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MADAGASCAR
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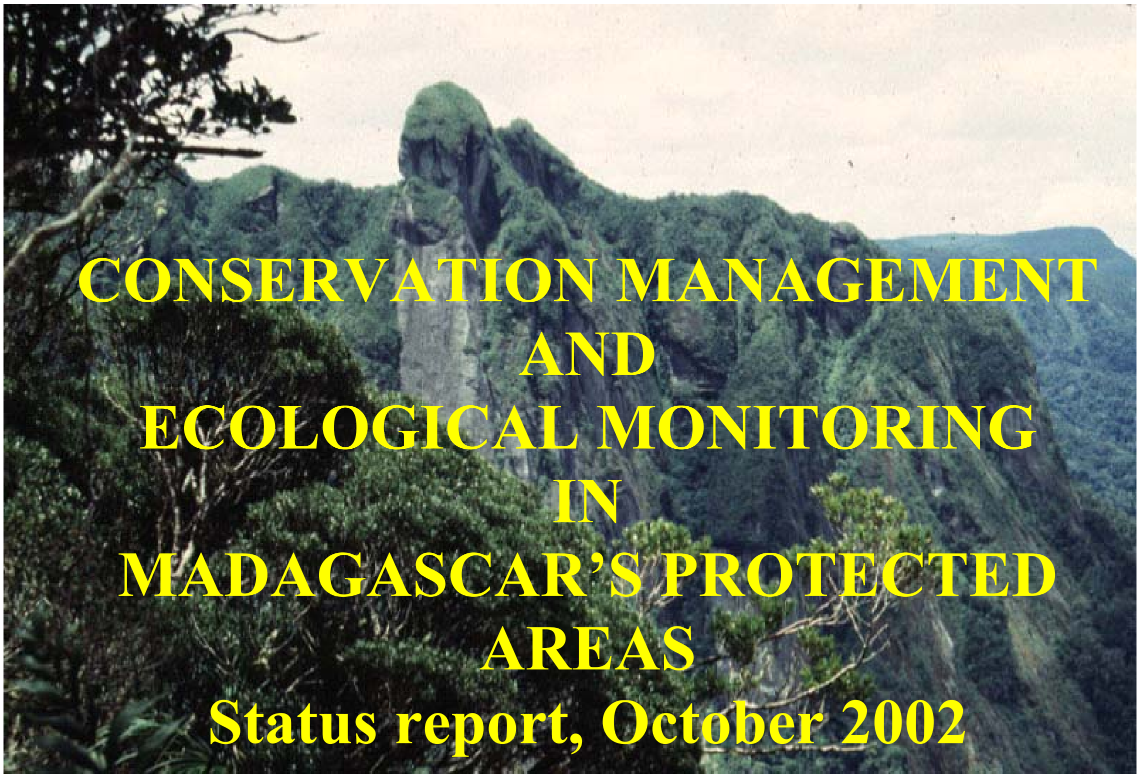
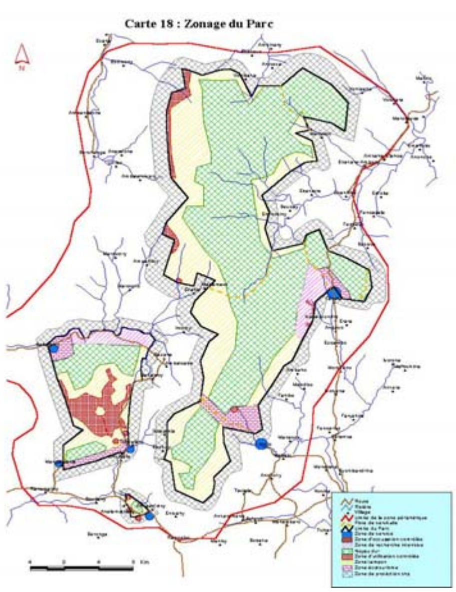
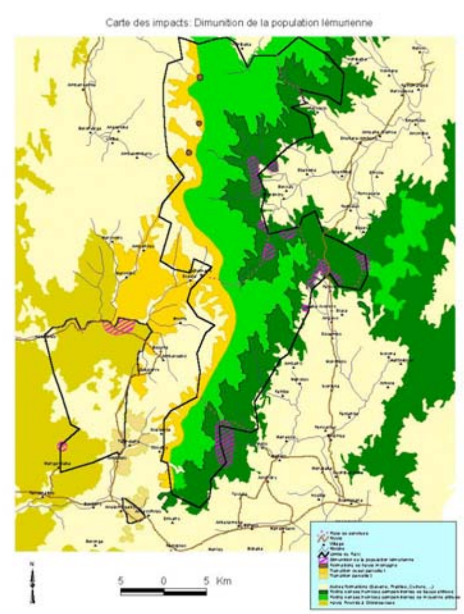


CONSERVATION MANAGEMENT AND ECOLOGICAL MONITORING IN MADAGASCAR'S PROTECTED AREAS

Status report, October 2002





CONTEXT

Protected area management standards

In the year 2000, Madagascar's protected area service (Parcs Nationaux de Madagascar, PNM) decided that adoption of internationally recognized management systems was to be major goal of the organization. This decision was linked directly to PNM's agreement to adopt an evaluation system developed by the World Commission for Protected Areas (WCPA), a division of the World Conservation Union (IUCN.) The WCPA evaluation system is promoted throughout the world as a means to compare the management efficiency of different protected area networks.

The WCPA is in the process of establishing guidelines and norms for different aspects of protected area management. One of the first to appear was that concerned with national protected area system planning. This was presented in 2000 and, happily, PNM's national system plan conforms closely to the WCPA recommendations. In parallel, the WCPA continued to develop guidelines and norms for conservation management, including ecological monitoring. Several models have been developed for conservation monitoring and evaluation, but there are few that specifically treat planning or implementation. However, some of the monitoring/evaluation models do require a considerable level of analysis and subsequent planning as part of their methodology.

Monitoring and evaluation

Ecological monitoring and evaluation of conservation success is notoriously difficult in many PA systems, and has been a constant challenge for PNM. Monitoring and evaluation are critical factors in conservation management, and any attempts to improve the effectiveness of the latter must be based on sound assessment systems. We therefore made sure that the conservation management system chosen by PNM addressed this issue.

Origins of the PNM conservation management system

The development of a Conservation Management Plan (PGC, Plan de Gestion de Conservation) is a direct follow-on from PNM's National Protected Area System Management Plan (Plan GRAP) that sets out the broad strategic objectives of the national network.

Following an extensive review of the available conservation management systems, PNM opted to use the model developed by The Nature Conservancy (TNC) as a platform upon which its own system could be established. The reasons for this are as follows: (a) it is clear that the TNC model has strongly influenced many other planning, monitoring, or evaluation systems such as those of Parks Canada and WWF; (b) it is by far the most exhaustive in terms of analyses designed to identify biodiversity priorities and to evaluate the importance of different threats as a basis for strategy development and monitoring programs; and (c) it is very clear that the system was developed by experienced field scientists and managers, thus ensuring scientific credibility and management utility.

The primary objectives of the TNC system are monitoring and evaluation: indeed, it is entitled 'Measurements of success.' The system can be applied equally to individual protected areas and broader landscape conservation programs. It provides a solid framework for monitoring of biodiversity health, threat reduction and the effectiveness of management strategies. The monitoring results can also be compared to stated management goals. At first sight, the TNC model is highly complex and difficult to grasp. However, once users gain experience, the model's logic becomes clear and the different analyses come together to build a solid comprehension of priorities for conservation management and how to measure success.

PNM's conservation management objectives

PNM requested MIRAY support to help develop a conservation management system that optimizes the value of a given PA in terms of biodiversity representation and conservation. The system also had to be designed to increase capacity and efficiency as measured by WCPA evaluation standards. Specifically, conservation management needed to improve the following:

- Conservation planning
- Improved information management for conservation activities
- Improved ecological monitoring and evaluation of management efficiency with respect to representing and conserving Malagasy biodiversity in protected areas
- Improved adaptive management approaches.

As in other national protected area systems, ecological monitoring and evaluation has always been a major challenge within PNM. This is perhaps the principal reason why the WCPA has focused much more effort on monitoring than on planning at the site level. In addition, knowing what needs to be monitored in order to improve management, together with wanting to demonstrate the anticipated improvements, implies that the managers understand the nature of their parks and have planned a range of strategies. The TNC system perhaps goes further than most in providing a solid methodology to analyze biodiversity priorities and to understand the nature and intensity of different threats as a precursor to establishing monitoring programs. However, it was clear that we needed to modify TNC's system to provide more assistance to PNM users and to place a greater emphasis on planning. In contrast to TNC, PNM users would appear to have less experience and training in conservation biology (such as biogeography), a field vitally important for setting credible biodiversity management priorities.

DEVELOPING CONSERVATION MANAGEMENT PLANS WITHIN PNM

The TNC system essentially comprises the steps briefly outlined in Table 1.

We ran initial tests of the TNC approach through small workshops in the south. Two PAs were also chosen for more intensive testing: Ranomafana NP and Andohahela NP. Jeffrey Parrish from TNC e-mailed copies of the manual and a computer-based planning program for PNM to test.

During the first workshop, it became clear that TNC terminology had to be modified fit commonly used PNM terms. We wished to follow TNC terminology as far as possible because each step in their system has a distinct appellation that reduces confusion. Table 2 provides a comparison between TNC and PNM terminology, and indicates additional steps that we included at PNM's request. For most of the rest of the present report, only PNM terms will be referred to.

The early workshops and field site visits indicated a strong interest in the TNC system as it was viewed as being systematic, robust and based on solid science. However, there was an immediate call for the change in terminology noted above, as well as criteria used to conduct analyses and set priorities.

Table 1: A brief overview of the TNC system
It is often referred to as the Five-S approach- Systems, Stresses, Sources, Strategies and Success but in fact goes further than this would imply.

Step	**Brief description**
Systems	The first part of Systems comprises an analysis of priorities based on national, regional and local endemism and diversity. Subsequently, it moves to Conservation targets that are ecosystems, habitats, distinct ecological communities or species requiring management because they are high biodiversity priorities and are currently or potentially threatened. Target identification is derived in large part from the previous step and usually no more than eight are selected. Focal targets such as species can be integrated into a larger ecosystem/habitat target. For example, a wetlands habitat may be specifically managed for invertebrate or plant species that are locally endemic to them. The viability or ecological integrity of each target is analyzed based on size, condition and landscape context criteria. The integrity assessment identifies important ecological factors that need to be managed in order to reduce critical stresses. The assessment also enables the definition of management goals expressed as monitoring benchmarks.
Stresses (part of Threats)	Stresses are the negative impacts on conservation targets that result from undesirable or incompatible human activities. All stresses identified for each conservation target identified and their importance ranked based on severity and geographical scope.
Sources of stress (part of Threats)	Sources of stress or what PNM and is partners have long called ‘pressions’ (pressures) – undesirable or incompatible human activities stress on one or more conservation targets. Sources of stress are analyzed for each stress and for each conservation target, and are assessed in terms of contribution to stresses and irreversibility (how difficult they are to reverse or halt.)
Threats – consolidated (built into Sources of Stress)	TNC combines stresses and sources of stress into a ‘threat.’ Threats can be defined as ‘critical threats’ which are active/anticipated sources of stress, or as ‘persistent stresses’ which are stubborn negative impacts that are a result of discontinued human activities. The separation of threats into critical threats and persistent impacts is of considerable interest. Critical or active threats are clearly the highest priority for management as they continue to cause harm to the conservation site. However, persistent stresses may be prioritized under certain conditions: if major critical threats are eventually reduced to acceptable levels, the park manager may wish to devote resources to restoration of degraded habitats or diminished populations. The two threat categories therefore clarify where management should focus on the reduction of active threats or the restoration of the environment. The level of threat can be evaluated by conservation target or by site.
Capacity evaluation	TNC evaluates management teams in terms of leadership and support, adaptive management/ planning experience, resource availability and partnerships.
Strategies	Strategies are developed based on the prior analyses. Strategy benefits are evaluated in terms of threat reduction/restoration value derived from the threats they are designed to reduce, feasibility and costs.
Success (=Monitoring and Evaluation)	Monitoring can measure biodiversity health or threat levels. Biodiversity monitoring may be directly linked to key concerns identified during target viability analysis or be more generalized to provide early warnings of new or as yet undetected threats. Benchmarks to evaluate management success or defined. Monitoring is tightly linked to clearly defined management goals.

Table 2: Comparison of the TNC and PNM methods and terminology

TNC	PNM terms in French	PNM terms in English	Comments
Systems	Analyse de la biodiversité	Biodiversity analysis	Much more detail provided using information from IUCN and CAMP evaluations.
	Cibles de conservation	Conservation targets	Evaluation criteria differ by being based on IUCN criteria.
	Rôle stratégique de l'AP	PA strategic role	Considered essential for marketing reasons. To ensure clarity, the role can be divided into (a) strict biodiversity functions and (b) ecological goods and services.
	Condition souhaitée (later replaced by Objectifs de gestion)	Management goals (set as user-defined measures of success and expressed as indicators and benchmarks)	Initially used to help define monitoring methods and benchmarks, but later modified in favor of clearer 'Management objectives.'
Stresses	Impacts	Impacts	
Sources of stress	Pressions	Pressures	
Threats – consolidated	Menaces	Threats	
	Sources	Sources of pressures	Considered important for strategy development.
Capacity evaluation	Evaluation de capacité	Management capacity evaluation	Enlarged to evaluate levels of information availability, surveillance and boundary marking progress. These are used to develop basic conservation management strategies.
Strategies	Stratégies	Strategies	
Success	Suivi écologique	Ecological monitoring	The user can measure threat reduction and/or biodiversity health, expressed as indicators and benchmarks.

Biodiversity analysis

Under 'Systems', TNC describes a detailed biogeographical analysis to determine biodiversity priorities. Their method requires a solid understanding of conservation issues such as representation of diversity and endemism at different geographical scales. A similar level of understanding of the underlying biogeography is rare within PNM and a greater degree of guidance is therefore necessary. We overcame the obstacle in two ways.

Firstly, we provide a list of habitat types present in each Malagasy PA using a vegetation classification that appears to widely acceptable. Each habitat is further assessed on the basis of threat, vulnerability[1] biodiversity value as measured by diversity and endemism. These assessments are best thought of a 'best guess' consensus among scientists, given the relative scarcity of solid research data and biogeographical analyses that exist. The assessments were made at a national scale: for example, what is the status of lowland humid forest compared to mid-altitude humid forest regarding threat? Furthermore, 'national' directly translates to 'global' in this context, as Madagascar is a unique biome.

Habitat classification is flexible and can follow any one of several recognized formats, including that presented in the Plan GRAP. The user classifies the habitat in a way that is useful in terms of management issues. For example, many distinct ecological communities such as open rock habitats may occur within a larger forest continuum but it is seldom necessary to consider them separately. Furthermore, if the user favors the Plan GRAP, different altitude bands within humid forest that are treated individually in the Plan GRAP may be linked as 'lowland forest' or mid-altitude forest.' The PNM user can rank the habitats if so desired, but it is more realistic for management purposes to define those that are important or not (such as secondary grasslands.)

Secondly, we provided an analysis of known species presence with respect to PAs. Only species with an IUCN Red Data Book assessment of vulnerable or more highly threatened are included. This list is then further modified to reflect whether the species is known only from one protected area or from one political province. (It may also be useful to include whether the species is confined to a singly ecoregion). The species information is a useful means to identify biodiversity priorities for a given PA. For example, a species known from only one park **must** be a priority for that site. One problem is that not every taxonomic group is covered by IUCN, and PNM users are encouraged to supplement the list and supply appropriate justifications. As with the case of habitats, we encourage the identification of important versus less important species, but a more detailed ranking may be carried out if desired.

Conservation targets

We experienced some confusion with TNC's 'Systems' and decided to clearly separate initial biodiversity analysis from conservation target identification/evaluation. TNC considers that targets can be ecological communities, ecological systems or species. The PNM approach also allows assessment of targets under the same broad categories, but also added a fourth: ecological functions. However, the last category tended to overly emphasize water functions in PNM protected areas leading to unrealistic attempts to single them out for direct management. We have managed to resolve this issue by incorporating rivers and other wetlands into larger forest habitats, except where they clearly need to be singled out.

A conservation target is a component of biodiversity that is (a) important regarding representation of biodiversity and (b) currently or potentially threatened. Representation value can be determined through an analysis of the habit or species with respect to its occurrence in different protected areas within the entire network. It can also be evaluated in terms of its uniqueness (e.g. a narrow evolutionary lineage) or general limited distribution or abundance. Threat can be estimated in terms of current or anticipated pressures. It can also be evaluated in terms of vulnerability (perhaps populations are so small a single natural event such as a cyclone could wipe them out). In some cases, threat is evaluated as the impact of past pressures that no longer exist (see **Threats**, below). The threat factor can be widely interpreted. In general, the conservation targets are identified if they face **high threat levels** that currently exist or may occur should management not prevent them, and are likely to lead to destruction, disappearance, degradation or perturbation. However, there may be cases

[1] Vulnerability differs from threat as a criterion as it reflects fragility rather than the risk of destruction/degradation

where naturally rare habitats or flagship species are not threatened, but PNM managers want to target them because they want to prevent the likelihood of any future risk, even if none is currently anticipated. For example, the Radiated tortoise is not highly threatened in one of its strongholds, Tsimanampetsotsa NP, but the managers feel that it must be targeted because it is one of the park's flagship species and is threatened elsewhere by intensive illegal collection.

There are many potential conservation targets that need not be so clearly singled out. For example, there is a local endemic mouse lemur only known from Ankarafantsika NP. This species is not directly threatened but its numbers could be reduced indirectly by vegetation loss in its valley bottom habitats. In such a case, the mouse lemur may be considered as an integrated target within a broader conservation target defined as valley forest. Such a broad conservation target is common in Malagasy PAs, and some habitat conservation targets can list quite large numbers of integrated targets. As a High Mountains Ecoregion local center of endemism, Marojejy NP has to list 'locally endemic herpetofauna' as an integrated conservation target in its different habitats to embrace more than 30 species that fall into this category.

Singling out a conservation target (or essentially multiple targets where there are many integrated into a broader habitat category) is done in order to concentrate conservation management where it is needed. Take the example of Andohahela NP. The lowland human forests and montane vegetation formations have been targeted because they are directly threatened. In contrast, the mid-altitude humid forests between them are not targeted as strong natural taboos protect them from virtually any human activity, benign or threatening.

TNC assesses the integrity (viability) of each conservation target using a modified version of the organization's own long-standing 'Element occurrence' Ranking. This is not applicable in Madagascar, and we had to develop an alternative. However, we did maintain TNC's assessment classification (Very good, Good, Fair or Poor), especially as it conforms closely to WCPA evaluation methods.

Initially, we looked at alternative viability assessment programs developed by other conservation organizations in order to develop usable criteria. However, none were found to be useful as PNM staff found them to be overly subjective or lacked clear criteria. For example, one evaluation procedure has a choice of five ratings ranging from 'Many' to 'Do not know' for criteria framed as *'The PA has high levels of biological diversity'* and *'The PA has a high number of endemic species.'* PNM personnel rightly felt that this type of assessment was unusable.

Setting criteria did in fact turn out to be one of the most difficult tasks in developing the PGC. Eventually we opted to employ IUCN Red Data Book criteria used to determine the conservation status of a given species, but we modified them to site-based assessments rather IUCN's global evaluation – this meant adjusting range, abundance and decline criteria to levels that PNM felt were reasonable for site-specific evaluations. The criteria are likely to be improved once feedback has been obtained and monitoring results provide a clearer understanding of risk.

TNC has three standard assessment categories; size, condition and landscape context. We provided several assessment criteria for each category, modifying them to suit habitat, species or ecological functions. PNM users may restrict themselves to these criteria, or may add additional ones as appropriate. Alternatively, if they know the target well, users may present a direct assessment with respect to the three evaluation categories, but in these unusual cases a clear justification must be provided. The justification must include a determination of what Very good, Good, Fair and Poor mean in their particular case. An example of viability assessment is presented in Table 3.

Notwithstanding the difficulties involved in assessing viability, PNM users feel that it helps them to better understand the nature of threats and their commensurate risks regarding biodiversity priorities.

The viability analysis leads to an assessment of key ecological factors or problems for each conservation target. For example, it may be determined that the critical problems for a particular habitat are degraded composition and structural changes following excessive illegal cutting. The key problem in turn is used to determine the priority **management goals** (e.g. remove the threat of illegal cutting to let the forest restore naturally, while monitoring the risk of increased numbers of invasive plants). Management goals can be set for different time frames. Short-term goals usually concern the containment of high-level threats, but longer-term goals may tend towards restoration, usually through natural regeneration in a well-protected habitat, but some reintroductions of locally extinct species or some enrichment planting. Many protected areas also set policies, such as zero tolerance of habitat loss. The management goals are stated as indicators and, in many cases, set as temporal benchmarks.

Viability assessment is assessed qualitatively, Very good, Good, Fair, Poor) and numerically using a score of 0 – 4 that can also be expressed as a percentage. The assessments are somewhat subjective and crude, but provide a **measure of biodiversity heath** when mean values are calculated using the results of all conservation target assessments (Table 4). In addition, trends in assessed values over time can be used in **ecological monitoring**. The results can be incorporated into PNM's evaluation system to look at trends in the entire network, by province, by ecoregion or by taxonomic group. What is of particular interest is that the user can determine his/her own measures of management success (demonstrated in Table 10).
This helps to set realistic goals and ensures that seeks practical solutions to real problems.

Each protected area produces a map of at least all conservation targets that are habitats. In some cases, species conservation targets can be included in the same map or presented separately. The composite habitat and/or habitat/species conservation map is used as a base-map for virtually all other mapping exercises, such as threat assessment. An example is provided in Figure 1.

Table 3: An example of conservation target viability assessment from Andohahela National Park.

The example is a target with numerous integrated species targets. The results of assessment by individual criteria are averaged to provide a value for each of the three main evaluation categories (size, condition, landscape context), using standardized TNC methods. These are in turn averaged to give an overall viability score, expressed numerically and qualitatively. Based on the assessment, key ecological factors or problems that must be managed are identified, and management objects are also established. The columns 'Criteria pertinence' and 'Confidence level' allow the reader to understand if some criteria are more important than others (or even critical or irrelevant), and how confident the PA managers are concerning the assessments in question.

Conservation target: Eastern lowland humid forest		**Rank: High**			
Target description: Habitat and species					
Nested (integrated) targets: *Dypsis malcomberi. D. macdonaldiana, Ravenea robustior. Marojejya insignis. Paragehyra gabriellae. Mantella haraldmeieri. Furcifer balteatus. Newtonia fanovanae. Daubentonia madagascariensis. Galidictis fasciata. Brachypteracias leptosomus. Geobiasts squamigera. Cryptoprocta ferox*					
Criteria	**Category and criteria**	**Criteria value**	**Category value**	**Criteria pertinence**	**Confidence level**
	Category: Size				
01	Surface area in the PA	Fair		Important	Very high
02	Stable or robust form	Fair		Important	High
03	Continued reduction	Good		Important	High
04	Known or suspected reduction	Good		Important	Very high
	Value: Size		**Fair**		
	Category: Condition				
05	Structural degradation	Good		Important	High
06	Composition degradation	Good		Important	High
07	Natural regeneration/restoration rates	Good		Important	Very high
08	Capacity to recover from natural cataclysms or pressures	Good		Important	High
	Value: Condition		**Good**		
	Category: Landscape context				
09	Connectivity or continuity within the PA	Fair		Important	Very high
10	Connectivity or continuity within the PA and exterior	Fair		Important	Very high
	Value: Landscape context		**Fair**		
	Overall viability (ecological integrity):	**Qualitative**		**Quantitative**	
		Fair		**2.83 (70.75%)**	
	Key ecological factor or problem:	Reduction and continued decline in surface area; altered structure and composition. (Isolation of the PA may be a future priority).			
	Management objective:	Reduce forest loss and illegal selective cutting. Favor natural regeneration of degraded sites.			

The user defines the key problems and then sets management goals. The latter are generally expressed as benchmarks or indicators that allow evaluators measure the degree of success predetermined by the PA.

Table 4: An example of biodiversity health assessment for a PA based on individual conservation target viability evaluations.
This example taken from Andohahela incorporates the assessment shown in Table 3, together with those of the other conservation targets at this PA. Values are calculated using standardized TNC methods, and the average value for all conservation targets represents a crude, but reasonable, measure of overall biodiversity health of the PA. This value can be directly integrated into PNM's WCPA-based management effectiveness evaluation system.

Although assessments are carried for the four targeted lemur species, the actual conservation planning based on threat assessment regroups the two species from the east as a single target, and the two from the Southern bush as a second united target. This is possible as the profiles of the grouped species is similar, and their threats are essentially the same.

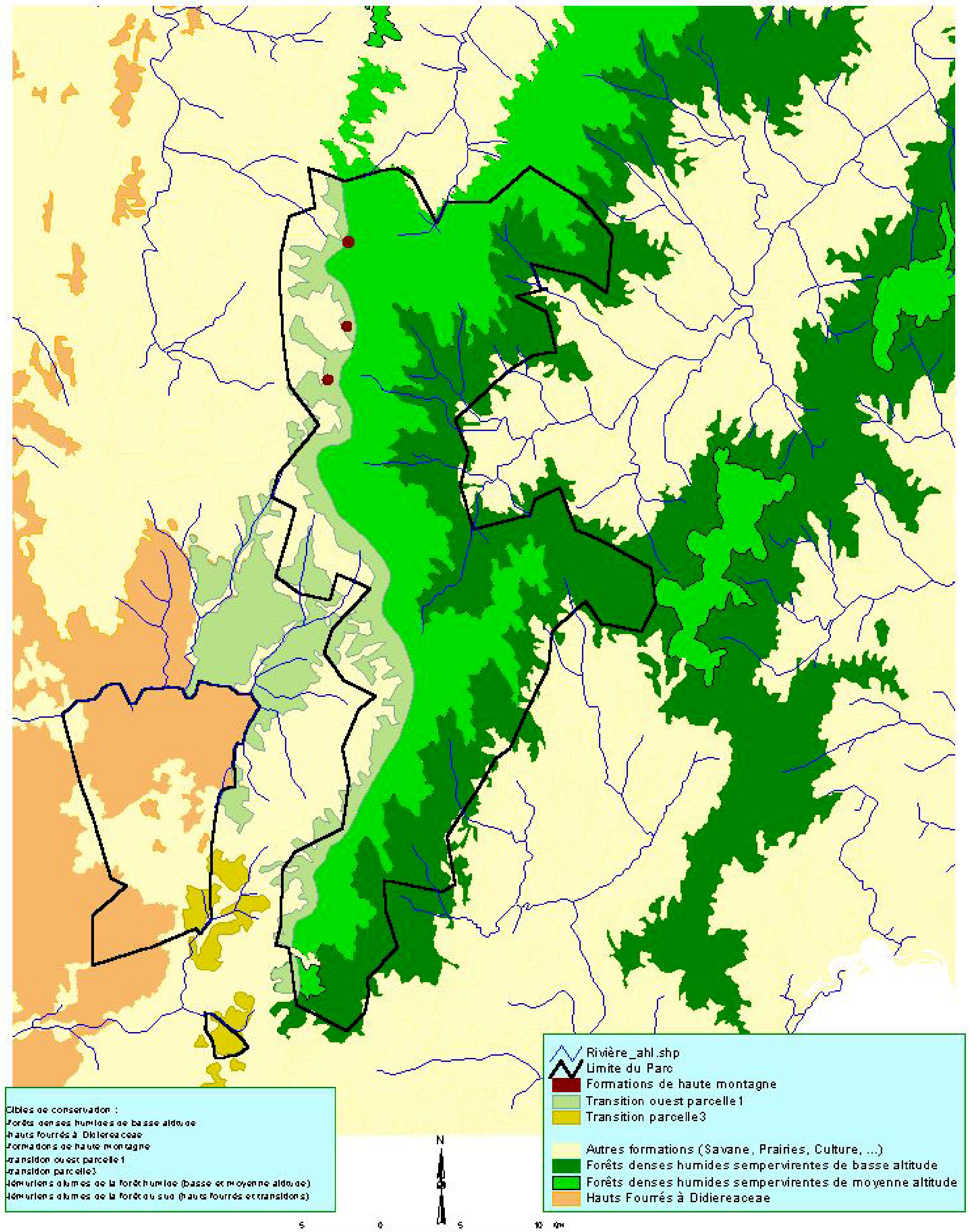
Conservation	**Description**	**Size**	**Condition**	**Landscape context**	**Overall viability**
Eastern lowland humid forest	Habitat and species	Fair	Good	Fair	**Fair (2.83)**
Montane vegetation	Habitat and species	Fair	Poor	Good	**Fair (2.33)**
Didiereaceae bush	Habitat and species	Fair	Fair	Poor	**Fair (2.00)**
Parcelle 3 transition zone, including *Dypsis decaryi*	Habitat and species	Fair	Fair	Poor	**Fair (2.00)**
Parcelle 1 transition zone	Habitat and species	Fair	Fair	Poor	**Fair (2.00)**
Eulemur fulvus collaris	Species (lemur)	Good	Good	Very good	**Good (3.66)**
Hapalemur griseus meridionalis	Species (lemur)	Good	Good	Good	**Good (3.66)**
Lemur catta	Species (lemur)	Fair	Fair	Fair	**Fair (2.50)**
Propithecus verreauxi verreauxi	Species (lemur)	Fair	Fair	Fair	**Fair (2.50)**

Estimated overall biodiversity health of Andohahela National Park:

Qualitative = Fair
Quantitative = 2.72 (68.00% *).
*** Percentage is based on possible maximum score of 4.00.**

Figure 1: An example of a composite conservation target map.
This example from Andohahela National Park does not show the species conservation targets, but there distribution is described at length in the Conservation Management Plan.
Note that the PA managers include extensive areas outside the park as corridor maintenance is one of their management goals.
Dark green – Lowland (Eastern Ecoregion) forest, Bright green – Mid-altitude (Central) forest, Dark red – High Mountains, Pale green – Parcelle 1 type Transition between Eastern/Central and Southern Ecoregions, Yellow-brown – Parcelle III type transition, Tan – Southern bush.
Original forest classification map adjusted to conform to management perceptions. Park limit in black.

Carte 2 : Les habitats du Parc et les cibles de conservation



Strategic role of the PA

The results of the biodiversity analysis an assessment of conservation targets (management priorities) can be used to define the strategic role of the PA.

The most important component of role is **biodiversity representation and conservation**. There are many ways to express this, such as:

- Representation of local endemism – only site, or one of very few sites, where particular species, habitats or ecological communities occur in the PA network,
- Representation and conservation of regional centers of endemism and/or diversity – the Ranomafana, Andringitra and Pic d'Ivohibe PAs occur in an identified sub-ecoregional center of endemism and diversity, and comprise an important platform for sustainable management of all natural habitats such as corridors remaining in this center,
- Representation of ecoregional endemism, by conserving a large viable block within a given ecoregion, or by being strategically placed within that ecoregion (the only PA within an area of several hundreds of square kilometers, for example),
- Representation of rare or unusual landscapes (Isalo, Ankarana…) or ecotones (transitions between major ecoregions, such as the northern slopes of the central high plateau, and the transition area between the Eastern and Southern Ecoregions in the southeast).

To put the concept of 'ecological functions' into a reasonable management context, many parks and reserves may also express their respective strategic roles in terms of **ecological goods and services**. For example, many parks are important watershed or water-catchment areas, and their natural forests protect water quality for large regions. Expressing ecological functions in this way, rather than as a conservation target, reflects management realities in virtually all cases: there are generally few direct threats to river systems in the PAs, but it is important to maintain good forest cover to maintain their quality as ecological systems and for human use.

Defining ecological goods and services as part of the strategic role of the park or reserve is universally considered to be vitally important. It provides a means for PNM to present persuasive arguments concerning protected area importance in the country's development when talking to decision-makers or the general public.

Threats

Threats comprise three components: impacts, pressures and sources. Curiously, the TNC system concentrates only on the first two in its planning/monitoring tool, although in supporting papers it does in fact emphasize an analysis of causes. PNM staff consider that splitting threats into the three categories, together with the accompanying methodologies offered by TNC, is a powerful means to analyze and understand the risks faced by a given park or reserve. Threat identification and analysis seems to be one of the easier parts of the conservation planning method. Ultimately, threat analysis facilitates the development of complex conceptual models of different threats, and allows a reasonably objective assessment of (a) the importance of each type of threat, (b) the cumulative level of threat faced by each conservation target, and (c) the overall level of threat faced by the PA. The information can be used to evaluate different threat levels by ecoregion, province or the country as a whole, as well of course at the individual site level.

Threats are identified and analyzed separately for each conservation target. An individual threat can affect several conservation targets and, clearly, each target can face more than one threat.

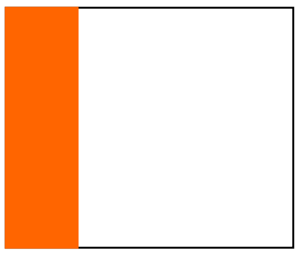
Threats are classified in two possible ways: **critical threats** comprising active or highly likely pressures; and **persistent impacts** where the pressures that created them are no longer occurring but the impact persists. The highest priority is to remove or reduce critical threats as they continue to have negative impacts on the conservation targets. Persistent impacts are treated by restoration strategies once high-level critical threats are under control.

Threats – impacts Impacts are the negative effects of undesirable human activities (pressures). They are first identified with the help of a comprehensive, pre-formulated list of possibilities (impacts can be selected from the list or used as examples to formulate others). Subsequently, their importance is evaluated using two TNC criteria: severity and geographical extent. The results of the two evaluations are combined to give an overall value for the impact using a standardized TNC reference table to combine severity and geographical scope assessments. However, in some cases PNM has a policy of zero tolerance of permanent habitat loss. This is based on a growing awareness that certain forms of habitat loss are in effect irreversible. For example, forest edge loss through fire or clear cutting seldom recovers as the resulting savanna or non-native vegetation remains highly vulnerable to further threats or is unsuitable for native species. In contrast, the same surface area may be lost inside the forest but, if the clear cutting is eliminated, the forest will eventually grow back. This is generally the case where loss is very small, but it may be permanent in certain highly vulnerable habitats such as Western deciduous forests. Where permanent loss is considered likely, the manager may rate the impact at the highest (Very high) of four possible levels of importance. This is similar to the TNC method where an assigned value can be overridden or weighted by the conservation manager. The assessment of impacts frequently takes the viability evaluation of the given conservation target into account. For an example of different ways to view impacts, look at the two potential models in Figure 2.

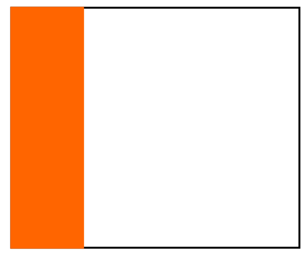
Threats – pressures Once all impacts on a given conservation target are analyzed, the pressures that caused each of them are analyzed. Pressures are analyzed by impact for each conservation target for reason that will become clear. For each impact, the pressure is evaluated using the TNC criteria: contribution to the impact, and the difficulty to control or halt it. PNM follows the TNC criteria closely, but provides more detail to help make the assessment. In addition, TNC's measure of 'difficulty' is evaluated entirely in terms of the financial costs of pressure abatement, but PNM factors in additional elements including resistance emanating from the tenacity of tradition and the involvement of politically/socially influential persons. Using cost as the sole criteria is probably too limited in TNC-managed areas, also. The contribution of a given pressures may vary between conservation targets, even though the impact is considered similar. For example, habitat loss may be the single most important factor causing population reduction in one species, whereas hunting is the most important for others.

Figure 2: Two apparently similar models showing negative impacts on conservation targets but requiring different assessments linked to likely viability outcomes. In Model 1, the impact may be considered less severe because the lemur population in question may recover very quickly once the hunting pressure is removed. In Model 2, natural or assisted restoration of the area of destroyed habitat is considered to be highly unlikely or even impossible as it occurs at the edge of the habitat.

Model 1: the geographical extent of the impact 'population reduction' for lemurs (colored/shaded area), emanating from hunting pressure, wherein no local extinction occurs.



Model 2: the geographical extent of the impact 'vegetation cover loss' for a target habitat (colored/shaded area), resulting from slash-and-burn practices.



Threats – general threat assessments Once all impacts and their related pressures are analyzed, they are combined to assess a range of different overall threat types. The combinations are somewhat difficult to describe but here goes! Firstly, for each conservation target, each impact-pressure combination is assessed using standardized TNC reference tables. The user can retain the 'Very high' status applied to irreversible impacts if desired, in this calculation. This first-level combination is simply referred to as an 'individual threat.' Subsequently, a level of threat is calculated for each active pressure for each target. TNC calls the result 'threat to system rank.' PNM calls it 'threat to target rank' for a stated pressure. The rationale of this analysis is quite clear. As the critical threat (active or likely pressure) is the greater risk of the two possible types of threat, it is identified as the most important part of the threat in question and is the basis for abatement strategies that are eventually developed and implemented.

The final step in threat assessment involves an analysis of all threats to all conservation targets in the PA. This is done by evaluating the importance of each critical threat (active pressure) by target across the entire PA. The results give: (a) an assessment of the cumulative level of intensity for each critical threat; (b) the cumulative level of threat for each conservation target; and (c) the overall level of threat faced by the PA (cumulative value derived from the results of (a)). The values are both qualitative and quantitative, and involve an internal calculation to accumulate risk levels where there are many individual threats. The best way to understand this complex analysis system is to look at the example below (Tables 5 – 7).

Once the threat assessment is completed, the managers may prioritize their activities. Firstly, they set a series of management objectives for the different threats. The objectives complement those designated for each conservation target. We have found it *very* useful to set management objectives separately in this way. Firstly, in most cases, management priorities will concern threat abatement: it is always a priority to reduce or remove threats that continue to cause significant negative impacts. In addition, it is relatively rare that management will concern a direct manipulation of the conservation targets themselves –

Table 5: Analysis of threats, examples – Impacts assessment.

Conservation target: Eastern Lowland Humid Forest (Andohahela National Park)		
Impact	**Geographical scope**	**Importance**
Vegetation cover loss	Medium	**Medium**
Modified structure and composition	Medium	**Medium**
Local canopy loss (linked to lemur tr	High	**Medium**
Habitat isolation	High	**High**

Vegetation cover loss and local canopy loss are probably best combined as a single impact.

These results are transferred to the next assessment table

Table 6: Pressure and threat analysis by conservation target

		Conservation target: Eastern Lowland Humid Forest								
		IMPACTS								
PRESSURES		**Vegetation cover loss**		**Modified structure and composition**		**Local canopy loss (linked to lemur trap setting)**		**Habitat isolation**		**THREAT TO TARGET**
		Mediun		**Medium**		**Mediun**		**High**		
Slash-and-burn	Contribution	Very high	**Medium**	N / A		Very high	**Medium**	Very high	**High**	**High**
(Individual threat) *e*	Difficulty	Medium		N / A		High		High		
	Importance	***High***		N / A		***Very high***		***Very high***		
Selective cutting	Contribution			Very high	**Medium**					**Medium**
	Difficulty			High						
Active pressure	***Importance***			***Very high***						
Fire	Contribution	Low	**Low**	Low	**Low**					
	Difficulty	High		Low						
Active pressure	***Importance***	***Medium***		***Low***						**Low**
Secondary products collection	Contribution			Low	**Low**					**Low**
	Difficulty			Medium						
Active pressure	***Importance***			***Low***						

Each pressure is analyzed in this table (contribution and difficulty combined as importance). If there is no link between a given pressure and impact, no individual threat is calculated.

Individual pressures and impacts are combined to produce individual threats

Individual threats are accumulated to determine the threat to target value derived for each critical threat (active pressure)

Table 7: Analysis of overall threat rank by critical threat and for the entire PA.

The threat-to target-value for each critical threat (last column on right in Table 5) is transferred to the present table for further analysis. Assessment methods have been standardized by TNC. The methods has several mechanisms to accumulate threat levels. The results allow the PA manager to balance the focus between conservation target prioritization and abatement of severe threats. The assessment also provides a descriptive and quantitative measure of threat for the entire PA that can be used in network-wide analyses and evaluation. The threat evaluation is followed by the definition of specific management objectives related to threats. These objectives help to define monitoring and evaluation plans. For example, in the Andohahela case, the managers may decide to reduce the level of all threats combined faced by the target 'Parcelle 1 transition zone' as this habitat occupies a small area and is only represented in this PA. Alternatively, the managers may decide to concentrate on two of the highest threats, fire and slash-and-burn cultivation, as their impacts are often permanent. They may also combine the two approaches to prioritize abatement of these two threats in the Parcelle 1 transition zone.

Persistent impacts are evaluated in the same way in a separate table. However, the results are not incorporated into the overall evaluation of threat to the PA.

	Protected area: Andohahela National Park							
	Conservation targets							
Critical threat (active pressure)	**Low altitude humid forest**	**Montane vegetation**	**Didieraceae bush**	**Parcelle 3 Transition Zone**	**Parcelle 1 Transition Zone**	**Eastern forest lemurs**	**Southern bush lemurs**	**Overall threat rank**
Slash-and-burn cultivation	High			Low	High	Low		**High 20.30**
Selective cutting	Medium		Low	Low	Low	Medium		**Medium 4.45**
Fire	Low	High	High	Low	High		Medium	**High 31.30**
Secondary forest product collection	Low		Faible	Low	Low			**Low 1.20**
Uncontrolled entry and browsing by cattle and sheep			Medium		Low			**Medium 2.30**
Invasion by exotic plant species			Low	Low				**Low 0.60**
Settlement			Low	Low	Medium			**Medium 2.60**
Hunting						High	High	**High 20.00**
Threat rank by conservation target	**Medium 14.30**	**Medium 10.00**	**Medium 12.45**	**Low 1.80**	**High 22.45**	**Medium 12.15**	**Medium 12.00**	**Very high 82.75**

The critical threat (active pressure) of invasion by exotic plants may be best considered as a persistent impact, or both. Field trials will answer this question.

indeed, such direct management is generally discouraged except in a few cases where it is necessary to implement activities aimed at assisting restoration.

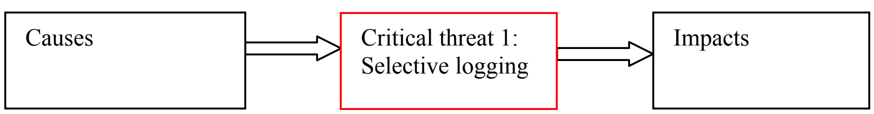
So why define management objectives for conservation targets? Firstly, the objectives are designed to pre-define ecological monitoring indicators. If the objective is to reduce a given threat to facilitate natural restoration towards a 'normal' species balance and habitat structure, it will automatically define ecological monitoring needs. Furthermore, although threat monitoring is generally easier and more rapid that target monitoring, some threats are very difficult to measure directly, and evaluating changes in the target provides an indirect assessment of the effectiveness of threat abatement strategies.

Threats – causes TNC does not include causes (in the PNM sense) in their Five-S planning/monitoring system, but it does place considerable emphasis on it in accompanying papers dealing with their system.

In PNM, the underlying reasons for the different pressures – the causes – are usually analyzed when the managers are developing their strategies and ecological monitoring programs (a more detailed explanation for this is provided later). Causes are identified and analyzed within the context of conceptual models centered on each of the critical threats. The conceptual models can be developed using a wide variety of formats.

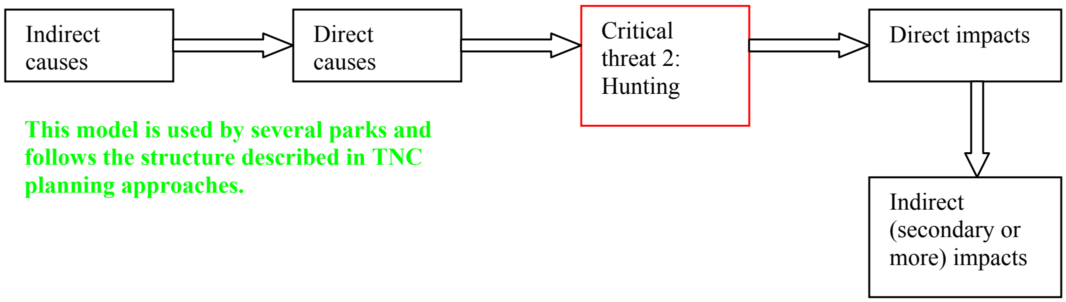
The simplest possible conceptual model format is as follows:

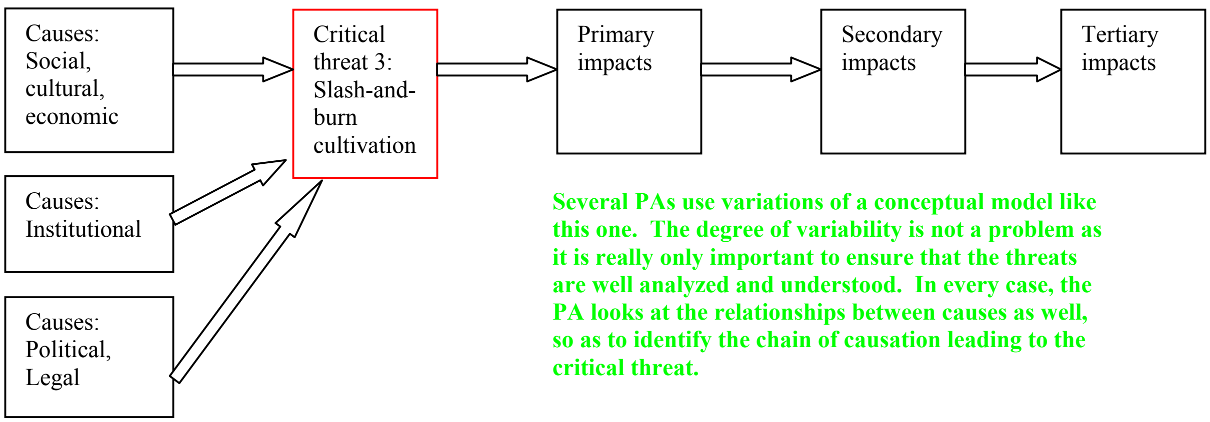
Figure 3: A simple conceptual model of the causes –pressure – impacts chain used to define strategies and monitoring.
It may be noted that individual PA teams develop substantial lists of causes, and no site has as yet used such a simple conceptual model.



To date, no site uses such a simple model, and a wide range of alternatives have been developed. The different forms of conceptual model that now exist in PNM is quite large, but each PA claims that its particular choice helps its staff to reconstruct the cause-to-impact chain in a way that helps them develop clear strategies and monitoring programs. Simple representations are provided in Figure 4, but some real examples will be shown later when strategies and monitoring are treated in detail.

Figure 4: More complex conceptual models of causes – pressure – impacts chains.

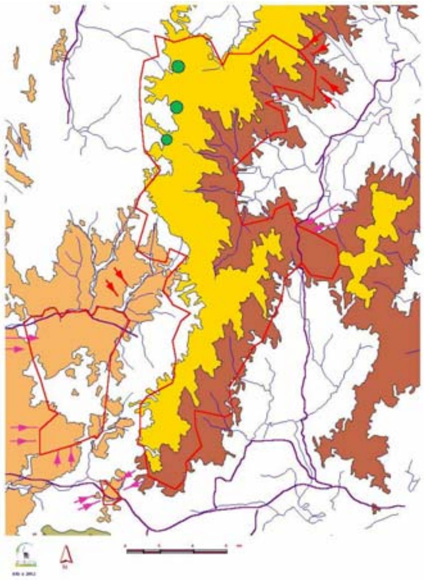




Causes may be the focus of some management strategies – remove the causes and the pressure should be reduced or disappear. It may also be easier in some cases to monitor changes in causes, but if monitoring occurs in this phase of the chain, it will probably be necessary to have some monitoring of key impacts as well.

Threat assessment is accompanied by maps of at least each critical threat. In some PAs, persistent impacts may also be mapped. A composite map showing the cumulative levels of all critical threats is also produced by each PA. An example of a critical threat map is provided in Figure 5.

Figure 5: Mapping threats – examples from Andohahela National Park.

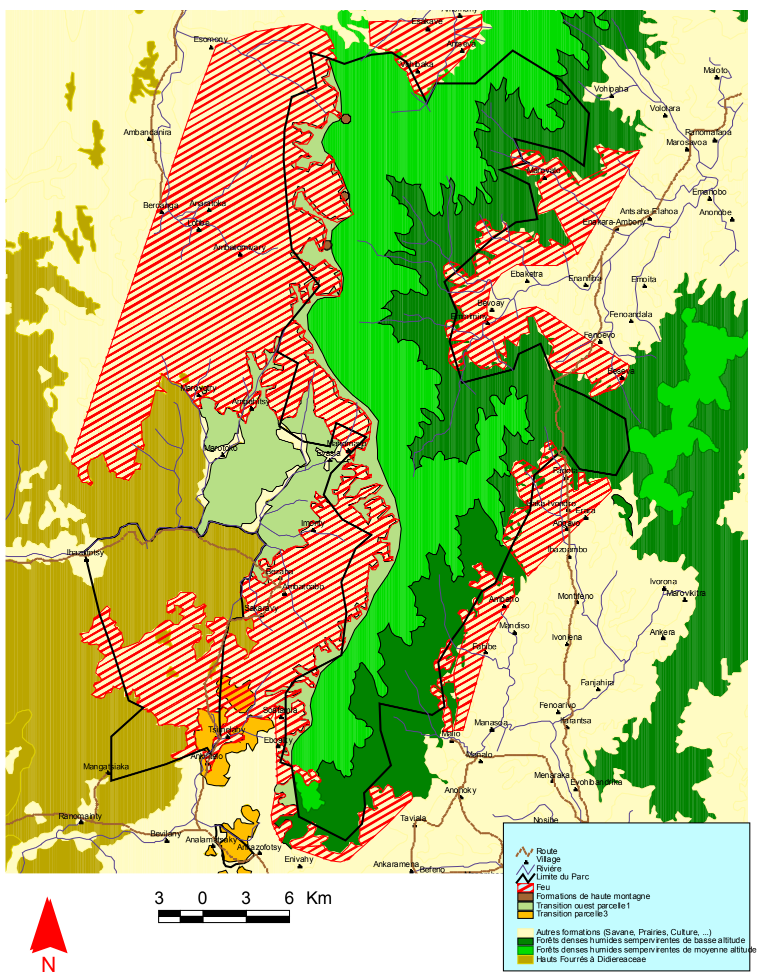


Map at left – Early maps tended to be based on forest classifications derived from Ministry of Water and Forest GIS database, and these often do not reflect management perceptions of habitat variation. Furthermore, threats were often identified as symbols or arrows outside of the PA, whereas most threats occur on the inside. Such mapping has significant shortfalls.

Map below – Using a base-map that has been reclassified to show management priorities (as in Figure 1), we now overlay threats to indicate their spatial relationship with the different conservation targets (example is fire).

A composite map showing the cumulative levels of all threats is also overlaid on the base-maps.

Carte 5 : Feu



Conservation management capacity evaluation

Before considering strategies and ecological monitoring, PA staff carry out a management capacity evaluation with respect to conservation. This is done for two reasons. First, it helps to determine if some fundamental conservation activities or needs are weak, and corrective action is thus needed. Secondly, it also provides a basis for determining where skills and resources are not adequate with regards to leadership and support, management capacity, resources (financial, materials, infrastructures and equipment), and partnerships and communication. The TNC Five-S system concentrates on the second factor only, and PNM has adopted it but has added others based on their specific utility in the context of Madagascar. It is not necessary to describe the additional capacity evaluation criteria used by PNM in great detail, but they comprise:

- **Management information availability and access**
  PNM requires every PA to have four obligatory, updated data sets – pertinent published information and reports, a recent habitat and land-use map, biological inventory data and socio-economic inventory data. Their availability is assessed, together with any obvious gaps in knowledge that are important regarding management needs. The analysis looks at whether information is simply not available, or has not been made available or is unknown to the PA.

- **The evolution of boundary marking and/or modification**
  Each year, a range of PAs include boundary modification and/or marking in their work plans. The present analysis allows the user to define boundary delimitation needs and to evaluate where the park or reserve is with respect to that goal based on a description of steps required to achieve full delimitation.

- **The level of surveillance and practical knowledge of the PA**
  The PA is divided into sectors on the basis of the level of surveillance and practical knowledge of the site's different sectors. Each sector is assessed using for evaluation categories (Fully adequate to Inadequate) and an explanation of each response is provided. Surveillance levels are not strictly determined by frequency of visits as some areas are relatively inaccessible or protected by taboos. Knowledge of the sectors concerns the understanding of the state of the environment and the comprehension of threat levels. The reasons provided for each response help PNM identify management challenges and thus develop appropriate strategies.

The above analyses are used to develop remedial strategies that are accompanied by clearly stated management objectives. Each PA may present them as a specific series of baseline strategies (e.g. an applied research or inventory program) or incorporate them into the wider strategy series developed to protect conservation targets (see below). It is worthy of note that surveillance evaluations led many PAs to propose overflights as a means to ensure adequate protection. We have tested this strategy and found it to be very valuable. For these reasons, the planning manual provides an exhaustive description of proven methods. In addition, many PAs discovered significant areas where knowledge of what is occurring in them is clearly inadequate.

Information gaps and lack of access to, or knowledge of, existing data have been identified as an important obstacle to PA management. The analyses carried out by 30 parks and reserves are currently being used to remediate the problem.

The evaluation results are averaged to provide a measure of conservation management capacity in the PA. The results can be incorporated into the WCPA evaluation framework, or provide an independent check on the latter.

Following several trial runs, the finalized capacity evaluation process caused no problems for PNM staff. Indeed, personnel were repeatedly asked if the assessment was too detailed, but staff insisted that it was a critically important tool to improve management. The formal evaluation of management capacity is in fact one of three assessments made during conservation planning, with the other two being biodiversity health (conservation targets) and level of threat (the evaluation summary was developed by TNC). The conservation management plan thus has a summary assessment table that can be used as a baseline for future monitoring and evaluation (Table 8).

Table 8: An example of a conservation management evaluation summary table.
The summary table is a useful at-a-glance summary of conditions at the time of conservation planning. It provides a basis for monitoring progress and comparing sites within the entire network or in smaller units such as ecoregions. Biodiversity health rank and capacity rank have a maximum possible score of 4.00 and can be expressed as percentages. Threat level estimates have no upper limit as the number and intensity of threats can vary considerably, and percentage values are thus not possible.

<table>
<tr><td colspan="2">Protected area: Andohahela National Park</td><td colspan="2">Location: Tolagnaro (Fort Dauphin), Toliara Province</td></tr>
<tr><td>PNM Ecoregions/transition zones</td><td>Conservation targets</td><td rowspan="3">Biodiversity health rank</td><td rowspan="3">Fair
2.72
(68.00%)</td></tr>
<tr><td>Eastern Ecoregion</td><td>Eastern lowland humid forest</td></tr>
<tr><td>Central Ecoregion</td><td>Montane vegetation</td></tr>
<tr><td>High Mountains Ecoregion</td><td>Didiereaceae bush</td><td rowspan="3">Threat levels</td><td rowspan="3">Very high
82.75</td></tr>
<tr><td>Southern Ecoregion</td><td>Parcelle 3 transition zone, including Dypsis decaryi</td></tr>
<tr><td>Ranopiso Transition Zone</td><td>Parcelle 1 transition zone</td></tr>
<tr><td>–</td><td>Eastern forest lemurs (Eulemur fulvus collaris, Hapalemur griseus meridionalis)</td><td rowspan="2">Capacity rank</td><td rowspan="2">Fair
2.38
(59.50%)</td></tr>
<tr><td>–</td><td>Southern bush lemurs (Propithecus verreauxi verreauxi, Lemur catta)</td></tr>
</table>

Zoning

The Protected Areas Code (COAP) provides specific zoning categories that each PA must adopt. PNM park and reserve staff were initially reticent regarding this task owing to perceived difficulties, but the exercise turned out to be relatively easy. Some PAs have only drawn up provisional zoning plans at this time, as the sites have only recently been accorded personnel, but revised zoning plans are anticipated in the near future.

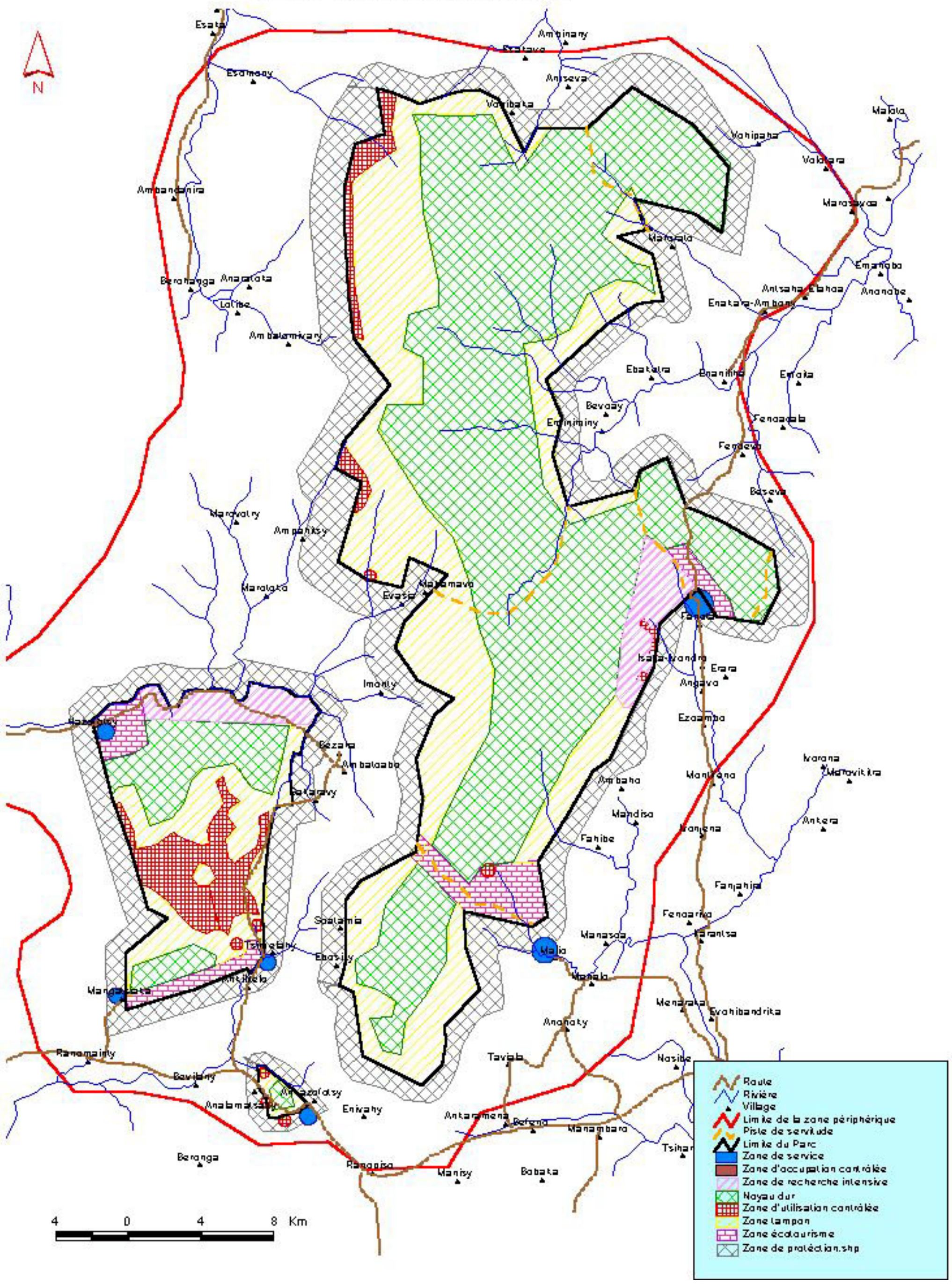
An example of zoning is presented in Figure 6.

Figure 6: An example of zoning from Andohahela National Park.

There are two basic zones within the PA – the strict conservation zone and the buffer zone. The strict conservation zone should include areas occupied by all conservation targets, and more than one area zoned in this way is common. The buffer zone may be further classified, if desired, as ecotourism zones, controlled utilization zones or controlled occupation zones, allowing some use of the PAs resources. Beyond the boundaries, there is a protection zone where park or reserve managers can impose restrictions on activities that threaten the PA, and there is a larger peripheral zone defining areas occupied by neighboring communities that may benefit from development activities supported by the PA or exert a direct influence on the park or reserve (delimited here as a red line).

Zoning is often complex, especially regarding the PA's willingness to respect traditional user rights. However, given the great deal of analysis that PA staff go through to determine community/PA interactions, the zoning appears to represent a valid compromise between conservation and peoples' needs.

Carte 18 : Zonage du Parc



Strategies and ecological monitoring

This final part of the planning process generated very high levels of interest, if not outright enthusiasm. Formulating appropriate management strategies and ecological monitoring programs requires the bringing together of the results of all of the previous analyses.

The TNC Five-S process includes a thorough methodology to evaluate the relative benefits each proposed strategy (its likely impact in terms of critical threat abatement or conservation target restoration). The results of this analysis are then combined with an evaluation of feasibility and cost to rank each strategy in terms of its overall value and likelihood of success. These analyses comprise three steps but we dropped one of them as it does not give the results stated in the TNC manual (our misinterpretation or perhaps a methodological flaw). We checked on this change in process with TNC and they did not consider it a problem as the two remaining steps seem to provide the same final results. An example of the results is provided later in this report.

Initially, we attempted to develop management strategies before moving on to ecological monitoring, but we found it was more effective to tackle both simultaneously for the reasons described below.

We began to develop strategies by setting out **management objectives**. These are based on the earlier analyses of conservation target viability and threat. We encountered no major difficulty with this process, but we did learn very quickly that the objectives had to be expressed essentially as monitoring indicators, or benchmarks, because otherwise we would not be able to evaluate them easily. Subsequently, we began to formulate the strategies themselves and ran into substantial difficulties. Firstly, for reason of institutional history and culture, the same old strategies that reappear every year in work plans and do **not** work were formulated. These strategies were also rather vague and it was obvious that no clear analysis of their feasibility had been undertaken. For some time we were blocked by this obstacle, but TNC's Jeffrey Parrish once again came to our aid. He sent a review document covering TNC approaches to strategy development and ecological monitoring (but not covered by the Five-S system) that we quickly modified and adopted for PNM.

Strategy and monitoring development is greatly aided by using the type of conceptual models presented in Figure 4. An example of such a model from Andohahela is presented in Figure 7. It should be noted that, although the causes and impacts are presented in summary form, their definition involved a highly detailed analysis.

The conceptual models are subsequently used to define potential strategies and ecological monitoring activities. An example is presented in Tables 9 (strategies) and 10 (ecological monitoring), using the conceptual model presented in Figure 7. Once again, analysis of the potential strategies and monitoring are very detailed, even though they are presented in summary form. Detailed planning helps to ensure that park staff do indeed have a reasonably clear idea of what they need to do with respect to management strategies and monitoring.

There are two principal advantages in developing the conceptual model approach. Firstly, PNM staff are required to carry out a very detailed analysis that helps them to:

1. Identify and understand the underlying causes behind each critical threat.
2. Identify more clearly the impacts of a given critical threat, and how the impacts interrelate.

3. Determine relatively easily where their management intervention should be focused – can it be done effectively, and will intervention at this level have the intended knock-on effects that ultimately abate the critical threat?
4. Identify options for ecological monitoring that will evaluate the effectiveness of management strategies (i.e. impact measurements).
5. Set clear benchmarks to measure management implementation, and determine where bottlenecks in implementation occur.

The level of detail that each park or reserve employs to analyze their respective conceptual models is a critically important factor regarding strategies and ecological monitoring. In particular, it helps to avoid strategies that have been presented in numerous PA annual work plans, but are clearly not doable as they are conceptualized. Thus, a commonly overheard question in workshops has been: "We have tried this before; why has it not worked?" An example of this thinking is provided in the text box accompanying Table 9. Essentially, the question forces an analysis of obstacles and challenges that have already been encountered, thus helping to find ways around them.

Secondly, the conceptual model greatly helps with making linkages between ecological monitoring on one hand, and strategies and management challenges on the other. This linkage is made fairly easily once the user sees the model and the table of potential strategies. However, it can be more complicated than that. TNC suggests a framework for approaching strategy and monitoring development based on three basic parameters: (1) knowledge and understanding of biodiversity (including the conservation targets), and thus confidence regarding what impacts different threats may have; (2) confidence in the effectiveness of different strategies; and (3) the level of threat. Monitoring programs may be more structured as applied research programs in cases where (1) and/or (2) are marked by low confidence. For example, if the park manager is not sure how a particular priority biodiversity component reacts to different threats, or what the impacts of the latter are, there may be a deliberate decision to carry out a study to better understand the potential problem. Similarly, if several management strategies have been identified that *may* reduce a given threat, the park may wish to test the efficiency of each strategy rather than simply confirm that the threat has been reduced or that biodiversity health improves. PNM staff find this analysis very helpful.

TNC proposes six different scenarios linking (a) understanding of biodiversity and the impacts of different threats, (b) confidence in strategies, and (c) threat level. They are in order:

1. ***No identified high or very high ranked threats, high confidence in our conceptual model.***
   - ***Focus on simple monitoring of potential new threats.***
2. ***No identified high or very high ranked threats, but low confidence in our conceptual model.***
   - ***As Scenario 1, but some applied research monitoring to detect unknown threats.***
3. ***High or Very High known threats, high confidence in our conceptual model, and a clear strategy is known to be highly effective in abating all known threats.***
   - ***Strategy implementation prioritized.***
4. ***High or Very High known threats, high confidence in our conceptual model, but a lack of clear strategies as to how to abate the known threats.***
   - ***Strategy implementation prioritized. Test alternative strategies.***
5. ***High or Very High known threats, low confidence in our conceptual model, but clear strategies as to how to abate the known threats.***
   - ***Strategy implementation prioritized. Carry out applied research/monitoring to detect currently unknown threats.***
6. ***High or Very High known threats, low confidence in our conceptual model, and a lack of clear strategies as to how to abate the known threats.***
   - ***Strategy implementation prioritized. Carry out applied research/monitoring to detect currently unknown threats. Test alternative strategies.***

Management costs increase through Scenarios 1 – 6, and this can be used to evaluate resource needs depending on the situation at a given PA. For example, it can help to modify the often-cited formula for calculating staff levels based on PA surface area – in cases of high threat levels, complex biodiversity issues, and complex socio-economic challenges, resource needs should be higher.

Figure 7: An example of a cause – critical threat – impacts conceptual model from Andohahela National Park.

(A) Indirect causes
- Attachment to traditional practices
- Subsistence economy with day-to-day need to obtain food
- Poverty
- Lack of interest/ conviction concerning new technology
- Migration
- Rapid demographic growth
- Socially/politically influential individuals who protect law breakers for their own profit
- Poor mobilization of resources for development projects aimed at reducing threats:
  - DEAP[1] funds relatively limited at present (few tourists)
  - Limited PNM MPAP[2] special funds for development projects
  - Difficult to interest several agencies regarding collaborating in favor of park conservation
  - DEAP and MPAP funds management system as yet inefficient

→

(B) Direct causes
- Limited availability of cultivatable land
- Under-production, with low agricultural yields
- Delays in approval and marking of the park's new boundaries
- Difficulty in upholding the law – official reporting of infractions and crimes, and legal pursuit
- Limited legal authority of PNM

→

(C) Critical threat (Active pressure)
Slash-and-burn cultivation

→

(D) Primary impacts
- Forest edge loss
- Forest fragmentation

→

(E) Secondary impacts
- Reduced living space for plant and animal species
- Altered forest structure and composition (during regeneration)
- Risk of establishment or increase in invasive species
- Risk of isolation of the park from other contiguous forest blocks (forest clearance in the northern corridor (Beampingaratra), to the east (Tsitongambarika) and to the west (between

Each conceptual model centers on a given critical threat. The impacts are derived from the assessments of viability of each conservation target and from the threat analyses. The model itself is used to define and analyze causes.
Note that each box in the model is given a letter code. Potential strategies and ecological monitoring activities are derived for each of the boxes, and the user then decides which ones to retain. An example of the potential strategies and ecological monitoring activities for the present model are presented in Tables 8 and 9.

[1] The DEAP comprises tourism entry fees, 50% of which are reserves for community development in the park's peripheral zone.
[2] MPAP comprise mini-projects designed to reduce or eliminate specific threats by providing alternative revenues through environmentally friendly activities. PNM has a special fund for these projects.

Table 9: An example potential strategies derived from the conceptual model presented in Figure 7.
Although the potential strategies are expressed in summary terms, the activities that each implies are thoroughly analyzed (see text box)..
Each category (A – E) related to the relevant box in the conceptual model.
See also Table 10.

	Potential strategies to abate slash-and-burn cultivation
(A)	1. Negotiate, establish and implement partnerships for development projects in targeted communitie
	2. Develop and implement education programs related to projects aimed at threat abatement and rel to locally-acceptable improved technologies.
	3. Lobby targeted influential individuals or those who may in turn influence them favorably.
	4. Increase DEAP funds for development through increased tourism revenues (requires more effectiv marketing of the park within the context of its location in a priority tourism area).
	5. Mobilize MPAP funds available within PNM for specific projects aimed at threat abatement.
(B)	6. Obtain government approval of the new park limits.
	7. Mark the new boundaries in key sectors.
	8. Establish and signpost protection zones and establish appropriate rules for their management.
	9. Implement appropriate management systems at key sites outside of the park.
	10. Integrate the protection zones and their management systems (strategies 8 – 9) in their respectiv PCCs[1] and PCDs[2].
	11. Support local structures (committees, *dina*[3]) in order to promote community-based surveillance of park and other key sites.
	12. Ensure local adoption and application of the COAP (Protected Areas Code).
	13. Strengthen collaboration with partners involved in law enforcement.
	14. Develop and implement awareness/education programs to accompany Strategies 7 – 12).
(C)	Covered by Strategies 1 – 14.
(D)	Covered by Strategies 1 – 14.
(E)	15. Monitor natural forest regeneration at cleared sites within the park.
	16. Implement appropriate management based on forest regeneration monitoring results.
	17. Promote and participate in ecoregional approaches to maintain key corridors.

An example of the analysis carried out to determine strategies – Strategy 1.
Park staff note several key constraints:

1. **PE II Development agencies seldom work in the more inaccessible areas around the park, even though threats may be highest there (a problem in virtually all Eastern ecoregion PAs).**
2. **The park and development agencies often have very different priorities, and threat reduction in PAs is seldom a pressing issue for the latter.**
3. **Since the PE I ICDP phase of park management, development agencies see no interest in working with the PA as the latter is not able to fund their activities.**
4. **Development agency criteria for support are often difficult to respect. For example, a minimum number of beneficiaries must be attained, but few community members are willing to participate as they resist attempts to introduce new technologies.**

The park therefore developed the following approach for Strategy 1:
It is essential to negotiate with the development agencies to demonstrate that joint funding applications are likely to be more successful, and to ensure that the interests of both parties (and the communities) are met. The park must also lobby at provincial and national levels to change agency strategies and priorities – threat reduction in PAs is a PE priority.

[1] Commune Conservation Plan.
[2] Commune Development Plan.
[3] Formal traditional agreements made within communities, between different communities, or between communities and the park.

Table 10: Ecological monitoring activities derived from Figure 7 and Table 9.

	Monitoring (defined as an indicator)	**Description**
(A)	(1) Number of partners and number of projects operational through partnership. (2) Level of investment in development projects.	- Number of formal and operational partnerships for development activities of interest to the park. T_0 comprises (a) the number of partnerships in 2002, and (b) the number of partner-based projects in 2002. - At T_0 (2002), the park had a disposable DEAP of FMG 16,595,800 (50% of total DEAP revenues) which have not yet been used for development. The park's objective is (a) to increase available development funds to FMG 65.000.000/year within five years, and (b) to have 100% DEAP spending in the same time frame.
(B)	(3) Boundaries official and signposted. (4) Surface area of forest at key sites outside of the park and managed under formal/informal agreement, and where clearance is prohibited. (5) Number, percentage and success of legal actions against offenders. (6) COAP approved and applied. (7) Number of protection committees participating in park surveillance, and number of operational *dina* interdicting forest clearance.	- At $T_{0,}$ the boundary modification proposal has been presented to the central government for approval. Boundary marking should await approval, but the population knows and recognized the new limits (agreed by communities and the park together). - At T_0 (2002), xx ha of natural forest outside the park and in the le Tsitongambarika Corridor are targeted for community management. The park's target sites are Ambolo, the Beampingaratra Corridor, Tsitongambarika Forest, and to the west of the humid forest areas of the park (between Parcelles I and II). Results will be considered: Very good if the percentage of targeted forest that is managed is >90%, Good if 76 - 90%, Fair if 51 - 75%, and Poor if <50%. - This monitoring includes three elements: reporting, charging offenders, and judgment. To date, these actions depend on the collaboration of the Ministry of Water and forests (MEF) and the courts. Measurement criteria are: (1) number of judgments/number of charges, (2) number of charges/number of offences given to MEF. The T_0 comprises results obtained in 2002, (to date (August 2002) no charges have been made). The results will be considered to be: Very good if >90%, Good if 76 - 90%, Fair if 51 - 75%, and Poor if <50%. - The COAP is awaiting final government approval. - The T_0 is based on levels during 2002. There are currently committees in every village in the peripheral zone and most are operational. Xx *dina* have also been established and xx are operational.
(C)	(8) Surface area of forest clearance in the park. (9) Surface area of forest clearance in the park's external protection zone.	- The T_0 is the mean annual surface area of forest cleared during the PE II. Monitoring will be continual, and summarized at the end of each year during the PE III. The park aims to reduce forest loss relative to that of the PEII, with results, when compared to mean annual rates during PE II, being judged as: Very good if <10 %, Good if 10 – 25%, Fair if 26 – 50%, and Poor if >50%. The methods will include use of satellite imagery and ground verification. - The T_0 is the average annual surface area recorded during the PE II. Monitoring will be continual and results reviewed at the end of each year during the PE III. The management objective is to reduce forest clearance to levels below that of the PE II. Results will be evaluation as Very good if <10 %, Good if 10 – 25%, Fair if 26 – 50%, and Poor if >50%. The methods will include use of satellite imagery and ground verification.
(D)	--	- Monitoring proposed for (C) and (E) will provide information relative to (D).
(E)	(10) Condition of the vegetation in regeneration zones. (11) Continuity between the park and key natural vegetation corridors.	- Monitoring will involve periodic verification to detect no new threats. If no new perturbations appear, we assume that natural regeneration is occurring 'normally.' The park routinely monitors regeneration in fixed plots in order to understand natural dynamics after clear-cutting. More detailed analysis of regeneration will be carried out if partner institutions are prepared to undertake this task. - Monitoring will consist of a verification of: (a) continuity between the park and its corridors, and (b) the continuity of the different corridors. Monitoring (a) will be based on satellite image analysis and ground verification, while (b) will be carried out using images only. Satellite image analysis is the responsibility of the DIR-U (PNM's Toliara Inter-Regional Office). The T_0 is the state of the corridors in 1999 or 2000 (depending on satellite image availability). We note that the corridor between Parcelles I and 2 is barely continuous.

It is worth pointing out what is meant by 'strategies' within PNM as their content is determined by analyses that we carry out within the TNC Five-S method. There is a need to ensure that each strategy is defined in such a way that it can be readily analyzed in terms of benefit (positive impact with respect to threat reduction or restoration value), feasibility and cost. Thus, if one considers a strategy to be a broad approach encompassing many complementary activities, it may be too complex to analyze: if some steps are inexpensive while others require substantial funds, mixed with a series of activities that are easy to implement while others involve numerous complex challenges, analyzing the strategy using the three components may not be realistic. PNM therefore uses simplified strategies that comprise a small number of easily analyzable activities. There appears to be no problem with this approach, and TNC reports that there is a debate on how to best deal with the issue, as well. It is simply important that the PNM user understands very clearly what each strategy means in terms of implementation.

The analysis of strategies is carried out in two steps. The first measures the strategy benefit, and the second measures overall value by adding in feasibility and cost. The Five-S method seems to be complex at first glance, but PNM have found it to be of considerable interest.

TNC measures strategy benefit with respect to its ability to abate threats or bring about restoration. The method looks at whether a given strategy will reduce a given critical threat or persistent impact for each conservation target. For example, a strategy may aim to reduce the threat of uncontrolled fire, and that threat may impact several conservation targets. We use the TNC method, but have had to adapt it to local conditions.

The TNC method begins by asking: "Does the strategy in question reduce the given threat by a full level (e.g. Very high to High), yes or no?" Only those that have "Yes" as a reply are included in the analysis of benefit. In practical terms, such an outright yes/no response to a full level of threat seems to be too rigid in Madagascar, so we modified our approach. The method is best understood by looking at Table 11. In brief, the strategy benefit is derived from the level of threat. Firstly, every (potential) strategy is listed in Table 11 (Step 1 in Table 11). Each threat that may be reduced by a given strategy is listed against it, by conservation target (Step 2), taking the latter information from Table 7. Using the TNC method, if the strategy will reduce the threat by a full level, then 'Yes' is the response, and the level of the threat is transferred to the strategy (Step 4). PNM users have found that few individual strategies can be assessed so clearly, and an alternative approach was necessary. It is possible that the PNM 'strategies' are defined more narrowly than those of PNM, or it could be because multiple strategies are required to reduce threats to Malagasy PAs. We therefore decided to allow more flexibility in ranking strategies.

We increased flexibility by saying: "If a strategy is among several that together reduce a threat, assess its relative contribution to abatement and so modify the benefit allocated to the strategy." Thus, if three strategies are related (improved surveillance, education and outreach, and support to development), PNM users assess the contribution of each to threat abatement (say, slash-and-burn cultivation). If the most important strategy is believed to be improved surveillance, its rank would be higher than those of the other two strategies.

Let's say the threat is ranked as 'Very high.' Improved surveillance alone will not reduce the threat to 'High', but as it is the most effective strategy we will assess its benefit as 'High.' Support to development may be the next most important and is assessed as 'Medium,' while education could be assessed as 'Medium' or 'Low.' The assessment of strategy benefit can only be lower than the level of the threat in these cases, and PNM has reasonably clear guidelines covering the assessment method.

Table 11: An example of the analysis of strategy benefits with respect to critical threat abatement or biodiversity restoration.
Only one strategy is analyzed here, but the exercise is repeated for each one. If a strategy reduces a threat by one level (High to Medium…), it is included in the analsys of benefit. It is rare to have a strategy reduce a threat by a full level in Madagascar, so PNM modifies the approach (see Steps 3 and 4).

Andohahela National Park		Eastern lowland humid forest		High altitude vegetation		Southern bush		Parcelle 3 Transition		Parcelle 1 Transition		Eastern forest lemurs		Southern bush lemurs		Strategy benefit by threat	Overall strategy benefit
Strategy	Criticalt hreat	Current threat status	Abate ment? Y/N	Current threat status	Abatem ent? Y/N	Current threat status	Abatem ent? Y/N	Current threat status	Abate ment Y/N	Current threat status	Abate ment? Y/N	Current threat status	Abate ment Y/N	Current threat status	Abate ment? Y/N		
S	Slash-and-burn	High (Fair)	Y					Low (No value)	Y	High (Fair)	Y	Low (No value)	Y			Fair	**Fair 8.90**
	Cutting	Fair (Low)	Y			Low (No value)	Y	Low (No value)	Y	Low (No value)	Y	Fair (Low)	Y			Low	
	Houses					Low (No value)	Y	Low (No value)	Y	Fair(Low)	Y					Low	
	Forest product harvest	Low (No value)	Y			Low (No value)	Y	Low (No value)	Y	Low (No value)	Y					No value	
	Hunting											High (Fair)	Y	High (Fair)	Y	Fair	

Step1: List the strategies in order. Strategy 1 is: Negotiate, establish and implement partnerships for development projects in targeted communities. Andohahela has 28 strategies, and each is assessed in turn.

Step 2: List each threat that the strategy targets. All relevant threats are listed for Strategy 1 before moving on to Strategy 2.

Step 3: List the rating of each threat/conservation target combination. This information is available in Table 6. For example, slash-and-burn cultivation is a low threat to Parcelle 3 Transition.

Step 4: Assess whether the strategy will reduce the threat by at least one level (High to Medium…) – Yes or No.
The TNC method only allows 'Yes' if the threat is reduced by a full level. The strategy then takes on the value of the threat in question as its value in terms of benefit.
PNM finds this assessment too severe as usually several strategies must act together to reduce a threat by a full level. Therefore, PNM can assess a lower benefit value so that a strategy reducing a 'High' threat but by less than a full level can be given a benefit rank of 'Medium' or 'Low', depending on its relative contribution. (Modified values in brackets).

Step 5: Assess the benefit of the strategy with respect to a given threat. The method is identical to that used to assess each threat (Table 6) using the same accumulation process.

Step 6: Calculate the overall benefit of a given strategy. Values are qualitative (High…) and numerical. The result is transferred to Table 11for further analysis.

Table 12: Assessing the overall value of strategies.
Once the overall strategy benefit is calculated in Table 11, the value is transferred to either 'Benefit – threat abatement' or 'Benefit – restoration' in the present table. Subsequently, benefit is further assessed in terms of leverage to provide an overall benefit value, then feasibility and cost analyses are added to rank the strategy in terms of its overall value. Example from Andohahela National Park. Only seven of the park's 28 strategies are assessed.

	Benefits				**Feasibility**			**Cost**	**Overall strategy value**	
Strategy	Benefit – threat abatement	Benefit - restoration	Leverage	**Overall benefit**	Management capacity	Ease of implementing	**Overall feasibility**	**Overall cost**	**Qualitative rank**	**Numerical rank**
1. Negotiate, establish and implement partnerships for development projects in targeted communities.	Fair		High	**Fair**	High	Fair	**Fair**	**Fair**	**Fair**	**3**
2. Develop and implement education programs related to projects aimed at threat abatement and related to locally-acceptable improved technologies.	Low		Fair	**Low**	High	Very High	**High**	**Fair**	**Low**	**4**
3. Lobby targeted influential individuals or those who may in turn influence them favorably.	Low		Fair	**Low**	High	High	**High**	**High**	**Low**	**4**
4. Increase DEAP funds for development through increased tourism revenues (requires more effective marketing of the park within the context of its location in a priority tourism area).	Fair		Fair	**Fair**	High	High	**High**	**Fair**	**Fair**	**3**
5. Mobilize MPAP funds available within PNM for specific projects aimed at threat abatement.	Fair		Fair	**Fair**	High	High	**High**	**Fair**	**Fair**	**3**
6. Obtain government approval of the new park limits.	Fair		Fair	**Fair**	High	High	**High**	**Fair**	**Fair**	**3**
7. Mark the new boundaries in key sectors.	Fair		Fair	**Fair**	High	High	**High**	**Fair**	**Fair**	**3**

However, strategy benefit assessment remains one of the least convincing components of the TNC system (but perhaps we have not fully acquired the expertise to use it correctly). We have battled with the method through several workshops, but PNM personnel always come back to the modifications above, and feel reasonably confident regarding the utility of the method.

PNM feels slightly uncomfortable with the assessment of benefit based on a straight transfer of threat level to strategy benefit. Justifiably, the question that is often raised is: "We eliminate a 'High' level threat to zero but can only rate the strategy benefit as 'High', but we reduce a 'Very high' threat to 'High' and give it a higher rating. Is this a valid assessment?" We will be exchanging ideas with TNC on this one. Furthermore, the analysis becomes difficult when comparing the relative benefits over different timeframes. For example, improved surveillance may provide rapid improvements, but is it really more effective in the long-term than support to community development or environmental education? Whatever the inherent weaknesses, it is the process of analyzing the potential value of strategies that is more important than the result.

Once the strategy benefit/individual threat is decided, it is a straightforward process to accumulate the benefit of each strategy relative to a given threat (Step 5) and the overall benefit of the strategy relative to all threats (Step 6). These two steps follow exactly the same methodology used for threat assessment (Table 7).

The overall strategy benefit is transferred to Table 12 for further analysis, either with reference to critical threat reduction or to persistent impact. Subsequently, leverage value (contribution to other strategies and threat reduction, or high-profile results) is calculated and the two results combined to provide a measure of overall benefit. Feasibility analyses that follow comprise an assessment of management capacity (leadership, experience…) and ease of implementation. The final assessment concerns cost. TNC uses monetary criteria, but PNM uses the likelihood of funding allocation or risk of reallocation of resources to other sites or activities. We opted for this approach as experience tells us that certain threats may be costly to reduce, but they may be so high profile that funds will be allocated. Controlling sapphire exploration in Isalo National Park is a good example – the strategy adopted was expensive but extra donor funds were found. We mentioned this approach to TNC and they are considering its merits.

Describing PNM's adoption and minor modification of the TNC Five-S system should not end before some further consideration is given to monitoring, as the latter has been a consistent problem in Madagascar and other national park services.

Monitoring, evaluation and applied research comprise the sector where PNM users have gained the most from the Five-S system. Firstly, it is now fully appreciated that well-analyzed information on the PA is a critical factor, and that it is intricately linked to effective management. It is clearly vital to know what damage threats are causing to the environment, and what specifically is being affected. The analysis of conservation target viability and threats combine to provide this information, and the introduction of the notion 'impact' is especially useful. Secondly, the development of the conceptual model linking viability to threats (Figure 4) allows the PNM user to decide how best to allocate management resources and to monitor their impacts on biodiversity health **and/or** threat abatement. The choice presented by the latter has greatly helped PNM move away from the notion that ecological monitoring must measure changes in the environment only through a series of biological indicators towards a clear view that monitoring must assess the effectiveness of management. If threats can be shown to be reduced or eliminated, management can be judged to be effective, confirmed by some well-targeted measure of the environment.

The change in mindset is leading to some radical shifts in monitoring approaches. The current use of static plots and fixed transects to obtain 'scientific' data used to compare 'threatened' forests with 'non-threatened' forests is in rapid decline. (Set up one or a few plots to monitor illegal logging, and the loggers will move to another part of the park!) With IRG/PAGE input, we have analyzed the data from such monitoring and found that variation linked largely to methodological difficulties arising from small sample sizes and working in dense forests generally exceeds any natural fluctuations in nature or masks real trends in population size, habitat structure and the like. Again with IRG/PAGE input, we are moving towards the development of simplified yet hopefully effective methods that, in most cases, require little or no scientific expertise or modification of normal work schedules to monitor key parameters. An example is provided in Figure 8, where earlier field trials of standardized scientific methods for lemur populations proved to be ineffective. The method adopted at present depends only on the frequency of encounters and does not need specialized training for park staff.

A series of such simplified methods for direct measure of biodiversity health is currently being developed, based on published reports from different protected area systems throughout the world. Similar methods are also being established to measure threat levels, where this is possible.

In most cases, a given protected area will develop a monitoring program that measures both threat levels and biodiversity health. Monitoring threat levels has the advantages that results are usually quickly obtained and easily understood by managers. If monitoring shows a drop in threat, it is reasonable to assume that new or modified strategies are effective. However, some threats are not easy to detect directly. Such is the case for lemur hunting or subsistence levels of tortoise harvesting. In these cases, it seems to be preferable to opt for direct monitoring of the conservation targets themselves (population size, structure, timidity).

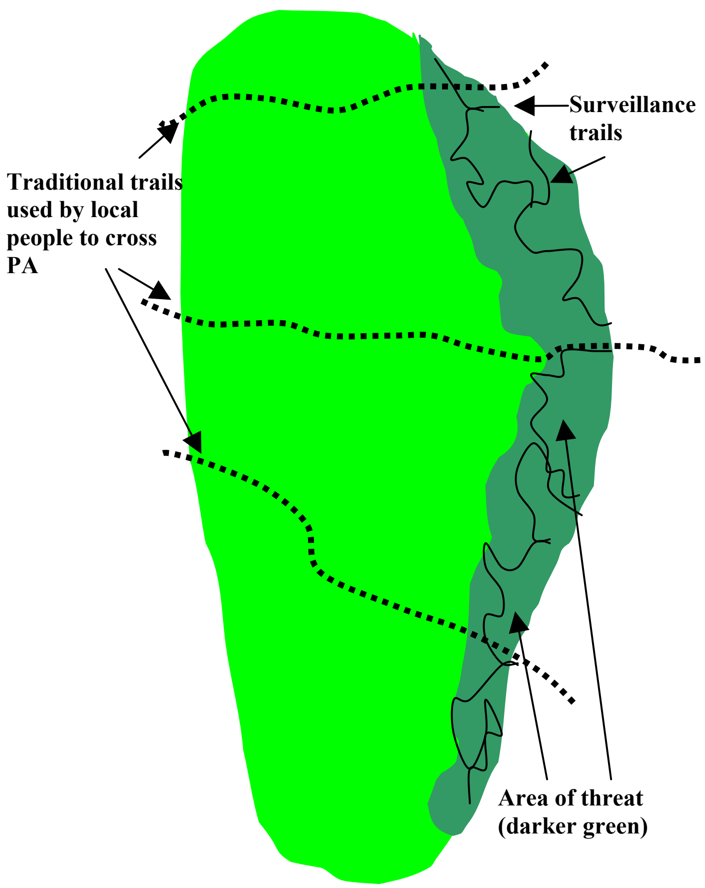
Direct measurement of the conservation target does, however, often suffer from slowness in obtaining meaningful results: monitoring regeneration after heavy selective cutting could take years in slow-growing Western forests, for example. The data obtained may be somewhat difficult to interpret for non-scientific protected area managers as well. Notwithstanding these constraints, direct monitoring of biodiversity health through the conservation targets or through more generalized indicators is important. Firstly, it is the most direct means of verifying management efficiency in terms of positive conservation impacts. Secondly, it may be easier to obtain an early warning of new or unknown threats using this approach, as direct threat measurement tends to focus on a single pressure at a time.

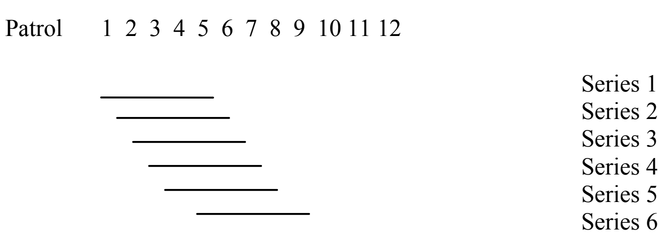
For some aspects of threat monitoring, we will be testing a self-evaluation method known as threat reduction assessment (TRA) developed under the auspices of the Biodiversity Support Program (a USAID-funded program implemented by WWF, TNC and the World Resources Institute, WRI). The method is relatively simple to implement and can produce results concerning threat abatement relatively quickly and in an easily understood format. Although to a large extent subjective, it would appear that the method is widely accepted.

Both threat and biodiversity monitoring can be used to test management hypotheses or specific strategies. With respect to the latter, several strategies may be tried to see which are the most effective. Different strategies can be applied in different sectors of the protected area, and the manager can use monitoring results to decide which are best.

Figure 8: An example of simplified monitoring to track the impacts of hunting and other pressures on lemurs.

The method is based on a simple determination of management objectives that pre-dermine the monitoring to be adopted. Most PAs set clear objectives over different time periods.





The patrols can be grouped into series (here they are in groups of five consecutive events). Grouping reduces the problem of variation in encounter frequencies linked to seasonal changes and weather. No sophisticated recording system is required as the ranger simply records all encounters without reference to a complex transect system or estimation of group size.

Management objectives:

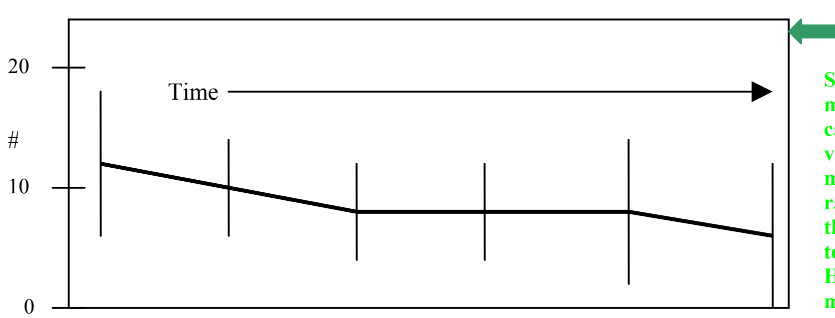
1. No local extinction within existing species range.
2. Reproduction continues in areas of high threat.
3. Population remains stable in non-threatened area.

Methods:

Rangers (ACEs[1]) carry out routine patrols in the area of high threat. As thy do so, all encounters with the targeted lemur species are recorded. The record may be a simple record of presence, or may note the number in a group and the presence of juveniles carried by females (in the appropriate season). After a certain period, normal changes in encounter frequency can be determined (seasonal changes…) and thresholds for detecting change can be set. For example, it may be found that in a given series of, say, five patrols three encounters are normal. If there is several time series where the number falls below this threshold, a problem can be reasonably deduced. Similar thresholds can be set for the frequency of juvenile records in the appropriate season.

The frequency of patrols in the threatened area may be variable, but is probably 1 – 3 months.

These data can be compared to encounter frequencies noted in the area of low/inexistent threat (protected by local taboos or largely inaccessible) where encounter norms for a healthy, undisturbed population can be obtained. A single annual transect on the traditional trails can provide these data, together with an early warning detection system to detect changes in the geographical extent of threat.



Comparison with 'scientific' methods.

Standardized primate density sampling measures variance (vertical bars) that can be due to weather conditions, visibility, etc. As a rule of thumb, if the means remain within the variance range, there is no difference between them. In this case, there is thus no way to tell if numbers are really declining. However, in some circumstances this method may be the best option.

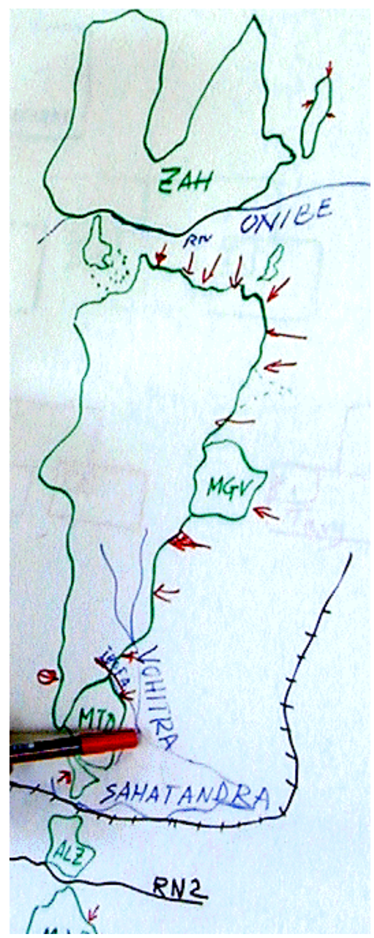
Mapping and spatial analysis

It is fair to say that the roles of GIS and PNM’s Protected Area Information System (SIAP) have been considerably clarified as we developed conservation management plans. In earlier times, SIAP tended to function as a rather remote entity within the organization that requested data from parks and reserves for overall network monitoring, but seldom provided a direct management services to the protected areas. This situation improved markedly when SIAPs were established at the DIR level, but it was clear that the relations between protected areas and these units still could be more productive. Through conservation planning, it became very clear that a major function of each SIAP is to provide a service identified as a particular need by park managers themselves – in this case maps that show the locations of major habitats, conservation targets and the location and intensity of different threats. Preliminary mapping begins with sketch-maps (Figure 9) that are then transformed in to GIS formats (such as Figures 1, 5 and 6).

Figure 9: A clear understanding of the utility of mapping and spatial analysis grew very quickly as conservation planning workshops evolved. This in turn provided a clearer relationship between the SIAP as a service provider and the park manager as the user.

Left: The Conservation Chief for the Andasibe PA complex presents a threat analysis for the Moramena Corridor during a Toamasina Province workshop. Right: Detail from the picture at left. Note that the often overlooked Mangerivola Special Reserve (MGV) plays a pivotal role in this priority corridor and that most of the threats emanate from the eastern side of the PAs and corridor (shown by red arrows), a feature typical of Eastern Ecoregion parks and reserves.

Right: Such simple sketch maps of individual threats are used to generate more precise and elegant GIS maps.



Early planning workshops indicated that spatial data to analyze conservation targets or threats was seldom carried out in any level of detail. However, this situation rapidly improved as we brought SIAP staff into the workshops and had them take a direct role in mapping. In the majority of cases, it is now the park director or head of conservation who determines the information that is included on a given map, following guidelines set by the Head Office to help standardize the products.

One notable shift in culture is the idea that maps are conveyers of information that help managers understand the situation, or help other interested parties gain a clear picture of the park, its context and its management priorities. There is less of a tendency to view maps as highly precise tools: many maps may not adequately reflect reality on the ground. For example, threat mapping has in the past been indicated by a limited number of symbols or by points where they have been accurately recorded using a global positioning system (GPS) unit, whereas most conservation managers known reasonably well the *general* spatial extent of most threats and thus can convey a more usable image of where they occur. This is not to say that precision mapping is discouraged – far from it – but rather to promote the notion that maps are *management tools* that have a very high practical value insofar as helping to determine what to do, where and why.

Beyond parks and reserves – the protected areas in a broader landscape context

The majority of protected areas extend the conservation planning process to at least the outer edges of the external peripheral zone (usually 2 – 5 km from the boundary). However, some parks and reserves feel that is of considerable importance to go beyond these rather narrow confines, and to consider the protected areas in a larger landscape context.

Such is the case for the protected areas in the Moremena Corridor area (Moramanga, Toamasina) – Zahamena, Mangerivola, Mantadia and Analamazaotra, where the PA managers want to complement individual site plans with a broader corridor conservation plan. Similar landscape approaches are being adopted at Andohahela (within the context of the Anosy planning region), Tsimanampetsotsa (Mahafaly Plateau), Ranomafana – Andringitra – Pic d'Ivohibe (Fianarantsoa Corridor), Bemaraha (Melaky), Mananara Nord – Masoala (Antogil Bay region and extending north to Marojejy), Anjanaharibe Sud – Marojejy, and Ankarana – Analamerana.

These sites and their approaches conform closely to proposed landscape-scale interventions presented in the Plan GRAP.

SPIN-OFFS

Developing conservation management plans throughout Madagascar has had some significant positive impacts, both within PNM and among some of its partners.

Information management

As already mentioned, lessons learned from conservation planning has greatly improved understanding of information needs within PNM. Some of the most important lessons are that the SIAP must be a tool that supports planning and evaluation, and that the SIAP must at least in part be a service provider for protected area managers. Advances in conservation planning were instrumental in leading to a workshop on information management, where PNM participants developed a much clearer notion of what information management is, and what use it is to them. Prior to this, there was a marked tendency to think of information management as a series of static databases of little practical use.

As also noted earlier, the concept of ecological monitoring as a management tool has been greatly clarified. In particular, there is now a much clearer understanding of the importance of measuring the **impacts** of management on conservation – earlier monitoring tended to focus almost exclusively on verifying implementation.

It is now clear that information needs must be clearly targeted to be of use to management. In addition, gap analyses in the evaluation part of conservation management has led to a call for greater coordination between management levels to ensure that information pertinent to conservation needs flows more readily to the field sites themselves.

Landscape or ecoregional partners

WWF's Ala Maiky Program in the Southern Ecoregion now uses the TNC Five-S system to plan and develop monitoring, and has adopted most of the modifications made by PNM. Using the same methodological approach clearly helps to improve mutual understanding and collaboration. Where the two organization's planning overlaps spatially, it will also be interesting to see how perceptions and priorities converge (or differ).

Impacts on other operational management planning approaches

Several protected areas urged PNM Head Office and MIRAY to provide similar planning support for community development activities and environmental education. Manuals for these two management themes have subsequently been drawn up and are currently being field tested. Their respective planning approaches are based on the analytical methods used for conservation management, and the manuals were developed with the full participation of park and reserve staff. However, the consultants who helped to develop the manuals had neither the luxury of a well-developed model from which to work (the equivalent of the TNC system) nor as much time to test and refine their contents. Hopefully, the resulting documents will however provide solid platforms to improve development and education planning processes.

LESSONS LEARNED

Several lessons can be drawn from the lengthy process of developing conservation management plans. Some of the lessons listed below concern conservation management directly, while others are more indirectly related. Some lessons are drawn directly from the conservation management planning process, while others are based on the authors' wider experiences.

- **Often recurring management bottlenecks exist that are critical to conservation objectives.**
  - Perhaps the most common bottlenecks occur with respect to boundary re-delimitation. Once the process moves from the protected area to the DIR or the Head Office, it stalls in many cases. In addition, there is a serious bottleneck concerning the allocation of approved budgets to the site, and known staffing short-falls often remain unanswered. It is possible that these problems are related to a lack of clarity regarding staff responsibilities and a lack of prioritization given to the needs of individual parks and reserves.

- **Which are best – highly complex management systems or simplified approaches and methods? (1) The case for complexity.**
  - Intuitively, it would seem that a less complex planning system would be most appropriate for a relatively new and inexperienced organization such as PNM.

However, our early trials using different approaches of varying levels of sophistication and complexity quickly led to an institution-wide decision that very thorough systems were likely to provide better results. PNM staff felt that thorough analyses would greatly improve their understanding of priorities (the conservation targets), the threats that had to be dealt with, the means to achieve desired results (the strategies), and the means of measuring success (monitoring). "Is this too complex?" was continually asked through the workshop series, but the answer was always a resounding "No!" Watching PNM staff working during workshops, and seeing draft plans develop, clearly indicated that their knowledge of their respective protective areas, together with the management challenges that they face, was significantly improved. For example, it is of particular note that earlier threat analyses did not include any consideration of negative impacts of pressures on the environment, thus limiting understanding of the relative importance of different pressures. Similarly, analyses that link causes to critical threats were generally superficial in the past. The manner in which PNM adopted the highly complex (modified) TNC system may be related to the high proportion of personnel with a technical background such as in forestry or agriculture. It is of interest to note that PNM field staff specifically requested manuals for development support to local communities and environmental education that used a similarly sophisticated approach as that adopted for conservation management.

- **Which are best – highly complex management systems or simplified approaches and methods? (2) The case for simplicity.**
  - Based on the experience of IRG/PAGE support to biodiversity planning at a regional scale and on conservation management development, it is critically important to establish viable ecological monitoring systems that are as simple as possible. Complex monitoring methods require high-level scientific training and it will be difficult to ensure at the site level for the foreseeable future. Rangers do not have the training necessary, and very few collaborative programs with research institutes provide useful monitoring information. Furthermore, there are very few well-trained scientists within PNM. Simplified effective monitoring stands in contrast to the nature of the very focus of its attention, namely the ecological processes that are at present poorly understood and, in many cases, require biologists to clarify. Another area of PNM operations that requires simplification is technical reporting of both implementation and management impacts. Measures of management impact within PNM are still underdeveloped and a significant proportion may not address the real issues at hand. Implementation monitoring (Did we do what we said we would do?) are overly detailed and excessive reporting time is a major burden to PNM staff. The balance between implementation and impact monitoring/evaluation appears to a significant problem within the NEAP as a whole.

- **PNM's capacity to provide scientific support to parks and reserves has improved in some sectors but remains too low.**
  - Besides the above mentioned overall low capacity for science within PNM, there are no scientists based at the level of the DIR, and only a few larger parks have scientists on their staff. Conversely, there are three biologists in the Head Office in Antananarivo. Few management units within PNM have the trained personnel capable of developing solid, mutually advantageous partnerships with research institutions and, in consequence, much research has little direct relevance to management. Some provinces, however, have benefited from collaboration with external scientists, often by actively seeking out partnerships and/or through a recently improved understanding of basic research needs. Such collaboration has mostly concerned inventories. One area that has greatly improved concerns geographical information systems, or GIS. Most PNM specialists in this field, the SIAP, provide information that the parks and reserves themselves have required as a management need, rather than the previous approach of driving information gathering from management units at higher levels than

the protected areas. The area of greatest interest that is still poorly addressed by research is probably the development of a sound understanding of the impact of threats on key ecological processes and/or priority conservation targets.

- **Setting clear visions, management goals and benchmarks, is critically important to any process-type programs within the NEAP.**
  - The conservation management planning process remained somewhat abstract until all analyses were put together to define management goals and the strategies to achieve them. Only when goals were set in the form of unambiguous monitoring indicators to measure success could the parks and reserves analyze the linkage between management challenges and the likely effectiveness of various potential strategies. It was especially helpful to set management goals over differing time periods. Thus, a long-term vision such as maintaining natural forest cover between two parks to reduce the likelihood of local extinctions provides a means for the site managers to ensure that their shorter-term goals are constantly orientated to the longer-range objectives. As in development interventions and environmental education, success in conservation is difficult to demonstrate, and that difficulty may have serious repercussions concerning credibility among donors, political decision-makers and the general public. At present, not all PNM protected areas can set clear benchmarks linked to projected time periods, but this difficulty is a priority for future development of conservation management. Similar challenges are apparent in regional development programs.

- **Defining the 'product' to be provided to the client is critically important.**
  - Agencies supporting organizations such as PNM deliver a wide variety of products including assistance for the development of 'processes' (e.g. regional planning) to the production of management 'tools' (e.g. maps). Both are valid, depending on circumstances. However, the positive impacts of processes are notoriously difficult to monitor, often because they are linked to vague management objectives. Conversely, 100% success may be claimed if a tool is delivered to a client while, at best, positive impacts resulting from the availability of the tool are only assumed. In the case of conservation management, we thought initially that the principal product would be the planning manual, leading to knock-on effects on the quality of management in the field. However, it quickly became apparent that the manual was only to be a small part of the product – the complex TNC planning system could not work as a stand-alone product, but had to be bought into by PNM staff and continuously adapted to meet local needs. Indeed, the manual and the process that it describes are considered to be PNM's own product, notwithstanding PNM's recognition of TNC's broader ownership. The products thus became (i) improved planning (and, hopefully, implementation) capacity, (ii) 'ownership' of a planning process that the users trust as it clearly reflects their needs, and (iii) a manual and the skills to use it in the future as trained staff pass on their understanding to others. Conservation management support led several protected areas to call for manuals to assist development and environmental education program planning. PNM and the MIRAY Program identified capable national consultants to develop the manuals. The consultants had far less time and resources (>20 workshops and >15 field visits for conservation) and the early measure of success was considered to be the two manuals. However, PNM was not satisfied with the early versions of the manuals as products. Thus, although the planning process seemed reasonably sound, PNM staff felt that the documents were difficult to use as they did not respond to their own perceived conceptual shortfalls regarding their understanding of the larger socio-economic and cultural challenges and their development of a clear vision of what they wanted to achieve. The response was to increase investment in development of the manuals (more than triple the original) and now we have manuals that provide a solid platform for improving management in these fields of intervention.

- **It is often difficult to develop partnerships between PNM and development agencies, thus limiting long-term conservation strategy options.**
  - Analyses of threats repeatedly identified the creation of development partnerships as a major obstacle, which was most evident in the Eastern forest regions, even in priority corridor areas. The major difficulty is the near or total absence of development agencies where many parks and reserves are most threatened. By definition, threats occur either in the protected area or very close to it. Many such areas are difficult to access and, in the majority of cases, there are few or no development agencies present. As a result, PNM assistance to community groups regarding the development of project proposals has consistently been thwarted in many high-threat areas. Additional, associated problems also include the stringency of conditions imposed before a project will be considered by a developmental funding agency, and the differences in thematic interests between PNM and those agencies. The above challenges may be to a great extent normal when attempting to conserve at a broad landscape scale. However, there does appear to be scope to improve protected area security by having a clearer vision of what is wanted in a given ecoregion and by facilitating partnerships near parks and reserves that favor their conservation.

- **Regional- and local- development programming has some significant constraints.**
  - There are effectively two problems: how community interests are represented, and the development projects that are funded. The various representational committees established at village, commune, and higher levels within the Regional Development Action Program (Programmes d'Action de Développement Régional PADR) are dominated by men, thus immediately under-representing women[2]. These representatives may also fail to represent the ethnic variation in the society, and may favor certain interest groups. However, having noted the above, the committees do seem to function reasonably well in many cases, and male-overrepresentation may be a cultural factor that will change only gradually. The second element may have more profound economic development consequences: the committees strongly lean towards approving community-wide projects like grain stores but seem to be unable to consider entrepreneurial ventures managed by small groups, families or individuals. Small business development may be a far more powerful means to stimulate economic development. For example, in many tourism areas it is clear that independently created businesses are developed by small groups or individuals to benefit from the presence of visitors, and they are a significant factor in terms of local employment and revenue flow in the community. One of the ways that PNM can address this problem is to reserve a part of their DEAP funds for such initiatives.

- **There is a need to improve efforts to increase environmental awareness throughout society.**
  - Although environmental education is a major challenge in many countries, its importance to long-term maintenance of viable ecosystems is not in doubt. Protection measures can be applied with some success in the great majority of parks and reserves in Madagascar, but they are vulnerable to events such as the virtual absence of funds for patrols that occurred during the recent political crisis. Outside of the protected area boundaries, it is even more difficult to ensure that critically important natural habitat areas are maintained to maintain viable, large blocks. A failure to address environmental awareness – and the related issues of sustainable development and improved living standards – is likely to result in a significant reduction of vital ecological goods and services and an irreversible loss of biological diversity.

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[2] One may also raise the question that, if a major function of PNM ACEs is community education and outreach – the ‘E’ stands for education – why are less than 1% of them women when the population is roughly 50% female?

- **There is a clear need to strengthen technical and scientific support delivery at the level of the DIR.**
  - A small number of specialists based in the Antananarivo Head Office cannot possibly deliver the technical and scientific support that is required at the field level. It is strikingly obvious that the best level for this support is the DIR. However, the DIRs themselves must ensure that they are in constant contact with their respective parks and reserves, and deliver the services that these sites perceive as needed for management.

The application of 'standardized' personnel and resource allocation norms to protected areas must be applied with respect to management needs.

  - Thanks to TNC's analytical model to assess conservation management needs described in the box on page 23, it is abundantly clear that the application of standardized formulas to determine personnel and other resource needs may veer well off actual requirements. For example, take the cases of Bemaraha and Ankarafantsika, two sites of approximately the same size and within the same ecoregion. The majority of Bemaraha's native habitat is largely protected naturally as most remains on pinnacle limestone, or tsingy. In effect, threat levels have been shown through conservation planning to be relatively low. Native habitats in Ankarafantsika, in contrast, are easily accessible and few natural resources required by local people are available outside of the park. It is thus not surprising that conservation planning exercises show that this park is highly threatened. Applying the same standards to determine resource needs would be highly inappropriate.

- **Ecoregional and sub-ecoregional variation in vulnerability and threat must be given a higher profile in protected area creation, modification and resource allocation.**
  - Most, if not all, scientists with a good knowledge of Madagascar would agree that there are marked variations in the degree of threat faced by different ecoregions and even sub-ecoregions. Indeed, we can say that some habitats do seem to be more vulnerable than others, and this must be taken into consideration when revising the national network, when planning conservation intervention priorities, or when deciding where resources should be allocated. Detailed recommendations are beyond the scope of this document (but see next lesson learned), but it is worth considering two elements as illustrations: the Eastern lowland humid forest and the Western Ecoregion. The Eastern lowland forests (say, up to 800 m) are in general threatened because of their accessibility and better suitability to slash-and-burn cultivation. Unfortunately, many lowland forests in protected areas are still the most vulnerable, in part because few development projects have been targeted for adjacent areas, and because management of such often-remote areas is generally difficult. Global warming effects may also decrease climatic protection (the rarity of long enough periods within which to burn for clearance) afforded to the altitudes where forest has been previously protected naturally, thus increasing vulnerability further up the eastern slopes. The Western Ecoregion's forests outside of a few inaccessible tsingy areas appear to highly vulnerable and threatened. Unlike the Eastern forests, there are few large blocks and connectivity is very low as a result of fragmentation. These forests are generally very accessible and should be a high conservation priority.

- **Representation of biodiversity within Madagascar's existing protected area network and through sustainable natural management programs is not adequate.**
  - One of the problems that further compounds the issues of vulnerability and threat is that local endemicity appears to be so high that current ecoregional models cannot hope to identify the number and location of protected areas or landscape approaches that are required to maintain biodiversity. It is unlikely that protected areas alone are the solution and thus forest management practices must be improved to maintain biodiversity in critical areas. However, many parks and reserves have

included boundary modifications to increase representation by capturing currently unprotected habitats that are not being used by local people. Early indications from recent inventories suggest that spatial heterogeneity is particularly marked in the Western Ecoregion, where sites only a few tens of kilometers apart support markedly different species compositions.

- **If biodiversity is to be maintained in the existing protected area network, PNM marketing must be greatly increased to obtain the funds required.**
  - There is an imbalance between conservation management needs and resource allocation in many of Madagascar's protected areas, especially regarding those sites that have only recently been targeted for management. Probably as many as half of the currently managed sites are under-resourced and under-staffed. Under present financial marketing systems, PNM cannot possibly hope to ensure adequate protection, and marketing would appear to an obvious solution, at least in part. Marketing effectiveness will depend on at least two factors: a demonstrated improved capacity with respect to conservation management, and a better understanding of biodiversity.

RECOMMENDATIONS

Based on the lessons learned, the following recommendations are offered.

- **Identified bottlenecks in management implementation should be rectified.**
  - Staff responsibilities should be clarified to improve follow-up of activities that involve different levels within PNM. In addition, PNM's institutional culture should be continuously monitored to ensure that conservation support to parks and reserves is always a priority.

- **Future technical support to PNM's technical management themes (conservation, ecotourism, community development support and environmental education) and supporting activities (marketing, financial sustainability) should target appropriate levels of planning and implementation sophistication.**
  - Some management themes probably require a greater degree of sophistication than currently existing approaches. Others, such as monitoring and evaluation may be overly complex with respect to the information needed. An improved equilibrium can be achieved by careful analyses of needs.

- **'Products' delivered through technical assistance should be carefully designed with respect to likely impacts of their utilization and management capacity.**
  - Assistance to processes should be firmly anchored to a vision, goals and clear benchmarks. Assistance that provides 'tangible' products such as plans, manuals or even ready-made programs should be tailored to ensure that it is a 'full-package' nature so that the products will have their desired outcomes through the build up of skills to use or implement them.

- **Community development and especially environmental education programs should be strengthened and contribute positively to protected area and broader ecoregional conservation aims.**
  - There is apparently a need for greater coordination between different actors involved in these sectors, and perhaps a recall of what the combined aims of the NEAP and PADR comprise in order to ensure that biodiversity is maintained. Investment in development and environmental education may be too low relative to other sectors. One of the areas that could be strengthened is the development of small businesses that either reduce threats to biodiversity or sustainably use it.

- **Scientific capacity regarding protected area management should be strengthened.**
  - PNM should strengthen its capacity to deliver scientific advice and technical support at the field level. This is probably best achieved in having science support personnel at the level of the DIR. Another complementary approach could include strengthening partnerships with scientific organization in order to answer management issues more consistently. There is a need to ensure that science training for future (and even existing) PNM staff in key positions is adequate, as the quality in country has suffered from years of relative isolation from modern scientific thinking.

- **Future technical assistance should target ecological monitoring and applied research.**
  - The TNC-system and other source-works used to develop the conservation management planning manual have greatly enhanced capacity within PNM. However, linked to the previous recommendation, there will be a need to test and refine ecological monitoring methods and strengthen capacity with respect to implementation and utilization of results. There is also a need to explore ways to develop capacity and approaches concerning applied research aimed at better understanding the links between threats and biodiversity priorities.

- **Allocation of resources to protected areas based on real needs should be reviewed and the resulting recommendations systematically applied.**
  - The Plan GRAP provided a basis overview of resource needs for parks and reserves depending on their specific characteristics. The conservation management planning process has provided further refinements to this basic analysis and now needs to be applied. It may be of particular relevance to parks and reserves managed as ICDPs and approaching transfer to full management under PNM.

- **The protected areas network should be reviewed to improve biodiversity representation.**
  - PNM has commendably already begun a review of the protected area system based on the Plan GRAP and the conservation management process. However, it is probably desirable to follow-on from earlier reviews of protected area priorities by holding a further workshop involving scientists and drawing on the results of recent research and conservation management planning.

- **A review of existing ecoregional conservation priorities should be carried out to help ensure that the PE III is well-targeted.**
  - If the current ecoregional priorities and intervention programs are not refined, there is a real risk that critically important habitats will be degraded to a point of non-recovery or even lost entirely. In a related fashion, there appears to be an urgent need to clarify forest zoning outside of protected areas in order to develop practical sustainable management programs that maintain surviving biodiversity. This does not mean that the majority of remaining natural habitats should be set aside for strict conservation, as programs that do not meet economic and subsistence needs are likely to fail.

- **An understanding within PNM of marketing needs to help maintain biodiversity in protected areas is recommended.**
  - An understanding of PNM's marketing needs relative to conservation is gradually increasing within the organization. However, responsibilities for marketing and their linkage to conservation needs appear to remain vague. It is therefore important to establish well-targeted marketing programs to address these issues.

NEXT STEPS

It is all very well to have nicely presented plans well illustrated with maps and full of sophisticated-looking tables. However, the conservation plans must be considered in their real context – tools that should help strengthen and continually refine management efficiency.

We thus plan to continue field support at selected priority sites in a range of representative ecosystems to see how well the plans reflect reality and do indeed improve management. It may be anticipated that some considerable attention needs to be given to conservation target viability questions and ecological monitoring, in particular.

It may also be of considerable interest to invite TNC experts to Madagascar to review our process and provide suggestions. Such short-term consultancy may be of interest to other programs such as WWF's Ala Maiky, and cost-sharing should thus be possible.

In a more ambitious context, we would hope that the modifications adopted for Madagascar may help to improve the central TNC 5-S process. In particular, the incorporation of TNC's own conceptual modeling of cause-pressure-impact for each major threat would seem to be of considerable value in terms of setting realistic strategies and ecological monitoring programs.