fragmented and inconsistent.

2.0 STUDY APPROACH

2.1 Selection of study sites

The consultant had several informal interviews and formal discussions with the staff of the Resource Management Support Centre of the Forestry Commission in selection potential study sites for the study. The selection was based on the probability of encountering the species when a search is conducted. The field workers of the Forest Services Division and tree spotters of Timber firms operating at the Forest Districts visited also confirmed and gave further clues for sites where there is a high likelihood of encounter of the species. Six Forest Reserves were visited (Table 1).

Table 1 Forest Reserves visited during the field work

Forest Reserve	Forest District	Compartments
Bia North Tributaries	Juabeso	19
Bonkoni	Goaso	23
Subim	Goaso	125, 150, 135, 159
Bonsambepo	Goaso	
Mpameso	Dormaa-Ahenkro	166, 172, 173, 190, 191, 192, 193, 194, 195, 227, 243, 146, 247
Asukese	Sunyani	105, 169, 2, 28, 93, 100, 101, 126

2.2 Data collection and analysis

2.2.1 Study team

The team consisted of the Consultant and his assistant, Range Supervisor and two Range Guards who are conversant with the forest reserve of interest in the district.

2.2.2 Measurements and estimates of data

In each forest reserve compartments with *Pericopsis elata* were visited. The individuals encountered had their diameter at breast height (DBH) and height recorded. The habitat condition scores were noted based on the physical environment and percent canopy gap. The reserves were scored between poor to excellent (1-5). Photographs of the species were also taken (Figure 1). The variables recorded were used to estimate the volumes of standing wood within the selected reserve. The numbers of individual trees were noted and densities estimated based on the area of the reserves.

2.2.3 Assumptions

- a) The projected increase in diameter was set at 1 cm per year (Anon, 2003)
- b) Tree density was estimated based on areas of the reserves
- c) Number of tree stems per hectare adopted was 2 stems/ha (Asukese Forest Reserve Management Plan, 2010)
- d) Potential wood export per year was estimated as 392.27 m³ (Five year average; 1998-2002; Anon, 2003)

2.2.4 Calculations

Areas of the selected forest reserves were estimated using the existing shape files using a menu in the ArcGis software. The stems per hectare for the selected reserves were estimated using the following relationships; the number of individual trees measured divided by the number of sampled compartments to obtain the average stems per compartment: The size of each compartment was estimated by dividing the area of the reserve with the number of compartments: and finally the plant density was estimated by dividing the average stem per compartment with the area of the compartment. The estimated volume of *P.elata* wood is obtained using the formula derived by Wong & Blackett, (1994): Volume of wood (m³)= 0.0006426D^{2.058}. The probable number of years a given volume of wood can be exploited was calculated by dividing yield with quantity exported per year.

All the estimates as detailed above were then tabulated. The reserves visited were used to create a distribution map using ArcGis software.



Figure 1: *Pericopsis data* (kokrodua) in an open canopy

3.0 FINDINGS

3.1 Distribution of *Pericopsis elata* in Ghana

Pericopsis elata is distributed in many forest reserves in the moist semi-deciduous vegetation zone in the Western, and Brong Ahafo regions of Ghana (Figure 2) and particularly in the Juabeso, Goaso and Dormaa Ahenekro forest districts. This distribution pattern has also been reported by Anglaaere (2008) and Swaine (1996)

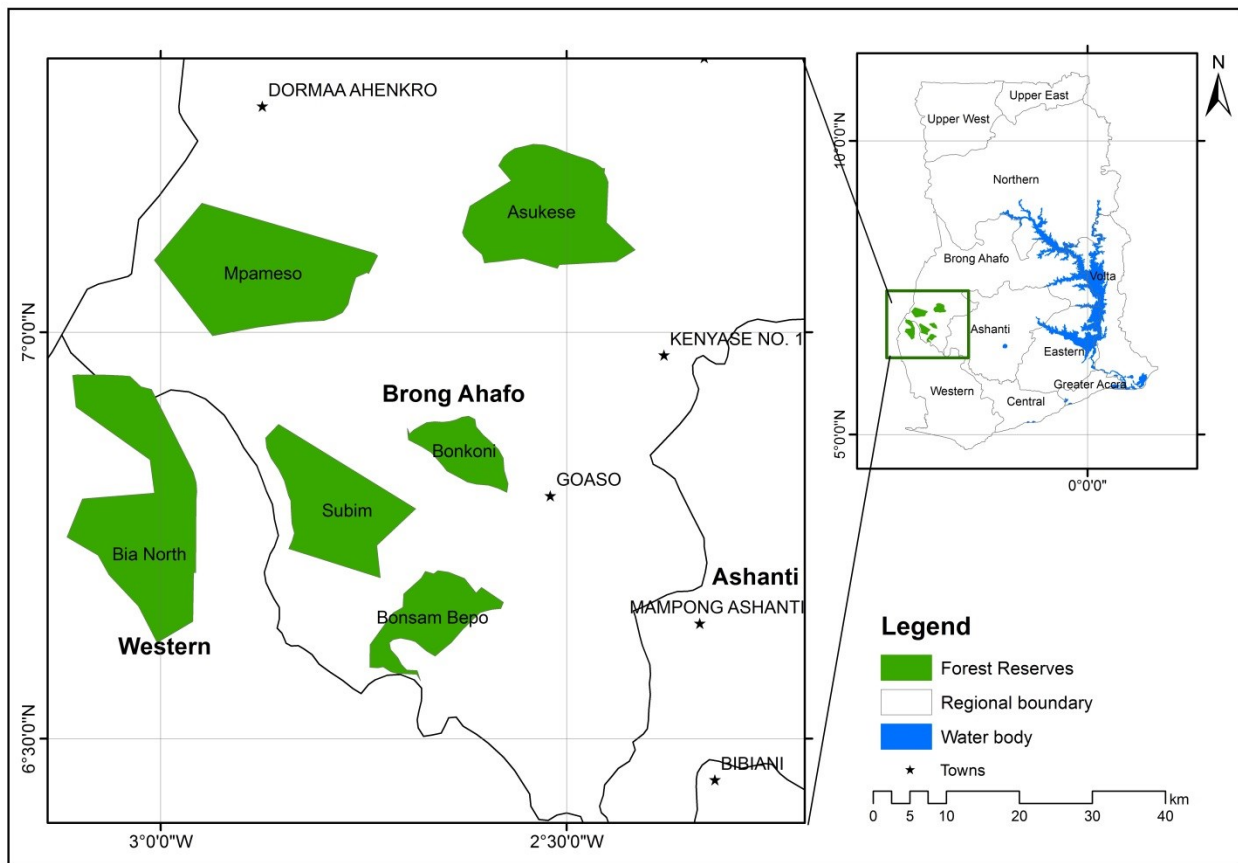


Figure 2: Distribution of *Pericopsis elata* in Ghana

3.2 Estimated tree stocks and volume of *Pericopsis elata* wood in selected forest reserves in Ghana

Tree stocks were generally low in all the reserves studied more particularly in Bonkoni (153 trees) followed by Asukese and Bia North Forest Reserves. The stocking density at Asukese Forest Reserve is as low as 0.013 tree stems per hectare (Table 1) which is far lower than stated in the management plan for the reserve (2 stems/ha; Anon, 2010). The 2 stems per hectare as noted in the Asukese Forest Reserve's Management Plan (Anon, 2010) seems an overestimation of the density due to low encounter rate of the species during the field visit. The low density estimates obtained for the selected reserves are similar to that obtained for *Pericopsis elata* in Cross River State in Nigeria (Anon, 2003). The diameter class (10-29 cm) contributes the least (0.05 %) to the volume of wood in the reserves studied with the diameter class (90-109 cm) being the highest (43 %: Table 2). Surveys have revealed few individuals in the smaller size classes and therefore confirm the view that natural regeneration in this species is unreliable and recruitment to the exploitable intermediate and larger size classes are often inadequate (Howland, 1979).

The total wood harvest can reduce to about a third when *Pericopsis elata* is harvested using the felling limit of 110 cm (DBH) (Table 3). As the felling diameter is reduced to 70 and 90 cm, the wood yield is increased. It is also clear that in maintaining the legal felling diameter (110 cm DBH) the existing volume of wood at the estimated harvest level will only last for three years (Table 4). To corroborate the finding, Alder (1989) reported the resource life (the number of years that a species can continue to be commercially utilized at the current rate of extraction) for *Pericopsis elata* to be zero. The scenario at the moment is not different from the situation some three decades ago which suggests that the species is still under threat and may not be sustainably harvested. With an annual diameter increment of averagely one centimeter (Bourland *et al.*, 2012) it may take 20 and 40 years to harvest trees that have diameters of 70 and 90 cm respectively.

Table 2 Tree stocks of *Pericopsis elata* in selected forest reserves

Forest Reserves	Acreage (hectares)	Trees/hectare	Number of trees in each reserve
Asukese	25301.31	0.013	322
Bia North	34165.5	0.022	765
Bonkoni	7325.90	0.021	153
Mpameso	33771.55	0.128	4331
Subim	2371.77	0.429	1018

Table 3 Estimated volume of *Pericopsis elata* wood in the selected forest reserves

Forest Reserves	Volume of Wood (M ³)							Total
	10-29	50-69	70-89	90-109	110-129	130-149	150+	
Asukese	1.31	15.64	26.41	40.09				83.46
Bia North				30.07				30.07
Bia Tano		7.82	13.21	10.02	14.18			45.23
Bonkoni		3.91			14.18	19.07		37.16
Mpameso		121.24	528.29	1002.22	680.42	57.21	19.33	2408.72
Subim			6.60	140.31	99.23			246.14
Total	1.31	148.62	574.52	1222.71	807.99	76.28	19.33	2850.78

Table 4 Potential exploitable *Pericopsis elata* wood at different diameter classes in selected reserves

Forest Reserves	Estimated volume of wood at harvest (m ³)		
	Diameter classes at harvest (cm)		
	70+	90+	110+
Asukese	66.50	40.09	
Bia North	30.07	30.07	
Bia Tano	37.40	24.20	14.17
Bonkoni	33.25	33.25	33.25
Mpameso	2287.48	1759.19	756.96
Subim	246.14	239.54	99.23
Total	2700.84	2126.32	903.61

Table 5: Potential number of years *P. elata* wood can be harvested at three diameter classes

Variables	Diameter classes at harvest (cm)		
	70+	90+	110+
Volumes (m ³)	2700.84	2126.32	903.61
Years	9.24	7.28	3.09

3.3 Habitat Conditions

The habitats of the selected reserves were graded as being poor to good. They are not in any better condition than what has been reported all management plans of the reserves studied. Asukese Forest Reserve had poor habitat condition (Table 5) and that could be the reason for the lowest estimated tree density. The rest were in good condition. *Pericopsis elata* is semi gregarious to gregarious tree which grows on flat ground, valleys and slopes (Anglaaere, 2008; Dickson et al. 2005). *P. elata* is a true pioneer species, stimulated to germinate by gaps in the canopy (Kyereh *et al.*, 1999; Hawthorne, 1995; Ampofo *et al.*, 1972,).

Table 6: Habitat conditions of the selected forest reserves

Forest Reserve	Habitat Conditions
Asukese	Poor
Bia North	Good
Bonkoni	Good
Mpameso	Good
Subim	Good

3.4 Conservation status

In Ghana, stocks of *P. elata* are reported to have declined (Hawthorne, 1995; Dickson et al., 2005). To forestall the situation, the Forest Service Division has set a felling limit of 110 cm at DBH for *Pericopsis elata* thus delaying harvest for the species to recuperate naturally. A permit is also required prior to harvesting of the species. The export of logs of *Pericopsis elata* has been banned since 1979 while a general log export ban has been introduced in Ghana since 1995. To

further restrain overexploitation there is an export levy of 30 percent on air-dried lumber exports for *Pericopsis elata*.

Several forest policies are being implemented to enhance sustainable forest management that will improve and sustain the production of wood and wood products from the existing forest reserves and off-reserve areas. The 1994 Forest and Wildlife Policy established the basis for sustainable forest resource management and this was implemented through the Timber Resources Management Act (Act 547) of 1997, the main legislation that governs the use of forest resources (Anon, 2003). The Forestry Commission is the executive agency responsible for forest management and forest industry and allocates Concessions, known as Timber Utilization Contracts. Further, the Forestry Services Division of the Commission sets the total annual allowable cut for timber within the country (SGS, 2002). The recent Ghana Forest and Wildlife Policy (Anon, 2012) noted a very high biodiversity loss of about 10 prime indigenous species including *Pericopsis elata* which may become extinct in less than a decade.

Further, Ghana has been successful establishing *Pericopsis elata* on a small scale in enrichment plantings (line and group methods) and in taungya and direct plantations. The annual diameter increment of these plantings ranged between 10.8 -13.1 mm (Anglaaere, 2008; Howland, 1979).

4.0 CONCLUSION AND RESEARCH NEEDS

4.1 Conclusion

Pericopsis elata (Fabaceae) is a valuable timber species occurring in moist semi-deciduous forests with annual rainfall of 1250-1500 mm. It is distributed mainly in the Western, and Brong Ahafo regions of Ghana and particularly in the Juabeso, Goaso and Dormaa Ahenekro Forest Districts. Estimated stocking densities were quite low ranging from 0.013 -0.429 stems per hectare. Wood volumes are also low with the least (0.05%) occurring at the low diameter class (10-29 cm). From the estimates, the total wood harvest can reduce to a third when *Pericopsis elata* is harvested with the felling limit of 110 cm at DBH. As the felling diameter is reduced to 70 and 90 cm the wood yield is increased. It is also clear that in maintaining the legal felling diameter of 110 cm at DBH, the existing volume of wood at the estimated harvest level will only last for three years and therefore similar to the previous situation where the resource life of *Pericopsis elata* was estimated as zero. The habitat condition for growth is fairly good in its range. Attempts to conserve the species have led to maintaining the legal felling diameter of 110 cm at DBH and improving value addition to the wood of the species. There has been several policy reforms aimed at enhancing sustainable forest resources management.

4.2 Research Needs

There is inadequate information on *Pericopsis elata* ecology in spite of its listing both in CITES Appendix II and on the IUCN Red List in Ghana (Howland, 1979; Anglaaere, 2008). It is therefore necessary for more research in the phenological patterns and fertility of the species, to help analyze the impact of logging on seed tree populations. In addition, there should be a study on the history of *P. elata* populations and why regeneration is dramatically lacking in its natural distribution area. A study must also investigate the genetic variation and spatial genetic structure of *P. elata*, to help us to understand the origins of its natural populations as well as their evolution. Plantation trials need to be conducted to identify affordable and effective enrichment methods (including pest identification and control techniques) that could be routinely applied by logging companies. Finally there should be regular monitoring of plant densities and estimates of

wood volumes of the species. It has been reported that management through controlled exploitation benefits the natural regeneration and population dynamics of *Pericopsis elata* primarily by creating forest gaps. Consequently, more research is needed before a definitive decision can be made to allow harvesting of *P. elata*, in order to ensure that this action does not threaten the species with extinction (Bourland *et al.*, 2012).

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