

DECLINING ORANGUTAN POPULATIONS IN AND AROUND THE
DANAU SENTARUM NATIONAL PARK, WEST KALIMANTAN,
INDONESIA

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This paper presents the combined results of two separate orangutan survey efforts and an assessment of land cover change analysis in the Danau Sentarum National Park (DSNP), West Kalimantan, Indonesia. These studies show that the DSNP and surrounding areas contain high numbers of orangutans, making these populations of global significance to the species' survival in the wild. However, in the Park and its surrounding areas, 40,339 ha habitat disappeared between 1973 and 1990, and 32,586 ha between 1990 and 1997. This equals a total decrease of 29% in the total orangutan habitat over the last 27 years. In that same period contiguous habitat patches judged to be large enough to support a substantial orangutan population also decreased in number and in size. Therefore, orangutan populations in DSNP are likely in decline. In addition to this, the most recent land cover changes and land-use plans indicate that much primary orangutan habitat is still targeted for logging or conversion into plantations. The main reason for the decreasing trend in orangutan populations is that the present Park boundary does not include the most important contiguous orangutan habitats in the north and east of the Park. We therefore recommend extending the boundary of the present park to include prime unprotected orangutan habitat. Also, connecting the Park to the nearby Bentuang Karimun National Park would join two important, now segregated orangutan

populations and therefore improve the long-term survival prospects for the species in this region.

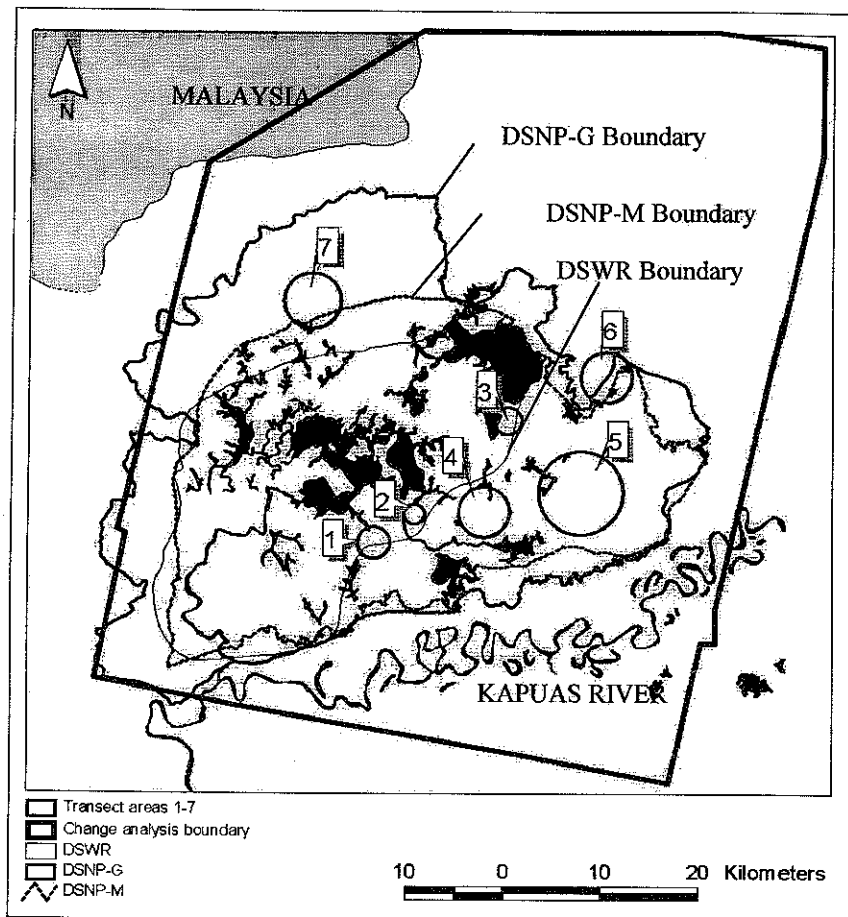


Figure 1. DSNP area protection boundaries, nest-count survey transect sites, and study area for vegetation analysis (solid black areas are lakes).

Introduction

The orangutan is now found exclusively on the islands of Sumatra and Borneo and over 90% of its habitat lies within the Republic of Indonesia. Rijksen and Meijaard (1999) estimated the 1997 orangutan population of Borneo to be 15,000 and that of Sumatra to be 12,000. Van Schaik *et al.* (in press) found that the orangutan's situation in Sumatra's lowland forests had drastically deteriorated since 1997 and updated Rijksen and Meijaard's estimate for the total Sumatran population to about 7,500. Van Schaik *et al.* predict that over the next ten years the Sumatran population will further decline to 4,500 in the most optimistic scenario, and to 1,500 in the more realistic one. The situation in Borneo is probably even worse. Experts now predict that the orangutan will go extinct

in the wild within the next 20 years unless significant changes in forest conservation are achieved (Rijksen and Meijaard 1999; van Schaik *et al.* in press). A major reason for the continuous decline in orangutan numbers is that humans and orangutans favor the same habitats, namely, alluvial flood plains and valleys. The outcome of the conflict is invariably losses for orangutans (Rijksen and Meijaard 1999).

Swamp forests are important for the conservation of orangutans because they represent prime orangutan habitat and are often less affected by logging and agricultural development than dry-land forests (Meijaard, 1997). These forest habitats offer high yields of soft-pulp fruit, orangutans' dietary mainstay, and can support orangutans at more than twice the density of other habitat types (Payne and Andau 1994; van Schaik *et al.* 1995b; Sugardjito and van Schaik 1992). The Danau Sentarum National Park (DSNP) region, with its core of seasonal lakes and freshwater swamps surrounded by peat swamp forest and hills, provides ideal habitat for orangutans (see Figure 1).

Despite the attractive habitat and suspected orangutan presence, incidental interviews and sightings suggested very few orangutans in the DSNP region by the mid-1980s (Giesen 1987). The probable reasons are, first, that orangutan presence is very hard to detect without specific search techniques and second, that human disturbance in the form of hunting and logging had driven orangutans away. Hunting in the region most likely concerns illegal trade in wildlife, not food. Orangutans live in close proximity to humans throughout the DSNP region (Meijaard *et al.* 1996); the human population in the greater DSNP area (DSNP-G in Figure 1) had reached 6,900 to 9,000 by the mid 1990s (Aglionby 1995). Inhabitants are mostly Muslim Malay fisherfolk and Iban Dayaks, who are unlikely to hunt orangutans for food for reasons of religion and cultural taboo. There are, however, some Iban that hunt and eat orangutan, and certainly the Maloh Dayaks that also occur in the area reported to be very keen on orangutan meat (Rijksen and Meijaard, 1999; pers. obs.). Logging has been a major source of human disturbance in the region and it commonly degrades areas of prime orangutan habitat (Payne and Andau 1994; Sugardjito and van Schaik 1992). Commercial logging from the late 1970s through the mid-1990s seriously degraded the swamp forest directly adjacent to DSNP. Much of that forest to the north, east, and west of DSNP was designated as Production Forest (Ministry of Forestry-National Forest Inventory 1993: see Giesen 1987; Meijaard *et al.* 1996).

Giesen (1987) had concluded that few orangutans remained around DSNP and those few ranged more or less permanently on relatively undisturbed high ground beyond the reserve's boundary. Two major issues provided the impetus to reassess the situation. As recently as 1995, almost no detailed information was available on Bornean orangutan distribution to guide habitat protection proposals (Rijksen *et al.* 1995; Soemarna *et al.* 1995). Meijaard *et al.* (1996) undertook a survey to establish orangutan presence in the DSNP region as part of a major effort to locate all remaining orangutan populations in Borneo (Rijksen and Meijaard 1999). Second, redefining the boundary and status of DSNP was under discussion. The original Danau Sentarum Wildlife Reserve (DSWR), designed to protect the region's unique wetland habitat, was gazetted in 1982 as an area of about 80,000 ha with a core of open lakes. Two extensions to the reserve were subsequently proposed (Figure 1), one of which has been implemented as a National Park (DSNP). The present DSNP boundary, a moderate extension of the Wildlife Reserve, appended about 50,000 ha of the hill areas to the southeast of DSWR plus the immediate catchment of peat swamp and low hills (Giesen, Deschamps, Dennis 1994). A second,

greater extension (DSNP-G) proposed to append an additional 60,000 ha covering much of the unprotected swamp forest beyond DSNP (Jeanes 1996). Neither proposal was designed for the specific protection of orangutans, so current quantitative estimates of orangutan distribution could help determine which proposal offers better protection of orangutan habitat. Russon *et al.* (1996) carried out a nest count survey to generate quantitative estimates of orangutan distribution in these three protected/potentially protected areas. In addition to the surveys, an assessment was made of the change in orangutan habitat between 1973 and 1997 in each of these three Danau Sentarum areas, based on remotely sensed data and field checks.

This paper summarizes present knowledge of the status of orangutans in the wider Danau Sentarum area. We analyze the most recent developments in the area and assess their potential impact on the remaining orangutans. Based on this we provide management recommendations for the Park.

Interview Survey

Meijaard *et al.*'s (1996) Danau Sentarum orangutan surveys were part of a Borneo-wide orangutan survey effort conducted between 1994 and 1997 (see Rijksen and Meijaard 1999). During that period, Meijaard made 4 visits to the greater Danau Sentarum area, followed by another recent one in October 2000. EM gathered information on orangutan presence mainly by interviewing local villagers and employees of timber and oil palm companies, and by collecting information from researchers and government staff in the DSNP area. Whenever possible, statements about orangutan presence were verified with concrete evidence (e.g., orangutan nests, locally captured orangutans, or hunting trophies like skulls). The data collected on orangutan presence were plotted on maps and compared with the distribution of potential orangutan habitat. Potential habitat was defined as all forest below 500 meter a.s.l., based on the 1995 forest cover data set made by the World Conservation Monitoring Centre (WCMC). An overlay of orangutan presence records and potential habitat generated an estimated distribution range.

These survey data indicated greater current presence of orangutans than expected and concentration of orangutans in swamp areas to the east and north of the lakes. Reports of orangutan presence in and south of Bentuang Karimun National Park, which lies 40 km to the northeast of DSNP, indicated that the DSNP orangutans were at the western-most limit of a much bigger population. Rijksen and Meijaard (1999) estimated the total remaining habitat available to the DSNP area orangutan population at some 600,000 ha, most of which is outside either of the two protected Park areas and rather fragmented. Present-day pressures on non-protected forest are such that the long-term survival of the orangutan outside the two Parks is considerably threatened. Considering the remaining amount of habitat and its suspected quality, these surveys suggested that the larger Danau Sentarum area could be of global importance for the survival of orangutans (Meijaard *et al.* 1996). The surveys also turned up evidence that trading in orangutans over the border into Sarawak, in Sawit (Kecamatan Badau), most likely involves orangutans from the DSNP region. Meijaard noted limited control of goods over the Indonesia-Sarawak border, near Badau, which would facilitate the smuggling of protected species like orangutans. However, because of the exploratory nature of the surveys, additional quantitative surveys were required to estimate population size and the conservation status of the area's orangutan population.

Orangutan nest survey

Subsequently, Russon, Erman and Dennis (in press) conducted a nest survey to generate quantitative estimates of orangutan distribution and the total orangutan population. Following van Schaik *et al.* (1995b), if nests are censused along line transects, the number of nests identified provides an estimate of nest density per km². This can be translated into estimates of orangutan density and of the total orangutan population.

Nests were censused along line transects in seven areas where Meijaard *et al.* (1996) obtained reports of recent orangutan presence. For each area, ± 3 km of line transect were sampled (per van Schaik and Azwar 1991). To minimize habitat variability within transects, area samples took the form of three 1-km or two 1.5-km transects (van Schaik *et al.* 1995b). Within the original Wildlife Reserve (DSWR), three areas were sampled (see Figure 1 for locations), (1) Hutan Nung, the protected forest southwest of Sekulat, (2) northwest of Bukit Pegah, and (3) a logged forest northeast of Leboyan. In the extension that generated DSNP, three areas were sampled, (4) Semujan and (5) Piat/Menyukung, two hill regions in the southeast, and (6) lowlands near Meliau. In the DSNP-G extension, one area was sampled, (7) lowlands in the largest block of the extension, to the north of DSNP. For more detailed description of methods, see Russon *et al.* (in press).

To factor differences in habitat quality into estimates, the habitat along each transect was classified in terms of two factors known to affect orangutan distribution, vegetation type and disturbance/degradation level (e.g., Rijksen *et al.* 1995; van Schaik *et al.* 1995b; Sugardjito and van Schaik 1992). Vegetation was classified into four types according to their capacity to support orangutans, based on vegetation features observed along each transect: 1. swamp/peat forest, 2. lowland hill forest, 3. open and fragmented forest (farmland, clearing, secondary forest), and 4. unusable (agriculture, regeneration after fire, recently burnt, settlement, water). Disturbance level was classified as low, medium, or high based on the overall degree of habitat damage observed along each transect (e.g., logged, burnt, farmed). Both classifications were verified against a 1990 Landsat Land Cover Map of the Kapuas Lakes region. Coverage of each habitat type was obtained from a Geographic Information System developed for the Kapuas Lakes region (Dennis, 1997) and recently updated on the basis of field surveys (Dennis and Kurniawan, 2000).

The nest census found few orangutan nests within DSWR. In the moderate extension, the present DSNP, moderate to high numbers of nests were found even though the areas sampled were designated Production Forest. Transects up hills and along the foot of a highly disturbed hill tended to reveal fewer nests than transects in adjacent lowlands. Nest counts along two transects near the Iban Dayak town of Meliau beg explanation. One transect passed through farming areas and a corridor of forest that ran between fruit gardens. In total 40 nests were located along this corridor although it was narrow, under 100 m long, and the only forest along this transect. The second transect, along the shoreline of a lake, generated a relatively high number of nests even though only one side was forested and that forest represented poor orangutan habitat (stunted inundated forest, repeatedly burned) (Giesen 1995). The likely explanation for these unexpected results is that both transects sampled an area just west of a large expanse of tall swamp forest, and transient or overflow orangutans from the swamp forest were traveling to feed on fruit

trees in this area. The swamp forest is classified as unprotected Production Forest and it lies just beyond the eastern DSNP boundary.

Table 1. Orangutan population estimates for the original DSWR, the present DSNP, and the greater proposed extension.

Habitat Type	DSWR			DSNP			DSNP-G	
	total pop.	habitat area ^a in km ² (% of total area)	added area ^a (km ²)	added pop. (total pop.)	habitat area ^a in km ² (% of total area)	added area ^a (km ²)	added pop. (total pop.)	habitat area ^a in km ² (% of total area)
swamp and peat forest	123 ^b	287 (36%)	189	573 (696) ^c	476 (36%)	403	1326 (2022) ^d	879 (44%)
Lowland hill forest	2	1 (0.1%)	63	113 (115)	64 (5%)	0	0 (115)	64 (3%)
open and fragmented forest	22 ^b	52 (6%)	31	35 (57) ^d	83 (27%)	143	61 (118) ^d	226 (12%)
Unusable	0	465 (58%)	225	0	690 (53%)	104	0	794 (40%)
TOTALS	147	805	508	721 (868)	1313	650	1387 (2255)	1963

^aall estimates of habitat areas are based on 1997 data.

^bdensity estimate for highly disturbed swamp/peat forest (0.43/km²).

^cdensity estimate for swamp/peat forest within DSNP (based on transects representing low to moderate disturbance, 3.03/km²).

^ddensity estimate for moderately disturbed swamp/peat forest (3.29/km²). This area was represented by three transects yielding exceptionally high density estimates, so we used a more conservative estimate for the whole area.

Transects in the greater extension, DSNP-G, generated the highest nest counts per km. These transects passed mostly through prime orangutan habitat, tall swamp forest with some peat near waterways. They tapped the edge of a large contiguous expanse of swamp forest that extends to the north and west of DSNP, up to the hills to the northeast and northwest and almost to the Sarawak border to the north. Numerous reports of orangutans from this forest and the forest's relatively low levels of disturbance suggest that orangutan densities may be similar across much of it. This swamp forest is contiguous with the swamp forest to the east of DSNP. It is currently unprotected Production Forest or Non-Forest (i.e. outside the area managed by the Ministry of Forestry).

Habitat-specific density estimates were used to estimate the orangutan population in each proposed protected area (see Table 1). Calculated population estimates are DSWR-147, DSNP-868, DSNP-G-2255.

These estimates are potentially upwardly biased. This nest survey, like others, was biased to higher density areas because of the statistical and practical difficulties of studying a sparsely distributed species (Rijksen *et al.* 1995; van Schaik *et al.* 1995a). Compensation was made for this bias by estimating relative to habitat type but travel difficulties also biased sampling to areas near waterways, which support

disproportionately high orangutan densities (Payne and Andau 1994; van Schaik and Azwar 1991). Upwardly biased estimates are problematic because they fail to detect the critical pattern for orangutans, dangerously small populations. Experts recommend correcting calculated estimates for systematic upward bias by a factor of 0.75, although the basis for this value is tenuous (Rijksen *et al.* 1995; van Schaik *et al.* 1995a; Tilson *et al.* 1993). Correcting the calculated estimates by 0.75 gives DSWR-110, DSNP-651, DSNP-G-1691. Corrected values may be interpreted as lower bound estimates (Rijksen *et al.* 1995), for 1996.

Forest cover and land use assessment

To relate the observed orangutan distribution to changes in forest cover and land-use patterns, RD conducted a land cover change analysis. Imagery used for the study of the Danau Sentarum area covered the period August 1990 through to May-July 1997 (Dennis and Kurniawan 2000) and included both Landsat TM and SPOT XS imagery. In a further project, the change analysis was extended back to July 1973 with Landsat MSS imagery. A site for vegetation change analysis was selected based on areas completely covered by the imagery from 1990 to 1997 (see trapezium shape in Figure 1). The resulting test site area is 425,650 ha and therefore includes a significant part of the vegetation beyond the National Park. In the test site, in total 21 different land cover classes were identified from the imagery and verified during fieldwork. For descriptions of the technical process, see Dennis and Kurniawan (2000).

The resulting vegetation maps for 1973, 1990, and 1997 were overlaid with the orangutan distribution. As no orangutan distribution maps exist for 1973 or 1990 it was assumed that orangutans occurred wherever there was suitable habitat, i.e., closed canopy forest. Although orangutans may temporarily occur in open or fragmented forest, it is assumed that these vegetation classes do not provide suitable long-term habitat. Results by Russon *et al.* (in press) support these assumptions. On this basis, the orangutan distribution for 1973 and 1990 was estimated by extrapolation. For each of the 3 years the total amount of orangutan habitat was calculated as the amount of closed forest. Furthermore, the mean size of each closed forest polygon was calculated to provide an estimate for average habitat patch size. Finally, the different habitat classes were evaluated for the proposed DSNP boundary.

Between 1973 and 1990, in the vegetation change test site, there was a 16% decrease in closed canopy forest and a 31% and 117% increase respectively in open and fragmented forest. The most obvious changes in orangutan habitat occurred in the swamps to the north and east of DSNP, where large gaps, especially around rivers, started to appear in what were previously closed and homogenous forest polygons. During these 17 years, some 40,000 ha of orangutan habitat disappeared.

Table 2. Overall change matrix 1973–1997.

Class name	Date: 1973 units: ha	Date: 1990 units: ha	Annual rate % 1973–1990	Date: 1997 units: ha	Annual rate % 1990–1997
Closed Forest	255,116	214,777	-1	182,191	-2.2
Open Forest	19,891	26,173	+1.9	44,501	+10
Fragmented Forest	11,949	25,938	+7.3	21,866	-2.2
Forest Re-	8002	8724	+9	12,367	+6

growth					
Shifting Cultivation Mosaic	61,507	41,650	-2	48,924	+2.5
Wood and Shrub	29,897	27,119	-9	27,027	-1.8
Grassland and Non-forest Regrowth					
Semi-permanent Agriculture	0	33,251		34,370	+0.5
Burnt Areas (incl new <i>ladangs</i>)	4,976	13,635	+10.8	20,224	+7
Water	33,901	33,903	0	33,903	0
Total		425,650		425,650	

Between 1990 and 1997, in the vegetation change test site, there was an 11% decrease in closed canopy forest, a 66% increase in open forest, and a 24% decrease in fragmented forest. Some of the most important changes from closed into open and from closed into fragmented forest occurred in freshwater and peat swamp forest to the west and east of the present reserve, in areas that our surveys showed to contain orangutan populations. More specifically, the total area of closed canopy forest decreased by some 24,000 ha, as shown in Table 2.

An analysis of the fragmentation effects of logging indicated that in 1973 there were 79 contiguous closed forest areas in the vegetation change test site with a mean size of 3,230 ha. This figure is strongly skewed by one very large contiguous forest area of 121,082 ha combined with a large number of smaller patches. In 1990, the number of contiguous forest areas decreased to 67 and their average size remained similar to that of 1973 (i.e. 3,205 ha). The size of the largest forest patch decreased by 20,000 ha to 100,964 ha. As of 1990, only one contiguous forest area appeared large enough to support a viable orangutan population, assuming an average density of 2 orangutans/km² and a minimum viable population of 2,000 (Sugardjito and van Schaik 1992; but other experts suggest that long-term survival may require a population of at least 5,000, e.g., Rijksen and Meijaard 1999). To identify areas in DSNP that could support substantial sub-populations, a minimum threshold of 10,000 ha was used (i.e., 200 orangutans). With this threshold, the number of contiguous orangutan habitat patches decreased from 6 to 5 between 1973 and 1997. This indicates that there remain 5 areas that may support substantial sub-populations; with active management (i.e. provision of extra feeding in times of food scarcity, enforcement of full protection from poaching, and possibly human-assisted gene flow between habitat patches), there may be a possibility that these sub-populations could survive in the long term. Figure 2 shows the change in closed forest areas between 1973 and 1997.

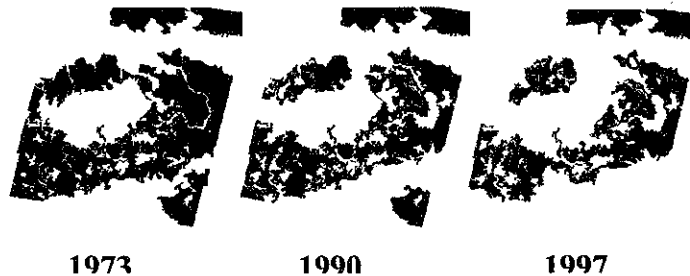


Figure 2. Forest fragmentation in DSNP between 1973 and 1997.

Discussion

The three surveys generated four main findings. First, a population of around 2,000 orangutans survives in the Kapuas Lakes region. The region supports an important orangutan population that may represent as much as 15-20% of the remaining Bornean population. Second, most of this population ranges in unprotected areas beyond DSNP. Findings concur with Giesen's (1987) impression, that the eastern hills beyond DSNP but within DSNP-G are important to the area's orangutans. Third, the highest orangutan densities are in swamp forests within DSNP-G, beyond DSNP. This is consistent with previous findings that the richest habitats for orangutans are good quality swamp/peat forest and lowland alluvial forest; they have potential to support orangutans at almost twice the densities of other habitats, like adjacent uplands (e.g., Payne and Andau 1994; van Schaik and Azwar 1991). Orangutans found in poorer habitat may migrate between habitat types according to food availability (te Boekhorst *et al.* 1990; Leighton and Leighton 1983). Fourth, both the total orangutan habitat and the mean size of contiguous habitat patches in the greater DSNP area decreased significantly between 1973 and 1997. Assuming that the overall habitat quality within the habitat patches remained constant, it can be concluded that the total number of orangutans in the DSNP area has declined between 1973 and 1997.

Finding unexpectedly high orangutan densities in some areas is more disturbing than encouraging. Some estimates were much higher than any found elsewhere Borneo. The likely explanation for exceptionally high nest densities in logged areas is that habitat disturbances elsewhere were displacing orangutans into these areas. The highest nest counts were from areas in the proposed extension just beyond the DSNP boundary. Orangutans could have been migrating into these areas from outer regions because of disturbances there (Meijaard *et al.* 1996) or from inside DSNP because of continuing disturbance due to increasing human pressure. Other areas of Borneo show similar patterns (Rijksen and Meijaard 1999) so the high counts may reflect population stress.

The assessment of the size of contiguous habitat patches in the wider Danau Sentarum area indicates that only one forest area may be large enough to contain a viable population of orangutans, assuming a minimum population size of 2,000. If the higher threshold of 5,000 is used, a contiguous forest area of at least 250,000 ha would be required. The present DSNP does not contain such areas, but an extension of the Park to the east and a link to the 800,000 ha Bentuang Karimun National Park to the northeast would encompass sufficient orangutan habitat to secure long-term survival (also see

Meijaard *et al.* 1996). Orangutan populations in other forest blocks in DSNP probably require management interventions. The degree to which this is necessary probably depends on the degree to which individual forest blocks are isolated from one another. Orangutans have been reported to travel distances of several km across degraded areas to reach better habitat (e.g. in the Kinabatangan River area, Sabah; near Samarinda, East Kalimantan). In DSNP, forest blocks are normally separated by waterways but waterways may dry up during seasonal droughts every 3-4 years. These dry periods would allow orangutans to migrate, so an important management issue would be ensuring that forest near waterways remains as undisturbed as possible to minimize crossing distances.

Findings show that the DSNP-G extension would offer important benefits to orangutans. Because of the distribution of habitat types, the 1.5-fold increase in reserve size offered by DSNP-G versus DSNP could support a 3-fold increase in orangutan numbers. The signs of population stress, however, indicate that protecting the area's orangutans requires extension beyond DSNP-G. GIS data show that DSNP-G stops short of unprotected swamp forests to the east, north, and west of DSNP. Orangutans ranging in the DSNP area likely depend on these swamp forests, perhaps migrating back and forth because of the area's pronounced seasonality. These data bolster recent recommendations to extend the park to cover all surrounding orangutan habitat and to create a forest corridor linking the extended reserve with the nearby Lanjak Entimau and Bentuang-Karimun National Parks and their important orangutan populations (Blouch 1997; Rijksen and Meijaard 1999).

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