

BORNEAN ORANGUTAN FACTS

45,000

Bornean orangutan (*Pongo pygmaeus*) is now estimated to number about 45,000-69,000 (Endangered)

GARDENERS

Orangutans are “gardeners” of the forest, playing a vital role in seed dispersal in their habitats.



50%

Bornean orangutan populations have declined by more than 50% over the past 60 years, and the species’ habitat has been reduced by at least 55% over the past 20 years.

3 - 5 YEARS

Females orangutan give birth to one infant at a time about every 3-5 years, so these species can take a long time to recover from population declines.

PAPER FROM RESPONSIBLE SOURCES

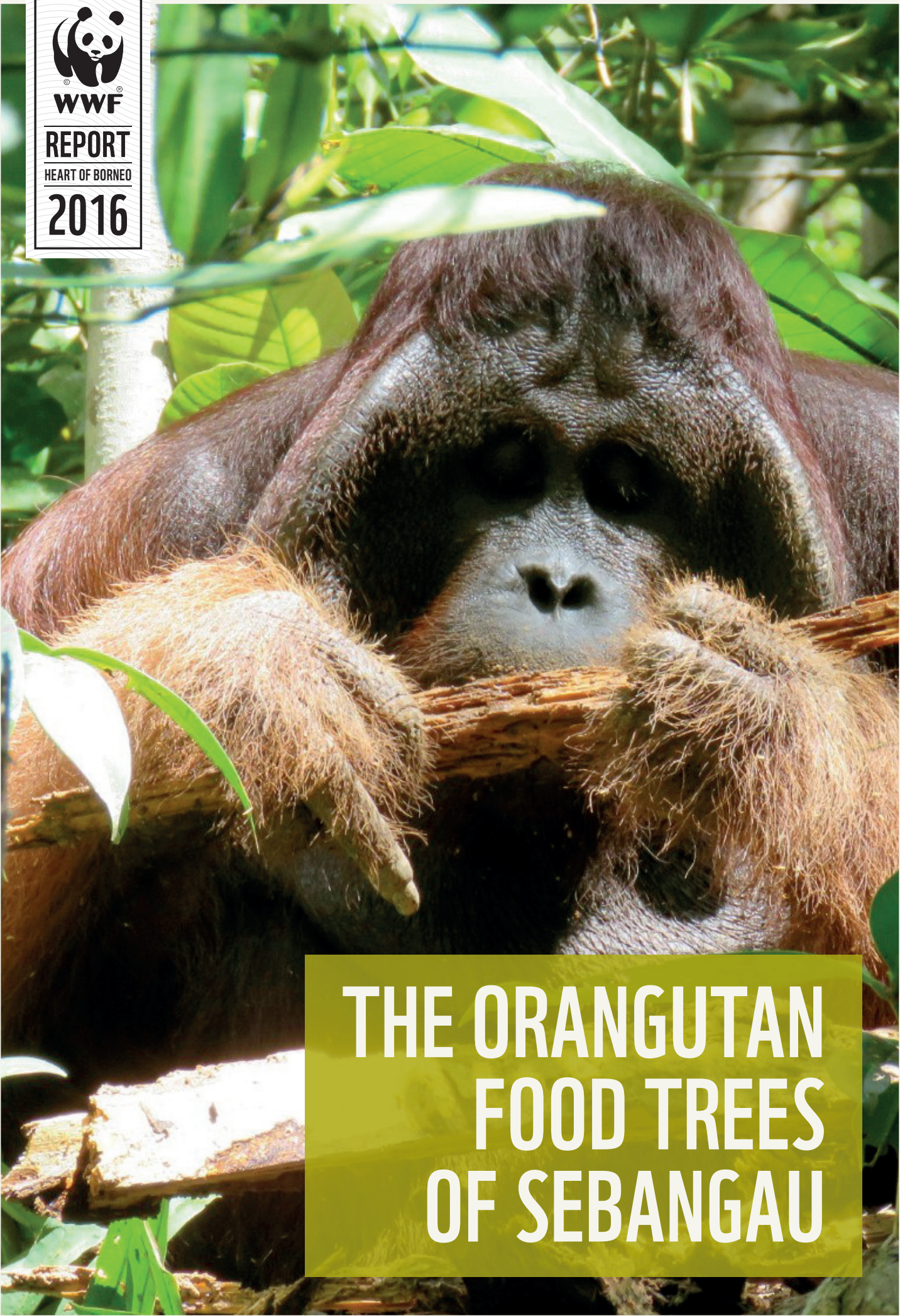
WWF · THE ORANGUTAN FOOD TREES OF SEBANGAU

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REPORT
HEART OF BORNEO
2016



THE ORANGUTAN
FOOD TREES
OF SEBANGAU

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WWF is one of the world's largest and most experienced independent conservation organisations, with more than five million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by: conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

HIGHLIGHTS AND CONCLUSIONS



We now know all the major tree species of Sebangau and know the species that produce fruits eaten by orangutans.



For the first time, the fruiting seasons of important tree species have been documented. The fruiting periods of each of the [favorite] orangutan food tree species are known.



We therefore also know when periods of low fruit availability occur, and what fruit species are important to provide food for orangutans during these periods. These trees can now be given special attention.



Locations of important fruit species are known now; this will give insight in the foraging movements of orangutans searching for fruiting trees. When a fruiting period of a certain tree species occurs, the locations with high concentrations of this species can immediately be checked.



As a result of climate change, regular annual patterns of high and low rainfall might change and consequently fruiting periods of food tree species. We will now be able to start making predictions on fruit availability.



We have confirmed the natural recovery of the forest and measured the speed of recovery. The individual trees grow very well and many saplings grow into bigger trees.



The new knowledge on fruit trees is directly applicable to our reforestation program. The most suitable food tree species will be planted. This will lead to a transformation of our replanting program. We will now plant more *Alangium*, *Elaeocarpus* and *Nephelium* trees.



Before the research was conducted, the major species used for replanting were timber species such as marsh meranti. These species often produce fruits that are hardly eaten by orangutans. Now we will focus much more on replanting fruit tree species, such as *Garcinia*, *Nephelium*, *Diospyros*, *Syzygium* and *Myristica*.

IMPACTS OF FIRES AND SMOKE



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Borneo was again violated by fires in 2015. Large areas of forests and shrub-lands got burnt and smoke heavily polluted the air for many weeks. Areas with peat soils were particularly strongly affected, because once the peat starts

to burn, the fires spread under the surface and these glowing fires can continue for weeks. Peat soils are normally saturated with water and hardly burn, but peat areas are disturbed and drained in many places and the dry peat burns easily.

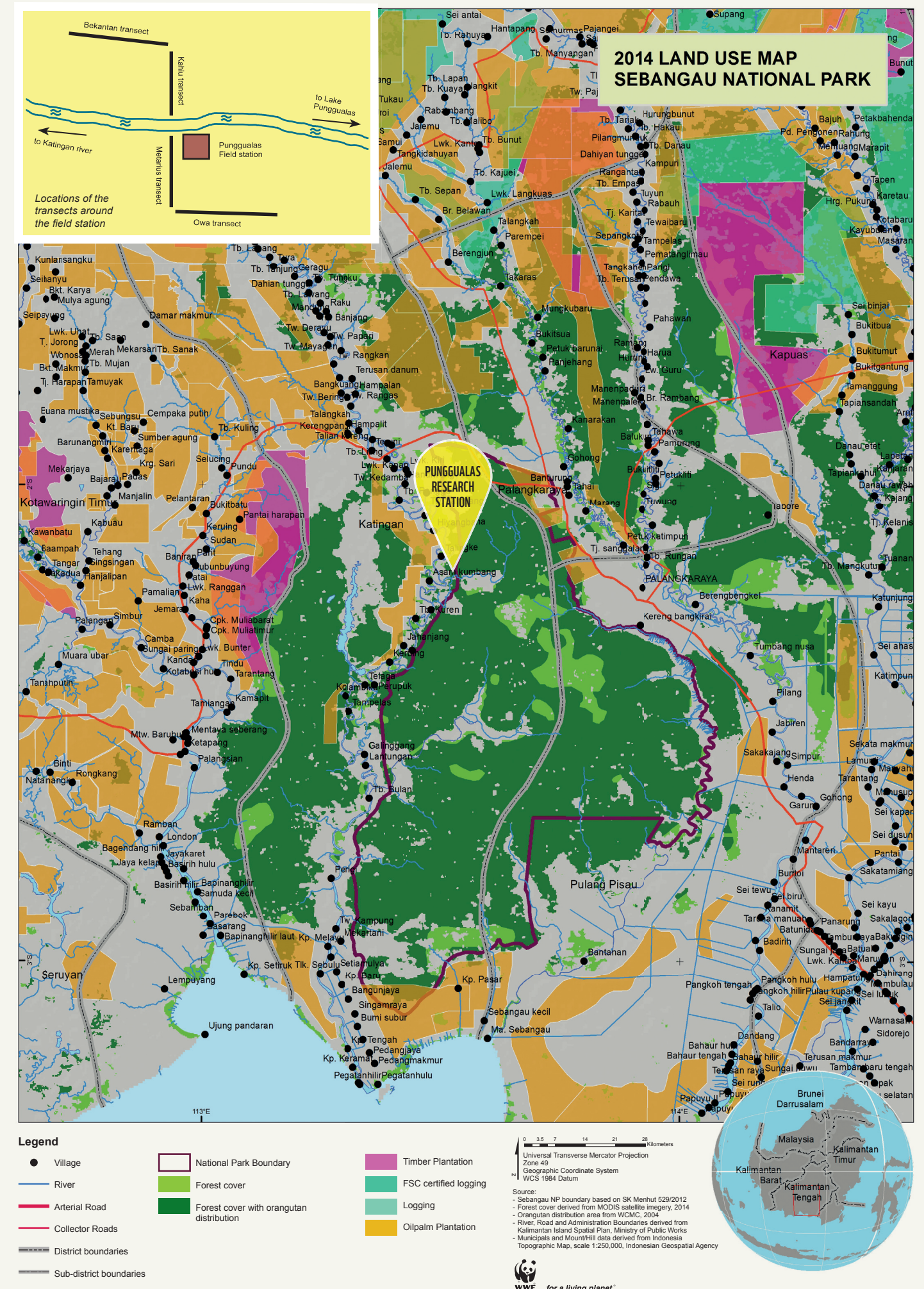
Wide areas bordering the Sebangau National Park became strongly affected by fires. Most sections of Sebangau, where the water retention capacity has been restored, were safe from fires. However, there were many fire spots at several locations inside the edges of the national park but also in the Sungai Bulan area in the interior of the park. Areas along the major rivers in particular got burnt in many locations. This has a major impacts on other wildlife that depend on these riparian zones as part of their habitats. One of these species is the endangered proboscis monkey.

Even in the interior areas of Sebangau far away from fire hotspots, the impact of heavy smoke was still very disturbing. The orangutans changed their behavior during the smoke season:

- they built their nests much earlier than normally
- the nests were much lower
- they ate fewer fruits
- they acted more aggressively toward observers.

No direct casualties of orangutans were reported from inside Sebangau, but several wounded and dead orangutans were found in areas just west of the national park. Orangutan habitats in many locations of Central Kalimantan were so much devastated that the orangutans had to be relocated, as was done by the BOSF organization.

A comprehensive study on the impacts of climate change was recently published. The predictions indicate strong climate change impacts to Sebangau for both the 2 degree as well as the 4 degree temperature rise scenarios. Large sections of the current orangutan habitats including most of Sebangau might become unsuitable. These impacts need to be anticipated urgently. Habitat restoration and planting new fruit trees for orangutans can be helpful. Orangutans will require better opportunities to migrate to higher and cooler habitats in the north, and there the preservation and restoration of landscape connectivity is of major importance.



INTRODUCTION



Sebangau National Park is a very large area (568,000 ha) in the southern part of Borneo, in the Indonesian province of Central Kalimantan. Most of it comprises swamp forests, in various development stages ranging from very open shrublands to closed canopy high forest. The area is famous for its large population of orangutans, one of the largest populations in Borneo.

In 2007, the estimated average number of individuals was 5,400 orangutans. The next survey was conducted in 2015, and found an estimated average number of 5,826 orangutans. This implies a population increase of 7.8%. Sebangau was officially established as a national park in 2004, with active involvement by WWF from the very beginning. This includes the management of the national park in collaboration with all stakeholders, restoration of damaged areas through dam building and replanting, and long-term research on the functioning of the ecosystem and its inhabitants, especially the orangutans. The orangutan population is doing well nowadays, with increasing numbers of individuals inhabiting the previously disturbed areas.

A research station was established in a severely damaged area in the eastern section of Sebangau, where large stretches of land had been logged, burnt and drained by canals. Research conducted at this station is mainly on terrain rehabilitation and replanting. The second research station, called Punggualas, was established in 2010 in the western section of Sebangau. The station is located in the middle of dense peat swamp forest with high densities of orangutans and many other animal species.



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Impression of the Punggualas station with two of the transects.

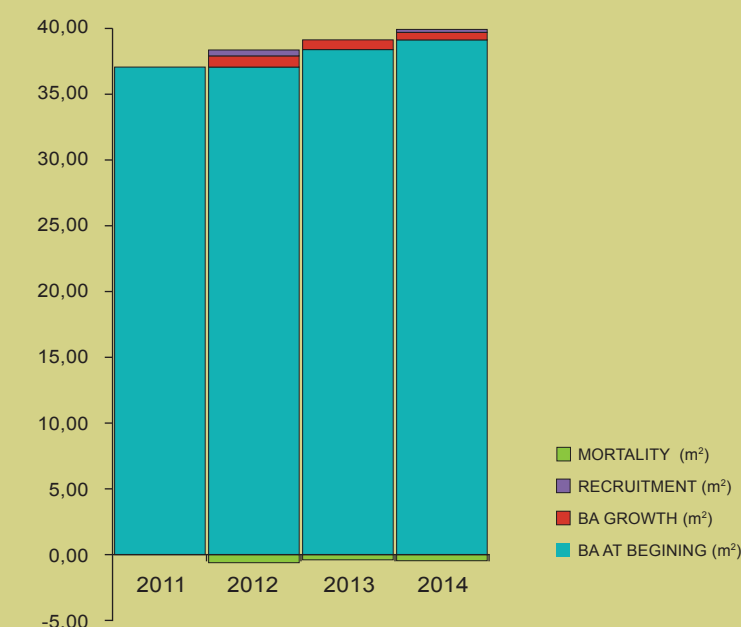
All trees in the permanent transects were measured for the first time in 2011 and this is repeated once a year. The diameter of each tree is measured at a fixed and marked point at the bole, so that the annual increase of the diameter can be precisely measured. The area (in square centimeters) of each tree is calculated from the diameter. The total area of all trees in the transect is the so-called Basal Area which is the theoretical surface occupied by all the boles. The basal area in square meters per hectare is the general measure for occupancy. The growth of a forest can be measured by annually checking this basal area.

A REPRESENTATIVE EXAMPLE FROM ONE OF THE PERMANENT TRANSECTS

The basal area in the first year of measurement was 37.12 square meters (m^2) per hectare (ha). In the next year this basal has already increased to 38.52 m^2 per ha. Most of this increase was attained just by the diameter growth of all the trees; some additional increase was caused by the saplings that grew into trees in one year time. Between 2011 and 2014, no less than 75 young trees reached the diameter class of 10 cm or higher. Naturally there were also some trees that died during this year but that number is much lower than the growth. Most of these were small trees that could not cope with the increasing competition for light through the canopy.

After three years the total basal area had already increased by 3.6 m^2 , which is very fast for a mixed natural forest. The rapid increase by growth and recruitment will continue for many years to come, until the forest canopy is entirely closed again by mature trees in all sizes.

It can be clearly seen that the trees of the peat swamp forest grow fast and that many of the saplings develop well. Only a few trees died during this period, leaving the remaining forest stand with healthy and vital trees. This development will continue for many years, until the forest is full again with the normal ratio of big and smaller trees.



PRODUCTIVITY

Tropical forests are dynamic ecosystems with continuous developments of flora and fauna. Trees grow in height and in width, with increasing diameters of their stems, until they die and collapse, returning their minerals to the soil. Seedlings develop into saplings, and some of these grow into trees.

The under-storey of a peat swamp forest usually has a dense cover of herbs and seedlings which follows the dynamics of the water level fluctuations. During the wet season, most of the peat swamp forest is inundated and a dense cover of plants of the forest floor grows in the water. During the dry season higher locations of the peat soil become exposed and some of the herbaceous plants become dry.

Much of the forest of Sebangau was subject to illegal logging until a decade ago, and in many locations the largest trees were removed by the loggers. Canals were dug throughout the area which resulted in a dramatic change of the hydrology with peat drying out during the dry season making it vulnerable to fires.

Nowadays the area is protected and disturbances have been reduced to a minimum. The forest is now being restored in the worst disturbed locations by closing the canals and replanting of open areas. In locations where there is still a decent canopy cover, the forest can recover naturally.

This recovery can be measured by routinely examining the diameters growth of the trees and the sapling that grow into new trees. There are always some trees that die naturally, but this mortality is much lower than the growth of the recovering forest.



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“since 2010, 1,227 nests have been counted and every month new nests are found in the survey area”

A network of permanent transects with a total area of 400 ha was established the next year to facilitate the long-term research on the forest ecosystem. Each has distance markers along its trail and all trees along the transects have been tagged and recorded. All transects were given names so one knows directly where a certain observation was made. The transects are surveyed on a regular base for sights and marks, including nest counts of orangutans and other wildlife. Since 2010, 1,227 nests have been counted and every month new nests are found in the survey area. Most of the nests are found in the lower canopy of the densest forests. The number of orangutans spending time in the research area has increased, with at least three new individuals (an adult male, a young male and an adult female). Camera traps are used for supplemental mammal surveys (such as sunbears), bird species are surveyed with tele-lenses, and additional inventories are made of fish, frog and snake species.

Phenology:
patterns and periodicity
of leaf and fruit production
of the tree species

Once a month each tree along every transect is examined for new leaves, dead leaves, flowers and fruits. This is done to obtain knowledge on the patterns and periodicity of leaf and fruit production of the tree species, called “phenology”. It is very important to obtain knowledge on the fruiting intensities of the forest, as it provide essential insight in the functioning of the entire ecosystem and its inhabitants.

TREE SPECIES OF SEBANGAU

A very high number of tree species can be found in the peat swamp forests of Sebangau. The tree species along the largest transects have all been identified and herbarium material is available.



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Right behind the station is a loop trail with name plates on all the common tree species, which is helpful for people who want to get to know some of the species. More than 200 tree species have been identified in Sebangau, and about 30 of these species can be considered very common, found in many locations of the forests. A few species originally comprised the major components of the forest canopy because of their large sizes and high numbers. The *Shorea* trees were often the largest trees in the forests with wide crowns towering over the canopy. Most of the large trees were removed during the illegal logging period, but *Shorea* trees are still very common and will gradually recover the canopy. *Gonystylus* trees were also important components of the canopy, but recovery of this species is slower. *Diospyros borneensis* was previously an important component of the canopy and is still very common, as relatively few trees of this species were removed.

Some species have become more common after the opening of the canopy by logging. The best example of this is *Campnosperma coriaceum*, which is a light-demanding species. Some of the most abundant species include *Litsea*, *Elaeocarpus* and *Evodia glabra*.



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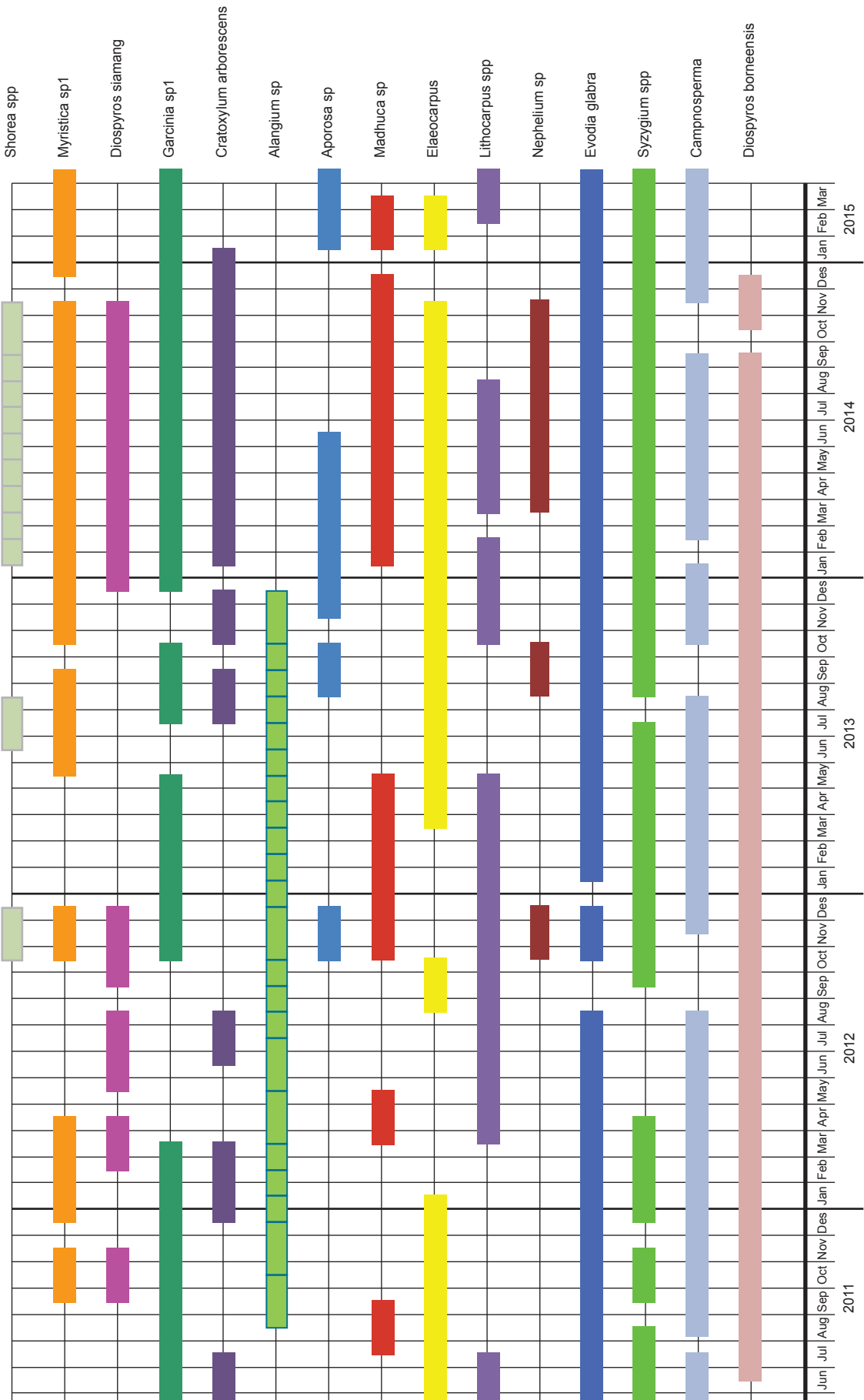
Favorite orangutan fruits of Sebangau:

- Garcinia* (wild mangosteen),
- Nephelium* (wild rambutan),
- Myristica* (wild nutmeg),
- Diospyros* (wild kaki & persimmon)

The most abundant of the orangutans' favorite fruit trees are the wild nutmegs (*Myristica*) and the wild guavas (*Syzygium*). *Nephelium* trees are quite common scattered throughout the forest, but another favorite, *Garcinia*, can only be found in certain locations.

The forest floor is in many places covered by sedges (*Cyperaceae*), growing in clumps. The characteristic pandan shrubs can be abundant forming a dense shrub layer of spiny leaves. Occasionally orangutans eat the young shoots of these plants. Climbing rattan palms grow scattered throughout the forest and the fresh cores of the stems provide some additional food for orangutans. Small numbers of *Nepenthes* pitcher plants grow scattered throughout the forest and obtain their nutrients mainly from the insects that get caught inside the pitchers. A high number of epiphytic plants grow on the stems and in the crowns of the older trees. Lianas are common in many locations and the fruits and flowers of many of the Liana species are eaten by orangutans.

The fruits of the trees appear in a very high variety, of course, with species from so many different plant families. Some species produce rather large fleshy fruits, while other species produce small berries or hard nuts. Some species produce fruits very often, nearly every month, while other species produce fruits only once a year or even less often. Most of the fruit species of this peat swamp forest are not very colorful; the colors are often green, brown or dull yellow, only a few fruit species are red. The sizes are generally quite small; most fruit species are within the 1-4 cm range and very few are larger than 6 cm. Orangutans appear to have a preference for the larger fruit species, but will also eat the small berries of a species such as *Campnosperma coriaceum*.



CALENDAR OF FLOWERING PERIODS OF COMMON TREE SPECIES OF SEBANGAU

Shorea spp. (Dipt.) Meranti

The genus *Shorea* is the source of Meranti timber, and the *Shorea* trees of Sebangau underwent the same fate as the Ramin trees. There are more than 100 species of *Shorea* species in Borneo, and in a wide variety of ecological and morphological characteristics. In the peat swamp forests of Sebangau, three species are very common, but as with Ramin, are nowadays found only in smaller diameter sizes. Recovery is almost as fast as Ramin and 50 years from now *Shorea* trees can be the largest components of the forest canopy again. *Shorea* trees follow very irregular fruiting patterns with often several years without fruiting and then a period of high fruiting intensities, which is known as “mast fruiting”. The winged and somewhat fatty fruits of *Shorea* are a well-liked additional food source for orangutans.

PERIODS WITH LOW
FRUIT AVAILABILITY

Fruit availability is not constant throughout the year and can be low during certain periods. Two of these periods have been recorded since the beginning of the phenology research at Sebangau. It is important to know the food sources to orangutans during these periods as it reveals the crucial species that bridge these periods and thus might require additional protection or rehabilitation.

In September 2011, fruit availability in the forest was very low. The only species that were producing considerable amounts of fruits were *Alangium sp.*, *Litsea sp.* and *Nephelium sp.*

“orangutans were frequently seen concentrating on the fruiting trees of *Nephelium*”

It was not easy for the orangutans to get enough fruit during this period. The fruits of *Alangium* and *Litsea* are quite small. *Nephelium* fruit however is larger and one of their favorites; orangutans were frequently seen concentrating on the fruiting trees of this species. This species is found scattered throughout most parts of the Sebangau forests. Orangutans were otherwise eating more leaves than usual and were also feeding on rattan shoots and small amounts of tree bark.

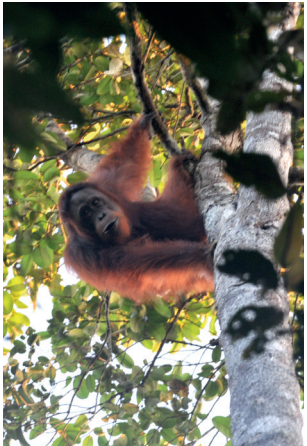
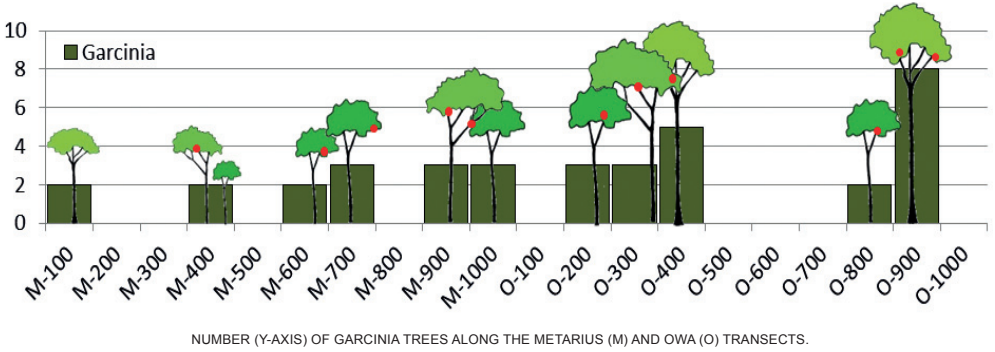
Another period with lower fruit availability occurred in August and September 2012. *Alangium sp.* was again one of the species that was fruiting intensively during this period. *Elaeocarpus* was also fruiting and these fruits are very nutritious for orangutans. A minor fruiting period of *Lithocarpus* occurred during these months, with a limited volume of fruits (acorns) available. *Diospyros borneensis* trees were fruiting but with low intensities and a few *Myristica* fruits were available as well.

This information leads to the recommendation to stimulate the natural regeneration of *Alangium* and to increase the number of *Alangium* saplings planted in the reforestation program. Neither in 2013 nor in 2014 did a noticeable period with low fruit availability occur. This might be related to the fact that in these years the dry period with lower rainfall was less prominent.

“Orangutans appear to have a preference for the larger fruit species, but will also eat the small berries of a species such as *Camposperma coriaceum*”

Research has been done on the food sources of orangutans, revealing a variety of plant species. The number of plant species eaten most often is however only a relatively small portion of the total number of species of tropical forests. Large fleshy fruits are often the favorite food of orangutans but other fruit species are eaten as well, including even rather hard and sour nuts. Leaves are also eaten quite often and the orangutans appear to be less selective for these, as long as the leaves are not too old and not too leathery.

The locations of all the tree species along the transects have been measured and mapped. It is now known for each tree species where to find high concentrations of that species. This facilitates the efficient planning of wildlife observations around trees that are fruiting during certain periods.

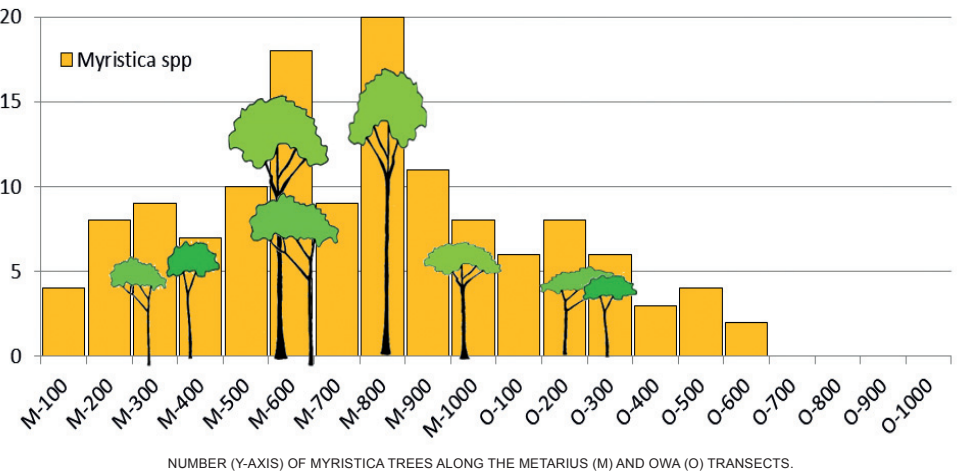


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For instance, wild Mangosteens (*Garcinia spp.*) are very much liked by orangutans and many other mammal species. Many mature trees of this species are found after 800 meters along the Metarius transect and between 140 and 400 meters along the Owa transect. Surveys concentrated at these locations during the fruiting period of wild Mangosteen will likely be rewarded with observations of primates, squirrels or civets.

The rambutan fruit of the forest, *Nephelium*, is another favorite of orangutans. These trees grow scattered throughout all of the transects, but are particularly common at the first section of the Bekantan transect.

The trees that produce the *Myristica* fruits are more abundant than the previous species, with up to 20 trees in a 100 meter section of the Metarius transect. At the end of the Owa transect however, *Myristica* trees are absent, as shown in the graph below.



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Measuring and identifying
trees along the Metarius
transect



Alangium can play an important role by producing fruits during periods of low availability of other fruit species. *Alangium* trees however grow only at farther locations, such as the last sections of the Owa and Bekantan transects. This species is almost absent at the Metarius and Kahi transects, so surveyors better walk some distance before starting their observations during these periods.

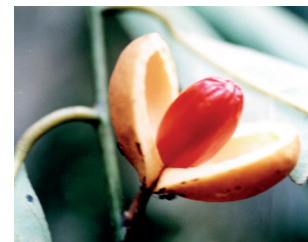
The fruiting periods of *Litsea* are comparable to those of *Alangium*, but *Litsea* trees are much more common. Many can be found at the first section of the Metarius transect and throughout the Kahi transect; *Litsea* is one of most numerous tree species throughout the Bekantan transect.

PHENOLOGY Tropical trees from peat swamp forests generally bear leaves the whole year around. Still, certain periods can often be distinguished during which many new leaves are produced as well as periods during which many old leaves are shed. After several years of recording these events for each tree along the transects, it is possible to recognize certain patterns.

During the months of July to October, only about 40% of all the trees produce new leaves. The lowest leaf productivity is in September, when only about 20% of the trees bear young leaves. This implies a lower food availability to animal species feeding mainly on leaves, such as *Presbytis* leaf monkeys. It also implies a more limited diet for orangutans, which feed on fresh leaves but not so much on old leaves. From December to April, nearly all of the trees (100%) produce smaller or larger amounts of new leaves.

Old leaves are shed throughout the year, though generally in small amounts. It is very uncommon to find a tree with an open crown having shed most of its leaves. Usually at least 50% of all trees shed some leaves throughout the year. During the months of July and August, almost all of the trees shed some leaves.

“Flowering and
fruiting of the trees
are naturally strongly
correlated, as fruiting
occurs after flowering
and pollination”



Myristica spp. (Myrist.)
© WWF-INDONESIA / STEPHAN WULFFRAAT

Myristica spp. (Myrist.) “wild nutmeg”

Two species of wild nutmeg are very common in the forests of Sebangau, each with different fruiting characteristics: the red nutmeg and the white nutmeg. The fruits of these wild nutmegs are up to 6 cm long, and consist of a large seed (the actual nutmeg), covered by arils (the mace) and then a fleshy layer, which is eaten by orangutans.

The red wild nutmeg is often starts fruiting in November or December, and then usually in short periods of 1-2 months. The number of fruits per tree is not high, but these trees are very common.

The white wild nutmeg is fruiting more often than the red nutmeg, and during longer periods (up to 4 month) which often start around April. This species has however a more limited distribution than the red nutmeg. This implies that nutmeg fruits are available to orangutans during many months of the year, however except during the months of September and October these fruits are rarely found.



Nephelium sp. (Sapind.)
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Nephelium sp. (Sapind.) “wild rambutan”

The fruits have a similar shape, though smaller, as the common rambutan and are one of the favorites of orangutans. They can also eaten by humans, tasting sour but sweet when fully ripe. The bark of this species can be recognized easily by the orange color and dots and the trees grow scattered in most locations with a closed canopy. The wild rambutans are often fruiting around October. There is however no guarantee for fruiting once a year and sometimes long periods of more than a year without fruits occur.



Syzygium spp. (Myrt.)
© WWF-INDONESIA / STEPHAN WULFFRAAT

Syzygium spp. (Myrt.) “wild guavas”

Trees of the genus *Syzygium* are very common in the forests of Borneo, from the peat swamp forests to the upper montane forests. The genus comprises a high number of species, which are often difficult to distinguish from each other. All of the species have in common that they produce fleshy fruits, that are eaten by orangutans. The wide variety include some species with rather large fruits (up to 5 cm), but most are with small fruits.

Fruiting of *Syzygium* trees occurs during most months of the year, but not during the driest months of August and September. The number of fruits per tree is rather low (less than 20% of the branches) and fruiting intensity is relatively constant without peaks.

Gonystylus spp. (Thymelaeaceae) - Ramin

Trees of the genus *Gonystylus* are the source of the well-known Ramin wood, which used to be in high demand in the international timber trade. Ramin trees were abundant throughout the forests of Sebangau, but most of the larger trees were taken out during the period of illegal logging. Ramin trees are still common here, but are found only in the lower diameter classes (below 20 cm). The forest is however recovering rapidly and gradually more and more Ramin trees reach maturity.

During the first years of phenology recording hardly any fruiting Ramin trees could be found, but nowadays fruits are found more often. In June and July 2014 a number of trees were seen to be fruiting, and these observations will increase as more trees are growing into larger sizes.



Elaeocarpus spp. (*Elaeoc.*)
© WWF-MALAYSIA / DONNA SIMON

stems are angular, and the bark is black but relatively smooth compared to most other *Diospyros* species. This species is rarely fruiting: between June 2011 and December 2013 it was fruiting only once, and even then not all of the trees. Each tree produced however many fruits and this attracted orangutans as well as other mammals. The species grows under a forest canopy and is thus not suitable for reforestation purposes in degraded areas.

***Elaeocarpus* spp. (*Elaeoc.*)**

This species is common in most areas of Sebangau and is an important food source for orangutans. The fruits are oval-shaped and up to 3 cm long, fleshy with a seed inside. The trees produce fruits several times a year, and every 3 or 4 months there is a short fruiting period. *Elaeocarpus* trees are often fruiting during periods when hardly any other tree species are fruiting, and thus are very important to the survival of orangutans in this area.



Garcinia sp. (*Gutt.*)
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***Garcinia* sp. (*Gutt.*) - “wild mangosteen”**

The fruits of *Garcinia* are large with a diameter of up to 8 cm. It is one of the largest fruits of the peat swamp forest of Sebangau, where larger fruits (such as the wild durian and wild jackfruit) are rarely found. The fruits contain about five juicy particles and are very much liked by orangutans and other mammal species. Even to humans these fruits are quite good to eat once one gets used to the sourness. This tree species produces fruits fruiting at least once a year, usually in November-January. Another fruiting period occurs often times in the middle of the year. Fruits are often produced in high intensities with large amounts during peak periods. Empty skins can then be found all around the vicinity of the fruiting tree, as orangutans and monkeys have picked and eaten most of the fruits from the tree.



Lithocarpus spp.
© WWF-MALAYSIA / DONNA SIMON

***Lithocarpus* spp. Tropical oaks (*Fag.*)**

The fruits of *Lithocarpus* resemble the acorns of oaks (*Quercus*). These fruits are pulpy and contain some tannin, but orangutans like to eat them. The species grow scattered throughout the forests of Sebangau, but only in those locations that are inundated during short periods as they cannot stand several months of inundation. Fruiting is usually once a year around April and May and fruit productivity can be high with more than a kilogram of fruits per tree. Minor fruiting periods might occur during other months of the year.

***Litsea* (*Laur.*)**

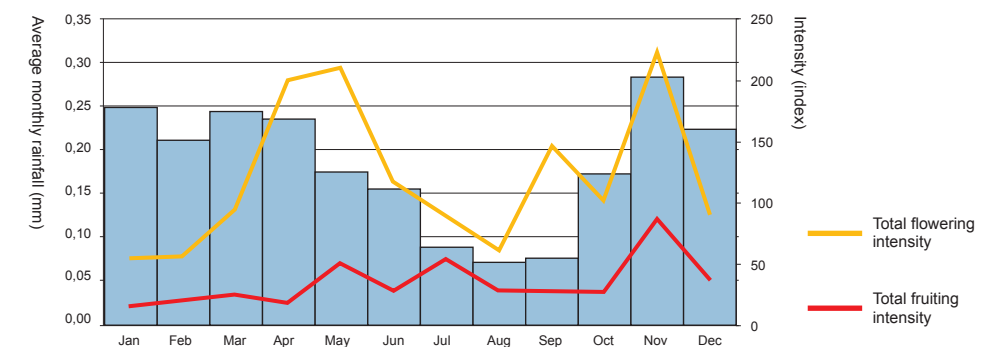
This species is abundant in certain locations, but absent in others. Their distribution is probably correlated to the composition of the peat soil. The fruits are generally smaller than 1 cm in diameter, and are placed in cupules. Each fruit has a large seed, surrounded by some flesh. The fruits are eaten by orangutans but given the shape of the fruit with its hard cupule, they need a large amount to fill their stomachs. *Litsea* is regularly fruiting each year from November to January.

***Madhuca* sp. (*Sapot.*) “wild custard apple”**

The skin of the fruit of this species is full of white latex, which starts dripping as soon as the fruit is picked or cut. Notwithstanding this sticky latex, this fruit is liked by orangutans. The fruits are small but grow in bundles, and are of a greenish yellow color. *Madhuca* trees grow scattered throughout the Sebangau forest. Fruiting does not occur often and only during irregular, short periods. Each location in the Sebangau forest has a different fruiting period for *Madhuca*, which makes it very hard to predict where the next fruiting period will occur.

The intensity index provides a better insight whether many or few amounts of leaves are produced or shed. By far the highest amounts of new leaves are produced during the months of January to April. The amounts of new leaves are low during the months of July to September. The amount of dead leaves is higher than the amount of new leaves during this period. Otherwise the amount of shed leaves appears to be rather constant throughout the year.

The production of new leaves coincides to a certain extent with the rainfall distribution throughout the year. During the driest months, with the lowest rainfall, the amounts of new leaves produced are at the lowest level. Once the rainfall increases, leaf production also increases, with the highest production during the wettest months.



“Occasionally (less than 5%) orangutans eat the flowers of certain species”

Flowering and fruiting of the trees are naturally strongly correlated, as fruiting occurs after flowering and pollination. The percentage of trees flowering can be quite high with up to one quarter of all trees producing flowers. Occasionally (less than 5%) orangutans eat the flowers of certain species. The highest numbers of trees flowering occur in the months of April and May, while during the months of October and November less than 5% of all trees bear flowers. The flowering intensity index takes into account not only the number of trees flowering, but also the percentage of the branches of each tree that are bearing flowers.

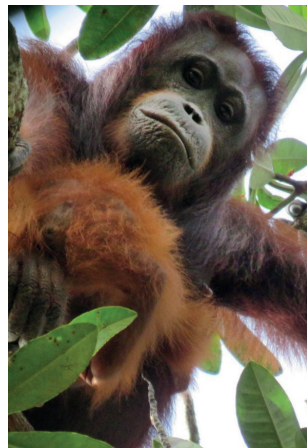
Flowering intensities can be quite high, even during periods with few trees flowering. Those few trees often bear high numbers of flowers, taking advantage of the temporary limited competition from other trees. The highest overall flowering intensities are of course recorded during the months of April and May when the highest number of trees are flowering. Flowers of most of the peat swamp forest trees are not very conspicuous: most of them are small and colored greenish yellow. Still, the forest canopy looks very special during periods of high flowering intensity, with many shades of light green.



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Flowering periodicity appears to be correlated to rainfall patterns. Flowering intensities are the highest at the end of the rainy season and the beginning of the drier season. The lower rainfall and particularly the increased number of days without rain appear to trigger the flowering of many trees. The flowering intensities gradually decrease with the ongoing drier period and are the lowest during the driest month of August. The increasing rainfall at the end of September coincides with higher flowering intensities, which continue during the first months with heavy rainfall. The ongoing rainy season with rain days almost every day in January and February coincide with the lowest flowering intensities of the year.

“Orangutans appear to have a kind of knowledge of the fruiting periodicity for their most important food species”



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The intensities of trees fruiting are always much lower than intensities of flowering, as only a portion of all the flowers develop into fruits. Many flowers drop from the trees before fertilization and it is a common sight to find the forest peat floor covered in dead flowers. Flower consumption by animals other than orangutans is also a rather important issue in the peat swamp forests.

It takes time from pollination to fruit development, and fruiting periods are therefore some weeks later after the flowering periods. On the other hand, fruits will often remain longer on the trees than their flowers. The highest fruiting intensities therefore occur during the months of May and July with another fruiting peak in November following the increased flowering in September and October.

This high level of fruiting can often be noticed by the many fruits dropped to the forest floor. The lowest fruiting intensities occur usually during the months of September and October. The amounts of fruits available during these months are indeed much lower, which has major impacts on the diet for orangutans and many other animal species such as sunbears, civets, squirrels and hornbills.

Following flowering, fruiting periodicity also appears to be correlated to rainfall patterns. The massive flowering at the end of the season with the highest rainfall is followed by increasing amounts of fruits during the next months. Fruit availability decreases during the driest months.

It is very important to obtain knowledge on the fruiting intensities of the forest, as it provides essential insight in the functioning of the entire ecosystem and its inhabitants. The fruiting periods and intensities of all the major species have now been recorded and are starting to show some regular patterns.

The fruiting periodicity of the various tree species show many different patterns and strategies. Orangutans appear to have a kind of knowledge of these patterns for their most important food species. This was observed by long-term orangutan researchers (Rijksen, Galdikas). They move from one location with fruiting trees to another and they might spend a few days at a particularly “fruitful” location.

Some species produce fruits **almost constantly**, discontinued only by short intervals of recovery. Most species however produce fruits **only during certain periods**. It is often possible to recognize a regularity or periodicity in the fruiting patterns of these species. Many species produce fruits once or twice a year, often during certain months. Some species produce fruits **only infrequently** and not even every year. Fruiting of such species is often triggered by natural phenomena such as extreme droughts.

THE FRUITING CHARACTERISTICS OF THE MOST COMMON SPECIES OF SEBANGAU

Alangium sp (Cornaceae)

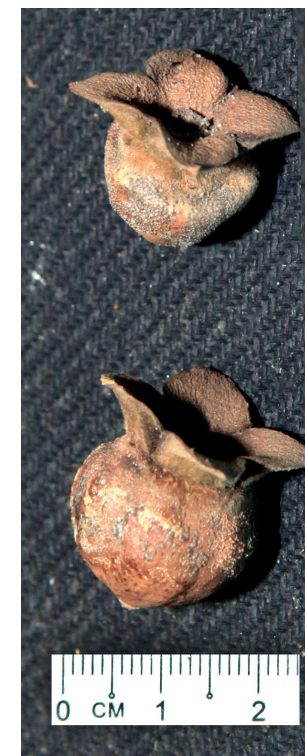
The fruits of this species are small (about 1.5 cm) berries, which are red when fully ripe. *Alangium* fruits are placed in small panicles, with about 6 fruits per panicle and several panicles on a branch. These fruits are eaten by orangutans and although not one of their favorites, they play an important role as food source during periods with few other fruits available in the forest. They usually break the entire branch instead of picking each panicle. The tree species in common in certain locations of the deeper parts of the forest, such as the last sections of the Owa and Bekantan transects. Fruiting does not follow very specific fruiting periods recognizable as such and the trees can produce fruit several times a year, but long periods without fruits can also occur.



Alangium sp (Cornaceae)
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Campnosperma coriaceum
© WWF-INDONESIA / STEPHAN WULFFRAAT



Diospyros borneensis (Eben.)
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Aporosa sp. (Euph.)

This species is common throughout the forest of Sebangau and is an important food source to many animal species. Although the fruits are small (less than 2 cm) and contain three large seeds and little flesh, they grow on spikes with many of these fruits. Orangutans and other primates can just pick the spikes and eat the fruits one after the other. Fruiting occurs during short periods once a year, often around December, which makes this species a steady component of the orangutan diet.

Evodia glabra (Rut.)

This species can stand long periods (several months) of inundation and is very common in the wettest sections of the Sebangau forests. The trees are fruiting very often and fruits are produced in large amounts, often showing intensity peaks. These small trees are very common but unfortunately their fruits are not eaten by orangutans because these fruits are toxic to them.

Campnosperma coriaceum (Anac.)

This species is one of the most conspicuous trees in the forest of Sebangau, with its leaves that grow as long 40 cm. It is a typical species of recovering forest and seedlings can only develop in open spots. This implies that the number of trees of this species will gradually decline with the continuing recovery of the forests of Sebangau. The fruits are rather small, 1.5 cm diameter, and in the shape of a very small mango. The species is indeed related to the mango (*Mangifera*), the same family. The fruits are not sweet but are liked by orangutans and are a steady component of their diet. Fruit productivity is high as there are usually two fruiting periods each year: a long fruiting period from October or November till February or March, and another fruiting period from May to July. During these periods, fruiting intensity peaks often occur in the middle of the seasons.

Cratoxylum arborescens (Hypericaceae)

This species is very common in locations with an open canopy and can stand long periods of inundation. The small fruits with many seeds and hardly any flesh are however rarely eaten by orangutans. Fruiting occurs annually during short periods, often in June-July.

Diospyros borneensis (Eben.) “wild persimmon”

Several species of *Diospyros* are present in the forests of Sebangau. Two of these species are common and can be easily distinguished by looking at the bark of the stems.

The most common species is *Diospyros borneensis* and these trees with their black charcoal-like bark can be found almost everywhere. The fruits are less than 3 cm in diameter, so much smaller than the fruits of *Diospyros siamang*, another common *Diospyros* species. The fruits are eaten by orangutans and are a stable component of their diets. Fruiting of *Diospyros borneensis* occurs in long periods, usually interspersed by intervals of only 3-4 months without fruit. Each tree produces only small amounts of fruits, but with so many trees frequently fruiting almost everywhere, orangutans can regularly get food from this species.

Diospyros siamang (Eben.) “wild kaki”

This species is not as common as the previous species but can still be found scattered throughout the forests of Sebangau. *Diospyros siamang* has large fleshy fruits, up to 8 cm in diameter, and is very much liked by orangutans and other mammals. The