4. Biodiversity Management in Practice (Case studies and how-tos)

Three case studies describe efforts in West and East Malaysia to rehabilitate natural areas in plantations for the benefit of wildlife and people. These illustrate how Adaptive Management principles allow practitioners to analyze and learn from novel situations, and overcome unforeseen problems.

Plate 16. **Enthusiastic volunteers at a tree-planting event in conjunction with the River of Life project in Negeri Sembilan.** *WA/Reza Azmi.*

4.1. River of Life Project, Tanah Merah. Negeri Sembilan

4.1.1. How it began

In 2005, an estate in Negeri Sembilan wanted a biodiversity assessment of its remaining wild areas in fulfillment of EurepGAP certification requirements. It had already designated 8 ha in the south as a Mangrove Reserve, and a small remnant lowland forest on a low hill as a Conservation Area. An external consultant was to conduct the assessment.

Plate 17. **An external consultant on site.** *WA/Khing Su Li.*

4.1.2. Assessment findings – what's important

While the two wild areas had some biodiversity value, their real potential lay in being connected to larger areas of natural habitat outside the estate, which acted as biodiversity reservoirs. Without this connection, much of the biodiversity in the fragments would die out eventually. Conversely, if the connections were made, the biodiversity in the patches might even increase.

4.1.3. Crafting the programme

The key component connecting the low hill forest fragment and the mangroves to the larger mangrove reserve beyond the estate was a small river, which flowed from the hill, through the estate, and eventually entered a larger river outside the estate.

In the estate, most of the riparian vegetation had been removed and the river itself canalised. This had effectively isolated the forested hill from the mangroves in a 'sea' of oil palm. In order to reconnect these areas, a rehabilitation programme called 'River of Life' was conceptualised.

4.1.4. Selling the idea

A report of the assessment and conservation recommendations was produced, and presented to the plantation management. The Powerpoint file was left with the manager, who used it subsequently to enthusiastically communicate the concept to his higher-ups. As the Board saw the benefits of the plan, the necessary backing was provided.

4.1.5. The action plan – encapsulating the vision

The action plan had six aspects:

Action 1: Rehabilitating the river

The poorly-vegetated river banks were prone to slumping, leading to excessive siltation and the need to desilt regularly. The banks were first stabilised by laying on 'eco-matting' – an organic, porous mat which allows the vegetation to grow through.

Plans were made to allow the river to revert to a more natural state of meander, and also to create more structure in the river by adding some rocks, allowing the riffles caused to oxygenate the water and break up the homogeneity of the aquatic habitat.

Action 2: Tree planting and forest enrichment

Degraded areas were to be rehabilitated by planting trees suitable for each habitat (e.g. *Rhizophora apiculata*, *Ceriops tagal*, and *Xylocarpus granatum* in mangrove areas, fruiting and flowering trees that benefit wildlife in the lowland forest fragment, and native riverine species such as *Dillenia*, *Saraca*, etc. along river banks where there was no tree cover).

Rather than plant the entire length of the river, which would have been costly, require much manpower and risk wholesale failure should the saplings die, the plan recommended the establishment of 'seed banks' - small areas along the banks where native trees were planted and fenced from grazing animals. Over time, as these trees matured and began seeding, it was hoped that they would seed the remaining areas of bank.

Action 3: Extending the mangrove reserve

Within the estate, an area of former mangrove adjacent to the reserve had been bunded and drained to plant oil palm. However, due to saline intrusion, the yields had been poor. It was decided to 'return' the area for conservation. By rerouting the bund, the area was to be allowed to revert to mangrove forest. This not only extended the existing mangrove area, a positive step for biodiversity conservation, but also increased the estate yield per hectare by excising unproductive land.

Action 4: Planning for replants

A buffer zone was demarcated along both banks of the river. At replanting, the palms within this zone were to be poisoned and left to die *in situ*, and there was no replanting. The dead standing palms were to provide shade and support for climbing plants, so that under-vegetation could more quickly regenerate. By establishing the buffer zones well before actual replanting, the better-vegetated areas would be more effective in reducing sedimentation of the river during land-clearing.

Action 5: Water quality monitoring

A water quality and biodiversity monitoring programme was implemented at the outset, so that changes as a result of the rehabilitation programme could be measured. Monitoring included keeping records of water quality assessment, frequency of 'slumping' (erosion events) and wildlife along the river.

Action 6: Education and outreach

This was a key element in the plan, and took several forms:

- Clear on-site demarcation and signage. This ensured that workers, contractors and members of the local communities were informed of the aim of the project, and that the areas were not wrongly managed or encroached upon.

- Linking with local business. The management of a neighbouring waste disposal facility, whose activities had the potential to negatively impact the river, were invited to join management plan meetings, to encourage 'ownership' of the initiative, and cooperation.

- Outreach into the local community. An Environmental Education course was designed and run in a local primary school. This enabled students, parents and school teachers to understand some of the critical linkages in the local ecosystem which the estate was attempting to restore, and raised awareness of the plantation's positive efforts to maintain a healthy local environment.

  Tree-planting events were organised, involving the school and other community members, as well as staff and workers of the estate. These events were sponsored by a national bank, and members of the local branch's staff also participated. A national radio station covered the event and aired some of the proceedings 'live'.

  The net result was that much of the cost of the event was met, and most of the manpower provided 'free'. The plantation company received valuable positive publicity and the events provided a natural opportunity for relationship-building with members of the local community. The events were enthusiastically participated in by all, and were highly motivational for the estate staff and workers.

Plate 18. **Primary school students learned about their environment as part of the River of Life project.** *WA/John Howes.*

4.1.6. Unforeseen problems

Inevitably, in such a pioneering initiative, there were unforeseen issues.

After monitoring the river had begun, it was found that one of the most serious causes of erosion was the local cattle, which broke the banks (and eco-matting) when they came to the river to drink. The herders refused to remove their livestock, and fencing the entire bank would have been expensive, with no guarantee that the problem would not recur. Building better stakeholder relationships could have improved this situation for both the cattle owners and estate.

A second problem was that the native trees planted were smothered by Giant Mimosa (*Mimosa pigra*), a fast-growing invasive alien species. Control of this weed is therefore a prerequisite for natural rehabilitation to occur. The preferred method of control was mechanical removal, as the use of herbicide in such conditions would have had undesirable impacts on the river.

4.1.7. Conclusion

The *River of Life* project ended in 2008 and was continued by Sime Darby. The pilot project was absorbed into a larger "plant a tree" project that spanned all plantation properties under the group. Most trees planted in the *River of Life* project were healthy when the site was last checked in 2010. The project's ideas have been widely communicated and were the subject of a number of newspaper articles, tree planting events and site visits.

Plate 19. **Cows were found to be a serious cause of riverbank erosion.** *WA/Reza Azmi.*

4.2. Kinabatangan - Corridor of Life (K-CoL) Project, Sabah[1]

The Kinabatangan is the longest river in Sabah, and its basin is arguably the last forested alluvial floodplain in Asia. It is one of only two places on earth where 10 primate species can be found together, and is also home to over 250 bird, 50 mammal, 20 reptile and 1,056 plant species. Since the 1950s, forest around the Kinabatangan has been encroached upon for logging and agriculture to plant cash crops like rice, coffee, cocoa, rubber, tobacco and, more recently, oil palm.[2]

The "Corridor of Life" is a joint initiative launched in 2002 by the Chief Minister of Sabah with the goal of establishing a forest corridor from the upland forests to the coastal mangrove swamps, where people, wildlife, nature-based tourism and local forest industries can thrive and support each other. WWF-Malaysia has been working with the Sabah Wildlife Department, local communities, several oil palm companies and other stakeholders to re-establish continuous forest along the banks of the river.

4.2.1. What is being done?

A number of oil palm companies[3] with plantations in the Kinabatangan flood plain have been involved in rehabilitating forest for wildlife. Specific steps include:

- Reverting unproductive plantation land (especially if it is also critical habitat for wildlife and/or part of a wildlife corridor) to natural forest
- Replanting degraded land with native trees
- Protecting existing forest remnants
- Creating wildlife bridges over drains to enable elephants and other large mammals to travel between forest areas.

4.2.2. How did the initiative begin at plantation level?

The Business and Industry Engagement Unit of K-CoL will typically begin by seeking to build trusting relationships with the management of the plantations involved. The approach is to seek genuine 'triple win' situations in which the oil palm company, local communities and environment all benefit. For example, if a company has unproductive land (but which is critical for wildlife habitat and/or wildlife corridor), it is a small sacrifice to set it aside instead for conservation and good CSR practice. Planting native trees sourced from village nurseries will bring revenue for the local communities, and the also benefit the wildlife.

At some point in the process, WWF-Malaysia has to engage the decision-makers in the companies. But before it does this, WWF-Malaysia must convince them of the benefits to be gained.

1 Contributed by Max Dionysius. WWF-Malaysia Business and Industry Engagement Coordinator of the K-CoL Project.
2 K-CoL Factsheet, WWF Malaysia, downloaded from: http://assets.wwfmalaysia.inga.bluegecko.net/downloads/kcolfactsheet.pdf on 28.02.2011
3 These include Sawit Kinabalu Sdn. Bhd (http://www.wwf.org.my/media_and_information/newsroom_main/?7120), Malbumi Estate Sdn Bhd (http://wwf.org.my/media_and_information/newsroom_main/?11100/Change-of-Heart-Taking-Action-to-Protect-Wildlife-in-Kinabatangan) and Genting Group (formerly Asiatic Development Bhd).

4.2.3. What were some key factors which enabled the initiative to succeed?

The main factor in building effective multi-stakeholder partnerships is the establishment of trust. This can only happen over time, over frequent meetings, frank discussions of objectives, and being able to see things from another's point of view. It is also essential that the solutions found genuinely meet the goals of all the stakeholders.

4.2.4. Were there any unforeseen difficulties or challenges to overcome?

Initially, there was considerable doubt that highly intelligent mammals like elephants would use wildlife bridges to cross drains. Since wildlife bridges are fairly expensive (c.RM20,000 each), it was important to establish whether they would be used before large-scale implementation. By a process of seeking advice, design changes, and monitoring the results by camera traps, an effective design was eventually produced.

Plate 20. **Wildlife bridge over a drain near the Kinabatangan River.** *WWF-Malaysia.*

Another difficulty encountered was how to plant native trees in areas prone to flooding. Some trial plots were established and monitored over a two-year period, until an effective method was derived. This involved identifying the species suitable and finding out how to plant them to withstand frequent flooding. This approach solved the problems on a small-scale before broad implementation to minimise the waste of resources and effort.

4.2.5. What difference has the project made for the a) plantation/company/ staff & workers b) local communities c) biodiversity?

Plantation companies involved benefit from the good publicity in a number of ways (e.g. The aura of being linked to an internationally-known NGO like WWF. Visiting multinational companies to Kinabatangan can see first-hand the positive steps being taken to enhance biodiversity. The projects attract interest not only at the national level but also in the international media. One plantation managing director was even commended by a Buddhist organisation in Taiwan for his company's effort to conserve wildlife.

Plate 20. **Appreciation letter to Malbumi.** *WWF-Malaysia.*

The Supreme Master Ching Hai International Association
www.Godsdirectcontact.org, email: SMCHIA@Godsdirectcontact.org
Tel: 1-408-218-2635; Fax: 1-928-222-3333

19 August 2010

Mr. Edward Ang, Managing Director
Malbumi Estate Sdn. Bhd.
P .O. Box 3535
90739 Sandakan, Sabah
Malaysia

Dear Mr. Ang,

We wish to humbly salute and express our heartfelt thanks to the Malbumi Group of Companies for your remarkable efforts to protect our planet's precious co-inhabitants and for ensuring that they continue to flourish in their natural habitat. Your clever leadership is helping to create a harmonious ecological balance benefiting all beings sharing planet Earth.

Recognising that agriculture development causes much upheaval in the natural habitat of the wild, you benevolently responded with the construction of nine culvert crossings, connecting waterways to enable wild animals to roam freely from one side of the region's Kinabatangan Sanctuary to another. Caringly providing an alternative, the man-made passage has achieved the desired results with the discovery of animals' footprints on the soil covered culvert crossings. When asked what advice you would give to other companies, you compassionately replied, "Only humans have the power and ability to ensure the future of wildlife, so we need to start making that difference." Thank you Mr. Ang, for candidly sharing your profound thoughts and wisdom! You are truly a beacon of light and an inspiration for others to follow!

We wholeheartedly thank Malbumi Estate Sdn. Bhd, and its esteemed Managing Director, Mr. Edward Ang, for excellent management and heartfelt commitment in making a significant difference to protect and cherish our precious wildlife and the environment. Your gracious effort is helping to pave the way to a brighter future for generations to come. May Heaven's grace bless you and all your dedicated staff.

With Great Honour, Love and Blessings,

Supreme Master Ching Hai

Local communities benefit through partnerships between WWF-Malaysia and the plantation companies. These communities, mostly housewives, collect the seedlings and seeds of native trees and plant them in nurseries, to be sold later to the plantation companies for forest rehabilitation.

Biodiversity benefits firstly from the protection and creation or rehabilitation of natural habitat. Another benefit is from the active enforcement of local laws. Patrols by the Sabah Wildlife Department and WWF-Malaysia monitor encroachment into riparian buffer zones and apply pressure on those responsible to rehabilitate illegally encroached areas. These patrols also seek to catch illegal poachers of wildlife. As a result, wildlife hunting is now greatly reduced in the area, from previously. The benefit of a multi-stakeholder approach in this case is to provide impetus to these enforcement activities. Where companies and communities invest in local conservation, protection of the natural resources becomes a high priority.

4.2.6. What is the most important advice you would pass to others who wish to attempt something similar?

Nowadays, the trend is increasingly that the end consumer wants to know where the products come from and how they are produced. So it is important for companies not only to be associated with conservation efforts but also to be actually to be seen implementing them on the ground. The best way forward is to start small; with a project which addresses local sustainability. In K-CoL, one of the issues is fragmented forest, so one way to address that is by tree-planting. In other areas, other issues may be more important. But whatever the main issues, start by contributing to the solution in whatever ways you can.[4]

4.3. Riparian Management Joint Project between PPB Oil Palms Berhad (Wilmar International) and Sabah Forestry Department[5]

Sabahmas Plantation is about 22 km from the town of Lahad Datu, in south-east Sabah. The Segama River forms the west boundary of the plantation while Tabin Wildlife Reserve is on the north-east. Segama River is the second longest river in Sabah and usually floods yearly during the monsoon, normally between November and March.

4.3.1. How and why it began

In December 2008, a biodiversity assessment of Sabahmas Plantation was done by the company's Biodiversity and Conservation Manager. The assessment revealed a large and viable population of Proboscis Monkeys on the Segama River and a highly variable, fragmented, and in several places, degraded riparian area, with oil palm planted (by the previous owner) up to the edge of the river in many places. A proposal was therefore put forward to management to restore, enlarge and enrich the riparian area, using Proboscis Monkey food plants. The Sabah Forestry Department and Forest Research Centre was approached for assistance to identify the trees along the river and recommend species for planting that are both flood tolerant and food species for the monkeys. On realisation of the scope of the project and the benefit to both parties, an MoU was signed between PPB Oil Palms Berhad and the Sabah state government.

4 For more information about WWF-M's work in the Kinabatangan Corridor of Life project, and about their work with oil palm plantations, visit: http://www.wwf.org.my/about_wwf/what_we_do/forests_main/kinabatangan___corridor_of_life/ or contact: Max Donysius (mdonysius@wwf.org.my).

5 Contributed by Calley Beamish. Biodiversity and Conservation Senior Manager, Wilmar International Ltd.

4.3.2. Crafting the project

The initial crafting of the on-ground implementation and the 5-year management plan was done by a team, comprising the Group Estate Manager, Senior Estate Manager, resident Conservation Senior Manager and Biodiversity and Conservation Manager. The project was supported by the Sustainability Controller and CSR Group Head.

4.3.3. Challenges and success in selling the idea

The Sabah Forestry Department Deputy Director was approached by the team to sell the idea of the development of an MoU and the benefits to both parties in its establishment. The Sabah Forestry Department was enthusiastic and supportive of the idea from the start and the MoU crafting began shortly after.

The idea of enlarging the riparian area beyond legal compliance which would cut into some productive areas (even though they were marginally productive due to annual flooding) was challenging. However, acceptance of the idea, and support in terms of a substantial budget and employment of dedicated personnel followed shortly after the company's director signed the MoU with the Chief Minister of the Sabah government.

4.3.4. The action plan – encapsulating the vision

Objectives

The Riparian Management Project is to restore and enrich 382.42 ha along a stretch of Segama River with the main objectives of:

1. Managing, restoring and enlarging the riparian buffer zone to 50 m throughout the Sabahmas Plantation boundary with the Segama River.

2. Enriching the habitat for wildlife, in particular, the endangered Proboscis Monkey.

3. Decreasing and mitigating soil erosion and improving water quality.

The action plan developed covered pre-year 1 preparations, followed by a five-year period of tree propagation, planting, and community development initiatives.

Pruning the Oil Palm

The team decided that in the areas where oil palm occurred, fronds would be pruned off leaving only the centre spear, to allow sunlight through to the under-vegetation whilst ensuring that the palms did not die. Fronds were pruned before tree planting, with the plan to prune them on a biannual basis.

The benefits of pruning the oil palm over felling/removal or leaving them untouched were decided as follows:

- Pruning allows the palms to survive with their roots an active barrier against soil erosion.
- The palm fruits are supplementary food for several mammals and birds which have adapted to oil palm habitat.
- Pruning will let sunlight through to the forest floor, giving the vital forest trees a better chance of survival .
- Felling the palms may damage the already regenerating tree seedlings and, in addition, cause an *Oryctes* problem, as the pest will breed in the rotting oil palm debris.

Pre-Year 1, 2009:

The following on-ground implementation began to ensure that the young trees were ready for planting in the first year of the five year project.

1. Surveying and marking the zones

The 50 m riparian area (Sabahan law only requires 20 m) was surveyed and marked out. A biodiversity assessment in 2008 had shown high variability in the quality of the riparian areas, so the team decided to categorise these into three zones:

Zone A - Areas with no significant forest trees or with oil palm right up to the river bank.

Zone B - Areas of mixed forest trees and oil palm and which did not conform to the 50 m riparian width.

Zone C - Areas where more than 80% of the 50 m wide proposed riparian buffer zones contained natural riverine forest but where enhancement planting may be required to supplement species of food importance to the Proboscis Monkey.

The total area (in hectares) of each zone was surveyed and the number of oil palms in these areas was counted.

Plate 22. **An example of a Zone A riparian area.** *Wilmar/Calley Beamish.*

2. Nursery, tree propagation and personnel

A nursery dedicated only to the trees to be planted was set up. Approval of a budget submitted by the resident Conservation Manager came from the CSR department and the Senior Estate Manager was instrumental in ensuring the successful establishment of a high quality nursery.

A search among the plantation workers found someone with very good local knowledge of trees, and the propagation of seeds, cuttings and wildlings collected in the riparian area began. One of the estate assistant managers was moved to help manage the nursery and implement the project under the resident Conservation Manager.

Eighteen trees that occur naturally in the riparian area were chosen as the main species for planting. Besides the need for them in the riparian area, the other criteria for selecting them were flood tolerance and being food sources for the Proboscis Monkey. Several more trees (over 26 species) were later identified and marked in the Sabahmas Plantation riparian areas by Forestry Research Council personnel as other potential species to plant.

Plate 23. **Sabahmas tree nursery.** *Wilmar/Calley Beamish.*

3. Engagement with communities and NGOs

Communities immediately around the plantation and in the Sukau area were gauged for their interest in propagating the plants on a paid basis. NGOs such as WWF-M and HUTAN, who were actively buying various trees from communities in the Kinabatangan River Basin, were also consulted. Communities selected were those who desperately needed support to ensure the continuation of their projects which they had set up to supply tree species for the Kinabatangan Corridor of Life Project, and because the communities immediately surrounding Sabahmas Plantation grow oil palm and did not wish to engage in tree species propagation as an economic activity.

4. Signing of MoU with state government

The MoU was signed by PPB Oil Palm's Director and the Chief Minister on the 26 October 2009 at the Forestry Department's "Enhancing Forest Ecosystems Connectivity and Corridors within the Heart of Borneo in Sabah" conference in Kota Kinabalu.

The PPB Oil Palm project fitted in well with the connectivity and corridors concept, as the Segama River riparian area on Sabahmas Plantation boundary is contiguous with Tabin Wildlife Reserve so is part of an important wildlife corridor.

5. Budget Allocation and staff

Following the signing of the MoU, PPB Oil Palm's senior management set aside a substantial budget for the five year project and confirmed the employment of dedicated staff under the management of the resident Conservation Manager to run the nursery and ensure the smooth implementation of the five-year plan.

Year 1, 2010:

Tree planting

Year 1 was laid out as a trial year during which trial and error evaluations would be taken and corrective measures developed.

Seedlings were purchased from communities in Sukau and transported to Sabahmas Estate.

Planting of propagated species from Sabahmas Plantation riparian area was done where there were no native seedlings present or where there was no natural regeneration. Pruning of the palm fronds allowed in more sunlight, enabling an increase in the growth of the natural regeneration that was already taking place in several areas.

Planting began starting from the first estate (there are three Estates in Sabahmas Plantation), with priority accorded to Zone A (most depleted of natural vegetation) and partial planting in Zone B in Estate 2. Propagation of seedlings for Year 2 continued with sufficient stock to cater for Year 1 mortalities which were re-planted later in the year.

Year 1 planting was highly successful, with mortality estimated to be less than 1%. Shoots from the new trees were highly popular with the Proboscis Monkeys, which were seen sitting on the ground feeding on them. Other mammals, including other primates and deer, were also seen browsing on the leaves. From the increased sightings of wildlife in the areas planted, it was concluded that the restoration had had a positive impact.

Publicity Planting Ceremony

A public planting ceremony was held in Sabahmas Plantation on World Environment Day, 5 June 2010. Besides the Sabah Forestry contingent, the media and PPB Oil Palm management and staff from several other NGOs and stakeholders attended, including the Wildlife Department, WWF-Malaysia and BORA. Datuk Sam Mannan, Director of Sabah Forestry Department, and the Managing Director of Wilmar International Ltd gave key speeches and all attendees took part in planting trees. This was followed by a press conference. This was a very successful and well publicised event.

Year 2- Year 3:

The second year (2011) began with completion of planting Zone B in Estate 1 and will be followed by Zone C planting as well as supply planting of any mortalities from Year 1. The plan will continue propagation of trees for each year following with sufficient stock for losses in previous years' planting, and planting by zone priority, working from Estate 1 to 3. A second nursery will be set up to cater for the furthest estate. Corrective measures and lessons learnt are to be incorporated as the project progresses. Biannual frond pruning and continued maintenance of the trees planted will continue, as will community development initiatives.

4.3.5. Are there any current or possible future difficulties to overcome?

The plantings so far have survived the annual floods. However, there may be more severe floods in the future, sufficient to yet cause problems. Upstream riparian areas of the Segama River have become severely depleted, which has increased the speed of water flow and the length of floods. Other possible difficulties in ensuring survival of the seedlings depend on the extent of their consumption by wildlife - whether only the shoots or the entire plants. Currently this is minimal. The only viable solution to these problems would be to cater enough saplings for re-supply.

During the planting, pruning and maintenance phases, extra labour is required, so a difficulty sometimes faced is the availability of labour. The project requires its dedicated labour force so as not to upset the plantation operations by frequently having to borrow workers.

4.3.6. What difference has the project made for a) the plantation/company/ staff & workers, b) local communities and c) biodiversity?

a. The Riparian Management Project has enabled development of an important partnership with the Sabah government. It has provided good Corporate Social Responsibility publicity for both the company and the Sabah Forestry Department. The project resulted in the employment of a dedicated team on-ground to ensure the implementation of the project.

b. The support to the local communities has contributed towards ensuring the sustainability of their tree nurseries in the Sukau region.

c. The project has increased the food supply for the Proboscis Monkey and also ensured better connectivity between hitherto fragmented habitat. Subsequent to the planting, there have been increased wildlife sightings in the area.

4.3.7. What advice would you offer to others who wish to attempt something similar?

1. **Be clear on the objectives of the project.** In other PPB Oil Palm plantations where we have done riparian projects, the objective was to restore the riparian areas, so only a few tree species are planted (not mixed planting as in this case) and the trees used were flood tolerant and fast growing native species. Working with Sabah Forestry Department and local nurseries in the purchase of seedlings has been highly beneficial. If the size of the area is small, it does not justify setting up a dedicated nursery for propagation.

2. **Form partnerships, especially with government, to guarantee success.** Forming partnerships with government and local NGOs who have expertise and advice to bring to the project will help to ensure success. Projects that engage with the government will ensure commitment and support (especially in terms of fund allocation) from the top company management to guarantee the success of the project.

3. **Form a team.** For a project like this to work, it is imperative to have supportive engaging teamwork from all levels (workers to top management) in the company and with the partners you are engaging with, which in this case was an invaluable team from the Sabah Forestry Department.

5. Research in Biodiversity and Oil Palm[1]

Research plays a vital role in understanding issues and providing solutions for effective biodiversity management. Relevant research is increasingly available via the internet and there are opportunities for plantations to encourage and be partners in further research in this developing field.

Plate 24. **River sampling.** *WA/John Howes.*

1 Chapter contributed by Sophie Persey. Biodiversity & Oil Palm Project Manager, Zoological Society of London, Indonesia (Sophie.persey@zsl.org)

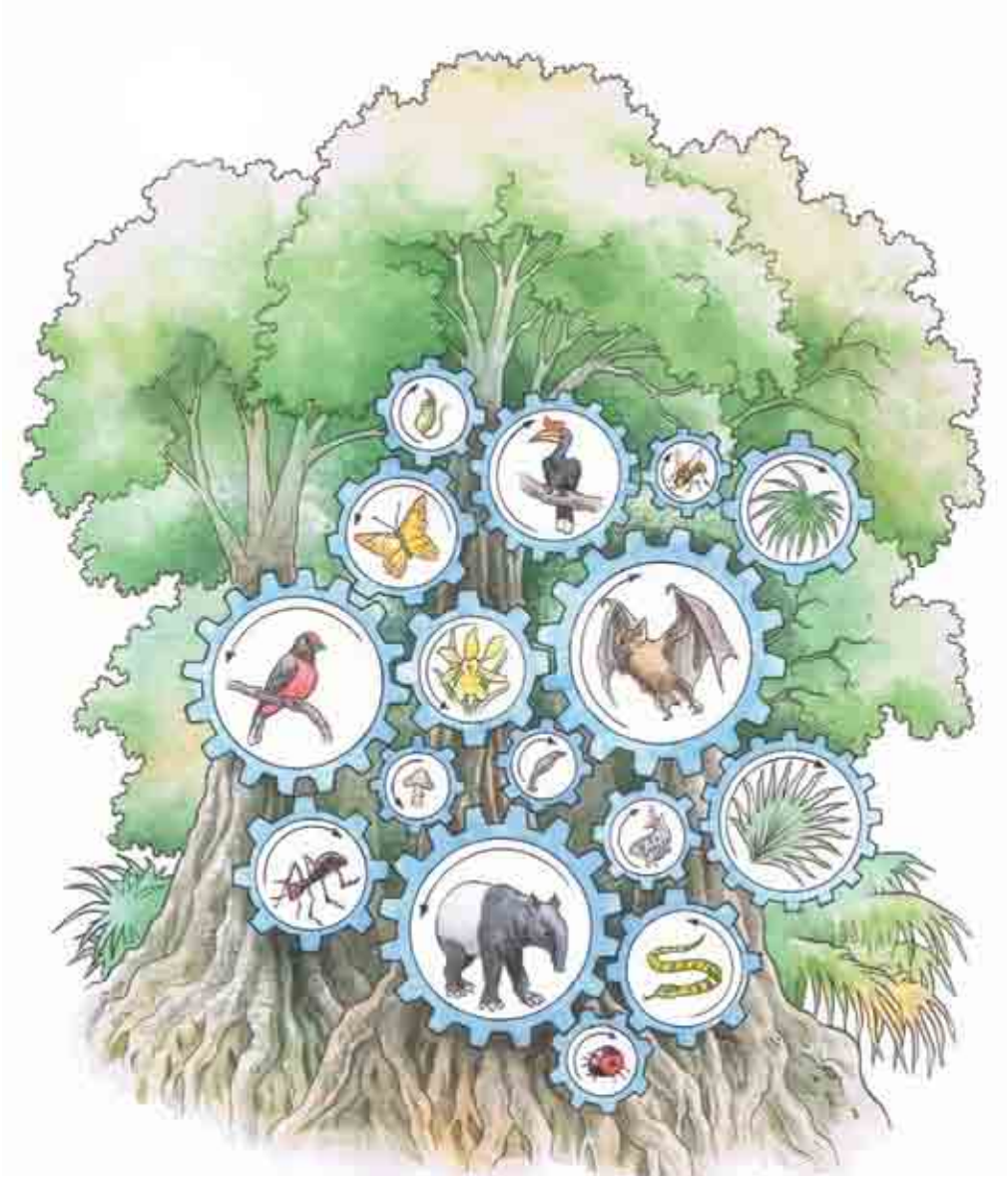
5.1. Role of research in conserving biodiversity

Conserving biodiversity is a bit like maintaining a complicated and finely tuned machine. We know that it plays a crucial role in providing us with many valuable natural resources and ecosystem services, and that its ability to do so depends on many complicated interactions between a huge variety of different species and the soil, air and water around them. However, there are still many unanswered questions about the specific function of each piece of the biodiversity 'machinery' and the conditions necessary to keep it running smoothly.

Without good information about which species are present in a particular ecosystem or landscape, the conditions necessary to keep these populations healthy (such as where they live, what they eat and their reproduction strategy), as well as an understanding of the role they play, and how they respond to changes in their surroundings (such as reduction in the size of their habitat or pollution), it can be extremely challenging to know how to conserve this biodiversity.

Therefore, research that provides answers to these types of questions can provide valuable guidance on how to manage a particular landscape, such as an oil palm plantation, in order to ensure that it continues to support biodiversity and the essential ecosystem functions associated with it.

Figure 18. **Illustration of biodiversity 'machine'.**



5.2. Research on biodiversity in oil palm landscapes

5.2.1. What do we know and why is this useful?

To date, less than 4% of research in oil palm has focused on its relationship with biodiversity[2]. The majority of this research has compared the biodiversity of primary and secondary forests with that of oil palm monocultures, and fragments of forest that remain within oil palm landscapes.

Although the number of studies has been limited, the results clearly show that, in general, the biodiversity in oil palm monocultures is severely depleted from that in primary and secondary forests. This is indicated by a significant decrease in number of species present (species-richness) and also by changes in the type of species present (community composition). In addition to providing information on the likely consequences for biodiversity if natural forests are converted to or fragmented by oil palm monocultures (see Box 8), such research can also help give insights into what might be causing this to happen (see Box 9). This can provide valuable guidance on the specific features of an oil palm landscape that promote/decrease biodiversity, so that the negative impacts on ecosystem functions can be minimised (see Box 10).

Plate 25. **The contrast between forest and oil palm monoculture is particularly obvious from above.** *Bablu Virinder Singh.*

2 1% of all papers published prior to 2007 (Turner *et al.* 2008) and 4% in the following three years (Foster *et al.* 2011)

Box 8. **Degraded lands are worth protecting: the biological importance of Southeast Asia's repeatedly logged forests.**

OVERVIEW: This study investigates the impact of logging on birds and dung beetles in order to assess the biodiversity value of heavily logged tropical lowland rainforests in Borneo and the potential consequences if they are converted to oil palm plantations.

KEY RESULTS:

- **Changes in the number of species present (species richness):** There was very little difference in the total number of bird species found in unlogged, once-logged and twice-logged forest, despite almost all the trees bigger than 40cm diameter being absent after the second logging rotation. The first logging rotation appears to have had a bigger impact on dung beetles, as the total number of species present was 18% lower in once-logged forest than in un-logged forest, although this did not decline further after the second logging rotation.

- **Changes in the type of species present (community composition):** although there were some differences between the bird and dung beetle species present in un-logged and once-logged forests, the second logging rotation appeared to cause more species to decline or disappear, including several bird species that are only found in Borneo (endemic). Despite this, 75% of the bird and dung beetle species found in un-logged forest were also present in the heavily degraded twice logged forest, including many bird species of High Conservation Value.

- **How long can these species survive in heavily logged forests?** This study was carried out shortly after the second logging rotation, so it is unclear whether the species that remain, particularly birds which have longer life cycles, will be able to persist in this degraded forest in the long term. However, many of these species were present at high densities and had managed to persist for 12-20 years after the first round of logging, which suggests that they may be able to survive for several years at least.

CONCLUSIONS & RECOMMENDATIONS: Although logging does have some negative impact on bird and beetle diversity, even heavily logged tropical lowland forests continue to support a large proportion of the species found in un-logged primary forests, including many of High Conservation Value. Since birds and dung beetles are considered to be good indicators of the overall biodiversity value of a habitat, it should not be assumed that heavily logged tropical forests are of low conservation value. In comparison to oil palm in the surrounding area, these twice logged forests support a far higher number of species, including larger populations of High Conservation Value species. Therefore, converting these areas to oil palm plantations is likely to result in substantial biodiversity loss.

Reference: Edwards *et al.* (2010). Degraded lands worth protecting: the biological importance of Southeast Asia's repeatedly logged forests. Proc R. Soc. http://dx.doi.org/10.1098/rspb.2010.1062

Plate 26. **White-crowned Hornbill (*Aceros comatus*).** *ZSL.*

Box 9. **Can oil palm plantations be made more hospitable to forest butterflies and birds?**

OVERVIEW: This study investigated how forest butterflies and forest birds are affected by the type and coverage of vegetation within the oil palm crop and the amount of old growth and secondary forest within and surrounding oil palm estates.

KEY RESULTS:

- Differences in the amount of natural forest cover within and around the oil palm estate had a bigger influence on the number of forest butterfly and forest bird species within the estate than differences in the vegetation within the oil palm crop.
- Larger areas of old growth forest surrounding the estate often resulted in higher numbers of forest butterfly species within the oil palm estate, but larger areas of young secondary forest often resulted in higher numbers of forest bird species within the oil palm estate.
- Of the vegetation types studied, increased weed cover had the biggest positive effect on the number of forest butterfly species detected, but increased prevalence of epiphytes and leguminous crops had the biggest positive influence on the number of forest bird species detected.

CONCLUSIONS & RECOMMENDATIONS: The most effective way to promote biodiversity within oil palm landscapes is to retain as much natural forest cover as possible by conserving any remaining patches of old growth or secondary forest within and around the estate. In addition to this, planting leguminous covers with the oil palm, avoiding the use of herbicides wherever possible, and allowing epiphytic ferns on the oil palm trunks enables the crop to support a wider variety of forest bird and butterfly species.

Reference: Koh, L. P. (2008). Can oil palm plantations be made more hospitable for forest butterflies and birds? *Journal of Applied Ecology* 45(4): 1002-1009. http://dx.doi.org/10.1111/j.1365-2664.2008.01491.x

Plate 27. **Tawny Coster butterfly (*Acraea terpsicore / Acraea violae*).** *ZSL.*

Box 10. **Oil palm expansion into rainforest reduces ant biodiversity in canopy, epiphytes and leaf-litter.**

OVERVIEW: This study looked at the potential impact of converting tropical lowland rainforest to oil palm monoculture on ant species that live in the canopy, Bird's Nest Ferns (*Aplenium nidus*) and leaf litter in Sabah, Malaysia.

KEY RESULTS:

- The total number of ant species recorded in the primary forest areas was almost 3 times higher than in the oil palm monoculture (309 species were found in the forest, 110 species were found in the oil palm).

- The impact of converting primary forest to oil palm monoculture is different for ants that live in the leaf litter, bird's nest ferns and the canopy. Whilst almost the same number of ant species are found in bird's nest ferns in forest and oil palm, far fewer ant species are found in the oil palm canopy (52% lower) and leaf litter (74% lower) than in forest canopy and leaf litter.

Figure 19. **Annotated photograph of oil palm plantation showing canopy, epiphytes and leaf litter.** *WA/Tan Kian Yong.*

- Very few of the ant species found in the leaf litter, bird's nest ferns or canopy in the oil palm were also found in the primary forest areas (59 out of 309 in total). It is estimated that approximately 81% of the forest ant species would be lost if these forest areas were converted to oil palm monoculture.

- A large proportion of the ant species found in the oil palm monoculture were non-native ant species that would not naturally be found in tropical lowland forests.

CONCLUSIONS & RECOMMENDATIONS:

- Although they might seem insignificant, ants interact with a large number of plants and animals and play important roles in dispersing seeds, maintaining the quality of the soil and nutrient cycling. To ensure that these processes continue in oil palm landscapes, which is essential for a healthy and productive crop, it is important to try and maintain as many different species of forest ants as possible.

- Since the number and variety of ant species found in Bird's Nest Ferns is very similar in forests and oil palm, allowing these epiphytes to grow on the oil palm trunks should help to increase the number of ant species (perhaps by as much as 15%) that are able to survive within oil palm plantations.

Reference: Fayle *et al.* (2010). Oil palm expansion into rainforest greatly reduces ant biodiversity in canopy, epiphytes and leaf-litter. *Basic and Applied Ecology 11* 337–345. http://dx.doi.org/10.1016/j.baae.2009.12.009

5.2.2. Winners and losers: what happens if natural forests are replaced or fragmented by oil palm monocultures and why?

Research has shown that the majority of higher fauna in tropical forests is very rarely recorded in oil palm monocultures. A key reason is that these species tend to have very specific habitat requirements, which can only be met by tropical forests. For example, they may only eat a particular fruit, live on a certain plant, or need large tree hollows to roost in. In comparison to the structural complexity and diversity of tropical forests, oil palm monocultures are far simpler systems. Although some ground cover is usually found in oil palm, and in some instances even a high diversity of tree ferns, the absence of important fruit trees, lianas and epiphytic orchids, as well as the reduced level of leaf litter, are thought to be key reasons why many forest species are unable to survive in oil palm monocultures. Unfortunately, these also tend to be species of high conservation concern (see Appendix 2) as their specific habitat requirements means that they struggle to adapt to changes in their surroundings and so suffer more as a result of deforestation (see Box 11).

Although the habitat requirements of many forest species may not be met within the oil palm stand itself, fragments of forest and vegetated riparian zones within oil palm landscapes will often continue to support them, at least in the short term. However, forest-dependent species that are unable or reluctant to move between patches of forest surrounded by oil palm are in danger of becoming isolated. If they become confined to a single patch of habitat that is too small to support a healthy population, then the species are at risk of becoming locally extinct.

Whilst many forest species suffer if natural forests are replaced by oil palm monocultures, a limited number of the more entrepreneurial species often thrive in oil palm. These tend to be species with general habitat requirements which take advantage of easily accessible food and a relatively predator-free environment. Because they are common, they tend to be species of lower conservation concern, and often become pests, for example Wild Pigs (*Sus scrofa*) and rats (*Rattus spp*) (see Box 12).

Table 28. **Summary of how different species are affected when natural forest is converted to oil palm.**

Winners	*Losers*
• Non-forest species	• Forest species
• General habitat requirements	• Specific habitat requirements
• Lower Conservation Concern	• Higher Conservation Concern
• E.g. Pests, invasive species	• E.g. Critically Endangered species

Plate 28. **Blood Python (*Python curtus*) in oil palm plantation.** *ZSL.*

Plate 29. **Tiger (*Panthera tigris*).** *ZSL.*

Box 11. **Tiger and other wildlife conservation in oil palm plantations, Jambi Province, Sumatra, Indonesia.**

OVERVIEW: This long term study looked at the abilities of medium and large mammals to survive in oil palm monoculture and unplanted areas of degraded land in an oil palm concession in Sumatra, Indonesia.

KEY RESULTS:

- 34 of the 38 mammal species (90%) detected in the landscape were also recorded within the boundaries of the concession but half of these species were only detected within the unplanted and degraded areas that remained within the concession and were never found in the oil palm monoculture. This included the Sumatran Tiger, Tapir (*Tapirus indicus*) and Dhole (*Cuon alpinus*), which are all species of high conservation concern.

- 13 species were occasionally recorded within the oil palm, including several of High Conservation Value, such as Sun Bear (*Helarctos malayanus*), Southern Pig-tailed Macaque (*Macaca nemestrina*) and porcupine (*Hystricidae spp*).

- Only 4 species (10% of the total) were regularly recorded within the oil palm. These were Wild Pig, Bearded Pig (*Sus barbatus*), Leopard Cat (*Prionailurus bengalensis*) and Common Palm Civet (*Paradoxurus hermaphroditus*), which are all quite common.

CONCLUSIONS & RECOMMENDATIONS:

- The majority of medium and large mammals in the landscape were very rarely, if ever, detected in the oil palm monoculture. This suggests that oil palm is not a suitable habitat for them (many are High Conservation Value species).

- On the other hand, many of the species never recorded in the oil palm crop were found in the unplanted and degraded areas of land within the concession. This suggests that such areas can provide valuable habitat for several species of High Conservation Value threatened by the loss of their natural forest habitat. This highlights the importance of carrying out a thorough HCV assessment prior to land clearing and finding effective ways to manage these areas to ensure that the wildlife they support persists.

Reference: Maddox *et al.* (2007). The conservation of Tigers and other wildlife in oil palm plantations, Jambi Province, Sumatra, Indonesia ZSL Conservation Report 7: i-ii, 1-62.

Plate 30. **Camera trap photograph of Clouded Leopard (*Neofelis nebulosa*).** *ZSL.*

Box 12. **Hyper-abundance of native Wild Pigs in a lowland dipterocarp rainforest of Peninsular Malaysia.**

OVERVIEW: The aim of this study was to estimate the density of Wild Pigs in a 2,500 ha fragment of lowland rainforest surrounded by oil palm plantations in Peninsular Malaysia.

KEY RESULTS: The density of Wild Pigs in this forest fragment was estimated to be much higher (47 pigs/km2 in 1996 and 27 pigs/km2 in 1998) than in other forest areas where Wild Pigs naturally occur (few studies in forests have estimated population densities higher than 5-10 individuals/km2).

CONCLUSIONS & RECOMMENDATIONS:

- There are thought to be two reasons for the high densities of Wild Pigs recorded in this fragment of forest:

    1. The absence of natural predators, such as Tigers and Leopards (*Panthera pardus*), which would normally cull the pig population, as well as the lack of competition for food due to the absence or low abundance of species such as Elephants (*Elephas maximas*), Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) and Tapirs.

    2. The high abundance of oil palm fruit in the plantations surrounding the forest fragment, which the pigs appear to feed on.

- Wild Pigs play many important roles in forest ecosystems, such assisting seed dispersal, but if the population explodes, they can also have negative impacts on the habitat. For example, a previous study in a national park in Borneo showed that very high levels of seed predation caused by the large Wild Pig population meant that very few Dipterocarp tree seedlings were able to survive, which is likely to affect the structure and composition of the forest.

- Increases in the population density of Wild Pigs in oil palm landscapes may lead to them becoming pests, resulting in possible loss of yield. Therefore, it is important to ensure that connected areas of forest sufficiently large to support natural predators, and competitors of the Wild Pig are conserved within oil palm landscapes so that the population is controlled.

Reference: Ickes, K. (2001). "Hyper-abundance of native Wild Pigs (*Sus scrofa*) in a lowland dipterocarp rainforest of Peninsular Malaysia." Biotropica 33: 682-90.

Plate 31. **Camera trap photograph of Wild Pig.** *ZSL.*

5.2.3. What are the consequences of these changes?

We know that oil palm monocultures support fewer species than natural forests, and that many of the species found in tropical forests would struggle to survive in these simpler surroundings and frequently become outnumbered by non-forest species that thrive. But why do these changes in the composition of the biodiversity that remains matter?

As explained above, many questions remain about the exact role of each species that makes up the biodiversity of a particular landscape, the interactions it forms with other species and its surroundings, or exactly what will happen if the population of this species increases or decreases. However, we do know that biodiversity is a delicately balanced system, and the more human-induced changes that occur, the more unstable this system becomes. This, in turn, increases the risk that this landscape/ecosystem will be unable to continue to provide us with the resources and services we depend on. For example, if a species of insect-eating bird is unable to survive when an area of natural forest is converted to oil palm, then the population of this insect is likely to increase. If we are lucky, another insect-eating species of bird will be able to take over the job of the species lost and continue to keep the insect population in check. However, if we are unlucky, and there are no suitable substitute species, then this insect population will likely explode, which may have negative knock-on effects on many other species in the landscape. Although there is some research to suggest that the changes in biodiversity in oil palm landscapes can have important implications for certain ecosystem services (see Boxes 13 and 14), no direct link has been demonstrated between the absence of a particular species and a concommittent measured change in a particular ecosystem function.

Box 13. **Insectivorous birds defend oil palm from insects.**

OVERVIEW: This study looked at the role of birds in controlling insect pests of oil palm by comparing the amount of leaf damage on one year-old seedlings accessible to birds and those protected from birds by wire cages.

KEY RESULTS:

- Leaf damage increased significantly on the oil palm seedlings protected from birds. This suggests that birds would usually eat the insects that caused the seedling leaf damage and are therefore important for pest control.

- The leaf damage on seedlings protected from birds was 28% higher than average leaf damage over the lifetime of an oil palm frond. Previous studies have suggested that 25% leaf damage results in a yield of 9% to 26%.

CONCLUSIONS & RECOMMENDATIONS:

- Insect-eating birds provide natural pest control, which can increase fruit yield and reduce the need for pesticides. Therefore, maintaining the diversity of bird species in and around oil palm can help ensure protection of the crop against insect pests.

- Other research has shown that the most effective way to promote bird diversity in and around oil palm is to conserve as much natural forest as possible. Planting leguminous ground cover and maintaining epiphytes on palms can also promote bird diversity in the estate (see Box 10).

Reference: Koh, L. P. (2008). "Birds defend oil palms from herbivorous insects." Ecological Applications 18(4): 821-825.

Plate 32. **A Bold-striped Tit-babbler (*Macronous bornensis*) foraging for insects on oil palm fronds.** *Lim Kim Chye.*

Box 14. **Bee diversity along a disturbance gradient in tropical lowland forests of south-east Asia.**

OVERVIEW: This study compared the bee species found below the canopy in a range of undisturbed and disturbed habitats, including an oil palm plantation in Peninsular Malaysia.

KEY RESULTS:

- A wider variety of bee species was found below the oil palm canopy than in natural forest. However, several important forest bee species, including honey bees (*Apidae*), were absent.
- Even though a wider variety of bee species were in oil palm, the total bee population was smaller than in less disturbed, primary forest.

CONCLUSIONS & RECOMMENDATIONS: Although the variety of bee species in oil palm was higher than in forest, the absence of honey bees is of concern, as they carry out pollination. Pollination is essential for the regeneration of natural forest, so it is important to ensure that areas of primary forest which can support honey bees are conserved within the oil palm landscape.

Reference: Liow *et al.* (2001). "Bee diversity along a disturbance gradient in tropical lowland forests of south-east Asia." Journal of Applied Ecology 38(1): 180-192.

Plate 33. **Bees are important pollinators.** *Dave Bakewell.*

5.2.4. How to access this research

The scientific findings from the relationship between oil palm and biodiversity can provide valuable guidance to those deciding how oil palm plantations are to be managed. However, the literature can often be difficult to access, either because it is in scientific journals which are only available to paying subscribers, or because the results are unpublished. Furthermore, the articles can be difficult to understand, because they are written in complicated scientific language, with little thought given to practical application of the results. In an effort to overcome this, the Zoological Society of London (ZSL) has produced an online database of the most relevant research on oil palm and the environment, which includes simple summaries of the findings and their practical relevance, in both English and Bahasa Indonesia. This database is freely accessible from the ZSL Palm Oil Environmental Resource Centre website (www.palmoil-environment.org), and the summaries can be searched or browsed. In addition, a list of the most relevant published research on this topic can be found in Box 15, which includes a link to the full article online. If you are unable to access the journal a particular paper is published in, a PDF format file of the paper can often be found by searching for the title on the internet, or contacting the corresponding author to request a copy of their research (their email address will usually be included in the abstract).

Box 15. Key References

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5.2.5. Initiating a biodiversity research project on your plantation

Why is it useful to carry out biodiversity research on your plantation?

The key measure of success in oil palm plantation management is a healthy and productive crop. An important factor contributing to this is the ability of oil palm to support biodiversity and the essential ecosystem functions associated with it, such as pest control, nutrient cycling and pollination. As described above, three types of information are needed to achieve this:

1. Which species are present in and around the plantation?

2. What impact does the plantation have on these species and what conditions are necessary to maintain their natural balance?

3. What role do certain species play in the ecosystem and how do they respond to changes in their surroundings?

Plate 34. **A healthy oil palm fruit bunch.** *ZSL.*

Ideas for how to initiate a research project on your plantation

The priority for most plantations should be to find the species living in and around the plantation (a species inventory) and their populations and conservation status (e.g. IUCN status, legal status and CITES status).

The research required to build a basic species inventory, at least of medium to large mammals and easy-to-identify birds, reptiles and amphibians, is simple and can be done by estate staff with some biological background or those who have had training in species identification.

Carrying out informal interviews with people living on and around the plantation is a very simple and valuable way of getting information about the species likely to be present in and around the plantation and the threats they face, such as unsustainable levels of hunting. A species inventory will usually be produced as part of a High Conservation Value Assessment of the plantation, which is required to comply with the RSPO Principles & Criteria, although these reports tend to vary considerably in the level of detail they go into.

To obtain comprehensive information about species that are more difficult to identify (e.g. many birds, insects, small mammals and fish), it may be necessary to invite a consultant (RSPO has a list of approved HCV consultants) to visit the plantation to carry out a more detailed assessment. The assessment can include an estimate of the population status (e.g. whether the species is rare or common in the plantation) and conservation status of the species identified. If species of High Conservation Value are found in or around the concession, further research is needed to determine the population status and distribution of this species in the plantation, in order to formulate appropriate management interventions.

Although some information is already available from the existing body of scientific research about the impact of oil palm plantations on certain species and the role they play in the oil palm landscape, many questions remain to be answered (see Box 17). Therefore, initiating research on your plantation which helps to answer these questions and provide information to guide management can be very valuable (see Box 16). One of the best ways of doing this is by collaboration with international and national research institutions, universities and NGOs. If your plantation is close to an established research station, such as the Royal Society research station in Danum Valley, Sabah, there may be visiting scientists from a wide variety of universities carrying out research there who would be interested in focusing on the relationship between oil palm and biodiversity. Entering into an MoU with the biology or forestry faculty of your local university and providing small grants to enable MSc and undergraduate students to carry out research on the plantation can also be a good way to initiate research to answer some of these questions.

Plate 35. **Camera trap photo of Leopard Cat.** *ZSL.*

Box 16. **Ideas for research to provide valuable information for plantation management.**

- What impact does the pollution of rivers by POME, chemical run-off and soil erosion have on fish and other aquatic organisms?
- What impact does application of POME have on soil-dwelling insects and bacteria involved in decomposition and nutrient cycling?
- How do predator-prey and plant-pollinator interactions within oil palm compare to those in large areas of contiguous forest?
- What role do different species play in providing natural pest control and how can populations of these be maintained or enhanced?
- Which species use the riparian zones and patches of natural forest within oil palm and do these patches provide suitable habitat to support them in the long term or act as pathways for movement between larger areas of habitat?

Box 17. **Case study: Investigating the role of small carnivorous mammals in controlling rodent populations in oil palm landscapes.**

Why is this useful for management?

- Outbreaks of rodent populations in oil palm plantations can result in significant reductions in yield (e.g. population densities of *Rattus tiomanicus* of 200-600/ha can result in approximately 5% loss of yield.[3])
- There are currently two common methods for rodent pest control:
  1. Rodenticides: these are expensive and may harm on the predators of rodents.
  2. Integrated Pest Management by, for example, the introduction of Barn Owls: the efficacy of Barn Owls in controlling rodent populations varies between different oil palm landscapes.
- This research aims to better understand how predation by small carnivorous mammals (e.g. civets, wild cats, mongooses) complements predation by Barn Owls in order to provide more effective natural rodent control in oil palm plantations. This research will assess variation in the diet of small carnivorous mammals and Barn Owls within and between several oil palm concessions. It will also gather information about where these small mammals are found in oil palm, which will provide an insight into how their populations can be maintained and enhanced within the oil palm landscape.

This research will be carried out on several PT SMART oil palm plantations in Sumatra and Bangka as part of a research programe led by CIRAD (France), SMART Research Institute and the University of France Comté, in collaboration with the Indonesian Institute of Sciences (LIPI) and the Centre for Biology & Management of Populations (France).

3 Wood, B. J. and S. S. Liau (1984). *A Long-Term Study of Rattus tiomanicus Populations in an Oil Palm Plantation in Johore, Malaysia: II. Recovery From Control and Economic Aspects.* Journal of Applied Ecology **21**(2): 465-472.

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8. List of Abbreviations and Glossary of Terms

8.1. List of abbreviations

AM	Adaptive Management
ARM	Adaptive Resource Management
BOD	Biological Oxygen Demand
B4BM	Biodiversity for Busy Managers
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	Chemical Oxygen Demand
CO_2	carbon dioxide
CSR	Corporate Social Responsibility
DOE	Department of Environment Malaysia
EPA	Environmental Protection Agency (USA)
FAO	Food and Agriculture Organisation (UN)
GHG	Greenhouse Gas
GIFAP	International Group of National Associations of Manufacturers of Agrochemical Products
GPS	Global Positioning System
HCV	High Conservation Value
HCVA	High Conservation Assessment
HCVF	High Conservation Value Forest
IBAT	Integrated Biodiversity Assessment Tool
IFC	International Finance Corporation
IPM	Integrated Pest Management
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
IWK	Indah Water Konsortium (Malaysia)

K-CoL	Kinabatangan – Corridor of Life
MA	Millennium Ecosystem Assessment
MoU	Memorandum of Understanding
MPOWCF	Malaysian Palm Oil Wildlife Conservation Fund
MSDS	Material Safety Data Sheets
MSW	Municipal Solid Waste
N_2O	Nitrous oxide
NCS	National Conservation Strategy (Malaysia)
NGO	Non-Governmental Organisation
NRE	Ministry of Natural Resources and Environment (Malaysia)
PE	Population Equivalent
PERHILITAN	Department of National Parks and Wildlife (Peninsular Malaysia)
POME	Palm Oil Mill Effluent
RSPO P&C	Roundtable for Sustainable Palm Oil Principles & Criteria
RTE	Rare, Threatened or Endangered
RWQA	Rapid Water Quality Assessment
SECD	State Environmental Conservation Department
SOP	Standard Operating Procedure
TEEB	The Economics of Ecosystems and Biodiversity
TSS	Total Suspended Solids
WWF-M	Worldwide Fund for Nature - Malaysia
ZSL	Zoological Society of London

8.2. **Glossary of terms**

biome	A biome is a major regional ecological community, characterised by distinctive animal and plant species. Two biomes are represented in Malaysia: Sundaic Lowland Forest and Sundaic Montane Forest (MNS, 2005).
entomopathonogenic	Parasitic on insects, killing or seriously disabling them.
homogenous	Uniform in nature; of the same kind.
HUTAN	A French NGO working to conserve the orang utan in Sabah since 1996.
natural corridor	A strip of land which facilitates movement of species between fragments of natural habitat. Establishment of a natural corridor involves intentional management and often, rehabilitation of native trees and plants.
Zero burning	Zero burning or 'the Zero Burning Replanting Technique' is a practice in which the old uneconomical standards of oil palm are felled, shredded and left to decompose in situ, rather than being destroyed by fire. This technique allows all plant tissues to be recycled, enhancing soil organic matter, and reduces harmful emissions.

Appendices

Appendix 1. How do we recognise a Critical Habitat?

According to IFC (2006), Critical Habitats are natural or modified habitats which have high biodiversity value based on a number of criteria. These are given below, with corresponding HCV categories, based on Stewart et al. (2008):

- Large numbers of endemic or restricted-range species found only in a specific area [HCV1 OR 3];
- Presence of known critically endangered or endangered species [HCV1];
- Habitat required for survival of particular migratory bird species or to support globally significant concentrations or numbers of individuals of congregatory species [HCV1];
- Unique assemblage of species that cannot be found elsewhere [HCV1 OR 3];
- Areas with key scientific value due to the evolutionary or ecological attributes present [HCV3];
- Areas that include biodiversity which has significant social, cultural or economic importance to local communities [HCV 4 OR 5];
- Areas recognised as particularly important for protection of ecosystem services (such as aquifer protection) [HCV 4].

An example of an attempt to prioritise Critical Habitats at state level (in this case, in Malaysia) is given below:

Table 29. **Table of priority habitats, as defined by the National Conservation Strategy (NCS) (WWF-Malaysia, 2009)**

Forest Type	Johor	Kedah	Kelantan	Melaka	Negeri Sembilan	Pahang	Perak	Perlis	Pulau Pinang	Selangor	Terengganu	Kuala Lumpur	Sabah	Sarawak
Extreme lowland	1		1	1	1	2	1				1		1	2
Lowland dipterocarp	2	1	1	1	1	2	2	1	2	2	2	2	2	2
Hill dipterocarp	3	2	3	3	3	3	3	1	1	3	3		3	3
Upper dipterocarp	2	2	2		2	2	2			2	2		2	2
Montane oak	2	2	2		2	2	2			2	2		2	2
Montane ericaceous	2	2	2		2	2	2			2	2		2	2
Heath	2		1	1		2	2	2			1		2	1
Limestone	2	1	2			2	1	1		2	2		2	2
Ultrabasic						3							3	
Quartz ridge						3				1				
River (montane)	3	3	3		2	3	3			3	3		3	3
River (sarace)	3	3	2	3	3	3	3	3	2	3	3		3	3
River (neram)	2	2	2			1	2				2		2	2
River (rasau)	3	3	2			3	3			1	2		3	3
Freshwater swamp	1					2	1				2		1	1
Peat swamp	2					1	1			1	2		2	1
Mangrove	3	1	2	3	2	3	2	2	2	1	3		3	3
Nipah	3	3	3			3	3			3	3		3	3
Scrub	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lake		2				1			2				2	2

1 = Highest priority
2 = Medium priority
3 = Least priority

Appendix 2. **How do we measure Rarity?**

An area with 50 House Crows and an equivalent area which is home to 50 Tigers do not have the same biodiversity 'value'. Clearly, in talking about species, not all biodiversity is equal.

Rarity is a concept used a lot in conservation literature.

Some species are naturally rare due to their **low density or restricted natural range**. For example, the endemic Malaysian Whistling-thrush (*Myophonus robinsoni*), frequents steep-sided stream gullies in forest between approx. 750 and 1700m in the main Titiwangsa Range of Peninsular Malaysia. The species was probably never common or widespread, even before the advent of hill station development.

Other species may have been naturally widespread, but have become rare due to significant **threats**. For example, most species which depend on lowland primary rainforest, a formerly widespread habitat in South-east Asia, are now endangered to some degree due to habitat loss. Other pressures, such as harvesting for trade or consumption may also impact particular species. Many species have become rare due to a combination of several pressures. For example, Straw-headed Bulbul (*Pycnonotus zeylanicus*) is one of many bulbul species under threat due to loss of lowland forest. As the species has a musical song, it has declined more than other bulbuls due to its widespread trapping for the cage-bird market.

Species which are naturally rare are particularly vulnerable to extinction when threatened by additional pressures such as habitat loss, hunting, trapping or harvesting, climate change, etc. One of the most well-established global initiatives to track extinction threats to species is undertaken by The International World Conservation Union (IUCN). IUCN is the world's oldest and largest global environmental network - a democratic membership union with more than 1,000 government and NGO member organisations, and with almost 11,000 volunteer scientists in more than 160 countries. The Red List is one of their key publications[1]; a global database of the status of all known species. The IUCN assigns one of seven categories of threat of extinction to each species (see Appendix 3).

1 http://www.iucnredlist.org/

Appendix 3. **Indicators for Rare, Threatened and Endangered Species**

There are three references to establish whether or not a particular species is threatened or has legally protected status:

1. IUCN Red List of Threatened Species (http://www.iucnredlist.org/)

2. CITES[2] Appendices I, II and III (http://www.cites.org/eng/app/appendices.shtml)

3. Relevant laws governing wildlife in Peninsular Malaysia[3], Sarawak[4] and Sabah[5]

If a species is found on CITES Appendix 1, or is protected under the relevant wildlife laws, or is listed as Vulnerable (VU), Endangered (EN) or Critically Endangered (CR) by IUCN, it is considered a Rare, Threatened or Endangered species.

2 Convention on International Trade in Endangered Species of Wild Fauna and Flora, of which Malaysia is a contracting party
3 http://www.wildlife.gov.my/pengumuman/Wildlife%20Conservation%20Act%202010%20Act716.pdf.
4 http://www.forestry.sarawak.gov.my/forweb/wildlife/mgmt/tpa/tprotsp.htm
5 http://www.wildlife.sabah.gov.my/

Appendix 4. How wide should a riparian buffer zone be?

In plantations where fertiliser, pesticides and herbicides are used, the maintenance of a vegetated riparian buffer strip of sufficient width is extremely important to minimise the amount of pollutants that enter the rivers. Width is the most important controllable variable for the effectiveness of riparian buffers in filtering pollutants. Topography, hydrology and geology have implications for appropriate buffer widths. In order to be effective, plants must either have access to high water tables or sufficient unsaturated flow. Also, plants will not remove pollutants from water which is moving too rapidly such as on steep slopes or in defined channels. Decisions on buffer widths are almost always a compromise between environmental goals and social or economic objectives, e.g. the value of water resources versus the value of adjacent land and plantations.

Table 30. **Riparian reserve guidelines in Peninsular Malaysia**

River width (m)	Width of riparian reserve (m)
> 40	50
20 - 40	40
10 20	20
5 - 10	10
< 5	5

Source: DID (2001)

The Guidelines for Rivers and River Reserves produced by DID (Drainage and Irrigation Department) specify widths of river reserves to a maximum of 50m, based on the width of the river (Table 30). However, it should be noted that the purpose of the guidelines is mainly for bank stabilisation; riparian zones as biodiversity habitats/corridors or water quality improvement require greater widths in general.

In Sabah, the establishment of river reserves is provided for under Section 40 of the Sabah Water Resources Enactment 1998, which states that river reserves "are to be established on land which is within 20 metres of the top of the bank of every river, including its estuary, where the channel is not less than three metres in width".

River reserves may also be established along channels less than three metres wide, upon the recommendation of the Sabah Water Resources Council. The purpose of the establishment of river reserves under Section 40 is for "protecting the volume or flow of water in water bodies and preventing the degradation of the quality of water resources and damage to the aquatic environment in water bodies". From a legal and/or management perspective, the width of riparian zones may either be fixed or variable. Fixed-width zones are easier to gazette, enforce and administer, but often fail to provide for many ecological functions. Variable width zones can be designed to carry out specific functions at various sections, taking into account the site-specific conditions and requirements along the length of the strip.

Source: Managing Biodiversity in the Riparian Zone (NRE, 2009b) http://www.nre.gov.my/Biodiversity/BioD%20Knowledge/RiparianGuideline.pdf

Appendix 5. **Soil Loss**

Earthworks and the loss of vegetation cover due to land clearing can have a significant impact on soil erosion. The following tables provide an illustration of the volume of soil loss in forest compared to land developed for agriculture (see Table 31 and 32).

Table 31. **Soil losses (tonnes/ha/yr) with slope and vegetation cover near Kundiawa, Chimbu Province (after Humphreys unpublished data) in Soils of PNG by Pieter Bleeker.**

Plot size (m^2)	% Veg. Cover	Number of plots	Average slope (degrees)	Soil losses (tonnes/ha/year)
Bare plots				
2	0	4	9.9	9.7
2	0	3	15.7	12.6
2	0	6	20.3	17.3
2	0	2	29.0	47.7
2	0	2	35.0	64.7
2	0	3	42.0	62.0
Fallow plots				
2	> 50	3	8.0	1.8
2	> 50	3	13.2	2.2
2	> 50	3	17.2	3.6
2	> 50	5	20.8	3.2
2	> 50	4	34.3	3.1
2	> 50	2	44.0	4.6

See: http://anthropology.uwaterloo.ca/WNB/SKeu%20Review%20of%20previous%20studies.htm

Within the context of oil palm, good legume cover has been shown to be an essential component of best management practices with regard to soil protection.

	Oil palm with good legume covers on undulating terrain	Oil palm on bare ground on undulating terrain
Soil loss (per ha)	80 kg/18 months ~53 kg/year	1.5 tons/18 months ~1 ton/year

Source: Ng et al., 2010.

Table 32. **Benefits of leguminous covers to reduce soil loss and nutrients in an oil palm plantation. The comparison here is between natural areas (regenerating undergrowth), areas under cover crop and bare ground.**

Cover Treatment	Runoff (mm/year)	As % total rain*	Soil loss (t/ha/year)
Bare	236	13	79
Creeping legumes	70	4	11
Natural	61	3	10

Source: Ling et al (1979)

* Total rainfall of 1,845 mm

Appendix 6. **An overview of IPM practices in relation to common leaf-eating insect pests in oil palm.**

Leaf-eating Pests of Oil Palm e.g., Bagworms of Nettle Caterpillars	
IPM Principles	**Management Prescriptions**
Acceptable Pest Levels	Threshold levels are between 5-10 live larvae per frond in a 10x10 palms sampling plot.
Preventive Cultural Practices	Cultural practices are focused on maximising natural population of predatory insects or organisms that prey on the insect pest. Thus (a) blanket weeding is discouraged; (b) soft-grasses and non competitive weeds are encouraged; and (c) natural hedges or vegetation are allowed to grow in unproductive areas.
Monitoring	Monitoring should be conducted regularly by a "pest & disease" gang and the frequency ensures that a field is covered every 4 months. The gang will check the palms for signs of pest damage at an intensity of one in four palm rows for every round of monitoring i.e. 1st, 5th, 9th, 13th harvesting path, etc. In the following round, they will cover the 2nd, 6th, 10th, 14th, etc. If an outbreak is detected a more detailed enumeration is initiated. The census over a 10x10 palms sampling plot would aim to count the number of live larvae per frond.
Mechanical Controls	Female bagworms congregate around the tips of the male inflorescence and manual removal is one method of control.
Biological Controls	The planting of host plants is encouraged to provide an alternative habitat for the predatory insects and parasites, for example: e.g., *Cassia cobaneensis*, *Turnera subulata*, *Antigonon leptopus*. These plants attract the natural predators e.g., Assassin bugs *Sycanus dichotomus* and *Cantheconidia furcellata*, of the pests. Parasitised larvae can also be collected and placed in containers that allow the adult parasitoids to leave after emerging. However, the planting of beneficial plants is more effective (see above). The effects of *Bacillus thuringiensis* (Bt) (2-3 kg/ha: Thuricide, Dipel) has been variable (e.g., up to 70 % larval mortality), depending on several factors, including climatic conditions. Normally, effective control requires at least two applications 3-4 weeks apart. Bt is a gram-positive, soil-dwelling bacterium, commonly used as a biological pesticide; alternatively, the Cry toxin may be extracted and used instead. Bt also occurs naturally in the gut of caterpillars of various types of moths and butterflies, as well as on the dark surface of plants.

cont'd

Leaf-eating Pests of Oil Palm e.g., Bagworms of Nettle Caterpillars

IPM Principles	Management Prescriptions
Responsible Pesticide Use	The pesticides used to control outbreaks include: Monocrotophos, Methamidophos, Trichlorophon (Dipterex), Cypermethrin and Cyhalothrin. The first two are applied as trunk injections and the others sprayed using knapsack sprayers or mist-blowers, depending on the height of the palms. To measure the overall effectiveness of a long-term IPM control for leaf-eating insects, monitoring of the total chemical toxicity (active ingredient/ha) of the chemicals applied is recommended. However, it is well-known that the two most commonly used pesticides (Monocrotophos and Methamidophos) are organophosphates acutely toxic to man and bird. However, as they are trunk-injected, their exposure to workers and the environment is reduced. Nevertheless, efforts need to be made to reduce their exposure to workers and the environment during application.

Toxicity of some pesticides used in oil palm

Pesticide	Oral LD_{50} for rats (mg/kg)
Tricholorophon	250
Pyrethroid	166
Methamidophos	20
Monocrotophos	18-20

One example template for monitoring individual chemicals used for leaf-eating insects is shown below:

Pesticide	% a.i.	Total volume applied (L)	Total area (ha) applied
Monocrotophos			
Methamidophos			
Trichlorophon (Dipterex)			
Cypermethrin			
Cyhalothrin			

Adapted from: Ang, 2000[6] AND en.wikipedia.org/wiki/Monocrotophos

6 CAUSES OF OUTBREAK AND FAILURE TO CONTROL BAGWORMS IN OIL PALM BY ANG BAN NA. MAY 2000 aarsb.com.my/Publication/Newsletter/PDF/2000-May.pdf

Appendix 7. **Typical Leachate Quality of Municipal Solid Waste (MSW) Landfills**

Leachate composition varies with the amount of precipitation and quantity and type of wastes disposed. In addition to numerous hazardous constituents, leachate generally contains nonhazardous parameters also found in most groundwater systems (see Table 33). These constituents include dissolved metals (e.g., iron and manganese) and salt compounds (e.g., sodium and chloride), and an abundance of common anions and cations (e.g., bicarbonate and sulphate). However, these constituents in leachate are typically at concentrations that may be an order of magnitude (or more) greater than the concentrations in natural groundwater.

Leachate from MSW landfills typically has high total dissolved solids and chemical oxygen demand, and a slightly low to moderately low pH. MSW leachate contains hazardous constituents, such as volatile organic compounds and heavy metals. Wood-waste leachates typically are high in iron, manganese, and tannins and lignins. Leachate from ash landfills is likely to have elevated pH and contain more salts and metals than other leachates.

Table 33. **Chemical analysis of leachate from MSW**

Parameter	Typical Range (mg per litre, unless otherwise stated)	Upper Limit (mg per litre, unless otherwise stated)
Total alkalinity (as $CaCO_3$)	730 – 15,050	20,850
Calcium	240 – 2,330	4,080
Chloride	47 – 2,400	11,375
Magnesium	4 – 780	1,400
Sodium	85 – 3,800	7,700
Sulphate	20 – 730	1,826
Specific Conductance	2,000 – 8,000 µmhos/cm	9,000 µmhos/cm
Total Dissolved Solids	1,000 – 20,000	55,000
Chemical Oxygen Demand	10 0 – 51,000	99,000
Biological Oxygen Demand	1,000 – 30,300	195,000
Iron	0.1 – 1,700	5,500
Total Nitrogen	2.6 – 945	1,416
Potassium	28 – 1,700	3,770
Chromium	0.5 – 1.0	5.6
Manganese	Up to 400	1,400
Copper	0.1 – 9.0	9.9
Lead	Up to 1.0	14.2
Nickel	0.1 – 1.0	7.5

Source: Based on Canter *et al.* (1988), McGinley and Kmet (1984), and Lee and Jones (1991)

Options for plantations in addressing this potential environmental hazard is to either improve the design of landfills (e.g., use liners, better construction to maximise space, etc) or to manage its waste streams systematically to reduce the potential toxic waste streams.

According to good principles of waste management[7], all wastes should be managed in the following order of preference:

- Avoidance – where possible, avoid creating waste;
- Reuse – develop ways to reuse the waste products;
- Recycling – if possible, identify waste that can be recycled onsite or offsite;
- Recovery of energy - consider harnessing energy/heat from machinery for other uses;
- Treatment – develop means to make the waste inert or safe to be disposed;
- Containment – develop means to contain the waste so there is little risk to the environment; and

Thus, in theory, disposal to landfill should only be considered as a last resort when there are no financially and technically practicable higher-level waste management options. However, for plantations located in remote areas, some options are not viable, or appear difficult and too costly to implement. This is clearly one area that would benefit from more investigation and trials. One way to reduce the volume of landfill waste is to develop and implement a waste separation and segregation system.

7 http://www.epa.gov/osw/

Appendix 8. **Selection of relevant scheduled wastes for oil palm plantations**

Main Code	Category Code	Code	Description
SW1	SW102	SW102 0101	Waste batteries in the form of whole
SW3	SW305	SW305 0101	Spent lubricating oil
SW3	SW306	SW306 0101	Spent hydraulic oil
SW3	SW307	SW307 0101	Spent mineral oil-water emulsion
SW3	SW309	SW309 0202	Oil-water mixture from any cleaning operation
SW3	SW312	SW312 0101	Oily residue from automotive workshop
SW3	SW312	SW312 0103	Oily residue from grease interceptors
SW4	SW430	SW430 0101	Obsolete laboratory chemicals
SW4	SW410	SW410 0301	Papers contaminated with scheduled wastes
SW4	SW410	SW410 0401	Filters contaminated with scheduled wastes
SW4	SW425	SW425 0401	Wastes from the production, formulation, trade and use of pesticides, herbicides or biocides
SW4	SW404	SW404 0201	Mainly clinical waste
SW4	SW409	SW409 0101	Disposed containers contaminated with chemicals
SW4	SW409	SW409 0102	Disposed containers contaminated with pesticides
SW4	SW409	SW409 0103	Disposed containers contaminated with mineral oil
SW4	SW409	SW409 0104	Disposed containers contaminated with scheduled wastes
SW4	SW410	SW410 0101	Rags contaminated with scheduled wastes
SW4	SW410	SW410 0201	Plastics contaminated with scheduled wastes

Source: Environmental Quality Act (1974)

Appendix 9. **What we learnt from the 1997-1998 Forest Fires**

The fires of the late 90s, which caused a severe haze across Asia, were a major turning point in the awareness of the fragility of natural areas. Severe droughts are caused by the *El Niño* phenomenon, which occurs every few years, and in the 90s, these led to widespread forest fires, especially on peat. The following facts were some of the health impacts of this regional 'haze' episode.

- An estimated 200 million people in Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand were affected by the haze.
- It was estimated that in Indonesia alone, fires on the islands of Sumatra and Borneo consumed 9 million hectares of vegetation.
- The number of cases of pneumonia increased 5 - 25 times in South-east Kalimantan (Borneo) and 1.5 - 5 times in South Sumatra.
- The number of outpatient visits with respiratory diseases in Malaysia increased 2- to 3-fold.
- In September 1997 in Jambi (Sumatra), the number of reported cases of upper respiratory tract infections was 50% higher than in the previous month.

Source: The World Health Organisation[8]

8 http://www.allcountries.org/health/vegetation_fires.html

Appendix 10. **Knowing your place in the world - a word about digital maps**

In the last few years, access to satellite images has become easier with the advent of Google Maps (http://maps.google.com) and Google Earth (http://earth.google.com/). All you need to get started is a good internet connection and a GPS location. Of course, there are limitations to what you can do, but to orientate oneself about a particular project site and surrounding land-use, this is a very useful resource.

For those more tech-savvy, building a geographic information database of project sites and the project area is the next level of sophistication. The software to do this used to be prohibitively expensive, but there are open source versions which are just as useful (e.g., Quantum GIS http://www.qgis.org). This allows you to build and analyse pieces of geo-coded information in relation to one another. This is especially useful when compiling information from different sources, for example Google Earth images with estate-specific features (roads, office complexes, fields) or satellite images.

Having access to other published datasets on global, regional, or national biodiversity (protected areas, species distribution maps, conservation priority areas) is also very useful. One such effort to compile and make such data available to more business decision-makers is IBAT (http://www.ibatforbusiness.org). IBAT for business is an innovative tool designed to facilitate access to accurate and up-to-date biodiversity information to support critical business decisions. This is a member-only domain but for plantation companies, it may be worth the investment.

Biodiversity in Plantation Landscapes is part of the Biodiversity for Busy Managers (B4BM) initiative by the Malaysian Palm Oil Council and Wild Asia. It aims to make the relatively recent industry-wide emphasis on biodiversity accessible and practical for those 'on the ground'.

Although biodiversity is much talked about, mostly in relation to the Roundtable for Sustainable Palm Oil Principles and Criteria (RSPO P & C) and High Conservation Value (HCV) assessments, there has not always been a clear presentation of key concepts, or guidance on how to apply them practically in estate management.

Biodiversity in Plantation Landscapes:

- Makes environmental/biodiversity issues easily understandable
- Focuses on the biodiversity issues of relevance to the oil palm plantation industry
- Offers solutions, tools and examples to enable plantation managers to protect and enhance biodiversity.

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