CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

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Geneva (Switzerland), 18-22 July 2017

BIOLOGICAL PARAMETERS USED IN SETTING CAPTIVE-BREEDING QUOTAS
FOR INDONESIA’S BREEDING FACILITIES

This document is submitted by TRAFFIC with respect to agenda item 14.*

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Conservation Biology will be publishing an article soon entitled “Biological parameters used in setting captive-breeding quotas for Indonesia’s breeding facilities”. This is relevant to Agenda Item 14 on Captive-breeding and ranched specimens. The full article is currently in press, although already available as an Accepted Article (see link) and attached as Annex 1. It is submitted here with the consent of the Journal. A brief summary is presented below.

The article examines the biological parameters behind the calculation of the quotas in Indonesia’s Captive Breeding Production Plan (CBPP)’s to determine suitability of the quotas set to regulate captive breeding. The biological parameters used in the CBPP were compared with information gathered from over 200 published sources (scientific papers, books, hobbyist magazines) and information on species life histories and species experts for all 129 species in the CBPP including how often species bred, and clutch or litter sizes.

Summarised findings:

- There were some significant differences in the biological parameters used in the CBPP compared to published literature. The number of animals that can be bred, as calculated within the CBPP, was higher than our calculations using published literature for 15 mammal species (104-898% higher), 71 reptile species (101-485% higher) and 2 frog species (1497-6667%). For example, for one frog species, the White-lipped Tree Frog *Litoria infrafrenata*, the CBPP sets a quota 67 times higher than the animal would have been able to produce naturally.

- The allocated quotas appear to contradict the calculations for reproduction used by the CBPP. For 38 species, the allocated quota was higher (by 100%-540%) than the CBPP-calculated maximum number of animals that can be produced.

- Quotas had been set for 2 species where, according to the CBPP, no breeding stock was present in any of the country’s registered breeding facilities (*Cuora amboinensis* and *Lanthanotus borneensis*).

- Quotas had been set for 4 species where no biological parameters are present in the CBPP (*Hemigalus derbyanus*, *Bothrochilus boa*, *Eunectes murinus* and *Pteropus personatus*).

Annex 1. Accepted Article version of the forthcoming paper.
Biological parameters used in setting captive-breeding quotas for Indonesia’s breeding facilities

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Abstract

The commercial captive breeding of wildlife is often seen as a potential conservation tool to relieve pressure off wild populations, but laundering of wild-sourced specimens as captive-bred can seriously undermine these and provide a false sense of sustainability. Indonesia has been at the centre of such controversy, therefore we examine Indonesia’s captive breeding production plan (CBPP) for 2016. A number of the quotas were found to be based on inaccurate and unrealistic biological parameters, and included species with no reported breeding stock. For 38 species, the quota exceeded the number of animals that can be bred based on the biological parameters (range 100\% - 540\%) using the equations

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used in the CBPP. A lower reproductive output was calculated for 88 species using published biological parameters compared to the parameters used in the CBPP. The equations used in the production plan also did not appear to account for other factors involved in breeding the proposed large numbers of specimens. We recommend that the captive breeding production plan be adjusted by using realistic published biological parameters, and remove quotas for species for which captive breeding is unlikely or for which no breeding stock is available. The shortcomings in the current captive breeding production plan create loopholes where mammals, reptiles and amphibians from Indonesia declared as captive-bred may have been sourced from the wild.

**Introduction**

Illegal and unsustainable wildlife trade is a major threat to biodiversity conservation (Rosser & Mainka 2002; Broad et al. 2003; Nijman 2010), leading to species declines (Van Balen et al. 2000; Shepherd & Ibarrrondo 2005; Natusch & Lyons 2012), and can ultimately threaten whole ecosystems (Duckworth et al. 2012; Challender et al. 2015). The lucrative global exotic pet trade is a major driver of the wildlife trade (Auliya et al. 2016), putting additional pressure on wild populations as demand grows.

Commercial captive breeding of wildlife is a potential conservation tool to alleviate the pressure on wild populations (Jepson & Ladle 2009; Nogueira & Nogueira-Filho 2011; Challender et al. 2015); advocates argue that this reduces the demand for wild-sourced animals (Robinson et al. 2015). However, for traders to favor captive-bred animals over wild-sourced specimens they need to be equally or more profitable (Bulte & Damania 2005). Captive breeding facilities require substantive investment in facilities, employment and operation costs (Snyder et al. 1996; Nijman & Shepherd 2015) relative to low costs for obtaining wild-sourced specimens.

The laundering of wild-sourced specimens fraudulently declared as captive-bred reportedly occurs on a large scale (Nijman & Shepherd 2009; Lyons & Natusch 2011; Nijman & Shepherd 2015), potentially having grave impacts on wild populations (Natusch & Lyons 2012). Since trade in certain
protected species is only permitted, or less scrutinized, for captive-bred specimens, there is incentive for traders and exporters to declare wild-sourced specimens as captive-bred to circumvent trade restrictions. This conservation management issue has been recognized by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), where at the recent CoP17 in 2016 a resolution (Resolution Conf. 17.7) for the review of trade in animal species reported as produced in captivity was passed. It highlights concerns that there is growing evidence of illegal trade in wild-sourced specimens mis-declared as captive-bred, and doubts about the legal origin of parental stocks of both native and non-native captive-bred specimens (CITES, 2016). As such, a regulatory mechanism specifically reviewing trade in animals from captive sources is in process to ensure compliance with CITES provisions (CITES, 2016).

Indonesia is one country that has been in the spotlight for laundering wild-sourced animals into the international trade by declaring them as captive-bred (Lyons & Natusch, 2011; Beastall & Shepherd, 2013; Nijman & Shepherd, 2015). Indonesia has an extensive harvest quota system for wild-sourced native species to supply both domestic and international markets. Indonesian wildlife is categorized as protected or unprotected under Government Regulation No.7, 1999. Commercial exploitation of protected species is prohibited, unless it concerns captive-bred animals (offspring of the second (F2) or subsequent generations) (Government Regulation No.8, 1999). Trade in wild-sourced specimens of unprotected species is allowed under a quota system. Businesses involved in commercial exploitation of wild and captive-bred native species are required to submit trade records annually and all specimens should be accompanied by legal documents. Non-native species are not protected under current Indonesian legislation.

The Captive Breeding Production Plan (CBPP) quantifies the number of animals allowed to be produced by registered Indonesian captive breeding facilities and, as it includes a breakdown of the species, breeding facilities involved as well as equations used to derive the number, could have been implemented to increase transparency and minimize laundering. This study examines the CBPP for

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2016. We compare the biological parameters used in the CBPP against parameters found in published literature for each species, identify shortcomings of the CBPP and explore the possibility that these allow wild-sourced specimens to be laundered as captive-bred. We recommend improvements to the equations and data used in deriving the captive breeding production plan, and to captive breeding management.

Methods

How the CBPP works

The CBPP separates species into four categories: I) CITES-listed and nationally protected species, II) nationally protected species not listed on CITES appendices, III) CITES-listed species which are not nationally protected, and IV) species which are neither nationally protected nor listed on CITES. Majority of species (116) on the CBPP are native to Indonesia with 13 non-native reptile species originating from other countries in Asia and the Pacific (5), Africa (5), and South America (3). Category IV (neither nationally or CITES protected species) for mammals erroneously includes one species listed in CITES Appendix III and one species in Appendix II (Table 1, marked with *). For 2016, a total quota of 4 273 029 captive-bred specimens was reportedly present for 118 of 129 species listed in the CBPP. For 24 species (marked by an asterisk in the CBPP), a note states that “Types can be used after being audited and receiving a recommendation from the Indonesian Institute of Sciences (LIPI)”, Indonesia’s CITES Scientific Authority.

The CBPP bases its calculations on current breeding stock and any remaining animals produced in 2015. Details of the number of breeding individuals per species present at 18 Indonesian breeding facilities and the proposed production plan per facility for 2016 are included. Five of the 18 facilities have no current breeding stock and are not allocated breeding quantities. In total, breeding stock is reportedly present for 81 of the 129 species. The proposed captive breeding quantity is based upon an equation calculating minimum and maximum reproduction factor (Renpro):
in which PJP (Prosentase Jumlah Induk Produktif) is the percentage of female animals reproducing, Reproduction (min or max) is the minimum or maximum clutch/litter size per breeding event, FRep (Frekuensi Reproduktif) is the annual number of breeding events, SuR the survival rate of the produced animals and InP (Indeks Pemanfaatan) the utilization index assuming a certain percentage of the offspring can be utilized (see Table 2 for an example). The rationale behind the percentages used for PJP, SuR and InP is unknown.

The spreadsheet containing a detailed audit of one of the breeding facilities shows how the calculated reproduction factor is used to calculate the minimum or maximum number of animals for each species that can be captive-bred by breeding facilities in 2016 (Eq. 2):

\[
\text{Captive bred animals}_{\text{min or max}} = \text{Breeding stock} \times \text{Reproduction factor (Eq. 2)} + \text{Stock 2015}
\]

Calculations using published biological parameters

Parameters regarding the ecology and breeding biology of the examined species were retrieved from the CBPP and compared with parameters obtained by the authors from published literature including scientific journals, books and herpetocultural magazines in six different languages (Dutch, English, French, German, Mandarin and Spanish), largely written by people with extensive experience in breeding these species. Information was cross-checked with species experts and the AnAge database (http://genomics.senescence.info/species), De Magalhaes and Costa (2009). In many cases reproduction is higher in captivity than in the wild (Auliya, 2006; Mendyk, 2011), and we took this into account by including breeding results obtained by private individuals or zoological institutes, who are often able to provide optimal husbandry conditions and therefore maximize reproductive
outputs. To illustrate inaccuracies in the biological parameters used in the CBPP, we used the same equations as the CBPP to calculate reproductive output.

The CBPP uses the maximum clutch/litter size of animals in the calculations of the captive-breeding quota; in contrast and to provide a more realistic reproductive output, the authors used both the average clutch/litter size and a calculated average reproductive frequency (average number of annual breeding events) in the equations. In most frequency distributions, maximum clutch/litter sizes are exceptions (Perlik, 1996). Moreover, clutch/litter sizes depend highly on the circumstances, e.g. high caloric diets (Mendyk 2011), and in the case of reptiles often on the size of the animal (Thomson and Pianka 2004), and clutch sizes of multi-clutching species tend to decrease throughout the breeding season (e.g. Georges et al. 2008). Using maximum clutch/litter sizes will over-estimate any potential reproductive output. Where frequency information was not available, we took a conservative approach and used a minimum reproduction frequency (number of annual breeding events) of one.

The average reproductive frequency was calculated as follows:

\[
\text{Eq. 3} \quad \text{Average reproductive frequency} = \frac{(\text{Maximum number of annual breeding events} + 1)}{2}
\]

(e.g. for a species with maximum reproductive frequency of 5 and minimum of 1, the average reproductive frequency would be \((5+1)/2 = 3\)).

Within the CBPP, the fact that not every female animal might reproduce during the annual breeding season, is already taken into account with a separate parameter (PJP).

Wherever captive breeding information for a species was unavailable, data for taxonomically closely related species was used. Where taxonomy of reptile species in the CBPP differed from the latest taxonomic insights, we followed The Reptile Database (Uetz & Hošek, 2015).

**Results**

**Differences in biological parameters**

The CBPP allocated quota and maximum reproductive output were compared with our calculations using biological parameters found from published literature and species experts (see Supplementary
Information). Calculated reproductive outputs using published literature and average reproductive frequencies resulted in a higher calculated reproductive output for five mammal species (\(\bar{x}=197\%, 100\%-359\%\)), and lower for 15 mammal species (\(\bar{x}=49\%, 20\%-95\%)\) than the CBPP reproductive output. The reproductive output calculated using published literature was lower for 71 reptile species (\(\bar{x}=60\%, 10\%-98\%\)) compared to the CBPP reproductive output, but for 22 reptile species published parameters yielded a higher reproductive output (\(\bar{x}=141\%, 100\%-5602\%)\) compared to the CBPP. For both amphibian species, literature reveals a single annual breeding event of 200-1000 eggs for the white-lipped tree frog (\textit{Litoria infrafrenata}) (Williams & Hero 1998) and 200-2000 eggs for White’s tree frog (\textit{Litoria caerulea}) (Hero et al. 2004; Cabrera-Guzmán et al. 2013), which corresponds to a mere 2% and 3% of the CBPP maximum reproductive output. This means that for the frog species, according to biological parameters in literature, 98% and 97% of the allocated CBPP quota respectively cannot be bred with the current breeding stock. The use of incorrect biological parameters is not confined to Indonesia’s native species, and include several non-native species like the Near Threatened Parson’s chameleon (\textit{Calumma parsonii}).

We compared CBPP-allocated quota for species where breeding stock was available with the calculated reproductive outputs using published literature. For only one mammal species (binturong), the CBPP-allocated quota was lower than the literature-based calculated reproductive output (74%). CBPP-allocated quotas exceeded the literature-based calculated reproductive output for the remaining 21 species (\(\bar{x}=241\%, 104\% - 898\%\)). For 38 reptile species, allocated captive breeding quota were larger (\(\bar{x}=187\%, 101\% - 485\%\)) than the literature-based calculated reproductive output, and lower for 54 reptile species. CBPP quotas allocated to both amphibian species comprised 6667% and 1497% of the calculated reproductive output for the white-lipped tree frog and White’s tree frog.

\textbf{Other CBPP irregularities}

Further examination of the detailed audit reveals that the proposed quotas are not actually based on the calculated Captive-bred animals \(\min\) or \(\max\), but rather seem to retrieve the numbers from a separate •
sheet in the CBPP called the ‘proposed production plan’, using a SUMPRODUCT equation. Because of this, the proposed quotas remain the same even when the biological input parameters are adjusted.

The CBPP contains biological parameters for 124 of the 129 species (Supporting Information), but lacks data for the banded civet (*Hemigalus derbyanus*), binturong (*Arctictis binturong*), Bismarck ringed python (*Bothrochilus boa*), green anaconda (*Eunectes murinus*) and masked flying fox (*Pteropus personatus*). Despite this, breeding quantities were allocated for all of these except binturong, raising the question as to how quotas for these species were determined.

There appeared to be inconsistencies between the allocated quotas and maximum biological output calculated using CBPP parameters (e.g. Table 3). Excluding species without allocated quotas, the difference between the allocated quotas and maximum biological output was the largest for mammals (n=21, $\bar{x}=181\%$, 67%-540%), followed by reptiles (n=91, $\bar{x}=80\%$, 2%-366%) and amphibians (n=2, $\bar{x}=71\%$, 41%-100%). For 38 species the quota exceeded the number of animals that can be bred based on the biological parameters (range 100% - 540%) using the equations used in the CBPP.

For earless monitor (*Lanthanotus borneensis*) and Southeast Asian box turtle (*Cuora amboinensis*), no breeding stock is reportedly present at any of the breeding facilities, yet quotas have been allocated for both species: 20 earless monitors allocated to one company, and 1995 Southeast Asian box turtles allocated to another. The earless monitor was included in CITES Appendix II with a zero quota for wild-sourced specimens at CITES CoP17. However, that a captive breeding quota has been allocated with no pre-existing breeding stock raises serious concerns that reportedly captive-bred earless monitor may have been taken from the wild.

**Discussion**

Despite being a promising starting point to audit commercial captive breeding operations in Indonesia, the CBPP possesses some shortcomings: the quotas are based on incorrect and unrealistic
biological parameters compared to what is known of the species’ breeding biology in published literature, quotas are allocated for species with no registered breeding stock, and allocated quotas in relation to the maximum reproductive output appear to be inconsistently assigned.

**Biological parameters**

Many species included in the CBPP originate from remote regions of Indonesia, such as isolated islands or Indonesian New Guinea, and biological information for these species is often lacking, bringing into question the veracity of the parameters used in the CBPP. Our research found that some biological parameters used in the CBPP varied wildly to the information available from published literatures, which results in a mismatch between the CBPP quotas and the number of animals that can be biologically bred. For example, the red-eyed crocodile skink (*Tribolonotus gracilis*) only lays one egg per clutch (Miralles 2004), but a clutch size of 5-12 is used in the CBPP. For Parson’s chameleon, the CBPP uses a clutch size of 24 - 100 and a frequency of 4 clutches per year, yet according to literature it only produces a single clutch of 20 - 65 eggs annually (Bartlett & Bartlett 1995; Le Berre & Bartlett 2009).

A number of species require specialized care to maintain, let alone breed (Ziegler et al. 2009; Mendyk 2014). Boelen’s python (*Simalia boeleni*) is one species for which captive breeding programs have been largely unsuccessful (Austin et al. 2010). Nonetheless, since a zero-harvest quota was established for wild-sourced specimens all exports have been declared as captive-bred or farmed (Lettoof 2015). Wild female Boelen’s pythons brooding eggs are located, and neonates collected when they hatch (Lettoof 2015). The juvenile snakes are then exported as captive-bred providing a false impression of captive breeding to evade the zero-harvest quota, even though under CITES they should be declared as ‘Ranched’. Short-beaked echidnas (*Tachyglossus aculeatus*) have also proven difficult to breed in captivity. Specimens at American zoos (119) have given birth to just 19 F1 individuals over the past 108 years (up to 2013), with only four surviving beyond 18 months (Beastall & Shepherd 2013). Only in 2014 was the second documented F2 offspring born in captivity (Wallage...
et al. 2015). It is very unlikely that the CBPP-allocated quota (50 specimens) can be fulfilled from only F2 captive-bred specimens.

For many species, reproductive success in captivity can be significantly higher than in the wild, e.g. multi-clutching in captive varanid species (Auliya 2006; Mendyk 2011). This is likely related to high caloric diets in captivity (Mendyk 2011) but can result in serious health problems due to excessive reproductive cycling (Mendyk 2014). For many species clutch size depends on body size (e.g. monitor lizards, King and Green 1999), but clutch sizes in multi-clutching species usually decrease throughout the season (e.g. Georges et al. 2008), and not all females multi-clutch (Naretto et al. 2015; Mendyk 2011). The equations used by Indonesia overlook the fact that not all eggs or offspring are viable (e.g. Horn 1989; Geczy 2009). When taking these factors into account, using average rather than maximum clutch sizes and reproductive frequencies would provide more realistic parameters of maximum reproductive outputs than using the CBPP equations.

**Issues with the equations used**

Indonesia’s CBPP is based on two equations which are supposed to be used to calculate the potential breeding output. Considering that the number of captive-bred animals did not change within the detailed audit when the parameters were changed, but continued reflecting the number from the proposed production plan, biological parameters appear to inadvertently not be accounted for in the calculation process. This is further supported by the proposed captive breeding quantities frequently exceeding the maximum possible reproduction according to CBPP formulas. In order to improve Indonesia’s CBPP, the number of animals allowed to be bred in captivity should be based on consistent information using standardized equations that take biological parameters into account and do not exceed the maximum reproduction possible.

It is unclear what the rationale is behind the percentages used for PJP, SuR and InP in Equation 1. Further explanation was requested from the Government of Indonesia but no response was received.
is unclear if InP assumes that only a certain percentage is viable for trade and the remaining are not, or if the remaining percentage is retained for population maintenance. Moreover, the standard percentages used differ from what literature indicates, e.g. the PJP for the common spiny bandicoot (Echymipera kalubu) is 80%, yet literature reveals a percentage as low as 67% (Cuthbert & Denny 2014).

Including animals from previous breeding seasons in the CBPP equation may artificially inflate the allocated quota as these animals may be included in the same quota for multiple years. From the final allocated quota, it is unclear what part comprises last year’s remaining stock, or newly bred animals. By including animals bred during previous season, there is a higher possibility of larger sized (juvenile to sub adult) animals that are more likely to have been wild-sourced being laundered as captive-bred under the guise of ‘born in previous seasons’. To increase the transparency of the CBPP, the animals bred in the previous year are recommended to be kept separate from the equations for that particular season to reduce laundering opportunities and still allow surplus animals to be traded.

The CBPP equations do not take into account several factors that impact the number of animals that can be bred. For example, for breeding facilities to be sustainable in the long term, survival of existing adult breeding stock and the gradual addition of juvenile individuals to the breeding stock needs to be taken into account; ensuring closed-cycle breeding operations can take several years for some species. Juvenile survival rates can differ from adults, and it can take several years for juveniles to reach sexual maturity (Schoppe 2008).

Conservation concerns

Indonesia’s captive breeding facilities have previously been scrutinized for falsely declaring wild-sourced specimens as captive-bred (e.g. Natusch & Lyons 2012; Nijman & Shepherd 2015), and large discrepancies between reported breeding stock and the actual breeding stock present at breeding facilities in Indonesia (Nijman & Shepherd 2009, Lettoof 2015). More worrisome still was the lack of

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suitable breeding facilities observed at several companies claiming to be commercially breeding wildlife (Nijman & Shepherd 2009).

Even with adequate facilities present, the large quantities for which captive breeding is allowed pose significant logistical challenges. For 2016 alone, Indonesia allocated a quota to breed 4,273,029 animals, for a large part consisting of tokay geckos (*Gekko gecko*) (2,856,000). A recent study revealed that wild-sourced tokay geckos are laundered *en masse* through registered captive breeding facilities, as it is economically not feasible to breed such large numbers and still make any profit, considering the enormous operational investments and the low selling prices (Nijman & Shepherd 2015). For breeding facilities to be economically viable, a cheaper, more acceptable alternative to wild-sourced specimens needs to be provided to the consumer (Bulte & Damania 2005, Damania & Bulte 2007). However, when profit margins are significantly reduced through costs of breeding, rearing and maintaining the large quantities for which captive breeding is allowed, even the industry itself acknowledges commercial breeding for some species as cost-ineffective (Soehartono, 2002).

The current approach (the CBPP) to setting quotas for the captive-bred pet trade is a conservation concern posing a serious threat to the conservation of Indonesian wildlife, as a false sense of sustainability is established when wildlife is laundered through breeding facilities. Population declines due to extensive collection have already been reported for several species (Shepherd & Ibarrondo 2005, Lyons & Natusch 2011); this is of particular concern for critically endangered species in the CBPP such as the Sulawesi forest turtle (*Leucocephalon yuwonoi*) and Roti island snake-necked turtle (*Chelodina mccordi*), or some range restricted species whose conservation status have yet to be assessed (e.g. earless monitor). Deliberate mis-declaration of wild-sourced animals as captive-bred also undermines the objectives and implementation of both national wildlife legislation and international wildlife trade regulations like CITES.
Based on previous studies into Indonesia’s captive breeding facilities and the findings in the current study, it seems unlikely that Indonesian breeders are breeding the numbers claimed in the CBPP, and some of the animals may in fact be wild-sourced. For many species, quotas are much higher than what top-notch breeding facilities can realistically produce, and these quotas may be exploited to launder wild-sourced specimens. The authors recommend that the captive breeding production plan be adjusted by: 1) setting new biologically realistic quotas that include all relevant factors influencing breeding success, 2) withdrawing quotas for species which have not been audited by LIPI or for which no breeding stock is available, 3) greater transparency about the underlying scientific sources used for CBPP calculations, and 4) including regular, unannounced inspections of breeding facilities. Because of the existing shortcomings in the CBPP, the captive-bred status of Indonesian animals cannot be guaranteed, undermining legitimate commercial breeders and traders and impeding conservation efforts. Until the abovementioned changes have been implemented, Indonesian mammals, reptiles and amphibians declared as captive-bred cannot be assumed to be so, as they may have been sourced from the wild.

Acknowledgments

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Annex 1


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### Table 1 Summary of the species in Indonesia’s captive breeding production plan for pets for 2016.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Category&lt;sup&gt;a&lt;/sup&gt;</th>
<th>CITES&lt;sup&gt;b&lt;/sup&gt;</th>
<th>IUCN&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Native&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-CITES</td>
<td>III</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>Amphibians</td>
<td>IV</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td>I</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>16</td>
<td>1*</td>
<td>1*</td>
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<tr>
<td>Reptiles</td>
<td>I</td>
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<td>5</td>
<td>2</td>
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<td></td>
<td>II</td>
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<td></td>
<td>III</td>
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<tr>
<td></td>
<td>IV</td>
<td>29</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>3</td>
<td>72</td>
<td>48</td>
</tr>
</tbody>
</table>

<sup>a</sup> I) Protected or CITES listed species, II) protected but not CITES listed, III) not protected but CITES listed, and IV) neither protected nor CITES listed.

<sup>b</sup>CITES I refers to CITES Appendix I, II to Appendix II and III to Appendix II.

An example of the calculation of the reproductive output for the sugar glider *Petaurus breviceps* using the input parameters as stated in the detailed audit of Indonesia’s CBPP.

### Table 2

<table>
<thead>
<tr>
<th>Calculation of reproductive factors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $\text{Renpro}<em>{\text{min or max}} = P_1 J P_2 * \text{Reproduction}</em>{\text{min or max}} * F \text{Re} * SuR * InP$</td>
</tr>
<tr>
<td>[ \text{Renpro}_{\text{min}} = 80 % \times 1 \times 3 \times 80 % \times 80 % = 1.536 ]</td>
</tr>
<tr>
<td>[ \text{Renpro}_{\text{max}} = 80 % \times 2 \times 3 \times 80 % \times 80 % = 3.072 ]</td>
</tr>
</tbody>
</table>

Calculation of reproductive output

2. $\text{Reproduction}_{\text{min or max}} = \text{Breeding stock} \times \text{Reproduction factor} + \text{Stock 2015}$

\[ \text{Reproduction}_{\text{min}} = 2080 \times 1.536 + 0 = 3195 \]

\[ \text{Reproduction}_{\text{max}} = 2080 \times 3.072 + 0 = 6390 \]

CBPP allocated quota for 2016: 4792 specimens

### Table 3

<table>
<thead>
<tr>
<th>Calculation of reproductive factors, CBPP versus using biological parameters from published literature:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-beaked echidna (Tachyglossus aculeatus)</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CBPP</th>
<th>$\text{Renpro}_{\text{min}} = 70 % \times 1 \times 1 \times 80 % \times 80 % = 0.896$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Renpro}_{\text{max}} = 70 % \times 2 \times 1 \times 80 % \times 80 % = 1.792$</td>
<td></td>
</tr>
</tbody>
</table>

| $\text{Reproduction}_{\text{min}} = 15 \times 10.24 + 18 = 31$ |
| $\text{Reproduction}_{\text{max}} = 15 \times 10.24 + 18 = 45$ |

**CBPP for 2016: 50 specimens**

<table>
<thead>
<tr>
<th>Published literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Renpro}_{\text{min}} = 70 % \times 1 \times 1 \times 80 % \times 80 % = 0.448$</td>
</tr>
<tr>
<td>$\text{Renpro}_{\text{max}} = 70 % \times 1 \times 1 \times 80 % \times 80 % = 0.448$</td>
</tr>
</tbody>
</table>

| $\text{Reproduction}_{\text{min}} = 15 \times 0.448 = 7$ |
| $\text{Reproduction}_{\text{max}} = 15 \times 0.448 = 7$ |

<table>
<thead>
<tr>
<th>Reproductive output:</th>
<th>7 specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remaining 2015:</td>
<td>18 specimens</td>
</tr>
<tr>
<td>Realistic quantity</td>
<td>25 specimens</td>
</tr>
</tbody>
</table>

| **Timor python (Python timoriensis)** |

<table>
<thead>
<tr>
<th>CBPP</th>
<th>$\text{Renpro}_{\text{min}} = 80 % \times 20 \times 1 \times 80 % \times 80 % = 10.24$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Renpro}_{\text{max}} = 80 % \times 20 \times 1 \times 80 % \times 80 % = 10.24$</td>
<td></td>
</tr>
</tbody>
</table>

| $\text{Reproduction}_{\text{min}} = 60 \times 10.24 + 74 = 688$ |
| $\text{Reproduction}_{\text{max}} = 60 \times 10.24 + 74 = 688$ |

**CBPP for 2016: 473 specimens**

<table>
<thead>
<tr>
<th>Published literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Renpro}_{\text{min}} = 80 % \times 4 \times 1 \times 80 % \times 80 % = 2.048$</td>
</tr>
<tr>
<td>$\text{Renpro}_{\text{max}} = 80 % \times 8 \times 1 \times 80 % \times 80 % = 4.096$</td>
</tr>
</tbody>
</table>

| $\text{Reproduction}_{\text{min}} = 60 \times 2.048 = 123$ |
| $\text{Reproduction}_{\text{max}} = 60 \times 4.096 = 246$ |

<table>
<thead>
<tr>
<th>Reproductive output:</th>
<th>184 specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remaining 2015:</td>
<td>74 specimens</td>
</tr>
<tr>
<td>Realistic quantity</td>
<td>258 specimens</td>
</tr>
</tbody>
</table>