



Krau Wildlife Reserve

Management Plan



August 2001

Management Plan for the Krau Wildlife Reserve.

2002- 2006

PERPUSTAKAAN PERHILITAN
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1. An Introduction to the Management Plan.

1.1 Managing for biodiversity.

Protected areas such as the Krau Wildlife Reserve (KWR) are now recognised as centres for biological diversity or more familiarly –*biodiversity*. When these reserves were established under state ordinance in the 1920's, it was to protect the habitat of large *game* or hunting species such as gaur¹. On federalisation in the 70's, emphasis changed from managing hunting species to managing threatened wildlife in general. And now at the start of the new millennium, management emphasis has been widened still further to include all biological species, the ecological interactions between them and the environment on which they depend -biodiversity.

Because the KWR is classified as a natural forest where no major commercial forestry or land development has taken place, it has been assumed the reserve is immediately suitable for the development of those opportunities that can be connected with conservation of biological diversity. These would include : conservation education, research and most importantly ecotourism. In our opinion, this is not the case. The reserve is in a weakened state and requires considerable management effort before scarce management resources can be diverted towards opportunistic development. This plan places emphasis on the KWR staff becoming better managers before they become developers.

One of the results of the management plan processes has been an improved understanding of the current weakness in protected area management in the Peninsula. This plan recognises that there is a critical need to:

- perpetuate the general public's faith in the government agencies such as the DWNP, that have been assigned responsibility to conserve natural resources, will succeed in; and
- ensure our ability as a nation to manage and develop our resources both sustainably and equitably.

1.2 Considerations.

This draft of the management plan for the Krau Wildlife Reserve (KWR) is the end result of a management planning process². The draft has been supported by input through a series of workshops and meetings with the KWR staff and the

¹ This document is drafted in English and as such the English common names for local species such as gaur and wild dog (usually of British Indian origin) are used in place of the more familiar *seladang* or *serigala*.

² An outline of the methods used in the process to obtain information for the Management Plan are given in Section 2. And the outcome of the workshops and meetings with the KWR staff and the PA Div staff are given in a matrix in Annex 2. This matrix lists issues explored by the meetings, and traces the arguments and considerations that lead to the suggested actions in section 7 and Annex 1.

Protected Areas Division (PA Div.) staff, and these in turn have drawn on information provided by project consultants, from discussions with the local communities (LC) as well as previous studies. In translating that information into a realisable management plan many compromises have had to be made. Not all urgent needs can be realistically met, not all narrow windows of opportunity can be taken. However, this is only one of what should be a succession of 5-year management plans, so that the suggested strengthening of management capacity at this point, should enable the KWR to undertake more effective development and management of new services and opportunities in the future.

To begin planning for management of such a reserve, it is necessary to look into the potential *out-puts* and *in-puts* for two broad areas of investigation :

- 1) reserve resources: the opportunities offered and management needed; and
- 2) reserve management: performance capabilities and capacity building needs.

The plan response to these investigations is given below, but first it is necessary to outline the assumptions held from 'old knowledge' and our understandings gained from 'new knowledge'.

Looking at the reserve resource, according to 'old knowledge', the biodiversity of the KWR has been judged to have a very high potential because:

- most species of vertebrate found in the Peninsula are recorded at the KWR;
- Half of the approximately 62,000 ha. reserve is lowland forest, mostly with a high niche volume,
- it contains G.Benom, an isolated mountain where endemic and limited-range species have been identified,
- the reserve protects an intact series of ecotones from the lowlands to the mountain top, and
- since the area has had minimal large-scale disturbance, it is reasoned that there has been minimal disturbance to the natural ecology of the site, its species richness and distribution, and thus its biodiversity.

And from 'new knowledge', it can be seen that:

- the potential niche availability of the forest is good;
- endemic vegetation is high;
- harvesting of non-timber forest products (NTFP) appear to be within sustainable levels;
- biological diversity of large mammals is comparatively high; but
- there are signs of chronic threat to biodiversity as the numbers of large mammal species are much lower than expected for a natural forest area and their range excessively restricted.

This suggests problems with management control over the reserve.

From 1942 to 1989, most of the area in the KWR was considered “*Black Area*” because of communist activities. The state of knowledge of wildlife species in the KWR remained incomplete. To enter the reserve required a permit from an army. During this period, permission to make several trips into the KWR were given to the DWNP for inventory, research and management purposes.

Through the 1960's and 1970's, much of the forests around the KWR were cleared and replanted with rubber and oil palm. Forest clearance contributed to the material development of the state and nation, but it created three detrimental effects on the reserve.

- 1) It displaced some of the local communities from their traditional forest collection areas, concentrating their dependence for non-timber forest products in the KWR.
- 2) It further isolated the KWR forest fragment from larger surrounding forests, reducing the movement of wildlife and flow of genetic material that could supplement the declining wildlife in the reserve and genetic loss.
- 3) It created new high density agricultural settlements at the edge of the KWR and made the KWR more accessible to exploitation and colonisation by exotics.

So to return to the first question on the opportunities and requirements of the reserve :

- the biological diversity of the KWR is high and as an *out-put*, it should be able to support use for research, conservation education as well as ecotourism. But through on-going local disturbance and isolation, there are chronic threats to large mammal survival and the biodiversity of the reserve.
- what is needed, is a reduction of human activities that are preventing the natural recovery of large mammal populations.

To return the second question, requires new strategies on management by the DWNP. The old strategies can be summarised by:

- maintaining a DWNP presence at the boundary, and
- perpetuating the current facilities.

1.3 Facing the future.

To move beyond this point, the DWNP needs to proceed with professional responsibility to fulfil its trust. In short: manage the reserve as the law requires so that its biological diversity will be conserved. Addressing this responsibility forms the largest part of the actions proposed by this management plan.

In brief the 5-year management plan proposes three main actions:

- 1) re-organising people into natural management communities;
- 2) re-defining the management approach; and
- 3) applying their collective experts to reverse declining trend of wildlife on the reserve.

1.3.1 Re-organising people into natural management communities.

Re-organising people will take into account the scale of management problems so that an appropriate management entity can respond. The management plan recognises four levels of management need (see Table 1.1 below), which would be addressed by :

- The on-site management at the KWR being consolidated into a unified and cooperative body responsible for the facilities and biological diversity of the KWR – *the Krau Wildlife Reserve Management Unit (KWRMU)*.
- The unified KWR will then in turn work with a natural grouping of local communities who have an interest in the KWR, so that these local communities can achieve their own development goals without undermining the value of the reserve. The local community groups would need to accept greater responsibility for managing their local resource base for sustainable development – *a local community management group (LCMG)*.
- The KWR managers will need to be supported by federal HQ by a group of other DWNP sections. In addition to assuming group responsibility for quality of management at the protected area, they would give support with specialist needs such as research, training, development, etc. – the *Monthly Productivity Meeting (MPM)* and
- Support will be needed at district and state level by a committee of state agencies under the state EPU responsible for ensuring that the development by their individual sector of the natural resources of the state is sustainable as a whole – a successor to the Project Technical Committee (sPTCor KWRTC); District Development Committee, and State Development Committee.

1.3.2 Re-defining the management approach.

Redefining what managers do will include:

- An ecosystems approach is suggested by the management plan as a means to unify the management of the reserve with the management of the natural resources of the state. This would reinforce the position of the, in support of federal policies – biodiversity) as an integral part of the state landscape and recognised as an environmental asset for the state. It would also facilitate

the recognition and management of buffers and biological corridors at the state level (see table 1.1 below).

- But managing ecosystems is new idea in the Peninsula, and unlike enforcing the Protection of Wildlife Act, 1972, ecosystems management does not yet have any established prescriptions or practices. The management plan suggests that the KWR management will need to use an adaptive management approach. A long-term strategic target is set for which the first 5-year plan period is used to build capacity and test management systems. Management targets and methods are proposed, and over annual cycles, performance should be monitored and management methods adapted as needed.
- The existing intersectoral approach available would be to look at PA's as a land use issues. This would fit into the planning provisions under the Town & Country Planning Act³.
- And, to develop a better sense purpose among managers at all levels, the management plan suggests that the concept of stewardship be adopted by each management grouping, including the local community. This will emphasise a requirement for managers to answer to a responsibility, rather than seek to fulfil their a perceived rights.

1.3.3 Reverse declining trend of wildlife on the reserve.

Reverse declining trend of wildlife on the reserve can only be done through a collective effort. It is not possible to defend a reserve from a hostile local community and an indifferent state government. Reversing a declining trend in wildlife will involve:

- Building management capacity at the KWR and the capacity to provide supporting services for the reserve from the DWNP,
- Building support for the conservation of the reserve among the local community, and
- Presenting to the state and other land and natural resource management agencies the arguments and needs for an holistic approach to sustainable development of natural resources.

Through these actions the KWR will be able to take firm steps towards meeting the objectives set by the project.

³ The Act has been amended by Parliament to allow the T&CP Director himself to head the planning process instead of the District Officer.

TABLE 1.1: SCALE OF MANAGEMENT INTEREST AND NEEDS FOR THE KRAU WILDLIFE RESERVE.

Issues	 Relative scale of management interest			
	State	DWNP	Local Communities	KWR
Scale of interest	Landscape and ecosystems at state level	Ecosystems at national level	Local forests and their NTFP resources	Reserve and local forest.
Area of interest	<i>Land use and sustainable development</i>	Biodiversity management & reserve tenure.	Sustainable use of NTFP, & local environment quality	Biodiversity of reserve, local ecosystems and reserve security.
Management tools	<i>Constitutional powers over land; State development and planning, laws.</i>	MoSTE Biodiversity policy; laws & DWNP sectoral resources and skills.	Traditions of reaching understandings with neighbours	Laws and staff; developing PA management skills.
Management needs	State based action to integrate ecosystems management needs into land management for sustainable development.	Capacity building to provide technical support and quality controls for protected areas and ecosystem management.	Recognition first, & then extension support to assist with community self-management of the use of NTFP resources on a sustainable basis.	Establishment as a credible management authority over the reserve, supported capacity building of staff and resources to conserve local biodiversity.
Mandate	T&CPA	PWA, PA-MP	Agenda 21, OAA	In-situ management strategy of the NPBD
Spatial area	3,595 x 10 ³ ha.	13,000 x 10 ³ ha.	250 x 10 ³ ha.	60 x 10 ³ ha.
Time scale	>20 years	20+ years	10 –20 years	5 years

2. Project Background

2.1 KWR project framework

2.1.1 Management Plan for Krau Wildlife Reserve

Presented here is a draft of the Management Plan for Krau Wildlife Reserve (KWR) 2001-2006 (henceforth referred to as 'the management plan').

This document is one of the deliverables of the *Management of Krau Wildlife Reserve, Capacity Building and Human Resource Development* project (henceforth referred to as 'the project'). This was a 3-year project funded by Danish Government through DANCED. The development objective of the project is stated as:

- *Improved biodiversity conservation and management through strengthening of a Protected Areas System.*

The immediate objective was given as:

- *Prepare and implement a Management Plan for the Krau Wildlife Reserve and achieve capacity building and Human Resource development in support of the planning and management of Protected Areas in Peninsular Malaysia.*

2.1.2 Role of the Management Plan in the project

One objective of the project was to install within DWNP the capacity to develop and implement a management plan that can be used as a model for the development of other protected areas in Malaysia⁴. This management plan is also intended to develop practical methods and procedures for creating management plans for protected areas in general.

Krau was chosen for a pilot project as it is thought to have:

- a rich biodiversity;
- traditional communities;
- a wide range of conflicts and challenges to biodiversity from :
 - tourism development;
 - agriculture; and,
 - infrastructure planning.

⁴ The management plan was considered to be a demonstration tool for future development of management plans in other protected areas. The strategic components were to include three main elements:

- *Collection and compilation of data necessary for developing a Management Plan.*
- *Development of DWNP staff and local communities' skills to facilitate their involvement in PA management preparation and management.*
- *Necessary infrastructure constructed to ensure appropriate utilisation of Krau.*

2.2 Role of the KWR in the DWNP 'Master Plan'.

In the *Capacity Building & Strengthening of the Protected Areas System in Peninsular Malaysia* (generally referred to by the DWNP as 'the Master Plan') makes specific mention of the KWR under implementing strategy. Krau was intended to be a demonstration area for the activities related to protected areas. These included:

- Institution building;
- Applied research;
- Public awareness;
- Interagency collaboration among:
 - Pahang state,
 - Forest Department, and
 - MoCAT;
- Local Community involvement/participation.

This was to serve as a case study to be replicated by the DWNP in the remaining protected areas. In addition:

- The procedure for undertaking management plans was to be established.
- Staff training requirements identified.
- And training and extension material developed to replicate the study.

Under revitalised management, the reserve was to integrate user opportunities with its on-going management activities. Management driven applied research was to provide data for biophysical and social management concerns, and this was expected to involve the participation of other institutions – universities, FRIM, NGO's etc. In addition, public awareness based on field activities and a future visitor centre was to be undertaken. This would have involved the support of MoCAT as a pilot project for its implementation of the National Ecotourism Plan (NEP).

The master plan also recognised the need to integrate the management of the whole Krau forest fragment area. This would have involved a close working relation with the Forest Department.

2.3 Approach to the project

Guidance for the approach to create this draft came through the project chief technical adviser (CTA) and was based on the requirements of the *Management of Krau Wildlife Reserve Capacity Building & Human Resource Development* project document. Section 2.1 mentions the project intention for the management plan was to act as a demonstration tool for a methodology the DWNP could apply to other PA's. Thus the process for drafting this plan was considered as important for capacity building at the DWNP as the plan itself.

An earlier draft outline for a management plan had been prepared as a result of recommendations from the Mid Term Review of the project. The draft outline was intended for further development through workshops and with relevant stakeholders to identify issues and discuss options for management responses, which should be included in the final draft.

The approach adopted was process-oriented. It was considered necessary to go through a series of scoping exercises with a group of key KWR and DWNP PA Div. staff to:

- identify key management personnel who would eventually be responsible for the execution of the management plan;
- understand their roles in management, the extent of their responsibility and tasks, and their capacity to execute;
- review the extent of knowledge of the protected area,
- identify management targets currently set by superior plans and policies,
- as well as the on-going and planned activities at the KWR.

This would allow the group to identify major management gaps and issues. The discussion exercise identified items for inclusion in *section 3 – Description*, of this draft.

This review process was undertaken through 6 meetings supported by project consultants and attended by DWNP staff at the KWR and staff from the PA Division. These meetings discussed issues brought up by specialist project consultants in their reports, the outcomes of workshops held for stakeholders at national and local level, as well as current issues from sciences that supports wildlife and ecosystem management. The results of the exercise formed the basis for *section 5 – Assessment Statement*, of this draft.

With the major issues and management considerations identified, a 2-day workshop was held in Kuala Lumpur to review options for a management response. The result of the discussion forms the basis of *section 4 -Situation Arising*, and is summarised as a table in Appendix 1, and forms the basis for *section 6 –Management Strategy*, and *section 7 –Management Actions*, of this draft.

The actions given in section 7 are not given as a sequence of deterministic prescriptions. That level of detail will have to come from annual action plans. For each group of actions, a single column is given for either an indicator or an output for the action. This plan has deliberately avoided offering too much detail or setting too rigid an output for actions.

2.4 Deviation from earlier guidelines.

The outline and contents of this management plan do not follow the suggested *Mid-term Review* draft outline. Those suggestions miss out steps, which are useful in a collective approach in the management planning process - those of :

- data analysis and evaluation, and
- making a firm assessment statement.

In the opinion of the management plan drafting team, a structure to analyse inputs, usually from incomplete information, is essential if the process is to be used as model or learning tool at other protected areas. Since the output of the management plan is intended to be a 5-year management treatment of the reserve, the assessment statement effectively becomes an opening statement. This can be matched to a closing statement at the end of the management plan period as well as at the end of each annual cycle. This is especially important since the adaptive management techniques have been adopted as a strategy and the four annual cycles within the plan are intended to allow on-going corrections for misdirection or mistiming in management.

2.5 Objectives

2.5.1 Initial objectives.

An initial set of management objectives was recommended by the project Mid-term Review Team and based on the strategy for the DWNP 'Master Plan'. Presented below is the initial suggestion for the main objective for the KWR:

- *To conserve the biodiversity of Peninsular Malaysia in general and the State of Pahang in particular.*

With immediate objectives suggested as:

- *To become an international loci of biological research in tropical humid forests;*
- *To become an environmental training centre at the national level; and*
- *To provide services outside of the reserve in support of environmentally sound development.*

2.5.2 Final management plan objectives.

These objectives were presented to the scoping group at the Krau Management Plan meeting held at the Wildlife Training Centre, Lanchang on 01-03-2001, and the same issue was reviewed once more on 12-03-2001. After lengthy discussion, a consensus was reached that a more focused set of objectives was

needed for the management plan, especially for the immediate objectives. The meeting suggested the objectives be redrafted as:

Main objectives:

- To conserve the biodiversity of Krau Wildlife Reserve in particular, and the state of Pahang and the Peninsula in general.

Immediate objectives:

- The conservation of biological integrity⁵,
- To get local community involvement in the management of the Krau Wildlife Reserve,
- The establishment of the Krau Wildlife Reserve as a national and international research, and education facility.

These are the objectives, which this management plan has attempted to address.

⁵ The use of the term *biological integrity* can be loosely defined as encompassing biodiversity at all levels together with the ecological interactions between and among species, and the processes which effect the environment. Usage in this plan is deliberately kept imprecise to reinforce the point that managing a biological reserve is still very much an exploratory exercise.

3. Description

Krau Wildlife Reserve (KWR) is unique in Malaysia, and the world, for its diversity of landscape, fauna and flora found within such a compact area. Scientists, managers and the general public alike, have been aware of the biological richness of KWR over the years, using the Reserve for different purposes at different times. It is only now, however, that it is beginning to become evident why there is such a strong need to preserve the biodiversity of this natural heritage area. The following section describes the KWR and its uses since gazettement. It is only through understanding the past uses and abuses of KWR, as well as increased efforts to achieve greater understanding of its resources that it is possible to truly establish an appropriate and sustainable plan for management.

3.1 History of Krau Wildlife Reserve.

3.1.1 Creation of the reserve

With its large forest resources and limited access, Pahang at the end of the 19th century was considered one of the states with the least need for wildlife protection. In the more developed states on the west of the Peninsula, conflicts between wildlife and development were already apparent. At the beginning of the 20th century, Perak was the richest and most developed state. Land clearance for tin mines and commercial agriculture was already having an effect on wildlife. By 1903, Perak had created the Chior Game Reserve to protect gaur, but it was not until the adoption of the *Wild Animals and Birds Protection Enactment, 1921* did Pahang even have a legal instrument to create a reserve for wildlife⁶.

TABLE 3.1 : SUMMARY OF GAZETTE NOTICES CONCERNING THE KRAU WILDLIFE RESERVE.

Notice	Area	Gazt. No.	Date	Legal instrument.
Original gazette	55,182 ha. 136,300 ac.	GN 3541	15.06.23	Wild Animals and Birds Prot. Enact. 1921
Regazette	53,042 ha. 131,000 ac.	GN 5685	04.09.25	Wild Animals and Birds Prot. Enact. 1921
Regazette	65,268 ha. 252 sq.mi.	GN 2848	09.06.39	Wild Animals and Birds Prot. Enact. 1921
Degazette	1,984 ha. 4,900 ac.	GN 102	22.04.65	Wild Animals and Birds Prot. Ord. 2 of 1955
Degazette	891 ha. 2,200 ac.	GN. 39	22.02.68	Wild Animals and Birds Prot. Ord. 2 of 1955
Gazette of Jenut	¼ mile around salt lick	GN 7454 GN 7079	13.11.25 23.07.27	Wild Animals and Birds Prot. Enact. 1921

⁶ The 1902 enactment for the protection of wild animals and birds had been adopted by Selangor and Perak in 1902 and Negri Sembilan in 1903. This was replaced in the three states by the *Wild Animals and Birds Protection Enactment, 1904*. But it was not until the adoption of the *Wild Animals and Birds Protection Enactment of 1911* did Pahang, adopt game laws.

MAP 3.1: THE KRAU GAME RESERVE AS MAPPED BY THE WILDLIFE COMMISSION, 1932

Pahang took an early lead in providing actual management for their protected areas – Taman Negara and the KWR. In his testimony to the *Wildlife Commission of Malaya*⁹ in 1931, Fetherstonhaugh, the first salaried Assistant Game Warden, FMS and Acting Game Warden for Pahang mentioned actions that included: establishing rangers posts at the reserve entrances; marking boundaries; organising patrols; and improving salt licks as steps taken to establish the KGR as a real sanctuary.

3.1.2 Proposals for National Park status

Game Reserves were intended as sanctuaries for game species and for the benefit of those that had licenses to hunt. In the same report, T.R.Hubback, the appointed commissioner, made the recommendation for the reserve be 'raised to the status of a National Park under the title of the "Gunong Benom National Park"¹⁰. Further recommendations were made to extend the eastern boundary to include the Jenut Kelebang and refine the arbitrary boundary on the west and north to follow the watershed. The boundary recommendations were taken up, but not conversion of the reserve to a national park.

Recommendations to change the status of the reserve to a national park were made once more in 1963¹¹. Five years later the Weber report on a National Parks System for Malaysia, did not support the proposal. This considered the KGR as too similar to Taman Negara to make a useful contribution to a *system* of national parks in Peninsular Malaysia, each representing a particular ecosystem or landscape identity¹².

3.1.3 The post war years

During the post war period, KWR was affected by five main issues:

- wildlife management,
- the communist insurgency,
- land clearance for plantation agriculture and local community settlements,
- harvesting by Orang Asli and other local communities, and
- changes in administrative control.

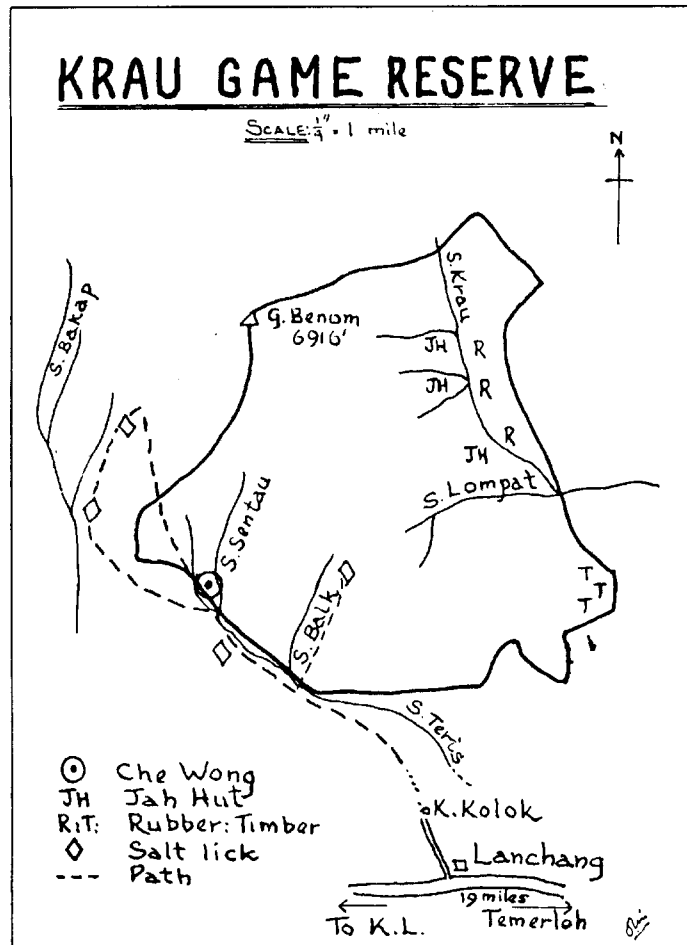
⁹ See Vol 1. p. 314, of the Report of the Wildlife Commission of Malaya.

¹⁰ See para 62, Vol II, p. 207, of the Report of the Wildlife Life Commission of Malaya,

¹¹ See p. 35 in Stevens, W.E, the Conservation of Wildlife in West Malaysia. 1968.

¹² See Weber, B.E. (1968) – A National Parks System for Malaya. Report to the Chief Game Warden. At the time the US model was the most developed, and it was considered appropriate to make only the best examples of an ecosystem type as a national park. Parks were for people to appreciate grand landscapes and heroic wildlife species. In a small country such as Malaya visitor needs could be met by, the single lowland /mountain forest example at Taman Negara. Weber was concerned that redefining Krau as a national park, would prevent areas with other non-represented ecosystems such as the swamp area at Tasek Bera and the then proposed lake at Belum/Temenggor from becoming parks.

In his survey in 1961, Milton noted disturbance from licensed loggers and jelutong tappers who had been given permission to exploit areas within the reserve¹³. He also noted the presence of rhinoceros at *Jenut Bakap* beyond the western edge of KGR, and made a recommendation that the reserve boundary be expanded westwards to include this area. No boundary changes were made and shortly after the area became the FeLDA Lembah Kelau development area. Seven years later, Stevens mentioned the then Game Department had evicted the cultivators, and terminated the jelutong tapping and timber licenses inside the reserve. Between 1966 and 1974, the forest was cleared along the eastern and southern boundaries and the FeLDA Jenderak estates were established. At FeLDA Bukit Damar, the new estate approached to within 1.5 km of the southern boundary. Although the FeLDA developments did not encroach upon the reserve itself, they reduced the size of the local forest ecosystem, especially lowland forest, and selectively converted the forest areas with the best soil, their salt licks and the habitat of the local gaur population. Between 1974 and 1989, the last 10 elephants in the KWR area were captured in these surrounding estates and translocated.



MAP 3.2: POST WAR SURVEY BY MILTON.

¹³ See Milton, Oliver, MNJ Vol. 16. 1&2, p.36-43.

Administrative changes have complicated the issues of where the KWR was actually located on the ground. When the reserve was created in 1923, the then KGR, now KWR, was mainly within the District of Temerloh with smaller parts in the Districts of Raub and Lipis. The district boundaries of Temerloh, Lipis and Raub followed an imaginary straight line between the mountain peaks (see MAP 3.1). In 1959, the District of Jerantut was created in the south-eastern part of Lipis placing the KWR in the Districts of Temerloh, Raub and Jerantut. Then, sometime in 1980s, the Pahang State Government with the assistance of the Survey Dept, redefined the boundaries between these three districts in the Gunung Benom area as following the watershed instead of the straight lines between mountain peaks. This resulted in the district boundaries being in alignment with the boundaries of the reserve¹⁴. Once the current boundary survey is completed, the KWR and district boundaries in the north and west of the reserve will be in alignment. The reserve will then be wholly within the Temerloh and Jerantut Districts with no pockets in Raub. However, some of the buffer areas around the reserve will be in Raub District.

3.1.4 Logging, land development and local communities

The Steven's report in 1968 did not consider logging to be incompatible with wildlife management in the reserve, providing it could be managed as a secondary consideration. However, when he considered the effects of the old logging areas east of Bukit Tapah, and clearance at the Jah Hut settlements along the Sg. Krau, he proposed to move the reserve boundary westwards to the Sg. Krau and the watershed between the Sg. Lompat and Sg. Tekal (see MAP 3.3), while expanding the reserve to cover all areas above 2,000 ft on G. Benom. This would have created natural boundaries for the reserve, included mountain areas recognised for having high endemism, but lost a significant area of lowland forest with several functional saltlicks and which was prime habitat for threatened species such as gaur. Stevens also recommended that the KGR become the Krau Wildlife Reserve (KWR), and that overlapping gazettement as a forest reserve be created allowing sustainable logging within the reserve. The two degazettements in the 1960's removed the Jah Hut settlements on the Sg. Krau from the reserve. In 1977 a security road was built by the military through this area linking Kuala Krau with Ulu Cheka.

And, in the same year, the area to the east of the settlements, that had once been a part of the reserve and then intended for OA land was logged (see MAP 3.2). It was also reported that a 25km² concession was granted in the north east corner of the reserve below Ulu Cheka¹⁵.

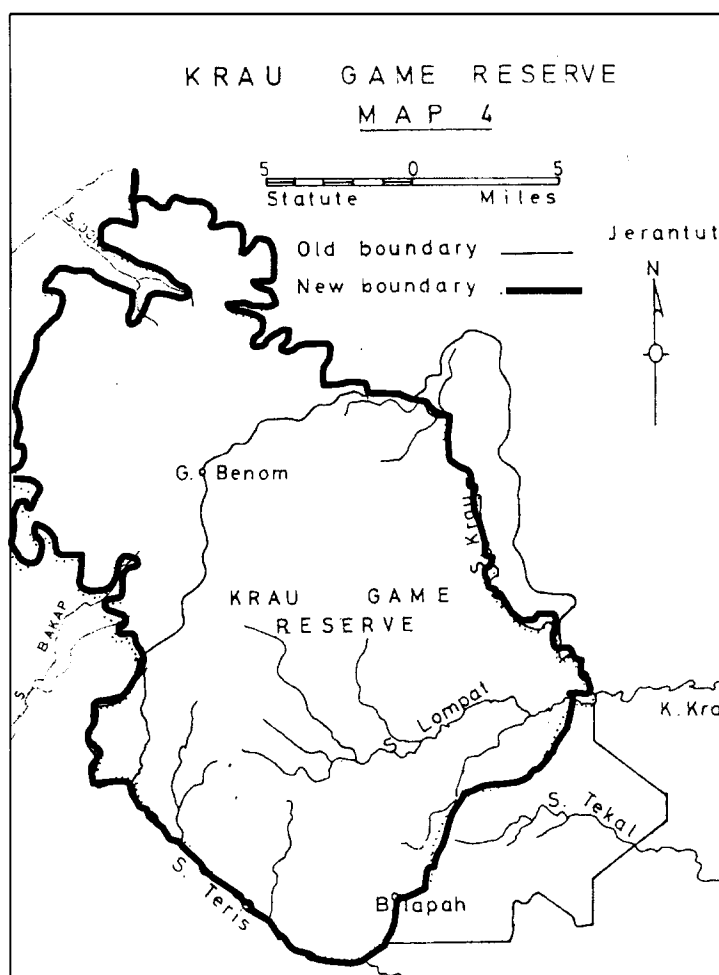
¹⁴ However, since the area has not been identified for development, a new of the district boundary was given a low priority and not undertaken by the state. The DWNP is now in the process of doing its own boundary survey, and it is understood that this survey will be accepted by the state as being both the survey of the reserve as well as the district boundaries in this area.

¹⁵ This was taking place at about the same time as the controversial logging in the proposed Endau-Rompin National Park area.

Apart from the periods between the Japanese Occupation and the imposition of martial law that followed, management of KWR has passed from Pahang State Game Department to the Federal Game Department (subsequently changed to the of Wildlife and National Parks (DWNP) in 1976) when the department was federalised in 1973. From 1945 until 1989, the area was considered a security risk.

The most recent land removal from the reserve was for an aquaculture project undertaken by then Fisheries Department at Ulu Cheka in 1996¹⁶¹⁷. The work was initiated in 1996; the full process of degazettement has yet to take place; and in compensation alternative land is planned to be added to the reserve. The DWNP has also undertaken a number of *ex-situ* projects at the periphery of the KWR.

MAP 3.3: STEVEN'S PROPOSAL FOR BOUNDARY SHIFTS



¹⁶ The area measured from recent survey plans indicates 437 ha was excised from the KWR.

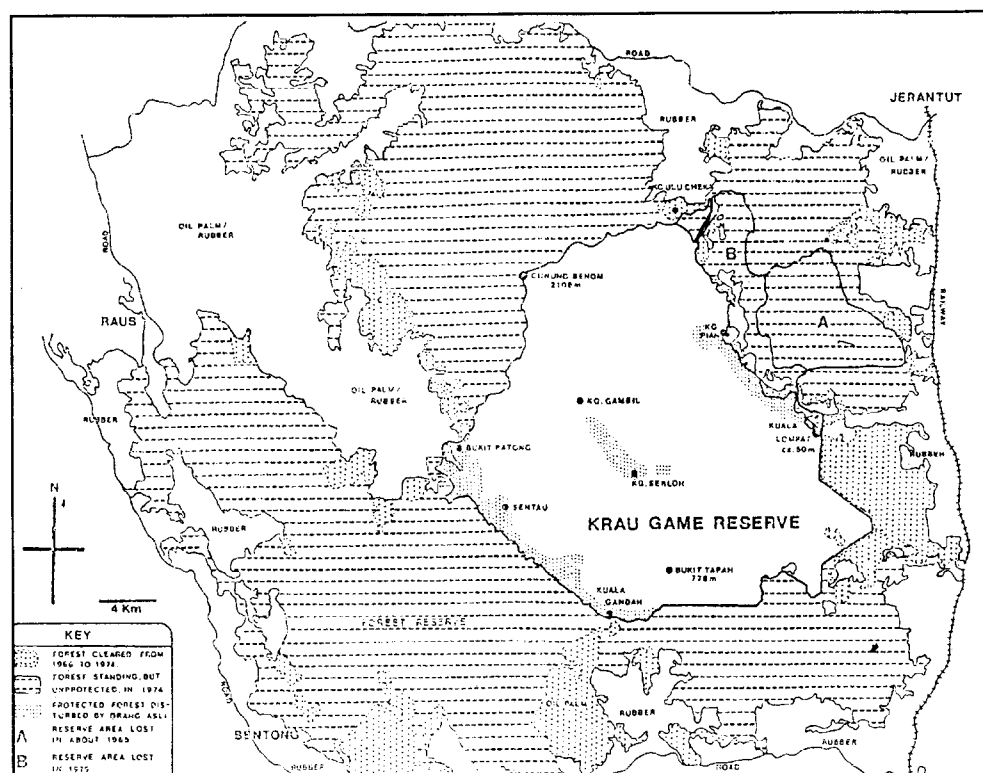
¹⁷ DWNP had itself earlier used an approx. 20 ha. parcel of KWR land at Jenderak for its own captive breeding work with gaur, sambar and the exotic Timor Deer.

3.1.5 Research and other opportunities

Records of scientific expeditions to examine flora and fauna in the KWR area go back to the 1920's. In 1967, a joint expedition with the British Museum of Natural History, University Malaya, and the Institute of Medical Research made a continuous transect from the lowlands to the summit of G. Benom. In 1995, the DWNP mounted an expedition of their own that compiled a species list, mostly of mammals and birds, in parts of the reserve. Since the 1970's Kuala Lompat has been used as a research site by students from Univ.Malaya, Univ.Kebangsaan and overseas universities.

The DWNP has located its Gaur and Deer captive-breeding unit at Jenderak Selatan, the Elephant Management Centre at Kuala Gandah, the Wildlife Training Centre at Bukit Rengit¹⁸. These centres undertake their operations as a separate function to the management of the reserve with few consideration given to the environmental or ecological effects made on the reserve. In addition the KWR also provides opportunities for recreation and tourism. Visitors use the waterfall and picnic area at Bukit Rengit, visit the elephants at Kuala Gandah.

MAP 3.4: MAP TAKEN FROM THE CALDECOTT REPORT OF 1979 SHOWING THE EXTENT OF THE SURROUNDING FOREST AT THAT TIME AND THE EXTENT OF FOREST LOSS TO THE KWR.

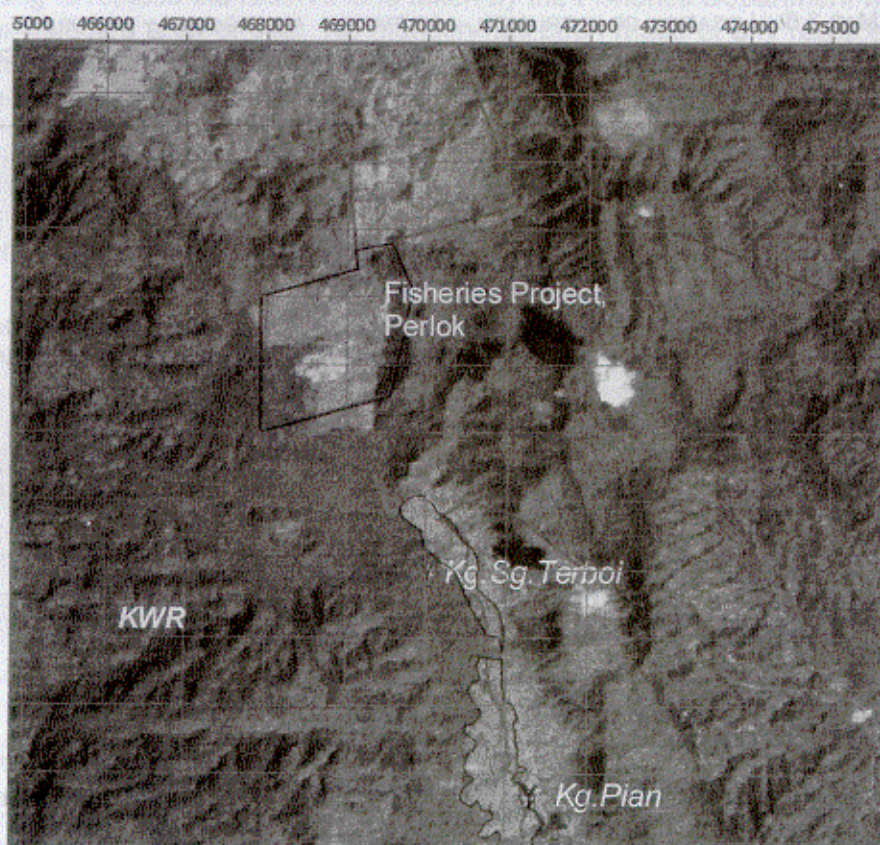


¹⁸ In 1996, the DWNP attempted to standardise the names of its facilities at the KWR as: Pusat Pemuliharaan Hidupan Liar/Wildlife Conservation Centre – WCC(Seladang & Deer) Jenderak Selatan; WCC (Elephant), Kuala Gandah; Wildlife Training Centre, Bukit Rengit; Wildlife Research Centre, Kuala Lompat; KWR Station, Perlok; KWR-S, Klau, and others.

3.1.6 Excisions, intrusion and land loss

The maps above have all given different boundary shapes to the reserve. At the time of writing, the DWNP is in the process of conducting a new boundary survey of the reserve. This map work, together with recent satellite imagery, have begun to indicate the extent of intrusion into the reserve. In 1996, the Fisheries Dept undertook a 4- year aqua-culture development project at Perlok on a 436 ha plot. This land transfer has still to be approved by the State Executive Committee¹⁹. In addition, the DWNP also has land within the reserve in use for own purposes at Kuala Lompat, Jenderak, Bukit Rengit and Kuala Gandah. And certain parts of the land has also been occupied and vegetation cleared by local communities inside the boundary

MAP 3.5: SATELLITE IMAGE OF THE PERLOK AREA. NOTE THE SATELLITE IMAGE AND THE BOUNDARY MAP DO NOT RECONCILE. BOTH HAVE BEEN PROJECTED ON THE COMMON RSO GRID BY DIFFERENT BUT BY DIFFERENT FEDERAL AGENCIES.

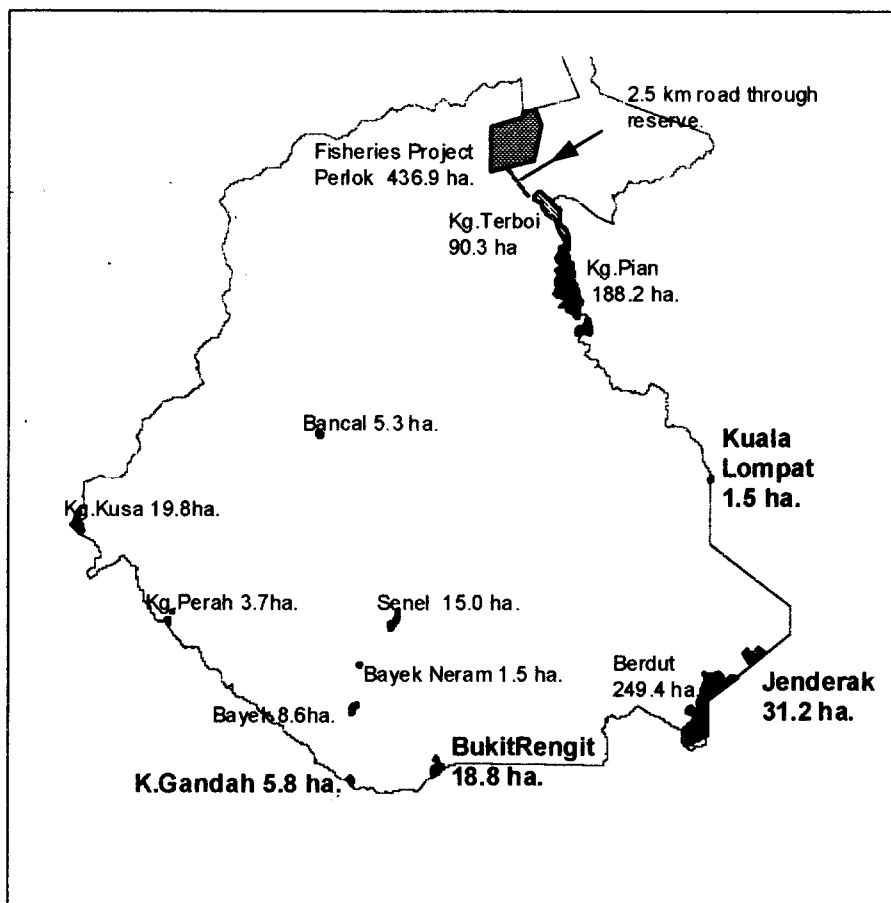


¹⁹ According to section 47(b) of the PWA, alterations to the boundary of a reserve should only be done after consultation with the Minister. In this case, there is no record that such consultation was done or that the DWNP was informed.

Table 3.1: Extent on intrusion and occupation of the KWR.

Category	Site name	Area in Ha.	Category total area	% of current reserve
Fisheries Dept.	Perlok	436.9	436.9	0.70%
DWNP	Lompat	1.5	39.9	0.09%
	Jenderak	31.2		
	Bkt.Rengit / Lanchang	18.8		
	Gandah	5.8		
Local communities	Kg.Terboi	90.3	606.5	0.97%
	Kg.Pian	213.3		
	Berdut	249.0		
	Bancal	5.3		
	Kg.Kusa	19.8		
	Perah	3.7		
	Senel	15.0		
	Bayek	8.6		
	Bayek Neram	1.5		

MAP 3.6: LOCATION OF INTRUSION, OCCUPATION AND RECENTLY DISTURBED AREAS IN THE KWR. AREAS ARE APPROXIMATE AND MEASURED FROM RECENT SATELLITE IMAGE



The satellite image base in MAP 3.5 shows the extent of land lost to the Fisheries Department as well as the extent of intrusion by local communities at Kg. Sg. Terbol and Kg. Pian. Using the satellite image as an information source, the extent of intrusion into the reserve is given in TABLE 3.1 above. It would appear the largest category of occupier in the reserve are local communities²⁰. See MAP 3.6 for locations below, and note the 2.5 km road cutting through the northeast corner of the reserve, bisecting the '*biological corridor*' towards Taman Negara.

It would appear the largest category of occupier in the reserve are local communities²¹. Though the actual size of the land take is not large, land take tends to be on the best lowland soils, across natural migration corridors and around salt licks. Land used by local communities can be argued as a present continuation of a long standing land-use practice in the area which in their fallow phase, create browse areas for large mammal herbivores. However new type of threat comes from the 2.5 km public access road from Perlok to Kg. Terbol. This creates a through road from Kuala Krau to the northwest which could attract increased non-local traffic and create a further enforcement problem.

It is understood that there have been discussion at the PTC and at the UPEN, Pahang to replace the reserve land taken by the Fisheries Department with an as yet unselected area or site. No mention has been made of any replacement for the land marked as Area A in MAP 3.4 and identified in that map source as lost from the reserve in about 1966. (See mention of GN 102 and GN 39 TABLE 3.1.)

3.1.7 Recent development projects at the KWR.

Summarised in TABLE 3.2 is a list of the development projects undertaken by the DWNP and other agencies at the KWR.

TABLE 3.2: DEVELOPMENT PROJECTS IN THE KWR AREA UNDERTAKEN BY FEDERAL GOVERNMENT AGENCIES FROM 1967 TO 2000.

No.	Project	Years	Value RM ²²	Nominal area developed Ha.
1	Gaur grazing area at Jenderak	1976-1980, 3MP	200,000	20
2	Gaur breeding paddocks, & staff quarters	1981-2000	4,000,000	30
3	Elephant management centre	1990-2000	3,000,000	20

TABLE 3.2 CONTINUED.

²⁰ These areas have been mapped from the satellite image. The images indicate the areal extent of disturbed and cleared forest. The images do not show abandoned clearings with mature secondary succession. The biophysical state of sites will need to be assessed from on-site audits.

²¹ These areas have been mapped from the satellite image. The images indicate the areal extent of disturbed and cleared forest. The images do not show abandoned clearings with mature secondary succession. The biophysical state of sites will need to be assessed from on-site audits.

²² Details in DWNP Annual Reports.

4	Wildlife training centre	1986-2000	5,000,000	40
5	Road development ²³	1967	200,000	2
6	Kuala Lompat	1991-1995	500,000	10
7	Perlok	1991-1995	150,000	5
8	Klau Post	1991-1995	150,000	(outside KWR)
9	Aquaculture Project through Fisheries Dept.	1996-2000	7,000,000	50
10	Boundary survey	2000-2001	1,200,000	-

3.2 Regional setting

Southeast Asian tropical rainforests support some of the richest assemblages of plants and animals in the world. Within Southeast Asia, Peninsular Malaysia is considered a species 'hot spot' with 208 known natural occurring terrestrial mammals species and 625 species of birds²⁴.

The present lowland rainforests of Peninsular Malaysia exist in fragments of the continuous forest that once extended²⁵ for 6.48 million ha. 871,140 ha of original lowland forest still remained in 1992, of which 431,644 were within protected areas 13.42 and 6.65% respectively (see MAP A.2)²⁶.

Apart from Taman Negara, the largest patches are at Ulu Jelai and Krau. The KWR still comprises large tracts(over 600 square kilometers) of almost completely unlogged forest. In particular, the central lowland forests of K WR support extensive plant communities and species, which sadly, with on-going disturbance of this habitat elsewhere in the Peninsula, will inevitably become a rarity within Malaysia.

Among the animals of K WR, only birds and mammals have been relatively well surveyed. The species composition of both groups still seems largely intact. However, some of the large mammals, such as the elephant and the sumatran

²³ An armed forces and state project.

²⁴ General information on Peninsular Malaysia can be found in sections of *Malaysia –Key Environments* 1988, edited by the Earl of Cranbrooke. Information for this section was also taken from early drafts of recent project documents which included: *A Review on the Research Activities of the Fauna and Flora at Krau Wildlife Reserve* by Dr Lim Boo Liat and others; *Management of Krau Wildlife Reserve Capacity Building and Human Resource Development –The Flora Component* by Lilian S.L.Chua & Saw L.G.; *Krau Wildlife Reserve Management Plan Capacity Building and Human Resource Development Project* by Krsten Thomsen; *Management of Krau Wildlife Reserve, Capacity Building and Human Resource Development Project* by H. Christensen.

²⁵ See Map A1: Original Habitat Model

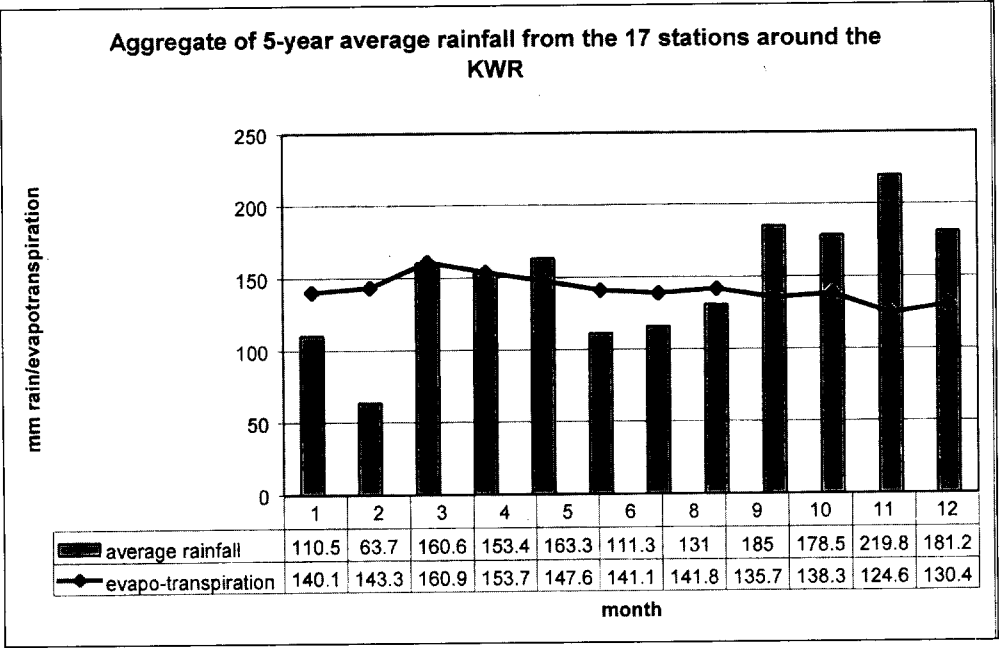
²⁶ In square kilometres these areas are respectively: 64,800; 8,711; and 4,316.

rhinoceros, are locally extinct. Furthermore, many species of mammals seem to occur in unusually low abundance compared to other forested areas in the region.

3.2.1 Climate

The KWR is located in one of the driest regions of Peninsular Malaysia. This can be attributed to its location relative to the Terengganu Highlands in the east and the main range in the west, which shield Krau from the effects of the north-east and south-west monsoons, respectively. The annual mean precipitation for 1980-1999, recorded at the nearest weather station at Temerloh to the south-east of the reserve was 1,968 mm, with slight peaks in April-June and in November. The annual 24-hour mean temperature for 1999 at Temerloh was 26.4°C²⁷.

CHART 3.1: AVERAGE OF THE 1986-1990 5-YEAR MEAN MONTHLY RAINFALL AND EVAPO-TRANSPIRATION IN THE KWR AREA.



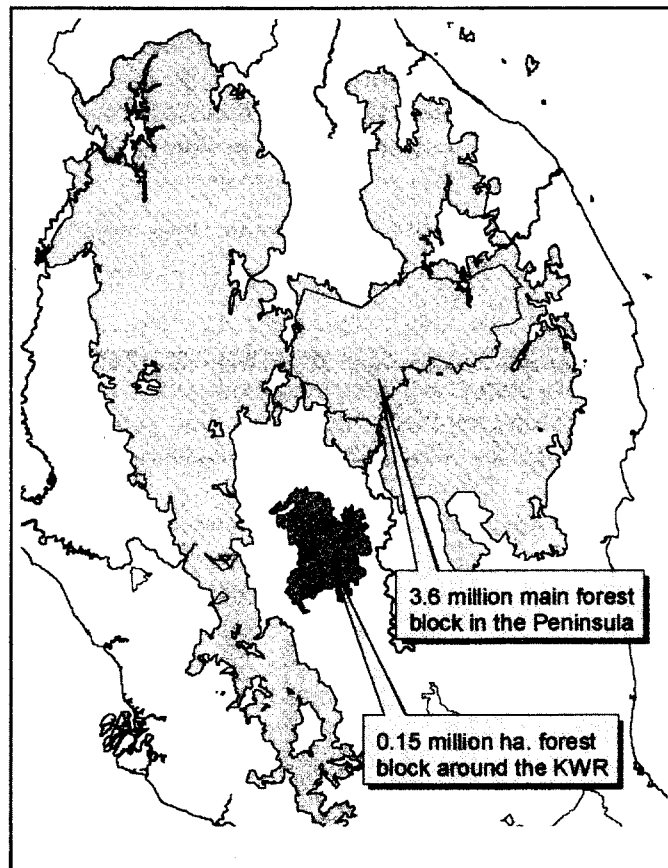
3.2.2 Landscape

Pahang is the largest state in the Peninsular with the largest area of remaining forest cover, forest reserves and protected areas. In terms of value for biological diversity, this state is ahead of all others. Because of the large area of natural forests, Pahang probably has the largest species diversity. At the landscape level, it has the largest range of biophysical conditions and these in

²⁷ Climate data from the Malaysian Meteorological Service, and annual rainfall data from Hydrological data from the Dept. of Drainage and Irrigation.

turn support the largest range of habitat types and ecosystem diversity in the Peninsula.

The largest forest block in the Peninsula, which contains part of the Taman Negara, extends into Pahang. This is connected to forests in Terengganu and Kelantan and westwards to the main range, covering an area of about 3.5 million ha.



MAP 3.7 MAJOR FOREST BLOCKS IN THE PENINSULA. (SMALL FOREST FRAGMENTS NOT SHOWN FOR CLARITY).

In comparison the KWR, together with its adjacent Permanently Reserved Forests, has an area of about 0.15 million ha. – over 20 times smaller. The KWR is surrounded by lower diversity agricultural land. Without a continuous forest link from the KWR to the larger forested areas around Taman Negara, the biological diversity of the KWR will inevitably decline. This is a natural result of isolation and will take place over biological time.

Elevation in the Reserve ranges from 45 to 2,108 meters above sea level. It consists of large tracts of mature forest in the flat lowlands of the southern and central areas. To the west, the terrain becomes progressively steeper and more rugged. With increasing altitude, the lowland forest gives way to a number of montane forest zones. The north-west boundary runs along a ridge system,

which consists of a series of high peaks covered with dwarf Ericaceous forest. An isolated hilly area is found in the south-central part of the reserve.

Three main river systems drain KWR. The Krau River forms part of the eastern boundary, the Lompat River runs from the centre of the reserve and joins the Kuala Krau at the eastern border and the Teris River forms the south-western boundary of the reserve.

3.2.3 Landuse and population.

The KWR is a 60,338 ha. protected area within a 156,607 ha. forest area. Most of the remaining forest, is a part of the Permanent Forest Estate (PRF) apart from the forests on the southern boundary of the reserve. Most of the earlier land clearance was for rubber, but most of the surrounding land is now planted with oil-palm (see MAP 1.6).

In a 5 km buffer area (66,292 ha) around the (60,349 ha.) reserve, landuse data from 1995 indicates :

- 14.5% of the area was plantation agriculture –commercial as well as FELDA estates;
- 26.7% was small holdings and local community settlements; and
- the remaining 58.65% were reserved and unreserved state forest.

Surrounding the reserve there are about 26 settlements with between 15,000 to 20,000 residents. Looking beyond to the 3 districts around the reserve there is a relative population decline in the Jenderak area. In the 1970's while Pahang was opening new land to settlers, state growth rate was the second highest at 4.2%. In period between the 1980 and 1991 census, the population of Pahang increased at a slightly higher rate than the Peninsula – 2.72% and 2.32% respectively. But in the three mukims, which surround the KWR – Jenderak, Kerdau and Gali, population growth rates were 1.62%, 2.09% and 0.89% respectively. In the period from 1980-1991, there was a general out-migration trend from the area varying from 0.63 % -1.83 % per year. This was being exceeded by births over deaths. 2000 census figures for the mukims are not yet available, but from the 2000 district figures in TABLE 3.1, it can be seen that growth rate in the districts around the KWR is actually lower than earlier projected. State growth rate in the 1991-2000 period declined to 1.82%, probably due to increased out-migration to other districts. This could be moderating the natural increase in human pressure on the reserve.

There are no reports of any new forest clearance and agricultural development schemes in the area and thus no sudden population in-migration is planned

TABLE 3.3: POPULATION GROWTH PROJECTION MUKIMS AND DISTRICTS SURROUNDING THE KWR.
SOURCE FROM: POPULATION AND HOUSING CENSUS 1991, DEPT. OF STATISTICS,
KUALA LUMPUR. MAY 1992.

Population	N ₀	N _t	Log _n (N _t /N ₀)/11		N ₂₀₀₁ =N ₁₉₉₁ r*9	
	1980	1991	r	r%	2000 estimate	2000 Prelim. count
Temerloh	91,641	118,015	0.0230	2.30%	145,148	136,162
Jenderak	16,294	19,462	0.0162	1.62%	22,507	na
Semantan	13,996	17,710	0.0214	2.14%	21,471	na
Kerdau	4,051	5,100	0.0209	2.09%	6,157	na
Lipat	1,005	1,145	0.0119	1.19%	1,274	na
Kajang						
Raub	64,414	73,909	0.0125	1.25%	82,710	79,432
Gali	41,499	45,390	0.0081	0.81%	48,843	na
Ulu Dong	3,705	4,141	0.0101	1.01%	4,536	na
Jerantut	59,043	74,391	0.0210	2.10%	89,872	81,215
Ulu Cheka	6,536	7,434	0.0117	1.17%	8,260	na
Tebing	2,375	2,774	0.0141	1.41%	3,150	na
Tinggi						
Burau	1,360	3,209	0.0780	7.80%	6,478	na
Pahang	768,801	1,036,724	0.0272	2.72%	1,324,047	1,231,176
Pen Malaysia	10,944,844	14,127,556	0.0232	2.32%	17,408,790	17,670,092

3.2.4 Soils

In the lowland forest area the soils are predominantly derived from intrusive hornblende-granite with exposures of syenite, pyroxene-granite prophyry and dioxite, but with a heavy sedimentary and organic overlay. On the north-east of Gunung Benom, soils are affected by Triassic sedimentary rocks and Quaternary volcanic effusives up to about 1,000 m; towards the summit of Gunung Benom granitic rock and boulders become exposed. Soil composition is also influenced by heavy leaching of nutrients on the steeper slopes with consequent breakdown of soil structure and development of an associated vegetation type. These factors tend to produce a rather acidic soil at higher altitudes.

3.2.5 Vegetation

Different types of forest cover the entire reserve. While lowland forest predominates in the central and eastern parts, the north-western parts are covered by a succession of upland and montane forests.

The species composition of the forests in KWR still remains largely unknown. However, data collected during a recent survey indicate that the Lowland dipterocarp forests of KWR are as rich in tree species as the richest forests of Peninsular Malaysia. Only about 400 plant species had been identified prior to this study; the number now stands at 674 (including some species growing at the border of the Reserve). The actual number of plant species growing in KWR is believed to be much larger and probably exceeds 4,000 of which more than 2,400 are woody species.

The tree family Dipterocarpaceae has Peninsular Malaysia as part of its centre of diversity. This is also reflected in KWR where the number of Dipterocarp species found so far is exceptionally high. Dipterocarp species are often used to characterise mature lowland and hill forest types in Malaysia. It should be noted however, that most forest types have variable assemblages of many tree species in different parts of the forest and that a "dominant species" may in fact make up a very small percentage of all stems.

Based on the work that has been done so far in KWR and on information from other parts of Peninsular Malaysia the following five floristic altitudinal forest zones in KWR can be recognised:

- Lowland dipterocarp forest;
- Hill dipterocarp forest;
- Upper dipterocarp forest;
- Montane oak-laurel forest and
- Montane ericaceous forest.

Lowland dipterocarp forest occurs below 300m and dominant species include *Dipterocarpus cornutus*, *D. baudi*, *Hopea sangal*, *Shorea acuminate* and *S. ovalis*.

Hill dipterocarp forest is found up to 750m, and some of the most abundant species are *Anisoptera laevis*, *Dipterocarpus grandiflorus*, *Shorea leprosula*, *S. curtisii* and *Vatica cuspidata*.

From 750m to 1,200m, the vegetation type becomes Upper dipterocarp forest, where *Shorea curtisii* becomes scarce and exclusive "high hill" dipterocarps such as *S. platyclados* and *S. ciliata* appears as well as *Eugenia* sp. and *Cryptocaria* sp.

This merges into Montane oak-laurel forest at about 1,200m. This forest type is tall and two-storied and characterised by the abundance of oak (*Quercus* and *Lithocarpus* species) and the presence of *Crayoxylon arborescens*, *C. formosum*, *Erodia glabra* and *Merrillia caloxylon*. Dipterocarps are not usually present.

Finally, Montane Ericaceous forest occurs on the highest mountain ridges above the Oak Forest. This is represented by dwarf and mossy vegetation. The number of oak species is low while species of ericaceous trees such as *Cytherea*, *Vaccinium* and *Rhododendron* are prevalent. Pitcher plant *Nepenthes* sp. and orchids are also abundant at higher altitudes.

The majority of lowland trees so far identified from KWR belong to species, which are considered widespread in Malaya. Only one rare species has been noted (*Diospyros daemona*), but this species is common in parts of Sarawak-Sabah.

3.2.6 Animals

Ecological model

Researchers working with mammals have adopted and modified the vegetation zones described in 3.2.5 above as a model for habitats, collapsing the lowland and hill dipterocarp forests into a general lowland habitat but with a separate riverine habitat to produce the following habitat model²⁸:

- Disturbed areas
- Riverine
- Lowland
- Hill < 1,000m
- Sub-montane < 1,500m
- Montane > 1,500m

For primates, disturbed areas have the lowest species richness, riverine the highest declining up-slope to montane areas.

Invertebrates.

No information has been collected during the course of this project on the invertebrate animals in the canopy, at mid and ground levels, underground or in aquatic systems. 1014 butterfly species are recorded from Peninsular Malaysia. In contrast to other animal groups, for instance mammals and birds, the maximum species richness amongst all Lepidoptera (butterflies and moths) occurs at around 600-1000 m.

Fish

Rather little is known about the fish fauna of the streams and ponds of the Reserve. In recent studies of the ichthyo-fauna in five river systems during 1993 and 1995, 68 species belonging to 19 families were collected and identified (out of 110 known from Peninsular Malaysia). The collection revealed six rare species of which one was a new record for Peninsular Malaysia.

²⁸ Habitat is used in this plan as a term to describe a forest type that can be easily recognised and mapped.

Amphibians and reptiles

These two groups were studied rather intensively in 1967 and also in connection with other more recent surveys. A total of 85 species has been recorded comprising 43 species of amphibians, 19 species of lizards and 23 snake species.

Mammals

Until recently most – if not all – of the larger forest mammal species of Peninsula Malaysia occurred in KWR. In total, 123 mammal species have been recorded from the reserve including 44 species of bats, 7 species of primates and 33 species of rodents. 38 of the mammal species in Krau WR are “Totally protected”. Among these are 15, which are listed by IUCN as globally threatened (Appendix 2). These comprise several species that are becoming rare and threatened over most of South East Asia, such as wild dog, clouded leopard, leopard, tiger, malayan tapir, malayan sun bear, gaur and serow. Among these, the tiger and gaur now have such reduced populations in KWR that their long-term survival is considered to be highly questionable.

The Elephant Conservation Unit Database 1974-1997 has 13 records from the KWR area. Of these 11 were captured, with three dying during handling, 6 were translocated to Taman Negara, 2 were sent to K.Gandah. Of the other 2 records, one was located in the Lembah Klau area in 1991 and not found again, and in the year 2000 the remains of the other were found behind the Aquaculture Project at Perlok. The last confirmed sighting of live elephant was from 13 Jan 1993, and that was one of the animals translocated²⁹. It could be concluded that elephant are effectively extinct in the KWR area.

Also the smaller cats (golden cat and marbled cat) are endangered, and it has been assumed that there are genetically viable populations of these species still in existence within the KWR and Taman Negara. The bearded pig is recorded at the reserve, but this may be an error as the KWR appears to be too far north and west for the range of the species. Two species of gibbons occur in Krau WR: Siamang and the White-handed Gibbon and have both been studied in detail in KWR. This also applies to the two species of leaf monkeys that occur; the Dusky Leaf Monkey and Banded Leaf Monkey³⁰.

Birds

The bird fauna of the lowland forests of KWR is relatively well surveyed, however, the montane forests were only last studied intensively over 30 years ago, during an expedition in 1967. So far, 298 bird species have been recorded

²⁹ 5 elephants were reported on the Sg.Terboi in the 1995 *Inventori Kepelbagaian Biologi*. No mention was made if this record was a direct sighting, track or other sign.

³⁰ Mention should be made of *Malaysia Primate Research Programme* with field surveys conducted between 1978 and 1981 by Universiti Kebangsaan, Universiti Pertanian and the University of Cambridge. This programme helped establish the KWR as a centre for research.

from KWR (lowland & montane species). From a single small plot of lowland forest at Kuala Lompat as many as 195 bird species have been observed.

The majority of lowland species that occur in KWR are relatively widespread and are also known from similar habitats in other parts of South East Asia. One exception is the Malayan Peacock Pheasant, which is endemic to lowland forests of Peninsular Malaysia.

The resident bird species of KWR includes seven species that are listed as Vulnerable on IUCN's global list of "threatened species": Wallace's Hawk-eagle, Wrinkled Hornbill, Crested Fireback, Crestless Fireback, Mountain Peacock Pheasant, Malaysian Peacock Pheasant and Straw-headed Bulbul.

In addition, 14 species occurring in KWR are listed as "Near-threatened" IUCN's global list of "threatened species" (Appendix 2).

3.2.7 Overview of published information.

This superficial examination of information available suggests much inventory work remains to be done before a more comprehensive diversity of the forest of Krau Wildlife Reserve is documented.

Research activities have been carried out almost continually since the early 1970's, but until recently, these have been concentrated in the Kuala Lompat area. The 1967 Gunung Benom expedition made a transect from the lowlands to the peak of the mountain. This was the most comprehensive study undertaken. It provided the earliest inventory of the reserve.

The KWR has been recognised in the *National Conservation Strategy* as having rare extreme Lowland Dipterocarp forest and being an important habitat for large mammals with G.Benom being especially important for conserving the biodiversity of montane species. Combined with the forests in the Taman Negara area, the KWR represents the last stronghold for a number of original lowland forest plant and animal species. And some of these animals are without genetically viable populations elsewhere in Peninsular Malaysia – perhaps in Southeast Asia.

For this reason and because KWR is one of the largest remaining examples of the former widespread forest ecosystem of Peninsular Malaysia, it is vital to prepare and implement a management plan that will ensure effective protection of the biodiversity of the reserve.

3.3 Recent Field Surveys.

3.3.1 Expanding the knowledge base.

The earlier animal survey have provided an inventory list of vertebrates and suggested that the KWR is a site of high biological diversity. Using camera-trapping data on large mammals detections from protected areas and other sites, biodiversity indices to compare relative diversity can be used³¹. This shows that the KWR has a high rank for large mammal biodiversity. But the data also indicates potential problems; diversity ranking for carnivores does not match the diversity ranking for herbivores.

Earlier inventories listed those species, which could find their *fundamental niche* within the reserve. New information is help in the understanding of the spatial extent of the current *realised niches*, and indicate which *interactions* are preventing large mammal species from filling their *fundamental niche* potential.

This new information is suggesting the population of large mammals is not as healthy as it should be. The cause appears to be continued human interference. For almost 40 years, the area was placed under security control, denying the DWNP and field researchers access to the core areas and limiting them to Kuala Lompat and the boundary. It was not until 1995 that the DWNP was able to undertake a field survey to examine biodiversity in the central lowland and G. Benom area of the reserve³². By comparing the animal records from this survey with the forest thematic map, it is evident that the KWR does not have as uniform species distribution across elevation bands as the earlier information suggests. Between 1999 and 2001 surveys were undertaken as a part of this project. As far as large mammals are concerned, the current studies are beginning to indicate that the realised niches of some large mammals species in the reserve is very much smaller than the potential spatial dimensions of the fundamental niche. Human activities are thought to be the cause.

3.3.2 Comparing biodiversity

Managing biodiversity in a tropical forest is a huge undertaking. Since this management plan is for execution by the DWNP, management for diversity of large mammals has been adopted as a practical surrogate for biodiversity.

Chart 3.2 compares the species diversity of large mammals at the KWR with other forests. The results are presented in tables 3.8 & 3.9 where the number of detections are normalised per 100 trap nights, and plotted in chart 3.2 as diversity indices for each site.

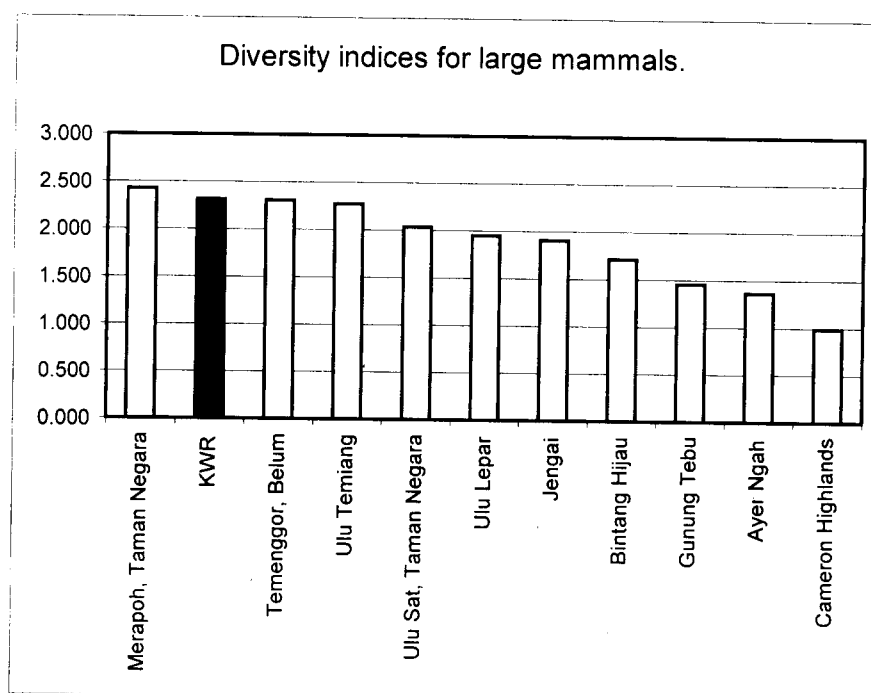
³¹ The DWNP and Wildlife Conservation Society (WCS) are currently undertaking a survey using camera traps, 100 m transects and 1 sq. km raster surveys as part of this project.

³² The 1995 DWNP survey did not investigate relative distribution but recorded the presence of species and at some stations their numbers present. It may be more accurate to describe the information gained as a record of mammal and bird species richness rather than biodiversity as the survey was entitled.

TABLE 3.4 RANKING OF BIODIVERSITY (H) OF 14 SELECTED LARGE MAMMALS AT CAMERA SURVEY SITES
(SEE TABLES 3.8 & 3.9) ³³

Rank	H species diversity index	Site	Site description
1	2.429	Merapoh, T.Negara	Virgin ³⁴
2	2.314	KWR	Virgin*
3	2.306	Temenggor /Belum	Virgin
4	2.277	Ulu Temiang	Logged
5	2.038	Ulu Sat, T.Negara	Virgin
6	1.951	Ulu Lepar	Logged
7	1.906	Jengai	Virgin/ logged
8	1.715	Bintang Hijau	Virgin/ logged
9	1.452	Gunung Tebu	Virgin/ logged
10	1.359	Ayer Ngah	Small holdings/logged
11	0.988	Cameron Highlands	Small holdings/logged

CHART 3.2 COMPARISON OF DIVERSITY INDICES FOR 14 SELECTED LARGE MAMMALS IN THE KWR AND OTHER FOREST AREAS (SEE TABLES 3.8 & 3.9).



³³ The Shannon-Weiner function, familiar to the DWNP, was used where $H = -\sum (p_i)(\log_2 p_i)$. See tables 3.8 and 3.9 for data values before conversion to proportions. It measures diversity by combining species numbers and evenness of species distribution. If any site had all 14 selected large mammal species evenly distributed, it would have an H value of 3.7.

³⁴ see Preliminary analysis on abundance of large mammals, Kae Kawanishi and others in J, Wildl. Man. & Parks, vol xvii, 1999, pp 62-82.

It appears that the KWR has a relatively high biodiversity value for the selected large mammals when compared to Taman Negara and other protected areas³⁵. This means the species richness and species evenness at the KWR is high. But the same data plotted for the separate feeding guilds in CHARTS 3.3 and 3.4 below, shows that carnivore diversity is not as healthy as herbivore diversity.

The large carnivores are more sensitive to environmental disturbance than the current assemblage of herbivores, and their numbers seem to be responding more acutely to disturbance and a decline in food availability. Disturbance and selective hunting are thought to be reducing population and distribution of herbivores more evenly; 2, possibly 5, large herbivores have become locally extinct at the KWR³⁶. But for carnivores, a threshold value for species tolerance has been crossed. So, it is probable that some species of large carnivores are undergoing an acute decline. However, the forest remains intact and the spatial size of the fundamental niche is assumed to be as large as ever. Given protection, it is thought that large mammal number could be self-restoring and start to reoccupy vacant space. Humans function as a competitor for range and prey as well as a predator of large carnivores. Human activity in the reserve is likely to need immediate management controls.

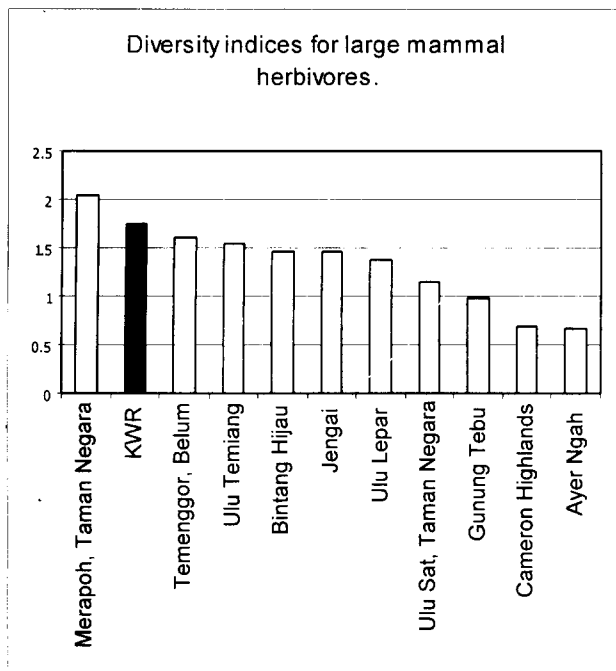


CHART 3.3: HERBIVORE DIVERSITY

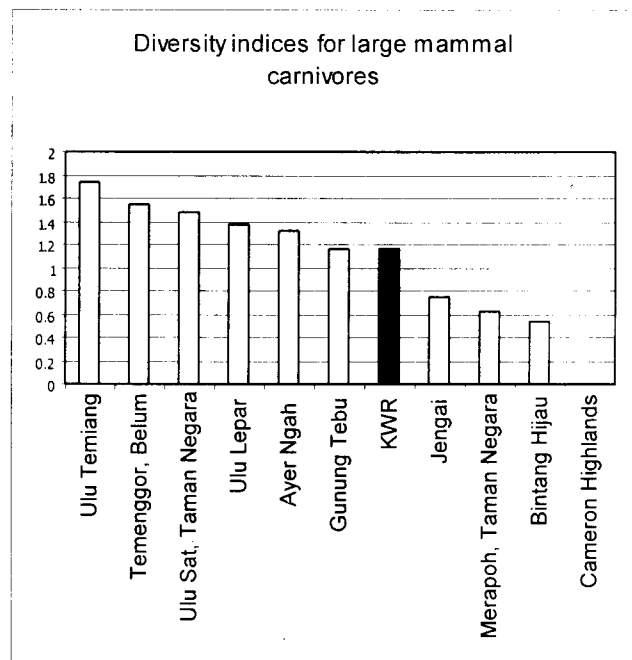


CHART 3.4: CARNIVORE DIVERSITY

³⁵ These are the carnivores: leopard, tiger, clouded leopard and wild dog; the herbivores: elephant, sumatran rhinoceros, tapir, bearded pig, wild pig, sambur, barking deer and serow, and the malayan sun bear.

³⁶ The large mammal survey is on-going and should be able to develop a species/human interaction model over the coming years.

3.3.3 Species distribution and habitat preferences.

However, not all non-regular species distribution is caused by human impacts, some species³⁷ appear to select particular forest types within the same altitude bands. TABLE 3.3 compares the results of the DWNP 1995 survey with the forest thematic map created by the FRIM 2000 (see MAP A1.8 & appendix 3 for information on map construction.).

TABLE 3.5: COMPARISON OF SPECIES RICHNESS FROM 1995 DWNP SURVEY RECORDS TO FOREST THEMATIC MAP UNITS³⁸

	Forest thematic type table	Habitat category	elevation range m.	median elevation m.	niche vol rank (1<3)	survey stations no.	area Ha.	mammal species count by FT area	mammal species count by 'habitat' area	bird species count by FT area	bird species count by 'habitat' area
Montane, small regular canopy	M1c	Montane	700-1500	1500	2	88	2,319	6	6	42	42
Hill, small canopy + scattered large trees	H1d	Hill	300-1500	700	2	24	3,479	1	12	18	140
Hill, large grey-toned canopy	H2g		0-1200	300	3	22	5,720	1		19	
Hill, large irregular canopy with emergents	H2e		0-1500	300	3	164	17,222	9		72	
Hill, small broken canopy with scattered large trees	H2b/1d		0-700	0	2	46	585	1		31	
Large irregular canopy with emergents	2e	Lowlands	0-300	0	3	293	8,069	15	26	89	223
Small broken canopy with scattered large trees	1b/1d		0-300	0	2	2	1,403	2		0	
Riverine, canopy scattered over a dense understorey	R2d		0-300	0	2	49	4,525	1		36	
Dissected, irregular canopy with emergents	D2e		0-300	0	3	261	13,006	8		98	
Disturbed secondary vegetation	3j	Lowlands disturbed	0-700	0	1	8	656	0	0	7	7
Cultivation/cleared land/non forest	3c	Lowlands cleared.	0-300	0	1	1	323	0	0	1	1

³⁷ This survey recorded a broad range of species that are less sensitive than large mammals to the activities of people.

³⁸ Detecting species richness is dependent on survey methods and effort. For the purposes of this Plan, it is assumed the survey methods and effort for each ecological unit was sufficiently similar to make an initial hypothesis for adaptive management.

The comparison supports general findings that :

- vertebrate diversity is highest in the lowlands and decreases with altitude bands, and
- it also suggests that bird and mammal species are not uniformly distributed within elevation bands, but have preferences for forest with high canopy – greater *niche* volume³⁹.

This localised habitat preference will have to be noted when zoning the reserve.

3.3.4 Small mammal survey.

Trapping work on small mammals on the ground and at mid-levels in trees supports earlier findings that species richness in undisturbed forests is greater than that in disturbed forests. Shannon-Weiner indices were found to be between 2.09-2.46 and 1.83-1.94 for the respective areas⁴⁰. It was also noticed that human settlements had a negative effect on small mammal diversity in adjacent forests.

3.3.5 Large mammal survey

Earlier animal surveys have provided an inventory list of vertebrates and an indication of their relative distributions. As part of this project, three different sampling techniques were undertaken by the WCS and the DWNP, camera trapping, 100 m track and sign transects and 1sqkm grid track and sign sampling⁴¹. The track and sign techniques and the camera trapping technique each have their own bias towards certain species, yet each technique can still provide data on the relative abundance of species records that can be compared to other forest areas.

The results are summarised in TABLE 3.6 below. The table shows large mammals over 5676 camera trap nights at 123 locations :

³⁹ The H2g Seraya ridge forests seems to be an exception to the species-richness / niche-volume trend.

⁴⁰ Data came from a project-supported study entitled *Small mammal community composition in lowland rain forest of Krau Wildlife Reserve Peninsular Malaysia*, S.L.L.Lundalh & A.Olsson being part of their MSc. Thesis. See note attached to TABLE 3.4 for more information on biodiversity as measured by the Shannon-Weiner function. The numbers are useful for comparing sites with similar species. The higher numbers (over 2.0) indicate a large set of species with an more equal abundance and distribution than the lower numbers below 2.0. Also note that this study makes no mention on the size of the area disturbed nor the proportion of the thematic area surveyed. It was assumed that the survey area was in all cases wholly within the forest successional stage and the disturbed area had limited opportunities for new colonisers.

⁴¹ This study, undertaken by the Wildlife Conservation Society (WCS), represented by Dr. R.K. Laidlaw, and the DWNP, used three types of sampling: camera trapping, 100m transects and 1 sq. km. grid sampling. This on-going study has provided most of the data on large mammal presence, distribution and relative abundance, upon which the status and management needs of large mammal species in the KWR has been based.

TABLE 3.6 CAMERA TRAP DATA ON RELATIVE ABUNDANCE OF LARGE MAMMALS IN THE KWR

Rank	Large mammal species	Detection rate/100 trap nights	Total no. of detections	No. of trap sites.
1	malayan sun bear	4.28	243	47
2	barking deer	2.48	141	67
3	wild pig	1.83	104	54
4	malayan tapir	0.79	45	23
5	leopard	0.78	44	25
6	tiger	0.30	17	11
7	sambur deer	0.26	15	6
8	wild dog	0.04	2	2
8	clouded leopard	0.04	2	2
9	serow ⁴²	0.02	1	1
9	gaur	0.02	1	1
10	indian elephant	0	0	0
10	sumatran rhinoceros	0	0	0
10	bearded pig	0	0	0

The results from the data show :

- wild pig, barking deer and the malayan sun bear were the most frequently encountered and had the most widespread distribution;
- the malayan tapir and black panther were relatively abundant and well distributed;
- the gaur, sambur deer and serow were the least abundant of the herbivores, with a restricted distribution;
- the absence of the indian elephant and the sumatran rhinoceros was expected;
- the historical extent of the bearded pig range is unclear;
- the relative abundance of the wild dog and the unexpectedly low abundance of the clouded leopard is the cause for concern; and
- after two thirds of the KWR has been surveyed, the minimum number of known tiger to occur is only two.

⁴² This could be an underestimate of serow numbers. The survey is still on-going, and has not yet at the time of writing fully surveyed the serow preferred habitat in the hill areas of the reserve.

In TABLE 3.7 below ranks the relative abundance of records from the 100m transect survey and gives comparisons to a similar exercise in the Merapoh area of Taman Negara.

TABLE 3.7: RANKING OF THE RELATIVE ABUNDANCE RECORDS FROM THE 100M TRANSECTS SURVEYS AT THE KWR AND MERAPOH.

Large mammal species	KWR			Merapoh		
	Rank	No of transects	% encounter	Rank	No of transects	% encounter
Wild pig	1	74	43.02	1	80	67.23
Malayan sun bear	2	49	28.49	7	8	6.72
Barking deer	3	49	28.49	2	49	41.18
Malayan tapir	4	31	18.02	4	42	35.29
Sambur deer	5	17	9.88	6	16	13.45
<i>Panthera</i> spp. (large cats)	6	9	5.23	8	4	3.36
Gaur	7	7	4.07	5	28	23.53
Cat sp.	8	1	0.58	10	2	1.56
Wild dog (dog spp.)	9	0	0	9	2	1.68
Serow	9	0	0	11	0	0
Indian elephant	9	0	0	2	49	41.18
Sumatran rhinoceros	9	0	0	11	0	0
Total transects		172			119	

The 100 m transect surveys give results similar to the camera traps. The transects however, do bias towards 'hard' footed species compared to the 'soft' footed predators.

Comparing the species ranking of the KWR 100m survey results with Merapoh shows broadly similar relative abundance of records except for the asian elephant and the malayan sun bear.

Elephants became absent in the core of the reserve between the 1960-1989 period when the DWNP was excluded from the centre of the reserve for security reasons. Bears are assumed to be relatively abundant today partly because it is thought that they can exploit neighbouring oil palm estates for food.

TABLES 3.6 compares the relative abundance of camera trap records between sites⁴³. The sites vary from lowland virgin forest to disturbed and logged sites to mountains. Though the camera trapping effort (number of trap nights) varies, they are considered by field experts to be sufficient to allow species records to be shown as number of detections normalised per 100 trap nights.

⁴³ This data is currently unpublished and is held in the DWNP by Wan Sharuddin and by R.K. Laidlaw for the WCS. The data is present in this management plan for comparison purposes.

The results indicate that:

- Highest and lowest mammal herbivore abundance are found on logged and small holding sites, (Ayer Ngah is in Kelantan where the local Malay community does not hunt pig which have the highest of all wild pig abundance but select barking deer which have the lowest, where as in the Cameron Highlands there is the lowest relative abundance of wild pig);
- Sites with a mix of logged and virgin areas have the second highest abundance; 12 to 21 records per 100 trap nights, but
- the virgin forest area Krau is unexpectedly low at 4.61, compared to other virgin sites.

For Ulu Sat, the low numbers of large mammal herbivores could be explained by the absence of salt-licks in the area. But at Krau, suitable forest space is available, and salt-licks plentiful. If the numbers are low, it is probably due to human disturbance.

A similar picture emerges from the TABLE 3.7:

- the KWR has as high a species richness as other virgin sites, but
- the KWR has the second lowest abundance record.

A conclusion is that the species richness for large mammals at the KWR is still relatively good, but numbers are in decline. Some local populations will be at, or may have crossed, the threshold for their minimum local viable populations – for example tiger⁴⁴. (The reserve is an isolated area where natural in-migration to supplement the population of local large mammals is becoming ever-less frequent.) Management intervention is needed immediately to reverse this trend.

⁴⁴ At the WCS internal meeting on tiger conservation (Thailand, 2001) populations with 6 breeding females were considered significant for conservation management.

TABLE 3.8 COMPARISON OF RELATIVE ABUNDANCE (NO. OF DETECTIONS / 100 TRAP NIGHTS) FOR LARGE MAMMAL HERBIVORES BETWEEN 11 SITES USING CAMERA TRAPS.

Site	Description	Altitude	No of trap nights	Barking deer	Wild pig	Malayan tapir	Sambur deer	Gaur	Serow	Asian elephant	Sumatran rhinoceros	Bearded pig	Total
Ayer Ngah	small holdings/logged	100-600	569	1.14	21.64	2.01	0	0	0	0	0	0	24.82
Ulu Temiang	logged	40-360	563	7.28	10.49	6.39	0	0	0	0	0	0	24.16
Bintang Hijau	virgin/ logged	860-1720	646	12.07	5.26	3.87	0	0	0.15	0	0	0	21.35
Gunung Tebu	virgin/ logged	40-500	781	1.28	16.01	3.71	0	0	0	0	0	0	21.00
Jengai	virgin/ logged	100-380	482	4.98	12.86	1.66	0	0	0	1.24	0	0	20.74
Temenggor, Belum	virgin	480-1120	812	7.39	1.97	0.86	7.76	0	0	0	0	0	17.98
Merapoh, Taman Negara	Virgin	100-<740	3395	2.89	2.80	4.83	0.35	0.09	0	1.21	0	0	12.17
Ulu Lepar	logged	20-260	1054	6.36	1.04	4.36	0	0	0	0.09	0	0	11.85
Ulu Sat, Taman Negara	virgin	60-626	734	5.04	1.36	0.27	0	0	0	0.23	0	0	7.08
Cameron Highlands	small holdings/logged	870-1425	469	4.90	1.07	0.00	0	0	0	0	0	0	5.97
KWR	virgin*	60-1300	5676	2.48	1.04	0.79	0.26	0.02	0.02	0	0	0	4.61

*

TABLE 3.9 COMPARISON OF RELATIVE ABUNDANCE (NO. OF DETECTIONS / 100 TRAP NIGHTS) FOR LARGE MAMMAL CARNIVORES BETWEEN 11 SITES USING CAMERA TRAPS.

Site	Description	Altitude	No of trap nights	Leopard	Tiger	Wild dog	Clouded Leopard	Total
Ulu Temiang	Logged	40-360	563	1.60	2.66	0.53	0.71	5.50
Temenggor, Belum	virgin	480-1120	812	1.85	0.99	0	1.48	4.32
Ayer Ngah	small holdings/logged	100-600	596	2.85	0.16	0.84	0.34	4.19
Jengai	virgin/ logged	100-380	482	2.49	0	0.21	0.21	2.91
Ulu Sat, Taman Negara	virgin	60-626	734	1.23	0	0.55	0.55	2.33
Gunung Tebu	virgin/ logged	40-500	781	0	1.54	0.38	0.26	2.18
Merapoh, Taman Negara	virgin	100-<740	3395	1.80	0.12	0.06	0.03	2.01
Ulu Lepar	logged	20-260	1054	0.85	0.85	0.19	0	1.89
Bintang Hijau	virgin/ logged	860-1720	646	0	1.08	0	0.15	1.23
KWR	virgin*	60-1300	5676	0.78	0.30	0.04	0.04	1.16
Cameron Highlands	small holdings/logged	870-1425	469	0	0	0.43	0	0.43

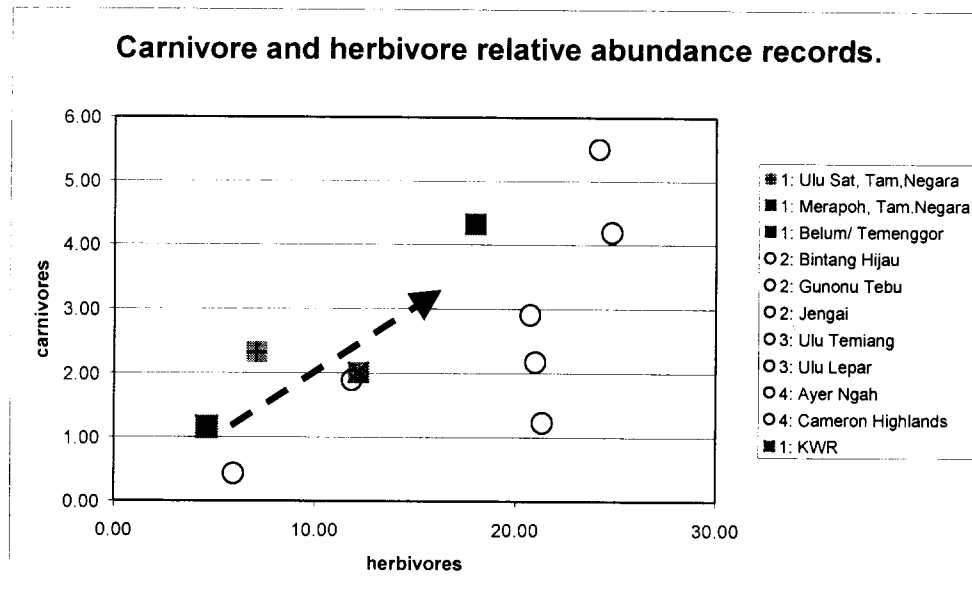
*Survey area mostly virgin

3.3.6 Recognising management needs.

Data on camera trap records from the Tables 3.6 and 3.7 are plotted as a scatter diagram in Chart 3.4 below⁴⁵. The points filled with solid boxes are protected areas and those shown as outline circles are mixtures of virgin and logged forests in the PRF and small holdings.

We have assumed that the points plotted for Belum and Merapoh represent the expected values for carnivore and herbivore abundance in protected areas, and have added a liner trendline for the ratio between carnivores and herbivores in protected areas⁴⁶.

CHART 3.4 COMPARISON OF CARNIVORE AND HERBIVORE RELATIVE ABUNDANCE FROM CAMERA TRAPPING, NORMALISED PER 100 TRAP NIGHTS.



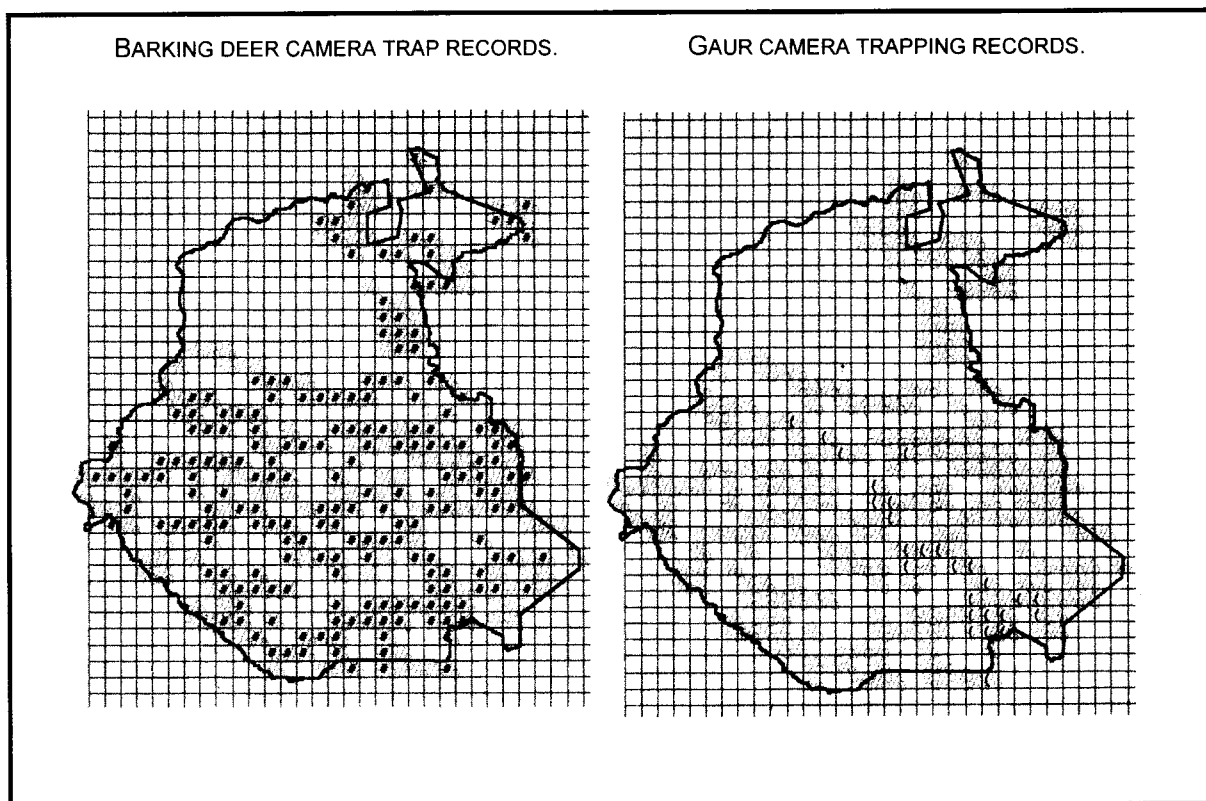
In general in forests that have been disturbed, herbivore abundance moves above the hypothetical ratio with carnivore abundance staying at former levels. Apart from the disturbed and mountainous area of the Cameron Highlands, the KWR has the lowest scatter point. The situation at the KWR suggests that the herbivore numbers have been heavily reduced and that the population of their natural predators has come down proportionately. It is possible that the cause is a natural result of fragmentation reducing the ecosystem size and habitat area, - however, the area of forest in the KWR area is larger than the Ayer Ngah site. The more likely cause is from excessive human disturbance, in particular from hunting or the result of non-hunting activities both within the KWR and in the surrounding forest.

⁴⁵ It should be noted that camera trapping samples animals on the ground, generally larger than the size of a pitta or ground squirrel, and that with a programmed delay between photographs, group and herd animals are recorded as a single detection and thus would be under numerated when compared to a transect survey.

⁴⁶ It is suspected that the Ulu Sat, Taman Negara, local trap-site herbivore population is under selective hunting pressure and thus lower than would be expected for a protected area. The local carnivores population may be able to maintain relatively high frequencies by feeding on prey from the surroundings source areas.

The effects of selective harvesting can be seen from the recent comparative survey between two sites near to a village and far from a village. The results show that mousedeer have similar relative abundance in both sites, but abundance of edible primate – a preferred food, at the site close to the settlements are much lower than at distant sites. Targeting of selected species can be seen by the distribution of barking deer and gaur in the maps below.

MAP 3.8 RECENT DISTRIBUTION OF GAUR AND BARKING DEER IN THE KWR. RECORDS OF PRESENCE TAKEN FROM BOTH PHOTO TRAPPING AND TRANSECT SURVEYS.

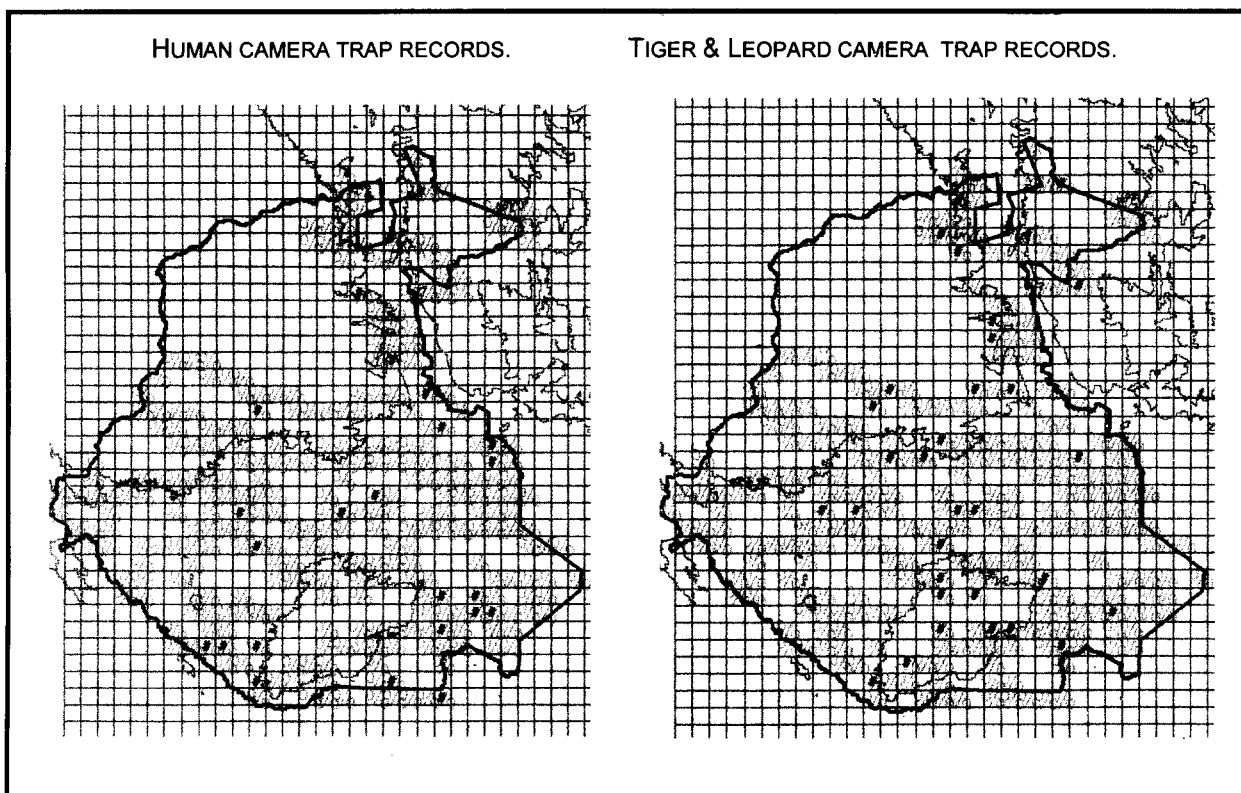


Data from the recent large mammal survey is plotted as 1 km. sq. raster cells in MAP 3.8 above. The light grey cells are areas which have been surveyed (at the time of writing, July 2001), the white have not. Barking deer are one of the most frequently encountered large mammals. From the area surveyed, they appear to have filled most of the spatial dimensions of their fundamental niche. For the gaur, their range is not controlled by habitat or ecotype preference. Gaur appear to be a targeted species and only a remnant population survives in a band midway between the access areas and settlements to the east and south of the reserve⁴⁷.

Besides selective hunting, humans are also selectively out-competing predators, especially the larger carnivores for range space. In MAP 3.9 below, the range of tiger and leopard, and human as recorded from camera traps is plotted on 1 sq.km. raster cells.

⁴⁷ Krau was reserved to protect the Gaur.

Map 3.9: Photo trap records of tiger and humans in the KWR⁴⁸.



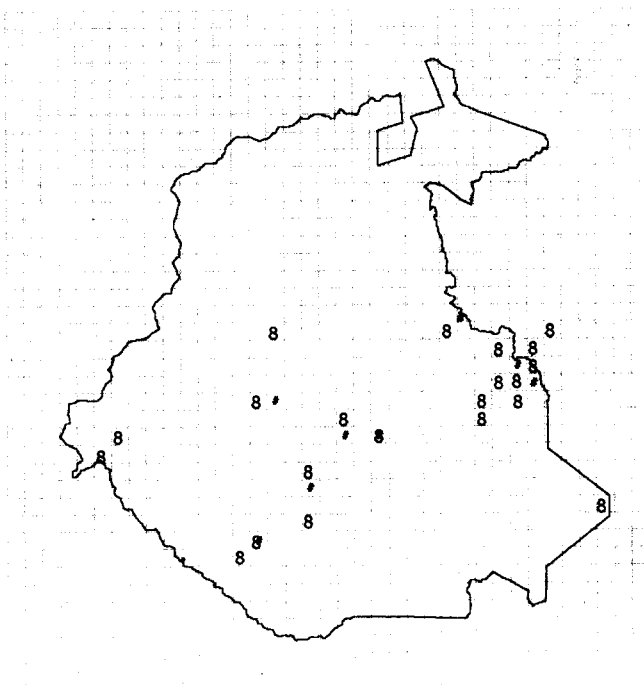
Also shown on the maps is the 200m contour. It appears that human activity is mostly below the 200m contour, and this has driven the tiger to seek sanctuary above that level. Bukit Tapah has been extensively surveyed, and shows a relatively good leopard and tiger –*Panthera* spp. presence but no humans. Once the camera trapping survey is extended to Gunung Benom, it is expected that new records will be made. Unfortunately, there are no salt licks above 200m., and thus *Panthera* spp have to come down to lower levels to seek prey species and this is where they come into competition with present human.

Panthera spp have the ability to avoid human encounters, but for species dependant on a immobile resource such as for sambur deer and saltlicks, avoidance is not always possible. MAP 3.10 below shows the distribution of saltlicks generalised into 1 km sq. rater cells and the camera trap locations of sambur deer. All the captures were within 1 km of saltlicks.

From the recent survey work it can be concluded that the disruptive effects of human activity must be controlled to conserve the biodiversity of large mammals in the KWR. It is assumed that if large mammals are conserved, so too will the biodiversity of other taxa and the ecosystem of the reserve.

⁴⁸ These are the camera trap records of humans. Human activity as recorded from the 1 km raster cell survey is far more extensive, but cannot be compared directly with the tiger and leopard camera trap records. (see map A 09.)

MAP 3.10: CAMERA TRAP DETECTIONS OF SAMBUR DEER WITH SALT LICK LOCATIONS. THE SAMBUR ARE REPRESENTED BY DARK SPOTS, THE SALT-LICKS BY THE CIRCLES.



If hunting and non-hunting activities that have an effect on wildlife can be controlled, it must be assumed that the population of depleted species is sufficiently resilient to make a self-recovery (only long-term monitoring will disclose this). The alternative is direct management of species, which can be an extremely costly management option.

The gaur is one species whose population at the KWR may not be able to make a self-recovery⁴⁹. In a supporting paper for this project a series of recommended actions were given that would precede any attempt at reintroduction of gaur in to the KWR⁵⁰. Among the 9 categories of recommendations given:

- this paper made reference to the Vortex simulation programme and suggested that the available founder population for captive animals was too small to make an effective stock for reintroduction;
- it identified critical habitat as being the ecotone between fallow ladangs and early successional stages of recovering forests; and
- assumed that there was sufficient habitat for 8-9 herds in the KWR⁵¹.

⁴⁹ See Map 3.8 for gaur range in the KWR

⁵⁰ See the working paper: *Analysis of Gaur Reintroduction project in Krau Wildlife Reserve*. Bengt Holst, 2000.

⁵¹ This is thought to be an error caused by assuming all land below 300m would be suitable habitat. Most forest in the KWR is virgin and cannot support grazers. Creating that area of artificial grazing ground would seriously undermine biodiversity. Also see Table 3.1 and map 3.6 which give approximate areas of human disturbance based on recent satellite imagery. These indicate the current extent of grazing area in the KWR.

The general recommendations for reintroduction of the gaur should be made for most other mammal species. These included to:

- establish the conservation management need;
- possess suitable stock on hand for reintroduction;
- ensure suitable habitat is available;
- bring under control the reasons why that habitat is vacant; and
- have capacity within the DWNP to manage a reintroduction project

3.3.7 Overview of animal status from recent field work.

It is understood that:

- From an ecosystem perspective, the KWR has retained its species richness and ecological diversity and is now together with the adjacent Krau Forest Reserve, an island of original biodiversity surrounded by agricultural lands.
- For the smaller vertebrates which depend on small spatial scales, the KWR remains a good home where some localised human disturbance causes an increase in species richness in the reserve overall.
- Comparing the camera 'trapping' records of the KWR with other forests, it is evident that species diversity is high, but the relative abundance of both herbivores and carnivores is low. This indicates that the large mammal community of the KWR is still reasonably intact, but its continued survival is under threat.
- The diversity index for large mammal carnivores is low. The carnivores are probably being out-competed by humans.
- Humans are practicing selective hunting.
- The sumatran rhinoceros is effectively extinct.
- The elephant was probably eliminated from the centre of the reserve by uncontrolled hunters (Those on the forest boundary were all caught and translocated in the 70's and 80's.)

It is believed that:

- the remaining large mammals in the reserve have a sufficiently resilient population for self-recovery if the reasons for their continued low numbers can be controlled – disturbance within and habitat loss without.

It is hoped that:

- the local communities, whose activities may be in conflict with management for biodiversity, can accept the principle of sustainable forest management.
- the DWNP will be allowed to build up its capacity to manage, and also to implement management, in the Krau Wildlife Reserve.

3.3.8 Plants and Habitats

The KWR has been the focus of zoo-centric research over the past 30 years. Fauna has been relatively well documented and these reports easily available for reference. Studies on vegetation have not however been undertaken, till recently there was scant record of plant diversity in the different floristic zones not to mention the lack of description of the different forest types. The variation in the vegetation matrix forms the primary basis of habitat differentiation these forests. With active management being currently planned and advocated the need for plant-centric studies was deemed necessary. Three studies were commissioned to fill what can termed as the “botanical vacuum” in the KWR , but more importantly to support management planning. The studies being:

- a qualitative botanical survey (Forest Research Institute of Malaysia);
- a quantitative botanical survey (K Thomsen) and;
- a ethnobotanical survey (H. Christensen).

The qualitative botanical survey records a total of 1508 taxa from 445 genera and 142 families. This study did not document lower plants such as bryophytes, mosses and lichens. This total number is inclusive of species recorded in the quantitative survey. The current records indicate approximately (the species number do not tally) 1084 dicotyledons, 328 monocotyledons, 4 gymnosperms and 48 fern and fern allies. The 5 most diverse families in the KWR are Euphorbiaceae, Palmae, Rubiaceae, Lauraceae and Annonaceae (Table 3.10), while the five most specious genera were *Syzygium* (Myrtaceae, 29 species), *Diospyros* (Ebenaceae, 23 species), *Calamus* (Palmae, 22 species), *Shorea* (Dipterocarpaceae, 19 species) and *Garcinia* (Guttiferae, 16 species).

TABLE 3.10 TEN MOST DIVERSE FAMILIES IN TERMS OF SPECIES DIVERSITY RECORDED IN KWR

Family	No. of genus	No. of species	No. endemic sp.	Predominant forest types
<i>Euphorbiaceae</i>	29	93	12	Lowland to hill forests
<i>Palmae</i>	17	62	15	Lowland to hill forests
<i>Rubiaceae</i>	30	60	8	Lowland to montane forests
<i>Lauraceae</i>	12	43	8	Lowland to montane forests
<i>Annonaceae</i>	21	42	9	Lowland to hill forests
<i>Dipterocarpaceae</i>	7	39	3	Lowland to hill forests
<i>Orchidaceae</i>	26	36	2	Lowland to montane forests
<i>Myrtaceae</i>	5	34	6	Lowland to montane forests
<i>Guttiferae</i>	3	33	11	Lowland to hill forests
<i>Leguminosae</i>	16	26	1	Lowland to hill forests

There are at least 158 endemic species recorded from KWR—this comprises 10.5% of the total taxa collected. These species are endemic to Peninsular Malaysia. Families with the highest number of endemic species were Palmae, Euphorbiaceae and Guttiferae (Table 3.10xx).

Important botanical findings in the KWR include the following:

- *Licuala sp. nov* (Palmae) is a new species encountered from the lowland dipterocarp forest at Sg. Kudung, south of the reserve. Consisting of less than ten mature individuals, the species will be named *Licuala krauensis* from its type locality KWR.

- *Scaphochlamys concinna* (FRI 45674) (Zingiberaceae), collected from the confluence of Sg. Baik and Sg. Neram in the present study, is the second collection after the type collection, which was collected from Perak in the late 19th century.
- *Alpinia petiolata* (Zingiberaceae). Collected from the swamp forest along Sg. Baik, the southeast part of the KWR, this species had so far been known only from the mountain forests. Until this collection appeared, there has never been a lowland record.
- *Calamus flabellatus* (Palmae) is known in Malaya from two collections i.e. by Corner from Sg. Kayu, Johor, presumably from the lowland swamp forest and Saw LG from Bintang Hijau FR, Perak. Encountered during the present study at Sg. Kudung in scattered, small populations, this is the third record for Peninsular Malaysia and the first for Pahang.
- *Licuala pahangensis* (Palme). Endemic to southwest Pahang (KWR and its vicinity), this species was surprisingly gregarious throughout most of the lowland forest in the KWR. Being a rare endemic, it is fortunately protected in KWR.
- *Phalaenopsis maculata* (Orchidaceae). This species has so far been recorded only from Sg. Tahan in Pahang. A new record for the KWR, it was collected as an epiphyte by the riverbanks of Sg. Lompat Hulu (c. 530 m asl).
- *Soejatmia ridleyi* is a rare endemic bamboo and is restricted to the lowland forests of Kelantan and Pahang. During this survey, it was recollected again beyond the Bukit Rengit Station and in the lowland forest along Sg. Baik Keratong.
- *Polyosma nullii* (Escalloniaceae). A very rare endemic recorded from only two sites in Peninsular Malaysia (upper montane forests of G. Ulu Kali and G. Benom), this species was not recorded in the present study. The single collection from G. Benom (c. 2040 m asl) was made by T.C. Whitmore in 1967.
- *Ardisia petricola* (Myrsinaceae). A very rare endemic known only from G. Benom, this species was not recorded in the present study. The single collection (c. 2040 m asl) was made by T.C. Whitmore in 1967.
- The KWR is home to several threatened tree species. *Hopea pubescens*, *Vatica bella* and *V. heteroptera* (Dipterocarpaceae) are categorised as critically endangered under the IUCN Red List Categories (1994). *H. pubescens* and *V. bella* were found in the lowland and hill forests while *V. heteroptera* occurred in the lower montane forest.
- The most unique vegetation encountered in the KWR was the freshwater swamp forest. This forest type is poorly studied in Peninsular Malaysia—there is only one detailed publication and this was for the Sedili Rivers in south Johor. Unlike that of Sedili, the freshwater swamp forest in the KWR is not under tidal influence and hence is floristically different.

The KWR can be divided into the following floristic zones 1) Lowland dipterocarp forests, 2) Hill dipterocarp forest, 3) Upper dipterocarp forest (lower montane), 4) Oak laurel forests (lower montane), 5) montane ericaceous (upper montane), 6) riverine forests (lowland) and 7) forest regenerating from disturbance (includes cleared patches). This KWR has the major floristic zones in a continuous topographical sequence presenting the potential for many ecotone interfaces. Using the generalised elevation zonation classes (Symington's classification) widely used for the forests of Peninsular Malaysia, the extent of the major floristic zones in the KWR delineated as shown in Map 3.11. Table 3.11 is a summary of the theoretical extent of the 5 major floristic zones and altered patches in the KWR. This should form the broad basis for species distribution in the KWR, as elevation and physiography are

strong determinants of localised assemblages of plants not to mention
endemism.

MAP3.11 FLORISTIC ZONES OF THE KWR

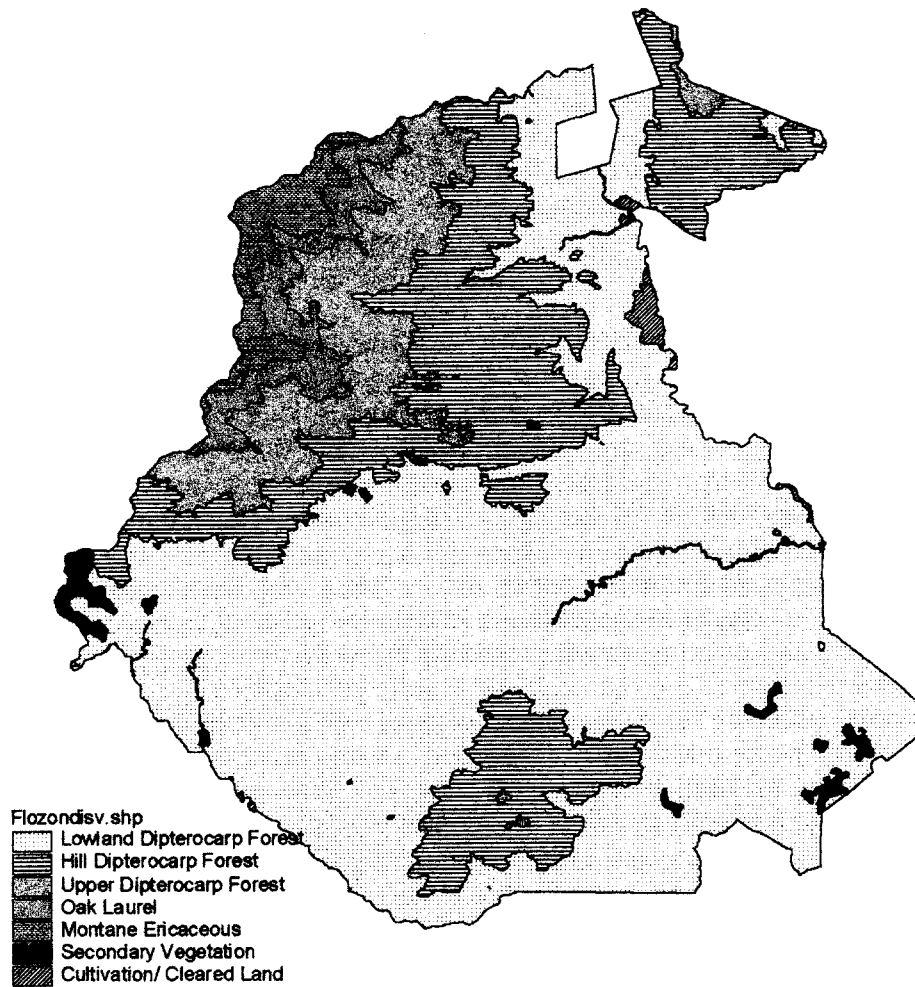


TABLE 3.11 EXTENT OF FLORISTIC ZONES IN THE KWR

Floristic Zone	Area(ha)	% of KWR
Lowland Dipterocarp Forest (Riverine Vegetation + Freshwater Swamp)	36759	61.2
Hill Dipterocarp Forest	13483	22.5
Upper dipterocarp Forest	5375	9
Oak Laurel Forest	1962	3.3
Montane Ericaceous Forest	1462	2.4
Secondary Vegetation (Regenerating)	656	1.1
Cultivation/ cleared land	333	0.6
Unclassified	10	0.02

The lowland dipterocarp forest in the KWR occur in flat and undulating low lying planes subjected to periodic inundation due to heavy rainfall. A dense network of streams, which drain as well as flood the forest dissects the terrain. Where there are pockets of heavy clay and silt localised fresh-water swamp forest occur even throughout the drier periods.

From the forestry point of view the lowland forest can be classified as "the red meranti-keruing association (*Shores-Dipterocarpus*)". Current recorded plant composition consists of the lowland forest of the KWR consists of 896 species from 38 genera and 118 families, 104 of the species are endemic to Peninsular Malaysia. Table 3.12 presents the 5 most diverse in the KWR

TABLE 3.12 FIVE MOST DIVERSE FAMILIES IN KWR'S LOWLAND DIPTEROCARP FOREST WITH THE NUMBER OF GENERA, SPECIES AND ENDEMIC SPECIES

Family	Genera	Species	Endemic species
Euphorbiaceae	28	85	11
Palmae	15	56	14
Rubiaceae	28	48	8
Annonaceae	20	41	9
Dipterocarpaceae	6	34	2

The riverine forest of the KWR is found to be herbaceous, besides this, the common tree species representative of riparian fringes in the Peninsular have been recorded.

Two sub-types of freshwater swamp forest have been distinguished in the KWR the first being vegetation on water-logged sandy clay and the second vegetation on water logged peat areas. The swamps are example of local variation in the lowland dipterocarp forest.

The hill dipterocarp forest lies on steeper terrain mostly above 30-45° slopes and form the headwaters of rivers flowing through and adjacent to the KWR. Seraya – balau ridge forest sub-type exists along Bukit Rengit and Bukit Tapah. 511 species form 267 genera and 89 families have been recorded to date in the hill dipterocarp forest of the KWR. At least 74 of the species recorded so far are endemic. Particular reference is made to *Vatica bella* listed by IUC as critically endangered. The five most diverse families in the hill dipterocarp forest are presented in table 3.13

TABLE 3.13 FIVE MOST DIVERSE FAMILIES IN KWR'S HILL DIPTEROCARP FOREST WITH THE NUMBER OF GENERA, SPECIES AND ENDEMIC SPECIES

Family	Genera	Species	Endemic species
Rubiaceae	27	42	7
Palmae	12	39	12
Euphorbiaceae	18	35	6
Lauraceae	9	27	4
Dipterocarpaceae	6	21	0

The montane forest surveyed so far seems to represent a transition zone at 1200m between the lower and upper montane zones. 246 species form 154 genera and 74 families have been recorded the latest botanical survey. The montane forest in the KWR could possibly contain the largest number of threatened species (this is not specific to the montane forest of the KWR alone) with some form of protection. *Vatica heteroptera* which is on the IUCN threatened list is found in the montane forest of the KWR. The five most diverse families in the montane forest are presented in table 3.14.

TABLE 3.14 FIVE MOST DIVERSE FAMILIES IN KWR'S MONTANE FOREST WITH THE NUMBER OF GENERA, SPECIES AND ENDEMIC SPECIES

Family	Genera	Species	Endemic species
Rubiaceae	16	21	2
Lauraceae	10	21	6
Melastomataceae	8	14	3
Euphorbiaceae	10	13	3
Myrtaceae	4	13	4

The quantitative botanical survey is summarised in Table 3.15. A total of 7.39 hectares (7 plots) were enumerated. At the least 46 tree families were recorded in the quantitative survey with Dipterocarpaceae, Leguminosae, Euphorbiaceae and Burseraceae being dominant. This represents trees above 10cm diameter measured at 1.3m above ground (Diameter at breast height). The total number of trees enumerated in the 7.39 hectares is 628 stems with a total basal area of 112.9 m². The basal area per hectare is 15.26 m² with a density of 85 stems per hectare. The total number of species recorded is 196. Table 3.xxx presents localised tree population variation and dominance in different forest sub-types in the lowland dipterocarp forest of the KWR.

TABLE 3.15 STRUCTURE AND NUMBER OF SPECIES OF TREE VEGETATION IN THE DIFFERENT QUANTITATIVE PLOTS.

	All Plots	Plot1 Secondary forest	Plot2 Mature forest- Type 1	Plot3 Mature forest- Type 1	Plot4 Mature forest- Type 2	Plot5 Mature forest – Type 2	Plot6 Secondary forest	Plot7 Mature forest- Type 3
Area (ha)	7.39	1.00	1.00	1017	1.00	1.10	1.10	1.01
No of stems	628	73	85	92	104	105	56	113
Basal Area (m ²)	112.79	9.02	17.26	16.09	19.85	24.46	6.45	19.65
No of species	196	37	52	47	59	43	36	58
Basal area/ha.	15.26	9.06	17.26	13.72	19.85	22.19	5.85	19.37
Density (stems/ha)	85	73	85	78	104	95	51	111

Secondary forest: approximately 35 years old, slightly hilly ground.

Mature forest-Type 1: On level moist terrain transected by small streams.

Mature forest –type 2: Tall mature forest on gently sloping well-drained ground.

Mature forest-Type 3: Mature forest on low to hilly to level swampy ground transected by small streams.

The quantitative survey of plants in the KWR is important in terms of determining the population of tree species. Empirical data helps better describe and characterise forest types and local variations. Quantitative estimations will allow deterministic rather than arbitrary comparisons of sites and monitoring. Information of this nature is needed for the management crucial habitats in the KWR. Summarised in table 3.16 is the ranked distribution of tree families in the KWR

TABLE 3.16 DISTRIBUTION OF BASAL AREA AND DISTRIBUTION OF PLANT FAMILIES IN QUANTITATIVE PLOTS IN THE KWR RANKED BY TOTAL BASAL AREA.

Family	Basal area										Stems										Regrowth	
	All plots	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 2+3	Mature forest	All plots	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 2+3	Mature forest		
Dipterocarpaceae	29.1	0.3	5.3	3.5	6.5	10.3	0.2	3.0	8.8	28.6	0.5	129	2	21	20	34	34	2	16	41	125	4
Leguminosae	19.0	1.8	2.1	2.6	3.5	6.0	0.4	2.6	4.7	16.8	2.1	65	13	9	7	10	13	4	9	16	48	17
Moraceae	17.1	0.8	3.1	4.0	3.1		0.7	5.4	7.1	15.6	1.5	90	4	14	20	17		3	32	34	83	7
Euphorbiaceae	7.7	1.2	0.7	1.0	0.7	2.1	1.3	0.7	1.7	5.1	2.5	63	13	6	9	4	13	12	6	15	38	25
Burseraceae	5.2	0.1	0.9	0.3	1.6	0.4	0.1	1.7	1.2	5.0	0.2	33	1	5	3	9	2	1	12	8	31	2
Sapindaceae	3.1	0.2	0.9	0.5	0.2	0.2	0.1	0.9	1.4	2.7	0.3	17	2	5	4	1	1	1	3	9	14	3
Myristicaceae	2.7	0.1	0.3	0.2	0.2	1.1	0.1	0.7	0.5	2.5	0.3	21	1	3	1	2	8	1	5	4	19	2
Nymphaeae	2.5		0.6	0.1	0.4	0.1	0.1	0.6	0.6	2.3	0.1	14		1	1	2	1	2	2	13	1	
Sterculiaceae	2.2			0.8	0.9		0.2	0.3	0.8	2.0	0.2	12			5	3		1	3	5	11	1
Anacardiaceae	1.8	0.1	0.5	0.4		0.1	0.1	0.6	0.9	1.6	0.2	11	1	3	2		1	1	3	5	9	2
Annonaceae	1.6	0.5	0.4	0.4		0.3	0.1		0.7	1.1	0.6	12	5	2	2		2	1		4	6	6
Apocynaceae	1.5			0.2	0.1	0.6	0.4	0.2	0.2	1.2	0.4	10			2	1	3	3	1	2	7	3
Bombacaceae	1.5				0.2		0.1	1.2		1.4	0.1	9				1		1	7		8	1
Oleaceae	1.5	0.1	0.1		0.3	0.6	0.5		0.1	0.9	0.6	13	1	1		3	4	4		1	8	5
Lauraceae	1.5	0.1	0.4	0.2	0.3		0.3	0.1	0.6	1.1	0.4	10	1	1	1	3		3	1	2	6	4
Rubiaceae	1.3	1.2	0.1						0.1	0.1	1.2	12	11	1						1	1	11
Fagaceae	1.2		0.3	0.1		0.7		0.1	0.4	1.2		11		3	1		6		1	4	11	
Meliaceae	1.1		0.3	0.2	0.6				0.5	1.1		7		2	2	3				4	7	
Rhizophoraceae	1.0	0.2	0.1			0.2	0.5		0.1	0.3	0.7	8	1	1			2	4		1	3	5
Combretaceae	0.7		0.5	0.2					0.7	0.7		2		1	1					2	2	
Ebenaceae	0.7		0.2	0.4				0.2	0.6	0.7		6		1	3			2	4		6	
Ixonanthaceae	0.7		0.1	0.2	0.1	0.3			0.3	0.7		6		1	2	1	2			3	6	
Flacourtiaceae	0.6				0.2	0.3		0.1		0.6		4	*			2	1		1		4	
Styracaceae	0.6	0.4					0.2				0.6	5	3					2				5
Dilleniaceae	0.6	0.6									0.6	4	4									4
Lecythidaceae	0.6				0.1	0.3	0.1	0.1		0.5	0.1	6				1	3	1	1		5	1
Sapotaceae	0.6								0.6			4						4			4	
Oxalidaceae	0.6			0.1	0.3		0.2		0.1	0.4	0.2	4			1	2		1		1	3	1
Malvaceae	0.5	0.5									0.5	3	3									3
Elaeocarpaceae	0.5	0.1					0.2	0.2		0.2	0.3	5	1					2	2		2	3
Indet.	0.4			0.2				0.2	0.2	0.4		2			1			1	1		2	
Thymeliaceae	0.3					0.3				0.3		3					3				3	
Clusiaceae	0.3				0.1		0.2			0.1	0.2	3				1		2			1	2
Verbenaceae	0.3	0.1	0.1		0.1				0.1	0.2	0.1	3	1	1		1				1	2	1
Tiliaceae	0.3						0.3				0.3	3						3				3
Chrysobalanaceae	0.3		0.1		0.1			0.1	0.1	0.3		3		1		1			1	1	3	
Alangiaceae	0.2		0.2	0.1					0.2	0.2		2		1	1					2	2	
Polygalaceae	0.2			0.1	0.1				0.1	0.2		2			1	1				1	2	
Rutaceae	0.2	0.2									0.2	2	2									2
Hypericaceae	0.2	0.2									0.2	1	1									1
Asteraceae	0.2	0.1					0.1				0.2	2	1					1				2
Magnoliaceae	0.2						0.2				0.2	1						1				1
Juglandaceae	0.1				0.1					0.1		1				1					1	
Sonneratiaceae	0.1	0.1									0.1	1	1									1
Cornaceae	0.1			0.1					0.1	0.1		1			1					1	1	
Ulmaceae	0.1			0.1					0.1	0.1		1			1					1	1	
Indet.	0.1		0.1						0.1	0.1		1		1						1	1	
Total	112.8	9.0	17.3	16.1	19.9	24.5	6.4	19.7	33.4	97.3	15.5	628	73	85	92	104	105	56	113	177	499	129

Habitats

Both qualitative and quantitative plant studies are crucial for the management of vegetation in the KWR be it for biological or economic reasons. Based on vegetation assemblages, broad scale habitats should be identified in the KWR to help manage habitats better. A preliminary attempt to map is detailed in Map A.07. The map is a product of aerial photo interpretation. The criteria used for habitat classification is the photo-type and physiography. In table 3.17 a matrix is presented with habitat description and elevation as components. Based on photo-type classification alone 15 (excluding the unclassified category classes of habitats can be identified. If elevation were to be considered as a factor, then a total of 23 habitats could be identified provided the changes in the habitats are significant as elevation changes.

TABLE 3.17 HABITAT DESCRIPTION MATRIX BASED ON PHOTO-TYPES, PHYSIOGRAPHY AND ELEVATION SHOWING % OF LAND AREA IN THE KWR

Habitat description - Phototype and Physiography	Elevation					300m	750m	1200m	1500m	>1500m	Total
Hill-Tree crowns large-irregular canopy with tall emergents						12.2	12.9	3.5			28.7
Dissected(physiographic), irregular canopy with tall emergents						21.7					21.7
Tree crowns large-irregular canopy with tall emergents						13.4					13.4
Hill-large grey-toned canopy						1.2	7.0	1.3			9.5
Riverine-Scattered canopy-tall, large and small crowns over dense understorey						7.5					7.5
Hill-Tree crowns small - dispersed canopy with scattered large trees							0.1	3.2	2.0	0.5	5.8
Montane-Tree crowns small-canopy compact,uniform height									1.3	1.9	3.9
Unclassified						1.0	2.2				3.4
Tree crowns small-irregular canopy-uneven height/Dispersed canopy with scattered large trees						2.3					2.3
Disturbed secondary vegetation						1.1					1.1
Hill-Tree crowns small-irregular canopy-uneven height/Dispersed canopy with scattered large trees						0.6					0.9
Tree crowns small - dispersed canopy with scattered large trees						0.8					0.8
Cultivation/cleared land/non-forest						0.5					0.5
Tree crowns large-broken canopy,uneven height						0.3					0.3
Hill, tree crowns large-broken canopy,uneven height/tree crowns small-dispersed canopy with scattered large trees						0.1					0.1
Hill, Tree crowns small-canopy compact, uniform height (negligible occurrence)						0.0	0.0	0.0	0.0	0.0	0.0
Total						62.8	22.5	9.0	3.3	2.4	100.0

Plant utilisation-Ethnobotany

The Chewong and the Jah Hut possess a unique knowledge of the use of forest plants. The recorded information is summarised in table 3.18

TABLE 3.18 UTILISATION OF PLANTS BY CHEWONG AND JAH HUT COMMUNITIES IN KWR

Utilisation	Approximate no of species
Food	242
Stimulants	22
Medicinal purposes	163
Poison	27
Fibre	71
Technical purposes	62
Religious purposes	62
Other uses	27

The table represents information collected during a 5 month study period by the ethnobotany specialist Dr H Christensen. She indicates that her study merely scratches the surface of the pool of knowledge and utilisation the CheWong and Jahut possess.

Rattan used for subsistence in the KWR

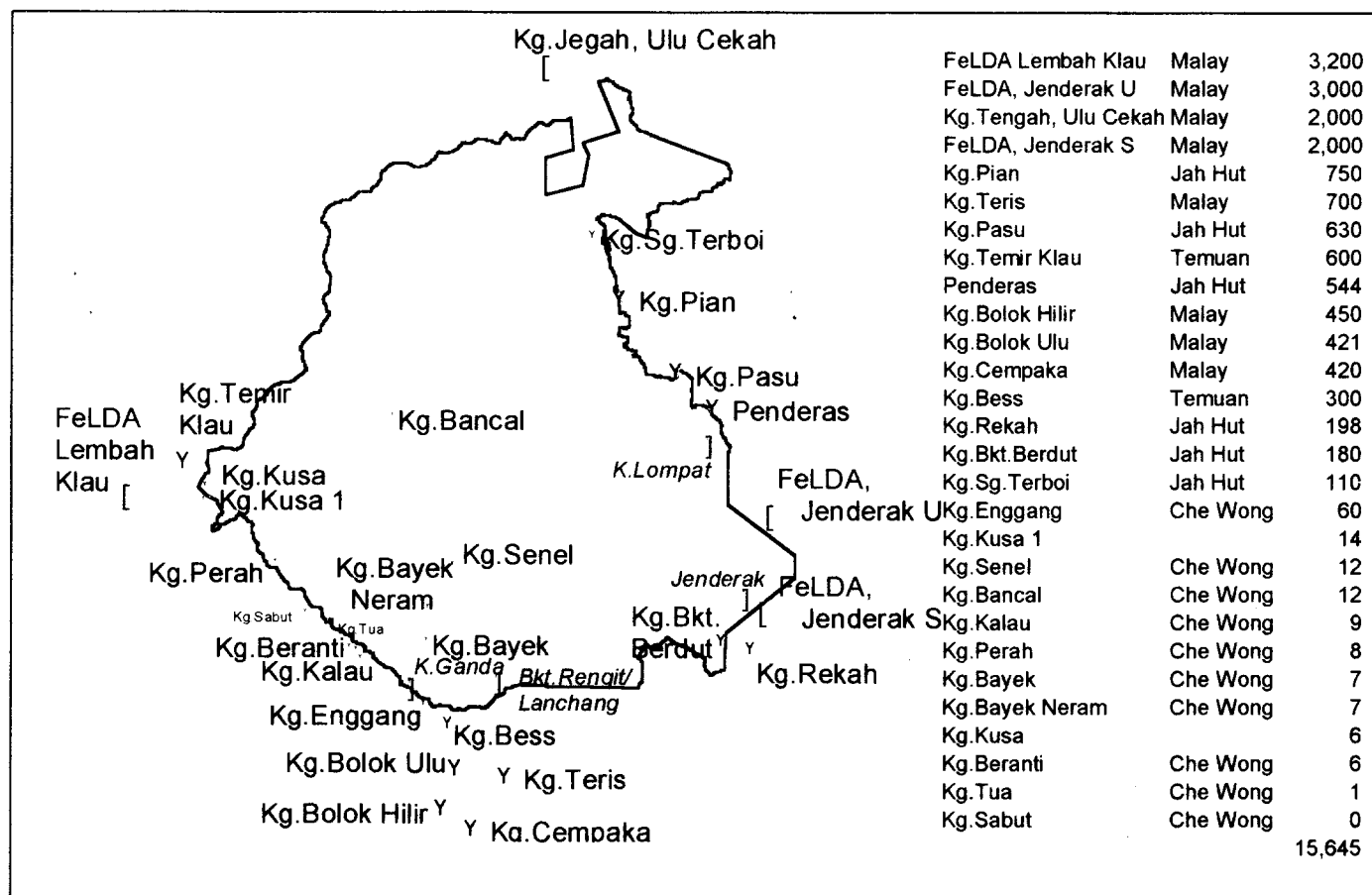
The Chewong and Jah Hut are no exemption to the fact that orang asli living near or in the forest in Peninsular Malaysia collect rattan for subsistence and sale. In the KWR, rattan has been traditionally a primary source of cash income for both communities. Approximately 40 species of rattan are recorded as being used by the orang asli community associated with the KWR and represent collection in the lowland forests in KWR (below 150 m above sea level). Christensen recorded 36 species of rattan utilised by the Jah Hut and 28 by the Chewong. The most important rattan species used for subsistence by the orang asli community are *Calamus densiflorus*, *Calamus javensis*, *Calamus laevigatus*, *calamus manan*, *Daemonorops sabut*, and *Korthalsia scortechini*.

If the orang asli were to only use rattan for their own subsistence, it would be unlikely to pose a problem for the biodiversity of rattan species in the KWR. Most of the frequently used rattan species for subsistence use are still found in great numbers inside the KWR close to the orang asli villages.

Commercial Collection of Rattan

The commercial collection of rattan in the KWR is an unmonitored activity. Though a recent attempt to quantify and monitor collection was made, it is very preliminary and unable to suggest any sustainable collection principles and protocols. Commercial rattan is reported to becoming scarce, an example would be *Calamus manan* is said only to be found in the interior of KWR. Excessive harvesting is the cause for the decline in the wild rattan population. Collection has to be managed and alternatives such as cultivation has to be given serious consideration.

3.3.9 People



MAP 3.12: TOWNSHIPS, SETTLEMENTS AND POPULATIONS AROUND THE KWR AREA⁵².

MAP 3.12 above summarises the information on the settlements and population from interviews undertaken as part of the project. This gives a view of *who* are the *local community* in the KWR area. The majority of the population are Malay who settled the area in the 1960's and 1970's, when the planned FeLDA settlements were being established. The oldest Malay settlements around Kg. Bolok and Kg. Cempaka date back to 1907 with later settlements forming as late as 1972. The Jah Hut and Che Wong have no memory of settlement elsewhere, as do the Temuan at Kg. Bess. The Temuan at Temir Klau were grouped there in 1961.

From a current management perspective, there are three types of people:

- 1) Orang asli exercising their rights given under section 52 of the PWA,
- 2) Poachers, and

⁵² Population figures are quoted from estimates made during the interview. They will need to be confirmed.

3) the local community who live in the surrounding buffer area.

Each group of people appears to have their own separate agenda and little interest and sometimes respect for the other.

The project survey suggested that the FELDA settlers, besides recreational interests, have relatively little to do with the forest, being supported by their work on the estate. Orang asli communities to varying degrees remain dependant on the forest for food, materials and produce for sale. In general the weaker groups fear and avoid confrontation with the strong, those dependant on the forest are aware of diminishing returns on their labours, and all hope for a better future. Excluding the Malay community suggests that there could be between 2,500 to 3,500 Che Wong, Jah Hut and Temuan with some level of dependency on the 30,000 ha of lowland forest in the KWR. Or 10 people per 1 sq. km⁵³. For their material needs, the more numerous Jah Hut and Temuan are more dependent on agriculture while the less numerous Che Wong are understood to depend more on the forest.

MAP 3.11 gives the location of current settlements, as a point size relative to the population of the settlement⁵⁴. Apart from the small Che Wong settlements at Bayek, Senel and Bancal, and the Jah Hut border settlements at Berdut, all settlements are outside of the reserve. However, people from the outside settlements do enter and use the reserve. Their areas of use are not random, but controlled by mutual recognition⁵⁵. MAP 3.12 below, illustrates the traditional *zones* of occupation and exploitation for the Krau Jah Hut community and the Che Wong community at Senel.

The Senel area still has a remnant of the Che Wong population that once lived in this part of their range. The majority have moved or been persuaded to move to the Kg. Enggang area at the reserve boundary. And most of the Jah Hut communities have now settled along the Sg. Krau. Points to note in MAP 3.5 include:

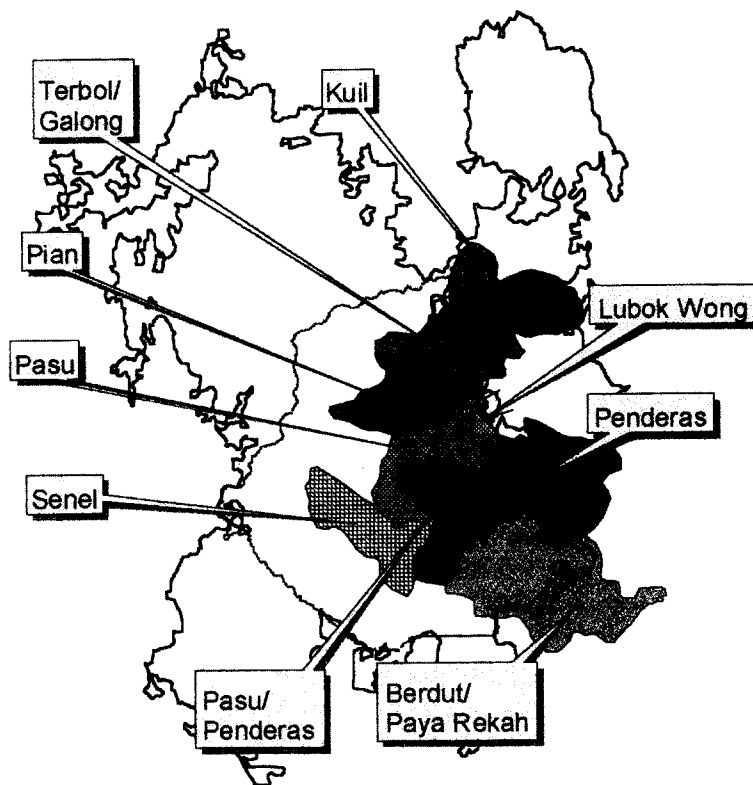
- the mutual recognition by different local communities of the boundaries of their areas of exclusive exploitation;
- the *knowledge* of traditional lands within the reserve is still alive, even in communities that have been settled outside for the over 40 years and are now less dependant on the reserve;
- the ability to recognise and locate these areas on the ground; and
- the loss of *traditional* forest areas to outsiders who did not comprehend or recognise their system of land occupation and use. (The forest once used by the Berdut, Rekoh and Penderas people was taken and cleared by FELDA, and occupied by outside people.)

⁵³ In 'Hunting of wildlife in tropical forests' by Elizabeth Bennett and John Robinson Sept 2000 (see pp 14 Box 3.3), a figure of one person per 10 km² is given for traditional human densities in neotropical forests dependent on the forest for their protein source. This comes with a warning that *...if this human carrying capacity is exceeded...then wildlife populations will be depleted, and people will be tied to a declining resource base.*

⁵⁴ Location was taken as a single GPS record, and gives no indication of the spatial extent of the settlement.

⁵⁵ The areas were mapped from oral history through informal interviews during the large mammal survey exercise..

MAP 3.13: AREAS OF TRADITIONAL EXPLOITATION OF THE SG. KRAU LOCAL COMMUNITIES AND SENEL TAKEN FROM ORAL SOURCES.



Experience gained from the project has provided some understanding of *where* and *how much* of the forest is used by people from project investigation into sustainable use of NTFP and the large mammal survey⁵⁶.

MAP 3.9 and A.09 gives the locations of human activity as recorded by photo traps and indicates people within the reserve generally remain below 200 m. The 'rentis' survey recorded signs of the presence of people which also supported a general 200 m altitude limits. This data gave an insight into extent of the range of people using the forest. In CHART 3.5 below the recent survey records of human activity is shown as records normalised per 100 ha. block in bands at 1 km intervals moving in from the reserve boundary. As expected, the linear trend line indicates that activity falls off away from the boundary, but it is interesting to see a peak of activity at the 4 km band.

⁵⁶ This survey on large mammals in the KWR is currently being undertaken by the DWNP and WCS as one of the surveys supported by this project.

CHART 3.5: SITES OF HUMAN ACTIVITY AS A DISTANCE FROM THE RESERVE BOUNDARY.

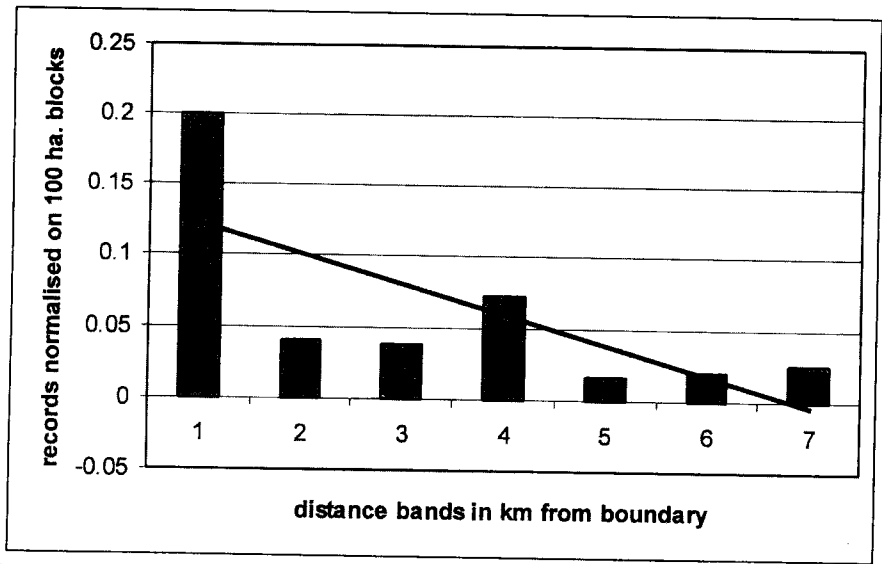
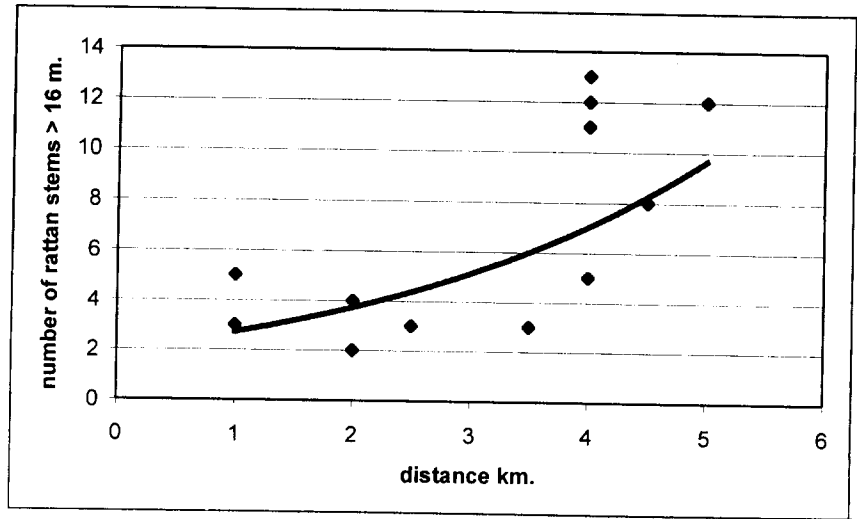


CHART 3.6 below, plots the relative abundance of rattan stems greater than 16m long. This is about the length rattan are selected for harvesting. At a distance of 4 km from settlements, the relative abundance of rattan stem increases. The 4 km mark appears to be the limit for intensive rattan collection.

CHART 3.6 THE NUMBER OF RATTAN STEMS OVER 16 M FOUND PER TRANSECT PLOTTED AGAINST THEIR DISTANCE FROM THE NEAREST HUMAN SETTLEMENT⁵⁷.



From the information available on what people are doing in the reserve, it is understood that people of the local community :

⁵⁷ A machine-generated polynomial trend line is superimposed on the plot for illustrative purposes only, and is intended to emphasise the positive relationship between large rattan frequency and distance. Data from project study on monitoring sustainable harvesting by Jan P. Feil.

- enter the reserve for many purposes to collect materials for self-use or produce for sale;
- hunt for sustenance, profit or sport;
- there are separate areas of traditional collection which to some extent are still observed and recognised by the local communities;
- there appears to be a general altitude limit of 200m for *normal* activities in the reserve;
- most records of people are within the 1 km band in from the forest boundary with an second peak in the 4 km band.

From recent field surveys of mammals in the KWR, it is apparent that:

- Human activities in the KWR have a negative impact on selected target species, and
- This continuing activity is preventing a self-recovery of wildlife numbers.

Since the area is a wildlife reserve, human activities must be controlled, allowing wildlife to recover - at material and social costs that may be imposed on the local communities of the KWR area. It must be borne in mind that ultimately the KWR is supposed to be a benefit for the people of Malaysia, the local community as well as all others.

However, until the PWA is amended or superceded, the rights for orang asli cannot be denied. However, like many acts the PWA is not entirely clear and will need legal interpretation⁵⁸.

The following subtle difference between the orang asli and other hunting communities should be noted:

- Orang asli legally entering the reserve to hunt legally for their own use and not for sale, using legal methods e.g. the Jah Hut or Che Wong.
- Orang asli legally entering, but illegally hunting unlisted species or hunting within ¼ mile of a salt lick.
- Orang asli legally entering the reserve to hunt species for illegal sale, e.g. the Jah Hut, Che Wong or Temuan.
- Non-orang asli local communities illegally entering the reserve to hunt illegally, protected or totally protected species, either for their own use and/or for sale, e.g. kampung Malays without a permit and out of season⁵⁹.

⁵⁸ Section 52 of the PWA states: *Notwithstanding anything in this Act, any member of an aboriginal community (as defined in the Aboriginal Peoples Act 1954) may shoot, kill or take the wild animals and wild birds described in Schedules Two and Four as deer, mouse deer, game birds and monkeys, for the purpose of providing food for himself and his family.* In schedule 2 the deer are : 1. Sambur, 2 Barking Deer, the mouse deer are: 3 large Mouse-Deer, 4 Lesser Mouse-Deer, monkeys are : 9. Banded Leaf-Monkey, 10, Dusky Leaf-Monkey, and 11. Silvered Leaf-Monkey; and in schedule 4 game birds are given as: 1, Red Jungle Fowl, 2. White-breasted Waterhen, and another 65 species of pigeon and waders with an open season between October and December. Among the animals hunted which are not mentioned are: fish, frogs, turtles, hornbills, pig and gibbons..

⁵⁹ This includes the reported use of poisons and explosives for fishing.

- Outsiders commissioning the local communities to hunt illegally, protected or totally protected species, for sale, e.g. business man in Mentakab commissioning hunting in the Perlok part of the reserve.
- Outsiders illegally entering the reserve to hunt illegally, protected or totally protected species, for their own use and/or sale, e.g. people from the town of Bentong hunting in the Lembah Klau part of the reserve without a permit and out of season.

Of the six types of hunting communities, the law should be enforced against the last five and wildlife populations monitored for signs of recovery.

In addition people are reported to enter the reserve to collect: rattans, keredas (*Pithecellobium bubalinum*) and the incense tree gaharu (*Aquilaria* sp.), as well as some localised tree felling and planking using chain saws.

The management of what people *do* and the effects they create is relatively straightforward. Using the powers laid down in the PWA, control over the reserve must be regained, ensuring all activities within are compatible with the management objectives of the reserve.

3.3.10 Enforcement of the Protection of Wildlife Act (PWA).

Under the Protection of Wildlife Act 1972 (PWA), all wildlife species and vegetation are supposedly protected. There are some NTFP species collected by the Orang Asli. NTFP collection in KWR by the Orang Asli was allowed by the act for their own consumption. However, this utilization for own consumption has shifted. Now, they gather NTFP to sell to middlemen and use the money to support their daily necessities. The amendment of the PWA 1972 needs to look into this matter as some of the NTFP such as frogs have reached unsustainable levels of collection.

In the past, there were few Ranger Posts in Krau Wildlife Reserve at sites such as Kuala Lompat and Bukit Patong. Currently, three posts with two G9/G10 at each post to function as the enforcement officer on site with some additional assistance from the state DWNP office.

The main task of these rangers is boundary patrolling, maintenance and enforcement of the PWA. Enforcement is based on sections of the PWA such as section 82 that state '*every person who knowingly enters a wild life reserve without a permit to do so is guilty of an offence and shall on conviction be liable to a fine not exceeding two thousand ringgit or to a term of imprisonment not exceeding one year or to both*'.

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TABLE 3.19 NUMBERS OF CASES AROUND KWR FROM 1995 UNTIL 2000

No.	I/P No.	Cases/Section
1.	202/96	Sec.82- entering KWR without a permit
2.	319/97	Sec.82- entering KWR without a permit
3.	351/99	Sec.82- illegal logging and entering KWR without a permit
4.	169/00	Sec.82- illegal logging and entering KWR without a permit
5.**	2000	Sec.82- illegal logging and entering KWR without a permit

* Sources : Pahang DWNP Enforcement Unit.

** Sources: DWNP/DANCED Jenderak Selatan.

TABLE 3.19, show that there are 5 cases occurred around KWR from 1995-2000. All the cases were charge under sec.82 : Illegal logging and entering wildlife reserve without permit.

TABLE 3.20- NUMBER OF CASES TO 5 KM RADIUS FROM KWR BOUNDARY (1997 UNTIL 2000)

No.	I/P No.	Cases/Section
1.	74/97	Sec.68-69 : Has in his unlawful possession a protected wildlife animal without a permit (one male Pig –tailed macaque and one female Pig-tailed macaque)
2.	117/97	Sec.68 : Has in his unlawful possession a protected wildlife animal without a permit (one male Pig –tailed macaque)
3.	186/97	Sec.68 : Has in his unlawful possession a protected wildlife animal without a permit (two male Pig –tailed macaque)
4.	315/97	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
5.	398/97	Sec.74(2): Takes a protected wild animal during prohibited hours (one wild pig)
6.	493/97	Sec.98; attempts to commit an offence shoot a protected wild animal without a permit .
7.	31/98	Sec.68 : Has in his unlawful possession a protected wildlife animal without permit (one hill myna)
8.	172/98	Sec.98: attempts to commit an offence shoot a protected wild animal (wild pig) without a permit .
9.	213/98	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
10.	288/98	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
11.	291/98	Sec.69 Has in his unlawful possession a protected wildlife animal without permit (one female Pig –tailed macaque)
12.	334/98	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
13.	457/99	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
14.	476/99	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
15.	40/00	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one pair of sambur deer trophy)
16.	42/00	Sec.68 : Has in his unlawful possession a protected wildlife animal without permit (one hill myna)
17.	265/ 00	Sec.83 : carries on the business of a dealer without a licences (wild pig meat)
18.	277/00	Sec.69 Has in his unlawful possession a protected wildlife animal without permit (two female Pig –tailed macaque)
19.	358/00	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one male Pig –tailed macaque)
20.	363/00	Sec.68 Has in his unlawful possession a protected wildlife animal without permit (one pair of sambur deer trophy)

Sources: Pahang DWNP Enforcement Unit.

TABLE 3.20 showed that there were 20 cases of other offences that occurred within a 5 km. radius around the reserve. Most of the cases involved keeping protected animals species such as pig-tailed macaques. This may not represent a serious threat to the species. Illegal hunting was not reported here.

3.3.11 Administration and Human Resources.

The DWNP is proposing a restructuring exercise to accommodate the following:

- increased scope of responsibility and workload;
- changes in the role of the department from mainly from wildlife protection to biodiversity conservation and;
- amendments to the wildlife act (1972) bringing about additional responsibility onto the department.

The current total manpower of the DWNP is approximately 797 and in the restructuring exercise the department will attempt to increase this by an *additional* 712 to 1509. The department is requesting for an additional 12 senior management posts, 72 middle management posts, 7 wildlife officers posts, 9 senior researcher posts and 78 research posts. The bulk of the increase, if realised, will be seen in the lower ranks where an additional 561 wildlife rangers are being requested.

Pre-empting this restructuring is the formation of the Protected Area Division in the DWNP last year. This division can be said to be the result of the DWNP/Danced 'protected area management capacity building project'. The PA division has been assigned the task of protecting and managing the 39 protected areas under the jurisdiction of the DWNP. A summary of the administrative structure of the DWNP is presented in fig 3.1. On paper the division has been assigned 4 staff with an acting head. However, the functioning of this division is not yet optimised and it can be considered to be in a "state of limbo". The factors contributing to this (current) state are:

- the non permanence of the current head of division.
- the lack of a definitive structure.
- the lack of clearly defined job description and hierarchical links between staff stationed in some of the protected areas.
- the role of this division in the department and in the managing of the protected areas is yet to be clearly defined.
- the period of transition between now and when the whole department is to be restructured and re-organised creates uncertainty.
- uncertainty in staff allocation to the division
- uncertainty amongst allocated staff as to role in the division and confusion over prevailing responsibility to previous divisions.
- relatively new division and requires a period of transition before optimising its potential functionality

The protected areas division needs to undertake a planning exercise to consolidated it existence and to meet the challenges of managing and conserving biodiversity in

Management Plan for the Krau Wildlife Reserve.

its protected areas. Currently the division has two areas under its care namely the Tasik Bera Ramsar site and the KWR. The KWR represents the model for protected area management in Peninsular Malaysia. The lessons learned in administrating this area will form the standard for all other protected areas. Figure 3.1 hierarchically places the KWR. As logic prevails, uncertainties in the functioning of the protected area division will create more uncertainties in the administration and management of the KWR.

The KWR management is currently in a state of flux as with its supra administrative division. There is a vertical administrative structure (Fig 3.1) but as yet there has been no attempt to identify and define horizontal linkages. The KWR has within its borders activities managed by other divisions in DWNP and the state DWNP office. These linkages however, based on management jurisdiction, will be further explored and finalised in order to implement actions outlined in the Management Plan.

In fig 3.2 the administrative structure and brief job responsibilities are summarised. This seems to be a theoretical structure which has yet to be tested. There is however optimism as far as the administrative structure is concerned and it is expected to evolve to be more functional and clear in the coming years.

The KWR currently has an acting head and the following manpower composition:

- 3 wildlife officers
- 2 assistant wildlife officers
- 5 rangers

The administrative vacancy is yet to be filled. It would seem that the KWR is understaffed and the administrative structure presented in fig 3.2 seems to be rather ad hoc. As a model for protected area management it would have to quickly initiate planning measures to identify administration gaps as well as manpower requirements.

For efficient management some semblance of the following need to exist: before the management plan can be implemented.

- Provision for training , support and welfare of uniform and non uniform staff.
- Supporting plans and manuals outlining standard operating procedures.
- Identification of management development needs and constraints.
- Up grading off facilities and planned investment to facilitate management.

In general, the current gaps in administration and human resource needs will have to be filled during the duration of this management plan.

3.4 Development of user opportunities.

3.4.1 Local communities.

Local communities within and around Krau Wildlife Reserve (KWR), has been recognized in this management plan as the important element for the survival of KWR. The diverse communities in and around KWR contributed to the various needs, concerns, problems, and opportunities. Local communities and the land they use cannot be approached as separate issues. Human activities have always had a great impact or modified the protected area. However, human impact can be overcome if they can treat the forest as renewable resource, protect the resource and use it on a sustainable basis.

Not many countries realized that the survival and quality of a protected area depend on the strength of people involvement because the people are directly and indirectly involved in utilizing the natural resources. The direct and indirect dependency of these local communities to KWR requires special attention in order to achieve a sound management of a protected area. It is believed that local community involvement in management and decision making process could minimize the threats to these protected areas through community organization rather than just merely full control by the government agencies.

In the past, local community participation in protected area management, especially for KWR, was neglected by the managing authority based on their passive and limited participation in management. Currently, with the DANCED-DWNP Project in Krau, local communities were included in the development of this management plan. A series of workshops have been conducted to gather input and feedback on the Management Plan. Some research was also conducted to provide background information on social structures, economics, land use and tenure, perceptions towards KWR and DWNP, ethnobotany, and natural resource harvesting.

As the result, researcher and consultants found out that there are activities that could be an advantage and disadvantage to the integrity of KWR. The advantages or opportunities could be useful to the local community involvement in KWR management were some of the ongoing activities and existing local association such as:

- Agro-forestry activities
- Orang Asli craft/carving
- Ecotourism activities
- Animal husbandry
- Fish pond
- FELDA settlers cooperative
- Jawatan Kuasa Keselamatan Kampung
- Persatuan Belia
- PIBG sekolah
- NTFP harvesting by the Orang Asli

These ongoing activities and association could be a potential for development of a more meaningful and extensive local community involvement in the future. To

complement the Local Community Management Group as proposed in this Management Plan, several mechanisms could be adopted to enhance collaboration between local community and the DWNP. These potential collaborations (as also proposed by the local communities during the series of workshop) could be:

- Establishing a Local Community Management Group to act as counterpart with the DWNP in the management and planning process;
- Developing a local community association such as Sahabat Krau, especially to create awareness among the youth;
- Identifying local people as Community Organizer to act as bridges with the managing authority;
- Developing a cooperative to ensure benefits return to the local community and to safeguard the local community from external economic pressure;
- Continuing and expanding the "Local Community Rangers" services to promote stewardship;
- Promoting a community-based ecotourism concept in the surrounding areas;
- Identifying alternative economic activities to ensure sustainable development within and around KWR;

3.4.2 Research.

As a result of research efforts, the KWR has one of the most comprehensive inventory lists of any protected area. However, most of this work concentrated on the higher vertebrates – mammals and birds, with relatively little investigation made of invertebrates and plants. To comply with the immediate objectives of the management plan, applied research on all aspects of biodiversity in the KWR should be carried out. This can be maximised by expanding the existing linkages with local universities and other institutions of higher learning. By opening this opportunity for potential research in the reserve, the KWR could be more widely promoted nationally and internationally. This may also encourage more sources of funding.

Suggestions for priority research within the reserve include, but are not limited to:

- inventory work to support resource management:
 - botanical and faunal surveys and
 - mapping up to Gunung Benom;
- monitoring for adaptive management:
 - comparative surveys on animal populations using previous studies. For example, monitoring primates, squirrels and pheasants;
 - monitor the impact of tourism, and
 - monitoring NTFP collection;
- basic research on:
 - collection of climatic data;
 - studies on the river ecosystem;

- studies of forest dynamics;
- plant phenology studies;
- collections of fertile plant specimens;
- faunal dynamics;
- ethology;
- local communities.

3.4.3 Education.

Whereas tourism can be considered as an opportunity that benefits from the natural state of the reserve, education, or more specifically conservation education, is an activity that will help support the reserve.

New education facilities have been completed at Lanchang (Bkt. Rengit) with lecture rooms, seminar rooms, a library, a room for a computer lab and an interpretation room. And supporting these facilities is accommodation, catering facilities, a surau and tennis court. In addition, there is an audio visual theatre at Kuala Gandah, and plans in development for interpretation facilities at Kuala Gandah, Bukit Rengit and Jenderak Selatan.

The DWNP has been using the facilities at Bukit Rengit to run courses on various aspects of wildlife management for over a decade. These courses have been attended by department staff, staff from other agencies as well as participants from abroad. The KWR and its captive animal facilities are visited by schools, other educational institutions as well as the general public. With its well appointed facilities, access to good forest, and short travel time (1 and a 1/2 hours to KL), the Bukit Rengit and Gandah areas offer a good opportunity to develop an educational service at the KWR.

Educational use of the reserve has included:

- Training in aspects of wildlife management,
- General conservation awareness and education,

This can be further expanded to support;

- Curricular based education,
- Field exercises for secondary and tertiary education,
- Non-curricular education on wildlife and conservation, and
- In support of local community awareness.

3.4.4 Eco-tourism.

In terms of ecotourism, it has been mentioned in several PTC meetings that the state government cautioned the DWNP not to adopt a national park concept for the KWR. With this in mind, the management plan has explored all the potential activities in the areas around the boundary of the site rather than in the middle of the reserve. Among the issues raised by the local state government were creating opportunities for local communities to take part in and benefit from ecotourism. This management plan outlines various opportunities to support such a mandate.

Eco-tourism will be allowed on G. Benom with strict regulations and rules. No new rentis or trails will be made inside the reserve. Perhaps the best route would be through Ulu Cheka and then along the boundary to G.Benom. The other alternative would be within the buffer zone.

Possible recreational activities could have included nature watching, trekking, camping and canoeing. In addition, the captive breeding centre for gaur and trained elephant would have presented additional visitor interest. However, the Krau is a reserve for wildlife, and its present purpose is for the conservation of biological diversity. The general view among staff and consultants is that visitor activities for eco-tourism should be developed in the forest areas *around* the KWR and make use of the existing elephant, gaur, research, education and training sites developed by the DWNP.

Tourism development potential has been identified closely linked with the 3 interpretive centres at the KWR. These include :

- the Bukit Rengit and Kuala Gandah area with potential for :
 - 'Jungle treks' and 'night walks',
 - canoeing along the Sg. Teris,
 - elephant rides,
 - 'tribal arts & crafts',
- at Jenderak Selatan for :
 - visits to the captive breeding centre which is one of the few places in the world to view the Malaysian gaur and sambur.
- And at Pos Lompat with its potential for :
 - bird watching,
 - treks along the Sg. Lompat and night walks⁶⁰,
 - naturalist tours,
 - canoe trips along the Sg. Krau from Perlok to Kuala Lompat,
 - as well as cultural tours to Kg. Penderas.

Facilities Recommended for tourism:

- establish and maintain a system of well marked trails;
- employ guides with a wide knowledge of the forest;

⁶⁰ Such proposals would need to be screened for possible conflict with the prime activity in the area – research.

- providing services at existing visitor centre equipped with:
- souvenirs - including: postcards and posters; local arts and crafts
- create a short nature trail close to the visitors centre where interesting trees are named and information points indicate common animals to look out for;
- first aid facilities, an emergency evacuation plan (helicopter pad) and an arrangement with a local hospital;
- canoe trips on the Sg.Teris and Sg.Kerau;
- elephant treks; and
- camping sites and picnic areas outside the KWR.

Increased tourism close to Kuala Gandah and Jenderak Selatan will inevitably lead to new employment opportunities; from which, it is very important that the local population should benefit. The Orang asli may be particularly useful as rangers and guides considering their extensive knowledge of the forest and its wildlife.

3.4.5 Captive management and breeding.

At present the DWNP manages two *ex-situ* facilities for animals at Jenderak Selatan for gaur and sambar, and at Kuala Gandah for elephants. The gaur are kept as a breeding herd. The elephants are non-breeders whose purpose is to assist with translocation of wild elephants.

Gaur and sambar captive breeding has been successful. Gaur breeding success is particularly important considering the threatened state of wild gaur and sambar. Jenderak Selatan is probably the best place to view this particular subspecies of gaur *Bos gaurus hubbacki* anywhere in the world. They are far more majestic than the Indian gaur, and retain the spirit and behaviour of wild cattle that is not seen in zoo or domesticated stock. However giving delight to visitors was not their intended role.

Work on mitochondrial DNA suggests the northern Thai and Indian Gaur to be broadly closely related to each other, with *B. gaurus hubbacki* a distinct subspecies. Numbers are too few to be self-sustaining in the wild, and their survival is considered dependant on active management of both the wild and captive herds. Management would include the option for re-introduction of captive raised animals into the wild⁶¹. From the habitat analysis during the project, it was found that the lowland part of the KWR along the Sg. Lompat was the most suitable site for the reintroduction of gaur.

At present, the day-to-day management of the captive management and breeding program in the KWR was under the responsibility of the Pahang DWNP. The Research and Conservation Division at DWNP HQ gives advice on technical matters to the project. What seems to be lacking is *coordinated planning* and standards in husbandry practice. This management plan suggests this issue be address in the management period.

⁶¹ See pp 68 *The Genetics and Conservation of Gaur and Asian Elephants on the Malaysian Peninsula*, E.Jean Brennan, 1995 for further comments on the role of captive breeding in gaur conservation.

3.5 Economic analysis.

Economic valuation of KWR can help meet its management objectives.

The recognition that a protected areas' biological resources have economic value can be a compelling case for conservation activity. High economic values can bolster arguments for protection of an area against other land use options, and help direct funding (both domestic and international) for adequate protection of the area. For example, it is possible that the global values of KWR will be significant in terms of the existence value of its biodiversity and carbon storage functions. Quantification of these benefits can be used in discussions with the international community on possible transfer of funds to conserve the area in the interest of the world.

KWR is under pressure from many direct uses of the area - excessive development of buffer areas, an aquaculture project within the park, the overharvesting of forest products, and illegal hunting, collecting, and tourism activities. How can economic valuation help argue against these activities, and for conservation? Once the conservation values of KWR are known in monetary terms they can be more easily compared with these other development activities - typically denominated in monetary terms. In this way it is possible to directly compare, for example, the conservation benefits which must be forgone because of an aquaculture development, or because of development activities within the buffer zone. Without monetary estimates it is very difficult to have any rationale debate about relative advantages and disadvantages. Monetary values are also more readily understood by decision-makers. This is not to say that economics is not the final arbiter of worth, but it can contribute to the decision making process by attempting to express many different concerns in a single consistent framework.

Economic valuation of KWR will highlight important values of the area (e.g., biodiversity and watershed values) which can assist in zoning decisions, and general management

Economic valuation can also indicate areas of unsustainable use. Direct use survey, and CVM surveys routinely uncover much about current use practices within the Reserve, and can highlight areas of stress. A comparison of the economic benefits of sustainable rather than unsustainable management, can further bolster the conservation objective along with the long time viability of the area (e.g., by determining optimal practices for the harvesting of NTFPs)

Economic valuation can be complimented with a distributional analysis of who gains and who loses from specific land use decisions and/or management regime, thus facilitating a more equitably distribution of resources. Crucial for Krau is an understanding of the dependence of local communities on the Reserve, and development of a management plan that integrates and enhances their traditional life style. It is important for the long term sustainability of the area that local / traditional communities benefit from conservation initiatives (e.g., be involved in management, tourism activities).

Economic valuation can establish the basis of any benefit sharing discussions. The CBD, to which Malaysia is a signatory, requires that the benefits arising from the commercial and other utilisation of genetic resources be shared in a fair and equitable way with the country providing such resources. An important aspect of this is ensuring that local communities who hold the knowledge on the use of forest products in KWR receive an adequate share of the benefits from any commercial development.

Economic valuation can activate appropriate conservation incentive measures and instruments (instruments and mechanisms required for capturing local and global values). Following the valuation exercise, appropriate mechanisms and incentives can be developed for capturing the Reserves many values.

Economic valuation of KWR could be include in the national accounting systems as an example of income derived from natural resource conservation.

4. Situation Arising

4.1 Conflicts.

This management plan is directed towards the conservation of biodiversity at the KWR. It has received information from three sources:

- 'old knowledge' of the reserve from earlier field studies and general information on the biodiversity of the Peninsula,
- 'new knowledge' of the reserve and surrounding areas from field work associated with this project, and
- information on the laws and policies governing the KWR, and its administration.

From old knowledge, the potential value of the KWR, and its importance as a centre for biodiversity is understood. Old knowledge also suggest that orang asli are a natural part of the forest, and that they are best left alone since their collection activity has very little impact on biological diversity of the reserve.

'New knowledge' updates information on biodiversity and provides a greater understanding of the effects humans are having on the reserve. At the landscape level, a rich diversity of vegetation ecotypes that have been created by topography and drainage can be seen, and have been left in their natural state. And for selected taxa among the larger of the higher plants, a high level of endemism is observed. Collecting of NTFPs is significant, and concentrated in areas within 4 km of settlements, and that present collection does not present a threat to plant survival. But there is a negative impact on large mammals.

There is little new knowledge on invertebrates, herpetofauna or birds. But for the larger mammals, a high value of biodiversity as expected for a protected area is seen. But there are problems with declining relative abundance of carnivores and some large herbivores. This can be linked to human disturbance.

Today, the gaur, tiger, clouded leopard, sambur and wild dog are still present but in such low numbers that they may not survive. Selective hunting over the last 30 years has probably contributed to the decline of these species and continuing human activity is preventing species recovery.

On top of this, there are now expectations from government and the private sector to develop in support of national policies and for potential commercial opportunities in surrounding the area. The forests and natural setting of the KWR could provide new opportunity for investment, employment as well as revenue generation for the state⁶².

⁶² In Section 19.38 of the 8th Malaysia plan it states "....Management plans will be formulated for all protected areas to ensure their integrity and to promote them as conservation ,research and eco-tourism areas.

The objectives for reserve are as follows:

Main Objectives.

- *To conserve the biodiversity of the Krau Wildlife Reserve in particular, and the state of Pahang and the Peninsula in general.*

Immediate objectives:

- *The conservation of biological integrity.*
- *To get local community involvement in the management of the Krau Wildlife Reserve,*
- *The establishment of the Krau Wildlife Reserve as a national and international research, and education facility,*

To meet these objectives, management faces four challenges:

- fulfil the original intention of the wildlife reserve, allowing for the natural restoration of low numbers of threatened wildlife species and thus meet the main and the first immediate objective⁶³,
- reach an understanding local communities to support conservation management to meet the second of the immediate objectives,
- meet the expectations of government for policy compliance and development of potential opportunities in the area to move towards meeting the third immediate objective, and
- overcome the capacity weakness for management at the reserve to undertake these tasks.

In this section, a review is made of the issues concerning biodiversity, people and management. It is necessary to identify the role of the KWR at the national and state levels and to understand how its management needs apply at the local level⁶⁴. One must begin by looking at the landscape context of the reserve, then move in to look at local biodiversity, people and management activities, ending with a review of the potential threats to the reserve and the constraints facing management.

⁶³ Part IV of the PWA does not define the functions of a wildlife reserve, but indicates it is for the protection of wild animals- mammals, and birds as well as protecting vegetation.

⁶⁴ Like a Local Agenda 21 approach, this would be a case of thinking nationally and acting locally.

4.2 At the landscape level.

4.2.1 Managing an isolated forest.

The forest around the reserve is now isolated, however, if managed as an isolated reserve, the value of biodiversity at the reserve will decline. It may be too expensive or too late for the state to take back land that has been alienated and restore a *physical* forest connection from the KWR to Taman Negara. However, it is still possible for management actions to be taken to slow the rate of species loss and the decline in biodiversity. To do this a '*functional* biological corridor' has to be maintained, allowing wildlife species and plants to migrate between 'islands' or along 'chains' of semi-natural vegetation between forests. It will take good inter-agency communication and a strong sense of working for a common purpose to maintain such a landscape function. However, for the more vulnerable species such as the large mammals whose populations are already low, the end result of isolation may be local extinctions unless wildlife species are managed on an individual basis⁶⁵. For large mammals although costly, this may be possible, but for the smaller species, of which there is very little knowledge, extinctions at the KWR will probably not be noticed until it is too late for management to respond.

Over a long time span, this decline is probably inevitable as the species diversity within the KWR settles to an equilibrium appropriate to its physical size. The lowest cost and most effective management option to reduce loss of biological diversity requires three actions:

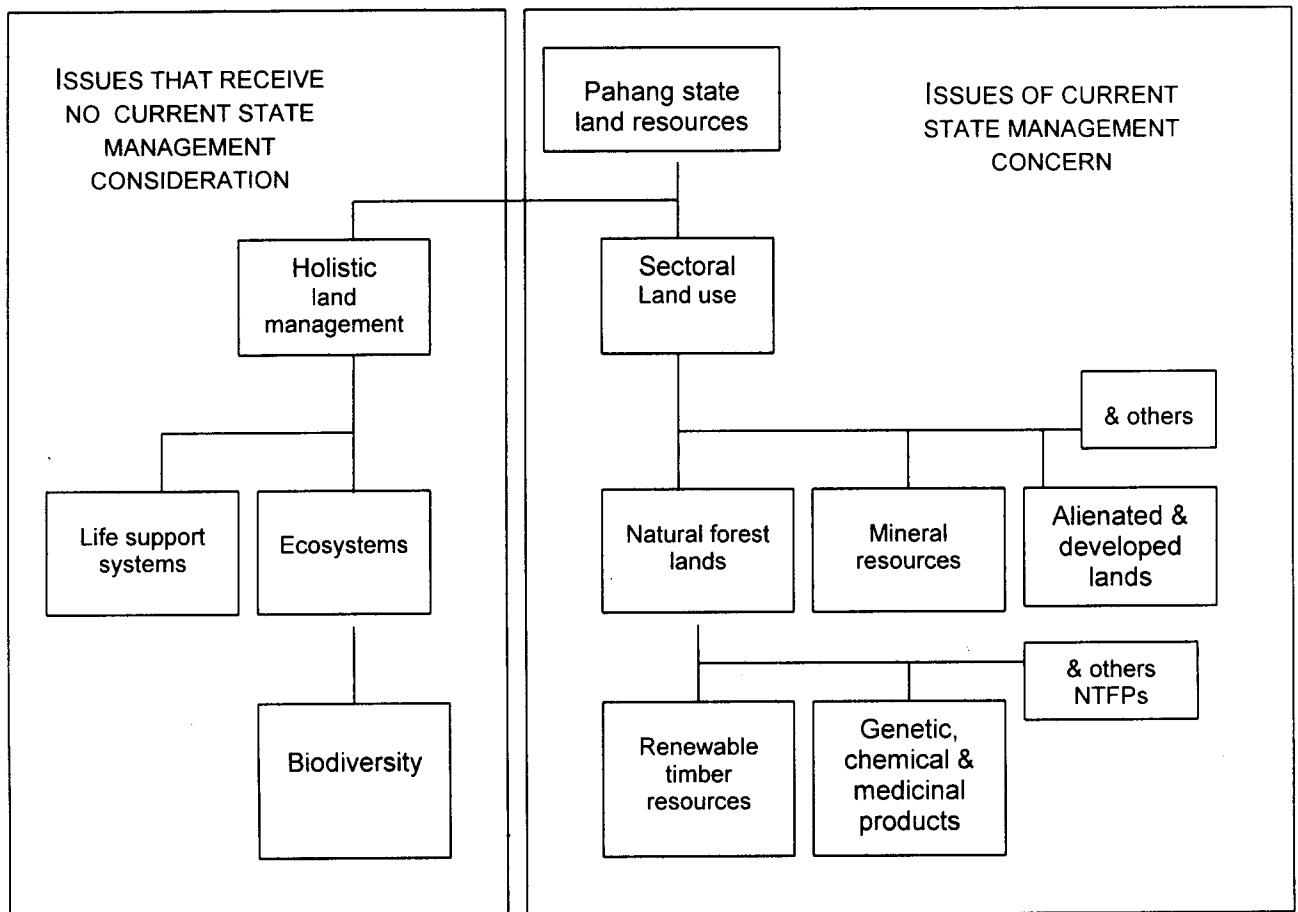
- stabilise local conditions by bringing human activities and disturbances to a minimum level;
- maintaining a *functional biological corridor* to the northeast between the KWR forest area and the Taman Negara and main contiguous forest in the Peninsula so that the chances of species migrating between forests remains good; and
- managing the *buffer areas* around the KWR reserve itself to ensure the remaining forest stays intact and there is no further loss in area.

The KWR staff have only limited power to control the first action, but the last two actions are outside the power of the DWNP and the field of responsibility of the KWR. They will need the support of and action by the state government and other agencies.

In FIG 4.1 below, an outline diagram is given to illustrate the relationship of biodiversity with the interests of the state.

⁶⁵ The DWNP is familiar with simulation programs such as VORTEX and can run scenario building simulations for local extinction. However, for the few large vertebrates whose populations can be monitored, the effect of biological corridors can be substituted by translocation – a technique that the DWNP has 25 years of experience. However, for other species about which there is little knowledge, it would be prudent to encourage natural migrations to continue.

FIG 4.1: A LANDSCAPE VIEW OF THE ROLE OF BIODIVERSITY IN PAHANG.



4.2.2 Management needs at the landscape level.

From the administrative position, this compartment approach to land management is convenient, but from the biological position it is far from ideal. Biodiversity and land are inseparable. To integrate the need for biodiversity management into other aspects of land management requires :

- 1) the state give recognition to the significance of its own landscape,
- 2) recognise that ecosystems are a component of the state landscape, and
- 3) that biodiversity is a part of the ecosystems of the state⁶⁶.

⁶⁶ Turning to section 19.38 Biodiversity in the 8th Malaysia Plan, it is noted "... the Government will implement the Biodiversity Action Plan in the various states. No details have yet been given on the actions or reference made to the guidelines for these actions and it is not known if the state of Pahang is to be included.

4.3 Forest

4.3.1 Biodiversity and Ecological models.

The forest forms the physical setting for the reserve. Unlike a national park where landscape and geomorphology are the essential features, in a wildlife reserve the item of prime concern is the range of fundamental niches⁶⁷ available for wildlife in the area. And for the KWR, these niches are all located within natural forest.

The most commonly used method to describe natural forests in Malaysia has been based on a Dipterocarp ecology model first developed by Symington, 1943⁶⁸. This model is based on elevation. Field surveys were undertaken and a list of plant names compiled for different elevation bands. During this project the forest has been described in a forest thematic map using crown characteristics from aerial photographs (see MAP A.08). It is understood the KWR has a remarkably high level of endemic plants, and that the collection of rattans and other NTFP support large sections of the local community. However there is still little information on:

- the relationship between the forest ecotypes described and biodiversity,
- the relationship between fundamental animal niches and forest thematic types, or
- the conservation management needs of the forest itself.

Inventory lists are under construction for tree species and selected vascular plants. And in time if research interest can be encouraged, a more full description could be made of the diversity of plant life. Lists have also been compiled on food plants and work done on feeding habits, especially for fruit-eating primates and birds, and food plants listed for large mammal herbivores. This is contributing to an ecological description of the reserve and a better understanding of biodiversity at the forest community level. However, they are far from complete.

It has been assumed that, because the forest has not been disturbed by modern logging activity, and because the physical structure of the forest has remained intact, it represents an area of high biodiversity. However, that biodiversity may be under threat. From an external perspective, the forest of the KWR is now only

⁶⁷ For the purposes of this management plan, a **fundamental niche** is used to describe the geophysical, forest type and general spatial conditions under which a species would live if there were no significant disturbance from human activity. Such a fundamental niche of an animal could be a subdivision of a larger forest type or habitat, or a grouping of many plant habitats or ecotypes. At present, human disturbance is limiting the distribution of some selected species forcing them into a much reduced range or **realised niche**. At an academic level, it may be more usual to look at a realised niche as being the product of multi-dimensional interaction with other species –competition, predation, etc. But for the purposes of the managing the reserve, the main concern is with interactions with that one dominant special of animal - humans. The term habitat is used as a description for a type of forest with an easily recognised character.

⁶⁸Published in 1943, Symington based his ecological model on J.Burt Davy's classification of tropical woody vegetation-types published in 1938. Note that Symington struggled to identify distinctive plant communities and main determining influence on distribution to be chance and opportunity. See Malayan Forest Records 16. Published by Univ. Mal. 1974.

a remnant of a much larger forest. G.Benom is an isolated mountain, so even though the lowland forest was part of a larger contiguous forest, the hill dipterocarp and forests above have always been isolated. As expected, some local plant endemism has been noted for G.Benom as well as a surprisingly high level of endemism in the wetter parts of the lowland forests. Now that the lowland forest surrounding the KWR are managed for productive forestry, it is reasoned that the KWR has become the local source for new seed and genetic material for commercial timber species⁶⁹. It was pointed out that if a biological corridor between the KWR and other forests ceases to function, animals will no longer be able to carry seeds and fungal spores between forests contributing to a potential loss of diversity within the whole forest block of the KWR and surrounding production forests. It is therefore in the best interest of Pahang to sustain a functional biological corridor between the KWR and other larger forests.

4.3.2 Forest Rehabilitation in the KWR.

Previously, there was no management practice being carried out in the KWR. As a result of several aerial surveys, the eastern border of the KWR and area around Kuala Gandah were severely disturbed⁷⁰. Abandoned clearings posed two scenarios. First, abandoned clearings are good for grazing species, if there is a continuous flow of forest succession. Second, abandoned clearings may create more noticeable forest gaps thus modify the dynamic movement of forest succession. This in turn disturbs the structure of the forest habitat.

Therefore, forest management practices cannot simply be excluded from wildlife management at the KWR.

Of the economic link between the forests and local communities, it appears that the present use of non-timber forest products (NTFP) is currently sustainable as far as rattan and fruits are concerned. Local community botanical knowledge was also recognised as being important, and it was recommended by the project consultants that the ethnobotanical collection areas be mapped and traditional knowledge on plants and plant use be recorded.

As to comply with international resolutions 'on local community' needs and obligations to national biodiversity policy, this plan will establish very important KWR-local community links. From the 6 workshop meetings, economic opportunities were raised several times.

4.3.3 Management needs for forestry.

Having understood the integrity of KWR biodiversity and its advantages to both KWR (fauna/flora), the linkages between the KWR and local communities have been identified the most important element as mutual benefit. Forest

⁶⁹ Generally it is assumed that there is a genetic flow from an area of high biological diversity to areas of lower biological diversity.

⁷⁰ The local communities that once settled in the reserve area have mostly settled outside so that old settlements are now reforested. The three Chewong and one Jah Hut settlement within, appear to be stationary maintaining some level of human activity around fallow and abandoned fields.

rehabilitation within the KWR boundary requires a cautious pattern at natural habitat. Improving, maintaining and monitoring of buffer zone activities must comply with strict rules and regulations. Activities, type of vegetation and development should be mutually benefit both parties (*i.e.*, the DWNP and local communities).

4.4 Animals in the KWR.

4.4.1 Incorporating new directions for management.

Wildlife management was always the traditional activity of the state game departments and the early federalised DWNP. For the last 25 years, the focus of the DWNP effort has been on those species mentioned in the schedules of the PWA, especially the large mammals. The main objective of this management plan reflects current policy of the MoSTE and DWNP which is *...to conserve the biodiversity of... the KWR.*

The studies undertaken at the KWR earlier and the recent studies connected with this project have focused mostly on mammals and birds. Most of the past research work undertaken at Kuala Lompat have examined arboreal species and small mammals while much of field effort associated with this project has looked at ground level mammals. Very little attention has been given to other vertebrates or invertebrates. If the reserve is to be managed for the conservation of biological diversity, two major issues will need to be addressed. These are:

- Developing baseline data on biological diversity from species to the landscape level, and
- Developing indicators to monitor for trends in biodiversity at all levels.

For purpose of managing a reserve, biodiversity is most usefully regarded as :

- a measure –*how much?*,
- which can be given both a spatial address – *where?*, and
- a date –*when?*

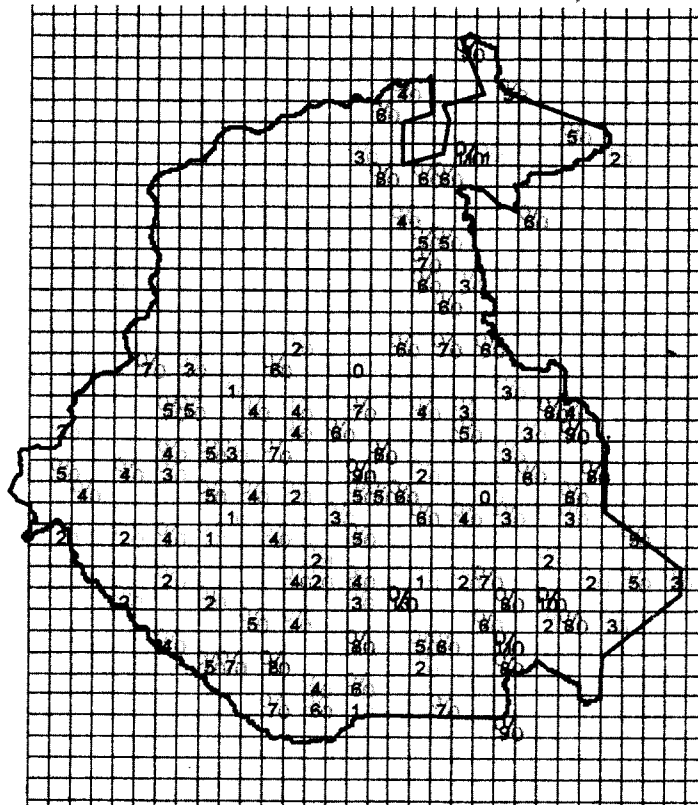
The management task is relatively simple to state:

- ensure measured values for biodiversity do not decline over time.

But as with almost all protected areas, the current information on biodiversity is incomplete. For the purposes of this plan, it is recommended that current data be used as the basis of an inductive approach to make a hypothetical model for the biodiversity of the KWR. And that this model be refined by deductive work based on monitoring results in the years to come.

Using the data available from the on-going DWNP/ WCS/ DANCED supported survey, the distribution of selected large mammal species has been plotted according to their presence in 1 km.sq. raster grid⁷¹.

MAP 4.1: RASTER MAP OF RELATIVE ABUNDANCE OF MAMMALS DETECTED BY CAMERA TRAPS⁷².



By August, 2001, 124 of a total of 603 raster cells of the reserve had been surveyed using 100m transects and the total number of selected mammal species present in each raster cell has been plotted in Map 4.1. The numbers given are unique records of the selected species in each cell, replicates species are not counted⁷³. This type of cell-based map uses data that can be collected relatively quickly and cheaply, to give an indication of changes in diversity for the species selected. It does not indicate absolute species diversity, but could be used monitor trends in response to management treatments.

⁷¹ This is the complete camera trapping database of mammals. Because of the current level of uncontrolled hunting in the KWR, the species are not named in this public document nor are their exact locations given. These details are held by the DWNP staff at the KWR.

⁷² The map dates from August 2001; the survey work is ongoing. The map will need to be redrawn for the action plan once the survey is complete.

⁷³ For more information on settlements see section 4.5 Local Communities.

The field surveys indicated that:

- non-targeted species, such as barking deer, are found throughout the reserve, but the numbers of targeted species such as sambur and gaur are low and their distribution localised. Wild pig numbers are also low, and
- tiger prefer higher elevations where disturbance by human activity is less; but have to move down to lower elevations to feed.

Human activity is having a negative impact on the diversity and distribution of selected large mammals. If the biodiversity large mammals is to be maintained or restored to levels expected of a protected area, the impacts of human activity has to be controlled.

4.4.2 Human effects on species richness

CHART 3.5 plotted the recent survey records of human activity shown as records normalised per 100 ha. block in bands at 1 km distance from the reserve boundary. This chart indicated that a greater part of human activity was localised around the boundary with a second peak in the 4 km band, and activity decreasing generally towards the centre. If human activity is the current cause of the reduced diversity of mammals, one would expect to see an inverse relationship with mammal species richness increasing towards the centre as human activity decreases.

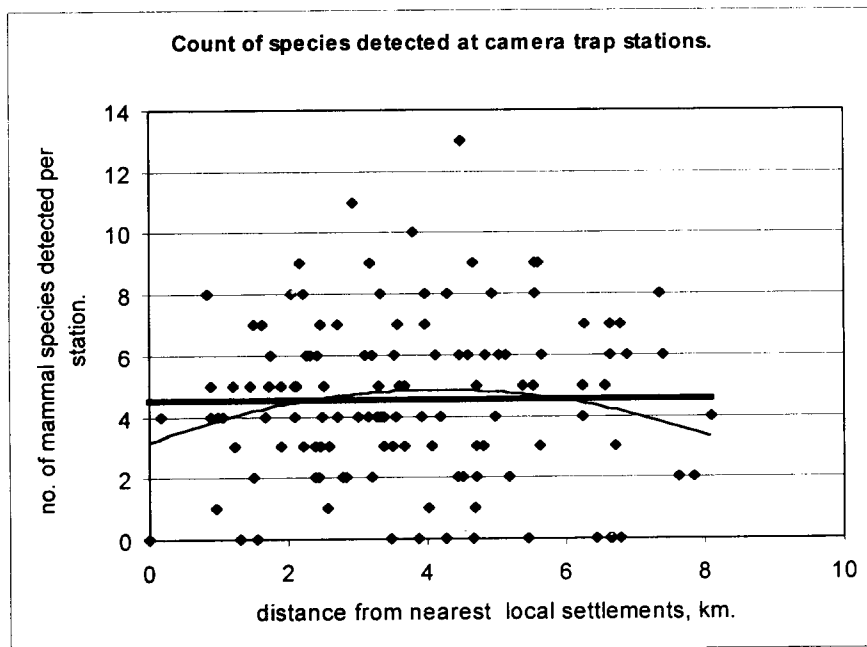


CHART 4.1. MAMMAL DETECTIONS FROM CAMERA TRAPS TO DISTANCE FROM NEAREST LOCAL COMMUNITY SETTLEMENT. (LINEAR TREND LINE BOLD, 2-POINT POLYNOMIAL FINE.)

Such an hypothesis is not supported by Chart 4.1. This plots the number of species detected by camera trap against the station distance to the nearest settlement. A linear trend line shows no change in mammal species detections

with distance from settlements. (However, a polynomial trend line suggests mammal detections come to a peak at about 3.5 km and then declines.) If human activity is having an effect on mammals, it appears to be effectively uniform across the reserve. The declining impact on rattan abundance by human collection from the boundary is thus not reflected in mammal species richness.

In CHART 4.2 below, the numbers of mammal species that were detected by camera trapping was plotted against distance from the forest edge. The linear trend line indicates a general decline in species detections from 5 per camera station at the boundary declining to 4 at 10 km from the forest edge. Fitting a 2-point polynomial trend line suggests a species detection decline from the forest edge to the 5.5 km point followed then by a small increase in species detected.

Local topography and the types of mammals detected may influence this result. Most of the mammal species detected are of continental asian origin, and it is expected that they would prefer forest edges. In addition the boundary area has the hill area at Bt. Tapah which serves as an effective refuge, and many of the saltlicks in the eastern part of the KWR that attract herbivores. Local conditions at the KWR has favoured conditions for mammals near the boundary. It appears that even if the centre were under less human pressure than the boundary areas, the reduced pressure is not significantly less as to make the centre more attractive to mammals than the boundary areas.

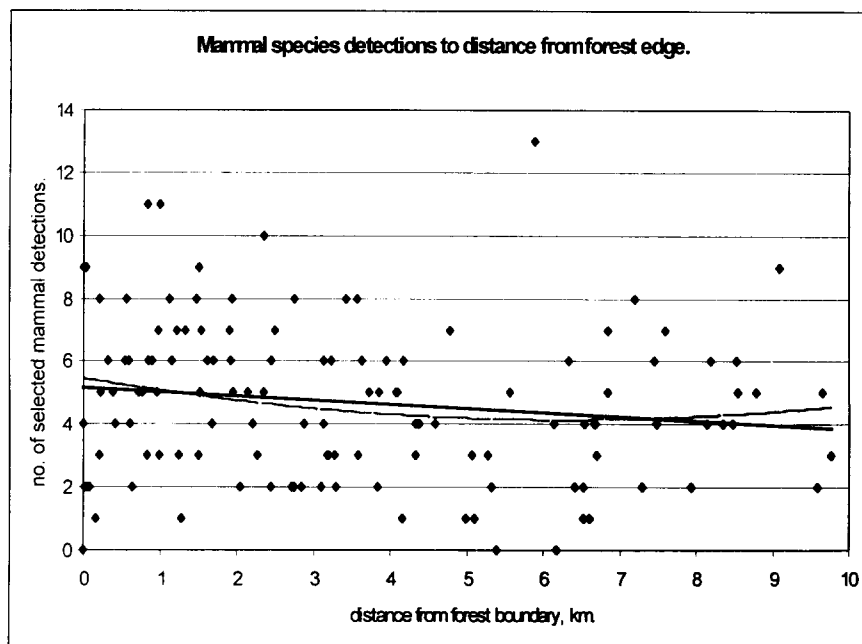


CHART 4.2: SPECIES NUMBERS TO DISTANCE FROM FOREST BOUNDARY. (STRAIGHT SOLID LINE IS THE LINEAR TREND LINE ; DASHED LINE IS THE 2-POINT POLYNOMIAL TREND LINE.)

We would suggest that even if human disturbance declines with distance away from the boundary, this change in disturbance has little immediate effect on mammal species detections. There are still sufficient benefits for mammals show preference to remain in the 4 km band in from the forest boundary.

CHART 4.3: AN HYPOTHETICAL MODEL SHOWING THE DECLINE HUMAN DISTURBANCE WITH DISTANCE FROM THE RESERVE BOUNDARY AND THE RECOVERY OF PLANTS – RATTAN AT AN EARLIER THRESHOLD LEVEL, AND A LATER RECOVERY OF MAMMALS.

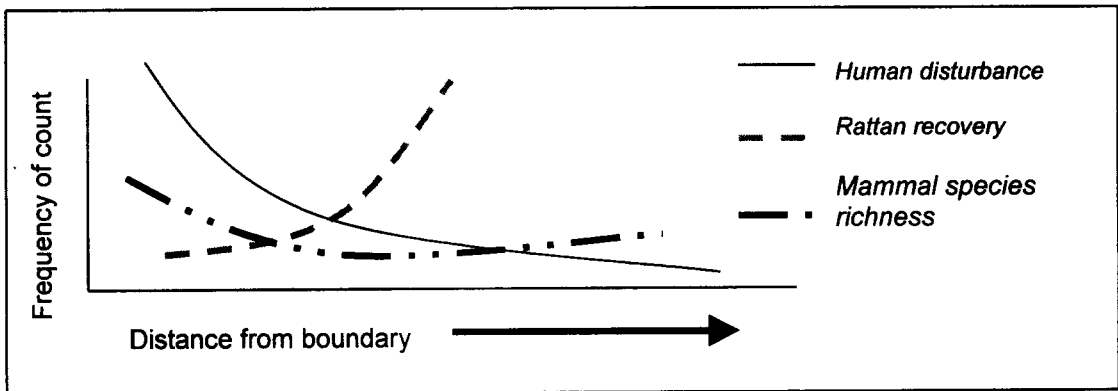
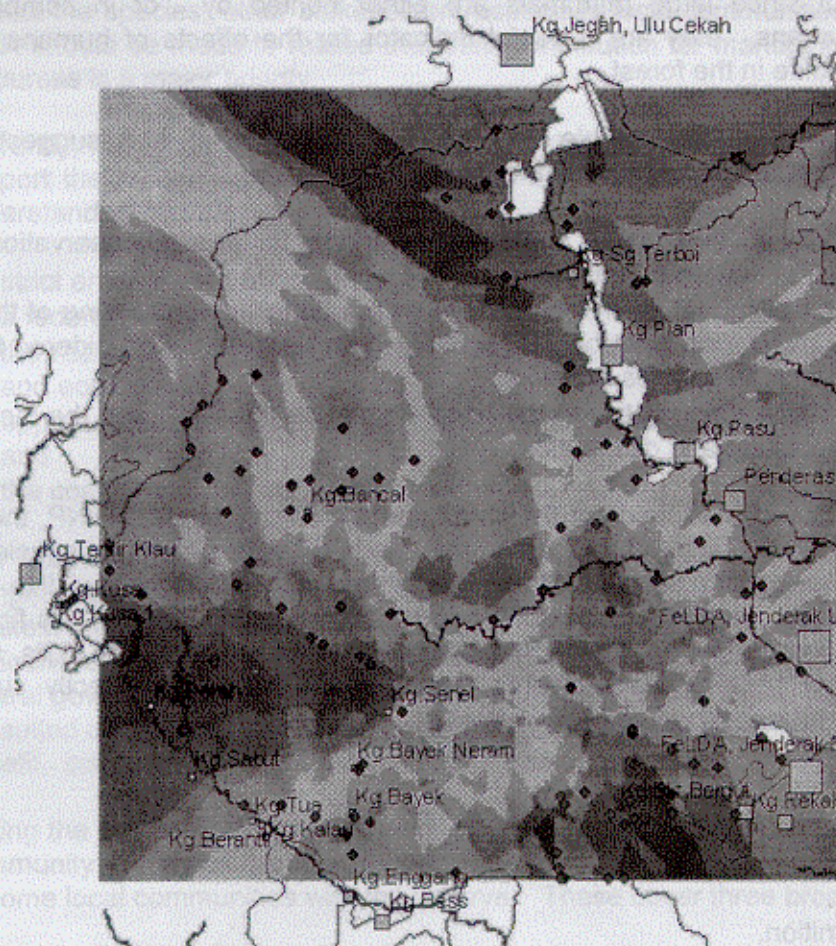


CHART 4.3 illustrates a hypothetical model of the possible relationship between humans activity in a reserve, rattan and mammal species. At the point where transport distance becomes a limiting factor for economic extraction of rattan, rattan detections increase suddenly, but mammals do not. Larger forest mammals may have both a greater economic limiting distance as well as a greater lag distance before recovery is detectable. This suggests that the KWR may not be large enough to support both the present level of human activity and function as a protected area for the species scheduled in the PWA.

4.4.3 Variable habitat quality.

The issues discussed above have assumed that the KWR would be a uniformly attractive habitat if not for human activity. This is not supported by Map 4.2 below. This shows a surface model of mammal species richness as detected by camera traps. (Green indicates areas of highest species richness and red areas of lowest species richness.) As expected, the lowlands show a generally higher mammal species richness than the mountain areas. However, the two areas of lowest richness are both in lowlands below 300m. The larger is in the west between Kg. Perah and Kg. Senel, with a smaller impoverished area on the Sg. Lompat. Both these areas are described in the Forest Thematic Map produced by FRIM as *Dissected, irregular canopy with emergents*, and are generally swampy. No suggestions have been offered for a cause, and the observation that this particular forest thematic type has poor mammal species richness –if real, would reduce models for habitat availability.

MAP 4.2: SURFACE MODEL FOR MAMMAL SPECIES RICHNESS BASED ON CAMERA TRAPPING RESULTS. (GREEN HIGHEST MAMMAL RICHNESS; RED LOWEST MAMMAL RICHNESS;)



4.4.4 In-situ animal management needs.

The various data sets presented in the Management Plan suggests that :

- from TABLES 3.8 and 3.9 that the relative abundance of the selected large mammal species are lower in the KWR than other protected areas, and also lower than some areas outside the PA's.
- there is a human presence throughout the surveyed area; it is assumed much of this activity comes from the local community settled both inside and outside the reserve, and though human activity declines after 4 km from the boundary, there is no significant increase in mammal species richness with distance from settlements.
- Mammals species detections increases towards the forest edge, probably due to better local opportunities – salticks, refuge on Bkt.Tapah and feeding opportunities at the forest edge. These benefits appear to outweigh any greater human disturbance the animals may meet nearer the forest edge.

- using mammals that can be detected by camera traps is not a perfect indicator for species richness or biodiversity for forest dependent animals. But since large mammals are either hunted by, or in competition with humans, they are a useful indicator for the effects of humans activity on wildlife in the forest.

Though the data available may not be conclusive, it does suggest that KWR management should investigate:

- which species are of management priority for *in-situ* conservation and their habitat management needs;
- the habitat values in the KWR to gain a better understanding of the potential for population and species recovery in areas currently considered to have low (mammal) species richness;
- the interaction between the people who use the KWR and the local mammal population and distribution.

Considering the origins of the KWR and the history of the DWNP, the strengths of the DWNP are with managing the needs of wildlife mammal species and less so in managing people. Managing the interaction between wildlife *in-situ* and people will be a practical priority for the annual action plans in this first five-year management period. This would build on existing management skills, and though capacity building lead towards management that more directly supports the policy for conservation of biodiversity.

4.5 Local community and Social issues.

4.5.1 Recognition.

For this first management plan period, management efforts would need to focus on controlling the causes of decline for biodiversity – people and their activity in the reserve. This statement will alarm and distress local communities dependent on the forest. They need the reserve for their immediate material needs. An unwritten assumption has been that if local people can be given time, they will become less dependent on collection from the forest, and develop other forms of support. Then the general belief is that nature will look after itself and biodiversity would be self-restoring if it is left to itself. But the KWR is :

- already an isolated forest into which wildlife cannot easily move and recolonise vacant habitat,
- possibly too small a forest block to support all its own residual wildlife diversity and population, and
- the reserve experiences continuous disturbance.

If the biodiversity of large mammals is to be conserved, it is possible that it may be too late to rely on management through benign neglect. Instead, active management based on scientific studies may be the only option; apart from accepting failure to meet management objectives.

Having recognised the existing issues on wildlife within KWR and the needs to protect the species, other stakeholders especially local communities around the KWR should be made to realise that their contribution for managing sustainable resources is a major priority.

Currently, the range of management tasks of the KWR include some that do not support the recognition above. The issues that need further strengthening and understanding include:

- strict enforcement of the PWA,
- a federal policy for biodiversity;
- the realisation of targets set at 8th Malaysia Plan for conservation research and eco-tourism;
- opportunity cost in support of managing biodiversity at the landscape level, and
- the cost for loss of resource use within the reserve.

The state has an obligation to conform with federal policies and does receive compensation in some form. But it may not be reasonable to expect some of the weakest members of society to bear a disproportionate cost for a national benefit – biodiversity. It must be accepted that the conservation of biodiversity is a federal government policy that the local communities never asked for, were never consulted on, do not really understand and from which they receive no immediate benefit, only costs through loss of income and opportunity.

During the course of the project, work has been undertaken on and with the local community which has brought out several issues which underline the dependency of some local communities with the reserve. These cover three broad areas:

- the lack of education and competitive skills which would facilitate income substitution;
- the lack of alternative economic opportunities; and
- the lack of awareness by stakeholders

The first two can to an extent be addressed by management from the KWR, but the third – land is quite difficult for the DWNP to deal with. However, land is a passionate issue and cannot be separated from any holistic approach to reserve management. The points continually raised by the local communities include:

- the local communities being bound to the area. The Che Wong and Jah Hut have nowhere else to go;
- the traditional range claimed by the Che Wong and Jah Hut have been restricted because land has been :
 - cleared for new settlers;
 - taken and cleared by expanding small holders;
 - reserved as forest reserves and logged; or
 - reserved as the Krau Wildlife Reserve where resource use is restricted.

Without some form of official response to land grievances, there is a risk that the KWR will be singled out by the local community as the easiest area where compensation can be unilaterally taken.

Another area where recognition is due has come not from the local communities themselves, but from the KWR as a result of employing project rangers from the local communities. Among their numbers are a pool of highly talented people with the knowledge, skills and ability to efficiently undertake supporting work for the project. The project and KWR has recognised the value of such local community rangers, and the contribution they can make to the management of the reserve. But there are difficulties in complying with government guidelines on pre-qualifications for regular employment at the KWR.

4.5.2 Rights.

Until recently, local communities were paid little consideration when management of protected areas was considered. Section 52 of the PWA, 1972, gave orang asli the right to hunt selected birds and mammals in the reserve...*for the purpose of providing food for himself and his family.*

The act is unclear in a few areas which include:

- whether Wild Pig are included since they are under schedule 2, but not mentioned in section 52, and
- is selling or exchanging an animal for the purpose of providing food within the meaning or spirit of the act⁷⁴?

In earlier sections, argument has been presented that human activities in the reserve have a negative effect on wildlife life species, and if species diversity is to recover, it will require human activity to be controlled. These activities include collecting rattans and other NTFPs. The PWA does not grant the orang asli the rights to collect and remove NTFP from the reserve (see PWA 48 (5) *No person shall disturb or cut or remove any timber or vegetation in a wildlife reserve*), and disturbance caused by extraction could be controlled by the DWNP should they wish to do so. However, reducing disturbance from hunting would require voluntary restraint by the orang asli and agreement not to pursue their rights to hunt. The local communities understand their rights to take, but they are generally silent on whether the DWNP should be pursuing their obligations to enforce the PWA when it affects their own interest.

4.5.3 Requirements.

Through the series of workshops held with the local communities, a general consensus was reached that any new management initiative for the KWR should also:

⁷⁴ From the time of the Wildlife Commission, commercial hunting has been viewed as an unacceptable activity.

- maximise economic benefits to the local communities,
- sustain the ecological integrity of the reserve,
- encourage a participation in the decision making process, and
- be based on a respect for human rights.

4.5.4 Beyond the local community.

The KWR was never intended as an exclusive reserve for local community benefit; there are other users or would-be users. These include the general public as individuals, institutions as well as investors who also have an interest in the reserve, and other government ministries and agencies⁷⁵. Now that the KWR has become more accessible, it is inevitable that people from outside the area will take a greater interest in the opportunities that the reserve presents. Two opportunities are included in the objectives: research and education, which are activities people come to the reserve to pursue. Added to this is the expectation of *ecotourism*, and opportunities for personal recreation, commercial nature and adventure tourism and the possibility of new private investment and jobs these industries could create.

However, the KWR is not a *national park* intended for the benefit of visitors. The KWR is a *wildlife reserve* intended to conserve wildlife and biodiversity. To displace the local communities from their activities within the reserve and replace them with tourists may not be a wise action, at least not in the immediate future.

From the perspective of a reserve manager, people and their activities are also a concern with the effects and impacts they have on biodiversity. This plan encourages the reserve managers not to take inflexible positions on the presence of people or functions occupying sites within the reserve, but rather consider the cost of managing their impacts on biodiversity, and the requirements for capacity building and public awareness that people management will require.

4.5.5 People-management to conserve biodiversity.

If the KWR is to support the conservation of biodiversity, it will need to reduce impacts from human activity as soon as possible. This will need to be done within the next few years, while animal communities still have the resilience for self-restoration. Enforcing exclusion on a hostile local community would be expensive and probably ineffective. Similarly being indifferent to other public interests and demands on the reserve may also damage credibility in management competence of the department.

⁷⁵ More often than not, government development initiatives originate from people as individuals in government, rather than a programmed response from government machinery. People who take development initiatives usually have some power.

Therefore, while remaining clear on responsibilities for the conservation of biodiversity, activities will have to :

- Include work with the support and mutual co-operation with the local communities,
- encourage interest in the reserve by other individuals and groups; and
- remain receptive to development initiatives from the private sector or other government while not compromising biodiversity.

The DWNP recognises that local communities need to:

- be recognised by the DWNP and in return give mutual recognition to the reserve and its purpose,
- have some security over their settlements and land – these are matters that can only be supported at state level,
- benefit from economic development so that dependence on resource extraction from the reserve is reduced, and
- be given an opportunity to develop a sense of ownership and stewardship over the reserve, so that each party can sustain and secure each other.

And for non- local community users, the reserve managers will need to learn how to:

- accommodate their legitimate needs while minimising their impacts on biodiversity.

Besides being authorised to enforce the PWA, 1982, there is a need for the DWNP staff in the KWR to be provided with a mandate to deal with local community issues. This will increase confidence in the local community in our effort to conserve biodiversity.

4.6 Enforcement.

Enforcement of the PWA will remain a major occupation of the DWNP over the plan period. However, to complement the adaptive management concept in KWR the law enforcement activities need to revise its vision and practices. With law enforcement it would also enable the reserve to reach its fullest capacity in conservation of biological diversity through the enforcement of the PWA, as well as promoting participatory community-based conservation concept in KWR. As a follow-up to the community-based conservation concept, a paradigm shift is needed in law enforcement in order to:

- ensure enforcement is carried out based on an updated KWR enforcement strategy and enforcement action plan;
- create alliances between DWNP and local stakeholders to control resource exploitation;
- promote effective sharing of management responsibilities among all the stakeholders involved;

- promote negotiation rather than aggression among all stakeholders involved;
- increase trust between DWNP and the local stakeholders;
- increase understanding and knowledge among all concerned of the views and positions of others that will lead to prevention of problems, disputes, and waste of resources;
- reduce enforcement expenditure through voluntary compliance;
- increase public awareness of conservation issues;
- increase sense of security and stability;

Therefore, the potential law enforcement varies from strict enforcement to outreach programs. Strict enforcement could be the enforcement of the PWA in the field together with an outreach program that could be programs conducted to create awareness as well as to provide information. Some of the potential activities could be:

- Zoning of enforcement areas namely Perlok, Kuala Lompat, Jenderak, Bukit Rengit, and Lembah Klau according to their respective radius to enable a more effective monitoring of the whole area.
- The enforcement section will consists of one G3 (Chief Enforcement Officer) based in Perlok to monitor the enforcement activities in the whole KWR and five G6 officers in each station that will report directly to the KWR Chief Enforcement Officer.
- Redefine their term of reference to create a more concerted management process for KWR. This could be done through identifying and clarifying the objectives of the enforcement unit. The conservative enforcement's "*Sasaran Kerja Tahunan (SKT)*" need to be changed and modified to complement the other functions in KWR management. The SKT based on the number of cases need to be revised. As a change, other SKT criteria could be developed for the enforcement purposes such as the number of dialogues or programs conducted with the local community, patrolling time conducted around the boundary, etc.
- Budgeting for the enforcement activities will need to support :
 - the salary and allowances for staff,
 - patrolling activities,
 - outreach programs such as dialogue, workshop, research, etc., and
 - other expenses related to keeping contacts with the local community.
- The need to coordinate session/meeting by the enforcement unit led by the Chief Enforcement Officer to coordinate the enforcement activities for KWR with the HQ and state DWNP law enforcement unit.
- Training needed for the staffs involved. Identifying courses relevant to the enforcement conducted by DWNP or other outside agencies (local and international) such as on negotiation, prosecution, field enforcement work, mediation, facilitation, other related courses.
- Conduct special programs, i.e.,
 - A workshop for hunters also could be conducted. Hunters must attend dialogue and workshop in order to get their hunting permits. After the workshop they will be issued a "card of attendance" and the permit. This could promote information sharing, understanding, and also be used as a mean to inform hunters of the determination of the DWNP to prevent

illegal hunting in the KWR as well as relaying information about the hunting regulations.

- Extension program:
 - Local Communities - e.g. Orang Asli Village, Malay Settlement and FeLDA scheme.
 - School children - extension program in schools around KWR
- Enforcement officers will also need to get involve in any local community programs to build trust and good relationship with the locals.
- Build and upgrade more ranger posts in critical areas such as Sg.Teris, Kg. Pasu, Kerdu and Jenderak Utara.
- Distribution of pamphlets to the villagers and through the local community around KWR e.g. balai raya, mosque, estate and government agency.
- Putting more signboard at all entry point e.g. Penderas, Pian, Perlok, Jentar Estate, Sg.Teris, Kg.Enggang, FeLDA Jenderak Utara/Selatan.
- Conduct more dialogue with the local community.
- Impose an entry permit system to facilitate monitoring.
- Hiring more Local Community youth as Rangers to act as bridges to the local community.

4.7 Supporting needs for management.

4.7.1 DWNP support for the KWR.

The manager at the KWR lack the necessary tools for management. Tools include staff, authority over budgets, field equipment, etc. as outlined below. This plan has outlined the need to restore species populations, and control human impact. These tasks may be beyond the current resources of the DWNP staff. The following issues may be considered to strengthen the KWR manager:

- Resources:
 - Adequate professional and uniformed staff to undertake management tasks;
 - Appropriate facilities and equipment to ensure work is done efficiently;
- Capacity building :
 - Retrievable data to initiate management for biodiversity;
 - The tools and systems for monitoring effects of management prescriptions;
 - Training in the application and use of these monitoring tools;
 - Training at work in the assessment of data to draw up management recommendations;
- Support to
 - Provide specialist skills from other DWNP divisions; and
 - Scientific institutions, especially within Malaysia.

Upgrading physical resources will present the least problems, building knowledge and human capacity the most. What has to be recognised is that there is no time to postpone current management needs while a new generation of managers

are trained overseas. Managers at the KWR need to be trained on-the-job. This will require an adaptive management approach. This is a cyclic approach to management that learns from success and failures, seeking to make continuous improvement. Starting from:

- whatever knowledge is available, management hypotheses are formulated,
- management treatments are drawn up,
- their effects monitored and assessed at the end of each management cycle, and
- management treatments modified as needed.

The management side is an art, but it is closely supported by science and research.

4.7.2 The KWR support for the DWNP.

The KWR presents opportunities for other DWNP sections as well as other government sectors. From the management perspective, research is either:

- a supporting activity commissioned for management support; or
- a users activity that exploits an opportunity at the KWR.

The former is of immediate concern to the KWR, the latter of greater relevance to the Research Division. As with education, tourism/recreation, training, research is a subject where the reserve provides a venue and the facilities for use. Though the use of the reserve would need to be controlled by rules and procedures, it may be best for the PA division not to develop a rigid provider-client relationship with the other DWNP sections. The reserve will always need a broad management approach. Using research as an example, the two divisions would have overlapping interests and responsibility depending on the out-come of the research. For example, the PA division would have greater interest in taking a lead in immediate research connected with local community collection in the reserve while the Research Division would be more concerned with investigation in forest or other biological productivity.

FIG. 4.1: EXAMPLES OF SPECTRUM FOR MUTUAL RESPONSIBILITY AND INTEREST

Research category	PA division	Research division
Fundamental		
Adaptive management		
Immediate management		

But sections of the DWNP also uses the KWR with little apparent benefit for the reserve. Examples include:

- the many buildings erected within the reserve. There are no documents available of impact studies undertaken prior to construction, nor any proposals or plans for the *environmental management* of the sites.
- DWNP activities within the reserve that make direct contribution to reserve management. These include the research facilities at Lompat, the gaur and sambur breeding centres at Jenderak, the training facilities at Lanchang and Bkt.Rengit, and the elephant unit at K.Gandah.

These are large investments which cannot be undone. But, if no environmental and ecological protocols are set or developed, it will be difficult to impose voluntary controls on potentially threatening activities in buffer zones.

4.8 Administration and Human Resources.

Points to raise include the need to :

- Bring KWR management into a single or at least united and cooperative body.
- Establish a collective management group for the KWR –the KWRMU or similar entity.
- Establish technical support from specialist divisions at DWNP HQ –the MPM.
- Provide unified KWR management with responsibility for the whole reserve including the facilities at DWNP developed areas.
- Empower KWR management to liaise with local communities and encourage the formation of a Local Community Management Group.
- Re-assign staff responsibilities according to current management needs and set TOR.
- Re-equip staff as needed to undertake roles efficiently and effectively.
- Undertake review of immediate management task and follow-up action plans selected according to priority from the management plan.
- Undertake gap analysis at the KWRMU and MPM to identify capacity building needs.
- Identify capacity building needs & training sources for professional and uniformed staff, as well as strategy to support on-going professional development.
- Undertake training, undertake performance evaluation and follow-up with improvements where needed.
- Address local community needs, and build links to support local community development for decreasing dependence on the material resources of the KWR.
- Establish structure for adaptive management :
 - Data base
 - Monitoring systems
 - Evaluation and assessment procedures
 - Data review

- Reports and
- Management improvements.
- Draw up Environmental Management Plans (EMP) for all DWNP facilities on PAs and implement⁷⁶.

4.9 Development of opportunities.

The purpose of the KWR has changed from a refuge for large mammals once hunted for sport, then broadened to a reserve for the protection of wildlife and now the scope has broadened still to managing an area for *conservation* of biodiversity. Ecological representative of the KWR has been identified to be one of the most suitable sites for managing an area for conservation of biodiversity. Examination of development of opportunities is included in this management plan as to check for any potential development activities should be allowed to be incorporated incrementally in manner as to reflect to all approved projects under the 8th Malaysia Plan.

4.9.1 Local communities.

At present, the use and dependence of the local communities have been identified as part of the *problems* of the KWR. Local communities include:

- the orang asli who have their rights for use of the reserve defined in the PWA;
- users who are legally or illegally present on the reserve, and
- others who do not enter the reserve, but are one of the 20,000 residents of the surrounding area.

Whether the reserve can adequately support a dependent orang asli community on a sustainable basis, has not been established⁷⁷. At present local communities exploit the reserve without regard to the long term sustainability of their actions. If this were to be self-managed as a sustainable activity, it will most likely require a reduced level of harvesting activity, it requires shifting of harvesting areas to outside the KWR. This is a big challenge and beyond the capacity of the DWNP or the KWR's staff alone. It needs active participation of all agencies at federal and state levels. Regional State planning and State Ecotourism Committee play a major role in facilitating the local community to take part in the development plan of the Pahang State. They would also coordinate between agencies including the DWNP. The existing committee will further enhance agreed resolutions on local community involvement in PA.

⁷⁶ The DWNP could adopt the SIRIM ISO 14000 family of standards as a guide for the EMPs. This would put the department in a good position to demand equal standards from any future resorts developed in the area, and the current Jab Perikanan project at Perlok.

⁷⁷ See section 3.3.9 People and reference to the recommendations for a minimum of 1 person per 10 sq km density dependant on neotropical forest for protein. At the KWR there is a 1 to 1 sq km ration of orang asli to lowland forest.

4.9.2 Research and monitoring.

The '*establishment of the Krau Wildlife Reserve as a national and international researchfacility*' has been identified as one of the immediate objectives for this plan. This is an ambitious target to meet. Though the KWR has the potential physical resource, and though the interest for research exists, the realisation of this objective will require a considerable commitment in human resource. Within the life of this plan the KWR should be able to:

- consolidate existing facilities already in place to accommodate research,
- begin to promote opportunities to a larger community research users, and
- establish the mechanism for identifying, commissioning and utilising research for its own adaptive management needs.

This could become a realistic foundation to move towards meeting the plan objective.

Considerations.

One of the most significant features of the KWR is that it has a virgin forest, and that this forest extends uninterrupted from alluvial lowland forest to montane forest. The area contains G.Benom, which has long been recognised as an important area for endemic plants, and lowland forest which recent botanical studies suggests may also have a large number of endemic species. Of the 0.875 million ha of original lowland forest to remain in the Peninsular by 1992, one of the largest contiguous blocks of 31,613 ha is at the KWR⁷⁸. And apart from the species restricted to particular edaphic forest or coastal regions, most forest species have been recorded at the KWR. However, there has been some level of human use at the KWR extending back before historical records. Local communities still depend on the KWR. And in addition, the KWR is now part of an isolated forest fragment, surrounded by a matrix of agricultural land, and expected to play its part in support of the development of the nation.

As far as resources for research are concerned, the KWR still has the research plots used by earlier research workers in a reasonably undisturbed state, and some access to the research results.⁷⁹ Access to sites in the reserve are better now than they were under security restrictions, and accommodation more refined.

The KWR provides research with an opportunity to study both the traditional biophysical aspects of the tropical forest that investigate biodiversity and support natural resource management, as well as social aspects such as forest-dependant communities, recreation, etc. Research at the KWR can help us, the nation as well as humanity in total, understand both our origins as well as future.

⁷⁸ See map 1.2 for details.

⁷⁹ Since research only goes back 40 years, it would be relatively easy to locate former sites if needed. Similarly, building a local data base of research findings or data should be possible.

Two other general considerations should also be considered. The first is that FRIM have been operating a successful forest research centre for many years at Pasoh to the south. The research work at Pasoh will in general compliment work at the Krau. However, research opportunities in the KWR even extends the scope of research on biodiversity at the different levels of: landscape, forest thematic unit community, and species level. As well as being a collection ground for work at the subcellular and genetic levels.

From the management perspective, research is either:

- a user activity for which the KWR provides the facilities and opportunities, and may learn something of management significance –*fundament research*; or
- a commission undertaken to provide the DWNP with information to assist management –*applied research*.

Fundamental Research

Responsibility for identifying and promoting opportunities at the KWR for fundamental research would need to be undertaken by the DWNP at a higher level than reserve management. The DWNP through the Research and Conservation Division should provide the opportunities to their staff and local and foreign universities to take part in this fundamental research. This will allow for a greater increase in the knowledge with the KWR; in other words “Centre of Excellence”. After decision on fundamental research has been made by the DWNP, the KWR manager would then:

- act as an immediate point of contact with the DWNP;
- maintain the facilities with reasonable access, safety and security;
- monitor research progress;
- liaise with local communities to provide field support where requested; and
- ensure researchers observe agreed obligations for sample collection, long-term marking, reports, data sharing and project closure.

The Research Division at the DWNP should alert the PA Division and the KWR on findings of management significance as they arise.

Fundamental researchers are one of the users of the KWR, and as with any user, the KWR management may not have enough resources or specialised knowledge to help certain researchers, instead they would need to hire local community assistance to help them out in their research work.

Applied research and monitoring.

The management plan recommends an adaptive approach to management.

Applied research and monitoring is useful for the DWNP because they :

- Do not have to wait until they are experts but begin management based on what they know;
- Continuously absorb and assess new data from monitoring; and
- Adapt their management based on findings from research.

For adaptive management, the PA Division and the KWR will need to identify their own research needs to support management actions for :

- Forest ecology;
- Diversity at the community level;
- Populations and distribution of threatened species;
- Sustainable harvesting by local communities;
- Development of local communities;
- Sustainable recreational use;
- Effectiveness of conservation education;
- Management and administration;
- Translocation and re-introduction;
- And others.

Meeting the objective.

Meeting the objective of research and monitoring has been suggested in the research guidelines. The guideline is an important tool for the researchers⁸⁰. The DWNP needs the confidence to identify their starting position and move on. Once that paradigm shift to conserve biodiversity is accepted, then research priorities would be identified, establish monitoring systems and assessment procedures, and then identify needs for management change and monitoring improvements.

As for fundamental research, meeting the objective should take no more than adopting an attitude of being a good service provider.

4.9.3 Education.

There is an opportunity to use the training and education facility to support the general needs of the DWNP. These are separate to the needs of the management needs KWR as a resource for biodiversity, but would assist meeting the third immediate objective for *..establishment of the Krau Wildlife Reserve as a national.....education facility.* The present facilities at the KWR could be developed for:

- providing uniformed staff with basic training;
- providing uniformed staff with supplementary training for :
 - enforcement and preparing evidence for prosecution;

⁸⁰ See the supporting document on research guidelines in the appendix.

- protected areas management;
- support for monitoring and data collection for research;
- support for education, nature interpretation and eco-tourism;
- animal husbandry, captive breeding and other specialist work;
- supporting courses for scientific basis for management of biodiversity for professional grades, etc.

The KWR is situated in the geographic centre of the Peninsular, and served by road and rail links.

In addition, the same facilities and the adjacent forest could also be utilised to support the training needs for other agencies at state and federal level that are responsible for forest or wildlife resources. And to develop further the initiative begun jointly with the Smithsonian, the KWR has the facilities to resume offering training at the regional level.

Aside from employment related work, there is an opportunity to use the KWR as a field station for universities, colleges and schools, as well as a facility to support non-curricular education such as 'nature camps'. There is an opportunity to establish a network of regional nature study centres around the peninsular to serve the needs of regional communities.

One important community to include is the local community that lives around the KWR. A special effort could be made to ensure that opportunity is given to the 20,000 adults and children in the local community to learn and be informed of the aims of protected areas and the KWR.

4.9.4 Tourism.

Tourism is an experience received by the customer, rather than a product limited to that offered by the provider. It is not just animals or trees that the visitors see, but also the truck that sends them, food they eat and the service they get from the 'rangers'. In order to provide a good tourism product, the DWNP will need considerable investment in capacity building. In the opinion of the project consultants, *'...if you cannot give a good product it is better to not even do it.'* It could also be added that for the DWNP to undertake tourism development at this point would divert management attention from the urgent enforcement and conservation management tasks that demand attention.

The activities suggested for tourism in section 3 take place on the boundary areas of the reserve along the Sg. Lompat and Sg. Teris and G.Benom. Any activity on the centre of the reserve will have two negative effects:

- contribute to further disturbance on the remaining large mammal population, and
- disturb the core area

Allocating areas for eco-tourism or other types of tourism around two proposed areas at Kuala Gandah and Jenderak may have an overall beneficial effect, by providing new opportunities for the local community away from the centre as well

as maintaining a relatively benign human presence on the borders that could compliment enforcement efforts.

If the number of visitors increases drastically wildlife reserves cannot just be left to take care of themselves anymore. Large groups of people need to be managed properly in order to avoid negative trends among sensitive animals and to fragile environments. The old proverb of "take nothing but pictures, leave nothing but footprints" is outdated and completely impractical. If there are enough foot prints they can result in significant damage to trails and vegetation and even lead to severe erosion problems and a reduced visitor satisfaction. From being wilderness areas where only very few people would venture into wildlife protected areas could become increasingly popular. The key issues in future protected areas conservation lies in proper management.

For the purpose of managing KWR, this plan proposed the KWR management unit uses biological carrying capacity strategy in their assessment procedure. Traditional methods of measuring the carrying capacity should be used as an additional tool if needed. Therefore, it is essential to understand that assessing *biological* carrying capacity should be done before undertaking a carrying capacity of *facilities* to support the needs of visitor⁸¹.

To avoid negative impacts on the local fauna in protected areas, management in many countries tries to control species decline by limiting visitor flow to a certain amount of people per day according to the respective area's biological carrying capacity⁸². However, the application of biological carrying capacity is by no means a simple task. In reality, limiting the number of visitors per unit time are often based on *ad hoc* figures collected and evaluated by the current park management.

In order to make biological carrying capacity applicable at all times it is necessary to measure the effect of human loading on fauna in a systematic manner. It is crucial that effects of visitors are continuously monitored by KWR staff and numbers regulated accordingly. The main problem and the big challenge is to develop a method that can be applied as a standard for measuring human impact irrespective of animal species, management and country. At present, there is little baseline data available and little understanding of the correlation wildlife status with human disturbance.

Interest in development of tourism potential can be expected to continue, the major issue for the KWR management is ensuring the *effects* of visitor use (and not the visitors themselves) do not cause negative impacts on their efforts to conserve biodiversity. Management would be supported by sets of documents. There is a need for:

- a set of self-regulating guidelines and codes-of-behaviour for visitors, tour guides and service providers, land users and developers. These would

⁸¹ KWR management will need to develop procedures for relating human impact with biological carrying capacity and how to translate this into a management tool.

⁸² Discussion on this topic can be found in *Ecological Stewardship* edited by N.C. Johnson and others, and published by Elsevier Science 1999.

apply to both the KWR ecotourism sites as well as the surrounding buffer areas. At a later date, when visitor numbers increase or demands from commercial service providers increase, these guidelines may need to be given legal standing as a common set of rules both in the DWNP managed protected area and as local Forest Rules in the adjoining PRF; and

- an Ecotourism Development Plan for the greater Krau area. This plan should be developed in conjunction with the Forest Dept., State Ecotourism Committee and other state agencies that control surrounding natural land and rivers, as well as local communities. The purpose of the plan would be to coordinate the equitable development by the public and private sector⁸³.

4.10 Policies and legal issues.

Malaysia became a signatory to the *Convention on Biological Diversity* (CBD)⁸⁴ in 1994. As a result, the government published the *National Biological Diversity Policy* (NBP) in 1998 through the MoSTE. This document outlined the areas of interest where the NBP could be applied and included a set of possible supporting actions. In conjunction with DANCED, the DWNP published the *Capacity Building & Strengthening of the Protected Areas System in Peninsular Malaysia – A Master Plan* in 1996. This documents explores ways for the DWNP and protected areas to contribute to the conservation of biodiversity. It is now understood that MoSTE expect the DWNP to become the leading agency for the application of this policy. There are two problems here :

- the DWNP only have management control over 0.8 million ha of the 13.1 million ha. of the Peninsula, and
- implementation of the NBP is not clear. As this plan identifies there are two factors involved: enforcement, and management work of the protected areas.

The NBP noted that the current protected areas are managed as self-contained units, for which there is limited information. It suggests more research is undertaken to address the latter, but makes no suggestions on how the management needs of a protected area can be integrated into an holistic management of the surrounding land.

Ideally, there should have been a set of inferior documents (see FIG 4.2 below) dependent on the NBP to give guidance on application in such fields as education, research, food security, agriculture and biosafety, as well as landscape management. That document on the application of the NBP in landscape management would have identified ecosystems management as an approach to provide guidance for planning, development and management of un-alienated state lands, reserves including the PRF, rivers, mining reserves, etc. as well as wildlife reserves and other protected areas.

⁸³ Lessons learnt from the Taman Negara experience should be incorporated.

⁸⁴ Section 1945 of the 8th Malaysia plan states '...Domestically, Malaysia will take steps to fulfil its Convention obligations and to ensure that its programs and projects are in line with its commitments.

FIG 4.2: A HYPOTHETICAL LINKAGE BETWEEN THE NBP AND THE MANAGEMENT OF PA'S.

The Convention on Biological Diversity (CBD)	Malaysia became a signatory to this international convention in 1994.
National Biological Diversity Policy (NBP)	In response to the CBD, The MoSTE published this document after a 2 year study.
Suggested Action Plans for: • <i>Education</i> • <i>Science and research</i> • <i>Food, agriculture and bio-safety</i> • <i>Development of biodiversity based industries, and</i> • Land and natural resource management	For application at Ministry level. Suggested Inferior documents that do <u>not</u> yet exist These action plans would allow biodiversity to be more broadly incorporated into sustainable development at the national level. It would identify to land managers the importance of their role in national development
Suggested Action Plan for land and natural resources • <i>Forest reserves</i> • <i>State forest and unalienated land</i> • <i>Mine reserves</i> • <i>Natural resources –water, minerals, plants & animals, etc. and</i> • Protected areas.	For holistic application at agency level. Suggested action plans which do <u>not</u> yet exist. An action plan for land management could support an holistic approach to environmental as well as biological resource management at the state level, through land use planning, and quality management standards.
Management plans for protected areas such as the KWR and the other 39 PA under management by the DWNP.	Without the two superiors action plans suggested above, there is no visible linkage between PA s , biodiversity and sustainable development.

This management plan has no information on whether a superior guidance document for protected areas will be available during the early part of this KWR management plan period to link PA management to biodiversity policy. But this plan anticipates that should such a superior plan be drafted, it would use an ecosystems management approach to unify sectoral land management by federal and state agencies in the Peninsula.

The DWNP was created from the Protection of Wildlife Act, 1972. This act makes no mention of biodiversity. And though, section 4.(4) gives power to the minister to...*give..directions of a general character..to be discharged by the Director General...or any other officer.*, these directions are supposed to be...*not inconsistent with the provisions of the Act.* Biodiversity has a much wider scope than the protection of wildlife. Whether it is or is not inconsistent with the act requires a legal interpretation. Thus the PWA, 1972 should amend this to accommodate biodiversity and biosafety accordingly.

There are other minor legal issues which could be attended to within the next 5 years such as deciding whether there is any further purpose for wildlife *reserves* in general, or whether any further notion should be abandoned that the KWR will ever be used for legitimate hunting in particular (section 48.(2)(a)). And ambiguities in section 52 concerning the rights of the orang asli should be clarified. These include a judgment on what constitutes ...*for the purpose of providing food...*

4.11 Threats and Constraints.

The direct threats from isolation and unsustainable use will significantly undermine the local value of biodiversity at the KWR. But more serious still to the survival of all protected areas are the indirect threats that come from beliefs and perceptions. Any doubts held by decision makers and the general public about whether conservation of biodiversity can be achieved, or is worth the cost and effort, represent a chronic threat to the survival of the KWR, other PA's as well as biodiversity in general.

Most of the constraints affecting the management of the KWR are resource based. Those that are not resource based include (but are not isolated to): Contemporary cultural norms concerned with responding to authority and power; There is a high degree of self-doubt over ability of the DWNP held by the department staff and; There is an alienated local community with interests in the KWR. The assumption held by this Management Plan that, if each constraint can be identified *and* overcome, management of the reserve would be able to perform more effectively, and with greater focus on the objectives of KWR and the primary task of conserving the biodiversity of the reserve.

4.11.01 Summary of threats.

The *threats* that face the KWR include:

- further short-term local extinctions of selected mammals (e.g. tiger and gaur) through uncontrolled activities, use by local communities as well as present management practices by the DWNP (rhino and elephant – already locally extinct, translocations);
- mid- to long-term decline in biodiversity through unsustainable use by local communities;
- further attenuation of in-migration of species and genetic material through isolation;
- further increase in out-migration of species and genetic material thus increasing isolation;
- further attenuation of migration imposed by public access roads through the reserve;
- difficulty to control contagious infection between wild and captive animals;
- further losses of surrounding forest land thus reducing effective habitat;
- *ad-hoc* building development imposed without consideration for site requirements and biodiversity;
- *ad-hoc* activities imposed without consideration of their impacts on biodiversity;
- invasion and dilution of local biodiversity from exotic species; and
- the discovery of minerals at concentrations to attract:
 - legal degazettement and conversion of forest to mining land;
 - illegal occupation and illegal mining; and/or
 - the effects of possible mining effluent along boundary streams.

The *implications* from these threats are:

- The DWNP, is seen publicly to have failed in their primary responsibility of enforcing the PWA and protecting the KWR;
- The loss of biodiversity, an asset of the whole nation, through uncontrollable and unsustainable use by local communities and local authorities (roads and dams);
- The perpetuation of the belief that people will remain ignorant and always be a threat to public lands, and
- The loss of confidence and interest by the government and people that conservation of biodiversity is a worthwhile enterprise.

These threats that face the KWR are not localised. The implications of failure are:

- that government cannot perform as an effective vehicle for conservation management, or worse,
- that conservation management is not achievable.

Before management can counter these threats, management *constraints* have to be addressed.

4.11.02 Resource constraints.

Looking first at the resource constraints that have been identified to date, they include:

	Item	Constraints
1	Legal	The PWA makes no mention of biodiversity, only enforcement of the PWA. This relegates biodiversity to subsidiary activity of the DWNP in both the eyes of the state as well as the DWNP staff. A clear legal mandate and similar amendments are needed.
2	Policy	The MoSTE has adopted a <i>National Policy on Biological Diversity</i> (NPB). Currently it remains an issue unto itself alone. Beyond adopting the word <i>biodiversity</i>. It does <u>not</u> appear to have provided any direct assistance to integrate biodiversity into the existing DWNP management structure, nor have it indicated how biodiversity should be managed at state level or within protected areas. Linkages are needed from policy to implement biodiversity management on the ground.
3	Manpower	The KWR is regarded by some of the local and neighbouring community as a public good for direct consumption. At present for the DWNP to fully manage with the present uniformed staff levels may not be realistic. Additional supporting manpower at sub-professional grades is needed for enforcement and monitoring,
4		At the professional level, a large investment in self-training and motivation will be needed. Security of tenure is needed to implement capacity building & provide confidence that self-investment is worthwhile.
5	Support within DWNP	Reserve managers provide general reserve management. They need the support of wildlife specialist service providers. The DWNP has these service divisions in name. Administrative Division will need to undertake its own gap assessment to identify and implement their own capacity building needs to support PA management in general and the KWR in particular.

6	Support from the scientific community & institutions	Wildlife management applies scientific findings. The body of scientific knowledge of tropical forests is continually growing. At present the local science appears to be self-consuming and is providing little new understanding of the forest for management application. The DWNP has to stimulate new science and provide support to expand the number and skills of local field biologists or professionals. By expanding KWR into several centres of wildlife research, either national or international, the DWNP will benefit through mutual relationships.
7	Training	If new management systems are to be put in place, changes will have to be informed and accepted by staff at the KWR and the PA Division. The DWNP will need to accept that continuous training (including high-level training) is needed in fundamental ecology, and applied subjects in order to support improvement through cycles of adaptive management.
8	Facilities.	Management can still function even if it is starved of tools, but this is wasteful of human potential, and the inefficiency will squander what time the KWR has before local wildlife population declines lead to unsustainable populations and irreversible genetic diversity loss. The KWR must be equipped to perform efficiently.

4.11.03 Institutional constraints.

The KWR does not exist in isolation but is a part of the Pahang landscape. To effectively manage the biodiversity of the reserve, the surrounding ecosystem has to be considered. Now at the state level the conservation of biodiversity and the management of ecosystems become an issue.

9	Ownership of issues.	Biodiversity is a federal issue <i>and</i> state issue. If the KWR is to avoid becoming an isolated forest fragment, losing its biological diversity through attenuated in-migration, it will need state and federal supported management in the buffer areas and along corridors. State needs to support <i>ad-hoc</i> buffer and biological corridors requirements for the KWR, or adopt an ecosystems approach to land management at state level.
10		DWNP will need to promote its efforts to sustain and manage biodiversity as having a national purpose, and that the resulting conservation of attractive landscape features can only be used if use does not conflict with conservation.
11	Identifying with a common purpose	The KWR is a 60,000 ha part of a larger 150,000 ha. forest fragment. Most of the forest is managed by the State Forest Dept. Though conservation management is an issue for timber certification, it is in practice dismissed by the Forest Dept as an issue for benign neglect.. Much of the surrounding forest is degraded and in need of rehabilitation if it is to remain 'forest land'. DWNP will need to build/trengthen institutional links between agencies to effectively manage biological exchange through buffer areas.
12		Within the DWNP, there is a need to further co-operation which will keep all policies, actions and activities transparent and coordinated. The PA division cannot perform in isolation; it needs on-going input from all the DWNP.

4.11.04 Constraints in perception.

13	Exile	Working at the KWR needs good lines of communication with either the state or the federal DWNP offices The DWNP needs to nurture remote staff and take care of their welfare (through visits, improved communication and equipment).
14	Inertia	Wildlife conservation is already an enormously difficult and complex task. Expanding this role to conserve biodiversity pushes the task beyond the realistic capability of the DWNP staff. Because the task is not easy, and does not have established prescriptions to follow, some may doubt it can be done or is worth doing. In addition, it is of some concern that conservation management for biodiversity has never been done before in the Peninsula. DWNP will be a pioneer. Building a culture of continuous self-improvement for adaptive management is the largest constraint facing the DWNP. The department at all levels needs to build the self-confidence to improve itself.

4.11.05 Significance.

Not all these constraints have an immediate significance for the manager at the KWR. Some of the higher level constraints concerning policy, the law and management of biodiversity at the ecosystem level are matters for the DWNP and the MoSTE to address in support of the KWR. The most significant constraints concern :

- 1) Local communities where the KWR staff face a huge task - of gaining first respect and then later, support for the conservation of biodiversity at the KWR;
- 2) The DWNP itself where shortage of management protocols and skills and a history of limited cross-division support may restrict the KWR of the management resources it requires; and lastly,
- 3) Decision makers at the state and federal government who may be more concerned with opportunities for secondary development, such as prioritizing tourism, rather than be willing to make effort to understand the values of conservation and research of nature at the KWR.

Preparing to face these constraints will need to be accepted as items for management action.

5. Assessment Statement.

5.1 Background considerations.

This Management Plan understands and is sensitive to :

- 1) the policies of the federal government concerning biological diversity and bio-safety;
- 2) the wishes of Pahang state to create income-generating opportunities in the vicinity of the Krau;
- 3) the needs of the local communities to find in the forests of the KWR area the resources to support their material and social requirements;
- 4) the desire of the DWNP to develop research opportunities, high quality training facilities and ecotourism opportunities at the KWR; and
- 5) manage the KWR avoiding the management weaknesses of Taman Negara.

But the reserve also has its own needs to be fulfilled; it was originally intended to be a reserve for *game* species, now identified more broadly for the support of biodiversity. And at present biodiversity is under threat.

5.2 Current state.

The Krau Wildlife Reserve is failing to meet its original objective as a reserve for wildlife. For security reasons, the DWNP did not have access to fully manage the reserve between 1960 and 1989. This forced a practice of management through benign neglect. In the 30 years since the Stevens report was published in 1972, *at least 2* large mammal species with commercial value have become locally extinct at the KWR. The numbers of large mammal species still present have fallen below the numbers expected of a protected area. If the wildlife population falls further, species such as the gaur, sambur, tiger and clouded leopard will become locally extinct. Then there would be less justification for continuing to maintain Krau as a *Wildlife Reserve* in its traditional sense.

A recent mandate adopted by the DWNP and its parent ministry the Ministry of Science, Technology and Environment (MoSTE) is to support biological diversity. It had been assumed that since the greater part of the KWR has not been logged, it should be in a natural state and thus have a high measure of biological diversity. Large mammal diversity has been surveyed as a part of this project, and the findings suggest biodiversity is still good but threatened. Because of insufficient information, the state of biodiversity of other vertebrates, invertebrates, non-woody or non-flowering plants remains unknown.

The threats to mammal biodiversity could be reversed through management action. But the DWNP – as the sole agency with responsibility may not have the capacity at present to undertake the task. The DWNP needs support at federal and state levels, and they need capacity building at the KWR and supporting sections within the department. But even then, new investment in

equipment, facilities and additional staff and training may not have any lasting effect if the causes for the decline in biodiversity cannot be halted and reversed. The causes are people and their activities.

The two major causes for the decline in species abundance of large mammals have now ended. These were: land development which reduced the size of the local ecosystem and isolated the greater Krau forest area. But species abundance has not recovered because it faces continuous disturbance from local communities and outside hunters. The possible scenario is that, one set of people caused the decline in large mammal abundance (during the communist insurgency), and another set of people maintain large mammal populations at low levels of abundance (activities since then). Management must now be directed towards this second group of people.

The DWNP will never have sufficient resources to defend the reserve from a hostile local community. To reverse the declining trend in biodiversity, it is necessary to develop support from the local communities who currently use the reserve. Unfortunately, it is unusual anywhere to expect any voluntary restraint on the part of the local communities. From discussion with local communities conducted as part of studies for this project, it appears that local communities are confident that the DWNP can provide opportunities for them in the management of the KWR. If the DWNP can gain the confidence and respect of the communities which have an interest in Krau, it will have a good chance in developing cooperative support from the people who are currently exerting excessive pressure on the reserve.

To summarise the current state:

- neighbouring land with the best soils has already been converted to agriculture, so that remaining buffer forests may be secure, apart from the blocks of forest on state land in the south between Gandah and Berdut.
- knowledge of biodiversity is growing, but still limited;
- diversity of large mammals is under threat;
- species abundance of large mammals is lower than expected for a protected area;
- the reserve is expected to provide an economic opportunity for local communities;
- human disturbance in the lowlands and in sensitive areas such as salt licks is high;
- illegal hunting of selected species threatens their survival;
- the effectiveness of present levels and methods for enforcement is inefficient;
- there is no effective coordination between the individual DWNP divisions and activities at the reserve;
- DWNP human resources are not numerically sufficient, lack training and skills development to raise management activities above current levels.;
- lack of awareness in terms of capability and integrity of the DWNP; and,
- expectations from the state and federal government to support policies for biodiversity for which there are no guidelines – i.e. for research, education and tourism.

5.3 Future action.

To safeguard the tenure of the KWR, and ensure its continued biological integrity, It is necessary to address the following actions outlined below :

- 1) DWNP to fully manage the reserve;
- 2) engage the support and good will of the local community to ensure the KWR is perpetuated as a natural reserve;
- 3) support the need for rural development of the state;
- 4) address the cause of decline in species abundance;
- 5) promote an ecosystems approach to the conservation of biodiversity at state level;
- 6) control the impacts from human activities in the reserve that are partly contributing to the decline in the numbers of large mammals and habitat;
- 7) suggest a stewardship role to the local community for the sake of managing bio-diversity;
- 8) allow for the natural restoration on species abundance and monitor for this trend;
- 9) accept management capability needs to be re-organised to support obligations for the conservation of biological diversity;
- 10) develop the capacity of the KWR staff to undertake monitoring and adaptive management for the reserve; and lastly
- 11) investigate the potential to further develop user opportunities at the reserve.

5.4 The recovery process.

5.4.1 Identifying priorities

The two species that are thought to have become extinct in the KWR over the last 40 years are: the sumatran rhinoceros and the elephant. There has been only a single recording of the clouded leopard and serow, from over 3,000 days of camera trapping, suggesting that that species may be under serious threat. Other mammal species whose numbers are approaching or may have dropped

below their *minimal viable populations* include the gaur and sambur deer, and the remaining large predators - tiger and wild dog.

This management plan accepts that a focus on the conservation of large mammal species may not address the current national or DWNP policy for management for biological diversity. However, the issues presented in section 4 -*Issues Arising*, indicate that especially KWR staff are beginning to learn how to manage a protected area for biological diversity. Before any further expansion in their role can be undertaken, the KWR staff and headquarters, will need the time to regain the ability to undertake their traditional core activity of managing wildlife, especially large mammals, and maintaining the integrity of the reserve. Then, from a position of strength, the KWR staff could acquire the necessary new skills to contribute to the conservation of biodiversity and support higher-level development plans of the department, the state and federal government.

5.4.2 Identifying needs for action.

As a result of the scoping exercise undertaken with the KWR staff, the PA Division, inputs from the DWNP/DANCED project consultants and reviews of major proceedings and the workshops with local communities and stake holders, this management plan recommends that:

- All levels of KWR staff needs to first re-build competence in their 'traditional' skills for large mammal or protected species management and the effective protection of wildlife reserves, and then undertake an expanded role of management for biological diversity.
- Effective DWNP management for biological diversity will require a gap analysis to identify gaps in capability and acquisition needs for new management skills⁸⁵.
- Decision makers must recognise that the KWR does not stand alone or only has relevance as a unit of a federal protected areas *system* run by the department, but rather the KWR is an integral part of a greater ecosystem of the state and Peninsula,
- Decision makers (at both state and federal levels) must recognise that KWR is more than an area for conservation of nature, it is also a centre of belonging and identity for local community groups.
- Decision makers accept that enforcement of the KWR through the PWA alone and defending reserve boundaries could never be the most effective method of protection; the integrity of the reserve can only be protected in partnership with a supportive local community.

⁸⁵ This has been somewhat covered by the present as well as previous DWNP/DANCED projects under TNA and consultant reports.

Management Plan for the Krau Wildlife Reserve.

- Only when the reserve has attend to its own needs and functions and has begun to perform as intended can it divert attention to develop opportunities to support external requirements for: biodiversity, ecotourism, research, training, community development, according to the roles of the DWNP, the state, the MoSTE and federal government.

6. Management Strategy.

6.1 Formulating the strategy.

The management plan objectives were listed in section 2.4 as:

Main Objectives.

- *To conserve the biodiversity of the Krau Wildlife Reserve in particular, and the state of Pahang and the Peninsula in general.*

Immediate objectives:

- *The conservation of biological integrity,*
- *To get local community involvement in the management of the Krau Wildlife Reserve,*
- *The establishment of the Krau Wildlife Reserve as a national and international research, and education facility,.*

These objectives were formulated as a result of a scoping exercise with the KWR management staff and were considered to be in support of the policies of :

- the DWNP;
- its parent ministry – the Ministry of Science, Technology and the Environment (MoSTE),
- as well as the international obligations of the Malaysian Federal Government for the conservation of biological diversity.

The second of the immediate objectives - community involvement, though treated as an objective in itself, can also be seen as one of the strategies that could be used to reach the first of the immediate objective for conservation of biological integrity. The third of the immediate objectives concerns functions and development opportunities at the KWR. This plan recognises the limited capacity of the DWNP and recommends to limit the involvement of the KWR to providing and promoting opportunities for other parties to undertake during the plan period. Development of opportunities could come later.

The strategy needs to take into consideration two major areas of people management by recognising :

- the need for the KWR staff to fully manage the reserve, and to be seen as an *authority* to be recognised, and
- creating a culture of continuous improvement in the KWR staff so that *capacity building* becomes a *personal* responsibility, which will require that the staff are not prematurely transferred out from KWR.

And in the local community, by addressing the need to :

- minimise the negative impact on wildlife, and
- increasingly involve and empower the local community in the responsibilities and management tasks of the reserve.

Once these issue have begun to be tackled, the KWR would be in a position to identify :

- user opportunities and initiate development of opportunities for research and education within the KWR, and ecotourism in the surrounding buffer areas.

6.2 The strategy.

For the objectives above to be met, this plan suggest a three-point strategy be adopted. These are:

- 1) The adoption of an *ecosystem approach* to reserve management.
- 2) The adoption of *stewardship* as the principle for reserve management, and
- 3) Re-organisation of administration into collective peer groups for *collaborative management*.

6.2.1 Strategy 1: The adoption of an ecosystem approach to reserve management.

The KWR is now a part of an isolated remnant of forest, surrounded by land developed for agriculture. But that does not mean the KWR has to be managed in isolation of these surroundings. There are nearby isolated forest patches which form a series of 'natural forest islands' to the largest forest block in the Peninsula around Taman Negara. In an ecosystem approach to management, the reserve with its surrounding *buffer* of forest on state land and in the PFE and the *biological corridor* through nearby forest 'islands' and semi-natural areas such as river reserves and agricultural land, would be managed in relation to each other. Adopting an ecosystem approach allows the reserve to linked to other ecosystems and habitats, and to be managed as a *component* in the ecosystems management of the state and the Peninsula.

6.2.2 Strategy 2: The adoption of stewardship as one of the principles for management.

The reserve is more than a land asset to support the agenda of the DWNP; it is both an area of biological interest over which the DWNP has management responsibility as well as being the home area of local communities. In crude terms these two parties – the DWNP and local communities, could represent incompatible and hostile interests with an overlying interest in the Krau forest. At present cooperative management would be not easy since the two parties have few issues in common. This could be resolved if both parties were to adopt a stewardship approach to the reserve. Each party could then seek and serve

mutually compatible responsibilities in support of the forest rather than demanding to execute what they regard as their individual rights over the reserve. This is a question moving from exercising *rights of dominion* over a resource to accepting *responsibilities of service* for a resource.

6.2.3 Strategy 3: Re-organisation of administration into collective peer groups.

There are five natural groupings of parties with interests in the KWR, with each proposed group representing interests at a particular level or scale (see fig 6.1 below). These are identified as :

A. A proposed successor to the current Project Technical Committee, (sPTC).

This grouping could in future allow the KWR and other government agencies at the district and state levels to better plan sectoral actions for holistic management. It would comprise of the state EPU and government agencies responsible for land, planning, the management of reserves, resources, etc. The project has identified the importance of *buffer areas* and *biological corridors* and the management plan has advocated these issues be approached as part of ecosystems management of the state landscape. These issues would be most productively discussed at the state level as part of land management and land use planning of the state⁸⁶.

B. District Development Committee (DDC).

Currently the three districts around the KWR, Jerantut, Raub and Temerloh, each has a district level development committee with an interest in land matters and implementing development proposals at the district level. It is understood that the state DWNP sit in these district committees. If the KWR were to attend these meetings, it would assist with coordination of buffer areas development, and oversee the implementation of planning initiatives set by the committee in para A above.

C. Monthly Productivity Meeting (MPM).

The KWR would report to the Protected Areas (PA) Division at the DWNP HQ in Kuala Lumpur. Though that division would be responsible for the quality of performance at the KWR, they could not by themselves provide all the technical input required to support a protected area. They would need to depend on sectional expertise either from other DWNP divisions or brought in

⁸⁶ See section 19.34 *Land Resources* 8th Malaysia Plan which states '...This will include the identification of integrated planning for environmentally sensitive areas or Kawasan Sensitif Alam Sekitar (KSAS). All states will be encouraged to identify, map and gazette environmentally sensitive areas as State KSAS, to prevent inappropriate development from encroaching into these areas. In addition, new physical planning guidelines will be developed to improve environmental quality and conserve natural resources. And section 19.39 which states '... the Government will implement the Biodiversity Action Plan in the various states. Theses suggest that there should be some state level support for integrating the functions of the reserve with its surrounding environment.

from outside. Similarly, the other DWNP divisions may have functions at the KWR such as training, recreation, public relations, enforcement and research. This grouping would oversee the quality of management, assist with adaptive management, as well as undertake their own projects and services at the KWR. It is recommended that this group publish a regular bulletin to keep its members and dependant community informed of DWNP activities and current directions in the field of conservation management.

The MPM would also assist identifying opportunities to reach the third immediate objective for developing the KWR as a centre for research and education, and assist with the regulation and administration of research and education.

D. The proposed Local Community Management Groups (LCMG).

The KWR is not an isolated location, free from human influence. Surrounding the reserve and living within its borders are local communities that have an immediate interest in the state of the reserve. The most closely associated with the KWR are the Che Wong community, some of whom still live within the reserve and the Jah Hut who are settled in an area recently excised from the reserve. In addition there are other communities in surrounding kampungs, on FELDA estates, in non-organised village settlements. It is in the interest of the KWR that this community be recognised so that a mutually supporting role can be developed for each other. The LCMG would be formed to represent the views of all parties with interests in the KWR. This management plan has proposed the group becomes more closely involved with the management of the reserve, gradually moving from a position of *reserve user* to *reserve guardian* and in the process adopting a stewardship role for the reserve.

E. And lastly the reserve management community itself, the proposed Krau Wildlife Reserve Management Meeting (KWRMU)

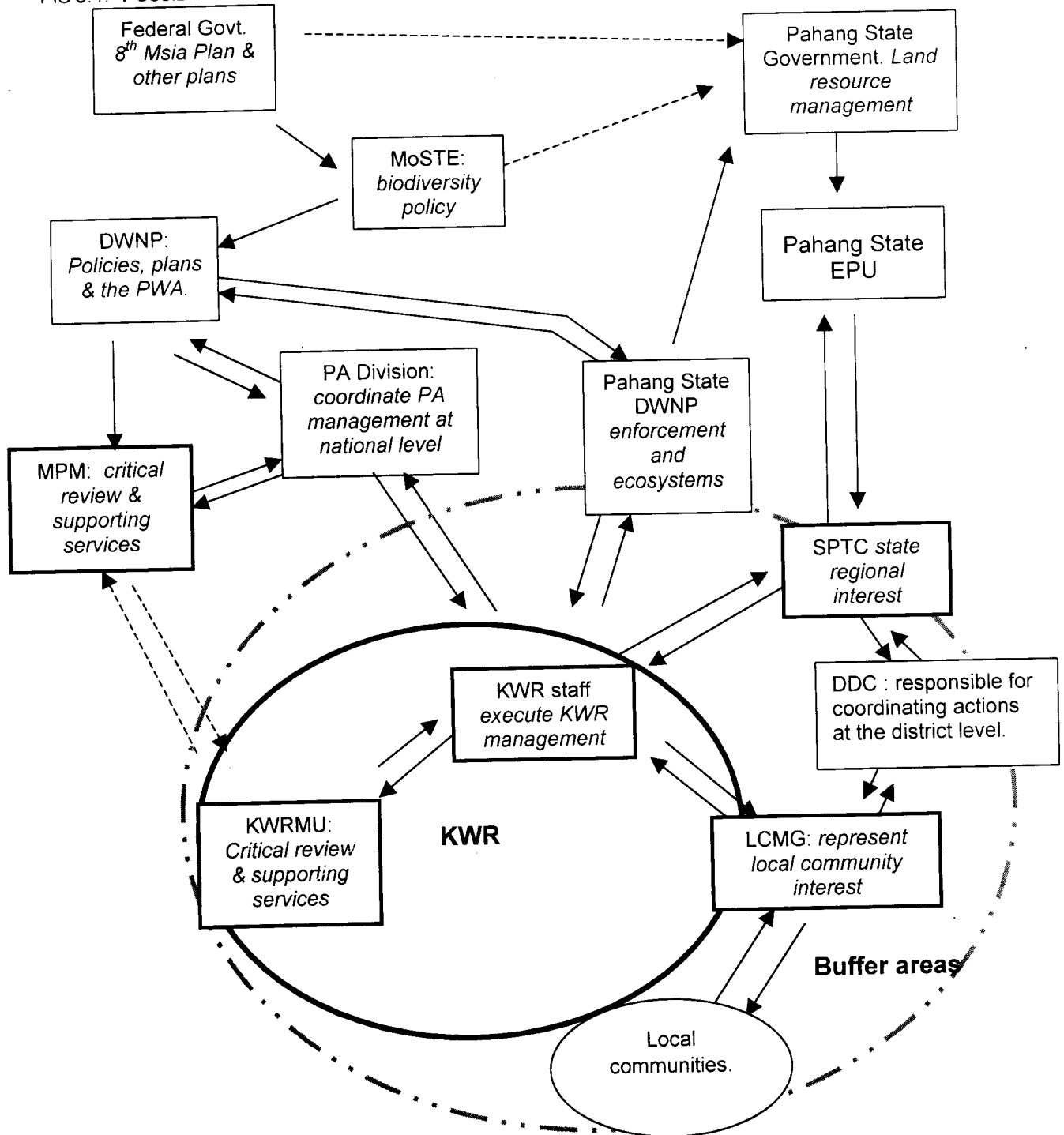
Until recently, the KWR was administered and managed as a set of independent DWNP functions reporting to different superiors in the state or federal office. At the time of writing, a new KWR staff entity has been created under the PA Division at HQ to manage the reserve itself, rather than DWNP functions within the reserve. It is understood that proposals have been made to unify management and responsibility under a single structure⁸⁷. If implemented, this would bring the separate DWNP functions that are essentially in occupation of parts of the reserve into a single management group. This is a positive development, however complete unification may not be desirable nor possible⁸⁸.

⁸⁷ Refer to communication from the DG, DWNP to the CTA DWNP/DANCED Krau project ref: JPHL&TN: 60-3/5(IP) (28), 27-04-2001.

⁸⁸ The elephant unit is a stand-alone service separate from the KWR management. Its base at K.Gandah benefits from a central location for operating over the whole Peninsula.

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FIG 6.1: POSSIBLE LINKAGES BETWEEN PROPOSED ADMINISTRATIVE AND MANAGEMENT GROUPINGS.



In the diagram above, the federal structures are placed on the left, with state structures on the right. The land area of the reserve is shown in solid line nested with the buffer areas. More details in the composition of the various groups are outline in section 7.

The groups mentioned above are a mixture of those with legal authority to manage and informal groups with no official standing but which comprise members who have either knowledge, resources or the coordinating ability to support KWR management. Table 6.1 below illustrates relationships between the management groups.

TABLE 6.1: GROUPS THAT UNDERTAKE MANAGEMENT ACTIONS OR PROVIDE SUPPORT FOR THE KWR.

Planning, advisory, and supporting functions	Responsibility for execution and actions.
MoSTE	DWNP
Have ownership over policies for biodiversity and a legal position for consultation over the tenure of the reserve.	The agency responsible for executing the PWA and also implementing the policy on biodiversity.
MPM	PA division
Comprising of other DWNP divisions at HQ with the skills to support management in protected areas: • Research Division – providing input to regulate fundamental research as well as quality controls for applied research and in-house DWNP work & animal husbandry; • Training and Education – providing input for capacity building as well as conservation education; • Development Division – providing quality standards for EMPs as well as controls for minimal impact development; • Eco-tourism Division – providing input for the development and regulation of commercial tourism and recreational use.	Hold responsibility for : • Setting standards of performance of all protected areas; • Setting management targets and monitoring performance; • Ensuring on-site managers identify management needs, undertake local gap assessments and report on supporting needs; • Ensuring resource and supporting needs are planned and provided; • Co-ordinating support other DWNP divisions; • Acting as secretary for the MPM
KWRMU	KWR
All parties in residence at the KWR have an impact on the reserve and should be able to self-manage their responsibility to the reserve. In addition they each have skills to support the management effort of the KWR. Because they may be under different DWNP sections or have no direct link with the KWR management, the KWRMU would enable each to meet as a peer group to discuss the management of the reserve. Parties would include: KWR staff; units under DWNP federal control; units under state control; representatives of uniformed staff; representatives from local community staff ; long-term researchers.	Officers with responsibility for the management of the KWR who report to the PA division. Though they have direct responsibility, they will still need the support from other DWNP sections resident at the KWR that may not be under their control.

TABLE 6.1 CONTINUED.

Planning, advisory, and supporting functions	Responsibility for execution and actions.
Local communities	LCMG
Around the KWR are about 20,000 people, living within economic, racial or cultural sub-groups, and with varying levels of dependency on the resources of the KWR. Inclusion in this group would be dependent on geographical location. An arbitrary guide of 5 km could be adopted.	This group would be created by the KWR from invited and self-appointed parties from the local community. The DWNP would expect; • Represent and can speak on the behalf of their community, • They can support the group identify the best course to meet their goals for sustainable development, as well as the goals of the DWNP for the conservation of the KWR.
The sPTC works above the district level and should assist the state EPU with sustainable development of the state. This would be the appropriate level to plan for biological corridor issues in general and the role of the KWR in the ecosystem of the state. The sPTC could represent the state as the steward for the beneficial owners of the reserve.	The three districts of Raub, Jerantut and Temerloh each have their own district level development committee dealing with district level land use and development. With the task of implementing state policy at district level, this is the body that would coordinate development activities in the buffer zones.

All these parties have a legitimate interest in the reserve at some level. Their function would be to provide support that would ultimately be used by the KWR staff, and provide on-going critical review of performance.

6.3 Strategy to meet immediate needs

The immediate needs of the KWR are simple to state but in practice require much work. These needs would address the 'people issues' of KWR capacity building and community work as stated in 6.1. These include :

- Rationalising the administrative structure of the KWR within the PA Division,
- Building capacity in the KWR staff and supporting functions at the DWNP,
- Incorporating a system of adaptive management into the KWR with support and quality controls coming from the PA Division at the DWNP HQ.
- Establishing stake holders and interested parties into natural groups to discuss issues of mutual interest concerning the KWR, and
- investing effort to develop the local communities as supporters of the reserve.

These 'people oriented' priorities would address the first and third immediate objectives for local community involvement and the conservation of biological integrity of the reserve.

The task of developing the KWR as a centre for research and education would be most effectively handled at the DWNP through the MPM. The role of the KWR being to provide opportunity for research and education. On-site managers

would have little time or energy to develop or promote these opportunities in the next 5 years.

These issues will need to be addressed from the beginning of the plan period to place the KWR staff in a better position to undertake some of the mid-plan developments of 6.4 below.

6.4 Mid-term needs

Among the expectations of the KWR and the roles it is expected to play include :

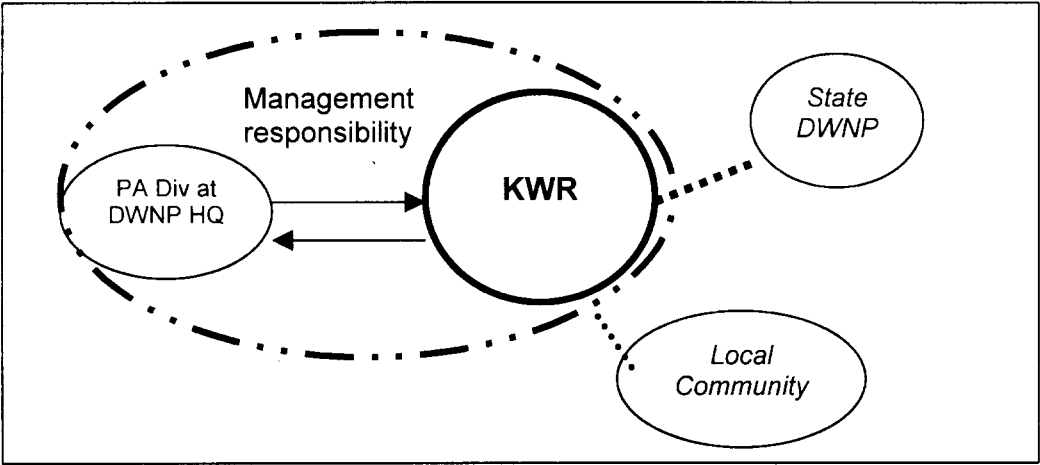
- an opportunity by sectors of the DWNP to exercise their functions of training, education, animal husbandry, tourism, research, etc.
- as a location for the local community for their material needs – food and other NTFPs, as well as their social or spiritual needs;
- as a resource for the state to contribute towards development of the state and the material benefit of its people through items such as entrepreneurial development for tourism, and
- by the federal government as an opportunity to meet its policies and international commitments for biological diversity.

Opportunities to develop these activities will take place once management capacity and administration has been established. Opportunities would be identified, capacity upgraded to handle development, and then development initiated. The actions to meet the second immediate objective for research, education and ecotourism would begin towards the end of the 1st 5-year plan period. On-going through this period would be general capacity building of the DWNP as well as local community groups for management support.

6.5 Preparing to meet long-term needs.

DWNP management of the KWR is mostly management of people. It would be far cheaper and far more effective if government regulates through the DWNP and nurtures the local communities with the necessary skills to manage themselves in a sustainable way. In the process, they would manage the reserve. And using 2020 as a target date, if the local communities could accept the principal of stewardship for the forest biodiversity, and be trained to undertake management responsibility, they will become potentially the most effective reserve managers of the future. This is in line with international recommendations from Agenda 21, the Biodiversity Convention as well as organisations such as IUCN and UNSECO.

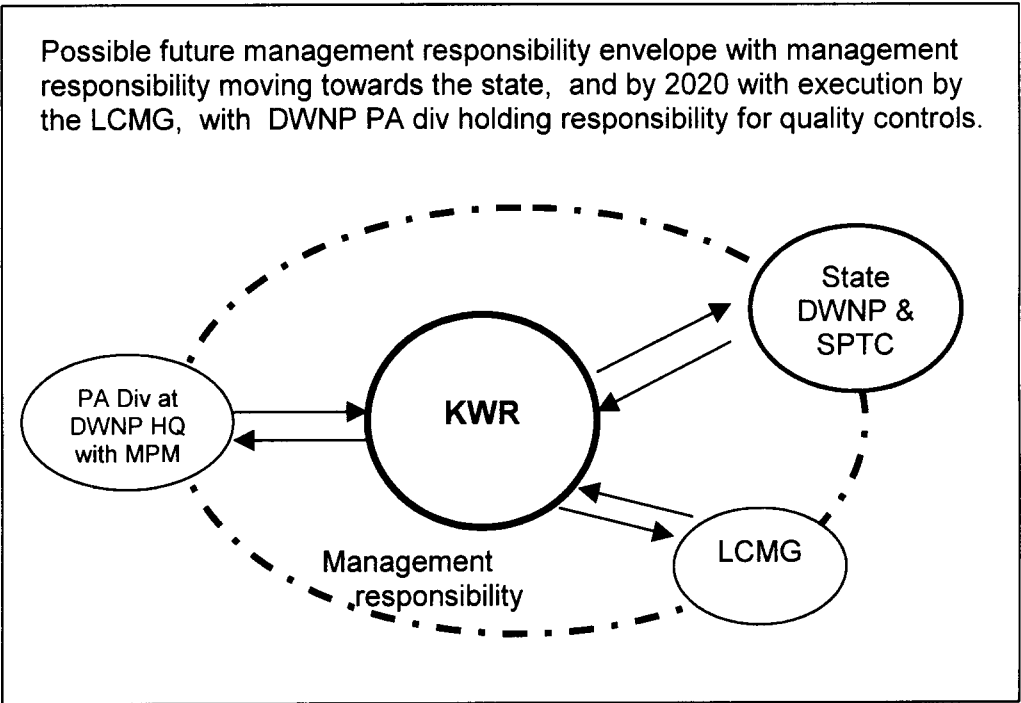
FIG: 6.2 STRUCTURE CURRENTLY PROPOSED WITH MANAGEMENT RESPONSIBILITY FOR THE KWR HELD BY THE PA DIV. AT DWNP HQ.



This excludes any *direct* link with the state DWNP office as well as the state EPU and other agencies.

If management evolution were allowed to reach a fully mature state, the local communities would assume a greater role in operations management, possibly assuming responsibility on behalf of the state and operating to quality standards set at federal level. The diagram in FIG 6.2 above illustrates the current state and FIG 6.3 below illustrates how this evolution of management responsibility could empower the state and local community.

FIG: 6.3 ENLARGEMENT OF MANAGEMENT RESPONSIBILITY FROM FEDERAL GOVT. TO INCLUDE THE STATE AND EVENTUALLY EMPOWER THE LOCAL COMMUNITY.



This enlargement of management responsibility would be in keeping with section 5.71 *Rural development strategies* in the Seventh Malaysia Plan, which includes development of a self-reliant society, development of a sustainable rural economy, as well as concern for strengthening family values. The assumptions for this long-term strategy makes is that :

- the DWNP recognise that a defensive or confrontational approach to reserve management could become a test of will and stamina which they may not win,
- the state of Pahang accepts the KWR as an essential component in its strategy to manage the natural resources of the state, and
- the local community accept that the future of their culture is related to the future of the reserve and that it is essential that they contribute to the survival of the reserve.

6.6 Strategy summary.

The management strategy proposed for the reserve in this section covers three periods shown below.

Short term:

- create peer management groupings,
- identify management responsibilities and obligations,
- undertake gap analysis of capacity for management groups and initiate capacity building,
- initiate a stewardship approach to management,
- introduce an ecosystems approach to management.

Mid-term:

- identify project development opportunities at the KWR,
- undertake gap analysis of capacity to manage developments and initiate capacity building,
- undertake the project development.

Long-term:

- integrate KWR management into the management of ecosystems in the state,
- bring local community involvement to its most effective level of responsibility for the reserve.

7. Actions.

At present the DWNP does not have an established set of management prescriptions that can be used as a basis for management of biodiversity in a protected area. There are established methods for enforcement of the PWA and patrolling of reserve boundaries, as well as established practices for managing DWNP functions at department centres. But conserving biodiversity needs greater technical and financial management resources than the DWNP currently has at its disposal.

The 10 areas for future action made earlier in section 5.3 map a course for the DWNP to undertake. The course is simple.

TABLE 7.1: AREAS FOR FUTURE ACTION.

Areas	Actions.
A. Establish management of the reserve	1) regain administrative functions of the reserve and be seen by the state and respected by the local communities as a credible management authority;
B. Collaborative effort	2) engage the support and good will of the local community to ensure the KWR is perpetuated as a natural reserve;
	3) support the need for rural development
	4) address the cause of decline in species abundance by supporting the development of the local communities within and around the reserve;
C. Anticipate the decline in biodiversity	5) Encourage the DWNP & MoSTE to promote an ecosystems approach to the conservation of biodiversity at state level;
	6) control the impacts partly from human activities in the reserve that are contributing to the decline in the numbers of large mammals and habitat;
	7) challenge the local community to adopt a stewardship role for the reserve;
	8) allow for the natural restoration on species numbers and monitor for this trend;
D. Increase the capacity of KWR and DWNP HQ staff to perform; and then	9) accept that DWNP management capability needs to be rebuilt to support its obligations for the conservation of biological diversity;
	10) develop the capacity of the KWR staff to undertake monitoring and adaptive management for the reserve; and
E. Holistic approach to development.	11) Investigate the potential of DWNP options to further develop user opportunities at the reserve.

Section 5.3 urges expedience. Management efforts need to respond quickly, but to be realistic, time is an issue with extinction rates.

In this plan, no detail of prescriptions are given under actions, neither are hard targets set for the output of the action. Instead, the plan recognises the need to create as much flexibility as possible for PA management staff by setting *courses* rather than *objects* for actions, and ranking a record of the learning experience as of equal value to a physical output. Achievements at the KWR are expected of course, but in this capacity building period, the lessons learnt from the action are considered as equally important - especially since there are issues at another 38 PAs to address.

7.01 Administration.

The KWR is a complex reserve to manage. It has very good bio-physical potential, but complex social and political constraints. Management priority over the next 5 years would have to focus on managing people, and this will need a strengthening of administrative arrangement.

During the consultative and investigative periods of this management plan exercise, a review of the needs for managing the reserve was undertaken. It was concluded that :

- the current administrative arrangements will not be able to support the management plan's main objective, namely reserve protection, conservation and the conservation of biodiversity;
- the reserve staff need strong leadership during the next five years of management changes;
- strengthening of administrative support is a priority.

Supporting interests can be collected into five natural groups at the federal, state and local levels. For administration within KWR, DWNP has the power to reorganise its own staff. But in the 'buffer zone' and the 'biological corridors', however, the reserve staff will need the support of the state to create the above four management groups. The priorities for administration are:

- bringing the staff of the individual DWNP units into a unified reserve body to coordinate DWNP work within the reserve ;
- creating management support and encouraging continuous self-improvement at the Monthly Productivity Meetings in DWNP HQ;
- helping build a local community group to develop mutual support in the KWR area;
- formalising channels of communication between the reserve staff and agencies that manage land and resources, and implement development at district level, and
- integrating the KWR into planning for sustainable land and ecosystems management of the state.

During the next 5-year period, it is proposed that the management of KWR will come directly under the Protected Area Division. This plan has recommended that KWR staff undergo a capacity-building phase, and the reserve will need

specialist support and guidance, in particular from the DWNP HQ Protected Areas, Research and Training Divisions. Furthermore, over the same period, the different local communities will need to become better prepared to take on a stewardship role for the natural resources of KWR.

In the years to come, however, managing KWR, and the other 38 protected areas in the Peninsula, from a single federal office may not be the most effective mechanism. Once the capacity for self-management has been restored to KWR by the DWNP HQ Protected Area Division, possibly by 2020, KWR management should be returned to the state. In consideration of the policy for biodiversity adopted by the DWNP and its parent the Ministry of Science, Technology and Environment (MoSTE), there is a need to integrate the management of KWR with the other land ecosystems of the state, in particular forest ecosystems. KWR is a land management issue, and as such, it comes under the interests of the state.

The indicators and outputs for actions are given as a document or report except for the actions for the LCMG which are given as activities. Priorities are given as : 1- *must do*, 2 - *should do*, and 3 – *could be done*.

7.02 Zoning

Zoning is a strategy to control the conflicting uses or demands for use of a protected area. Zoning can be used to relieve the negative impact of human disturbances in a protected area, so that the biodiversity within has a chance to recover to expected levels. Zoning, however, effects people, their opportunities and their livelihood. In the case of KWR, therefore, zoning was identified, at an early stage of the scoping exercise, as an issue in its own right. Biodiversity in KWR is threatened by incompatible use by both local communities and other reserve users. The local communities, in particular the Jah Hut and the Che Wong and to a lesser extent the kampung Malays, have had the longest association with the reserve. This association continues to this day. Other reserve users include, DWNP for its own non-reserve management functions, such as ex-situ animal management, education and training, and more recently, external researchers. Furthermore, there are new demands for access to the reserve, for example, commercial ecotourism.

DWNP KWR staff will be in a position to enforce zoning rules on DWNP, researchers and tourists within the reserve. They may not, however, be in a position to enforce zoning rules outside the reserve or even rules that are unacceptable to the Jah Hut or Che Wong communities inside the reserve. Most zoning actions, therefore, will be directed towards negotiations with people and other government agencies who will be most affected by changes in management practices in KWR.

The two broad areas for action to address zoning are:

- to promote development and maintenance of buffer zones and biological corridors at the state level through the SPTC.
- to engage local communities and other divisions in DWNP in the zoning process for areas within KWR and its immediate surroundings.

7.03 Biodiversity

Within the reserve, biodiversity is inversely related to human disturbance. The main focus of action here is for the KWR staff to control and reduce negative human impact on the reserve. The four broad areas for action in support of biodiversity in KWR are:

- promoting forest connectivity within the state, and particularly for the greater Krau area forest fragment;
- reducing human pressure in KWR;
- monitoring future activities that are likely to have negative impacts in KWR;
- encouraging and building the supporting science base for biodiversity management within KWR and the capacity to manage for biodiversity within DWNP.

In support of policy development in DWNP and in MoSTE, the management objective for KWR has shifted from the management of game animals, to wildlife conservation, to management for biodiversity. MoSTE is in the process of translating the National Biodiversity Plan into actions for land and protected areas management. However, the science supporting biodiversity for management application to protected areas is lacking. In consideration of these planning gaps, this management plan has assumed that an ecosystems approach would be the most practical approach to incorporate biodiversity into management actions for KWR.

Through long standing practice the staff in KWR have manned the boundary to enforce the Protection of Wildlife Act, or to serve their sectoral functions. They have limited capacity to expand their workload to include management for biodiversity. Any greater involvement will require capacity building and more technical staff.

KWR is considered an important site for the conservation of biodiversity. KWR, however, is now an isolated fragment of a once larger forest. The value of biodiversity is inevitably declining with increased fragmentation of the forest. This decline will accelerate, if KWR is managed as an isolated unit without consideration given to its surrounding environment. As a long term strategy, decline can be attenuated, if KWR is managed as an integral part of the state ecosystems otherwise there is a great risk that many large mammals will disappear. This will require promotion from the DWNP and MoSTE for the state to adopt consideration for biodiversity in state development and land use planning (see "19.34 Land Resources" and "19.38 Biodiversity" in the "8th Malaysia Plan").

7.04 Enforcement

The core activity of DWNP is the enforcement of Act 76, Protection of Wildlife Act, 1972. This empowers DWNP to enforce rules to protect species within reserves, and those species listed in schedules 1 to 4 of the Act. During the Emergency period, DWNP were denied access to enforce the Protection of Wildlife Act within the reserve, functioning only as a presence at stations on the boundary. During that time, some of the forests surrounding the reserve were cleared and new settlers moved in, both Malay and Chinese. They, together with the resident Orang asli local communities, are now habitual resource users of the reserve. Section 52 of the Protection of Wildlife Act grants Orang asli the right to hunt in a reserve for the purpose of providing food for himself and his family.

Some enforcement effort is required to ensure orang asli rights specified in the Protection of Wildlife Act are not exceeded, but the bulk of enforcement work would be to:

- control illegal entry;
- prevent illegal hunting either for sport or commercial gain;
- prevent illegal resource extraction, e.g. logging;
- inform hunters and collectors of the objectives of KWR and seek their support and cooperation.

The following subtle difference between the KWR hunting communities should be noted:

- Outsiders illegally entering the reserve to hunt, for their own use and/or sale.
- Outsiders commissioning the local communities to hunt.
- Local communities illegally entering the reserve to hunt.
- Local communities legally entering the reserve to hunt species for illegal sale.
- Local communities legally entering the reserve to hunt legally for their own use and not for sale, but using illegal non-traditional methods.
- Local communities legally entering the reserve to hunt legally for their own use and not for sale, using legal traditional methods.

Of the six types of hunting communities, the law should be enforced against the first five and wildlife populations monitored for signs of recovery.

7.05 Ecotourism

Ecotourism could create new work and opportunities in the area. The forest, mountains, rivers, wildlife and local communities have the potential to bring in new investment, jobs, and *visitors-with-money-to-spend* into the area. However, the KWR is not a national park intended to support visitors, the KWR is a wildlife reserve, intended to support biodiversity. If ecotourism is to take place, it has to be done without compromising the value of the KWR as a reserve for biological diversity. Ecotourism is different from developing commercial tourism opportunities, it needs to be planned so that it meets the criteria set out in the *National Ecotourism Plan*.

7.06 Research.

As a protected natural area of tropical forest, the reserve should attract interest from researchers as a site to undertake :

- short and long term fundamental research,
- as well as a site for management oriented research.

The former is one of the user-opportunities that the KWR can offer, the latter an essential part of adaptive management. Since the G.Benom expedition was mounted in 1967, there has been an almost continuous research interest in the area that has contributed to the international profile of Krau.

One of the immediate objectives of the management plan is '*The establishment of the Krau Wildlife Reserve as a national and international research, and education facility*'. It could be argued that the KWR has already been established as a site for research and the objective already realised. However, if opportunities for research are not promoted, and research interest not kept alive, there is a danger that the future reputation of the KWR will only be based on the activities of the past. The issue over the next five years will be keeping the KWR running as a functional and productive research facility.

The objective could only be met with support from the DWNP, the MoSTE and research bodies in Malaysia and overseas.

7.07 Conservation Education.

As with research above, one of the objectives of the Management Plan is to establish the reserve as an educational facility. Research, tourism and conservation education are user opportunities. Management of the KWR would regulate the first two, but be actively involved with the conservation education. Over the "7th Malaysia Plan" period, extensive new buildings were constructed on reserve land, newly cleared, at Jenderak Selatan, Bukit Rengit and Kuala Gandah. These buildings are primarily for education and training purposes. Currently, the DWNP Training Division runs a series of educational and training events from the Bukit Rengit facilities.

This Management Plan recognises that conservation education plays an essential supporting role for the management of the reserve and the conservation of its biodiversity. Whereas ecotourism can be considered as a user opportunity for which KWR acts as a regulator. Conservation education should be viewed as a nation-building activity in which KWR takes an active role. Conservation education, however, also needs to be directed towards the local communities, because without the informed support of the population, protection of the reserve will become ineffective.

7.08 Training

Currently the Education and Training Division conducts its activities at the Bukit Rengit Training Centre. There, they provide courses for general DWNP staff and other agencies. Although these facilities are located inside the reserve, they serve as a general resource for DWNP, and provide no direct benefit for the reserve itself. Any further development at these sites and extension of facilities should be regarded as user opportunities and thus provided at a cost to the reserve.

However, the KWR has its own training requirements and currently these are met by training-through-work-experience. This Management Plan has recommended an adaptive management approach as being the most suitable for introducing new objectives such as biodiversity into the responsibilities of operational management staff and that management tasks be undertaken with some form of quality assurance. The KWR staff, however, will need training, so too will the trainers. Currently the Education and Training Division has minimum the capacity to support PA Division needs. Training is a critical activity. Trainers have to identify both the service needs they have to support, as well as their own capacity gaps, human resource and training requirements.

7.09 Monitoring

Adaptive management is a cyclic activity. Current knowledge is used to upgrade the previous level of knowledge. Adopting this approach of knowledge our management objectives will be realised. Management objectives are then translated into a management action based on the hypothesis. The effects of these management actions are monitored and the management treatment is then adjusted as needed.

Every management exercise is based on current knowledge. Management of a task, as complex as biodiversity, will never be based on complete knowledge. The best that can hoped for is that a little more knowledge is continually gained. This is done through regular monitoring and assessment.

7.10 Local Communities.

Up to this point in the Management Plan, extraction from the reserve, both directly and indirectly, by people living at some distance from the reserve and also by the different local communities, has been regarded as one of the reasons why the biodiversity of the reserve is frequently disturbed. The priority for DWNP and the KWR staff is therefore to increase the enforcement and reserve management rather than use its resources to embark on new projects for research, training, and ecotourism. This Management Plan suggests that DWNP consider the various local communities as a potential resource, as yet undeveloped. The task on hand is to turn the different local communities from being a part of the current problems of the reserve into being a large part of the future solution. This has never been done before in Peninsular Malaysia. It is a

very difficult task, but it is an opportunity for all stakeholders to create a model for future reserve management.

7.11 Miscellaneous.

The actions above were based on the issues that were identified through the course of discussion with the KWR management staff and consultant reports. The three items presented here under miscellaneous were identified in the general course of discussion. These were:

- The use of environmental management plans (EMPs) to ensure that facilities sited at the KWR did not impose additional risks or threats to the reserve,
- The issue of forest certification which the state of Pahang is seeking for the productive forests of its PRF,
- The issue of exotic and invasive species, and
- The issue of landscape management and general biodiversity of the State of Pahang.

7.12 Closure

Before the mid-term (year 2) and end of the management plan period (year 5) a closure report would need to be prepared and submitted.

7.13 Summary of actions by executor.

In the tables (7.13) in ANNEX 1 the 65 actions proposed by this management plan are grouped according to the body that would be executing the action. The action numbers refer to the same action numbers in the subject categories in 7.01 to 7.12 above. The descriptions in the actions are given as a document or report except for the actions for the LCMG which are given as activities. And as above priorities for annual action are given as : 1- *must do*, 2 - *should do*, and 3 – *could be done*.

Glossary

BCC	Biological carrying capacity
BioD	Biological diversity
CBD	Convention on Biological Diversity
CC	Biological carrying capacity
C-education	Conservation education
CTA	Project technical adviser
DANCED	Danish Cooperation for Environment and Development
DDC	District Development Committee
DWNP	Department of Wildlife and National Parks
EMP	Environmental management plan
EMP	Environmental Management Plans.
EPU	Economic Planning Unit in the Prime Ministers Department
FD	Forestry Department
FelDA	Federal Land Development Authority
FMU	Forestry Management Unit
FRIM	Forest Research Institute, Malaysia
H'	Used to denote a value for biodiversity
HQ	Head quarters
HR	Human resources
IUCN	International Union for the Conservation of Nature
JHEOA	Jabatan Hal Ewal Orang Asli
KGR	Krau Game Reserve
KL	Kuala Lumpur
KSAS	<i>Kawasan sensitif alam sekitar</i> (sensitive environmental areas).
KWR	Krau Wildlife Reserve
KWRMU	Krau Wildlife Reserve Action Group
LAC	Limits of acceptable change
LC	Local communities
LCMG	Local community management group
LUZ	Limited Use Zone
MIS	Management information system
MoCAT	Ministry of Culture, Arts and Tourism
MoSTE	Ministry of Science, Technology and Environment
MVP	Minimum viable population.
NBP	National Biodiversity Policy
NEP	National Ecotourism Plan
NTFP	Non-timber forest products
PA	Protected Area
PA Div	Protected Areas Division
PRF	Permanent reserved forest
PSD	Public Service Department
PTC	Project Technical Committee
PWA	Protection of Wildlife Act, 1972.
QMS	Quality management systems
SIRIM	Standards and Industrial Research Institute of Malaysia
SOP	Standards of Practice
sPTC	Successor to the Project Technical Committee
TK	Traditional knowledge
TOR	Terms of reference
WCS	Wildlife Conservation Society