Predicting size limit of wild blood python (*Python brongersmai* Stull, 1938) harvesting in north sumatera

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**Abstract.** Blood python (*Python brongersmai* Stull, 1938) is one of heavily exploited wildlife in Indonesia. The high demands on its skin trade have made its harvesting regulated under quota-based setting by the government to prevent over-harvesting. To gain understanding on the sustainability of *P. brongersmai* in the wild, biological characters of wild-caught specimens were studied. Samples were collected from two slaughterhouses from Rantau Prapat and Langkat. Parameters measured were morphological (Snout-vent length (SVL), body mass, abdomen width) and anatomical characters (Fat classes). Total samples of *P. brongersmai* in this research were 541 with 269 male and 272 female snakes. Female snakes had the highest proportion of individuals with the best quality of abdominal fat reserves (Class 3). Linear models are built and tested for its significance in relation between fat classes as anatomical characters and morphological characters. All tested morphological characters were significant in female snakes. By using linear equation models, we generate size limit to prioritize harvesting in the future. We suggest the use of SVL and stomach width ranging between 139.7 – 141.5 cm and 24.72 – 25.71 cm respectively to achieve sustainability of *P. brongersmai* in the wild.

**Keywords:** Anatomy, conservation, morphology, *Pythonidae*, sex ratio, slaughterhouses

1. **Introduction**

Skin trade has become a major supplier for global leather industry to achieve optimum industrial outputs. Majority of global worldwide supply on reptilian skin is provided from South East Asia, comprising countries such as Malaysia, Viet Nam, Lao People’s Democratic Republic, and Indonesia. Indonesia is known to supply skin from five species, viz. the water monitor (*Varanus salvator*), two species of python (*Python reticulatus* and the blood python *Python curtus* complex), the rat snake (*Ptyas mucosa*), and the spitting cobra (*Naja sputatrix*) [1]. Pythons have been
heavily exploited in Indonesia since rising demands on commercial leather industry with globally known and well-studied species, reticulated pythons or Python reticulatus [2,3]. Other members of Pythonidae like Burmese python and Short-tailed python are currently facing serious threats from exploitation in the wild and their trade are still managed and approved in Appendices of Convention on International Trade in Endangered Species of Wild Fauna and Flora [4].

As formerly described as subspecies of P. curtus complex, Python brongersmai now become one of the most exported Short-tailed python species in Indonesia with central harvesting area located in North Sumatera [5,6]. While many comprehensive studies have been conducted to assess population of reticulated pythons in Indonesia, it is still detrimental to Python brongersmai as second most exploited species. In Indonesia and Malaysia, sustainable harvests are hoped to be achieved by using quota-based settings. However, study case on reticulated pythons showed many negative effects on applying quota which then recommended placing by an alternative strategy which is by promoting size limit of future catchment [3]. Size limit is one of biological attributes that may be used as predictor along with other attributes: like population demography and reproductive output [7]. Predicting size limit may be an alternative way to manage harvest by giving governmental force into local gatherers [8]. A practical size limit need to be pointed out to local hunters to achieve sustainable population of P. brongersmai in the wild. Here we provided current biological characteristics of wild-caught P. brongersmai in order to construct predictive unit to become a size limit approach for future sustainable harvesting in North Sumatera.

2. Methods
2.1 Study Sites
The research was conducted at rural area located in Rantau Prapat and Langkat, districts of North Sumatera. Based on this study, wild Python brongersmai were collected by local hunters around oil palm plantation. Surveys were conducted once per month for three months to ensure high catchment volume due to stockpiling and fluctuative catchment rate or gain of snakes in the wild. Snakes were gathered at slaughterhouse and for confidential issue, specific location was not declared in this research. Wild-caught snakes were carried using plastic sacks and delivered alive until being slaughtered by the local gatherers.

2.2 Measurement of morphological and anatomical characteristics
Snakes were directly counted (N) during three months of observation. Specimens were measured immediately after they were killed. Sex assessment was done by observing protruding hemipenis in male but not in female. Morphology and anatomy as biological characteristics were measured such as: Snout-vent length (SVL; cm), body mass (g), stomach width (cm) and abdominal fat reserves. Measurement was carried out using calliper with accuracy of 0.1 centimeter. Abdominal fat reserves were scored using arbitrary unit with following categorization: Class 0 (zero) being the lowest quality of fat reserve with no sign of fat deposits; Class 1 (one) with diameter between 1 – 2 cm, Class 2 with diameter between 2 – 3 cm, Class 3 being the best quality of fat reserve with diameter above 3 cm (Figure 1).

![Figure 1. Representative images of Abdominal Fat Reserves: Left (Class 0, Poor); Right (Class 3, Best)](image-url)
2.3 Confirmation on reproductive characters
Dissection on freshly-skinned bodies was made to ensure their sexes by visual inspection as well as categorizing their maturity state. Determination of male snakes was based on presence of male gonads, testes; with categorization of adult male having turgid testes with opaque and thickened efferent ducts. Determination of female snakes was based on presence of female gonads such as: oviductal eggs, vitellogenin ovarian follicles, and corpora lutea in adult females.

2.4 Data analysis
All numerical characters including morphological and anatomical characters were analyzed descriptively (mean values and standard deviations/SDs) as showed in tables and graphs. Relationship between morphological and anatomical characters were subjected to linear regression model and significance was tested with the aid of software Minitab ver. 16.0.

3. Results and Discussion
We measured 541 snakes, comprising 269 male and 272 female Python brongersmai during three months of sampling period. Among two study areas, Rantau Prapat district had higher collection of P. brongersmai (N = 511) than Langkat district (N = 30). Specimens data were pooled (N = 541) and presented (Table 1).

Table 1. Biological attributes of Python brongersmai collected from North Sumatera

| Trait                  | Male       | Female     | Total      |
|------------------------|------------|------------|------------|
| N                      | 269        | 272        | 541        |
| Snout-vent length (cm) | 135.03 (9.46) | 140.18 (11.03) | 137.41 (11.86) |
| Stomach width (cm)     | 23.69 (2.05)  | 24.91 (2.35)  | 24.3 (2.28)  |
| Body mass (kg)         | 3.62 (0.75)   | 4.19 (0.95)   | 3.9 (0.91)   |

Note: Table shows mean values (SD in parentheses)

During study, we found that slaughterhouses had coordination with specific small home-scale leather industry or local gatherers to accommodate supply of raw materials on snake skins. Fluctuating catchment rate was known to explain different collection between areas in different districts and in different time [9]. Even though, we only studied blood python caught in the slaughterhouses, reticulated python (P. reticulatus) was also found in this study and not considered in our data. Processing techniques applied to the killed snakes were considered same as reported previously [2]. By looking at our data of nearly 1 : 1 (269 : 272) ratio of male versus female snakes, we may indicate that harvesting occurred in random and non-selective meaning. Both male and female snakes had opportunity to be caught due to same habitat characteristic and movement in the wild with most natural habitat being converted into oil palm plantation. Future research will have to reveal significance of anthropogenic cause of converted natural habitat to movement ecology of this species. Survey on P. brongersmai in 1999 showed more males than females as well as greater morphological characters.

Morphological characters showed a diverse variation of samples during survey. Based on survey in 1999, the smallest size was 85 cm, which was not found in this study [2]. It may indicate that species with mentioned size did not exist anymore in the wild but accurate field study needs to be conducted to strengthen our assumption. Trappers or Hunters also had their personal judgment for not catching snakes with small sizes due to economical reasons [6]. Differences between male and female snakes or sexual size dimorphism were found slightly different in this study. Female snakes tend to show bigger size than male due to investment on reproductive output [10]. This study showed domination in size of female snakes to almost all morphological characters. The bigger female will ensure successful reproduction in the wild and tend to positively correlated with survivorship of offsprings and fecundity [11]. Abdominal fat reserves were dominantly found at class 3 in female and class 2 in male snakes (Figure 2).
Figure 2. Proportion of *P. brongersmai* individuals with different classes of abdominal fat reserves: Male (Black bars), Female (White bars)

The differences showed a higher proportion of reproductively female snakes in the wild by considering indirect clue from proportion of individuals with a classes of abdominal fat reserves. By observing ovarian follicles, it was found that majority of class 3 female showed connection to total individual that mature and reproductively active. We later tested whether distribution of fat classes were related to morphological characters (Figure 3). Based on statistical test, relationship between fat classes distribution and other traits was found significant in female snakes. Male snakes only showed significant relationship between fat classes and stomach width. Hence, SVL, body mass and stomach width variables may be used to predict classes of abdominal fat reserves in female snakes (Table 2).

Figure 3. Fat classes relative to morphological characters: SVL, stomach width and body mass
Table 2. Relationship between fat classes and other traits of male and female *P. brongersmai*

| Fat Classes          | Traits                     | Statistical test         |
|----------------------|----------------------------|--------------------------|
|                       | Snout-vent length (cm)     | R-sq = 0.00%; r = 0.04; P = 0.55 |
|                       | Stomach width (cm)         | R-sq = 0.15%; r = -0.07; P = 0.24 |
|                       | Body mass (kg)             | R-sq = 1.44%; r = -0.13; P < 0.05 |
| Male                 | Snout-vent length (cm)     | R-sq = 1.11%; r = 0.12; P < 0.05 |
|                       | Stomach width (cm)         | R-sq = 8.83%; r = 0.30; P < 0.05 |
|                       | Body mass (kg)             | R-sq = 16.89%; r = 0.41; P < 0.05 |
| Female               | Snout-vent length (cm)     | R-sq = 1.11%; r = 0.12; P < 0.05 |
|                       | Stomach width (cm)         | R-sq = 8.83%; r = 0.30; P < 0.05 |
|                       | Body mass (kg)             | R-sq = 16.89%; r = 0.41; P < 0.05 |

The result also supports the fact that female snakes tend to invest more energy input that may affect their morphology which also explained for the sexual dimorphism [15]. To assess sustainable harvest in the future, several acts must be carried out, one of which by promoting practical size limit of catchment. Based on significant relationships, we can predict optimum morphological characters of female snakes since it showed a positive correlation between stated traits. Before considering our finding on linear equation models on snakes traits, many studies focused on body condition scores or indices to predict anatomical character based on morphology. Since body indices were still a long debate and argued to provide an indirect measure on reproductive condition in snakes [12,13,14], here we provide basic empirical evidence by directly relating all morpho-anatomy variables using simple linear regression models as supported by statistical analysis. Female with fat class categorizing between 2 and 3 must be considered as priority harvest since it still appeared in large volume of catchment that may related to their numerous individuals in the wild. By applying linear equation models, several size limit are suggested with fat class (2 and 3) as predictors (Table 3).

Table 3. Size prediction of female *P. brongersmai* in relation with morphological characters

| Trait                     | Linear equation model | Size limit         |
|---------------------------|-----------------------|--------------------|
| Snout-vent length (cm)    | y = 136,1 + 1,801x    | 139,70 – 141,50    |
| Stomach width (cm)        | y = 22,75 + 0,98      | 24,72 – 25,71      |
| Body mass (kg)            | y = 2,99 + 0,53x      | 4,06 – 4,58        |

In field application, we assume that measuring SVL and stomach width characters will be more applicable rather than weighting each snakes by using mass analyzer. Therefore, we hope to affect our local hunters to specify their priorities by following instruction based on limited attributes. Since the models were formulated on female snakes, more efforts have to be made in the field to differentiate sex correctly. We also hope to inform local gatherers so they are aware of excluding snake with the size outside of suggested ranges back to their natural habitat. Future study is needed to test whether this model may enhance survivorship of lower fat classes by evaluating caught snakes in the same area.

4. Conclusions

We proposed size limit restriction on harvesting *Python brongersmai*. The size limit are determined by relating number of individuals exposing large anatomical representatives (fat classes) with their morphological characters. Restriction are made for each of morphological characters but we suggest the use of SVL and stomach width as size ranges to follow up ease of application in the field.
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