



Shifting apes: Conservation and welfare outcomes of Bornean orangutan rescue and release in Kalimantan, Indonesia

Julie Sherman^{a,*}, Marc Ancrenaz^{b,c}, Erik Meijaard^{b,d,e}

^a *Wildlife Impact, PO Box 31062, Portland, OR, 97217, USA*

^b *Borneo Futures, Block D, Unit 8, 1st Floor, Shakirin Complex, Spg 88, Kg Kiulap, BSB BE1518, Brunei Darussalam*

^c *HUTAN-Kingabatangan Orang-utan Conservation Programme, P. O. Box 17793, 88874, Kota Kinabalu, Sabah, Malaysia*

^d *Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Canterbury, CT2 7NR, UK*

^e *School of Biological Sciences, University of Queensland, QLD, 4072, Australia*

ARTICLE INFO

Keywords:

Bornean orangutan
Conservation
Reintroduction
Translocation
Law enforcement

ABSTRACT

For more than 50 years, Critically Endangered Bornean orangutans (*Pongo pygmaeus*) have been rescued from poachers or captors, rehabilitated, and released into natural habitats. Wild orangutans are also translocated—intentionally captured from habitat patches and insecure situations for the purpose of releasing them into areas considered to be safer. Although these activities are widely applied, data on orangutan conservation and welfare effects are lacking. Our study improves understanding of these outcomes through analysis of Bornean orangutan rescues and releases conducted in Kalimantan, Indonesia between 2007 and 2017. We collected data on orangutan rescues ($n = 1517$) and releases ($n = 1219$) from rescue facility reports, newspaper articles, and scientific publications, and assessed outcomes in relation to action plans, international standards for wildlife releases, law enforcement, and wild orangutan population and habitat conservation. High levels of orangutan killing and illegal possession drove rescue facility intake, while deforestation, actual or potential human-orangutan interactions, and fires drove large-scale wild orangutan translocations. We found rescue facilities held 1112 orangutans in 2017, a number largely unchanged since 2007 despite 1219 reported releases including 605 ex-captive orangutans and a minimum of 523 translocated wild orangutans. Rescue has not facilitated notable changes in law enforcement, nor forestalled wild orangutan losses. Translocations in particular pose serious risks to conservation of orangutan metapopulations and individual welfare. Substantial changes in law enforcement, human attitudes and behaviors toward orangutans, and improved management of human-orangutan coexistence are needed to disrupt the current cycle of orangutan killing and illegal possession followed by rescue and release. These changes would enable a much-needed renewed focus on protecting wild orangutans in their natural habitats.

1. Introduction

The Bornean orangutan, *Pongo pygmaeus*, is classified as Critically Endangered by the IUCN Red List of Threatened Species (Ancrenaz et al., 2016). The main threats to Bornean orangutans in Indonesia are forest clearing for industrial agriculture, forestry plantations, mining, smallholder cultivation, and rural development, fires, and killing for bushmeat, human-orangutan conflict, and live capture (Abram et al., 2015; Santika et al., 2017; Voigt et al., 2018; Wich et al., 2008, 2012). Indonesia's Act Number 5, 1990, prohibits capture, injury, killing, transport, trade, and possession of orangutans, which is punishable by up to five years imprisonment and/or a maximum fine of IDR 100 million, or approximately \$7100 USD at September 2019 exchange

rates (Nijman, 2017). International trade of orangutans is likewise prohibited under Indonesia's Act Number 8, 1999. Nonetheless, killing, possession and trade—primarily national—of orangutans is widespread in Indonesia (Davis et al., 2013; Freund, Rahman, & Knott, 2017; Nijman, 2017). Forest clearing and increased human access to orangutan habitats are contributing factors as both can result in orangutans coming into more frequent contact with people, facilitating killing of adults and capture of infants, which are often kept or sold as pets (Freund et al., 2017; Gaveau et al., 2013; Meijaard et al., 2011; Santika et al., 2017). Orangutan infants are strongly dependent on their mothers for an average period of eight years or more (van Noordwijk et al., 2018), thus obtaining infants requires mothers to be killed in nearly all instances (Freund et al., 2017; Meijaard, Wich, Ancrenaz, &

* Corresponding author.

E-mail address: julie@wildlifeimpact.org (J. Sherman).

<https://doi.org/10.1016/j.jnc.2020.125807>

Received 6 November 2019; Received in revised form 10 January 2020; Accepted 6 March 2020

1617-1381/© 2020 The Author(s). Published by Elsevier GmbH. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Marshall, 2012; Russon, 2009; van Noordwijk, 2009).

For more than 50 years, removing orangutans from illegal situations such as trade or possession as pets (commonly called 'rescue') and subsequently releasing them into natural habitats has been a prominent conservation strategy (Grundmann, 2006; Harrison, 1961; KLHK, 2018; Rijksen & Meijaard, 1999; Russon, 2009; Sugardjito & van Schaik, 1992). Two categories of rescue and release are commonly practiced in Kalimantan. The first category begins with surrender or confiscation of orangutans illegally held, orphaned, or legally held in unsuitable situations, that are then taken into rescue centers. These animals are rehabilitated, and, if deemed suitable candidates for survival in the wild, released into natural habitats. Practitioners call releases of these ex-captives 'reintroduction,' although technically these activities encompass both reintroduction (release into indigenous range areas where previous populations have been extirpated), and reinforcement (release of individuals into existing conspecific populations) (IUCN/SSC, 2013). The second category is translocation of wild orangutans purposefully captured by rescue practitioners from perceived unsuitable habitats or insecure situations and released into natural habitats elsewhere (Kaye, 2016; Maruf & Rayadin, 2015; ProKal, 2017). These translocations are also conducted when wild orangutans are stranded away from natural food sources, are captured or attacked by humans, or are in need of medical intervention (Beech, 2019; Mendonça et al., 2016; Tabuchi, 2016). Despite the widespread use and significant resource allocation to rescue, rehabilitation and reintroduction, as well as to wild capture and translocation, there are few peer-reviewed studies of the conservation outcomes of these activities (Russon, 2009; Wilson, Meijaard, Venter, Ancrenaz, & Possingham, 2014).

Indonesia's orangutan action plan for 2007–2017 (*Strategi dan Rencana Aksi Konservasi*, called 'SRAK 2007') mandated all orangutans to be released from rescue facilities by 2015 (Ministry of Forestry, 2009). SRAK 2007 also called for preventing any loss of orangutans from concession lands, and concluded that translocation of wild orangutans from "damaged habitat" should be a last resort (Ministry of Forestry, 2009). A 2019–2029 orangutan action plan (called 'SRAK 2019'), was published in 2019 but has been withdrawn for further revision (Foresthints, 2019). The draft SRAK 2019 stated that rescue centers are over capacity, and called for all suitably rehabilitated ex-captive orangutans to be released into natural habitats by 2022 (KSDAE, 2019). It further authorized wild orangutan translocations from forestry, mining and agricultural concessions when the animals are in unsustainable or insecure situations but did not provide details about such qualifications, and indicated such translocations should be minimized (KSDAE, 2019). Both the SRAK 2007 and the draft SRAK 2019 plans stipulated orangutan releases should comply with relevant IUCN guidelines (KSDAE, 2019; Ministry of Forestry, 2009). The IUCN developed international standard guidelines for wildlife releases conducted primarily for conservation purposes, and best practice guidelines for great ape reintroduction, both aimed at preventing harm to wild conspecific populations, improving success for released animals, and promoting self-sustaining populations (Beck et al., 2007; IUCN/SSC, 2013). These guidelines are bounded by precautionary principles of: (1) not endangering resident wild conspecifics via disease, hybridization, excessive social disruption or exacerbated competition for habitat resources; (2) not endangering other interacting native taxa or the ecological integrity of the area; and (3) prioritizing conservation of the taxon and of resident wild conspecifics over the welfare of individual releasable animals (Beck et al., 2007; IUCN/SSC, 2013). Releases to improve individual welfare, reduce captive populations, secure funds or publicity, or move animals for economic development purposes do not meet IUCN criteria for conservation releases (IUCN/SSC, 2013).

Today several assumptions underpin orangutan rescues and releases: (1) the act of rescuing illegally held orangutans facilitates law enforcement efforts (Sherman & Greer, 2018); (2) release of ex-captive

orangutans can provide individuals a chance to live independently in natural habitats (Russon, 2009); (3) releases support conservation by protecting habitats; and (4) releases help to re-establish locally extirpated populations or bolster diminishing wild populations, thereby meeting IUCN guidelines (CITES/GRASP, 2006; Grundmann, 2006; Palmer, 2018; Russon, 2009). The welfare of surrendered or confiscated orangutans is also assumed to be improved through transfer to rescue centers (Trayford & Farmer, 2013); however, analysis of this aspect of rescue is outside the remit of this study. Peer-reviewed studies testing these assumptions are lacking, although some studies have looked at some specific aspects of rescue and release success. Russon (2009) investigated orangutan rehabilitation and release elements including rehabilitation success, survival after release, and success in establishing self-sustaining populations. Wilson et al. (2014) looked at cost effectiveness of rehabilitation and reintroduction, and Palmer (2018) addressed the ethics of rescue and release. To improve orangutan conservation outcomes, it is vital that management decisions on Bornean orangutan rescue and release are based on empirical evidence of risks and effectiveness in meeting conservation goals. We collected 10 years of available data on Bornean orangutan rescue and release activities, with the objective of improving understanding of how orangutan rescue and release strategies are applied in practice, and their conservation and welfare outcomes and risks.

This paper aims to answer the following research questions: (1) do rescue facilities meet SRAK 2007 goals to release all ex-captive orangutans by 2015, and is the SRAK 2019 goal to release all suitable ex-captive orangutans by 2022 achievable given current progress?; (2) what are the reasons for orangutans being taken into captive care facilities?; (3) do rescues of illegally held orangutans facilitate law enforcement?; (4) what are the welfare and survival outcomes for released ex-captive orangutans?; (5) what are the reasons for capture and translocation of wild orangutans?; (6) are wild orangutan translocations employed as a last resort, as per SRAK mandates?; (7) do translocations support wild populations and released individuals' welfare?; (8) do releases of ex-captive orangutans and translocations of wild orangutans support habitat protection?; and (9) do releases comply with IUCN guidelines?

2. Methods

We conducted a systematic review of public and unpublished data on Bornean orangutan rescues and releases between January 1, 2007 and December 31, 2017 (Appendix A). These data covered an estimated 85 % of the total number of the rescues and releases in public reports from practitioners. We determined this percent coverage by comparing the total numbers of individual rescue and release events we found data on with the total numbers of rescues and releases in practitioners' public reports. We collected data from self-published reports and public tax/charity commission records of Bornean orangutan rescue centers in Kalimantan, as well as third party published sources, and peer-reviewed studies. We also collected data from archived newspaper articles by searching Prokal and TribunNews (Kalimantan), Jakarta Post and Jakarta Globe (Indonesia), Borneo Post, and Borneo Today (Borneo regional) websites, using the search term "orangutan" to capture any relevant news published between 2007 and 2018 (the hyphenated term orang-utan is not commonly used in Indonesia). We presented initial sets of compiled self-reported annual data to each rescue center for review and input in June 2018. We also sent an email survey to rescue and release practitioners and orangutan researchers about their views on post release monitoring (PRM) best practices. The survey was sent to 10 orangutan rescue centers and nine orangutan researchers (Appendix A). We received six responses, three from rescue and release practitioners and three from researchers not associated with orangutan rescue and release. Additional unpublished data or contextual information were gathered through semi-structured interviews with 43 stakeholders via phone, email and in person (Appendix A). We compiled data on

annual captive populations and annual numbers of orangutans rescued (sum of total animals rescued annually between 2007 and 2017 = 1517), annual release numbers by type (reintroduction/reinforcement, translocation, wild captured orangutans held for more than six months in captivity, re-release) (sum of total animals released annually between 2007 and 2017 = 1219), and annual births and deaths at rescue facilities, as well as mortality incidences during translocation or post-release. These data were taken from rescue centers' annual reports, tax or charity commission reports, and from annual summary data on websites or social media where formal reports were not provided. Where numbers from various sources were in conflict, we selected the number best supported by most sources or verified by communications with rescue centers. We also compiled and coded available data on as many of the individual instances of orangutans rescued and released as available, a subset of the 1517 rescues and 1219 releases that were identified from annual records ($n = 1285$ total number of individual orangutans rescued; $n = 1031$ total number of individual orangutans released). Sources are listed in Appendix A. We excluded from our dataset records of large-scale captures and translocations of an additional 1224 orangutans by industry and private companies because we were unable to verify if these instances were represented elsewhere in our dataset. We aggregated data by rescue/release entity and identified possible duplicates using any available combination of animal name, age, date and circumstances of rescue or release. We excluded all duplicates and any records where it was unclear if the animal had been previously recorded. We compiled data by individual orangutans where possible, including name, sex and age, or when these identifiers were not available, by date, location and/or description of rescue or release circumstances. Rescues were classified as: (1) confiscation (seizure of animal by law enforcement authorities); (2) surrender (willing hand-over by captor or rescuer); (3) wild capture (for translocation to another habitat); (4) other rescue types (medical interventions, transfer of legally held animals in unsuitable conditions); and (5) re-captures of previously released orangutans (Appendix B). Releases were classified as: (1) reintroduction/reinforcements (release of ex-captive orangutans that spent more than 6 months in rehabilitation facilities); (2) wild-to-wild translocation ('translocation' per practitioner terminology; any wild orangutan captured and released within six months or less); (3) wild captured orangutans held in captivity at rescue centers for more than six months; and (4) re-releases (release of previously released and recaptured orangutans) (Appendix B).

Our aim was to seek potential improvement in the effectiveness of orangutan conservation activities, rather than to point to concerns related to specific entities conducting rescue and release. Hence stakeholder inputs and data attributable to individual stakeholders were kept anonymous, and data are presented by variables rather than by entity.

Due to inconsistencies in data reporting and availability across sources, we made a set of assumptions to classify data systematically (Appendix B). We used dependence on mother and age of sexual maturity to define infant and adult age classifications, respectively. Bornean orangutans are strongly dependent on their mothers until they are weaned at 6–9 years old (van Noordwijk, 2009). To avoid overestimating the number of dependent orangutans and thus the capture of infants associated with killing of mothers, we used the lower bound of this range—six years—as the age at which orangutans could become independent juveniles, and we classified orangutans five years and younger as infants. We based our adult age class of ≥ 15 years on the age of first reproduction for wild Bornean orangutans (Russon, 2009; van Schaik, Marshall, & Wich, 2009).

Reasons for rescue of both surrendered/confiscated and wild captured orangutans were based on the proximate rationale provided in rescue records, such as illegal possession as a pet, or desire to prevent a wild orangutan consuming human crops (Appendix B). We also collected available data on underlying factors, such as fires or forest clearing in orangutan habitats, which in turn can result in orangutans traveling or foraging in agricultural fields (Appendix B). Capture, harm,

possession, sale, or trade of orangutans is illegal whatever the motivation, excepting intake and release of orangutans by permitted facilities such as rescue centers. Hence, motivations that may be driving people to illegally obtain or keep orangutans, such as concern for their welfare, were not considered here. Previous analyses found that most rescued orangutans were illegally held as pets, and more rarely were intended for sale or trade, or were victims of bushmeat poaching or of retaliatory killings over orangutan crop consumption or other human-orangutan interactions (Freund et al., 2017; Nijman, 2017; Russon, 2009). The subset of records in our dataset which provided detailed information on rescued orangutans' history showed that 96 % of the orangutans illegally held captive were kept as pets at some point. We thus considered illegally held orangutans were kept as pets unless rescue records noted other reasons. Records of other reasons for orangutans being held captive were rare, and included being sold, used as a tourist attraction, found orphaned and immediately delivered to authorities, or being held in relation to a negative interaction with humans. To decrease the proportion of instances with missing data, we also inferred that all records of illegally held orangutans which lacked any explanation for their captivity were held as pets. Parameters and assumptions used to code raw data are detailed in Appendix B.

We estimated killing by counting the number of orangutans (OU) reported killed in rescue records, and added the sum of an estimated one adult (the mother) killed for each rescued infant for all records wherein no such information was provided. Other crimes including possession, trade or harm were recorded and summed whenever noted in rescue incident records. The number of crimes (Y) was determined by the equation:

$$Y = K_{OU} \text{ reported or estimated killed} + A_{OU} \text{ reported captured, attacked or injured} + P_{EOU} \text{ held captive} + P_{OOU} \text{ snared/seized from hunters.}$$

3. Results and discussion

3.1. Performance against SRAK 2007 goals for ex-captive orangutans

Rescue and release activities were conducted by nine entities in Kalimantan: specialized care facilities (rescue centers), private businesses and corporations, and by *Balai Konservasi Sumber Daya Alam* (BKSDA), the Indonesian agency for natural resource conservation. The BKSDA rescue centers in Kalimantan were treated as a single facility. Each non-governmental (NGO) rescue center organization was treated as a single facility, even if it had multiple care centers or pre-release habitats, i.e. semi-natural managed habitats used for rehabilitation.

The SRAK 2007 mandated release of all captive orangutans by 2015. In 2007, there were 1100 orangutans in five rescue facilities including BKSDA (Fig. 1). Four new facilities began accepting surrendered or confiscated orangutans, one each year in 2009, 2013, 2015 and 2017. During this period one of the initial five facilities was emptied and its animals transferred to one of the remaining three facilities. Later during the study period it was reopened and began again accepting rescued orangutans. Captive births were a regular occurrence at two rescue centers and their associated pre-release habitats, and rare at other facilities. At least 119 orangutans were born in captivity during the study period. Forty-nine of these captive born orangutans (63 %) were released into natural habitats between 2007 and 2017. Captive populations remained fairly stable over the study period, fluctuating from a low of 1100 orangutans in 2007 to a high of 1258 in 2016 (Fig. 1). Captive populations reported for 2007–2008 and 2017 may be underestimated as most rescue centers did not have publicly accessible annual reports for those years at the time of this study.

A total of 994 orangutans were taken into rescue centers between 2007 and 2017, at an average rate of 90 animals per year (Fig. 1). This intake excludes 523 wild captured and translocated orangutans, many of which were held in captive facilities for several days up to six months

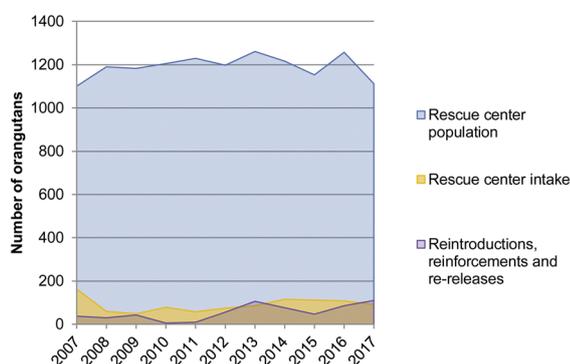


Fig. 1. Trends in orangutan rescue center captive populations, intake, and reintroductions, reinforcements and re-releases 2007–2017. Intake and release numbers based on the larger of either the number presented in published annual reports, or the sum of individual orangutans reported rescued and released in each year. Wild orangutans captured and held more than six months in captivity are included under intake and reintroduction ($n = 98$).

prior to their release in another location. Annual intake peaked in 2007, following the repatriation of 52 orangutans confiscated in Thailand (TRAFFIC, 2015), and extensive clearing for plantation expansion (Austin, Schwantes, Gu, & Kasibhatla, 2019; Santika et al., 2017). Captive population peaks followed rescue peaks, and also reflected a 2013 peak in captive births at one rescue center, concurrent with opening of a sixth rescue center which added new captive care capacity (Fig. 1).

Practitioners released 605 ex-captive orangutans during the study period. The pace of ex-captive releases rose sharply after 2011 when new release habitats in Bukit Baka Bukit Raya National Park, Bukit Bakitap Protection Forest, Mount Tarak Protection Forest and Kejhe Sewen Restoration Ecosystem were selected. The total number of rescues nonetheless exceeded that of ex-captive releases (Fig. 1). Captive populations decreased at only one of the nine rescue centers, and increased in seven, with the eighth having the same number of animals in 2007 and 2017 following large numbers of both releases and rescues.

3.2. Reasons for intake of orangutans to rescue centers

Orangutans appeared to be popular pets in Kalimantan, with 632 (90 %) of the 699 orangutans confiscated or surrendered coming from illegal ownership. Illegal trade played a minor role in orangutan rescues ($n = 11$; 2%), with five orangutans rescued from persons selling them nationally, and six seized from international trade. Nearly all persons holding orangutans as pets claimed to have found them as infants alone on the ground or been given them already orphaned. A recent study in West Kalimantan by Freund et al. (2017) also found captors made this claim. However, only five of the recorded instances described situations in which this appeared plausible; that is, the orangutan was found in circumstances not related to negative human-orangutan interactions, and the person who found it immediately sought help for the orangutan rather than selling or keeping it as a pet. Well-intentioned concern for orphaned orangutans' welfare may drive people to buy or accept infant orangutans; this is often the case with buyers of protected wildlife, although it is illegal nonetheless and actually fosters poaching and trade rather than reducing it (Sherman & Greer, 2018). Eight orangutans (1%) were rescued from poaching events such as snaring, and another 11 (2%) from capture, harassment or attacks by humans. Twenty-eight animals (4%) were rescued from captive care facilities with unsuitable conditions. One additional animal was rescued from a tourist attraction and two more were rescued to address illnesses or injury from natural causes, such as injuries from a fall or agonistic interactions with conspecifics or other wildlife. Many illegally held orangutans were kept in

horrific or deadly conditions where rescue likely saved their lives and enabled improved welfare.

3.3. Relation of rescues to law enforcement

Our dataset provides a measure of detected and reported orangutan crime from 2007–2017. This is presumed to be a small subset of actual crimes, most of which are likely undetected. Detection rates in Kalimantan are expected to be low due to limited effort, corruption and a reluctance to punish local citizens (CITES/GRASP, 2006; Nijman, 2017), as well as the difficulty of access and remoteness of many areas where orangutans are found. Killing of orangutans remains a significant issue, based on recent science (Freund et al., 2017; Meijaard et al., 2011; Trayford, 2013) and the indications in our dataset. All researchers and rescue centers we spoke with said orangutans are still being killed in the areas where they work. Most also told us that killing instances had locally decreased following their work with surrounding communities, but evidence was not available to assess this.

There were a total of 719 orangutans affected by crimes—killing, and injury, harassment, possession, sale or purchase of orangutans—in the 1285 records we compiled on individual rescues (Fig. 2). Most crime was related to animals confiscated or surrendered ($n = 699$). Of the 699 orangutans confiscated or surrendered 670 (96 %) involved orangutan crime. Illegal possession as pets was most common, accounting for 632 animals (90 %), of which 599 (86 %) were infants five years or younger (Appendix C). Another 21 animals (3%) were harmed, in trade, or held captive for reasons other than being a pet. The 29 cases (4%) which did not involve crime were handovers of animals from zoos/other facilities and orangutans found orphaned. Other types of rescue—wild captures, medical and other rescues, and recaptures of previously released orangutans—($n = 586$) accounted for 52 crimes (9%).

While killing estimates were highest in 2007 due to the number of infants rescued that year, killings and reported illegal purchases of orangutans did not decrease overall between 2008 and 2017 (Fig. 2). Additionally, in 33 instances captors showed resistance to following the law despite being informed that their actions were illegal (Fig. 2). Rescue center reports indicate authorities often will not seize illegally held orangutans if owners do not wish to give them up. There were four instances of law enforcement outcomes during the 10 year study period: one conviction, two arrests and one additional inconclusive investigation. The conviction rate for this dataset is 0.1 %, which is not an improvement over previous assessments of orangutan-related law enforcement (Freund et al., 2017; Nijman, 2005, 2017). We are conducting more detailed analysis of law enforcement contexts for subsequent publication.

The surrender or confiscation of the animals alone does not represent successful law enforcement (Nijman, 2017), although it does provide the potential for improved orangutan care at specialized care centers. These rescue centers can play a direct role in wildlife law enforcement by providing both care for seized animals and facilitation of law enforcement outcomes by tying acceptance of animals to authorities' willingness to investigate and prosecute perpetrators (Nijman, 2017; Sherman & Greer, 2018).

3.4. Welfare outcomes of ex-captive releases

Researchers we interviewed said that rehabilitation practices have improved over time, but that selection of reintroduction and reinforcement candidates and release sites is not necessarily grounded in current understanding of *P. pygmaeus* behaviors such as the maternal knowledge transfer necessary for effective foraging (Schuppli et al., 2016), male territoriality (Utami Atmoko, Singleton, van Noordwijk, van Schaik, & Mitra Setia, 2009), and female philopatry (van Noordwijk et al., 2012). Extended time in captivity has also been suggested as a risk to success of released orangutans (Grundmann, 2006). We analyzed

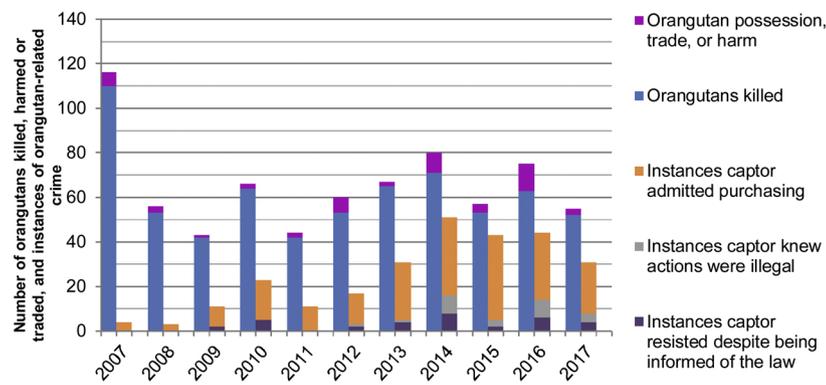


Fig. 2. Law enforcement aspects of rescues 2007-2017 (n = 719 orangutan-related crimes). Orangutan trade is purchase, sale, barter or gifting of animals. Harm to orangutans includes physical injury and harassment. Instances of captor purchase, knowledge of illegality, and resistance are a subset of orangutan killing and other orangutan crimes. These instances were noted where reported and are not mutually exclusive. For years where a variable is not displayed those data were missing or unclear.

the age class, sex and time in captivity of released orangutans (n = 431). Thirty-nine percent of released orangutans were adults 15 years or older, and 75 % were 10 years or older. Released orangutans were predominantly female (60.4 %), while 38.2 % were male, and 1.4 % of unreported sex. Fifty-two percent of released animals were captive for more than 10 years. Thirty percent were captive between five and 10 years, and 18 % were captive five years or less.

Data available from hard releases, where released animals were not provided supplementary food or other support, showed most rehabilitants struggled during the first few months while learning how to forage locally (Anon. rescue center reports; Basalamah et al., 2018). Limited data for a single rescue center suggest that compared to wild conspecifics, some hard released orangutans spent an abnormally high amount of time resting and sleeping instead of foraging. This center found that five of 59 animals (8%) were found or presumed dead within 12 months of release (one after only eight weeks), while an unspecified number of animals had to be provisioned or recaptured due to starvation or malnutrition. The center has subsequently altered its practices to include provisioning when released animals show signs of malnutrition.

Rescue center reports of post-release behaviors suggested that competition among individuals might explain some rehabilitants' difficulties in adapting. Previously released females with established home ranges near release sites were also suspected to limit newly released females' dietary choices and arboreal behavior. Aggressive behaviors among newly and previously released adult males were also reportedly common, as were resultant serious injuries. Many reintroduced large males and some adult females were reported as being aggressive to humans (see Table 1). Total numbers of these incidents, or of their relative prevalence among released animals, were not reported.

These issues can result in recapture of released orangutans, which in turn causes additional stress to the animals (Wilson & McMahon, 2006). Researchers and some rescue centers we interviewed suggested that most recaptures were not officially recorded nor used to improve management of rehabilitation and releases. We found records of 69 previously released orangutans being recaptured (Table 1). Four orangutans (6%) subsequently died while in captive care; 38 were re-released. Three of these 38 animals (8%) died following re-release. Ten of the 38 re-released individuals had been recaptured multiple times. Some individuals were responsible for multiple incursions into camps or crop fields. In one example, eight released orangutans were responsible for 18 instances of crop foraging and other damage to human property, with one orangutan responsible for seven cases and another responsible for three. One rescue center publicly reports these data, and, following deaths of recaptured and re-released orangutans, changed its policy to make recapture and re-release a last resort. They are instead focusing on better managing negative human-orangutan interactions, typically by providing compensation payments to villagers for property damage or consumption of human foods by released orangutans.

3.5. Post-release monitoring and survival of ex-captives

Monitoring rehabilitated and reintroduced ex-captive orangutans is difficult, but recent developments in implantable radio tracking devices have improved potential (Robins et al., 2019). All six of the rescue centers releasing ex-captive orangutans use tracking implants on some or all released animals (Table 2). Post release monitoring (PRM) of reintroduced orangutans was viewed as critical by all respondents to our PRM survey. Practitioners felt that monitoring should last at least one annual cycle to determine home range and cover seasonal variation of food availability which drives orangutan behavior. One practitioner stated orangutans should be followed daily for the first month due to their being in an unfamiliar area with unfamiliar resources and unfamiliar orangutans, and thus being especially vulnerable to getting lost or to aggressive encounters with resident orangutans. However, all researcher respondents felt monitoring needed to be conducted for much longer to establish reliable survival estimates. Rescue center reports indicated PRM beyond three years (the typical maximum life span of radio tracking implants) was conducted opportunistically (Table 2). Regardless of the PRM scheme, many released individuals were not seen again. Public data on post release monitoring results are rare, but as shown in the examples below, reported percentages of animals not re-encountered were as high as 55–95 %, depending on the site and time since release (Anon. rescue center reports; Siregar, Farmer, Chivers, & Saragih, 2010). Rescue centers' public reports considered unencountered animals to be alive but with non-functioning tracking implants or to have dispersed out of tracking implant and/or feeding platform range, while unpublished data acknowledged death as a possible explanation. Evidence to support either outcome was lacking.

Russon (2009) found rescue facilities reported post-release survival rates for Kalimantan of 20–80 % from 1971-2007. Public data on survival rates were insufficient to update this analysis. However, there is some evidence that long-term survival rates for some released ex-

Table 1

Reasons for recapture of released orangutans (n = 69). Ill/injured by resident wildlife indicates injury was caused by species other than orangutans.

Reason for recapture	Number of orangutans
Ill/injured by resident wildlife	1
Orphaned	1
Potential interaction/perceived risk	2
Captured/attacked/harassed	4
Failure to adapt	5
Intraspecific orangutan conflict	6
Starving /malnourished/underweight	6
Aggressive to humans	8
Crop foraging	18
Ill/injured - unknown cause	18

Table 2

Post-Release Monitoring (PRM) regimes for ex-captive orangutans. We found five different PRM practice regimes among the six rescue and release facilities.

PRM regime type	Monitoring methods	Frequency	Duration of monitoring after release	Notes
1	Radio tracking implant + ground follows	Daily first 2–3 days, after this ad hoc during daily patrols	Nest to nest follows first 2–3 days, then radio tracked. 1 month intensive, 1 year	Nearly all can be followed for 1 month, see only 40–50 % after this
2	Radio tracking implant + ground follows	Unknown	3 months to 3 years, dependent on rehabilitation history	
3	Visual monitoring at feeding platforms	Opportunistic	Opportunistic	
4	Visual monitoring at feeding platforms + radio tracking implant	Unknown	2 weeks	
5	Radio tracking implant + ground follows	Daily or as often as possible	Plan to continue for decades	

captive populations may be lower than 20 %. For example, a follow up survey in 2000 by Grundmann (2006) found only 11 of the 191 orangutans (6%) released in Meratus forest between 1997 and 1999, while Siregar et al. (2010) reported that 16–18 of 345 animals released (5%) were encountered in 2009, and a 2016 analysis estimated 30–40 surviving animals from a total of 349 (9–11 %) released between 1997 and 2002 (Utami-Atmoko et al., 2019). One rescue center publicly reported post release survival outcomes at one site for releases conducted between 2012 and 2015. During the first two years post-release 44 % of the released animals were actually seen again 15 months after release and 19 % were seen 28 months after release. The site had survival rates of 71 % after one year post release, 41 % after two years, and 27 % after three years, with 10 % of released animals found dead. In all cases, unencountered animals were assumed to be alive. Together these examples suggest long-term survival rates could be as low as 6–27 %.

Rehabilitated orangutans have been released in several areas with the goal of creating self-sustaining populations through reinforcement of small wild populations. Data were available for three such areas in addition to the Meratus population discussed above: (1) two rescue centers released totals of 17 and 69 animals by 2017 in two units of a single habitat area, respectively, with no wild births by rehabilitants reported; (2) 160 animals were released by 2017, and there were six births; and (3) 73 animals were released by 2017, and there were two births. It was not possible to determine if these populations could be self-sustaining over the long term due to the recent release dates and lack of available data.

3.6. Capture and translocation of wild orangutans

The capture and translocation of wild orangutans by release practitioners has been heralded as a solution for orangutan survival in the face of forest conversion (CITES/GRASP, 2007). One researcher stated the government and local people are “really excited and really proud” of translocation; their view is, ‘We are going to take orangutans that would otherwise be killed and we are going to put them in the forest and save them.’ Researchers confirmed that over the past 10 years there has been a push to train teams to catch orangutans in plantations and move them elsewhere. Indonesian government regulation P.53/Menhut-II/2014 appears to encourage translocation of “healthy” animals from areas where they could potentially interact with humans. Wild orangutans captured for the purpose of translocation ($n = 621$) were nearly equivalent to the total number of ex-captive orangutans released between 2007 and 2017 ($n = 605$). Most of the wild captures resulted in translocations to new habitats within 6 months ($n = 523$; 84 %) while another 98 wild orangutans (16 %) were held in captivity more than six months, and in some cases held 2–5 years or longer before suitable release sites could be found. Translocations were highest in 2015 and 2016 in the aftermath of the extensive 2015 forest fires. During this period orangutans were removed from areas affected by forest fires and from areas considered to have a high risk of human-

orangutan interactions. Practitioners reported that orangutans entered these human-modified areas as a result of fires in their natural habitats, and in some cases had to be moved from burned areas where no standing trees or other food resources were available.

3.7. Reasons for capture and translocation of wild orangutans

News stories and rescue centers’ accounts suggested wild orangutans were captured and moved in large numbers from concessions, generally when the concession wanted to clear an area but not run afoul of the law, or wished to prevent crop foraging by orangutans living in or near the plantation (Aji, 2011; Asrianti, 2011). Large translocations have also been conducted to move orangutans out of what rescue centers considered marginal habitat, although this approach has been controversial (Kaye, 2016). At least three rescue/release organizations reported having contractual agreements with industrial agriculture, forestry and mining concessions to find and translocate orangutans that are considered a “problem” or to be “at risk.” Some interviewees reported these organizations were paid up to US\$2000 per orangutan by concessions for conducting translocations. Many researchers and practitioners we spoke with noted that translocations often go unreported, with orangutans “dumped,” often into inappropriate locations, with neither formal documentation nor post-release monitoring. One practitioner noted that information on removal of wild orangutans from concessions is unavailable because contracts between concession companies (such as oil palm or pulp and paper) and rescue/release organizations are covered by Non-Disclosure Agreements. Government reports on SRAK implementation also referred to translocations with no details beyond, “some activities carried out by parties that are not monitored,” and, “Relocation of orangutans in one population group in one landscape” (FORINA, 2013).

Orangutans were also translocated at the request of local community members or smallholder plantations. Some practitioners reported that they comply with translocation requests regardless of the situation to prevent potential harm to the orangutans. Only two of the nine facilities we spoke with said they had refused at least once to move orangutans. One practitioner commented that it is “better to relocate them than leaving them in oil palm, since it is better for them to be in natural forest,” and “better they are translocated than killed.”

We found 539 records that identified reasons for capture and translocation of wild orangutans (Fig. 3). We based our classification on the primary rationale for capture or rescue (Appendix B). For example, in cases where villagers alerted authorities or rescue centers about orangutans in the village or foraging in crops as a result of fires driving the animals out of their natural forest habitats, the reason for capture was “potential interaction/perceived risk” or “crop consumption,” respectively (Appendix B). In such cases fires were the driver of the orangutan displacement or unusual foraging patterns, but the primary reason for capture was the villagers’ concern about the animal in village areas or crops.

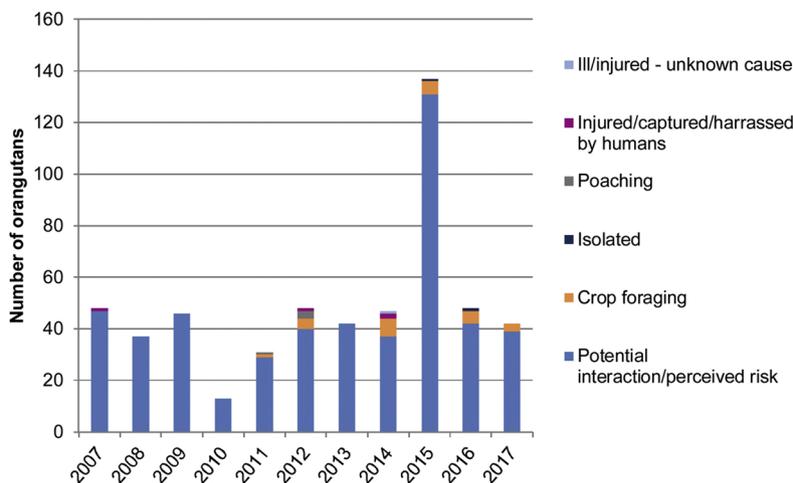


Fig. 3. Reason for capture and translocation of wild orangutans (n = 539 orangutans). Poaching indicates animals were snared or pursued by poachers at the time of rescue. Isolated animals were rescued from a location where they appeared to have no local food sources and no route to natural vegetation.

Orangutans were mainly captured to pre-emptively avoid potential interactions with humans (Fig. 3). Crop consumption was reported for 5% of translocated orangutans. Few were rescued from injuries, capture, or harassment by humans, although there were several additional instances of orangutans with human-inflicted injuries where the primary reason for capture was to remove the orangutans from situations where they could interact with humans (Fig. 3). Orangutans are able to travel on the ground and in anthropogenically modified areas (Ancrenaz et al., 2014; Spehar et al., 2018). We therefore did not consider orangutans captured in small forest patches, human crop areas, or even in an area with only a few trees or a single tree to be isolated unless their situation was described as being devoid of any food sources or proximity to natural vegetation.

Available data on 539 translocated orangutans suggest they were predominantly healthy (92%) when captured from the wild, indicating that these animals had managed to survive rather well in these habitats perceived as inhospitable (Fig. 4). Of the few (4%) that were starving, malnourished or underweight, at least half appeared to have been driven out of their habitats by forest fires.

3.8. Translocation as a last resort

Effective methods to prevent orangutan crop foraging have been trialed in Sumatra and Sabah Malaysia, with success limited by

participants' appropriate implementation (Ancrenaz, Dabek, & O'Neil, 2007; Campbell-Smith, Sembiring, & Linkie, 2012; Campbell-Smith, Simanjanong, Leader-Williams, & Linkie, 2010). Nonetheless, interviewees for this study indicated little or no use of deterrents in Kalimantan to keep orangutans out of crop areas, except by isolating an area with drains filled up with water since orangutans cannot swim. We found mention of mitigation measures to drive orangutans away from some community lands in West Kalimantan as a means to avoid translocation, as well as records of translocations following these efforts, and two stories on local honey growers, who wanted a physical barrier to deter orangutans' honey consumption (Fachrizal, 2013, 2014).

All orangutan rescue centers in Kalimantan conducted awareness raising activities during the study period. Several reported that these activities addressed human-orangutan interactions. However, researchers and rescue centers concurred that local people nonetheless preferred to have orangutans moved away from their gardens, plantations and homes, even where these adjoin or are near forests. Newspaper and rescue center articles on orangutan conflict directed the public to call authorities or rescue centers when an orangutan is sighted so the animal can be "protected" by its removal to a "safe location." One rescue center news blog stated, "This is the fifth rescue [the rescue center] team has carried out in the area because the forest is being cleared and the wild orangutans are being pushed closer and closer to

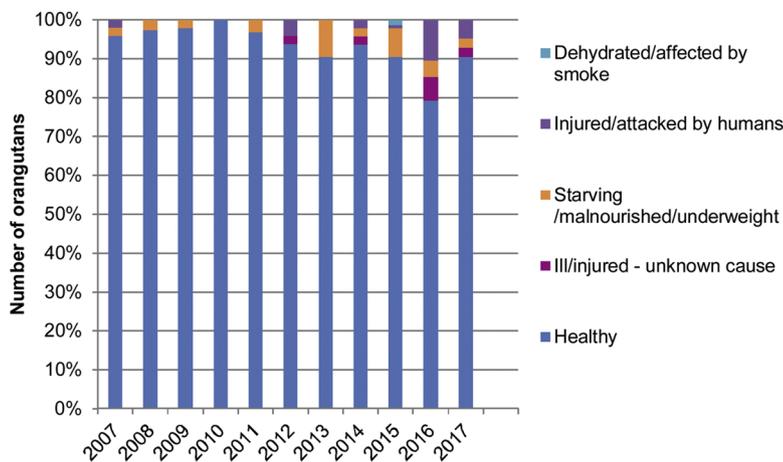


Fig. 4. Condition of translocated wild orangutans at time of capture (n = 539). Translocated orangutans were coded as healthy unless otherwise described in the record of their capture or rescue. Human agency in orangutan injuries or illness was coded only where noted in rescue records, otherwise injured animals were listed as Ill/injured – unknown cause.

the village. The local people are very helpful and have always contacted BKSDA to report any orangutan they see," (Anon. rescue center news blog, 2014). Another post noted this outcome as a direct result of outreach efforts: "by working closely with villagers and oil palm companies to mitigate human-wildlife conflict...[t]his strategy is working, as the [rescue center] is called upon to rescue stranded orangutans, rather than the individuals being harmed. Within one week...staff were called upon to translocate four orangutans that had entered villager's farm land...the land owner did the right thing by requesting that the orangutan be translocated," (Anon. rescue center news blog, 2014). Government likewise espoused this approach, advising the public via newspaper articles that, for example, "[government official] hopes that all the people of [region] who might be aware of the existence of wild orangutans on plantations or residential areas, to immediately contact or convey to the BKSDA to immediately take action as soon as possible," (ProKal, 2017). Some practitioners expressed concern that these messages, while intended to forestall orangutan killing, also promote translocation in lieu of conflict mitigation. As one researcher noted, "If you ask people who tolerate orangutan crop raiding if they have problems, then people will say yes and want you to take the orangutan." Researchers also reported that such pre-emptive moves are the norm for concessions since addressing orangutan protection takes time, money, and landscape-level planning.

3.9. Welfare outcomes of wild orangutan capture and translocation

All researchers we communicated with expressed strong concerns about the welfare and survival of translocated orangutans, and noted that empirical studies are critically needed. The captures themselves pose risks and increase stress, particularly for older individuals (Mendonça et al., 2016; Wilson & McMahan, 2006). Data were not available on the estimated number of orangutan injuries or death associated with capture. Several researchers concurred that translocating elderly males is not good for their welfare. Some researchers noted this is particularly true for males coming to forest edges to forage in crop areas because they are outcompeted by younger males. Similarly, researchers stated adult females would have trouble establishing home ranges as unrelated females will not tolerate each other. However we found the majority of translocated orangutans (60 %) were adults, with 31.8 % males and 28.5 % females (Appendix C).

3.10. Translocation of viable populations

Several large-scale translocations were reported during the study period, including 75 from the Wilmar Group, 166 from the Makin Group (possibly a subset of 983 orangutans reported, but unconfirmed, as rescued from the Makin Group (Asrianti, 2011)) and 77 from a Central Kalimantan riparian forest. The recent population and habitat viability analysis (PHVA) estimates that populations of at least 100 individuals of Bornean orangutans meet the minimum viable population standard (dependent on conditions including threats and whether the animals are related), and even as few as 50 individuals could be a viable population providing they have space to increase their numbers, the habitat is effectively protected and hunting is prevented (Utami-Atmoko et al., 2019). By these definitions as many as three viable orangutan populations have been moved since 2007 (Asrianti, 2011). At least one of these populations was released into an area with an already viable resident orangutan population. Researchers we interviewed pointed out that large-scale translocations bring risks of increased competition and potentially lowered resident orangutan birth rates, or of exceeding carrying capacity in the release habitat. Scientists interviewed for a news story about large scale translocations remarked that translocated orangutans could experience decreased welfare as they would not know where to find food, and could be at risk of being killed by resident orangutans (Kaye, 2016).

3.11. Habitat suitability

We found reports of multiple releases into several protected areas, including Gunung Palung National Park, Tanjung Puting National Park, Betung Kerihun National Park, Kutai National Park, Mawas Conservation Area, and Sebangau National Park, all of which have viable orangutan populations (Utami-Atmoko et al., 2019). Practitioners told us BKSDA decided where releases could occur. Some researchers and practitioners we interviewed noted that some selected sites were inappropriate due to resident orangutan populations or proximity to villages or crop foraging opportunities. One interviewee indicated that community or concession forests accepting translocated orangutans may be ignoring concerns about carrying capacity or other issues because they receive payment or other benefits. Practitioners and researchers alike stated that it is extremely difficult to find suitable areas for translocation. One scientist, who is also a rescue center practitioner, noted that suitable release sites do not exist, "because any "suitable" forest will be either already populated to the brim with [orangutans], or be unsuited e.g. because of hunting. I have not heard of any proper suitability analysis before translocations are being made."

3.12. Translocation monitoring and survival

Practitioners reported they did not collect monitoring data for translocated orangutans due to the practical difficulties of following them, but all assumed that these animals would do well because as wild animals they know how to survive in the wild. One rescue center radio-tracked 38 wild captured and translocated orangutans, and found 35 animals (92 %) alive after the first year, 20 after the second year (53 %), and 12 after three years (32 %), with one animal found dead and 25 (66 %) unaccounted for. Translocation practitioners we interviewed said they often had no choice but to capture and move these animals, as they would otherwise not survive in fragmented habitats or would be killed by local people. The assumption that orangutans cannot survive in plantations or fragmented habitats is contrary to current understanding of orangutan use of oil palm and timber plantations (Ancrenaz et al., 2015; Oram, 2018; Rayadin & Spehar, 2015; Seaman et al., 2019). It is also fundamentally incompatible with the belief that once captured and released into an unfamiliar habitat, orangutans will thrive and are likely to be alive even if not monitored or seen again.

3.13. Habitat protection outcomes

Rescue centers regularly advocate for orangutan habitat protection, and several of them were instrumental in purchase of key habitat areas and the establishment of a number of formally protected areas used for releases, including Mawas Conservation Area and an extension to the Lamandau River Wildlife Reserve, as well as community forests, ecosystem restoration concessions and High Conservation Value habitat set asides within concessions. Rescue facilities also provided regular monitoring, patrol and firefighting staff for release sites, which include many of the national parks within orangutan range. Further, many ran advocacy campaigns seeking improved protection for threatened landscapes and their wild orangutan populations, including the Sungai Putri and Tumbang Koling forest areas.

3.14. The importance of maintaining orangutan metapopulations across landscapes

There is a need for further research to assess how habitat edges and forest fragment areas are impacted by removal of wild orangutans for translocations, and how this in turn may affect orangutan metapopulations. Metapopulations are composed of one or multiple orangutan subpopulations in a larger area bounded by geophysical barriers to dispersal, such as non-forested areas and large rivers (Voigt et al., 2018). Insights from Sabah (Malaysian Borneo) indicate that

orangutans, even resident females, can sometimes survive in small forest patches for years or even decades, and males travel through agricultural landscapes to visit them, maintaining gene flow among populations (Oram et al., 2019). Breaking up these metapopulations via removal of animals from forest patches could negatively impact the overall population dynamics and increase risk of population extirpation.

3.15. Compliance with IUCN guidelines

The IUCN guidelines for great ape translocations require habitat suitability assessment before release, and preclude releases into viable wild great ape populations to prevent disease transmission, competition and other negative impacts (Beck et al., 2007). Several release sites were used across Kalimantan but in many cases no site name or information was provided in public records beyond “a safer location” or a “forest.” Few data are publicly available on analysis of any release habitat suitability. We found records of numerous releases into habitats with viable wild orangutan populations. Further, poaching, habitat encroachment and negative human-orangutan interactions remain threats within some of these release sites (Utami-Atmoko et al., 2019), which therefore do not meet the IUCN guidelines for suitable great ape reintroduction habitat, in which previous causes of decline must be addressed such that they no longer pose a threat to the taxon (Beck et al., 2007).

The guidelines also preclude release of individuals that are overly human-focused or otherwise not behaviorally suited to survive in the wild (Beck et al., 2007). Many orangutans in rescue facilities are not suitable for release, and in some cases behavioral assessments to determine suitability may be insufficient, resulting in release of individuals unlikely to successfully adapt post-release (Trayford & Farmer, 2013; Trayford, 2013), which contravenes IUCN guidelines.

The IUCN guidelines define success as any or all of: establishing self-sustaining, viable populations, improving conservation status, facilitating the persistence of traits or other benefits beyond individual welfare, and restoration of lost ecosystem function (Beck et al., 2007; IUCN/SSC, 2013). The IUCN guidelines for conservation translocations (including reintroductions and reinforcements) exclude release of confiscated captive animals for welfare or rehabilitation purposes as being primarily for individual and not population level benefits, in addition to posing high behavioral, genetic and disease risks to wild populations (IUCN/SSC, 2013; Moehrenschrager, 2019). Further, these guidelines stipulate that reinforcement must provide a conservation benefit to the receiving population as opposed to only the released individuals in order to be considered a conservation release (IUCN/SSC, 2013). While there is ample evidence Bornean orangutan species conservation status has not improved over the past decades (Ancrenaz et al., 2016; Santika et al., 2017; Voigt et al., 2018), lack of available post release monitoring data, and in some cases the short time elapsed since releases began, precluded analysis on whether self-sustaining, viable populations have been established.

4. Conclusion

4.1. Caveats

Public access to orangutan management data is scarce in Indonesia. The SRAK 2007 mandated publicly accessible databases on rescues, human-orangutan interactions, and captive populations; however, none were accessible at the time of writing. Although we spoke with all nine Kalimantan rescue facilities, only two provided detailed data in response to our queries. Many do not have detailed data accessible online. Individual facilities' available data were often inconsistent among reports and news even for the same variable in the same year. Few data were available on rescues and releases conducted by parties other than NGO rescue centers, e.g. government-led facilities, concessions and

other private businesses. Our results indicated large numbers of rescues and releases, particularly those conducted by or for concessions, may not be reported publicly. Improved transparency on rescue and release activities would enable further research to improve effectiveness of these strategies. Our dataset provides some information on 85 % of the publicly reported rescue and release events conducted by rescue centers between 2007 and 2017. The missing 15 %, if made available, could affect the outcomes of our analyses, as could information that was overlooked.

4.2. The urgent need to review orangutan conservation strategies

Despite releasing more than 600 animals since 2007, rescue facilities housed more than 1,000 orangutans in 2017 (Fig. 1). At current rescue and release rates, captive populations will not decrease, particularly if captive births continue apace (Fig. 1). Lack of suitable release sites, ongoing forest loss, and carrying capacity limit potential for releases. Achieving the SRAK 2019 goal of emptying rescue centers will not be possible even beyond 2024 without cessation of the killing and negative human-orangutan interactions that result in animals coming into captive care (Figs. 2 and 3).

Orangutans were rescued primarily because they were held illegally as pets (which is related to orangutan killing) (Fig. 2), and to remove mostly healthy wild orangutans from perceived unsuitable habitats or insecure situations (Figs. 3 and 4). Local popularity of orangutans as pets has held for decades (Nijman, 2017) despite more than 50 years of rescue activity. This appears unlikely to change without substantial alteration in application of wildlife laws. The rarity of investigation, arrest and prosecution among the 719 orangutan-related crimes in our dataset, along with evidence that legal prohibitions are well known (Meijaard et al., 2011), and our findings that these prohibitions have been willfully ignored even in the face of confrontation by law enforcement authorities suggest effective deterrence is lacking (Fig. 2). Deterrence is created when the risk of detection or punishment is perceived as high (Nagin, 2013; Rowcliffe, de Merode, & Cowlishaw, 2004), which could be addressed through investigation of all reported crimes, followed by prosecution and application of penalties appropriate to the severity of the crime and financial circumstances of the perpetrator.

Contrary to the SRAK mandate for zero losses from concession lands, hundreds—or possibly more than one thousand—orangutans were lost or removed from these habitats between 2007 and 2017 (Figs. 3 and 4). This could be indicative of concessions' continued focus on moving out unwanted orangutans. Recent studies indicate that the role of industrial plantations in orangutan habitat deforestation and destruction has been reduced between 2010 and 2017, and that fires and smallholder agriculture are now the dominant factor driving deforestation (Austin et al., 2019; Gaveau et al., 2019). We therefore expect that demand for rescues in smallholder agriculture settings will increase while demands in concessions continue, unless human behaviors change and alternative human-orangutan interaction mitigation measures are implemented. As much as 80 % of Kalimantan's orangutan population—tens of thousands of animals—are outside protected areas (Utami-Atmoko et al., 2019), with close to 10 000 animals estimated in concessions (Meijaard, Morgans, Husnayaen Abram, & Ancrenaz, 2017). It is obvious that rescuing this number far exceeds the capacity of rescue programs, and suitable release sites do not exist to accommodate so many (Fig. 1). In order to protect wild orangutans, there appears no choice but to ameliorate human attitudes and behaviors towards orangutans, and to improve management practices in unprotected habitat, including small forest patches distributed across agricultural landscapes.

Wild orangutans were typically captured and translocated as a first response rather than a last resort, even when no release sites were available. Welfare and conservation outcomes of removing wild orangutans for translocation have been little studied despite regular use.

The potential risks to released animals' welfare and to the conservation of resident wild populations are high, and the current practices of ad hoc release site selection and of releasing orangutans into viable wild populations do not meet IUCN guidelines to avoid endangering wild conspecifics. Studies are urgently needed to determine translocated orangutan welfare and survival rates, and impacts to resident conspecifics and rescue habitats. Similarly, further study of longer term impacts of ex-captive orangutan reintroductions/reinforcements are needed to understand welfare impacts and effectiveness in establishing self-sustaining viable populations.

Funding sources

Financial support to conduct the research and to prepare this article was provided by the United States Fish and Wildlife Service Great Ape Conservation Fund [grant number F17AP01081], the Arcus Foundation, New York, NY [grant number G-PGM-1610-1985] and the IUCN Species Survival Commission Primate Specialist Group - Section on Great Apes [project grant number P02472]. The funders had no involvement in study design, in the collection, analysis and interpretation of data, or in the writing of the paper and the decision to submit the article for publication.

Declaration of Competing Interest

Julie Sherman, Marc Ancrenaz and Erik Meijaard have all worked with or for both rescue and release-related great ape organizations, as well as groups focused on conservation of wild ape populations, and have hundreds of personal contacts within groups working on a range of great ape conservation strategies. They are current and past recipients of funding from organizations that support orangutan rescue and release strategies as well as traditional conservation strategies, including the Arcus Foundation and the United States Fish and Wildlife Service. Julie Sherman works for Wildlife Impact, which provides services to wildlife rescue and release organizations and organizations that implement *in situ* wildlife conservation strategies. Erik Meijaard has been consulting on *in situ* orangutan conservation strategies to ANJ-Agri, which owns oil palm plantations, and he worked for several years for an orangutan rehabilitation center (1994–1997). Marc Ancrenaz works primarily on management of wild orangutan populations in Malaysian Borneo, but also coordinates with a rescue center there, and is a close collaborator with Sabah Government organizations.

Acknowledgements

The authors thank all interviewees, rescue centers and other experts who provided data and context, the Balai Konservasi Sumber Daya Alam (BKSDA) Kalimantan, and the Sabah Wildlife Department. Several individuals provided insights and review that improved the paper, including Maria Voigt, Truly Santika, Linda Brent, Suzanne Walker, Erica Lyman and Kari Nienstedt. We also thank the reviewers for their constructive and valuable comments.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.jnc.2020.125807>.

References

Abram, N. K., Meijaard, E., Wells, J. A., Ancrenaz, M., Pellier, A. S., Runting, R. K., ... Richardson, D. (2015). Mapping perceptions of species' threats and population trends to inform conservation efforts: The Bornean orangutan case study. *Diversity & Distributions*, 21(5), 487–499. <https://doi.org/10.1111/ddi.12286>.

Aji, W. (2011). *Orangutan Dibantai Demi Lindungi Kebun Kelapa Sawit*. December 6, Retrieved from <http://www.tribunnews.com/nasional/2011/12/06/orangutan-dibantai-demi-lindungi-kebun-kelapa-sawit>.

Ancrenaz, M., Dabek, L., & O'Neil, S. (2007). The costs of exclusion: Recognizing a role for local communities in biodiversity conservation. *PLoS Biology*, 5(11), e289. <https://doi.org/10.1371/journal.pbio.0050289>.

Ancrenaz, M., Gumal, M., Marshall, A. J., Meijaard, E., Wich, S. A., & Husson, S. (2016). *Pongo pygmaeus*. *The IUCN red list of threatened species 2016*. e.T17975A17966347.

Ancrenaz, M., Oram, F., Ambu, L., Lackman, I., Ahmad, E., Elahan, H., & Meijaard, E. (2015). Of pongo, palms, and perceptions – A multidisciplinary assessment of orangutans in an oil palm context. *Oryx*, 49(3), 465–472. <https://doi.org/10.1017/S0030605313001270>.

Ancrenaz, M., Sollmann, R., Meijaard, E., Hearn, A. J., Ross, J., Samejima, H., ... Wilting, A. (2014). Coming down the trees: Is terrestrial activity in orangutans natural or disturbance-driven? *Scientific Reports*, 4(4024), <https://doi.org/10.1038/srep04024>.

Asrianti, T. (2011). *No justice for C. Kalimantan orangutans*. December 9, Retrieved from Jakarta Post <https://www.thejakartapost.com/news/2011/12/09/no-justice-c-kalimantan-orangutans1.html>.

Austin, K. G., Schwantes, A., Gu, Y., & Kasibhatla, P. S. (2019). What causes deforestation in Indonesia? *Environmental Research Letters*, 14(2), 024007. <https://doi.org/10.1088/1748-9326/aaf6db>.

Basalamah, F., Atmoko, S. S. U., Periwatari-Farajallah, D., Qayim, I., Sihite, J., Noordwijk, M. V., ... Schaik, C. P. V. (2018). Monitoring orangutan reintroduction: Results of activity budgets, diets, vertical use and associations during the first year post-release in Kehje Sewen Forest, East Kalimantan, Indonesia. *Biodiversitas Journal of Biological Diversity*, 19(2), 639–650. <https://doi.org/10.13057/biodiv/d190242>.

Beck, B. B., Walkup, K., Rodrigues, M., Unwin, S., Travis, D., & Stoinski, T. (2007). *Best practices guidelines for the re-introduction of great apes*. Gland, Switzerland: SSC Primate Specialist Group of the World Conservation Union.

Beech, H. (2019). *One casualty of the palm oil industry: An orangutan mother, shot 74 times*. June 29, Retrieved from New York Times <https://www.nytimes.com/2019/06/29/world/asia/orangutan-indonesia-palm-oil.html>.

Campbell-Smith, G., Sembiring, R., & Linkie, M. (2012). Evaluating the effectiveness of human-orangutan conflict mitigation strategies in Sumatra. *The Journal of Applied Ecology*, 49, 367–375. <https://doi.org/10.1111/j.1365-2664.2012.02109.x>.

Campbell-Smith, G., Simanjorang, H. V. P., Leader-Williams, N., & Linkie, M. (2010). Local attitudes and perceptions toward crop-raiding by Orangutans (*Pongo abelii*) and other nonhuman primates in Northern Sumatra, Indonesia. *American Journal of Primatology*, 72(10), 866–876. <https://doi.org/10.1002/ajp.20822>.

CITES/GRASP. 2006. CITES/GRASP orang-utan technical mission Indonesia.

CITES/GRASP. 2007. CITES/GRASP orang-utan technical mission Malaysia.

Davis, J. T., Mengersen, K., Abram, N., Ancrenaz, M., Wells, J., & Meijaard, E. (2013). It's not just conflict that motivates killing of orangutans. *PLoS One*, 8, e75373. <https://doi.org/10.1371/journal.pone.0075373>.

Fachrizal, A. (2013). *Hutan Jadi Sawit, Orangutan Panen Tikung Petani Madu Kapuas Hulu*. November 1, Retrieved from Mongabay: Indonesia. <https://www.mongabay.co.id/2013/11/01/hutan-jadi-sawit-orangutan-panen-tikung-petani-madu-kapuas-hulu/>.

Fachrizal, A. (2014). *Kala Elang, Beruang dan Orangutan Dianggap Hama bagi Petani Madu*. May 23, Retrieved from Indonesia: Mongabay. <https://www.mongabay.co.id/2014/05/23/kala-elang-beruang-dan-orangutan-dianggap-hama-bagi-petani-madu/>.

Foresthins (2019). *Action plan for orangutans revoked for upgrade*. October 1, Retrieved from <https://www.foresthins.news/action-plan-for-orangutans-revoked-for-upgrade>.

FORINA. 2013. Data dan Informasi Tentang Evaluasi Implementasi Asistrategi dan Rencana Aksi Konservasi Orangutan Periode 2011–2013 dan Rencana Kegiatan 2013–2015 Regional Kalimantan Timur. Forum Orangutan Indonesia.

Freund, C., Rahman, E., & Knott, C. (2017). Ten years of orangutan-related wildlife crime investigation in West Kalimantan, Indonesia. *American Journal of Primatology*, 79. <https://doi.org/10.1002/ajp.22620>.

Gaveau, D. L. A., Kshatriya, M., Sheil, D., Sloan, S., Wich, S., Ancrenaz, M., ... Meijaard, E. (2013). Reconciling forest conservation and logging in Indonesian Borneo. *PLoS One*, 8(8), e69887. <https://doi.org/10.1371/journal.pone.0069887>.

Gaveau, D. L. A., Locatelli, B., Salim, M. A., Yaen, H., Pacheco, P., & Sheil, D. (2019). Rise and fall of forest loss and industrial plantations in Borneo (2000–2017). *Conservation Letters*, 12, e12622. <https://doi.org/10.1111/conl.12622>.

Grundmann, E. (2006). Back to the wild: will reintroduction and rehabilitation help the long-term conservation of orang-utans in Indonesia? *Social Science Information*, 45(2), 265–284. <https://doi.org/10.1177/0539018406063643>.

Harrisson, B. (1961). Orang utan: What chances of survival. *Sarawak Museum Journal*, 10, 238–261.

IUCN/SSC (2013). *Guidelines for reintroductions and other conservation translocations. Version 1.0*.

Kaye, M. (2016). *Orangutan refugees: Weighing when to rescue the apes*. March 30, Retrieved from Mongabay <https://news.mongabay.com/2016/03/orangutan-refugees-weighing-when-to-rescue-the-apes/>.

KLHK (2018). *KLHK Telah Selamatkan Lebih dari 1.000 Individu Orangutan*. [Press release]. Retrieved from <http://www.fordamof.org/index.php/berita/post/4348>.

KSDAE. 2019. Strategi dan Rencana Aksi Konservasi Orangutan Indonesia 2019–2029. Republic of Indonesia.

Maruf, A., & Rayadin, Y. (2015). *Standard Operating Procedure (SOP) Translokasi Orangutan di Perkebunan Kelapa Sawit*.

Meijaard, E., Buchori, D., Hadiprakoso, Y., Utami-Atmoko, S. S., Tjiu, A., Prasetyo, D., ... Mengersen, K. (2011). Quantifying killing of orangutans and human-orangutan conflict in Kalimantan, Indonesia. *PLoS One*, 6(11), e27491. <https://doi.org/10.1371/journal.pone.0027491>.

Meijaard, E., Morgans, C., Husnayaen Abram, N.K., Ancrenaz, M. 2017. An impact analysis of RSPO certification on Borneo forest cover and orangutan populations. Borneo Futures Brunei Darussalam.

Meijaard, E., Wich, S., Ancrenaz, M., & Marshall, A. J. (2012). Not by science alone: Why orangutan conservationists must think outside the box. *Annals of the New York*

- Academy of Sciences, 1249, 29–44. <https://doi.org/10.1111/j.1749-6632.2011.06288.x>.
- Mendonça, R. S., Takeshita, R. S. C., Kanamori, T., Kuze, N., Hayashi, M., Kinoshita, K., ... Matsuzawa, T. (2016). Behavioral and physiological changes in a juvenile Bornean orangutan after a wildlife rescue. *Global Ecology and Conservation*, 8(C), 116–122. <https://doi.org/10.1016/j.gecco.2016.08.004>.
- Ministry of Forestry. 2009. Orangutan Indonesia conservation strategies and action plan 2007–2017.
- Moehrenschrager, A. (2019). *Optimizing novel conservation translocation strategies for all species: Extinct in the wild & confiscated. Paper presented at the IUCN Leaders meeting.*
- Nagin, D. S. (2013). Deterrence in the twenty-first century. *Crime and Justice*, 42, 199–263. <https://doi.org/10.1086/670398>.
- Nijman, V. 2005. Hanging in the balance. An assessment of the trade in gibbons and orangutans Kalimantan, Indonesia. TRAFFIC Southeast Asia Kuala Lumpur, Malaysia.
- Nijman, V. (2017). Orangutan trade, confiscations, and lack of prosecutions in Indonesia. *American Journal of Primatology*, 79(11), <https://doi.org/10.1002/ajp.22652>.
- Oram, F. (2018). *Abundance, feeding and behavioural ecology of orangutans (Pongo pygmaeus morio) in the fragmented forests of the Kinabatangan floodplain. (PhD thesis).* Kota Kinabalu, Sabah: University Malaysia Sabah (ITBC).
- Oram, F., Elahan, H., Daisah Kapar, M., Maharani, W., Bernard, H., Lackman, I., ... Payne, J. (2019). *Conservation across boundaries -co-existence of wild orang-utans and oil palm. Paper presented at the 8th European Federation of Primatology meeting & Primate Society of Great Britain winter meeting 2019.*
- Palmer, A. (2018). Kill, incarcerate, or liberate? Ethics and alternatives to orangutan rehabilitation. *Biological Conservation*, 227, 181–188. <https://doi.org/10.1016/j.biocon.2018.09.012>.
- ProKal (2017). *Orangutan yang Masuki Kebun Warga Kembali Dilepasliarkan.* August 13, Retrieved from ProKalteng <http://kalteng.prokal.co/read/news/41643-orangutan-yang-masuki-kebun-warga-kembali-dilepasliarkan.html>.
- Rayadin, Y., & Spehar, S. N. (2015). Body weights of wild Bornean orangutans living in human-dominated landscapes: Implications for understanding their ecology and conservation. *American Journal of Physical Anthropology*, 175, 339–346. <https://doi.org/10.1002/ajpa.22709>.
- Rijkse, H. D., & Meijaard, E. (1999). *Our vanishing relative. The status of wild orang-utans at the close of the twentieth century.* Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Robins, J. G., Husson, S., Singleton, I., Nowak, M. G., Fluch, G., Sanchez, K. L., ... Walzer, C. (2019). Implanted radio telemetry in orangutan reintroduction and post release monitoring and its application in other ape species. *Frontiers in Veterinary Science*, 6, 111. <https://doi.org/10.3389/fvets.2019.00111>.
- Rowcliffe, J. M., de Merode, E., & Cowlshaw, G. (2004). Do wildlife laws work? Species protection and the application of a prey choice model to poaching decisions. *Proceedings of the Royal Society, Series B. Biological Sciences*, 271(1557), 2631–2636. <https://doi.org/10.1098/rspb.2004.2915>.
- Russon, A. E. (2009). Orangutan rehabilitation and reintroduction. In S. Wich, S. U. Atmoko, T. M. Setia, & C. P. van Schaik (Eds.). *Orangutans: Geographic variation in behavioral ecology and conservation* (pp. 327–350). Oxford, UK: Oxford University Press.
- Santika, T., Ancrenaz, M., Wilson, K. A., Spehar, S., Abram, N., Banes, G. L., ... Meijaard, E. (2017). First integrative trend analysis for a great ape species in Borneo. *Scientific Reports*, 7(1), 4839. <https://doi.org/10.1038/s41598-017-04435-9>.
- Schuppli, C., Meulman, E. J. M., Fors, S. I. F., Aprilinayati, F., van Noordwijk, M. A., & van Schaik, C. P. (2016). Observational social learning and socially induced practice of routine skills in immature wild orang-utans. *Animal Behaviour*, 119, 87–98. <https://doi.org/10.1016/j.anbehav.2016.06.014>.
- Seaman, D. J. I., Bernard, H., Ancrenaz, M., Coomes, D., Swinfield, T., Milodowski, D. T., ... Struebig, M. J. (2019). Densities of Bornean orang-utans (*Pongo pygmaeus morio*) in heavily degraded forest and oil palm plantations in Sabah, Borneo. *American Journal of Primatology*, 81(8), e23030. <https://doi.org/10.1002/ajp.23030>.
- Sherman, J., & Greer, D. (2018). The Status of captive apes: Beyond capacity: Sanctuaries and the status of captive apes in shrinking natural habitats. In Arcus Foundation (Vol. Ed.), *State of the apes: infrastructure development and ape conservation: Vol. 3*, (pp. 224–255). Cambridge, UK: Cambridge University Press.
- Siregar, R. S. E., Farmer, K. H., Chivers, D. J., & Saragih, B. (2010). Re-introduction of Bornean orang-utans to Meratus protected forest, East Kalimantan, Indonesia. In P. S. Soorae (Ed.). *Global re-introduction perspectives: additional case-studies from around the globe* (pp. 243–248). Abu Dhabi, UAE: IUCN/SSC Re-introduction Specialist Group.
- Spehar, S. N., Sheil, D., Harrison, T., Louys, J., Ancrenaz, M., Marshall, A. J., ... Meijaard, E. (2018). Orangutans venture out of the rainforest and into the Anthropocene. *Science Advances*, 4(6), e1701422. <https://doi.org/10.1126/sciadv.1701422>.
- Sugardjito, J., & van Schaik, C. P. (1992). *Orangutans: Current population status, threats, and conservation measures. Proceedings of the conservation of the great apes in the new world order of the environment, Dec. 15-22, 1991.* Republic of Indonesia: Ministry of Forestry and Tourism, Post and Telecommunications 142–152.
- Tabuchi, H. (2016). *How big banks are putting rain forests in peril.* December 3, Retrieved from New York Times <http://www.nytimes.com/2016/12/03/business/energy-environment/how-big-banks-are-putting-rain-forests-in-peril.html?ref=business>.
- TRAFFIC. 2015. Thailand repatriates smuggled orangutans to Indonesia. <https://www.traffic.org/news/thailand-repatriates-smuggled-orangutans-to-indonesia/>: TRAFFIC.
- Trayford, H. R. (2013). *Continuity and Change: (Re)Conceptualising Practice in Orang-utan (Pongo spp.) Rehabilitation and Reintroduction in Indonesia. (PhD).* University of Cambridge.
- Trayford, H. R., & Farmer, K. H. (2013). Putting the spotlight on internally displaced animals (IDAs): A survey of primate sanctuaries in Africa, Asia, and the Americas. *American Journal of Primatology*, 75(2), 116–134. <https://doi.org/10.1002/ajp.22090>.
- Utami Atmoko, S. S., Singleton, I., van Noordwijk, M. A., van Schaik, C. P., & Mitra Setia, T. (2009). Male–male relationships in orangutans. In S. A. Wich, S. S. Utami Atmoko, T. Mitra Setia, & C. P. van Schaik (Eds.). *Orangutans: Geographic variation in behavioral ecology and conservation* (pp. 225–233). New York, US: Oxford University Press.
- Utami-Atmoko, S., Traylor-Holzer, K., Rifqi, M.A., Siregar, P.G., Achmad, B., Priadhati, A. 2019. Orangutan population and habitat viability assessment: Final report.
- van Noordwijk, M. A. (2009). Development of independence-Sumatran and Bornean orangutans compared. In S. Wich, S. U. Atmoko, T. M. Setia, & C. P. van Schaik (Eds.). *Orangutans: Geographical variation in behavioral ecology* (pp. 189–203). Oxford University Press.
- van Noordwijk, M. A., Arora, N., Willems, E. P., Dunkel, L. P., Amda, R. N., Mardianah, N., ... van Schaik, C. P. (2012). Female philopatry and its social benefits among Bornean orangutans. *Behavioural Ecology and Sociobiology*, 66, 823–834. <https://doi.org/10.1007/s00265-012-1330-7>.
- van Noordwijk, M. A., Utami Atmoko, S. S., Knott, C. D., Kuze, N., Morrogh-Bernard, H. C., Oram, F., ... Willems, E. P. (2018). The slow ape: High infant survival and long interbirth intervals in wild orangutans. *Journal of Human Evolution*, 125, 38. <https://doi.org/10.1016/j.jhevol.2018.09.004>.
- van Schaik, C. P., Marshall, A. J., & Wich, S. A. (2009). Geographic variation in orangutan behavior and biology. In S. A. Wich, S. U. Atmoko, T. M. Setia, & C. P. van Schaik (Eds.). *Orangutans: Geographic variation in behavioral ecology and conservation* (pp. 351–362). Oxford, UK: Oxford University Press.
- Voigt, M., Wich, S. A., Ancrenaz, M., Meijaard, E., Abram, N., Banes, G. L., ... Kühl, H. S. (2018). Global demand for natural resources eliminated more than 100,000 bornean orangutans. *Current Biology*, 28(5), 761–769. <https://doi.org/10.1016/j.cub.2018.01.053> e765.
- Wich, S. A., Gaveau, D., Abram, N., Ancrenaz, M., Baccini, A., Brend, S., ... Meijaard, E. (2012). Understanding the Impacts of Land-Use Policies on a Threatened Species: Is There a Future for the Bornean Orang-utan? *PloS One*, 7(11), e49142. <https://doi.org/10.1371/journal.pone.0049142>.
- Wich, S. A., Meijaard, E., Marshall, A. J., Husson, S., Ancrenaz, M., Lacy, R. C., ... Singleton, I. (2008). Distribution and conservation status of the orang-utan (*Pongo* spp.) on Borneo and Sumatra: how many remain? *Oryx*, 42(3), 329–339. <https://doi.org/10.1017/S003060530800197X>.
- Wilson, H., Meijaard, E., Venter, O., Ancrenaz, M., & Possingham, H. P. (2014). Conservation strategies for orangutans: Reintroduction versus habitat preservation and the benefits of sustainably logged forest. *PloS One*, 9(7), e102174. <https://doi.org/10.1371/journal.pone.0102174>.
- Wilson, R. P., & McMahon, C. R. (2006). Measuring devices on wild animals: what constitutes acceptable practice? *Frontiers in Ecology and the Environment*, 4(3), 147–154. [https://doi.org/10.1890/1540-9295\(2006\)004\[0147:MDOWAW\]2.0.CO;2](https://doi.org/10.1890/1540-9295(2006)004[0147:MDOWAW]2.0.CO;2).