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Source: Primate Conservation, 2014(28) : 179-188

Published By: Conservation International

URL: <https://doi.org/10.1896/052.028.0114>

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Population Dynamics of a Reintroduced Population of Captive-Raised Gibbons (*Hylobates lar*) on Phuket, Thailand

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Abstract: Confiscated and donated white-handed gibbons (*Hylobates lar*) originating from the local wildlife trade have been rescued by the Gibbon Rehabilitation Project (GRP) and rehabilitated on Phuket since 1992. Here we present some results of this long-term gibbon reintroduction project. Following unsuccessful early release attempts beginning in 1993, GRP has experimented with reintroduction methods and developed a protocol that has succeeded in re-establishing a small independent breeding population in a 22-km² forest fragment on Phuket. Eight breeding families of gibbons were released into the Khao Phra Thaeu non-hunting area between October 2002 and November 2012 using a soft-release reintroduction method in which the gibbons were provisioned with fresh food in the trees for at least one year, or as long as they needed it. The adult pair in the first gibbon family that was reintroduced there has remained together for 10 years post-release, they have maintained the original pair-bond and raised three wild-born offspring. The reintroduced population has seen eleven infants born in the wild, including a second-generation gibbon born to the first wild-born female. Female interbirth intervals and ages at first reproduction in the reintroduced population are comparable with those in wild populations. Of the seven adult females originally released, two remain with their original mates and two remain in the wild paired with different mates. By the end of 2012, three of the six wild groups were not nuclear families, indicating a flexibility of group composition seen in well-studied wild populations.

Key Words: Gibbon, *Hylobates lar*, rehabilitation, reintroduction, white-handed gibbon, wildlife trade

Introduction

The threats that gibbons are facing from habitat degradation are strongly exacerbated by pressure from the flourishing illegal wildlife trade for pets, entertainment, and traditional medicine (Nijman *et al.* 2009). All but one species of gibbon are now listed as Endangered or Critically Endangered on IUCN's Red List (IUCN 2008), and without targeted conservation efforts several species of gibbons may face imminent extinction (Melfi 2012).

Conservation measures often suggested to help save threatened and declining populations from extinction are different forms of conservation translocations (Wilson and Price 1994; Molur *et al.* 2005; IUCN 2013). However, the potential species conservation benefits of primate translocation projects are perhaps often exaggerated, and translocation projects should not be judged solely on this criterion (Cheyne 2009b; Osterberg *et al.* in press). We start with a quick review of the history of primate conservation translocations.

To date, the successful population restoration of the small golden lion tamarin in Brazil (Beck *et al.* 1994) is the only example from the primate world where released animals have survived in large enough numbers to breed and boost declining wild population numbers (Beck 1995; Cowlshaw and Dunbar 2000). Recent conservation translocation projects with great apes have resulted in high individual survival for released animals (*Pan troglodytes*: Goossens *et al.* 2005; *Gorilla gorilla*: King and Courage 2008; King *et al.* 2012), but because of the apes' longer life history it remains too early to say whether these attempts will help boost wild populations and thus become significant for species conservation.

No equivalent results have been reported on gibbons to date. Because the illegal wildlife trade in Asia has for a long time posed a considerable threat to wild gibbon populations in many range countries (Cheyne *et al.* 2008; Nijman *et al.* 2009), it was once not unusual that gibbons were released from overcrowded holding facilities without appropriate rehabilitation (Indonesia: Bennett 1992; Cheyne 2004; Thailand: Eudey 1991–1992). The continued pressure on government

facilities and NGOs to accommodate the growing numbers of animals coming in from the wildlife trade is often the reason behind hasty decisions to release confiscated wildlife without conducting appropriate pre- and post-release work. The truth is that the financial costs of appropriate rehabilitation programs for long-lived primates such as gibbons can be extremely high (Kleiman 1996; Cheyne 2009a). Many past gibbon release projects have been heavily criticized because of high animal mortality or lack of post-release monitoring (Loftin 1995; Ware 2001; Cheyne 2009b). Many such release efforts we are aware of have not been documented or even reported.

The earliest documented release program in Thailand was carried out by the SEATO Medical Research Laboratory in the 1960s, aimed at establishing a sustained supply of gibbons for medical research on an island in the Gulf of Thailand (Berkson *et al.* 1971; Brockelman *et al.* 1973, 1974). Although the project was not directly aimed at achieving conservation goals, it nevertheless proved that captive-raised adult pairs released into the wild can survive and reproduce. It yielded other findings important to later population restoration efforts—captive-raised gibbons tend to assume the same monogamous pair-bonding and aggressive territorial behavior as those in the wild (Carpenter 1940; Ellefson 1974). But the gibbons did not reproduce fast enough to support experimental medical research, and their use for this purpose was discontinued around 1976. The Laboratory then decided to release its remaining gibbons in a forested area in Kanchanaburi Province. The effort was poorly monitored, and its success could not be properly evaluated (Tingpalapong *et al.* 1981). A total of 31 animals were released, and most simply disappeared over the 9-month period in which follow-up observations were made.

In 1991, the groundwork was being laid for the establishment of the GRP in Phuket when the IUCN Captive Breeding Specialist Group and Thai Royal Forest Department (RFD) sponsored a gibbon Population and Habitat Viability Analysis (PHVA) workshop in Thailand (Tunhikorn *et al.* 1993). It had been realized that poaching continued to pose a threat even to large gibbon populations in protected areas (Brockelman 1993–1994) as the growing protected area system in the country did not succeed in offering protection from hunting (for example, Vandergeest 1996). In 1992, a new law required all owners to register their captive gibbons (Tunhikorn *et al.* 1993), but the illegal trade for pets and for tourist photo props continued undiminished. The high numbers of white-handed gibbons in rescue centers around the country provided opportunities for the establishment of reintroduction projects (Eudey 1991–1992; Tunhikorn *et al.* 1993).

The GRP was thus founded in 1992 by the chief RFD officer in Phuket at the time together with an American zoologist. Although administered under the Wild Animal Rescue Foundation of Thailand (WARF) since 1994, the GRP was also closely affiliated with the Wildlife Conservation Division of the Royal Forest Department (later included in the new Department of Parks, Wildlife and Plant Conservation),

but managed and implemented largely by an appointed director with the help of international volunteers. The GRP's education and reintroduction program has operated continuously to the present.

The GRP initially began releasing gibbons in a forest on Phuket, but the released animals wandered out of the forest into farmland and human settlements in search of food and human companionship. The project then chose to release gibbons on islands off the coast of Phuket in Phang Nga Bay, as an intermediate step in their rehabilitation prior to release into natural gibbon habitat (Kamerich 2000). In the first attempts both immature and adult gibbons were released in social groups or adult pairs on several small islands between 1993 and 1995. Problems were encountered that limited the success of the releases: weak pair bonds between adults, inadequate area of some of the islands, inadequate food provisioning (most islands were rather remote), and lack of security from humans and their pet dogs. Of the 13 animals released initially, 12 disappeared and were presumed to have died from stress, dog attacks or perhaps being shot by loggers (Breuker 1996). It was subsequently decided to reattempt reintroduction of gibbons on Phuket, following the guidelines of the PHVA workshop (Tunhikorn *et al.* 1993) and IUCN guidelines for non-human primate reintroductions (Baker 2002).

In order to mitigate the poaching of reintroduced animals, the GRP has been carrying out all-important education work in the local schools surrounding the release site, as well as educational projects aimed at international tourists. The latter educational efforts were designed to combat the illegal gibbon trade in Phuket's tourist areas. The GRP was not designed as a species conservation project, but rather grew from an animal welfare need. The project objectives remain to rehabilitate gibbons from the pet trade and tourist industry, to reintroduce suitable candidates back to the wild, and to educate the community at large about gibbons and the forest environment. In the process, a small reproducing population of gibbons has been re-established in the largest forest fragment on the island of Phuket.

We thus describe a conservation translocation effort aimed at re-establishing a viable population of the focal species within its indigenous range (IUCN 2013) and we do this by presenting a case study from the longest-running gibbon reintroduction program to date—The Gibbon Rehabilitation Project (GRP) in Phuket.

Methods

Study area

The Khao Phra Thaew Non-hunting Area (KPT), established in 1980, protects the largest remaining forest area on Phuket Island, including about 2,228 ha of tropical semi-evergreen forest. The area is surrounded by rubber plantations, villages and roads. The forest area covers steep hillsides 5–500 m above sea level. 8°03'N, 98°24'E (Rawasi 2004) (Fig. 1). Almost no large wildlife has survived the poaching; white-handed gibbons were last seen in the early 1980's.

Forest rangers of the Department of National Parks, Plant and Wildlife Department (DNP) currently patrol the area to prevent hunting and logging.

Reintroduction methods

All the gibbons arriving at the GRP are wild-born and either confiscated or donated from the illegal trade in which they are sold for photo props or pets. Over the years, quite a number of gibbons have also been born at the GRP, and many of these first generation captive-born animals have been released before maturity as dependent offspring in a family group. All gibbons that are not participating in the reintroduction program are prevented from breeding. Individuals are excluded from the reintroduction program for any of the following reasons: they have tested positive for diseases, such as Hepatitis B, Tuberculosis, Herpes Simplex Virus or HIV during their initial 90-day quarantine (Punnadee 2006); they belong to a non-native species of gibbon; or they exhibit either physical or psychological trauma. In 2012, 19 (35%) of GRP's 54 captive gibbons were judged to be unsuitable for participation in the reintroduction program (Osterberg *et al.* in press).

After passing their health screening and psychological assessment, gibbons are moved from the quarantine site to

the rehabilitation site, located at Bang Pae waterfall by one of the entrances to the KPT forest. There the young gibbons are socialized in large play-groups, and older individuals are found compatible mating partners by introducing them to mature and available, opposite-sex individuals. All direct human contact is stopped. Once the gibbons have formed a strong pair-bond, duetted, copulated, and raised at least one offspring successfully past infancy, the family is included in the reintroduction program.

Since 2002, GRP's aim has been to release one gibbon family per year. Occasional delays to this plan have been due to insufficient volunteer availability, and in some recent years also the lack of available gibbon families. Before each release, a suitable territory for the new family is selected in the KPT forest, and a grid of trails, spaced 50 m apart, is cut around the release site. Once a detailed release plan has been made, a "training cage" is built in the forest. The selected gibbon family then spends its last 3–4 months in captivity there, getting used to the sounds and smells of the forest. GRP staff go into the forest once a day to feed the family.

Initially, the release procedure also included the use of a smaller "acclimatisation cage", made out of nylon mesh and hoisted about 10 m into the forest canopy in the territory selected for the family. The acclimatisation cages were only used in the 5–7 days immediately pre-release, thus preparing the gibbons for a life at greater heights. Five out of eight releases (2002, 2003, 2004, 2006 and 2009) have used this technique. For the 5th release in 2007 the selected territory had to be abandoned, and a new training cage was quickly built farther inside the forest, as another family (released 2003) suddenly expanded their territory in the direction of the first training cage and fought with the family inside. No acclimatisation cage was built after the change of location. In the last two releases this laborious process was abandoned as unnecessary since the gibbons were encouraged to climb higher after release just by feeding them high in the trees. Food is supplied post-release in a basket pulled into the canopy with a rope. By using several alternate feeding stations, and by moving these farther into the family's intended territory, the animals are encouraged to explore and expand their home-range. Feeding has continued for more than a year for all released families. The importance of post-release food provisioning is discussed in detail in Osterberg *et al.* (in press).

All released gibbons have been followed and observed after release. During the first few weeks after release, alternating teams of volunteers and staff carried out all-day focal-animal sampling (Altmann 1974). After the gibbons' initial 2–4 week acclimatisation, observations were made *ad libitum* daily for at least a year, but usually longer. In order to reduce human presence around the released animals, all-day observations were generally avoided after the first month, but the reintroduced population continues to be checked upon by GRP staff indefinitely, as this is the only way to determine reintroduction success as well as follow social and family developments over time. For more details on GRP's post-release monitoring methods see Osterberg *et al.* (in press).



Figure 1. Location of Khao Phra Thaew non-hunting area on Phuket.

In this paper we present demographic data on births, deaths, infant survival, interbirth intervals, ages at first reproduction, pairbond maintenance, and other observations of importance to the dynamics and survival of the reintroduced gibbon population on Phuket.

Results

Below we list all groups present at the end of this study and summarize the history of each. Released groups that have disintegrated or merged with other groups are mentioned only where they have been of relevance to the current group compositions. All groups are named after the breeding adult female.

Kip's family consisted of the bonded pair and their 2-year-old son at the time of release on 5 October 2002. The adult pair has remained together and has to date raised three wild-born babies past infancy in the wild (Fig. 2). Their captive-born son was translocated from KPT in 2012. The first wild-born baby in Kip's family, named Hope, dispersed from



Figure 2. Adult female Kip, released with her mate and one captive born son in 2002, pictured with her third wild-born offspring Omyim in 2010. Photograph by Phamon Samphanthamit.

her natal group in 2011 and became a mother to the first second-generation wild-born infant in September 2012.

Lek's family was released with two dependent young (Dao and Arun) on 15 August 2003. Lek's mate failed to adjust to the wild and when, by early 2005, he had returned to the rehabilitation site seven times, no further attempts were made to return him to his family. Lek subsequently formed a new pair with a subadult male who was released without a family in the hope that he might pair with the lone female. Lek also adopted the juvenile male offspring, Yoge, released in 2004, upon the disappearance of his parents, whilst she rejected his older sister. Lek, her two biological offspring and the two new family members remained together until the dispersal of all the young between 2008 and 2011. Since 2011, Lek has lived in a nuclear family with her new mate and their wild-born son.

The family currently known as *Dao's family* was released under the name of *Nuan's family* with two dependent offspring on 26 September 2007. After the disappearance of the adult male a year later, maturing female Dao from Lek's family fought with the adult female, Nuan, in order to claim her son Payu as a mate. Nuan was injured and returned to GRP, whereas Dao and Payu became a breeding pair that has given birth to two wild-born offspring. Dao adopted Payu's younger sister who has remained with the group.

Jita's family was released with one infant offspring (Claire) on 10 December 2009, and the group was renamed *Hope's family* after both the adults "failed" their reintroductions (Jita disappeared in 2011 and her mate Tony had to be recaptured 3 years post-release in November 2012 after repeatedly showing aggression towards humans). After Jita's disappearance, the father and daughter merged with a young, wild couple: Hope (the first wild-born from Kip's family) and her mate Yoge (the adopted male from Lek's family). Claire remained as an adopted juvenile with this family after her father's recapture.

Kushta's family was released on 27 April 2011. In fact, this was Kushta's, and her now 7-year old son's, second release following an unsuccessful attempt in 2006 when Kushta's mate immediately disappeared and Kushta and her young son were returned to GRP. In 2011, Kushta's family consisted of the adult female with her two biological offspring from two different previous pairings, and an adolescent male playmate of the older of these offspring. Although this unrelated young male copulated with Kushta prior to release and conceived an infant with her, he was too immature to act as the group's adult male, and their newborn infant was probably subsequently attacked and killed by "wild" male Arun (the captive-born infant in Lek's family) after the family's release. Kushta's juvenile daughter was also attacked by Arun and had to be returned to the GRP.

Cop's family was released with one juvenile offspring on 18 November 2012. The family is so far adapting very well to the wild; they remain a close unit and stay high in the canopy. They were observed singing together for the first time in the wild just six days after release (although Cop did not produce a great call at that time).

In total, eight gibbon families and two sub-adult males—30 gibbons—have been released into the KPT forest since 2002. The success rate of the individual reintroductions has been high. The first family, released in 2002, gave birth to their first wild-born offspring in 2002 and still survives at the release site. In 2003, after the release of a second family, all seven captive-raised animals as well as the wild-born infant were doing well. However, between 12 and 18 months post-release, the ex-pet adult male in the second family made seven voluntary returns to the GRP rehabilitation site and was recaptured and returned to a cage (Table 1).

This male started exhibiting such wandering behavior after conflicts with the male in the first family. All subsequently released families have similarly faced potentially aggressive confrontations with already-established groups in the forest. In August of 2012, the adult captive-born son of the first family was recaptured and translocated to another forest after he failed to acquire a mate in the reintroduced population and started returning to the rehabilitation site and trying to fight with captive males over their female partners. Until his recapture nearly 10 years post-release, the first family exhibited 100% reintroduction success, having increased their numbers with three wild-born infants and, in September 2012, also a second generation wild-born. Ten years after the first release, 16 (53%) of the 30 captive-raised gibbons that had been reintroduced still survived in the forest. One gibbon was translocated to another forest and remained wild. Eight gibbons (27%) were returned to captivity for various reasons. The two gibbons that have been released twice are both included as two separate releases, once in the 27% that were returned to the GRP and once as part of the 53% that now appear to be adjusting successfully. The loss of gibbons has been low throughout the 10-year period and only five have been lost to unknown fates (Table 2).

The released gibbons that have remained in the wild have, through new births, expanded their population to 23 individuals by the end of 2012. Eleven infants have been born in the wild to five females. There have been nine live births, of which one infant died after just one week and a second disappeared shortly after his second birthday. Seven wild-born gibbons

remain alive at the time of writing, the oldest of which has already reproduced. The two young females (one released as a juvenile, the other wild-born) that have matured, dispersed and reproduced have given birth to their first babies at 9 years 7 months and 9 years 11 months, respectively. Three females have given birth more than once to infants that survived to at least two years. The interbirth-intervals between these infants averaged 38.5 months ($N = 4$; intervals = 33, 35, 38 and 48 months; $SD = 6.7$) (Table 3).

After her second release in 2011, the adult female Kushta has had two miscarriages or stillbirths in the forest. The first infant was observed dead during the family's initial months in the wild when the female was being claimed by a "wild" male (Arun, released as a 1-year-old infant in 2003), who expressed what appeared to be infanticidal behaviour toward the newborn infant. The subadult father of Kushta's infant did not defend his offspring, and had immediately exhibited submissive behaviours towards Arun. The dead infant's body was never recovered after the mother was seen carrying it around one day and infanticide could never be definitely confirmed. However, shortly after this incident Kushta's nearly 3-year-old juvenile daughter from a previous pairing was also attacked by the male and eventually she had to be separated from her family and returned to captivity. Arun has since stayed with Kushta and the rest of her family.

Wild-born infant mortality (stillbirth or death in the first months of life) in the reintroduced population was 18%, not including the death of Kushta's first infant, since she was not living in a natural group situation at the time and her situation was further complicated by release stress and a group takeover by the infanticidal male.

With the exception of Kushta's first family, at least one individual from each reintroduction attempt remains in the wild today. Members of all the other reintroduced families have managed to adapt, either as a unit or by joining already existing groups. This social flexibility means that four out of the current six groups are, or were at some point, non-nuclear families, consisting of merged groups or containing "adopted" juveniles, as identified in the group summaries above.

Discussion

The white-handed gibbon is the most common gibbon species in zoos around the world. Despite its apparent abundance, the species has experienced a severe (more than 50%) decline in numbers in the past 40 years and is listed as Endangered on IUCN's Red List (Brockelman and Geissmann 2008). In 1975, Brockelman (1975) estimated that forests in Thailand could harbor as many as 220,000 white-handed gibbons, but by 1990 the maximum number was estimated at 110,000 (Tunhikorn *et al.* 1993; Tilson *et al.* 1997) and declining rapidly. These declines have been due mostly to hunting rather than to deforestation (Brockelman 1993–1994), so the population cannot simply be estimated by extrapolation over the forests in the protected area system without intensive sampling. There is no recent estimate of the current population in

Table 1. The percentage of reintroduced, captive raised, individuals from each family that remain within the reintroduction site, 1–10 years after their release.

Release year	No individuals released	%1 year	%2 years	%5 years	%10 years
2002	3	100	100	100	66
2003	4	100	75	75	
2004	4	75	25	25	
2006	3	0			
2006	2	50	50	50	
2007	4	100	50	50	
2009	3	100	66		
2011	4	75			
2012	3				

Table 2. Details of the reintroduced gibbons and their fates to date.

	Name	Sex	Date of birth	Place of birth	Back-ground	Date of rescue	Years at GRP	Age at release	Date of release	Result	Status December 2012	Comments
1	Kip	F	1989	Wild	Pet trade	09/05/1994	8+	13	05/10/2002	Wild	Wild	
2	Joe	M	1985	Wild	Pet trade	09/05/1994	8+	17	05/10/2002	Wild	Wild	
3	Thong	M	19/02/2000	GRP	GRP	na	2,5	2,5	05/10/2002	Wild/translocated	wild	
4	Lek	F	1992	Wild	Pet trade	06/02/1994	9+	11	15/08/2003	Wild	Wild	Pair with Bank 2006
5	Bo	M	1987	Wild	Pet trade	27/10/1993	10	16	15/08/2003	Returned	GRP	Voluntary return
6	Dao	F	08/05/2000	GRP	GRP	na	3+	3+	15/08/2003	Wild	Wild	Pair with Payu 2008
7	Arun	M	02/09/2002	GRP	GRP	na	1	1	15/08/2003	Wild	Wild	Pair with Kushta 2011
8	Pompam	F	1989	Wild	Pet trade	13/07/1995	9	15	10/12/2004	Poached 2006	Dead	
9	Bird	M	1988	Wild	Pet trade	13/07/1995	9	16	10/12/2004	Disappeared	na	Disappeared after fights with Joe and Bo in 2005
10	Sabai	F	01/02/2000	GRP	GRP	na	5-	5-	10/12/2004	Returned	Dead	Returned with injuries from attack by Lek in 2006, died of pneumonia at GRP 2008
11	Yoge	M	21/06/2003	GRP	GRP	na	1,5	1,5	10/12/2004	Wild	Wild	Pair with Hope 2011, 1st wild-born to Kip
12	Bank	M	2000	Wild	Semi wild	21/11/2005	<0,5	6	07/02/2006	Wild	Wild	Pair with Lek 2006
13	Khun Nguan	M	2000	Wild	Semi wild	21/11/2005	<0,5	6	07/02/2006	Returned	dead	Returned to GRP with medical complications in 2006, died.
14	Kushta	F	1990	Wild	Photo prop	06/04/1996	10	16	10/03/2006	Returned	wild	Re-release in 2011
15	Bozo	M	1989	Wild	Pet trade	28/05/1993	13	17	10/03/2006	Disappeared	na	
16	Nat	M	19/09/2004	GRP	GRP	na	1,5	1,5	10/03/2006	Returned	Wild	Re-release in 2011
17	Nuan	F	1986	Wild	Pet trade	22/09/1996	11	21	26/09/2007	Returned	GRP	Returned with injuries after fight with Dao in 2008
18	Khao	M	1991	Wild	Pet trade	18/11/1995	12	16	26/09/2007	Poached 2008	Dead	
19	Payu	M	14/07/2001	GRP	GRP	na	7-	7-	26/09/2007	Wild	Wild	Pair with Dao in 2008
20	Namthip	F	18/03/2006	GRP	GRP	na	1,5	1,5	26/09/2007	Wild	Wild	
21	Jita	F	1993	Wild	Photo prop	07/06/1994	15	16	10/12/2009	Disappeared	na	
22	Tony	M	1991	Wild	Photo prop	07/06/1994	15	18	10/12/2009	Returned	GRP	Recaptured due to aggressive behavior towards humans 2012
23	Claire	F	26/11/2008	GRP	GRP	na	1	1	10/12/2009	Wild	Wild	Adopted by Hope & Yoge 2012
24	Kushta	F	1990	Wild	Photo prop	06/04/1996	15	21	27/04/2011	Wild	Wild	Pair with Arun 2011
25	Muki	M	2004	Wild	Photo prop	03/01/2006	5	7	27/04/2011	Wild	Wild	
26	Nat	M	19/09/2004	GRP	GRP	na	6.5	6,5	27/04/2011	Wild	Wild	
27	Pee Mai	F	01/01/2009	GRP	GRP	na	2+	2+	27/04/2011	Returned	GRP	Recaptured 2012 after being attacked by Arun
28	Cop	F	2002	Wild	Photo prop	04/03/2004	8+	10	18/11/2012	Wild	Wild	
29	Jorn	M	2004	Wild	Pet trade	18/05/2006	6+	8	18/11/2012	Wild	Wild	
30	Sherpa	M	03/10/2010	GRP	GRP	na	2	2	18/11/2012	Wild	Wild	

Thailand, or the world. The unknown rates of current decline make it imperative to develop diverse approaches to conservation that involve management and protection of both wild and captive populations.

Past gibbon translocations have received a lot of criticism due to inadequate planning and post-release monitoring, poor survival, and the fact that these efforts have been so poorly shared and published (Loftin 1995; Ware 2001; Cheyne 2009b). We wish to help rectify this problem by describing in detail the dynamics of the reintroduced population in the longest running gibbon reintroduction program in the world.

The first gibbon family released by the GRP in 2002, using the described soft release method, has fulfilled the three criteria for successful reintroduction listed by Cheyne (2009b): they have survived 10 years post-release; they have maintained the original pair bond; and they have reproduced in the wild, in this case raised three wild-born babies past infancy. Eleven gibbons have been wild-born at the reintroduction site, including a second-generation infant to the first wild-born female of this first family.

We have reached the point at which reintroduction of gibbons seems feasible, although it does require considerable labor and cooperation among diverse stakeholders to succeed. At the GRP, 83% of animals participating in the reintroductions have survived the process, 60% of reintroduced animals have adapted, or appear to be adjusting, to life in the wild, and

53% of all gibbons reintroduced during the past 10 years are still living at the original reintroduction site. This is comparable with the 57% survival of wild-born golden lion tamarins participating in the often-cited successful population restoration project (Beck 1995). Of the zoo-born tamarins only 27% survived their release. Recent translocations of great apes have also achieved good survival rates. In the conservation translocation attempt of 51 western gorillas in Congo and Gabon between 1996 and 2006, survival was 84% (King and Courage 2008) and of 37 released chimpanzees in the Congo, 62% still remained in the release area after eight years, whilst some of the females that had disappeared were believed to be alive having joined wild groups (Goossens *et al.* 2005). The high survival rate of the chimpanzees was partially attributed to medical intervention. At the GRP, the 83% survival rate may likewise be due in part to long-term human assistance and medical intervention. In comparison, only about 65% of the gibbons available to the GRP were deemed fit enough to attempt reintroduction at all, which indicates that no more than 40% of gibbons received by GRP have been, or may be, successfully reintroduced.

That gibbons may be more flexible in lifestyle and behavior than often given credit for (Palombit 1994, 1996; Reichard and Sommer 1997; Brockelman *et al.* 1998; Fuentes 2000; Whittaker and Lappan 2009) raises hopes for their adaptability under artificial conditions. Long-term data from

Table 3. Reproductive females in KPT, their ages at first births and interbirth intervals.

Female	Origin	Age at first birth	Name and gender of offspring	Offspring's D.O.B	Offspring's place of birth	Interbirth interval*
KIP ¹	Pet trade	~6–7yrs	Tara (f)	19-Dec-95	GRP	Firstborn
	1989		Bamboo (m)	03-Jan-98	GRP	24,5
			Thong (m)	19-Feb-00	GRP	24,5
			Hope (f) ¹	21-Oct-02	Wild in KPT	32
			Toffee (f) ¹	21-Oct-06	Wild in KPT	48 ²
			Omyim (f) ¹	30-Dec-09	Wild in KPT	38 ²
LEK ¹	Pet trade	~8yrs	Dao (f) ¹	08-May-00	GRP	Firstborn
	1992		Arun (m) ¹	02-Sep-02	GRP	28
			Kopi (?) ⁴	20-Nov-07	Wild in KPT	60,5
			Redy (m) ⁵	25-Sep-08	Wild in KPT	10
			Peanut (m) ¹	30-Jun-11	Wild in KPT	33 ²
DAO ¹	GRP, May-00	9yrs, 7months	Newbe-Mek(m) ¹	20-Dec-09	Wild in KPT	Firstborn
			Sai Fa (?) ¹	01-Nov-12	Wild in KPT	35 ²
KUSHTA ¹	Tourism	~10 yrs	Yindee (f)	2000	GRP	Firstborn
	1990		? ³	2003	GRP	36
			Nat (m) ¹	19-Sep-04	GRP	12
			Pee Mai (f)	01-Jan-09	GRP	52
			? ³	06-Jul-11	Wild in KPT	30
			? ³	05-Apr-12	Wild in KPT	9
HOPE ¹	Wild in KPT	9yrs, 11months	Happy (?) ¹	01-Sep-12	Wild in KPT	Firstborn
	Oct-02					

*Months since previous infant. ¹Gibbons surviving in KPT at time of writing, ²individuals used in calculating the interbirth interval between surviving wild born infants, ³Stillborn or dead after birth, ⁴Died after one week, ⁵Died after two years.

Ketambe in Sumatra (Palombit 1994, 1996) and Khao Yai National Park in Thailand, has raised doubts on the traditional belief that gibbons are obligatorily monogamous and strictly territorial (Reichard and Sommer 1997; Brockelman *et al.* 1998; Sommer and Reichard 2000; Bartlett 2003; Reichard and Barelli 2008). In an 18-year-long study in Khao Yai National Park, only two-thirds of the 13 study groups showed social monogamy, and none of the groups exhibited life-long monogamy. Some groups showed considerable territorial overlap where, often friendly, interactions with neighbors, known to be relatives, occurred (Reichard and Sommer 1997; Sommer and Reichard 2000; Bartlett 2003). Gibbon groups in KPT have also proved to be socially flexible, and four of the current six family groups are, or have at some point been, non-nuclear, consisting of merged groups or containing “adopted” juveniles. A similarly interesting observation on gibbon social flexibility was also noted from the SMRL project in 1976 and 1977 when four released gibbons joined wild gibbon groups in the release area (Tingpalapong *et al.* 1981).

The life history characteristics of gibbons released in KPT have also been shown to be similar to those of wild gibbons. The interbirth interval for the three females that gave birth more than once in the wild averaged 38.5 months between surviving infants, comparable to the average (41 months) for wild white-handed gibbons in Kao Yai Park (Brockelman *et al.* 1998; Reichard and Barelli, 2008). The age at first birth for two young females, one wild born herself and the other reintroduced as a juvenile, was just below 10 years, also within the range of wild gibbons in Khao Yai (usually 9–12 years; Brockelman *et al.* 1998; Reichard and Barelli 2008).

The results at GRP give some hope with regard to the possibility of using reintroduction as a management method for captive gibbons in the future. It remains uncertain whether reintroduction of long-lived primates will ever play a significant role in the conservation of the species or just serve the more modest goal of restoring local ecosystem function where gibbons used to play important roles as seed dispersers (Osterberg *et al.* in press).

In Thailand, as in other habitat countries, long-term management of gibbon species in captivity is not an option. Even if the many gibbons in captivity were made available, developing a sustainable captive population, as is being implemented in North American and European zoos for some species, would be prohibitively expensive. The Thai government’s Wildlife Conservation Division devotes nearly all its resources to conserving wild populations and habitats, and has no programs besides the GRP for either captive breeding or translocation of gibbons. The care of the captive population is justified only in terms of promoting animal welfare—particularly for the endless stream of confiscated and donated individuals arriving from the illegal wildlife trade. In all habitat countries, this mindset is likely to change only if—or when—the populations decline to critical levels.

The educational programs developed by GRP have been strongly beneficial to the project. They change peoples’ attitudes to zoos and captive animals in general. The thinking is

guided toward conservation problems of the population, and the project clearly makes the connection between captive gibbons and what is happening in the wild. The message is one of compassion towards the population, with the aim of inspiring people to value the conservation of the species in the wild, and making people see that being placed in a cage, or on the end of a chain, is traumatic for a gibbon. As such, the GRP hopes to inspire a wider motivation to participate in and support the reintroduction program.

Acknowledgments

The authors thank the DNP, particularly Mr. Awat Nithikul, Chief of Khao Phra Thaeu non-hunting area, Mr. Nopadol Preksawan who helped establish the project, and Mr. Thavorn Srioon, previous head of Bang Pae Station, for supporting our work through the years. We extend our gratitude to all GRP volunteers, past and present, for helping to run the project, and especially to Damiana Rawasi for her analysis of the data from the 2002 release. We also want to thank all the people and members of the public whose support and funding has helped to make our work possible, and of course our gratitude goes out to the GRP staff, both present and past, for working so hard towards the goal of returning the gibbons to Phuket’s forest. We also thank Kim McConkey, Ben Rawson, Susan Cheyne, and an anonymous reviewer for their most helpful suggestions on this manuscript.

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Received for publication: 8 November 2014

Revised: 18 December 2014