



Distribution and Population of Siamang (*Symphalangus syndactylus* Raffles, 1821) in KHDTK Aek Nauli, North Sumatra

Sharfina Elda Larasati^{1*}, Dones Rinaldi¹, Wanda Kuswanda²

¹Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry and Environment, IPB University, West Java

²Head of Environmental and Forestry Research and Development Center, Aek Nauli, North Sumatra

Abstract

Siamang (*Symphalangus syndactylus*) is one of the endemic Sumatran primates from the Hylobatidae family. Siamang distribution can be found in North Sumatra, southern Lake Toba, to Bukit Barisan Selatan. Siamang has a unique morphology in the form of a voice bag (gular sac), so it can make a very loud sound on voicing behaviour. This study aimed to identify the distribution, population characteristics, and voice timing of siamang in Special Purpose Forest Area (KHDTK) Aek Nauli. The research was conducted in April–May 2019. Data collection was carried out by means of field observation with triangle count and concentration count, interviews, and literature study. There are 15 distribution points of Siamang that are dispersed in three types of land cover; primary and secondary, as well as pine-dominated forests. Based on Chi-square test, the spatial pattern of Siamang has been clumped, which means χ^2_{hit} is more than or equal to 0.025. The number of Siamang is about 15 groups, with 49 individuals. The population was estimated to be between 39 ± 11 individuals with an accuracy of 71.8%. Population density was around 2.05 ± 0.57 individuals/km² and 0.78 ± 0.57 groups/km². The vocalisation of siamang in KHDTK Aek Nauli is most often done at 09:00–11:00h.

Keywords: Chi-square test, Hylobatidae, triangle count, voicing behaviour

1. Introduction

Siamang (*Symphalangus syndactylus* Raffles, 1821) is one of the endemic animals to the island of Sumatra from the Hylobatidae family. Siamang can be found on most of Sumatra Island, starting from North Sumatra, south of Lake Toba, to Southern Bukit Barisan. There are three types of Hylobatidae on Sumatra Island, namely *Hylobates agilis*, *Hylobates lar*, and *Symphalangus syndactylus*, all of which have similar habitats and social behavior (Mubarok 2012). According to Gittins and Raemaekers (1980), Siamang has the characteristic form of a vocal sac (gular sac) and membranes between their fingers and toes. Siamang is a type of monogamous primate consist of one adult male and an adult female with one to four offsprings.

Siamang occupies three types of land cover, namely primary and secondary forests, lowland forests, swamp forests, and mountain rainforests (Kwatrina *et al.* 2013). Siamang habitat is a tropical forest that is distributed from the lowlands at altitudes above 300 to 1500 meters above sea level (Kuswanda and Gersetiesih 2016). According to Cowlshaw and Dunbar (2000), the presence of siamang plays an important role in forest ecosystems, first, to help the process of plant growth (forest regeneration and succession) by eating leaves and fruit, and second, as pollinators and dispersers of plant seeds, so that in general siamang plays a role as a key species in the ecosystem.

Most siamang habitats are currently experiencing a decrease in quantity and quality because of forest conversion for plantations, especially on the island of Sumatra (Nijman and Geissman 2008). According to Geissmann *et al.* (2006), around 70–80% of the siamang's main habitat has been lost over the last 50 years along with increasing forest destruction. Habitat fragmentation results in wild animal, including siamang, inhabiting small areas with very limited carrying capacity so that population growth is less than optimal because they must be able to adapt to changes in the ecosystem. The occurrence of forest fragmentation due to plantation causes siamang to be pushed into narrow habitats and areas (Nijman and Geissman 2008).

The remaining siamang populations on the island of Sumatra are mostly found in protected conservation areas (Nijman and Geissman 2008). The Aek Nauli Special Purpose Forest Area (KHDTK) is one of the forests that is thought to support habitat for siamang. However, siamang conservation efforts in the Aek Nauli KHDTK have not been carried out optimally. One of the basic data needed in preparing conservation plans is population data (Kwatrina *et al.* 2013). Based on this, this study was conducted to provide data and information regarding the distribution and population of siamang because the first step in management is inventory.

*Corresponding author

Email Address : sharfina.larasati@gmail.com

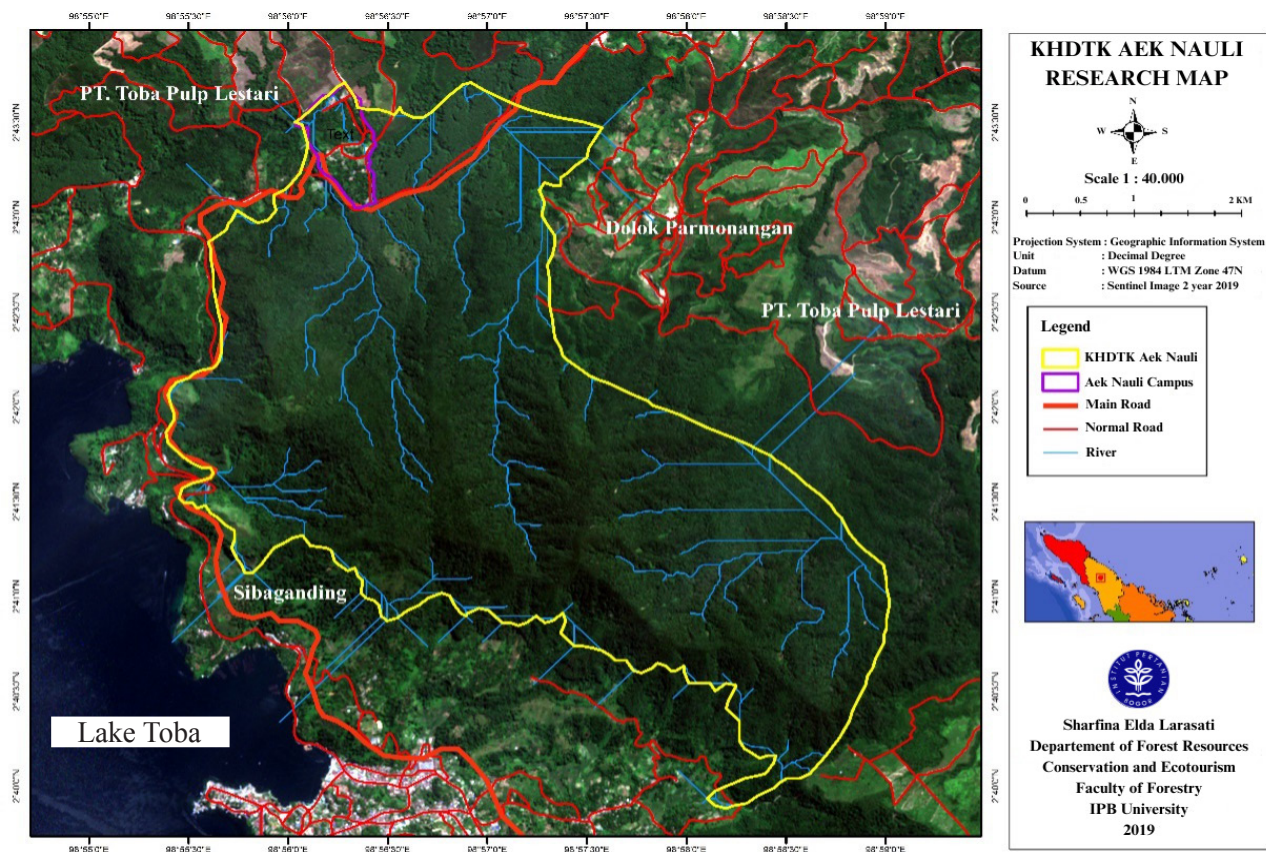


Figure 1. Location map of the study of the distribution and population of siamang in KHDTK Aek Nauli, North Sumatra

2. Materials and Methods

2.1 Time and Location

This research was carried out in April-May 2019 on three types of land cover, namely primary, secondary, and pine-dominated forests with an altitude of 1,100–1,700 meters above sea level located in KHDTK Aek Nauli, Simalungun Regency, North Sumatra (Figure 1).

2.2 Types and Methods of Data Collection

The research collected two types of data, primary and secondary. The type of data collected can be seen in Table 1.

2.3 Data Analysis

Data were analyzed descriptively, results were summarized and presented as distribution points and spatial patterns using Google Earth Pro, ArcGIS 10.5, ERDAS Imagine, and the Chi-square test. The number of population, population density, and vocalisation activities are presented in tabular and graphical form using Microsoft Excel.

3. Results

3.1 Habitat Conditions

Observations were carried out in KHDTK Aek Nauli, with a research area of 1900 ha with hilly and steep topographic conditions, which have tropical rainforest type, highland hills. The altitude of the

observation location is 1143-1715 meters above sea level, and it is divided into three types of land cover, namely primary, secondary, and pine-dominant forests. One location is a primary forest at an altitude of 1686–1715, seven locations are secondary forests at an altitude of 1143–1538, and one location is a pine-dominant forest at an altitude of 1187 meters above sea level. Observations were made in April–May 2019, which is transition months from the rainy to the dry season with an average temperature between 18–25°C and air humidity of 69–100% (Table 2). Based on observations and interview with locals, there are two large river flows in the research location used by siamang, namely the Kisat River and the Aek Nauli River.

3.2 Siamang Distribution

The results of observations of siamang in KHDTK Aek Nauli covering an area of 1900 ha identified 15 groups of siamang in nine locations. The siamang was encountered when they were swinging from tree to tree (branching), eating, resting, and making sounds. A total of seven groups of Siamang were met directly, four groups by voice, and four other groups through interviews with the surrounding community. The distribution of the siamang population in KHDTK Aek Nauli is spread across three types of land cover. Siamang is found mostly in secondary forests, at 77.8%, and in primary forest and pine-dominant forest, at 11.1% each. Based on altitude class, most of

Table 1. Type of data collected in this study

No	Type of data	Parameter	Method
1	Habitat condition	Location and the size of the area Topography Geology and land Climate and hydrology Research location condition	Literature study
2	Siamang ditribution	Siamang meeting intersection (x, y coordinate) Siamang angle discovery/azimuth (α) Estimated distance between observer and Siamang (meter) Distribution pattern	Interview, triangle count, and concentration count
3	Siamang population	Siamang group amount Population density Number of individual in group Age structure	Interview, triangle count, and concentration count
4	Siamang vocalisation	Active vocalisation activity	Triangle count and concentration count

Table 2. Temperature and humidity during the observation at nine locations in Aek Nauli, North Sumatra

No	Location	Temperature (°C)		Average (°C)	Humidity (%)		Average (%)
		1	2		1	2	
1	Waterfall	26	21	23.5	67	83	75
2	Tanjung Dolok	25	25	25	80	60	70
3	Sibaganding	24	25	24.5	76	62	69
4	Bakaran Kapur	24	24	24	73	87	80
5	Pines	24	23	23.5	100	100	100
6	Kisat River	23	22	22.5	95	100	97.5
7	Aek Nauli	23	23	23	80	80	80
8	Sae-sae Hill	18	18	18	100	100	100
9	River border	21	20	20.5	95	100	97.5

the KHDTK Aek Nauli area is included in the altitude class of 1100-1550 meters above sea level and a small part is included in the altitude class of 1550-1700 meters above sea level.

Based on the results of observations, the minimum height position where the siamang group was found was in the secondary forest type with a height of 1174 meters above sea level at Sibaganding, while the maximum height position was in the primary forest type with a height of 1673 meters above sea level at the Sae-Sae Hill location. The distribution of siamang at KHDTK Aek Nauli was 15 points at nine different locations obtained from coordinate data of siamang locations, which were then analysed spatially using ArcGIS 10.5 software and ERDAS Imagine 2014 (Figure 2).

Based on the analysis of spatial distribution patterns using the distribution index (ID), the distribution of the siamang population in KHDTK Aek Nauli is distributed according to a random distribution pattern. This is proven by results showing the value of $ID = 3.23$ with the value $\chi^2_{hit} = 45.22$, where the value χ^2 based on the Chi-square $_{hit}$ table test is $\chi^2_{0.975} = 5.62$ and $\chi^2_{0.025} = 26.11$. This is supported by the results of the Chi-square table test on group distribution, where the calculated χ^2 value is more than or equal to the χ^2 table value. This value indicates that the siamang population is clustered.

3.3 Siamang Estimated Population

Based on observations through direct encounters, 23 individuals were identified spread across seven groups, while the calculations through indirect encounters identified 26 individuals spread across eight groups (Table 3). Analysis from field observations in an area of 1900 ha obtained an estimated population number of 39 ± 11 individuals with an accuracy of 71.8%. Population density is 2.05 ± 0.57 individuals/km² and 0.78 ± 0.57 groups/km². The location with the highest number of siamang is in Pembakaran Kapur, which consists of three groups with a total of 15 individuals. Based on Table 3, the average size of the siamang group at KHDTK Aek Nauli is 3.27 individuals/group. Figure 3 shows the percentage of siamang distribution in KHDTK Aek Nauli.

3.4 Siamang Age Structure

The adult male and adult female age classes appear to be dominant at KHDTK Aek Nauli. The adult age class always occupies the largest percentage because the age structure grouping is carried out qualitatively with the age interval between the classes not being the same. This results is an accumulation of individuals in classes that have the widest age intervals, while in classes that have short age intervals the number

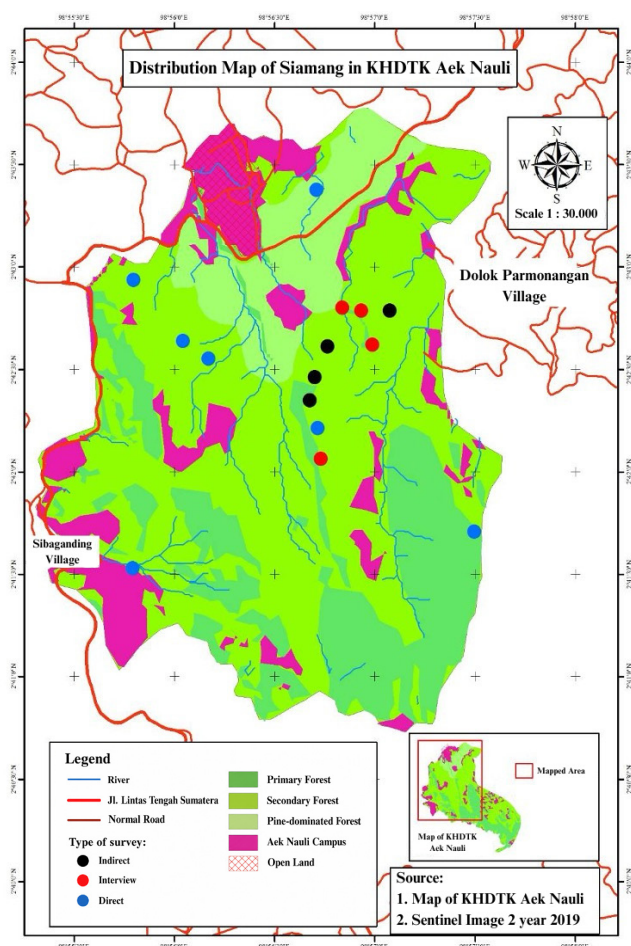


Figure 2. Siamang distribution map in KHDTK Aek Nauli.

of individuals will be small. So the age distribution of a population is based on the age interval in each category. Table 4 shows an overview of the age distribution for each age class according to the class width.

3.5 Siamang Vocalisation Activities

Based on the results of observations in the field for 19 days, 21 great call activities were identified with an average of 2 times/day. A great call is a vocal activity carried out by male and female simultaneously with a definite rhythm, where the female's vocalisations in a great call are more dominant and louder compared to male individuals. Great call activities were often carried out at 09:00-11:00h, seven and eight times, respectively (Table 5).

Other vocal activities such as morning call, group call, male solo, and duet call during the observation period were identified 105 times with an average of 12 times/day. This number was obtained based on identifying sounds beside great calls. Every time the observer heard a siamang sound in a short and irregular rhythm, the observer would count it as other vocal activities. Other sound activities were oftenly carried out at 10:00-11:00h (Table 5). At 15:00-16:00h, the observer did not hear any sound activity because of the rain until one sound activity was identified at 16:00-17:00h. The frequency of how often siamang carried out vocal activities during the study was processed by calculating the percentage of time (Figure 4).

Table 3. Siamang age structure at nine observation areas in Aek Nauli, North Sumatra

No	Group	Group Composition						Total
		AM	AF	YA	J	C	B	
1	Upper waterfall*	1	1	1	1	-	-	4
2	Lower waterfall*	1	1	-	1	1	-	4
3	Tanjung Dolok*	1	1	-	1	1	-	4
4	Sibaganding*	1	1	-	-	1	1	4
5	Bakaran Kapur 1	1	1	-	1	1	1	5
6	Bakaran Kapur 2	1	1	1	1	1	1	6
7	Bakaran Kapur 3	1	1	-	1	1	-	4
8	Pines	1	1	-	1	-	-	3
9	Kisat River 1	1	1	-	-	-	-	2
10	Kisat River 2	1	1	-	-	-	-	2
11	Kisat River 3	1	1	-	-	-	-	2
12	Aek Nauli area*	1	1	-	-	-	-	2
13	Sae-ae Hill*	1	1	-	-	-	-	2
14	River border	1	1	-	-	-	-	2
15	River border*	1	1	-	1	-	-	3
Total		15	15	2	8	6	3	49

AM – Adult Male, AF – Adult Female, YA – Young Adult, J – Juvenile, C – Child, B – Baby;

* = Groups met directly

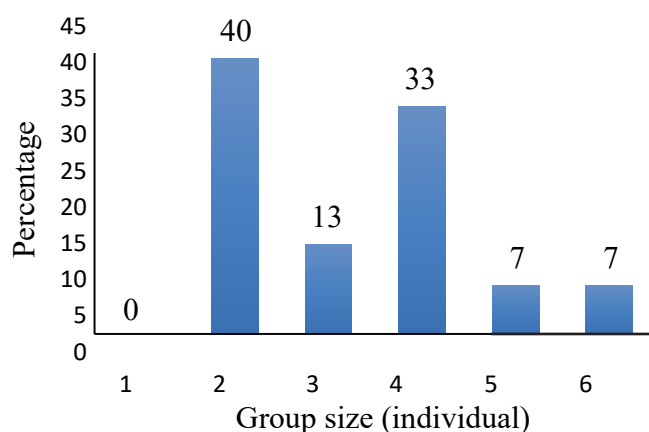


Figure 3. Siamang group size in KHDTK Aek Nauli

Table 4. Siamang age structure in annual interval

No.	Age class	Age (year)	Age gap (year)	Population data per age class	Annual interval (individual)
1	Baby	0-2	2	3	1.50
2	Child	2-4	2	6	3.00
3	Juvenile	4-6	2	8	4.00
4	Young Adult	6-8	2	2	1.00
5	Adult	8-35	27	30	1.11

4. Discussion

4.1 Siamang Distribution

Distribution is the position of an individual or a group in a certain geographic area. The siamang in KHDTK Aek Nauli is distributed throughout almost the entire area at 1174–1674 meters above sea level. At this altitude, it is still considered a good habitat for siamang because more groups are found at an altitude of 1100–1550 meters above sea level, where the habitat is dominated by the type of vegetation that is preferred by siamang, namely plant species from the Moraceae family. Plants from this family have fruit with thick flesh and a soft texture, like the *Ficus* sp. and is favored by siamang as a food source (Kuswanda and Gersetiasih 2016).

Forests at 1100–1550 meters above sea level is also suitable for siamang because there are tall and strong tree species available for siamang to move around. Even so, one group was found in high position >1600 meters, namely at the Sae-Sae Hill.

The condition of KHDTK Aek Nauli, which is a mountainous highland forest, means that siamang are used to their habitat. The higher the area, the fewer types of vegetation there are, especially the food trees where siamang search for food and move around. The identified siamang groups are spread across primary, secondary, and pine-dominated forest. Secondary forest is the area where the siamang groups are mostly found. This is because the areas at an altitude of 1100–1550 meters above sea level provide many food trees. This proves that the presence of food is also important for siamang in determining their habitat. Siamang were oftenly found on the banks of rivers and streams, related to the large number of food trees

around. In pine-dominant forest areas, only one group of siamang was found. Although siamang also eat the fruit of *Pinus merkusii*, this is not their main type of food.

Distribution patterns are strategies of individuals and groups of organisms to maintain their lives. There are two limiting factors in species distribution patterns, biotic and abiotic. Biotic factors are food, vegetation, other organisms, and the character of the species itself, while abiotic factors are climate, soil, water, and landforms. In KHDTK Aek Nauli, siamang groups are often found in secondary forest areas, this is in accordance with biotic limiting factors where the types of food available are abundance and varied. Beside food, the existence of species with the same food preference in an area makes it possible for competition, but during the observation period, an negative encounter between siamang and other species were not seen. This shows that there are no competition in KHDTK Aek Nauli that threaten the siamang. According to Elder (2009), siamang consuming more leaves are expected to reduce direct competition with other Hylobatidae when they live sympatric.

The distribution and population of animals is influenced by the availability of food, which causes siamang to choose certain places in their habitat. The clustered spatial distribution pattern shows that habitat conditions are not the same for all areas in KHDTK Aek Nauli, because siamang needs such as shelter and food are focused on several areas (clustered). The distribution of animals in groups can also be influenced by social behavior and other factors (Alikodra 2002).

4.2 Siamang Population Characteristic

A total of 15 groups of siamang consisting of 49 individual were identified in the KHDTK Aek Nauli area, covering an area of 1900 ha. 7 groups were met directly and 8 groups indirectly through voice identification and interviews. One identified siamang group had a complete age structure within it, namely the Bakaran Kapur 2, where each age class was represented by one individual. The phenomenon of groups with more than four individuals is due to the presence of adult offspring who have not yet found a partner (Mubarok 2012). A group of siamang with maximum number means that the Bakaran Kapur 2 location was a suitable habitat for them because it can provide enough sufficient food sources. The group's location also bordered the Kisat River, where many types of food plants available on the riverbank. This group also had babies that are very vulnerable. Up to two years old, babies are still in their mother's arms. The survival of babies in monogamous animals requires more care compared to non-monogamous animals (Hoi and Griggio 2010).

Siamang requires a long time to regenerate. This can be seen from the low number of infant compared to adult age classes according to annual intervals. Siamang are monogamous and individual will form a new group after passing through the young adult

Table 5. Siamang vocal activities based on frequency

No	Observation time	Great call activity (time)	Other vocal activities (time)*
1	08:00-09:00h	3	19
2	09:00-10:00h	7	23
3	10:00-11:00h	8	27
4	11:00-12:00h	2	11
5	12:00-13:00h	Naught	6
6	13:00-14:00h	Naught	6
7	14:00-15:00h	Naught	12
8	15:00-16:00h	Naught	Naught
9	16:00-17:00h	Naught	1
Total		20	105
Average		2	12

*morning call (08:00-11:00), group call, male solo, and duet call

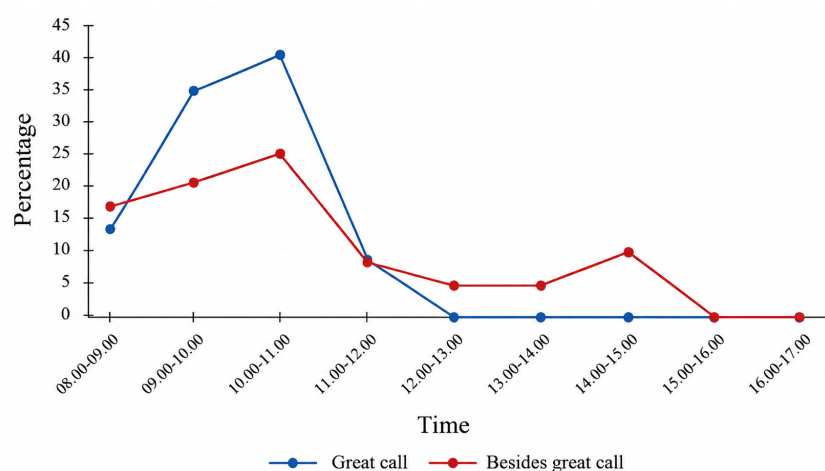


Figure 4. Siamang vocal activity frequency per time observation

phase and ready to reproduce. It takes about seven months for siamang to become pregnant with two to three years gap between the birth of one baby and another. During its lifetime, siamang can give birth up to four times with a life span of up to 35 years (Supriatna and Wahyono 2000). This is what makes it possible for the age class of adult male and female pairs to have a very high figure, namely 60%. At the time of the research, it is likely that the siamang was pregnant but was not visible to observers, or it could be that the pair of siamang was a newly formed group, so it took time to reproduce.

Population density is the size of the population in an area unit which shows the abundance of a species. The siamang population density in KHDTK Aek Nauli covering an area of 1,900 ha shows quite low figures, with estimated population density values of 2.05 ± 0.57 individuals/km² and 0.78 ± 0.57 groups/km². This population density can be said to be quite low because when compared with the siamang population density in the Dolok Sipirok Nature Reserve and its surroundings with an area of 69.7 km², namely 3.40 individuals/km² and a group density of 3.43 groups/km² (Kwatrina *et al.* 2013). A research conducted by Mubarok (2012) regarding siamang in the Batang Toru Forest Area shows a population density of 9.37 individuals/km² and 3.37 groups/km². According to

Palombit (1997), population density can be influenced by food, structure and composition of vegetation, and demography.

The average size of the siamang group at KHDTK Aek Nauli is 3.27 individuals/group. Siamang group usually consists of a parent pair with one or two offsprings (Kuswanda *et al.* 2013). According to Gron (2008), siamang can live in a group consisting of six individuals, but four individuals in general. Compared with other studies, including research conducted in the Dolok Sibual-Buali Nature Reserve with the size of the siamang group was 3.43 individuals/group (Kwatrina *et al.* 2013) and a research conducted in the Bukit Barisan Selatan National Park with the size of the siamang group was 2.61 individuals/groups (O'Brien *et al.* 2004), the size of the siamang group at KHDTK Aek Nauli is relatively normal.

Based on the description of the age structure, it can be said that the siamang population in KHDTK Aek Nauli is likely to grow in the next few years. The age structure of a population can be used to assess the prospects for sustainable development of a population, so that the success of a wild animal's can be estimated or assessed (Sampurna *et al.* 2014). According to Kwatrina *et al.* (2003), indications of a population that is difficult to reproduce can also be seen from the small number of groups that have

offspring. For example, in the research, three siamang babies were expected to reach the adult phase in the next six years and form a new group to then breed. Bakaran Kapur can be said to have good conditions and capable of supporting the existence of siamang. In this location, there were two offsprings from two different groups, that are predicted to develop well because they will be supported by the availability of food sources. According to Alikodra (2002), wild animal populations fluctuate from time to time according to environmental conditions.

4.3 Siamang Vocal Activity

Choosing the time to call, both great call and other vocal activities of siamang in KHDTK Aek Nauli started in the morning at 08:00h when the observations began. At the time of the research, a transition from the rainy to the dry season, it was oftenly rained at night till the morning. In general, siamangs do not or are slow to vocalise in the morning when it rained in the evening and do not vocalise in rainy morning (Sari and Harianto 2015). Therefore, siamang in KHDTK Aek Nauli started to actively vocalise when the rain stopped.

The two vocal activities of siamang are dominated in the morning at 09:00–11:00h. Siamang tend to engage in vocal activity at that time because the sun was just shining through the gaps between the trees where siamang started doing their daily activities. This is in accordance with research conducted by Mubarok (2012) on a group of siamang in the Batang Toru Forest Area that siamang carry out vocal activities after sunrise.

In great call activity, the frequency began to decrease at 11:00h until stopped at 13:00h. In other vocal activities, the frequency began to decrease at 11:00h and stopped at 15:00h. Siamang tend to reduce their vocal activity according to their rest time by also reducing moving activities such as branching. When there is not enough sun shines on the forest area starting at 15:00h, siamang have finished their daily activities and go to their sleeping trees. According to Duma (2007), the Hylobatidae family tends to end its daily activities in the afternoon to rest earlier than other types of diurnal primates.

During observation, the voices of female individuals sounded more prominent, loud, and shrill compared to male individuals who tended to emit short notes when carrying out vocal activities. Their call can last for 3 to 15 minutes and can be heard as far as 1 to 2 km. Voice activities are carried out as territorial arrangements between groups and as a medium of communication between couples (Mubarok 2012). Male and female individuals have vocal behavior at different stages and times which can be done solo (male solo) or duet (duet call) and can also take a form of group vocalizations (group call) (Mubarok 2012). In nearly adult male siamang, vocal activity is also carried out to attract opposite sex (Duma 2007). Vocal activity is usually done on food source trees or those close to food trees.

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