CHAPTER 23

Orangutan rehabilitation and reintroduction

Successes, failures, and role in conservation

Anne E. Russon

Photo © Anne E. Russon

23.1 Introduction

Orangutan rehabilitation projects that aim to help ex-captives return to free forest life have operated throughout the orangutan's modern range, on Borneo and Sumatra, since Harrisson's pioneering efforts in Sarawak in the 1960s (Harrisson 1961, 1962). Twelve such projects have been launched, eight of which remain active (Fig. 23.1). Their continuing operation owes to the incessant influx of ex-captives. Early literature reported small numbers of arrivals but total intake exceeded 500 by the mid 1990s, has rocketed since, and probably exceeded 2500 at the point of writing (Peters 1995; Leiman and Ghaffar 1996; see Table 23.1). Ex-captives, virtually all wild-born orphans, now represent a significant proportion of the world's orangutans surviving in the modern range (Singleton *et al*. 2004) and they offer important insights into orangutan adaptation. For these reasons, they deserve serious consideration.

Some see potential for great ape rehabilitation and reintroduction to produce conservation benefits (Hannah and McGrew 1991; Yeager and Silver 1999;

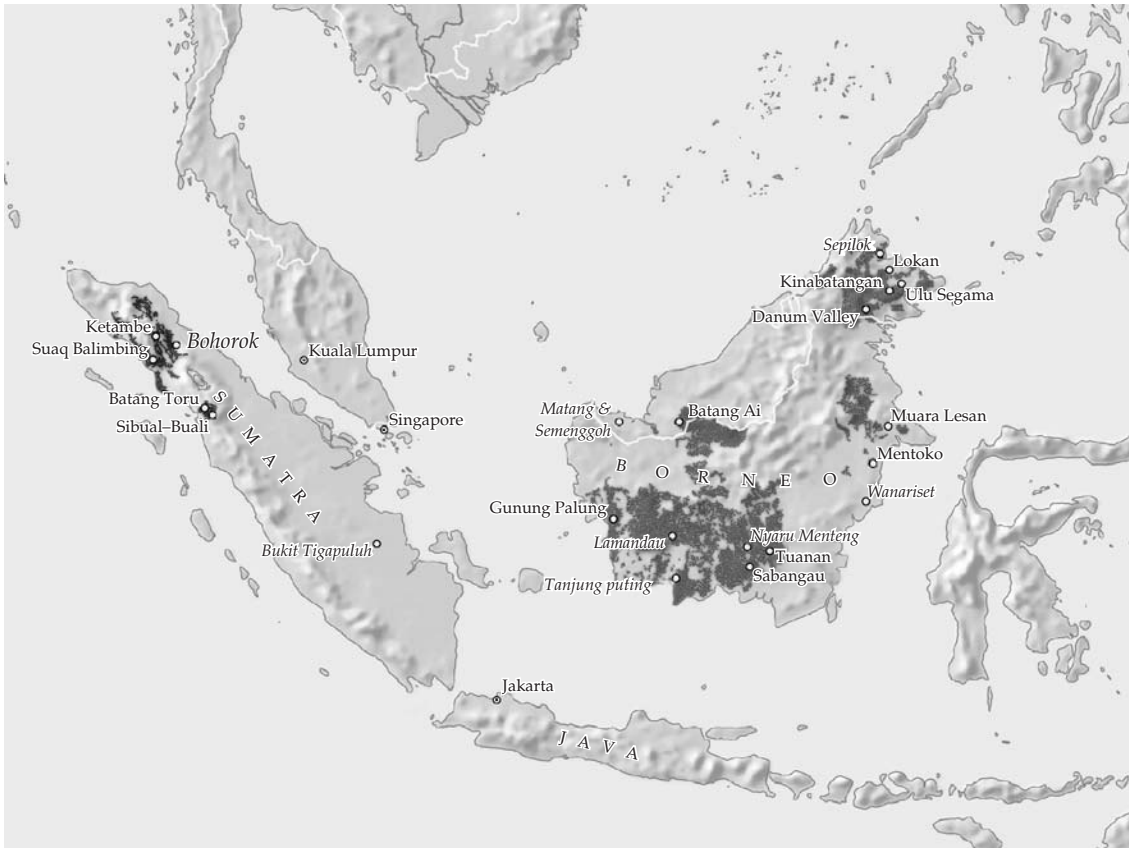

Figure 23.1 Orangutan rehabilitation and wild sites. Approximate locations of currently operating orangutan rehabilitation/reintroduction projects are in italics. The remaining sites are sites where wild orangutans are studied. Tanjung Puting supports both wild orangutan research and rehabilitation.

Rijksen 2001). Across taxa, however, most reintroductions cannot be considered successes (Griffith *et al*. 1989; Beck *et al*. 1994). Scientific and conservation experts have questioned whether orangutan rehabilitation's contribution to conservation has been positive or negative since its early days of operation. After only one decade of operation, pessimistic experts concluded that its value was nothing more than law enforcement, conservation propaganda, and fund-raising potential (Rijksen 1982). It has been so perennially ridden with difficulties that its harshest critics have condemned it as liability or even a blight—a very costly process that fails most ex-captives, exploits them as commodities to attract tourist revenues, falsely salves consciences, and misrepresents and undermines conservation (Sugardjito and van Schaik 1991; Lardoux-Gilloux 1995; Leiman and Ghaffar 1996; Yeager 1997; Rijksen and Meijaard 1999; Rijksen 2001). Others have spoken for its positive contributions to enforcing wildlife protection laws, public awareness, habitat protection, orangutan survival and welfare, and reintroducing orangutans to areas from which they had been eradicated (Peters 1995; Rijksen and Meijaard 1999; Singleton personal communication).

Twenty-five change-laden years have passed since the first assessments were made. This chapter assesses the role of orangutan rehabilitation in the conservation of orangutan populations in their natural habitat in light of its more than 40 years of operation.

Table 23.1 Rehabilitation project statistics

Site	Timeframe	Total intake	Sex (M:F)	In care	Total number released	Survival (%)	Number of years	Deaths (%)	Disappear (%)	Sources
Sepilok	64–71	41						25		1
	64–89	>200			~80	~40				2, 13
	64–01	~300		~200	>100					3
	74–07	>600								26
Ketambe	71–74	31	1:0.94		31	45–58		42[B]	19	4
Bohorok	73–77	74				86, 62[C]		14		5
	73–79	98	1:0.88[D]		25					6
	73–91	>190				82		18		7
	73–92	187			>176					8
	73–96	>204				81		19		7
	73–96			8	~176		13			27
	73–96	176–288			176	26–28	13			28
	73–00	>218								9
Tanjung	71–90	108								7
Puting	71–96	162						20		7
	71–00	>200		>130						10, 11
	74–94	>180			>180					12
	81–82		1:1.9		26		12	19	42	12[E]
	81–83				26	38	2	19	42	28
	91–96	54								7[F]
	1997	68–89								7[G]
	73–97	162			162	17	14			28
	71–04	237								29
Lamandau	2003				31					23
	03–04				40					24
	01–07				>100					25
Semenggoh	75–00	~60			~32					13
Matang	94–00	15			3					13
Wanariset	91–92	67	1:0.76	57	10	90	1	10	20	32
	91–94	114		61	40	95	3	5%		33
	91–97				82	20–45[A]	0.75–3			14, 15, 16
	91–99					20–80[A, I]				7
	91–01	804	1:0.95		407[H]			20%		16
	91–07	>1000		219						17
	99–03	108								29
Nyaru	99–00	>50								18
Menteng	99–01	>74								19
	99–02	125	1:1.08	17						31
	99–03	223								29
	99–07	536								17

Table 23.1 (*cont.*)

Site	Timeframe	Total intake	Sex (M:F)	In care	Total number released	Survival (%)	Number of years	Deaths (%)	Disappear (%)	Sources
Sumatran	2002	34	1:1.67							21
Orangutan	02–03	56								21
Conservation	02–04	68	1:0.94		>23[J]					21
Project	02–05	94			47	70				20, 22
	02–06				85–90					20
	02–07	115	1:0.89	60	70	100	5	0	0	30

Empty cells: no information available. [A]Resighted; [B]8 deaths by predators; [C]ecologically and socially rehabilitated; [D]annual sex ratio 1:4–9:5; [E]free-ranging rehabilitants ranging near the rehabilitation center, 1980–82; [F]reported government nature conservation agency intake (PHPA); [G]reported held covertly; [H]82 released in Sungai Wain, 325 in Beratus; [I]confirmed deaths; [J]releases to 03/04.

1, de Silva 1971; 2, Payne and Andau 1989 (*c.* 40% 'successfully rehabilitated'); 3, Fernando 2001; 4, Rijksen 1978; 5, Frey 1978; 6, Aveling 1982; 7, Rijksen and Meijaard 1999; 8, Storm 1992; 9, Sumatran Orangutan Society 2000; 10, Orangutan Foundation International 2000; 11, Orangutan Foundation International-UK; 12, Yeager 1997; 13, Mohd-Ramlee 2005; 14, BOS Orangutan Reintroduction Project at Wanariset 2000; 15, Swan and Warren 2001; 16, BOS Orangutan Reintroduction Project at Wanariset staff communication, March 2001; 17, http://www.orangutan.or.id (26 August 2007); 18, BOS Orangutan Reintroduction Project at Nyaru Menteng staff communication; 19, http://www.orangutan.or.id (08 February 2007); 20, Pratje personal communication; 21, SOCP website (21 January 2007); 22, PanEco Annual report 2005; 23, http://www.orangutan.org/press/fieldnews0304.php (25 January 2007); 24, http://www.grasp.org.au/projects/ byapeprojectindex.htm (25 January 2007); 25, http://www.orangutan.org.uk (25 January 2007); 26, Kuze *et al.* 2008; 27, Singleton and Aprianto 2001; 28, Rijksen 1997; 29, Nijman 2005; 30, http://www.sumatranorangutan.org/site_mawas/UK_GE/DIAs/list_mawas.htm (7.11.2007); 31, Nyaru Menteng Annual Report (June 2001–June 2002); 32, Smits 1992; 33, Smits *et al.* 1994.

23.2 Concepts in rehabilitation

In orangutan circles, the terms 'rehabilitation' and 'reintroduction' have sometimes been used with non-standard meanings. Beck *et al*. (2007) define rehabilitation as the process by which captives are 'treated for medical and physical disabilities until they regain health, are helped to acquire natural social and ecological skills, and are weaned from human contact and dependence, such that they can survive independently (or with greater independence) in the wild' (p. 5), and reintroduction as 'an attempt to establish a species in an area which was once part of its historic range, but from which it has been extirpated or become extinct' (p. 4). For the vast majority of great apes with captive backgrounds, return to forest life is inconceivable without some rehabilitation, so the two are intrinsically linked. The few exceptions are mostly recently captured individuals that are already old and competent enough to survive on their own.

Early projects to return wild-born ex-captive orangutans to forest life were called rehabilitation projects, emphasizing the process of helping ex-captives gain the capabilities needed for free forest life. They also returned rehabilitated ex-captives to natural habitat but deliberately placed them in areas with existing wild populations; as such they do not constitute reintroductions. Rijksen adopted the label 'reintroduction' in the 1990s for a new method he developed to achieve the same goals, partly to distinguish it from older methods but also to spotlight his emphasis on releasing ex-captives only into forests free of wild orangutans (Smits *et al*. 1995; Rijksen and Meijaard 1999). His method includes rehabilitation, using modified techniques, so what he labeled reintroduction subsumes both processes. Since the mid 1990s, practitioners have often used the two names interchangeably regardless of the techniques or processes involved. We follow standard usage of rehabilitation and reintroduction when specific processes are involved but, for convenience, use 'rehabilitation' for the enterprise as a whole.

23.3 Rehabilitant orangutans

Orangutans that reach rehabilitation are almost all wild-born, illegally captured as infants by killing

their mothers (Frey 1978; Peters 1995). They come from all areas within the modern range on both Borneo and Sumatra. Most appear to be victims of hunting or habitat loss. They are hunted as food, pests, or commodities for sale on the black market; habitat loss is mainly due to large-scale forest removal for timber, other extractible resources, and plantations (Frey 1978; Tilson *et al*. 1993; Rijksen and Meijaard 1999; Singleton *et al*. 2004; Buckland 2005).

Duration of captivity varies widely, so some ex-captives arrive at rehabilitation projects after years in captivity and others only days after being captured. Arrival ages and numbers vary with the effort devoted to confiscating captives, but arrivals have always been predominantly young (63–97% under *c*. 7 years old: Rijksen 1978; Aveling 1982; Swan and Warren 2001; Nijman 2005; SOCP 2007). Many arrive under 4 years of age, probably because infants are the most attractive as pets, but those held captive for years arrive as adults or near-adults (Frey 1978; Aveling 1982; Peters 1995; Singleton personal communication). In a few cases, females have reproduced in captivity and arrive with immature offspring.

Captives come from living conditions that vary from abusive to pampered, but inadequate care under poor conditions is the most prevalent (Payne and Andau 1989; Peters 1995). Significant numbers arrive seriously disabled, physically and/or psychologically, from accidents, inadequate captive care, or abuse by 'owners'. Typhoid, hepatitis A/B/C, tuberculosis, tetanus, respiratory disease, and significant parasite loads have all been diagnosed at intake; that almost all parasites are easily treatable is an index of the quality of care normally provided (BOSW unpublished data; Singleton personal communication). Physical damage includes gunshot and machete wounds, amputated, maimed or broken limbs, deep neck or waist wounds and scars from chaining, paralysis, blindness, and internal damage (Russon personal observation, Singleton personal communication). Behavioral and psychological damage include physical and sexual abuse, prolonged isolation as young infants, identification with humans, and abnormal experience that subverts learning forest competencies and fosters counterproductive learning.

23.4 Conservation goals in orangutan rehabilitation

The contributions of orangutan rehabilitation to conservation are a function of its goals and, for those consistent with conservation, its approaches to and success in achieving them. By IUCN standards, the primary goal of great ape reintroductions should be to establish self-sustaining populations in the wild, by re-establishing extinct wild populations or supplementing wild populations that are under carrying capacity, not viable, or not maintaining viability (Beck *et al*. 2007). Rarely has this been the main goal of orangutan rehabilitation, although efforts are progressing in that direction.

The first orangutan rehabilitation projects aimed primarily to help enforce orangutan protection laws by providing legal holding facilities for orangutans confiscated from illegal captivity; they also aimed to enable ex-captives to resume independent forest life (Frey 1978). Other conservation-oriented goals were secondary, e.g., supplementing supposedly depleted wild populations, promoting conservation funding and education—to which end tourism was encouraged, and ex-captives' welfare (de Silva 1965; Rijksen and Rijksen-Graatsma 1975; Harrisson 1961; Aveling 1982; Rijksen 1982).

Orangutan rehabilitation projects assessed and refocused their goals at the end of the 1980s. Returning ex-captives to forest life remained a central goal, but not supplementing wild populations. By the late 1970s, experts concluded that supplementing wild populations with ex-captives probably stressed rather than supported them, because there were probably already too many wild orangutans for remaining habitat (MacKinnon 1977b; Rijksen 1978, 1982). Rehabilitants also posed disease threats, some having been diagnosed with serious infectious human diseases that could spread to wild populations including hepatitis-B, tuberculosis, and poliomyelitis (Rijksen and Rijksen-Graatsma 1975; Kosasih *et al*. 1977; MacKinnon 1977b; Frey 1978; Rijksen 1982, 2001; Yeager 1999). Tourism was identified as a probable source of disease, especially where it was poorly managed and allowed close proximity with ex-captives. Flawed behavioral practices were identified, some of them

caused by inaccurate 1970s views of orangutans as 'desocialized' and fast developing. Among them were expecting ex-captives to acquire survival competencies without social input, releasing them individually, not integrating them into existing communities, imposing independence too young, and excessive human contact (MacKinnon 1977b; Borner and Gittens 1978; Frey 1978; Rijksen 1978, 1982). Rijksen (1978) argued that orangutan behavioral rehabilitation has two essential dimensions, ecological and social: the former develops the competencies for surviving independently in natural habitat (foraging, ranging, predator avoidance, nesting); the latter fosters orangutan social competencies (e.g., relationships, social structures, communication) and discourages involvement with humans.

This polarized practitioners into two camps. One prioritized wild orangutan protection by instituting tighter controls on rehabilitants (e.g., stringent medical protocols, prohibiting tourism, strict reintroduction) and emphasized social over ecological rehabilitation (Smits *et al*. 1995; Rijksen and Meijaard 1999). Since 1995, Indonesian law has required that rehabilitants be released only to areas with no existing wild orangutan population. This is similarly preferred, but not required, in Sabah (Ancrenaz personal communication). The other camp maintained 'old' methods, notably, releasing ex-captives into wild populations and promoting tourism.

Near the end of the twentieth century conditions shifted abruptly. Indonesia, which holds over 80% of the world's wild orangutans, suffered extraordinary political, economic and natural upheavals in the wake of President Soeharto's fall from power, economic collapse through much of Asia, and the ensuing lawlessness and political chaos. Results included rampant forest destruction, poorly controlled development on Sumatra and Borneo, civil war in Aceh—the heart of Sumatran orangutan habitat, and even greater habitat fragmentation and depletion of wild populations (Singleton *et al*. 2004). Economic interests in oil palm development are now escalating threats to orangutans and their habitat, especially in Borneo (Buckland 2005). New roads, cut in the name of economic development, create major threats in Sumatra. This has caused unprecedented surges in ex-captive arrivals at rehabilitation projects and much greater difficulty in locating suitable habitat. Good habitat is becoming so scarce that rehabilitants now compete with wild orangutans rescued from life-threatening situations for the few suitable sites.

A variety of other factors have affected the goals of orangutan rehabilitation projects. The people involved have often fallen into one of two traps, commercial advantages of tourism and sentimental attachment to ex-captives (Rijksen and Meijaard 1999). Both distort rehabilitation by biasing decisions toward personal agendas or putting the needs of the few above the needs of the many. Funding difficulties and low professional investment in ex-captives compared to their wild or captive conspecifics share responsibility for these problems (Irwin 2001). Many projects operate without secure funding. Some turned to tourism as one of the few sources of funds available. If orangutan rehabilitation operates without reliable funding free of political or commercial strings and as quasi-self-supporting, some consider it cannot achieve its conservation goals (Rijksen and Meijaard 1999). Shifting political forces, national and international, have altered threats to orangutans and avenues for protecting them, so rehabilitation projects have little choice but to adjust their goals—indeed, government-operated ones have their agendas defined by political priorities. Ex-captives unsuitable for reintroduction have accumulated in rehabilitation centers to the point of making individual welfare a priority, up to and including providing lifelong sanctuary-quality care (Rosen and Byers 2002).

The upshot is that assessments of orangutan rehabilitation's contribution to conservation must recognize that conservation is only one of the many intertwined forces that guide it. We assessed orangutan rehabilitation's success in achieving conservation-oriented goals in terms of establishing self-sustaining populations and individual success in resuming forest life (survival, reproduction, progress). We used these indices because they are among the few relevant indices for which quantitative data are available across populations. Success in resuming forest life has rarely been assessed systematically for orangutan rehabilitation (Yeager 1997) largely because it requires

systematic long-term post-release monitoring, which no project has achieved to date.

23.5 Success in achieving conservation goals

23.5.1 Self-sustaining populations

Early orangutan rehabilitation projects aimed to release ex-captives into wild populations near where they originated because of prevailing conservation and scientific views and the techniques then available: wild populations needed supplementing, Borneans and Sumatrans were subspecies, rehabilitants were suitable as supplements, and provenance could be identified from location of confiscation and morphology (Frey 1978; Aveling 1982). Views on supplementing wild populations changed, confiscation location and morphology proved inaccurate indices of provenance, and orangutan taxonomy has been revised. Orangutans have been confiscated far from where they could have originated (Bali, Java, Paris, Taiwan, Thailand, Japan), accurate tests for provenance were unavailable until recently, and genetic and morphological evidence have convinced many experts that Bornean and Sumatran orangutans are distinct species and Borneo supports three geographically delimited subspecies (Groves 2001, Warren *et al*. 2001). Largely because of this poor information, substantial numbers of rehabilitants have been added to wild populations and ex-captives of different provenance have been inappropriately mixed (Payne and Andau 1989; Bennett 1991; Meijaard *et al*. 1996; Yeager 1997; Warren *et al*. 2001). Some projects have adjusted their methods in light of improved information and now practice reintroduction and assess provenance genetically. Only those that do could potentially to meet the standard of establishing self-sustaining populations of rehabilitants.

What constitutes a self-sustaining population is, however, debated. The term refers to an isolated population's potential for long-term survival. Conservationists often target the minimum viable population (MVP), the minimum number of individuals needed to achieve a given probability of survival for a given period of time, although some consider MVP too insecure, too difficult to estimate, or inferior to other criteria (e.g. Reed *et al*. 2003; Brook *et al*. 2006; Sanderson 2006; Traill *et al*. 2007). MVP is typically estimated mathematically, e.g., population viability analysis (PVA: Miller and Lacy 1999). The newest orangutan PVA produced MVP values of 250–500 for 99% probability of survival for 1000 years for both Borneo and Sumatra, although populations this small remain vulnerable to even low levels of logging or hunting (Singleton *et al*. 2004). At typical orangutan densities, the larger MVP requires 125–1000 km^2 of suitable habitat in Borneo and 80–350 km^2 in Sumatra (Singleton *et al*. 2004: Chapter 22). These values do not apply directly to rehabilitant populations because they differ on many critical parameters, including genetics (most are founders), demographics (age range is atypical), behavior (survival competencies are typically subnormal), habitat (possibly suboptimal), and human involvement. While other threats are absent, even a few dozen rehabilitants have considerable potential for long-term survival.

No better reference points are available, so we used wild MVP to gauge how well orangutan rehabilitation contributes to self-sustaining populations. Only two projects practice reintroduction and only since the 1990s: the BOS Orangutan Reintroduction Project at Wanariset (BOSW) and the Sumatran Orangutan Conservation Project (SOCP). BOSW reintroduced Bornean rehabilitants into two protected forests in East Kalimantan, Sungai Wain and Beratus (Meratus). SOCP reintroduces Sumatran rehabilitants into a former logging concession bordering on Bukit Tigapuluh National Park, an area that supported wild orangutans until the 1830s but not by the 1990s (Schlegel and Mueller 1839–1844). Sungai Wain is too small to support a self-sustaining orangutan population (*c*. 35 km^2 of forest in good condition) and only about a dozen of the 82 rehabilitants released there remain; others died, disappeared, or were relocated (Peters 1995; Russon and Susilo 1999). The Beratus population may meet wild MVP criteria. BOSW reintroduced 325 rehabilitants there; the protected area is also quite large (*c*. 288 km^2) and contiguous with a vast expanse of logging concession forest. This population's status is unclear, however, because it has not been monitored continuously and increased illegal logging since 2002 has seriously increased threats.

The Bukit Tigapuluh population has the potential to meet MVP criteria although only 77 rehabilitants have been released to date (Pratje personal communication). Bukit Tigapuluh covers over 1440 km^2 of lowland forest, virtually all suitable for orangutans, so it could support a population of well over 1000.

23.5.2 Reproduction

Little is known about rehabilitants' reproductive success beyond incidental reports, at virtually all sites, of small numbers of free-ranging females with offspring (Payne and Andau 1989; Rijksen and Meijaard 1999). Assessing orangutan reproductive success is difficult given their slow reproductive rate. For females, first and last reproductions are estimated at 15–16 and 38 years respectively and interbirth intervals at 6–9 years (Galdikas and Wood 1990; Singleton *et al*. 2004; Wich *et al*. 2004b; van Noordwijk and van Schaik 2005, see Chapter 5). Ex-captives typically resume forest life as semi-independent immatures, so successfully reproducing even once entails maturing and supporting the offspring to weaning, i.e., a lag of up to 10–15 years post release. Persistent difficulties with post-release monitoring account for the dearth of credible statistics.

Reports nonetheless suggest patterns worth considering. Rehabilitant Bornean females may reproduce earlier (10–12 years) and more often (*c*. 4 years) than wild females (BOSW unpublished data; Kuze *et al*. 2008; Russon unpublished data; Yeager 1997). This could be an artifact of small, ad lib samples but several factors suggest it is valid. It is consistent across five Bornean sites (Tanjung Puting, Kaja, Sungai Wain, Beratus, Sepilok) managed by four projects. Supplemental provisions could accelerate reproduction by improving nutrition (Koyama *et al*. 1992; Tutin 1994; Knott 2001; Takahasi 2002; Altmann and Alberts 2003; but see Brewer *et al*. 2006). Female rehabilitants in Tanjung Puting were more likely than males to range near provisioning sites (Yeager 1997) and many continued to use provisions as adults (Russon personal observation). Sepilok females assessed by Kuze *et al*. (2008) were also frequent provision users. It is also consistent with data indicating shorter interbirth intervals in captive orangutans that have not been influenced by infant pulling or other management interference (see Chapter 5).

Infant mortality rates may also be higher in rehabilitant than wild females. Based on samples from 12 rehabilitant females in Tanjung Puting and 14 at Sepilok, infant mortality was high, *c*. 30% and 57% respectively (Yeager 1997; Kuze *et al*. 2008). High infant mortality could reflect poor mothering, especially in primiparous females. One primiparous female in Beratus lost her 1-year-old to dehydration/starving because she was already weaning him; another in Tanjung Puting probably lost a healthy infant to drowning through inattention while traveling in water (Russon, personal observation). Especially at Tanjung Puting and Sepilok, it could also be due to stress, competition, or poor health caused by high orangutan densities or high human contact (staff, tourists) in areas where these females ranged (Yeager 1997; Snaith 1999; Kilbourn *et al*. 2003; Kuze *et al*. 2008).

23.5.3 Survival

How long rehabilitants must survive post-release to qualify as successful is uncertain for several reasons, among them normal wild orangutan mortality. Wild mortality is estimated to vary up to 5.5% with age, 2.5% with sex, and 5.5% with environmental conditions (Singleton *et al*. 2004). The best estimates, for wild Sumatran orangutans, show 5–8% mortality in the first year of life and the transition to independence (8–11 yr) and $<2\%$ mortality at all other ages; mortality is probably higher on Borneo, especially for adults, because of the harsher ecological conditions (Knott 1998a; Singleton *et al*. 2004; Wich *et al*. 2004b, see Chapter 5). Prolonged droughts that recur at 2–10 year intervals in conjunction with the El Niño Southern Oscillation (ENSO) pose major survival threats to orangutans, especially on Borneo (Knott 1998a; Delgado and van Schaik 2000).

Other factors plague rehabilitant survival statistics. Rehabilitants' ages are all estimates, which limits the potential for credible age-specific survival indices. Age and time post-release covary, so one must be controlled statistically to assess the role of the other. Poor captive care can have long-term debilitating effects that undermine survival. The methods used to assess rehabilitant survivorship are dubious, e.g., disappearances may sometimes

have been treated as survivals (Rijksen 2001), and survivorship has rarely been assessed for multiple timeframes although it varies with time post-release in other primates (Kleiman *et al*. 1991; Tutin *et al*. 2001; Beck *et al*. 2002; Goossens *et al*. 2005b). Time-linked events beyond ENSO cycles could affect rehabilitant survival, such as forcible relocation or withdrawal of post-release support.

None of the rehabilitant survival estimates we found fully address these concerns. The values most commonly reported are overall survival rates representing whatever methods were used to generate them at whatever point in time data were compiled. They show post-release survival rates of 20–80% (see Table 23.1). Rijksen and Meijaard (1999) estimated overall success rates of 40% as realistic and 80% the best possible, but this too is simply impressionistic.

Whether these survival rates are poor, as critics claim, is debatable. We compared them with survival rates from other primate rehabilitation and reintroduction efforts, because primates share heavy reliance on learning for many species-appropriate responses, prolonged dependency, acute social needs, sensitive learning periods in development, and debilitating effects of captivity (Yeager 1997; Beck *et al*. 2002; Russon 2003a; see Table 23.2). Comparability is limited by differences between species and projects (e.g., captive- vs wild-born subjects, pre-release training systems, age at release, release methods, post-release monitoring, duration of life post-release) and poor orangutan survival data. Values suggest that survivorship for orangutan rehabilitation projects is as mixed as it is for other primates, not the best, but also not the worst.

Table 23.2 Survival rates in primate rehabilitation and/or reintroduction efforts

Species	Number released	Release type	Age at release	Birth	Number of years post-release	% Survival	Comments	Source
Orangutan	>1000	M	M	W	?	20–80 (40)	Most released as juv–adol	Table 1
Golden lion tamarin	71, 140	R	M	1W/70–139C	5, 1, 2	38, 44, 30		1, 2
Chimpanzee	9 *	M	M	5W	>1	~55	Release to natural forest site	10, 11
	83 *	R	M	79W/4C	1	>33	Release to islands	10, 11
	20, 37	S	J-AL	W	1–3, 3–8	70, 62	2 died, 5 disappeared	3, 4
Gorilla	4 *	S	I-J	9W/2C	>1	25	Released to natural forest	11
	>7 *	R	J-AL	5W/2C	1	86	Released to islands	11
Gibbon	122	?	?	?	?	10	*H. muelleri*	5
	31	S	J-AD	25W/6C	3–4	13	*H. lar*; 4 confirmed surviving; 24 disappeared	6
	2, 2, 2	R	AD pb	W	2, 2, 0.1	100, 50, 100	*H. agilis albibarbis*	7
	16	R	AD pb	W?	<5	50	pairs released after having reared >1 offspring	8
Black and white ruffed lemur	13	S	J-AD	C	5	38	Released when independent, able to reproduce (2–12 years)	9
Golden langer	6, 4	R	AD	W	5, 9–11	0, 25	2 groups released	12

Numnber released: total number of individuals released; values marked * represent total numbers for multiple projects. Release type: R reintroduction, S supplementation, M mixed (various methods used), ? unclear.

Age at release (per source): M, mixed; I infant; J, juvenile; AL, adolescent; AD, adult; AD pb, adult bonded pairs; ?, unclear.

Birth, number, number of individuals per birth type; W, wild-born; C, captive-born; ?, unstated.

1, Kleiman *et al.* 1991; 2, Beck *et al.* 2002; 3, Tutin *et al.* 2001; 4, Goossens *et al.* 2005b; 5, Bennett 1989, 1992; 6, Tingpalapong *et al.* 1981; 7, Cheyne 2004, 2005; 8, Shanee and Shanee 2007; 9, Britt *et al.* 2004; 10, Hannah and McGrew 1991; 11, Beck unpublished ms; 12, Gupta 2002.

Reasons for poor survival are also similar in other primates. Common causes of death include inadequate foraging, disease, parasites, skill-related injuries, and assaults by predators, conspecifics, and humans (Hannah and McGrew 1991; Bennett 1992; Russon 1996; Yeager 1997; Beck *et al*. 2002; Goossens *et al*. 2005b). Poor rehabilitation practices are probably major contributors to these inadequacies (e.g., poor candidate or release site choice or preparation, relocations, preventable human conflict, inadequate post-release support) but so are factors beyond the control of rehabilitation, notably interference of disabilities or habits caused by captivity and human interference (Tingpalapong *et al*. 1981; Hannah and McGrew 1991; Bennett 1992; Yeager 1997; Tutin *et al*. 2001; Beck *et al*. 2002; Britt *et al*. 2004; Goossens *et al* 2005b; Mohd-Ramlee 2006; Cheyne 2004, 2005; Farmer *et al*. 2007).

23.5.4 Post-release progress

Progress in adjusting to forest life can indicate how quickly and how well reintroduced orangutans adjust, how effectively they were rehabilitated, what competencies are difficult to acquire, and who copes best or suffers most. Most quantitative evidence represents a few types of behavioral adjustment (activity budgets, diet) although other ecological and social competencies are equally important, e.g., nesting, ranging, arboreality, antipredator skills, orangutan relationships, and indifference to humans (Rijksen 1978; van Schaik and van Hooff 1996). Available data typically represent duration of forest life post-release which confounds the effects of learning with those of development—notably, sensitive periods for learning and age-specific abilities (e.g., strength, cognition), needs (e.g., nutrition) and interests (e.g., play, sex, aggression) (Russon 2003a).

This makes it difficult to unravel the causes of behavioral change. However, inadequate survival competencies appear to account for many rehabilitation failures (Beck *et al*. 2002). Starving or consuming toxic fruits accounted for almost 20% of known deaths in 91 captive-born golden lion tamarins (Beck *et al*. 1991). Many primate survival competencies require learning, much primate learning entails experience, and experience increases with duration of forest life. Behavioral change post-release that indicates learning has been reported in rehabilitant great apes (Hannah and McGrew 1991; Peters 1995; Kuncoro 2004; Russon 2002, 2003a; Grundmann 2006; Russon *et al*. 2007a). Because great apes develop extremely slowly, behavior changes that owe mainly to learning should be more rapid than those that owe mainly to development (e.g., strength, sociosexual interest). This should hold for ex-captive orangutans: they typically resume forest life as juveniles or adolescents so learning motivation, pressures, and abilities are high (Russon 2003a). Consistent with learning, greater change has been found in the first year post-release than the second in other reintroduced primates (Stoinski and Beck 2004).

Further complications are that wild orangutan activity budgets and diets vary between and within populations as a function of habitat, fluctuating food availability, age/sex class, and reproduction (Fox *et al*. 2004; Wich *et al*. 2006a, b; see Chapter 9). Measures also differ across studies but post-hoc standardizing is not always possible, so even wild populations cannot be compared in straightforward fashion (see Chapter 8). Rehabilitant findings also suffer from non-standard data collection and differences in the presence of wild orangutans, demographics (mostly immatures), effects of captivity, and provisioning regimes. Profiles represent a period of exceptional food scarcity for Tanjung Puting rehabilitants (Snaith 1999), for example, and varied levels of reliance on supplemental provisions: Bukit Tigapuluh—19% of total feeding time (Pratje personal communication), Beratus—46% (Grundmann 2006) and 26% (Kuncoro 2004), Sungai Wain—8% (Fredriksson 1995), Tanjung Puting—38% (Snaith 1999).

We therefore compared activity budgets and diets of *novice* (<1 year post-release forest life) and moderately *experienced* rehabilitants (1–3.5 years, to limit developmental effects) with the wild population ranging in the most similar habitat (Tanjung Puting with Tanjung Puting wild, Sungai Wain and Beratus with Mentoko, Bukit Tigapuluh with Ketambe—although no wild Sumatran population offers a good comparison based on habitat). We removed time eating provisions from rehabilitant values but behavior profiles are probably still

affected (e.g., more rest, less travel). Even adjusted these ways, available findings afford only crude assessment.

23.5.4.1 Activity budgets

Available findings on rehabilitant and wild activity budgets are shown in Table 23.3 and Fig. 23.2. For most wild orangutan populations, we were able to use values for immatures (juvenile–subadult) although including wild adult females did not change patterns.

No consistent differences appeared between novice and moderately experienced rehabilitants (Fredriksson 1995; Kuncoro 2004; Grundmann 2006). The two Beratus studies were conducted about three years apart and included several of the same rehabilitants but show different patterns. This probably owes variously to provisioning, seasonality, and/or sampling changes (Kuncoro personal communication). Rehabilitant–wild comparisons do not suggest that rehabilitants adopt wild activity profiles with experience—if anything, they suggest general differences (4/5 studies). Rehabilitants may spend less time feeding than comparable wild populations (Tanjung Puting, Beratus/K, Beratus/G) but more time in travel and other activities (Bukit Tigapuluh, Sungai Wain, Beratus/K, Beratus/G). Provisioning is one possible explanation.

Studies of other reintroduced primates suggest similar patterns. Reintroduced golden lion tamarins showed evidence of adjusting to forest life over the first year post-reintroduction—juveniles and adults increased resting time, adults increased foraging time—but persistently spent less time traveling, feeding and foraging than wild conspecifics (Stoinski *et al*. 2003; Stoinski and Beck 2004). Rehabilitant chimpanzees released into Concouati-Douli National Park adopted activity patterns similar but not identical to wild chimpanzees (Farmer *et al*. 2007).

23.5.4.2 Diet

Only Sumatran and East Kalimantan rehabilitant sites provided information suitable for comparisons. Findings on diet represent time feeding (see Table 23.4, Figs 23.3 and 23.4).

Comparisons suggest that in Borneo, experienced rehabilitants resemble wild orangutans more closely in diet than do novices. For more experienced versus novice Bornean rehabilitants, average percentage of feeding time per food type exceeded the wild range in 1/15 versus 5/15 cells respectively (see Table 23.4). Deviations from average wild orangutan rates also tended to be smaller for more experienced versus novice rehabilitants (Wilcoxon matched-pairs signed ranks test, $n = 15$, $p < 0.107$). Novices spent relatively less time eating fruit and more eating non-fruit foods than experienced rehabilitants (notably vegetation in Sungai Wain and Beratus/G, insects in Sungai Wain and Beratus/K). Overall, compared with wild orangutans, rehabilitants may rely more heavily on *other* foods. This could result from their identifying foods by trial and error for lack of expert guidance or their tendency to be more terrestrial than wild orangutans (Peters 1995; Kuncoro 2004; Grundmann 2006). They eat items that wild orangutans ignore in areas where both forage (Snaith 1999) and use more foods from the forest floor (e.g., terrestrial invertebrates, shoots of grasses [*Graminae* spp.]). and rattans, and stems of gingers [*Zingiberaceae* spp.]) (Fredriksson 1995; Grundmann *et al*. 2001; Kuncoro 2004; see Chapter 9).

Riedler (2007) found similar dietary patterns in eight 3–5-year-old Sumatran rehabilitants studied 6–12 months after their transfer to Bukit Tigapuluh. She compared three who were forest-oriented and human-avoidant (forest group) with five who were less forest-oriented and 'human-bonded' (human-bonded group). The forest group spent more time eating fruit and less time eating other food types (notably, leaves and other items) than the human-bonded group. The forest group also ate from more species, ate fruit from more species, used higher levels in the canopy, and built more new nests than the human-bonded group. Overall, these Sumatran rehabilitants also devoted more time to *other* foods than wild conspecifics, mainly because they frequently fed on stems which were predominantly available on the ground. These findings parallel the Bornean findings reported above, experience-related ones included if these two Sumatran groups resemble, respectively, more experienced and novice Bornean rehabilitants. Sumatran rehabilitants were also more often near conspecifics when they ate fruits versus leaves; a plausible interpretation

Table 23.3 Activity budgets of wild and forest-living rehabilitant orangutan populations

Population	Study time span	Duration (months)	Prov	n	Post-release forest life	Age class	Sex	% Feed	% Rest	% Travel	% Other	Source
Wild												
Ketambe	71–75	48	N/A					42.5	43.5	14.0	0.0	1
						AD	F	43.0	44.0	13.0	0.0	1
Tanjung Puting	11/71–1/75	48	N/A			AD	F	62.2	18.2	17.6	2.0	1
						S	M	64.5	15.1	18.2	2.2	1
						J-AL	F	69.3	10.9	18.2	1.6	1
						J-S		66.9	13.0	18.2	1.9	1
Mentoko	4/70–8/71	12	N/A			J-AL	F	42.1	42.0	12.6	3.3	1
	82–84		N/A			S	M	57.2	30.5	12.2	0.1	1
Ulu Segama	10/69–11/70	12	N/A			AD	F	31.9	50.6	17.6	0.0	1
Rehabilitant												
Bukit Tigapuluh	03–05	3–36	Y	15	<1–3 years	J-AL		41.6	37.8	16.8	3.8	2
Tanjung Puting	6/98–10/98	5	Y	3	15–20 years	AD	F	53.2	25.2	14.7	0.0	3
				5	3–4 years	J		49.3	15.3	13.2	3.5	3
Sungai Wain	10/94–2/95	5	Y	5	1.7–3 years	AL		64.1	13.9	15.9	6.0	4
				2	9 months	J		61.2	15.3	13.5	8.0	4
				10	1–4 months	J		51.2	32.2	13.3	3.0	4
Beratus	7/98–12/98	14	(Y)	2	6 years	AL	M	44.5	30.5	18.5	6.5	5
	4/99–12/99											
				4	1.7–3.5 years	J-AL		48.5	32.5	16.0	2.5	
				19	<1 years	J-AL		32.0	46.0	15.0	7.0	5
	8/02–1/03	6	(Y)	2	>6 years	S-AD		20.8	49.6	15.9	11.1	6
				9	1–3 years	J-AL		50.0	27.6	10.8	11.6	6
				1	<1 years	AL	M	54.3	23.2	18.7	3.9	6

Prov (provisioned): Y, yes; (Y), sometimes during study; blank, no.

n, sample size. Post-release forest life: (rehabilitants) duration of forest life post-release.

Age class: J, juvenile; AL, adolescent; S, subadult; AD, adult; blank, mixed.

Sex: M, male; F, female; blank, mixed.

Percentage feed/rest/travel/other, cell values are averages (except Tanjung Puting rehabilitants, medians).

Beratus/G, values estimated from published graph, post-release forest life class members identified post hoc.

1, Rodman 1988; 2, Pratje personal communication; 3, Snaith 1999; 4, Fredriksson 1995; 5, Grundmann 2006; 6, Kuncoro 2004.

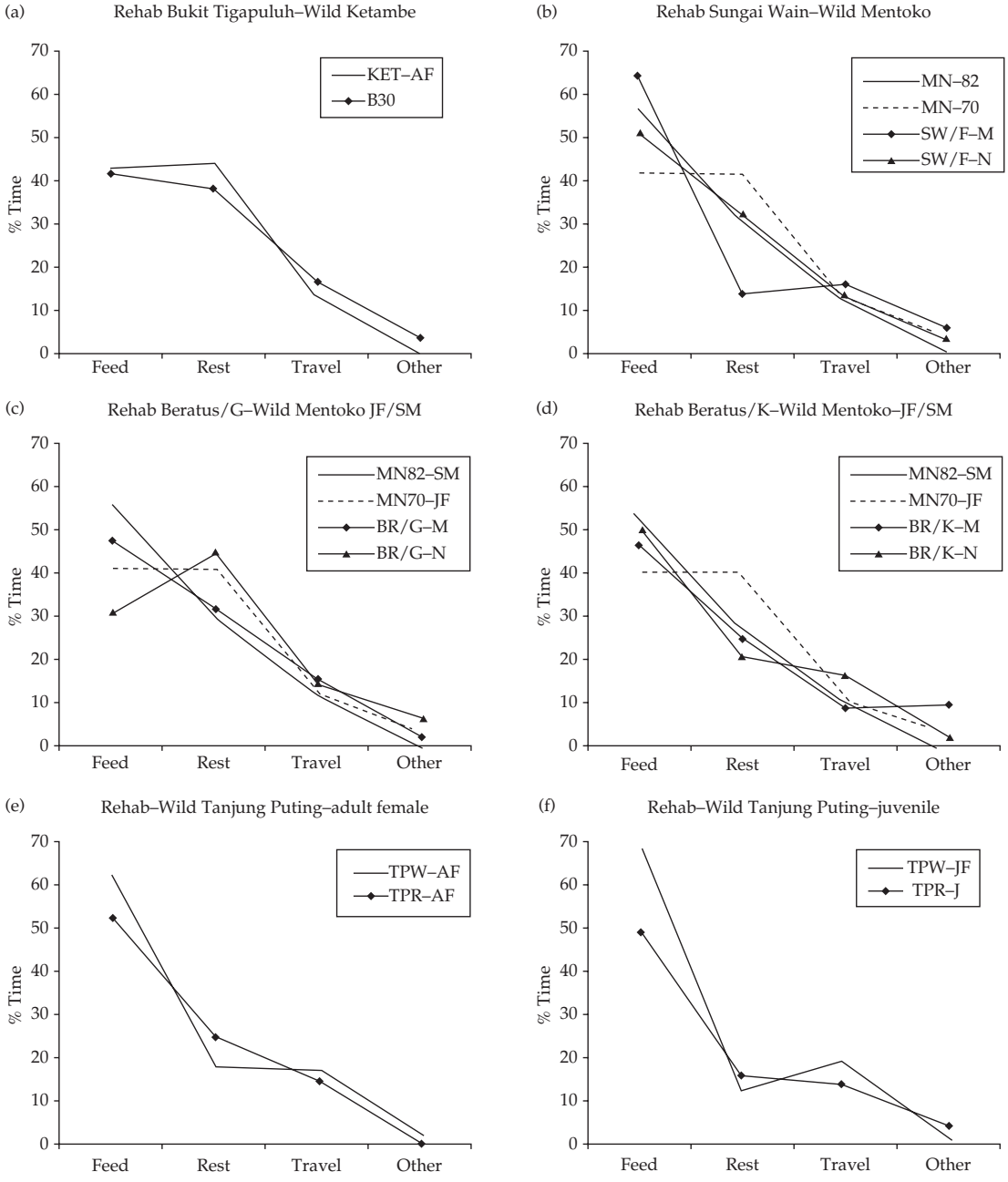

Figure 23.2 Activity budgets in wild and rehabilitant orangutans. Figures 23.2a–23.2f compare individual rehabilitant communities with the wild community living in the most similar habitat. Rehabilitant values are presented by forest experience (moderately experienced 1–3.5 years; novice < 1 year). Wild populations: Ketambe, KET; Tanjung Puting, TPW; Mentoko (1970–71 values), MN-70; Mentoko (1982–84 values), MN-82; For comparability, the values shown are averages for wild immatures; where no immature values were available, we used wild adult female values as most similar. Rehabilitant populations: Bukit Tigapuluh, B30; Sungai Wain (Fredriksson values), SW/F; Beratus (Grundmann values), BR/G; Beratus (Kuncoro values), BR/K; Tanjung Puting, TPR. Age or experience (suffix): -M (moderately skilled); -N, -N2 (novice: 0–1 year, 0–3 months); -AF (adult female), -JF (juvenile female), -J (juvenile).

Table 23.4 Diets of wild and forest-living rehabilitant orangutans

Population	Study time span	Duration (months)	Prov	n	Post-release forest life	Fruit	Vegetation	Bark	Insect	Other	Source
Wild											
Ketambe	71–75	48	N/A			67.5	16.5	2.6	8.8	4.8	1
						57.5–71.5	0.6–20.1	2.2–3–3	5.7–11.7	1.8–10.6	
Suaq Balimbing			N/A			66.2	16.5	1.1	13.4	3.8	1
						62.7–69.6	10.6–20.1	0.8–1.4	12.2–14.6	3.6–4.1	
Gunung Palung	9/94–5/95	9	N/A			66.8	10.8	9.3	4.2	8.9	1
						20.0–100.0	0.0–36.0	0.0–37.0	0.0–16.0	0.0–60.0	
Tanjung Puting	11/71–1/75	48	N/A			60.9	14.7	11.4	4.3	3.9	2
						16.4–96.1	0.0–39.6	0.0–47.2	0.0–27.2	0.0–41.1	
Mentoko	4/70–8/71	12	N/A			53.8	29.0	14.2	0.8	2.2	3
						25.7–89.0	5.3–55.6	0.0–66.6	0.0–11.1	0.0–2.5	
Ulu Segama	6/68–11/68	12	N/A			62.0	23.5	10.5	1.0	0.0	4
	10/69–11/70					7.7–90.8	7.5–76.9	0.0–37.0	0.0–9.1	0.0–0.0	
Rehabilitant											
Bukit Tigapuluh	03–05	3–36	Y	15	<1–3 years	32.9	42.4	12.7	2.7	9.3	5
Tanjung Puting	6/98–10/98	5	Y	8	3–20 months	11.4	9.1	17.9	29.0	13.0	6
Sungai Wain	10/94–2/95	5	Y	5	1.7–3 years	30.5	32.0	6.7	1.7	29.1	7
				10	0–0.5 years	13.9	46.1	3.2	28.9	7.8	6
Beratus	7/98–12/98	14	(Y)	4	1.7–3.5 years	63.8	31.1	3.3	1.0	0.4	8
	4/99–12/99										
				19	<1 years	36.7	59.4	0.7	0.4	2.2	8
	8/02–1/03	6	(Y)	9	1–3 years	78.9	16.2	1.5	1.6	1.8	9
				1	<1 years	74.5	8.2	0.0	14.9	2.4	9

Prov, (provisioned); Y, yes; (Y), sometimes during study; blank, no; n, number of subjects; Exper, (rehabilitant) years of forest life post-release.

Diet,cells show percentage of total time feeding per food type: first row, average (except median, Tanjung Puting rehabitants) 2nd row, range (if available).

1, Wich *et al.* 2006a; 2, Rodman 1988; 3, Rodman 1973a, b, 1979 per Rodman 1988; 4, MacKinnon 1974, 1977a estimated from Fig. 19; % total feeding observations per Rodman 1988; 5, Pratje personal communication.; 6, Snaith 1999 (vegetation = leaves, other includes other plant matter; no significant differences between adult females and juveniles on a daily basis); 7, Fredriksson 1995, groups 1 and 2 vs 4 and 5; 8, Grundmann 2006 estimated from Figure 2, 'other' interpreted as provisions; 9, Kuncoro 2004 original data.

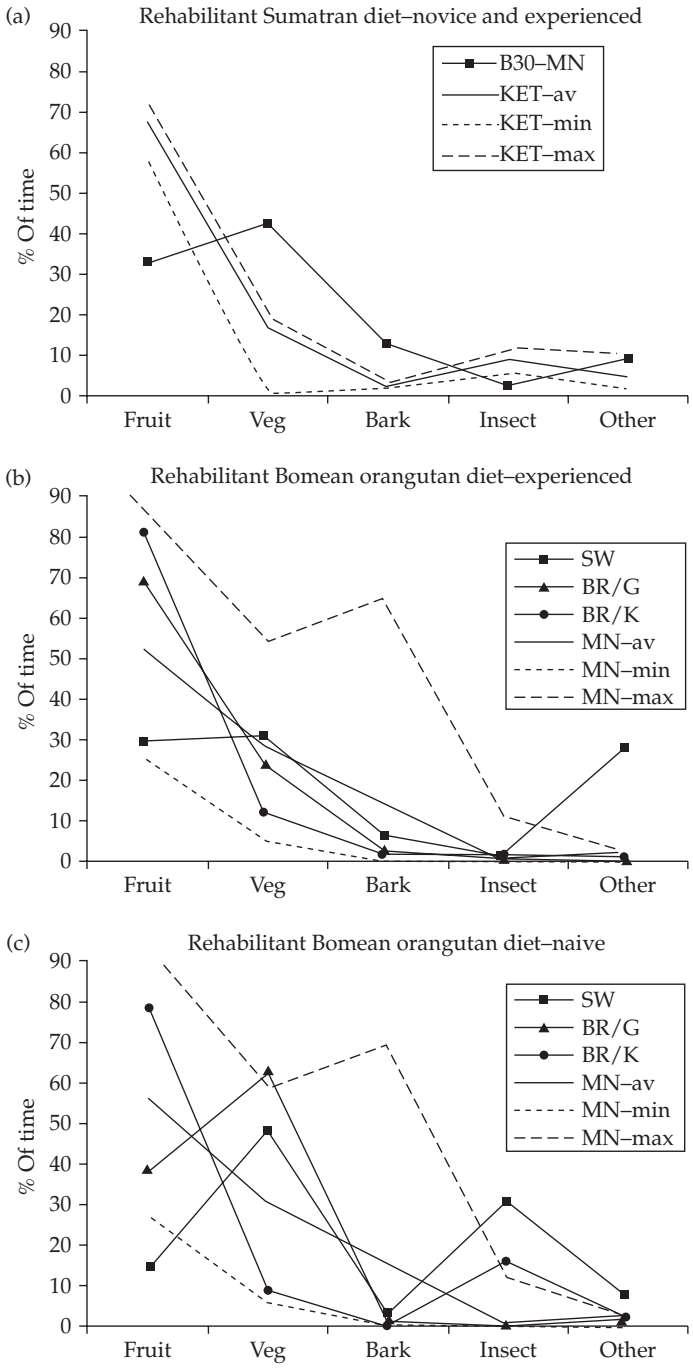

Figure 23.3 Diets of wild and rehabilitant orangutans. Figures 23.3a–23.3c compare individual rehabilitant communities with the wild community living in the most similar habitat. 23.3a, diets of naive to moderately experienced Sumatran rehabilitants at Bukit Tigapuluh compared to the wild diet at Ketambe (solid line, average; dotted lines, range), 23.3b, diets of moderately experienced rehabilitants compared to the wild diet at Mentoko (solid line, average; dotted lines, range), 23.3c, diets of novice rehabilitants compared to the wild diet at Mentoko (solid line, average; dotted lines, range). Wild populations: Ketambe (KET); Mentoko (MN). Rehabilitant populations: Bukit Tigapuluh (B30), Sungai Wain Frederiksson values (SW/F) Beratus Grundmann and Kuncoro values (BR/G, BR/K).

is that fruit is more difficult to find than leaves so increased fruit eating requires more sophisticated skills and social input is important in acquiring them.

Within Sungai Wain, when several rehabilitants foraged in the same area at the same time, the less experienced always ate from fewer species daily than the more experienced (Russon 2002).

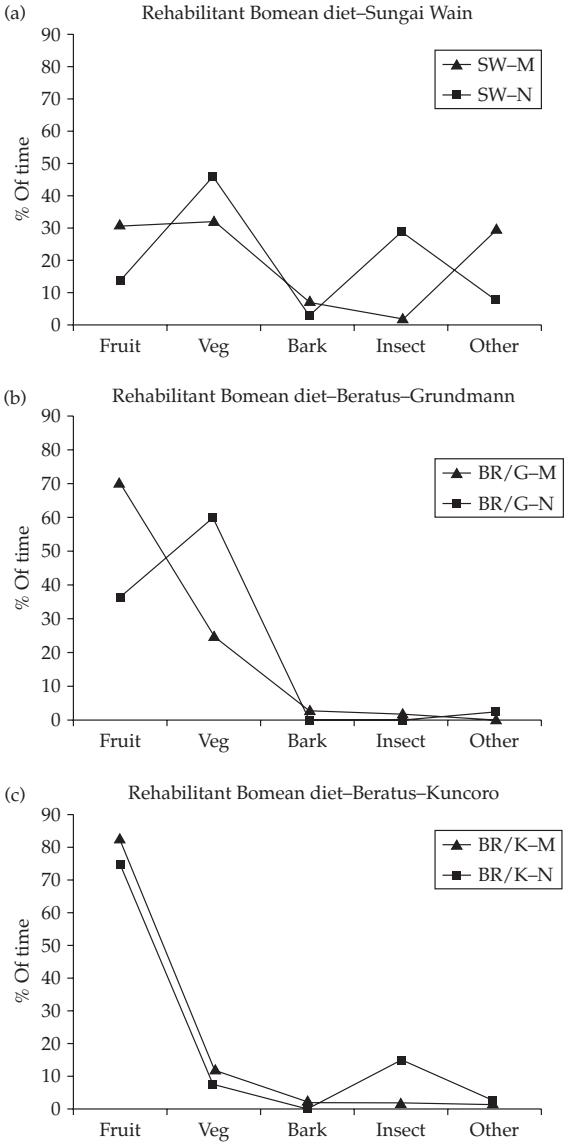

Figure 23.4 Within-site comparisons, diets of novices versus more experienced Bornean rehabilitant orangutans. Figures 23.4a–23.4c compare the diets within individual sites for novices (N) versus moderately experienced (M) rehabilitant orangutans. Rehabilitant populations: Sungai Wain (SW), Beratus Grundmann (BR/G) and Beratus Kuncoro values (BR/K).

In Beratus, Grundmann (2006) found that novices had very narrow daily diets: for 19 novices, mean number of items eaten daily was 4 and this included *Zingiberaceae* spp., which are nutritionally quite poor. Time-related changes have also been found in rehabilitant diets at the community level. Rehabilitants in Sungai Wain ate from 111 species in 1995 and 241 in 2000, a difference that almost certainly involves growing local knowledge (Peters 1995; Russon 2002). Studies in Sungai Wain early after reintroductions began reported very few resident rehabilitants eating embedded foods like underground nesting termites or stem cores (Peters 1995). These are important local staple foods but they are difficult to obtain (Russon and Susilo 1999; Kuncoro 2004; Grundmann 2006). Later studies reported more of the same residents eating them, sometimes in social contexts. Findings are consistent with the view that more time in the forest affords better foraging competencies and that social learning may be involved (Russon 2002, 2003a). Social input may be particularly important for technically difficult foods, such as those that are patchy in time and space (e.g., fruits) or embedded. Riedler's (2007) study at Bukit Tigapuluh found very similar differences. Findings are consistent with the view that more time in the forest affords better foraging competencies and that social learning may be involved; social input may be particularly important for technically difficult foods, such as those that are patchy in time and space (e.g., fruits) or embedded (Russon 2002, 2003a; Riedler 2007).

Reintroduced captive-born golden lion tamarins have shown some similar diet-related patterns, e.g., inappropriate food choices and failing to recognize good extractive foraging sites (Stoinski *et al.* 2003).

23.5.5 Other considerations

Assessments of orangutan rehabilitation's success in achieving conservation goals should also consider factors beyond the control of rehabilitation projects themselves and additional activities that may contribute to conservation indirectly.

Some failures that occur in the hands of rehabilitation projects owe rightly to species characteristics or captivity. Orangutans, as great apes, have characteristics that handicap their chances for successful reintroduction, including survival competencies that depend heavily on learning, highly flexible behavior, and extremely slow devel-

opment and reproduction (Hannah and McGrew 1991; Yeager 1997). Both extremes of captive care—inadequacies and luxuries, capture under 1 year of age, prolonged captivity (>4 years), and identification with humans can have devastating effects (Aveling and Mitchell 1982; Rijksen 1978, 1982; Fernando 2001). Malnutrition, illness, or maiming can cause physical damage that may not show serious consequences, or even become evident, until well into rehabilitation. Prolonged early isolation can cause irreversible abnormalities like self-clinging, rocking, or self-abuse; pampering can create human-identified orangutans; and prolonged captivity can delay learning of survival competencies beyond important sensitive periods (Peters 1995; Mallapur and Choudhury 2003; Stoinski and Beck 2004).

On the positive side, rehabilitation projects undertake various activities that contribute to conservation indirectly. They have always assisted law enforcement and Borneo Orangutan Survival Foundation (BOS) reintroduction projects have led major confiscation operations in Indonesia since the 1990s. Initially, their help appeared to help curb illegal trade in orangutans but weak follow-up and penalties left gains insecure (Borner and Gittens 1978; Aveling 1982; Aveling and Mitchell 1982; Rijksen 1978, 2001). Rates of poaching and habitat destruction that outpace confiscations, the high profits from orangutan sales, and difficulties in obtaining prosecutions, convictions, and effective penalties all probably undermine success. In Sumatra, only one recent case has been reported of convicting and imprisoning orangutan poachers (Pratje personal communication). This support in enforcing laws against illegal trade in orangutans remains important, however, as recent repatriations of illegally held captives from Taiwan, Japan, Malaysia and Thailand show.

Rehabilitation projects contribute to welfare by caring for orangutans that cannot be returned to free forest life. Before projects for rehabilitating and protecting orangutans existed, almost all pet orangutans died during capture or captivity and wild orangutans probably died when displaced from their habitat: more Sumatran orangutan habitat was probably lost between 1850 and 1980 than since and all the orangutans displaced simply 'disappeared' (Singleton personal communication). That so many refugee orangutans now reach rehabilitation centers and survive owes to the success of these centers in finding, rescuing, and treating them.

Rehabilitation projects also support conservation through related research. Genetic studies that led to revising orangutan taxonomy are based heavily on data from rehabilitant orangutans (Muir *et al*. 2000; Warren *et al*. 2001). Studies on rehabilitants have also contributed to understanding orangutan ecological and social competencies (e.g., foraging, nesting, tool use, reconciliation, deception, social learning, innovation, culture), stress, and temperament. Rehabilitants have been a focus of medical studies, so much so that the art of keeping orangutans alive has benefited from the experience gained. Studies comparing wild, captive, and rehabilitant orangutans helped prove that rehabilitants catch human diseases if exposed to them and can communicate those diseases to other orangutans and humans.

Many articles and documentaries on orangutans feature rehabilitants. Questions of education aside, they have spurred donations internationally to support orangutan protection, brought funds and attention to areas that tend to be economically depressed, and have publicized the effects of destructive palm oil plantation practices on orangutans. It is probably in part due to this publicity that the oil palm industry is beginning to make efforts to find solutions.

The high costs of rehabilitation have been criticized, but most expenses cover purchase of local goods and services and salaries for local employees. Both help to turn local people away from activities destructive to habitat and wildlife, involve them directly in protection work, and educate them in better practices.

African ape sanctuaries are moving toward reintroduction (Carlsen *et al*. 2006) and the International Union for the Conservation of Nature (IUCN recently published reintroduction guidelines designed specifically for great apes (Beck *et al*. 2007). Rehabilitation has operated on a much larger and longer scale for orangutans than for African apes, so it stands to offer important input on effective practices and common pitfalls.

23.6 Current orangutan rehabilitation practices

Rehabilitation practices have often been suboptimal so they bear some responsibility for success rates and can almost certainly be improved. Improvements have been made, especially those in the 1990s that addressed recognized pitfalls. We sketch orangutan rehabilitation and reintroduction as it operates today as a basis for identifying current practices that are effective, those that remain flawed, and possible remedies (see Fig. 23.5).

23.6.1 Intake

Genetic testing can now determine ex-captives' provenance to the subspecies level and in Indonesia rehabilitants are now managed as distinct subpopulations. Several projects routinely test newly confiscated ex-captives genetically (e.g., Borneo Orangutan Survival Foundation Wanariset [BOSW], Borneo Orangutan Survival Foundation Nyaru Menteng [BOSNM]), although not always to the subspecies level, and aim to rehabilitate them in areas consistent with their provenance. All projects also now quarantine all newly arriving ex-captives then test and treat them for medical disorders before introducing them to other rehabilitants. Protocols have improved greatly over time and standards have been established (Payne and Andau 1989; Rosen and Byers 2002; Beck *et al*. 2007). Practices still differ across projects. Medical care may not yet fully address psychological needs, although some projects now try to alleviate the distress associated with medical procedures (e.g., stress, depression, isolation). A pressing need is effective social, emotional, and behavioral support for ex-captives who must remain under restrictive medical care, especially infants.

23.6.2 Eligibility for release

From intake onwards, ex-captives' suitability for release is assessed. Incurable contagious disease (e.g., chronic hepatitis-B), permanent physical handicaps (e.g., blindness, paralysis, amputation), failure to acquire appropriate competencies, emotional disorders, and dangerousness all rule out release on welfare or safety grounds. Other potentially insurmountable handicaps include too little

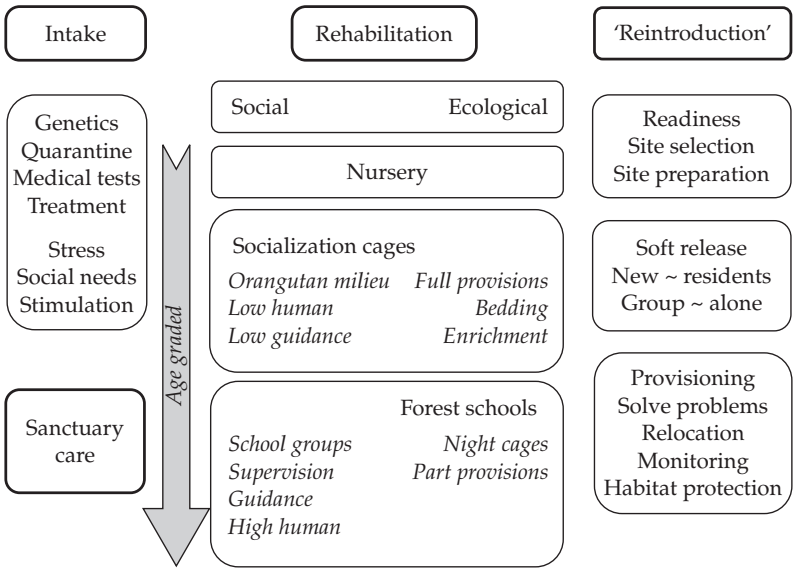

Figure 23.5 Current orangutan rehabilitation and reintroduction practices. The figure shows major program components (bold boxes) and critical elements within each. Italicized entries under Socialization Cage and Forest School represent qualities relevant to social and ecological rehabilitation respectively.

life in the wild during infancy (i.e., capture under 1 year old), captivity that was too harsh or too easy, irreversible bonding with humans, and failure to resocialize to orangutans (Aveling and Mitchell 1982). Those ineligible for release are often managed separately in sanctuary-like care. As the numbers needing permanent care increase, providing for them is becoming increasingly difficult. Currently, most are eventually relegated to cages. Islands are possible alternatives if suitable in size, habitat, accessibility, and safety.

23.6.3 Behavioral rehabilitation

Ex-captives enter behavioral rehabilitation once confirmed healthy. All projects of which we are aware program for both ecological and social needs; some now also give explicit attention to alleviating stress and emotional problems. Some standards have been established (Rosen and Byers 2002) but adherence is unknown.

Behavioral rehabilitation programs are typically age-graded because ex-captives range from newborns to adults. Ex-captives are typically placed in age-graded 'peer' groups as one basis for compatibility (e.g., young infant, older infant, juvenile, adolescent, adult). Incompatibility within groups creates serious risks of stress and physical injury. Intensive, parent-like human 'nursery' care is provided for very young infants. Care shifts to supervisory as youngsters develop and to conspecific social support as early and as much as possible, to wean ex-captives from humans. The stages created often depend on local conditions. Sepilok has three: infant (nursery), intermediate supported release (outward bound, survival training), and independence (Lardoux-Gilloux 1995; Fernando 2001). Nyaru Menteng, which was caring for *c*. 550 ex-captives by 2007, has more (Russon pers. obs). Ideally, care, groupings, and staging are individualized. Some forest school programs, for example, allow youngsters who can build and sleep in proper tree nests, or who at least sleep in trees, to stay in the forest overnight (Pratje, personal communication; Russon personal observation).

Programs provide opportunities for learning more than direct training because good teachers are rarely available. The main approach is placing ex-captives in contexts supposed to foster appropriate learning, typically forest schools (safe forest areas) or socialization (group) cages. Rijksen advocated group cages for social rehabilitation (Smits *et al*. 1995). It is also the practical solution for ensuring the safety of highly vulnerable ex-captives or managing those too large or aggressive for forest schools. Forest schools make better sense for ecological learning because they offer real forest experience. Ex-captives may be moved between contexts as needed, e.g., from cages to forest schools when old enough, from forest schools to cages if they prove unmanageable. Both contexts have shortcomings. Socialization cages minimize human contact but preclude supervision and limit options for resolving conflicts. Forest schools enable supervision and greater flexibility in handling social situations but maintain human involvement. Caging also entails providing full provisions, bedding, and behavioral enrichment that are quasi-natural at best; forest schools reduce these artificialities to partial provisioning and facultative caging, mostly overnight.

It is recognized that the more closely behavioral programs simulate species-normal processes and the more flexible and individualized they are, the more effective they should be (Peters 1995; Smits *et al*. 1995; Rijksen and Meijaard 1999; Fernando 2001; Russon 2002; Pratje and Singleton 2006). Achieving this while also gradually but persistently orienting ex-captives away from humans still proves difficult. Current approaches, for instance, assume that rehabilitation will follow from living in these contexts. Most ex-captives are immatures, orangutan socialization and ecological learning is normally mediated by mothers, and normal interaction does not occur in closed groups. Leaving ex-captives to sort out orangutan sociality and acquire forest competencies without supervision and expert social input is therefore a questionable practice.

23.6.4 Readiness for forest life

Criteria have been articulated for assessing ex-captive orangutans' readiness to tackle semi-independent forest life. They include suitable age (young enough to adjust to forest life, old enough for semi-independence), age-appropriate survival

competencies, and indifference to or fear of humans (Rosen and Byers 2002). Orangutans are best released as juveniles or adolescents because this is their best period for semi-independence, learning, and integrating into a forest community. Essential survival competencies include recognizing forest foods and dangers, nesting, foraging, navigation, arboreal travel, danger responses, and effective conspecific communication and relationships. These are not yet quantified and applied systematically.

23.6.5 Forest sites

Where to release ex-captive orangutans has been a concern since experts concluded that they threaten wild orangutans and Indonesian law has required reintroduction. Standards have been proposed. In both Malaysia and Indonesia, ideal is suitable habitat within the current orangutan range that is free of and isolated from existing wild populations. Increasing difficulty in finding such areas, however, especially in Borneo, has led to proposals to allow ex-captives in areas with non-viable wild populations if necessary (Rosen and Byers 2002). Some projects have already done this, e.g., in Lamandau, although whether this area's wild population is non-viable is questionable (Singleton *et al*. 2004). Better methods are now being developed for assessing these criteria. At minimum, surveys need to assess wild orangutan presence, habitat carrying capacity, and threats. Brief surveys cannot assess them all; forest productivity, for instance, a key element in estimating carrying capacity, requires long-term monitoring.

Sites deemed suitable need preparation before releases begin because post-release work is important to success, program improvement, and accountability. Basic needs include mapping (to identify locations for releases, provisioning, headquarters, local threats), developing trails and access routes, building (e.g., basic support facilities, provisioning sites), and establishing working relations with local human communities. Few projects have thoroughly prepared sites before releasing rehabilitants with the result that preventable problems have developed.

23.6.6 Resuming semi-independent forest life

Two approaches are used to bring ex-captive orangutans to semi-independent forest life: voluntary (for those being rehabilitated in suitable forest; Rijksen 1982) and releases into forest areas that require independence (Smits *et al*. 1995).

The voluntary approach has mixed success. In Tanjung Puting, female rehabilitants overcrowded the project camp and provisioning areas, probably because wild females normally establish independent ranges near where they were raised so they do not move far voluntarily (Galdikas 1995; Yeager 1997). Sepilok uses multiple feeding sites successively deeper in the forest to gradually draw ex-captives away from project support. Its staff report that most have dispersed by adulthood, but some resist independence and cause serious conflicts (de Silva 1971; Payne and Andau 1989).

Some projects use formal releases, i.e., transfer ex-captives to forest areas far from where they were rehabilitated. Most releases are soft, in that provisions and other supports are provided for some period after release, but hard releases are sometimes used, typically to relocate individuals who are difficult to manage to unfamiliar areas. Group and individual release protocols have both been used. Individual releases, especially hard ones, were criticized for probably creating social and ecological stressors severe enough to seriously jeopardize survival (Rijksen 1978, 1982). Group releases were promoted in the 1990s on the view that groups would provide built-in social support (Smits *et al*. 1995; Rijksen and Meijaard 1999) and up to 40 ex-captives have been released together. Group releases also have problems, however, notably competition for access to provisioning areas, breakdown of pre-release social bonds, and difficulties monitoring all newly released individuals (de Vries 1991; Russon 1996; Singleton personal communication). Another recommended group practice, releasing groups far from one another, makes it impossible for newcomers to learn from experienced rehabilitants (Russon 1996). Releases in very small groups (e.g., 2–4 orangutans) or individually may best suit orangutans' dispersed sociality and facilitate monitoring and support

immediately post-release (Pratje, Singleton, personal communication).

23.6.7 Post-release support and monitoring

Post-release monitoring is the only basis for tracking individual progress, developing problems, success, and habitat productivity. It is especially important after provisioning is withdrawn (Baker 2002; Rosen and Byers 2002). Some projects monitor rehabilitants immediately post release and some have continued for several years by following accessible rehabilitants, periodic searches, and occasional nest censuses (e.g., Peters 1995; Russon and Susilo 1999; Siregar *et al*. 2002; Pratje and Singleton 2006). This level of monitoring has caught some failures to thrive early enough to take corrective action but not all: some are detected too late and lead to death, others undoubtedly remain undetected.

Systematic monitoring over longer terms has not yet been achieved. This is partly because it is extremely difficult with orangutans, who are semi-solitary, cryptic, wide-ranging and dwellers of dense tropical rainforest habitat. Radio tracking, for instance, is impractical and probably unsafe (Aveling 1982). To be effective for monitoring free-ranging rehabilitants, telemetric devices need extremely strong transmitters and batteries that last for many years; to be safe, they need fastenings appropriate for individuals that are still growing, ultimately very large bodied, arboreal, extremely dextrous, and extremely intelligent (Rosen and Byers 2002). The technology is not yet up to the job. If and when telemetry overcomes these difficulties, it would relieve many monitoring difficulties.

23.6.8 Habitat protection

Areas into which rehabilitants are released should have protected status, but formal status has proven to be no more effective for rehabilitants than it is for wild orangutans. Several rehabilitant sites have reported serious threats, e.g., illegal logging (Bukit Tigapuluh, Beratus, Sungai Wain, Tanjung Puting). Orangutan patrols operated by the Sumatran Orangutan Conservation Programme (SOCP) are among the few efforts in that direction. Similar efforts are needed elsewhere, along with activities directed specifically to protecting habitat.

23.6.9 Tourism

Recognition of tourism's costs to ex-captive orangutans led to efforts to stop or at least control tourism at rehabilitation projects. In Indonesia, the government ordered several rehabilitation projects closed because they had become overrun with tourists (Rijksen and Meijaard 1999). Stopping tourism with rehabilitant orangutans has proven difficult, however, because of economic benefits to some and claims that tourism can benefit conservation in ways that offset its recognized costs to rehabilitants (MacKinnon 1977b; Frey 1978; Aveling 1982; Rijksen 1982). Some rehabilitant projects are now closed to tourists (Smits *et al*. 1995; Singleton personal communication) but tourism remains a driving force at projects that prioritize its benefits over its costs (Payne and Andau 1989; Galdikas 1991). Two of the projects ordered closed (Bohorok, Tanjung Puting) continue to offer up rehabilitant orangutans as tourist attractions, so the costs of tourism to rehabilitant orangutans are not yet under control.

23.7 Discussion

While many criticisms of orangutan rehabilitation are justified, claims that it achieves exceptionally poor success or that its programs are the main reason for failures may not be. Expectations for success have probably been inflated (Rijksen and Meijaard 1999). Insofar as available statistics are credible, they suggest that orangutan rehabilitation success rates are within the range reported for other primate reintroductions. Some failures also rightly owe to factors beyond rehabilitation's control. Programs that provide poor planning, social and diet management, supervision, and choice of release area bear a share of the responsibility, but so do handicaps created by captivity and species qualities (Tingpalapong *et al*. 1981; Bennett 1992; Mohd-Ramlee 2006). Orangutan rehabilitation has also improved its practices over time and it contributes to conservation in multiple ways. Its

role in confiscating and caring for ex-captives and displaced wild orangutans in particular remains an essential facet of law enforcement.

Despite improvements, some problem practices remain and almost certainly undermine success rates. Even medical care still faces challenges. Tests remain fallible for the presence of some diseases or the risks of transmitting them in orangutans; tuberculosis, for example, is especially difficult to diagnose in orangutans and the risks of transmitting chronic hepatitis-B are disputed (Warren *et al*. 1999). False negative test results afford unexpected disease outbreaks in ex-captives previously considered healthy, while false positives may impose lengthy isolation on ex-captives incorrectly identified as contagious. Current conditions at some projects, housing hundreds of ex-captive and displaced wild orangutans well beyond their capacity, increase risks of introducing and rapidly spreading human diseases given the numbers of human attendants needed and the overcrowded conditions caused.

Behavioral rehabilitation also faces hurdles. On the ecological side, Rijksen's (1978) view that ecological rehabilitation is easily achieved may not be true in Borneo. Many failures in Bornean rehabilitants signal inadequate forest skills (Russon 1996; Yeager 1997). Borneo's harsher habitat and poorer food resources may require especially complex foraging skills because of heavy reliance on embedded or otherwise defended foods that are difficult to obtain (Russon 2002, see Chapter 9). Ex-captive orangutans rehabilitated in conditions that rely heavily on caging pre-release are probably most likely to have inadequate ecological skills post-release.

Social rehabilitation has changed significantly but further changes are warranted. While orangutans may live in loosely defined communities (van Schaik and van Hooff 1996) they are not group-living, so group-based methods may be suboptimal. Social caging imposes a regimented form of social life that is not needed to resocialize ex-captives; it also creates social stressors (e.g., competition, sexual harassment, bullying) and favors peer-shaped skills that are potentially counterproductive. Given the opportunity, immature ex-captives readily form relationships with other orangutans for support and learning, but often prefer *older* partners (Bowden 1980, Lardeux-Gilloux 1995, Yeager 1997). Social caging requires enrichment to make life palatable and educational but cage enrichment is an impoverished substitute for forest life and difficult to sustain. Social caging is susceptible to prolongation, given its convenience, and can result in healthy ex-captives living caged for years. Relationships with cage-mates may create post-release problems by collectively maintaining or reverting to dangerous captive habits (e.g., sleep/nest on the ground). Social supports, social learning, and community integration are undoubtedly important. The challenge is designing an orangutan-acceptable, rehabilitation-appropriate form of sociality without stress.

Human habituation remains a major impediment to effective orangutan rehabilitation because it has proven almost impossible to erase its effects. Even ex-captives who readapt well to free forest life may not abandon human ways—some simply become adept at both (Russon and Galdikas 1995; Snaith 1999). Its effects include disrupted behavioral rehabilitation; seeking human contact post-release that leads to wounds or even death; treating humans like conspecifics (e.g., aggression, sexual advances); and transmitting human diseases (Yeager 1997; Homsy 1999; Wallis and Lee 1999; Woodford *et al*. 2002; Russon personal observation). Even rehabilitation practices designed to draw ex-captives away from humans are not entirely successful because restrictions erode easily, especially when ex-captives seek contact. Tourism, where permitted, remains a major problem for this reason (Lardoux-Gilloux 1995; Leiman and Ghaffar 1996; Yeager 1997; Rijksen and Meijaard 1999). How best to satisfy infant orangutans' needs for maternal care is also unresolved. Women make better mother surrogates than orangutan peers, but early learning is highly formative so lengthy involvement with them could lead to persistent human orientation.

Release and post-release issues also remain unsolved. While release site criteria have been established, for instance, few structures are in place to ensure compliance and assessment is complicated. Assessing a site's suitability for rehabilitants requires a broad range of technical expertise and some critical features, notably the site's carrying

capacity, are difficult to estimate. While some projects are now making serious efforts to improve post-release monitoring, success to date remains relatively short term (*c*. 5 years).

Finally, new issues continue to arise. SOCP recently attempted to reintroduce a near-adult female born and raised in an Australian zoo. Some consider this unjustified on scientific, ethical, and conservation grounds (Beck *et al*. 2007) but others see it as justified by the benefits produced. West Australia's government launched a memorandum of understanding to help protect the megafauna of Bukit Tigapuluh because of West Australian involvement with SOCP in this area (Pratje personal communication). Second, rehabilitation's very success in locating, confiscating, and caring for refugee orangutans has contributed to a 'new' problem: rehabilitation centers are now so overcrowded with orangutans ineligible for return to free forest life that they are desperately searching for other ways to provide the sanctuary-like care needed.

Comparisons with other primate reintroductions may offer guidance on how best to move ahead. Many of the factors that influence the success of orangutan rehabilitation also apply to other primates, including features of primate adaptation, captivity effects, and program design. Common effects of captivity include: handicaps are created by impoverished social and physical conditions and missing sensitive periods for survival learning; prolonged captivity in inadequate social conditions from early in life is the most debilitating because it disrupts early experience in the wild and extends captive influences; and captive skills and habits interfere with acquiring survival competencies (Aveling and Mitchell 1982; Hannah and McGrew 1991; Beck *et al*. 2002). The common underlying theme is that success post-release depends on survival-related competencies. Learning then stands out as critical, as does development because it schedules, enables, and constrains learning (Russon 2003a; Stoinski and Beck 2004). The more programmes resemble species-normal life, the more effective they are then likely to be (Stoinski *et al*. 2003). In this light, providing early exposure to contexts that foster survival-related learning, notably near-normal physical and social environments, providing continuing support for learners, and methods attuned to sensitive developmental periods for learning and to the interfering effects of captivity all stand out as critical. Social themes in learning are also consistent with evidence of the importance of social learning and cultures (Russon 2003a; van Schaik *et al*. 2003a).

Additional factors identified in other primates ring true for orangutans (Hannah and McGrew 1991; Beck *et al*. 2002; Stoinski *et al*. 2003; Stoinski and Beck 2004; Strum 2005; Goossens *et al*. 2005b). Younger ex-captives tend to survive better than older ones. To be effective, pre-release programs may require years versus months of experience, and active teaching. Skills trained in captive settings may not transfer to forest life. Pairing learners with more competent conspecifics enhances learning. Intensive post-release care may have great value in maximizing short-term survival, but longer term effects need consideration. Adjusting to forest life probably continues beyond the first year and may occur in phases (e.g., a short-term phase of rapid change in the first one or two years after relocation, then a longer phase of more gradual change) and it may not reach optimal levels within the first generation. Changes may differ between the two phases, so short-term indicators may not be valid indicators of long-term outcomes.

While orangutan rehabilitation projects have not succeeded in quelling orangutan poaching, their efforts have not lacked impact. The forces that threaten orangutans are probably just too large for these projects to control: they include massive illegal wildlife trafficking; logging, first legal then illegal; forest conversion for oil palm plantations; and El Niño-linked droughts and fires (Rijksen and Meijaard 1999; Yeager 1999; Buckland 2005; Nellemann *et al*. 2007). These events have brought Bornean and Sumatran wild orangutans, respectively, to endangered and critically endangered status (IUCN 2007). Consequences for rehabilitation projects include unprecedented surges in arrivals of ex-captives and great difficulties in locating suitable sites to reintroduce them. It is unrealistic to think that a few rehabilitation projects funded by independent donors can effectively counter onslaughts of these proportions.

Finally, there is the issue of need. Ex-captive orangutan numbers continue to increase and

several rehabilitation projects are now bursting at the seams. Indeed, rehabilitation and reintroduction are products of our failure to combat the root cause of threats to orangutans—habitat destruction and hunting orangutans. As such, they are necessary services unless or until these problems are solved. All agree that the only real solution to rehabilitation problems is stemming threats to wild orangutan survival and that a main stumbling block has been enforcement. Until and unless enforcement and prevention are achieved, and in light of serious threats to the survival of wild great apes worldwide, providing care for great apes taken illegally from the wild and returning them to free forest life where possible remains a necessary service.

Acknowledgments

Thanks to Peter Pratje, Ian Singleton, Ben Beck, Purwo Kuncoro, and Joshua Smith for comments that contributed significantly to the quality of this paper. We are very grateful to several projects and individuals for contributing unpublished or original data, including Purwo Kuncoro, Peter Pratje, Ian Singleton, the BOS Foundation and its orangutan reintroduction projects at Wanariset and Nyaru Menteng, the Orangutan Research and Conservation Project, and the Sumatran Orangutan Conservation Project. Much of the empirical work that forms the basis of this chapter was conducted in Indonesia, so we are especially grateful to Indonesia's Ministry of Forestry, Nature Conservation Agency (PHKA, BKSDA), and Institute of Sciences (LIPI) for its sponsorship and support. The authors of this chapter also receive funding support for their orangutan-related research from the L.S.B. Leakey Foundation in the USA and the Natural Sciences and Engineering Council and Glendon College of York University in Canada.