# Biological Monitoring in the Selva Maya

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# Biological Monitoring in the Selva Maya

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Editors


Archie Carr, III – Angélica C de Stoll


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Belize tropical Forest and Protected Areas Planning Proyect

Division of Forestry, Ministry of Natural Resources, Belize

Cover: Tikal National Park, Guatemala. Photograph by Andrew Stoll

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# Foreword

**Peter Bridgewater**
Director, Division of Ecological Sciences
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Monitoring, so what is it about, and why should we do it?

Conservation of biodiversity, the balance of use and care, is a set of values that are not independent from the broader values of society. Effective conservation policies must be practical, easily understood and acceptable to society. Such policies must be particularly relevant to the local, especially indigenous, people, and local managers who interact daily with the biotic and abiotic components of a particular region. But as our world is consumed by global change it is ever more important we are engaged in following that change, and that means establishing and following monitoring protocols. Monitoring of change to biodiversity therefore will be an essential component of future conservation management.

U.S. MAB, as part of its' core tropical ecology efforts, funded an interdisciplinary proposal to increase communication and co-operation among scientists, the wider public, and managers of protected areas in the Peten region of MesoAmerica. U.S. MAB deliberately tested a strategy to concentrate its scarce resources on one area, as an experiment to see if such relatively small amounts of funds could make a difference. U.S. MAB has also been instrumental in developing the highly successful Biosphere Reserves Integrated Monitoring Programme (BRIM). BRIM is set to be a pace-setter in global monitoring effort. UNESCO-MAB has an interest in monitoring simply because globally, Biosphere Reserves represent the best asset for comparative monitoring purposes.

The tri-national Peten region is the largest tropical broad leaf forest remaining in Central America. Like all such areas, it is subject to increasing human pressures, which range from increasing demand for farm land to international petroleum corporations looking for product. We know of many ecological disturbances from casual observation, yet we lack a systematic monitoring programme to chart what we think might be happening, and set about the next difficult phase of defining policy action for management to remedy problems which monitoring will inevitably identify. We can then bring an informed view to bear in doing such work.

Under the auspices of the Tropical Ecosystems Directorate of U.S. MAB, partnerships were formed with many local and regional organizations, regional specialists, scientists, organizations, governmental, and non governmental, to come together to identify and to initiate a carefullycrafted, soundly based, long term monitoring programme. What was missing from all this was clear practical guidance : hence this book ! The book provides for all well accepted standard scientific monitoring principles and practical guideline methodologies for all who are willing to undertake this essential work.

I commend the book to all who are able to become involved with the monitoring excercise, and look forward immensely to seeing the results. Although, this Manual has been prepared for Central America, it will have uses over a far wider area.

# Introduction
## Monitoring in the Selva Maya
**Archie Carr, III**

This document sets forth a set of guidelines useful to the task of monitoring certain taxa of biota in the Maya Forest (Selva Maya) of Guatemala, Belize and Mexico. The guidelines are defined as *protocols.* They are procedures or methodologies for collecting specific types of data at specific time intervals in precise ways. Importantly, each protocol is the product of debate and discussion by numerous scientists working in all parts of the Maya Forest. The protocols reflect the combined experiences of these individuals and may be regarded as consensus statements about which data to collect, and how and when to collect it.Monitoring protocols are given for the following taxa:

Plants
Insects (Butterflies)
Frogs
Birds
Mammals

In the case of plants, the protocol calls for counts to be taken of all woody plants above a certain diameter. Thus, a broad spectrum of species will be documented. Among the animal taxa, however, each protocol limits the number of species to be sampled to a very few. These are diagnostic species, and the justification for each one is given in the text. Much discussion went into these selections. Monitoring studies, like most types of field research, are inevitably constrained by money and time. It is therefore crucial to select monitoring species that will efficiently yield useful insights about the status of the forest ecosystem.

For example, a monitoring program for a tropical forest might well focus on the jaguar, *Pantera onca*, as a target species. It is a big, top carnivore, requiring exceptionally extensive home ranges. The jaguar is often considered a keystone species, having an unusually important role in maintaining the integrity of the ecosystem, and being susceptible to changes in that system. Changes in abundance of jaguars may be a response to fluctuations in the prey base. The prey base itself may be a diverse set of fauna, ranging from armadillos to tapirs, and thus any suggestion of a decline in jaguar abundance has potentially grave implications for the status of a much broader community of fauna.

Monitoring the jaguar provides insights into the status of the forest. Importantly, the jaguar is also relatively easily observed at least indirectly. The tracks of the jaguar allow it to be monitored, whereas other top carnivores, notably the harpy eagle, are rarely seen and thus difficult to quantify. Observability is a critical consideration in the choice of monitoring species. This criterion is reflected in each of the protocols that follow.

Other selected species, like the frogs or butterflies, are chosen for a monitoring campaign for very different reasons from those pertaining to a top carnivore. Frogs may be, (and almost certainly are) exceptionally sensitive to very subtle environmental change. Alterations in water or air quality might be detected by the scientist first by observations of declines in amphibian populations. Only the most sophisticated of bio-chemical sensing equipment might be able to detect a biocidal agent. The frog, and it's juvenile phase, the tadpole, is osmotically intimate with the aqueous environment, and thus vulnerable to changes in that medium.

Several of these highly sensitive species are identified in the following protocols for the Selva Maya. It is worth noting that these species function like the often cited coal miner's canary. The little bird was taken into the mine to sing. When it stopped singing, there was a great likelihood that the mine atmosphere was polluted. The miners' lives were in jeopardy. As human beings tamper with the hydrology of the Selva Maya, or introduce into the environment peculiar, exotic chemicals used in oil drilling, or alter the micro-climate of the northern Peten through deforestation, the delicate frogs may die off…and that will be a signal, like the death of a canary, that it is time for the humans to flee.

The Selva Maya is the most extensive tropical broadleafed forest remaining in Central America. Scientists, conservationists, and governments in the tri-national region of the Selva Maya have expressed their intent to maintain the integrity of the great ecosystem. The challenge to do so is not trivial. Population flux in the area is as active as anywhere in Latin America. Other developmental forces are at play, like petroleum exploration, timber cutting, cattle ranching and, of course, tourism. These events may all be considered to be perturbations to the environment. The monitoring proposed in this document offers a verifiable way to measure those perturbations.

Two other new circumstances are implied by the publication of these protocols. First, monitoring of fauna and flora over such a vast area as the Selva Maya clearly requires the support of computerized equipment capable of managing large amounts of data. Through the same initiative that has led to the development of the protocols, a tri-national data base system has been established, tentatively known as BIOMAYA. Nodes for this network have been established in Belize, at EcoSur-Chetumal, Mexico, and at CECON in Guatemala.

Secondly, the appearance of the protocols and the data base implies a network of people; of concerned scientists. They live in the three countries that hold dominion over the Selva Maya. Importantly, the conservationists in Guatemala, Belize and Mexico also have good friends and collaborators in the United States and Europe, all of whom share the indigenous passion to save the Selva Maya. It is believed that so long as these individuals can remain in contact with one another, communicating and collaborating across borders, there is hope for the survival of the grand forest.

Support for the development of the monitoring protocols and the BIOMAYA data base was routed through the Wildlife Conservation Society (WCS). The funds originated with the United States Man and the Biosphere Program, Tropical Ecosystem Directorate (MAB/TED). The decision to commit this support to the Selva Maya has its origins in the UNEP Environmental Congress held in Rio de Janeiro in 1992. MAB/TED funds are supporting other initiatives around the Selva Maya through projects administered by non-governmental organizations other than WCS.

The USMAB program will come to an official end during 1999. It will be deauthorized by the US government. Monitoring of the Selva Maya, however, must go on. It will be the intent of WCS to remain in evidence in the region, assisting where we can to support the tri-national monitoring campaign. Knowledge is power, it is said, and as the monitoring program evolves, perhaps we who revere the great forest will gain some measure of power over its fate.

**Acknowledgements**

Development of the monitoring protocols and data base for the Selva Maya has demanded the contributions of numerous individuals. The first phase in the process occurred in October, 1997 on the occasion of the **Maya Forest Biodiversity Workshop on Inventorying and Monitoring,** organized by Roan Balas McNab of WCS. Over fifty concerned ecologists from the Maya Forest countries and the USA committed themselves to the development of these protocols to help standardize the collection of data throughout the region. Support for the effort was also provided by Olga Herrera-MacBryde of the Smithsonian Institution who compiled and edited the workshop proceedings.

In July, 1999, a final review of the monitoring protocols for the Selva Maya was undertaken in Guatemala City. For this event, we are, grateful to the leaders of the Mesoamerican Society for Conservation Biology (MSCB), who agreed to allow us to sponsor a Selva Maya workshop during the course of the regular annual meeting of the MSCB. Staff members of CECON, with offices at San Carlos University, were instrumental in organizing the Selva Maya workshop. Chief among these was Mercedes Barrios, assisted throughout by Ana Carolina Rosales.

Pilar Negreros also contributed to the many logistical requirements of the meeting. Claudio Mendez, also from CECON, worked diligently at organizing the presentations of papers concerning monitoring. Claudio and Carlos Galindo-Leal also chaired a panel discussion on the challenges of monitoring biota in the Selva Maya. Coralia López Selva was responsible for translating the majority of the text in the following pages, and Juan Carlos Rodriguez was the proofreader of the document.

We are also grateful to Angélica Canales de Stoll for her creativity and skills in layout and organization of the final document, and Andrew Stoll for assistance with the digital version of the document. In addition, we are grateful for the principle authors appearing on the following sections: Carlos Galindo-Leal, James Comiskey, Francisco Dallmiere, Shahroukh Mistry, Carmen Pozo de la Tijera, John Meyer, Carolyn Miller, Dave Whitacre, Bruce Miller.

Although each monitoring protocol has benefited from extensive debate and discussion among many biologists, the above named persons have been particularly generous with their time and patience in making them ready. Carolyn Miller, for example, contributed to three of the main chapters.

A less visible participant in the evolution of a monitoring program for the Selva Maya has been Jeff Waldon of Fish and Wildlife Information Exchange at Virginia Tech University. He is the chief architect of the database software upon which the monitoring results are now (in the case of Belize) or soon will be installed.

Chapter I

# Biological Monitoring

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"Some of the greatest disasters of humankind were inflicted by the narrowness of men with a sound methodology"
A.N. Whitehead

## Objective of the present protocols

The monitoring protocols presented in the following sections are simplified guidelines, designed to yield useful results, but not requiring advanced training in order to be implemented. The idea behind these protocols is to introduce standardized methodologies to produce a set of baseline data, and to allow comparisons of these data throughout the Selva Maya region. The suggested monitoring would focus on broad regional comparisons, allowing us to distinguish between local and regional trends. These protocols are not necessarily designed to assess environmental impacts of highly localized perturbations like tourism development, timber and non-timber forest product extraction, wildlife hunting, oil exploitation,or other development and/or conservation projects. To assess the impact of these activities it would be necessary to modify the protocols and develop appropriate designs adjusted specifically to answer these questions, following the discussion given above.

Design and implementation of monitoring protocols for the Selva Maya is expected to be an on going and evolving process. The fact that a methodology has been used for many years does not necessarily mean that it is the most suited to a given situation, or that it can not be refined in one way or another. We should expect the procedures given below to be modified as information and experience grows in the tri-national region.

Why should we monitor?

Monitoring is a periodic evaluation to assess trends. It provides a baseline to understand the behavior of a system through time. Monitoring provides a way to assess if the objectives of an action are met. It also provides feedback to change the actions if the documented trends are unwanted. Monitoring is badly needed to understand the effects of social, economic, demographic, and environmental policies. In this publication we will focus on biological monitoring.

Biological monitoring is necessary to describe the natural dynamics of biological communities, the consequences of human influences, and to predict and /or prevent unwanted changes. We should first have a clear idea of the question to be addressed. To do this, it is necessary to identify the problem, reduce it to a tractable size, carry out preliminary analyses and formulate predictions. Monitoring programs on conservation issues often should document both natural and anthropogenic dynamics.

From a biological standpoint two types of monitoring activities have been suggested for conservation and development projects, biodiversity monitoring and impact monitoring (Kremen 1994, Margoluis and Salafsky 1998.). The first type involves documenting changes in biological diversity using indicator groups. To obtain an idea of changes in biological diversity we require a suite of complementary indicators from landscape to genetic level (Table 1) (Ecotono 4, Noss 1990). The second type involves the assessment of hman activities on those species that are under management (timber, non-timber forest products, fisheries, etc.). A simple experimental design for impact monitoring would include three types of sites: areas with and without management regulations, and protected areas (Kremen 1994).

| **Level** | **Composition** | **Structure** | **Function** | **Tools for inventories and monitoring** |
|---|---|---|---|---|
| Regional landscape | Ecosystem types and extension | Connectivity | Dispersal | Satellite image |
| Ecosystem – Community | Species identity | Water availability | Biotic interactions | Community sample |
| Species – Population | Relative abundance | Habitat use | Demographic processes | Radiotelemetry |
| Genetic | Allele diversity | Polymorphism | Inbreeding effects | Electrophoresis |

Table 1. Example of schematic matrix to choose indicators of composition, structure and function for inventories, monitoring and evaluation within four levels of organization (modified from Noss 1990).

**What should we monitor?**

As mentioned above, it is necessary to periodically assess several levels of biological organization, from land use dynamics (i.e. loss of forest cover) at a regional level (Sandler et al. 1997) to genetic aspects of local populations (Ecotono 4, Noss 1990). At the species level, it is important to monitor species under management activities (i.e. cedar, mahogany, xate, guano, chicle, game species), exotic species (i.e. pigs, cattle, African bees), vulnerable species (i.e. crocodiles, tapir, wild cats) and indicator species which provide early warnings of changes that are not detectable by other means (Kremen 1992, Landres et al. 1988, Noss 1990) (Table 2).

Several taxa and a number of levels of organization were proposed at the Maya Forest Biodiversity Workshop in Flores, Petén, Guatemala to monitor biological changes in Selva Maya (McBride 1997). Selected taxa may differ in how effectively they indicate trends. Therefore, the questions about why and what to monitor should be clear before the taxa and methodology are chosen.

How should we monitor?

There are a couple of issues regarding the establishment of a monitoring protocol. The first issue relates to the experimental design. Basically, the experimental design depends on the objective of monitoring. Are we interested to document changes in relation to habitat loss, habitat deterioration, fragmentation, overhunting, transmission of diseases, or just natural fluctuations? To distinguish among the causes we need an experimental design. The key questions are: Where and how do we place our sampling units (transect, traps, watering hole observations, recordings)? How many replicates do we need? What are the control sites? How often should we monitor? (Table 2).

The experimental design is the logical structure of the monitoring exercise. The objectives should specify aspects like nature of experimental units, number and classes of treatments (including controls), properties and responses to be measured, assignation of treatments to experimental units, number of experimental units (replicates) to be used, and spatial distribution (Hurblert 1984, Caughley and Sinclair 1994, Heath 1995, Krebs 1998).

The second issue relates to the sampling design. Once we have decide what organisms are to be monitored, we have to decided on a sampling protocol. Issues such as size, nature of sampling unit shape, and number have to be defined (Table 2). There are a variety of methodological references available to monitor plants (Goldsmith 1994 Dallmeier and Cominsky 1998), butterflies (Sparrow et al. 1994) amphibians (Heyer, et al. 1994, Olson et al. 199x,), birds (Bibby et al. 1992, Ralph et al. 1995), terrestrial (Voss and Emmons 1996, Wilson et al.1996) and marine mammals (Eberhardt et al. 1979), multitaxa (Méndez et al. 1995) and general monitoring references (Schemnitz 1980, Cooperrider et al. 1986, Goldsmith 1994, Sutherland 1996).

| | |
|---|---|
| Why monitor? | What is the question we need to address?<br>Problem identification<br>Reduction of general to specific problems<br>Preliminary analysis and predictions |
| What to monitor? | What level are we interested (Landscape, community, population, genetic)?<br>Are we interested in a focal species or groups (endangered, managed, pest)?<br>Are we interested in biodiversity trends?<br>What group will provide an answer?<br>Which variables should we measure? |
| How to monitor? | What is the appropriate experimental design?<br>(Controls, replicates, interspersion, stratification, variables to be measured)<br>What is the appropriate sampling design?<br>(Type, form, size of sampling unit, spatial distribution, sample size) |

Table 2. Sequence of relevant questions to answer before starting a monitoring program.

Monitoring is a long-term endeavor. Researchers interested in monitoring should take this into account to plan for funding, personnel, and equipment maintenance. Monitoring projects should have clear experimental (controls, replicates, random selection, interspersion) and sampling design. It is a waste of time, energy and money to begin a monitoring program without considering the experimental and sampling design (Terborgh 1989, Caughley and Sinclair 1994, Heath 1996, Krebs, 1998).

Tuning methods

One of the basic aspects of monitoring is to use standard methods to allow year to year comparisons. However, establishing and refining the methodology requires experimentation and may take several years. Even within the relatively homogeneous region of Selva Maya, there are differences in soils, rainfall, and plant and animal phenology that may influence the selection of methods. It is important to remain flexible to modify the methodology during the learning stage.

Monitoring intensity

The intensity of monitoring depends on the objectives and knowledge of the phenomena under scrutiny. It is important to decide the intensity regarding time, space, and variables under study. Generally, limited financial and human resources limit monitoring intensity. Therefore, it is of great relevance to adequately decide on the right balance between these three factors.

**Time:** The degree of detail needed determines the periodicity of the assessments. We may want to monitor daily, seasonally, annually or multi-annually. We recommend to begin with high frequency monitoring programs that may become less intensive once we obtain the seasonality patterns of the phenomenon under study and the best time for an annual period can be determined.

**Space:** Monitoring is complicated by the spatial heterogeneity provided by topography, climate, soil, geology, vegetation and human activities. On one hand, we need to know how far to extrapolate our findings obtained from a few chosen sites. Are we sampling representative habitats? To answer this question we minimally require to be acquainted with the spatial heterogeneity of the vegetation. In turn, we need to differentiate between human-related effects and the natural dynamics. Therefore, it is necessary to include control sites (without human activities), which by definition are inaccessible.

Some studies have attempted to use core areas in reserves as control sites. However, often the large distance between treatments and controls and the fact that core areas were located in a biased manner precludes the comparisons (Galindo-Leal et. al., 1993). There is a compromise between distance and reliability of comparisons. The closer the sites to be monitored and compared the more similar the habitats and the higher the reliability of comparisons. Comparison between distant places include differences in habitat composition and structure, climate, soil, etc. Even in an area as seemingly homogeneous as the Selva Maya, the composition and structure of vegetation changes as a result of narrow topographic gradients.

Larger differences are influenced by a south-north precipitation gradient. Since the aim of suggesting monitoring protocols is to compare trends among large geographical regions such as Selva Maya, special care should be placed in the reliability of comparisons. More often than not, comparisons between protected sites (inside reserves) and sites with human influence are filled with confounding variables which obscure causality.

**Variables:** Selected variables to be measured vary according to the objectives. We can monitor presence or absence of different species, their relative or absolute abundance, their demographic characteristics such as growth, survival, reproduction, immigration and emigration, sex and age structure, etc. The more details we need, the more intensive and detailed the monitoring will be. At the most general level we only require a species identification, but for the most detailed levels we must distinguish among individuals. There are a variety of available methods for plant and animal population estimation and software to facilitate the computations (See Ecotono 5). Some of these programs may be obtained through the web site http://www.stanford.edu/group/CCB/Eco/index.html.

**Monitoring biases**

Several factors may bias the results of a monitoring program, including observer skills, detectability, methodology, project design and data analysis.

**Observer skill:** Each observer has a different skill level, which changes with experience. If the observers sample different sites, the recorded differences may be due to differences in their skill level and not to real site differences. The same problem may arise if the observers change from year to year. A solution to this problem is to mingle observers to avoid the bias. The first assessments will be affected by the learning period. The length of time of this period depends on the group difficulty and the experience and capacity of the observers. For this reason, we should regard the first observations of every monitoring program with caution.

**Detectability:** Habitat structure differentially influences the detectability of organisms. We may obtain a higher number of individuals or species in open habitats than in closed habitats because of higher detectability in the former. Seasonality also influences detectability. Species activity changes with season. Conditions in the wet and dry season improve or hamper detection of different organisms. Human activities that modify the behavior of species, may make their detection more difficult.

**Methods:** Each available method of population assessment including direct observations (sightings, calls), captures (traps), and indirect observations (signs, tracks) are appropriate for some groups but not for others. Even within one species, some methods are better for certain age classes (juveniles vs. adults) or sex classes (females vs. males).

**Design and analysis:** The type of design and analysis chosen can also bias the results (Galindo-Leal 1986, 1992). Decisions concerning plot location, plot distance, size, shape, and number are fundamental to the acquisition of a reliable sample. Pseudoreplication (the use of sample units that are not independent) in the design and analysis often biases the results (Hurlbert 1984, Galindo 1986) (See Ecotono 2).

Monitoring analysis

When establishing a monitoring program it is important to have a clear idea of the type of statistical analysis to be used. Often, after several years of monitoring we realize that our design did not meet the needed assumptions or that it lacks important elements (Galindo-Leal 1992). Before we begin monitoring, a statistical power analysis should be carried out.

When we compare trends we may obtain two results: we may find no difference (accept the null hypothesis) or we may find differences (reject the null hypothesis). There are two possible types of errors (Green 1989). Often, differences are not evident because of small sample sizes. Lack of trend detection when there is a trend in reality is known as type II error. This error may be common in conservation studies, since populations are often small and have high variability (Rotenberry and Wiens 1985, Taylor and Gerrodette 1993).

Acceptance of a null hypothesis may have serious consequences in conservation projects. For example, let us imagine that a species is declining, but our population estimates do not detect differences. If we conclude that there is no difference (making a type II error), then conservation measures will not be taken to improve the trend. We will also have wasted time and money. To determine if our design is adequate to avoid a type II error we require a power analysis (Gerrodette 1991, Peterman 1990). Statistical power is the probability to reject a false null hypothesis. There are a number of available programs to assess statistical power (Thomas and Krebs 1997). To obtain more information refer to Ecotono n. 2 and 5 (http://www.stanford.edu/group/CCB/news.htm/). Power analysis software may be obtained through the web site: (http://www.stanford.edu/group/CCB/Eco/table.htm).

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## Internet resources

United States Geological Survey (USGS). Patuxent Wildlife Research Center
Power analysis and monitoring http://www.im.nbs.gov/powcase/powcase.html
How to create a monitoring program http://www.im.nbs.gov/statistics/statist.html
Biodiversity Monitoring--Status and Trends,
http://www.pwrc.nbs.gov/stbiod3.htm

North American Amphibian Monitoring Program (NAAMP)
http://www.im.nbs.gov/amphibs.html

MAYAMON. Maya Forest Anuran Monitoring Project. Proyecto de Monitoreo de los Anuros de la Selva Maya http://fwie.fw.vt.edu/mayamon/maya_home.html

Ecological Assessment and Monitoring Network (EMAN) Environment Canada
Protocols for monitoring organisms of terrestrial ecosystems
http://www.cciw.ca/eman-temp/research/protocols/terrestrial/
http://www.cciw.ca/eman-temp/research/biodiversity.html

Center for Conservation Biology (CCB) Stanford University
http://www.stanford.edu/group/CCB/Eco/resources.htm

Chapter II

# Vegetation Sampling Protocols for the Selva Maya

**James Comiskey,**
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(SI/MAB)
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Introduction

This protocol details the methodology to study vegetation at the sites in the Selva Maya. The methodology has been used extensively in temperate regions and has recently yielded valuable results in a tropical lowland and montane monitoring project conducted by the Smithsonian Institution's Monitoring and Assessment of Biodiversity Program (SI/MAB) in the Urubamba Region, Peru. The methods described here will be used to conduct assessment in a standardized manner at each site so that suitable comparisons between sites can be made. This methodology has several key differences from the previous 1 ha methodologies used in the field. Notably, the selection of sites is more objective, the type of plot used is considerably smaller but with greater replicates and the vegetation types measured have been expanded to include non-woody species and trees down to 1cm dbh.

The methodology chosen for the assessment of plant diversity in the region involves the use of modified Whittaker vegetation plots. The modified Whittaker plots will be used so that a large number of plots can be placed at a site rather than only one or two large 1 ha plots. The layout of a plot is illustrated in Figure 1. A plot of 0.1 ha provides the framework, within which vegetation sub-sampling can take place. The sampling of vegetation at different scales (subplot sizes) allows us to examine species richness at local and larger scales in order to estimate richness for the entire area.

The location of these plots should be chosen randomly so as not to create a subjective bias. Details of how to establish these plots, collect data and specimens, and data management are presented below. The methodology is divided into four sections. The first; describes the process of reducing bias in the selection of plot sites. The second; section deals with the environmental data that needs to be collected for each plot. The third; details how to establish, map out and mark a modified Whittaker plot. Section four; explains which plants to measure and what measurements to take.

The key purpose of this protocol is to provide detailed methods to simply and quickly assess the vegetation types, and baseline information for monitoring. The objectives are to increase the number of samples taken at the site by using numerous smaller plots rather than a large 1 ha plot, and to measure a greater variety of life-forms (trees, shrubs and herbs). Less emphasis is placed on surveying of the plot or permanently marking the plot or trees. Tagging and numbering of trees enables the plots to be revisited in subsequent years.

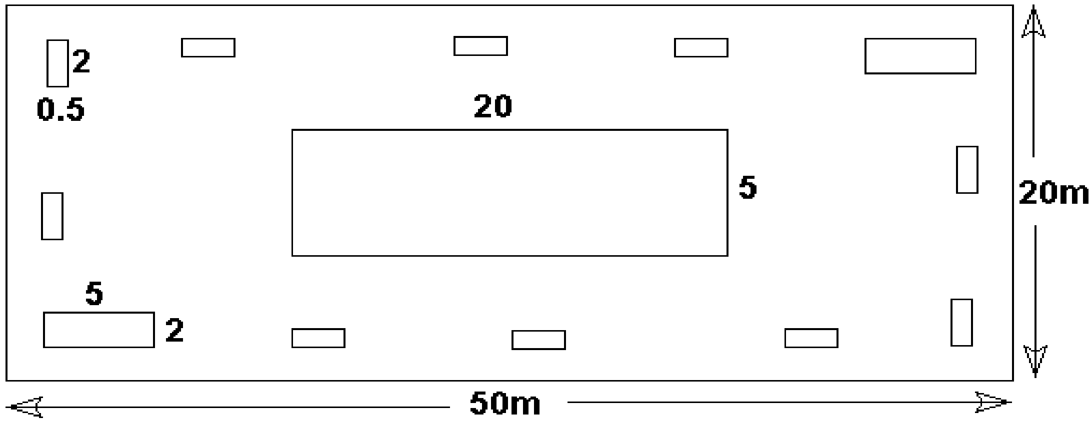


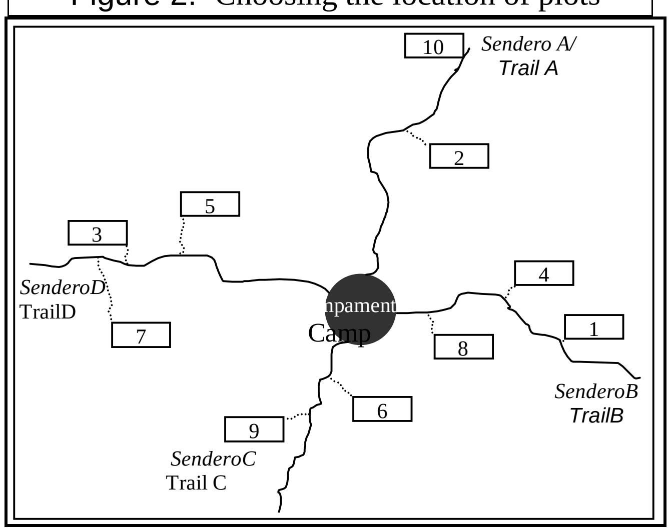

Figure 1: Layout of a Whittaker plot and its subplots.

**Select the Location of Study Plots**

The sample size will depend on the time available, the heterogeneity of the habitat, and number of replicates needed for statistical significance. Minimally it is recommended that at least 10 plots be sampled; however, given the complexity of the forest habitats in Selva Maya the exact number will depend on the time available to sample plots. It is recommended that as many plots be sampled as possible during the allotted timeframe.

The exact location of these plots should be selected randomly. To choose a plot location at random do the following steps (where the procedure calls for a random number pick one from the provided list (Table 3) or use the millisecond display on a watch.

Figure 2: Choosing the location of plots



**1) Choose a Random Trail:** From the trails available, randomly choose one. For example, if you have four trails, pick a number from the random table. If the random number is between 0 and 24, pick trail A, if between 25-49 pick B, etc.

| **For 3 Trails** | | **For 4 Trails** | | **For 5 Trails** | |
|---|---|---|---|---|---|
| Random # | Trail | Random # | Trail | Random # | Trail |
| 00-32 | A | 0-24 | A | 0-19 | A |
| 33-65 | B | 25-49 | B | 20-39 | B |
| 66-98 | C | 50-74 | C | 40-59 | C |
| | | 75-99 | D | 60-79 | D |
| | | | | 80-99 | E |

**2) Choose a Random Distance from camp:** This will be the distance along the trail from the camp that the plot will be placed. Use the formula ***Distance=50 + (RandomNumbe*** x ***2)***. This assures that the plot will be at least 50m from the camp and no further than 250m.

**3) Choose One Side of the Trail:** Decide if the plot will be on the left or right side of the trail. Left if the random number is between 0 and 49, right if it is between 50 and 99.

**4) Choose a Random Distance from trail:** This will be the distance from the trail where the plot will be placed. Use the formula ***Distance=10 + (RandomNumber/ 2)***. This assures that the plot is at least 10m from the trail and no further than 60m.

This process should be continued until a suitable number of randomly chosen sites is selected. A table should be constructed at each study site to keep track of the exact location of each plot (see Table 1). Figure 2 shows a map of the area with plots along the trails. It is not necessary to evenly distribute the plots between all the trails.

Typically, more sites should be chosen than needed, so that if a site is physically inaccessible, the next randomly chosen site can be measured. If a site is determined to be inaccessible then it is important that the next randomly selected plot be chosen. It is not suitable to simply move a plot to an area that appears to be suitable habitat to easier terrain.

**Collect Data about the Plot and its Environment**

It is very important that sufficient reference information about the plot, and its habitat be collected, so that any changes in the vegetation between sites can be explained. For example, the vegetation on a steep North facing slopes of montane regions may be quite

| Plot # | Trail | Distance from Camp (m) | Side of Trail | Distance from Trail (m) |
|---|---|---|---|---|
| 1 | B | 120 | Left | 10 |
| 2 | A | 130 | Right | 30 |
| 3 | D | 130 | Right | 20 |
| 4 | B | 90 | Left | 20 |

different from a site on a South facing slope. Since the sites will vary in elevation and other features it is important that these be noted. The spatial distribution of sites can also help discern patterns in vegetation structure. The variables to be measured include:

1) **Latitude and Longitude information** (along with UTM values): This can be obtained from the GPS unit. Enter values for degrees, minutes and seconds.

2) **Elevation:** Use an altimeter. The value provided by the GPS unit is not as accurate. Make sure that the altimeter stays calibrated. Enter values in meters.

3) **Slope**: This is an angular measurement of how steep the ground is inclined. Units are degrees. To measure slope, use a theodolite and a surveying stick to calculate the angle of the ground. Alternatively, tie a 20m long string between 2 poles at the same height. Place these poles along the elevation gradient of the plot and measure the angles of the string.

4)**Aspect:** This is the compass direction that the slope faces (i.e., N. NE, E, SE, S, SW, W, NW, N)

5) **Soil Characteristics:** The percentage of sand, silt, clay and organic material in the soil. This is measured by taking a soil sample and placing it in a 1000ml glass cylinder up to the 300ml mark. Add water almost to the top and mix thoroughly so that all clumps are broken. Allow the sediment to settle (takes 30 min or longer depending on the amount of clay). The sand and gravel normally settles on the bottom, followed by the silt, then the clay and finally the organic material. These form layers that can be measured with a ruler to calculate percent values.

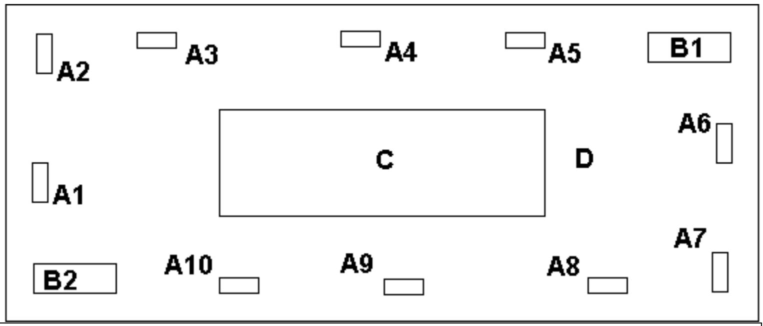



Figure 3: Names of the Subplots. Note that 'D' refers to the entire plot area that is not covered by the subplots A1,A10,B1,B2 and C.

**Establish the Whittaker Plot**

The Whittaker plot consists of a large 0.1ha plot that measures 20 by 50m. Within this plot are several subplots of different sizes (Figure 3).The largest subplot (C) is 20m by 5m and is in the center of the plot. Two smaller subplots (B1 and B2) are 2 × 5m and located in two opposite corners of the plot. Finally, there are ten small subplots (A1-A10) of 2 x 0.5m placed just inside the periphery of the plot.

To establish a plot, first create a rectangular plot 50m wide and 20m tall. Using a theodolite, surveying stick and 50m tape, shoot one line 50m long and another at a right angle that is 20m long. Place stakes at the start and end of these lines and also at the 8m mark on the short side and at 9, 15, 21 and 35m marks on the long side (Figure 4). Now survey the other long side by using the theodolite and surveying stick. Once this side is measured place stakes at the start, end and at the 15, 29, 35 and 41m marks. Form the forth side by simply joining the open ends of the two long sides. Now place a stake at the 8m mark on this side.
(Figure 4).

To create the ten 2 × 0.5m subplots, obtain four flags or sticks and tie them with string in a rectangle such that it measures 2m by 0.5m. This frame can then be placed at each of the ten locations along the plot periphery. One frame should be placed at the marks in the diagram (Figure 4). These frames should be placed at a distance of 2m from the edge of the plot so as to sample vegetation that has not been trampled on during the creation of the plot. These 1m subplots are named A1 through A10 in a clockwise manner starting from the bottom left corner. Care should be taken to walk as little as possible within the site and to ensure that the vegetation in A1-A10 subplots is not trampled.

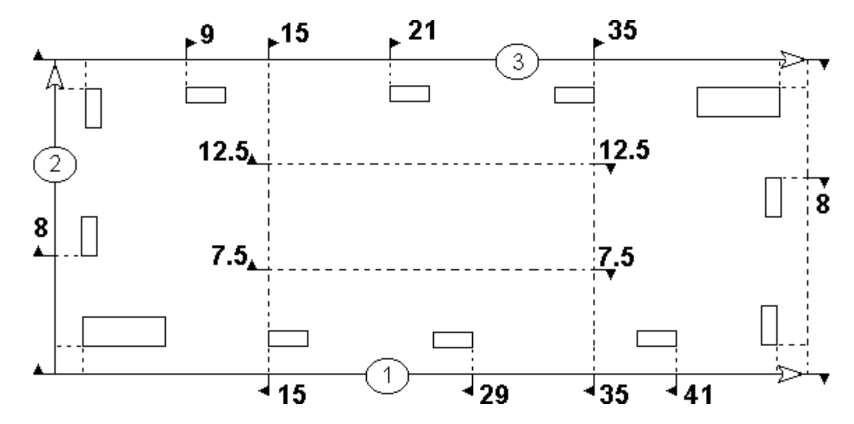



Figure 4: Surveying the plot and placing markers.

To create the center 5x20m (subplot C), connect the 15m marks on both long sides by a tape and place two flags, one at the 7.5m mark and the other at the 12.5m mark. Do the same for the stakes at the 35m mark along the long sides (Figure 5). The goal is to create a center plot of 20 by 5m. Leave the corner stakes in place until all data for the plot is collected.

To create the first of the two 2x5m subplots (subplot B), walk a distance of 2m into the plot from the top right corner. Place a flag at this and create a 5m by 2m subplot. Do the same for the opposite end and keep these subplots marked until all measurements for the plot are done.

**Measure the Vegetation**

Different size classes of vegetation are measured in the Whittaker plot. In the smallest subplots (A1-A10) all herbs, grasses and saplings are identified and counted. In the two corner subplots of 5 x 2 m (B1 &B2), all trees and shrubs ≥ 1 cm dbh are measured. In the central 20 x 5 m sub-plot (C), all trees ≥ 5 cm dbh are identified and measured. All trees with a diameter at breast height (dbh) ≥ 10 cm are identified and measured in D, which is the entire 0.1 ha plot area not already covered by the subplots.

**It is important that the herbs and saplings in the ten 0.1m subplots be sampled first since measuring trees will require trampling over much of the plot.**

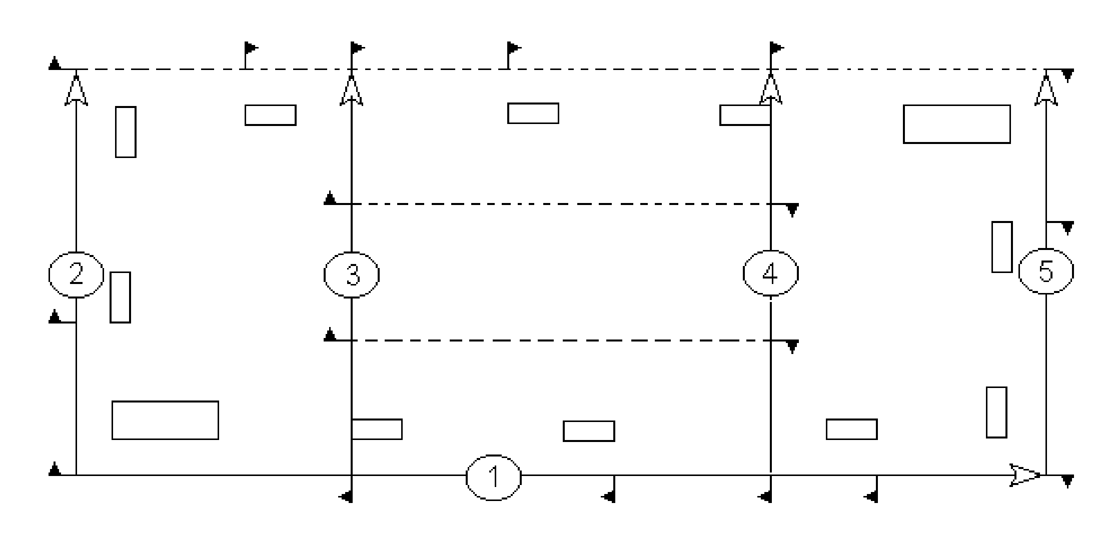



Figure 5: Establishing the rest of the plot

**Measuring Herbs, Grasses and Saplings in subplots A1 to A10**

Herbaceous plants, along with saplings and grasses should be identified and counted in the ten 2x0.5 m subplots. Include all plants less than 50cm in height. The DBH and height of these plants are not measured, simply their abundance. We expect the herbaceous layer to be a good indicator of potential impact, and this will be clearly visible through the change in species composition and cover of the sub-samples. The identification of plants to species may not be possible in the field, nevertheless it is important to collect specimens and to assess the overall cover of like individuals in the quadrats. If temporary names are given to plants (e.g., *Inga sp1*) then it is helpful if these temporary names are kept consistent across all plots (i.e., the same plant is not called *Inga sp2* in another plot).

Measure trees in subplots B1 & B2, C and D

In the two B1 and B2 subplots all woody individuals with a DBH of 1cm OR GREATER are identified and measured. For each individual, the DBH and height is reported. In the central subplot C all woody plants with a DBH of 5cm OR GREATER are identified and measured. Finally, the entire plot area (except that already covered by B1, B2 & C) is surveyed for trees with a DBH of 10cm or greater. It is important to not resurvey the subplots as these trees have already been measured in those subplots.

**Measuring Tree DBH**

The measurement of dbh is relatively simple. A dbh tape is placed around the tree at 1.3m height and the diameter measured. If a dbh tape is not available a normal measuring tape can be used to measure the circumference and this value can be divided by π (3.1416). Care should be taken to assure that the tape is accurately placed around the stem, and that stems or vines are not included in the measurement. Most stems are not perfectly round and smooth. Each tree presents a unique shape for which an accurate dbh measurement needs to be taken. Buttresses, vines, multiple stems, etc., all present variations that need to be measured with accuracy and repeatability. The next section deals with such atypical measurements. Smaller trees (under 5cm) can be measured with calipers to allow for easy dbh measurement. Since stems are rarely circular, use the largest dbh by rotating calipers at 1.3m height.

#### Measuring DBH of Atypical Tree Shapes

Trees are often found in position or conditions that are not conducive to easy measurement of dbh. They are frequently leaning, prone, broken or sprouting and this makes measurement of dbh difficult. It is important that a common methodology be used to measure the dbh of these trees so that variation between plots and/or researchers is minimized. If situations are encountered that are different or unique, detailed notes should be kept describing the method used to measure dbh. See the attached diagrams to help determine where measurements should be taken for atypical

### Shapes Measuring Tree Height

Tree height should be measured with a clinometer as accurately as possible. It is important to consider slope and observer height when measuring height. Additionally, when taking height measurements of plants, such as palms, the height should be measured to the top of the shoot, not to the top of the fronds as they can actually reach much higher

### Collection of Voucher Specimens

Collection of voucher specimens of woody species will aid the identification. Wherever possible, the botanist should identify morpho-species in the field in order to reduce the need for multiple collections. All trees inventoried in the plot should have an associated collection. In addition, the botanists should make general collections of species not inventoried throughout the plot. This can be accomplished by surveying the entire plot for individuals of species not measured and by examining the adjacent areas. The specimens will be initially processed in the field and preserved in alcohol. Subsequent, drying of the specimens will take place at the processing center or herbarium.

**Table 3: Sample table of random numbers between 0 and 99:**
Use this table, or create a similar table, to find suitable locations for the placement of plots.
**Note:** Either choose numbers haphazardly from the table, or start in one corner and work down the table, marking out the numbers already used so that the pattern is not repeated.

| **Random Numbers (0 a 99)** | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 | 66 | 10 | 11 | 34 | 34 | 66 | 41 | 23 | 1 | 37 | 52 | 33 | 75 | 54 | 74 | 69 | 45 | 38 | 47 |
| 45 | 72 | 71 | 55 | 45 | 39 | 74 | 23 | 62 | 9 | 6 | 52 | 67 | 55 | 45 | 40 | 84 | 31 | 82 | 7 |
| 87 | 36 | 72 | 44 | 77 | 91 | 15 | 86 | 3 | 78 | 56 | 71 | 10 | 89 | 97 | 95 | 9 | 24 | 71 | 14 |
| 52 | 3 | 78 | 57 | 93 | 10 | 82 | 87 | 96 | 87 | 49 | 100 | 20 | 97 | 8 | 66 | 67 | 53 | 70 | 24 |
| 75 | 32 | 22 | 84 | 95 | 62 | 64 | 47 | 47 | 19 | 28 | 65 | 70 | 91 | 91 | 44 | 85 | 77 | 52 | 45 |
| 42 | 2 | 18 | 60 | 84 | 15 | 64 | 21 | 75 | 41 | 65 | 73 | 52 | 100 | 81 | 43 | 27 | 23 | 7 | 83 |
| 6 | 79 | 55 | 35 | 22 | 59 | 15 | 33 | 30 | 50 | 15 | 31 | 29 | 24 | 49 | 99 | 48 | 73 | 49 | 25 |
| 85 | 68 | 90 | 35 | 36 | 23 | 40 | 39 | 70 | 23 | 2 | 28 | 66 | 90 | 27 | 0 | 61 | 9 | 5 | 51 |
| 26 | 38 | 38 | 78 | 86 | 41 | 99 | 72 | 56 | 58 | 17 | 89 | 52 | 53 | 41 | 21 | 90 | 86 | 63 | 97 |
| 71 | 67 | 81 | 9 | 34 | 9 | 51 | 90 | 74 | 5 | 52 | 29 | 58 | 38 | 98 | 78 | 96 | 10 | 93 | 51 |
| 81 | 96 | 97 | 3 | 72 | 99 | 13 | 38 | 83 | 44 | 89 | 4 | 54 | 60 | 97 | 2 | 58 | 13 | 53 | 77 |
| 2 | 51 | 59 | 13 | 57 | 37 | 85 | 69 | 67 | 23 | 86 | 30 | 18 | 78 | 65 | 98 | 72 | 29 | 4 | 60 |
| 42 | 91 | 84 | 57 | 65 | 4 | 73 | 47 | 70 | 25 | 49 | 9 | 0 | 23 | 53 | 30 | 19 | 67 | 27 | 65 |
| 57 | 6 | 58 | 54 | 38 | 69 | 92 | 84 | 8 | 17 | 87 | 7 | 65 | 38 | 70 | 27 | 83 | 73 | 97 | 28 |
| 19 | 3 | 81 | 64 | 85 | 88 | 77 | 47 | 19 | 26 | 21 | 8 | 88 | 80 | 57 | 98 | 12 | 73 | 65 | 49 |
| 64 | 5 | 38 | 51 | 45 | 40 | 94 | 54 | 88 | 93 | 85 | 1 | 69 | 21 | 59 | 8 | 62 | 68 | 86 | 31 |
| 6 | 68 | 26 | 49 | 2 | 59 | 56 | 93 | 95 | 37 | 24 | 33 | 50 | 8 | 87 | 16 | 56 | 49 | 15 | 29 |
| 82 | 80 | 30 | 30 | 15 | 1 | 47 | 61 | 16 | 75 | 65 | 39 | 57 | 70 | 26 | 32 | 63 | 6 | 77 | 85 |
| 93 | 58 | 56 | 65 | 55 | 53 | 99 | 23 | 1 | 32 | 95 | 45 | 52 | 70 | 77 | 2 | 12 | 45 | 20 | 41 |
| 0 | 16 | 73 | 98 | 3 | 77 | 23 | 72 | 2 | 86 | 89 | 75 | 15 | 96 | 80 | 34 | 3 | 68 | 23 | 79 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73 | 53 | 94 | 80 | 81 | 48 | 30 | 36 | 45 | 37 | 86 | 75 | 92 | 30 | 51 | 77 | 76 | 25 | 54 | 71 |
| 16 | 82 | 85 | 24 | 7 | 90 | 86 | 25 | 78 | 65 | 87 | 98 | 52 | 73 | 83 | 75 | 18 | 46 | 50 | 3 |
| 2 | 83 | 51 | 21 | 17 | 70 | 45 | 89 | 86 | 57 | 83 | 46 | 59 | 4 | 12 | 32 | 82 | 43 | 50 | 61 |
| 70 | 76 | 44 | 8 | 54 | 59 | 18 | 70 | 96 | 12 | 81 | 31 | 75 | 75 | 94 | 26 | 16 | 82 | 3 | 33 |
| 70 | 67 | 54 | 35 | 36 | 3 | 98 | 76 | 6 | 79 | 4 | 90 | 47 | 82 | 96 | 26 | 19 | 46 | 36 | 89 |
| 75 | 75 | 82 | 58 | 51 | 46 | 54 | 49 | 42 | 95 | 18 | 60 | 25 | 41 | 39 | 5 | 25 | 5 | 42 | 63 |
| 91 | 23 | 18 | 64 | 31 | 73 | 54 | 50 | 7 | 83 | 93 | 60 | 62 | 100 | 62 | 86 | 8 | 3 | 7 | 13 |
| 80 | 23 | 83 | 62 | 39 | 60 | 11 | 39 | 58 | 21 | 92 | 53 | 76 | 60 | 22 | 32 | 74 | 20 | 5 | 21 |
| 52 | 0 | 37 | 21 | 88 | 20 | 39 | 81 | 32 | 44 | 22 | 38 | 79 | 82 | 14 | 11 | 72 | 56 | 14 | 55 |
| 46 | 88 | 4 | 79 | 54 | 6 | 55 | 58 | 42 | 48 | 57 | 7 | 27 | 28 | 96 | 77 | 79 | 66 | 16 | 95 |
| 83 | 59 | 33 | 1 | 90 | 8 | 11 | 97 | 58 | 71 | 31 | 56 | 12 | 21 | 34 | 93 | 21 | 33 | 69 | 78 |
| 86 | 33 | 80 | 33 | 24 | 19 | 73 | 84 | 59 | 38 | 3 | 80 | 31 | 70 | 0 | 1 | 35 | 70 | 25 | 64 |
| 5 | 74 | 65 | 91 | 37 | 94 | 19 | 91 | 60 | 54 | 80 | 27 | 51 | 49 | 80 | 72 | 72 | 99 | 79 | 61 |
| 85 | 48 | 74 | 71 | 83 | 60 | 31 | 39 | 25 | 27 | 63 | 10 | 83 | 76 | 74 | 61 | 73 | 42 | 55 | 94 |
| 50 | 51 | 93 | 9 | 4 | 1 | 83 | 55 | 27 | 27 | 42 | 6 | 0 | 9 | 95 | 66 | 50 | 12 | 56 | 94 |
| 92 | 96 | 39 | 10 | 77 | 65 | 36 | 56 | 32 | 1 | 89 | 29 | 92 | 35 | 86 | 87 | 95 | 78 | 91 | 42 |
| 91 | 23 | 39 | 32 | 74 | 44 | 64 | 48 | 92 | 59 | 77 | 60 | 34 | 17 | 62 | 54 | 7 | 99 | 80 | 8 |
| 61 | 5 | 85 | 76 | 16 | 33 | 38 | 51 | 1 | 33 | 23 | 53 | 15 | 82 | 66 | 9 | 32 | 62 | 22 | 81 |
| 24 | 87 | 50 | 49 | 77 | 50 | 94 | 62 | 84 | 100 | 4 | 18 | 15 | 48 | 64 | 20 | 68 | 16 | 21 | 72 |

Chapter III

# Monitoring of Butterflies in The Calakmul Region, Mexico

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Since 1997 we have been developing a project called, "Inventory and Survey of Amphibians, Reptiles and Butterflies of the Calakmul Reserve in Campeche". The proyect has included systematic sampling during the three seasons of the region: Dry, rainy,and northers. Upon analysis of the data collected during the first year of sampling, we have detected some species of butterflies that might act as indicators of the degree of disturbance in the forest of the locale, notably, medium height subperennifolia and the low subcaducifolia forests. These two types of vegetation are the most abundant in the region, and often form a mosaic by becoming interwoven between themselves and with others types of less common regional vegetation types. Two important butterfly species are *Memphis forreri* and *Fountainea euryphyle*, both indicators for primary forests (Fig. 1).

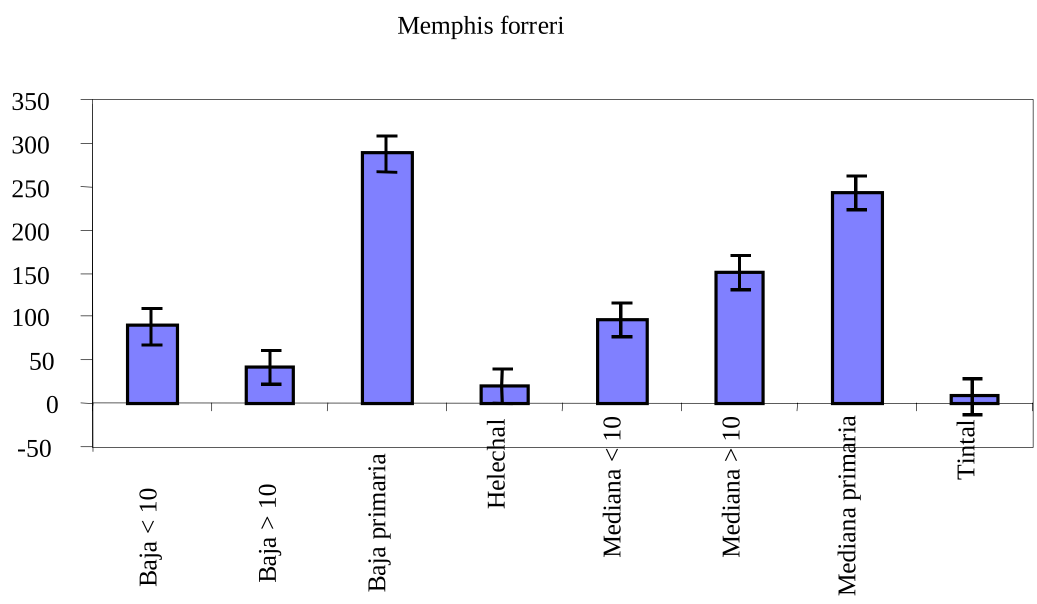
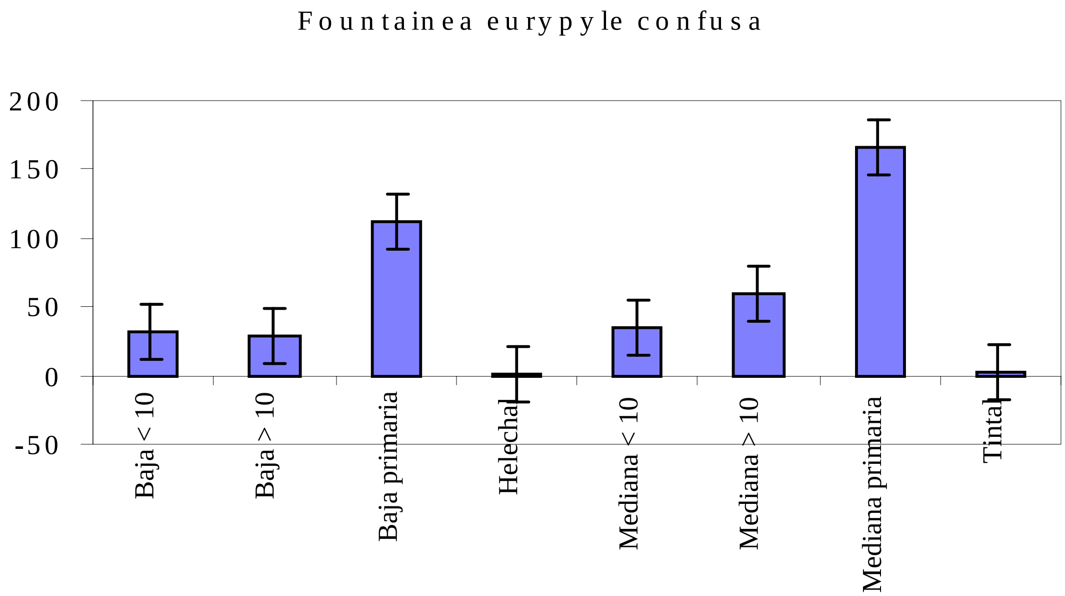



**Figure 1.** Number of individuals per trap, collected in different habitats.




The project evaluates three succession (*acahuales* of less and more than 10 years, and conserved forest),for both medium and low forests. During these two and a half years, besides pinpointing species of butterflies that may act as indicators, we have also detected some patterns in the fenology of certain species that could be useful to show changes in natural processes that take place in the region. One of these patterns is a north-to-south lattitude gradient of species abundance during the season. Another is a demographic explosion of some species in certain seasons. This happens with the genera *Protographium* and *Marpesi,* and with the migrations of the species *Kricogonia lyside* .

In the pages that follow we propose a simple monitoring program which we assume will allow us to learn; although very generally, if the processes detected in the zone are uniform, or if there are any habitat modifications that somehow affect the general resources.

We consider this monitoring program a pilot study which might be modified as the project progresses, and as results are obtained following implementation. We use three sampling methods that we have found to be complimentary to each other: Van Someren-Rydon Traps baited with a fermented plantain, pineapple, sugar,and beer. Aerial entomological nets and visual records (Fig. 2).

Transects must be 1,000 m long, crossing several types of vegetation, but with at least 100 m of homogeneous vegetation in types encountered. The traps are placed every 50 m, in an alternating pattern on each side of the transect (Fig. 3). In Calakmul, we require at least two transects in the North zone of the reserve and two in the south.

In accordance with the seasonality of the region, the most productive sampling months, for the selected species are: April (during this month there is a massive presence of the species *Kricogonia lyside*), August, September, October and November (Fig. 4)

The traps should be set at 7:00 hrs,and must be checked from 14:00 to 17:30 hrs. During a walk-through of the transects, the observer will stop for 10 minutes at each trap and will record (Fig. 5) the number of individuals observed, by whichever of the three methods, for each of the selected species: *Kricogonia lyside, Archaeoprepona* *demoophon gulina*, *Fountainea euryphyle confusa*, *Memphis forreri*, *Morpho achilles hyacyntus* and species from the genera *Potographium* and M*arpesia* . A walk-through of the open roads should be done between 9:00 to 13:00 hrs, during which the number of individuals spotted from each of the selected species will be recorded. To correctly identify the species, observers use a guide that shows laminated wings of each of the species studied.

The species selected for this program have been recorded in the Guatemalan Peten region (Austin *et al* 1996), as well as in Belize (Meerman and Boomsma, 1993). Accordingly, if the monitoring program we are proposing for the Calakmul reserve was adopted for regional use, it would enable us to determine if the latitudinal variation in the butterfly abundance recorded for Calakmul during the year was a regional phenomenon. Initial findings in guatemala suggests that this is the case (Claudio Méndez, personal communication).

Included below is a list of recommended literature which has supported the project design for the Calakmul initiative. it will also be a great assistance for those interested in monitoring butterflies and other indicator species in general.

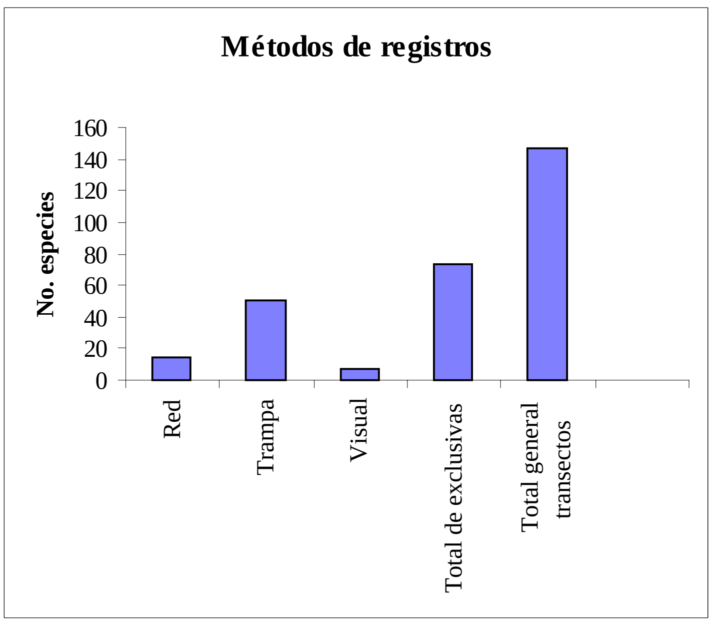
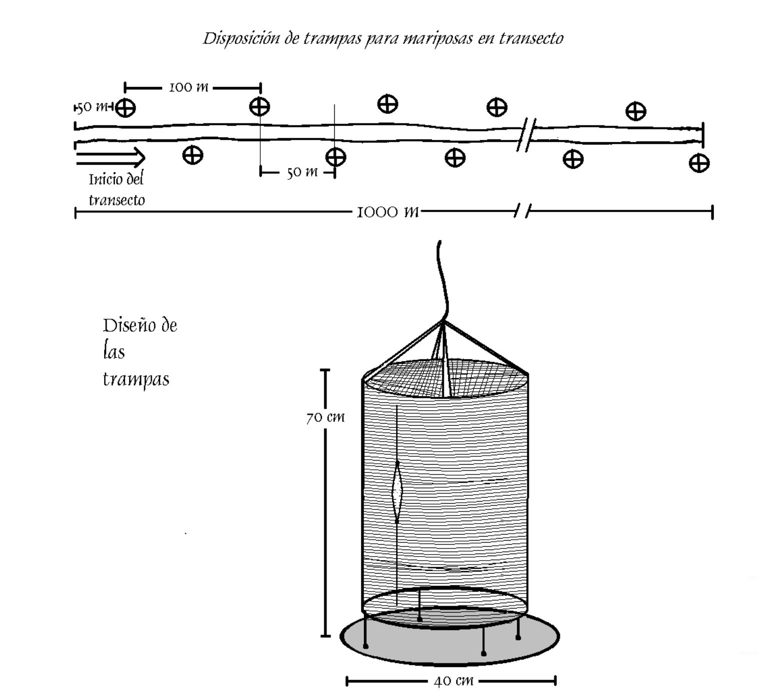



Figure 2. Number of species registered exclusively by one method of sampling.



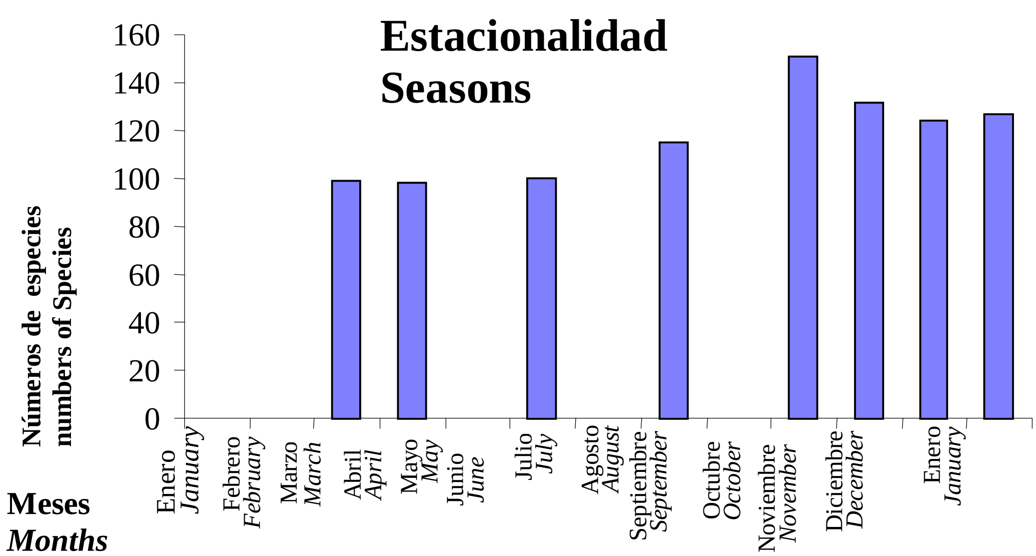




Figure 4. Number of species registered per month.

**BUTTERFLIES**
Zone:
Transect: Date: Climate conditions:

| | | | | | |
|---|---|---|---|---|---|
| Onset time:<br>Observer: | | | | | |
| Final time: | | | | | |
| Number of Trap | Species | Type of Record | Distance, direction per transect | Time | Comments Climate |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Figure 5. Format for butterfly monitoring field data recording

RECOMMENDED LITERATURE

Austin, G. T., N.M. Haddad, C. Méndez, T. D. Sisk, D. D. Murphy, A. E. Launer and P. R. Ehrlich, 1996. Annotated Checklist of the Butterflies of the Tikal National Park Area of Guatemala. Tropical Lepidopter, 7(1):21-37.

Beccaloni, G. W. and K. J. Gaston, 1995. Predicting the Species Richness of Neotropical Forest Butterflies: Ithomiinae Lepidoptera:Nymphalidae) as Indicators. Biological Conservation 71: 77-86.

Brown Jr., K.S.. 1972. Maximizing daily butterfy counts. Journal of the Lepidopterists Society 26: 183-96.

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Chapter IV

# Anuran Survey Protocol

**John R. Meyer and Carolyn M. Miller**

Under the auspices of the Declining Amphibian Populations Task Force (DAPFT IUCN/SSC), the Belize Declining Amphibian Populations (BELDAP) Working Group was established in 1997. Consisting of six volunteer scientists, a working group chairperson and scientific advisor, monitoring of 19 anuran species began at 13 sites in Belize. Participants at La Selva Maya Biodiversity Monitoring workshop (October 1997) agreed to adopt this protocol. Thus, the project was expanded to include interested scientists in Mexico and Guatemala. The name MAYAMON reflects this expanded geographic area. Development of a training kit for participants is underway.

The advantages of the MAYAMON protocol are that it requires no special equipment, no handling of live animals, and is readily implemented. One observer, familiar with anuran vocalizations and identifications, may conduct the surveys. The following protocol is the same that is in use by MAYAMON with one exception. Paired sites are recommended in order to compare and contrast changes over time between disturbed and non-disturbed sites. A preliminary list of anurans has been compiled which includes those common to all sites with additional species to be added based on localized considerations. Those species are shown on the sample data sheet which follows.

An additional, protocol is recommended, targeting Eleutherodactylid species. Visual Encounter Surveys (VES) should be used, both in forest and riverine habitats when it is suspected that Eleutherodactylids occur. The number of animals counted by this method should be tallied.

I General considerations

A. Each participant will commit to a minimum of 5 years of survey

B. Each participant will select from 2 to 6 sites to monitor; the same sites will be monitored from year to year.

   1. "Paired" sites will be selected; i.e. one site subject to disturbance and the other site "undisturbed" or pristine.

C. Data will ultimately be pooled and all participants will have joint authorship of any resultant publications.

II Survey method: Vocalization counts

A. Sites will be one of the following:

   1. Section of stream (one or both banks) between 100 and 200 m in length

   2.2. Pond (permanent or seasonal) less than 500 m, swamp, or marsh between 100 and 200 m in length.

B. Each site will be described with respect to the following:

   1.Physical characteristics

   2.Surrounding environment

   3.Any noticeable changes on an annual basis

   4.Annual photo

C. Each site will be surveyed annually for vocalizing anurans for 5 years as follows:
1. Once a month, roughly evenly spaced, during the months of June, July, August, Septemberor October.
2. Surveys will be nocturnal, sometime between the hours of 1900 and 2300
3. Duration of survey at each site will

D. Only those anuran species listed on the *MAYAMON Site Survey Form* will be monitored.

E. Vocalization counts for each species will be estimates as follows:
a. 1= 1-5 individuals calling
b. 2= 6-20 individuals calling
c. 3= 21-50 individuals calling
d. 4= >50 individuals calling

F. Sight records of individuals seen but not heard will be put in “Comments”

III Eleutherodactylid protocol: VES surveys

A.Transect surveys should take place in “undisturbed” or pristine areas since. Eleutherodactylids are unlikely to occur in disturbed areas.
1.Transects will be 2 m x 250 m
2.In forested areas for *Eleutherodactylus chac, E. rhodopis, E. psephosypharus* and *E. laticeps*
a. *Syrrhopus (Eleutherodactylus) leprus* may also be detected by vocalization concurrent with the above species. If so, record the distance to vocalization in meters
3. Along and/or in, a stream for 250 m for *E. rugulosus* and *E.sandersoni*
a. use both banks if they are no more than 1 meter from the center line (rough approximation)
b. if greater than 1 meter from the center line, survey just one bank

B.Timing
1. Duration of VES surveys will be between 30-60 minutes as conditions dictate
2. Surveys should be nocturnal

IV All data will be recorded on the *MAYAMON Site Survey Form* and forwarded to the coordinator at the end of the season for entry into a computerized database. Each participant will be provided with a summary of the project on an annual basis.

# MAYAMON ANURAN SURVEY PROJECT

**SITE SURVEY FORM**

1 = 1-5 individuals 2 = 6-20 individuals 3 = 21-50 individuals 4 = >50 individuals

| Site ID: | Survey Date: | Observer: | Start Time: | End Time |
|---|---|---|---|---|
| Weather Notes: | | | | |
| SPECIES NAME | VOCALIZATION CATEGORY | COMMENTS | | |
| *Bufo campbelli* | | | | |
| *Bufo marinus* | | | | |
| *Bufo valliceps* | | | | |
| *Leptodactylus labialis* | | | | |
| *Leptodactylus melanonotus* | | | | |
| *Physalaemus pustulosus* | | | | |
| *Gastrophryne elegans* | | | | |
| *Hypopachus variolosus* | | | | |
| *Hyalinbatrachium fleischmanni* | | | | |
| *Agalychnis callidryas* | | | | |
| *Hyla ebraccata* | | | | |
| *Hyla loquax* | | | | |
| *Hyla microcephala* | | | | |
| *Hyla picta* | | | | |
| *Phrynohyas venulosa* | | | | |
| *Scinax staufferi* | | | | |
| *Smilisca baudinii* | | | | |
| *Smilisca cyanosticta* | | | | |
| *Triprion petasatus* | | | | |
| *Rana berlandieri* | | | | |
| *Rana valliant* | | | | |
| *Rhinophyrnus dorsalis* | | | | |

Chapter V

# Bird Survey Protocol

**David F. Whitacre and Carolyn M. Miller**

Point count transects were selected as the primary method to monitor abundance patterns of birds in La Selva Maya. There are several advantages to point counts. They are low cost requiring no special equipment or technology. They may be conducted with as few as two observers with one acting as recorder. Although accurate bird visual and vocalization recognition is essential, specialized training in handling of live birds is not necessary. Point count transects may be used in a variety of terrains including aquatic habitats. We recommend sampling during the dry season to census birds when they are most readily detected. Sampling during early dry season should detect migrant species still on wintering territories. Later dry season sampling detects resident species on breeding territories. With trained observers, this technique should be readily implemented by Selva Maya monitoring site participants.

To augment point count transects when time and personnel permit, pre-dawn listening counts and canopy-emergent counts may also be conducted. These two techniques may be carried out simultaneously and offer improved opportunities to detect certain species frequently overlooked using point count transects alone, such as psittacines, raptors, and columbids. These techniques are likewise low cost and readily implemented. Canopy-emergent surveys may be conducted from a cliff or Maya temple. However, surveys from emergent trees will require training and special equipment.

Species identified as those of special concern during La Selva Maya Biodiversity Monitoring Workshop (October 1997) were: Jabiru *Jabiru mycteria*, Wood Stork *Mycteria americana*, Orange-breasted Falcon *Falco deiroleucus*, Great Curassow *Crax rubra*, Ocellated Turkey *Meleagris ocellata*, members of the family Rallidae, and Scarlet Macaw *Ara macao*.

I. General considerations
- A. Each participant will commit to a minimum of 5 years of survey
- B. Each participant will select from 2 to 6 sites to monitor; the same sites will be monitored from year to year.
  - 1. "Paired" sites will be selected; i.e. one site subject to disturbance, the other site "undisturbed" or pristine.
- C. Data will ultimately be pooled and all participants will have joint authorship of any resultant publications.
- D All data will be recorded on the appropriate *La Selva Maya Site Survey Form* and forwarded to the coordinator at the end of the season for entry into a computerized database. Each participant will be provided with a summary of the project on an annual basis.

II Survey method: Point counts for songbirds and allies
- A. Sites
  - 1. Surveys should be organized into routes of 12 countes
  - 2. Points should be spaced at least 200 m apart

3. Count birds within a
   a. 50 m radius
   b. 50-100 m radius
   c. 100 m to infinity

B. Each site will be described with respect to the following:
1. Brief description of physical characteristics, habitat type at each point
2. Surrounding environment of route
3. Any noticeable changes on an annual basis

C. Each site will be surveyed annually for birds for 5 years as follows:
1. Each route of counts should be conducted twice during dry season between the periods of
   a. 1 February through 20 March (targets migrants on wintering grounds but count all species)
   b. 21 March through 30 May, or until rainy season begins, but not after 30 June
2. Each route should be censused beginning at dawn and ending 2.5 hours after sunrise when activity begins to wane
3. Count for ten minutes
4. Each count team will be responsible for a minimum of five count routes
5. Counts should not be conducted after activity begins to markedly wane as may be the case in open habitats where temperatures heat up more quickly.
6. Some routes can be done by vehicle, while others will be traveled on foot or by boat.
7. Counts should be suspended if rain, wind, cicadas, brown jays, or howler monkeys make ten conditions will again improve after a few minute espite

D. Recording data
1. Count for 10 minutes but record detections in 5 minute increments
2. Record birds thought to be within
   a. 50 m
   b. 50-100 m
   c. 100 m to infinity

III Survey method: Pre-dawn counts

A. Sites
1. Counts are unlimited radius, one hour in duration.
2. Counts should end at official sunrise as determined via Nautical Almanac or other source
3. Counts should be a minimum of 2 km apart; 3 km or more is preferable.
4. Counts may be conducted on the same date with the canopyemergent count if convenient.

B. Each site will be described with respect to the following:
1. Brief description of physical characteristics, habitat type at each point
2. Surrounding environment of route
3. Any noticeable changes on an annual basis

C. Each site will be surveyed annually for birds for 5 years as follows:
1. Should be conducted once during dry season (February-June).
2. Count requires two observers: the recorder observer keeps time and records data; the primary observer stands and constantly rotates over the entire compass range.

Detections are called out to the recorder and both compare notes on detections and identification.

D. Recording data

1. Record detections in 5 minute increments
2. At the end of the count, note number of distinct individuals believed to have been represented per species.
3. A fixed list of ubiquitous species, unique to locations, should be included on data sheets. This serves as a reminder to record them and conversely, lack of detections may be significant.

IV Survey method: Canopy-emergent counts

A. Sites

1. will have a clear view, 120 degrees in width over the forest canopy, extending to a radius of one kilometer from the lookout point, and may be one of the following:
   a. In open areas
   b. Along rivers
   c. In areas of contiguous forest
      (1). from the crown of a canopy emergent tree, cliff or Maya temple
2. Counts may be conducted on the same date with the pre-dawn count if convenient
3. Counts will be conducted at each site once per year between the months of February and June

B. Each site will be surveyed annually for birds for 5 years as follows:

1. Beginning one half hour after official sunrise as determined by the Nautical Almanac or other source
2. The total count duration will be no less than 2.5 and up to 4 hours

C. Each site will be described with respect to the following:

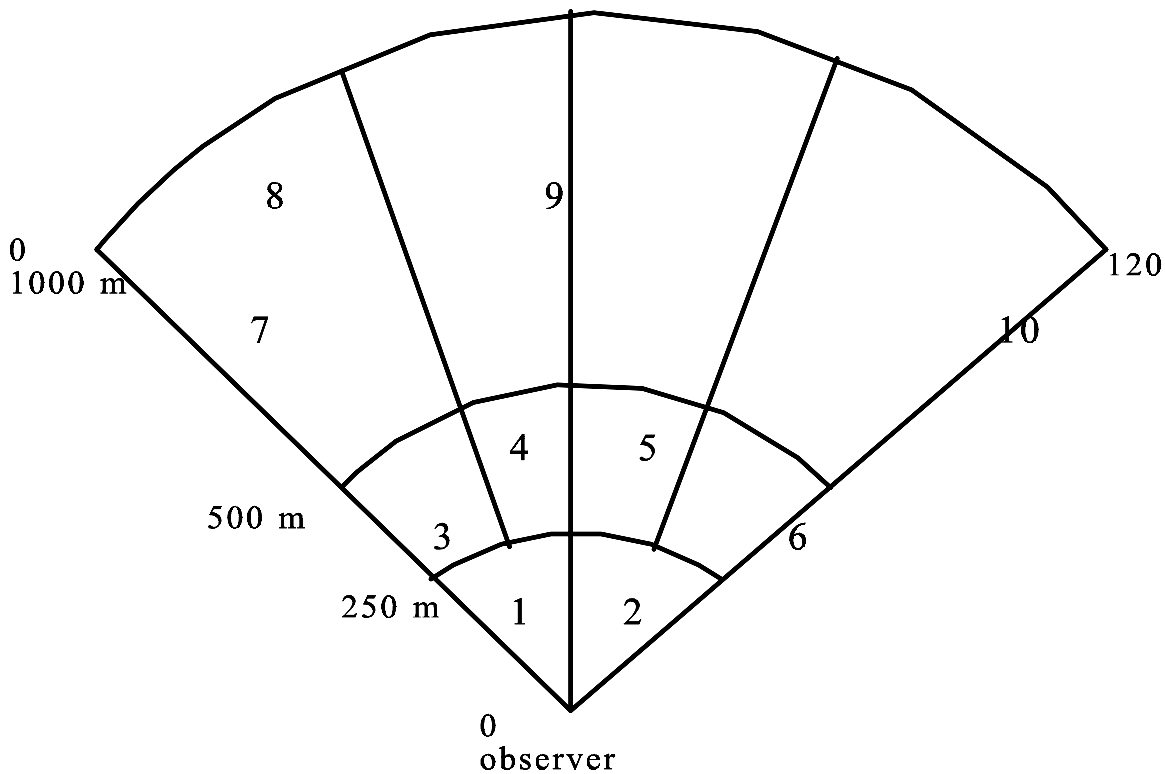
1. Physical characteristics
2. Surrounding environment
3. Any noticeable changes on an annual basis
4. Annual photo

D. Recording data

1. Count for 5 minutes
2. Detections should be recorded using 10 zones as shown below:
3. Indicate nature of detection as follows:
   a. P = perching
   b. V = heard
      (1). v + v = seen and heard
      (2). no designation means presumed seen
   c. = flying
   d. _= flying; a clear reverse heading seen during a short time span
      (1). Example: a flock of 35 *Aratinga* fly out and back in a short time span
   e. = copulating
   f. , , etc. = numbered comments; elaborate on reverse of data sheet
      (1). Example: Bat falcon attacking Swallow-tailed Kite (nest defense?)
4. Use superscripts with above codes to indicate which zone birds are detected

a. Example: $1^9$ $1^9$ $1^9$ $1^8$ $1^7$ = 1 *Buteo albicaudatus* flying through zones 9, 8 and 7

b. Example: $1_p^9$ = 1 *Sarcoramphus papa*, perched in zone 9



Mo/Day/Yr: ____/____/_____ **SELVA MAYA BIRD POINT COUNTS** Page ____ of_

(10 min. counts in 5 min. increments; < 50 m, 50-100 m, >100 m radius; 200 m apart)

Observers:______________________Weather: clear, few clouds, ptly cloudy, drizzle, rain. Temp.____EC. Habitat or vegetation type:________

Description:___________________________________ Site & Location:_____________________________________________

| SPECIES | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | < 50 m | | | | | | | | | | | | | | | | |
| | 50-100 m | | | | | | | | | | | | | | | | |
| | >100 m | | | | | | | | | | | | | | | | |
| | < 50 m | | | | | | | | | | | | | | | | |
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| | >100 m | | | | | | | | | | | | | | | | |
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| | < 50 m | | | | | | | | | | | | | | | | |
| | 50-100 m | | | | | | | | | | | | | | | | |
| | >100 m | | | | | | | | | | | | | | | | |

DATA ENTRY: Entered in ____ on ____/____/____ by _____.

Mo/Day/Yr: ____/____/_____

**SELVA MAYA PRE-DAWN BIRD COUNTS**

(Use hash marks)

Page ____ of_____

Observers:______________________Weather: clear, few clouds, ptly cloudy, drizzle, rain. Temp. EC. Habitat or vegetation type:________

Description:_____________________________________ Site & Location:________________________________________________

| SPECIES | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time |
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DATA ENTRY: Entered in ____ on ____/____/____ by _____. Checked____/___/___by____

Mo/Day/Yr: ____/____/_____

## SELVA MAYA CANOPY-EMERGENT BIRD COUNTS

Page ____ of_____

(Use quadrant zones & codes as shown in manual)

Observers:____________________Weather: clear, few clouds, ptly cloudy, drizzle, rain. Temp.____EC. Habitat or vegetation type:________

Description:______________________________________ Site & Location:___________________________________________________

| SPECIES | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time | Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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DATA ENTRY: Entered in ____ on ____/____/____ by _____. Checked____/___/___by____

Chapter VI

# Mammal Survey Protocol

Bruce W. Miller and Carolyn M. Miller

Mammals might be considered the most complex group for monitoring given their differing habitat uses. Many specialized and labor intensive techniques exist to sample specific taxa, such as live trapping rodents, and mist-netting or acoustically recording bats. For the purposes of regional monitoring, it was decided to concentrate on medium to large mammals to give an overall indication of the health of mammal communities throughout La Selva Maya.

Within the scope of the Selva Maya Monitoring project, these protocols meet the agreed upon criteria. Participants should consider these protocols as a dynamic starting point that may be subject to modification as the Selva Maya Monitoring project develops. Readers wishing a more in depth review of mammal monitoring techniques are referred to Wilson et al. (1996).

Participants at La Selva Maya Biodiversity Monitoring workshop (October, 1997) agreed that medium to large mammals of concern across the Selva Maya, either as game species, indicator species or species of conservation concern are:

Agouti (*Agouti pa*ca)
Baird's tapir (*Tapirus bairdii)*
Brocket deer (*Mazama americana, M. pandora)*
Collared peccary (*Tayassu tajacu)*
Coyote (*Canis latrans)*
Gray Fox (*Urocyon cinereoargenteus*)
Jaguar (*Panthera onca*)
Middle American spider monkey (*Ateles geoffroyi)*
Northern Raccoon (*Procyon lotor)*
White-lipped peccary (*Tayassu pecari)*
White-tailed deer (*Odocoileus virginianus*)
Yucatán Black Howler (*Alouatta pigra*)

Line transects were selected as the primary method to monitor these species. The advantages of line transects are that they can be conducted by a few observers that can readily identify mammals and mammal sign. The transects should be conducted both diurnally and nocturnally in order to get a temporal representation of species

A secondary technique, camera-trapping, is recommended in cases where finances and security permit their operation and where personnel may be trained to operate them. This method has the disadvantages of a high initial expense, security considerations and need for personnel training However, our experience shows camera-trapping is unparalleled for gathering data on shy or secretive mammal species. It also has the advantage of being non-intrusive and allows large areas to be monitored by only a few trained people. It has been extremely useful when circumstances permit its use.

I General considerations

A. Each participant will commit to a minimum of 5 years of survey

B. Each participant will select from 2 to 6 sites to monitor; the same sites will be monitored from year to year.
C. "Paired" sites will be selected; i.e. one site subject to disturbance, the other site "undisturbed" or pristine.
D. Data will ultimately be pooled and all principal participants will have joint authorship of any resultant publications
E. All data will be recorded on the appropriate La Selva Maya Site Mammal Survey Form and forwarded to the mammal coordinator at the end of the season for entry into the BIOMAYA database. Each participant will be provided with a summary of the project on an annual basis.

II Survey method: Line transects

A.Sites

1.Surveys should be organized into routes of 2 km If 2 km is not possible, then record the transect length which should be a minimum of at least 1000 m
2. Existing trails or roads may be used for transects and need not be laid out in a straight line
3. Multiple transects should be separated by a minimum of 2 km to minimize potentially recounting the same animals
4. Sites should be selected so that they represent a single habitat (i.e. transects should not pass through differing habitats)

B. Each site will be described with respect to the following:

1. Brief description of physical characteristics, habitat type at each point
2. Surrounding environment of route
3. Any noticeable changes on an annual basis
4. Annual photo

C. Each site will be surveyed annually for 5 years as follows:

1. When access permits, line transects should be conducted twice per season between the months of:
   - Dry season (February, May)
   - Wet season (July, November)
2. Diurnal transects should be conducted between 0530 - 0900 h
3. Nocturnal transects should be conducted between 1900 - 2300 h
   - Surveys should avoid nights during bright moon phases
4. Duration of each transect survey should be between 1.5 and 2 hours depending on transect length
   - The rate of walking should be 1 km per hour and can be gauged by recording elapsed transit time between 100 m or 500 m marks (100 m=6 minutes)
   - It is helpful to mark transects every 100 m in order to judge walking speed
5. Transects should be conducted as quietly as possible, by avoiding stepping on sticks, dry leaves and loud talking
   - However, some researchers report spotting of nocturnal animals may be enhanced due to detection of eye shine when arboreal mammals look toward the source of sound

D. Equipment for nocturnal surveys

1. Observers should have headlamps and backup flashlights, preferably with halogen

bulbs

2. A large bright halogen bulb flashlight or spot lamp should be used for scanning for arboreal animals
3. The lens of one spot lamp or flashlight should be covered with red translucent material
- The red filter is perforated with a 4 mm diameter hole to permit a beam of focused white light. This may be less frightening to animals and permits detection of eyeshine
- An unfiltered light should be used to identify the animals when located since the red filter may not provide sufficient light
4. A spare light and sufficient batteries should be available for the survey team

E. Observer

1. Three observers are optimal, but no less than two
2. One observer scans the understory
3. One observer scans canopy and elevated areas
4. One observer records observa tions, keeps track of the rate of progress and watches the trail for tracks and other sign
5. These tasks may be rotated among observers to prevent neck fatigue when scanning the upper level vegetation

F. Recording data

1. Species identification
- Positive identifications may not always be possible especially at night. In such cases the genus or common name (e.g., "medium arboreal opossum") will suffice
2. How the animal was detected; i.e., seen, heard, sign etc.
3. Estimated distance of animal from observer
4. Age and sex if it can be determined
5. Time of observation
6. Groups of animals (e.g., primate troops, peccary herds)
- The center of the group is used for distance estimates
- Give an estimated number when conditions prevent a direct count
7. Standard information such as: location, date, start and ending time, length of transect, weather (temperature and general information), name and number of observers
8. Primate troops may be heard but not seen
- Note number of troops and approximate distance from observers

G. Species of concern as enumerated above should be recorded and compiled on the *Selva Maya Mammal Monitoring Data Sheet.*

H. Other mammal species detected may be shown under Comments

III Survey method: Camera-trapping

A. Camera-traps should be organized along transects or at water holes

1. One or more camera-traps may be used; for a 2 km transect, 10 camera-traps placed every 200 m has worked well
2. Camera-traps should be spaced at least 200 m apart
3. The camera lens should cover the entire expanse of the infra-red beam in order to record animals breaking the beam anywhere along its length

1) We have found a 1-2 m wide transect to be optimal
4. Cameras also need to be placed close enough to the expanse covered by the infra-red beam in order to adequately illuminate it with the flash
5. Optimal height from the ground for placement of triggering devices is 20-30 cm todetect medium to large mammals

B. Length of time deployed
1. Traps should operate 24 hours per day for a minimum of 14 days

C. Camera-traps should be checked no more than once per week to avoid disturbance to the site.
1. We have found every 14 days to be optimal

D. Data and analysis
1. Identifiable photographs of species are the key data elements
- Each animal record for at a given location should include date and time of occurrence
- A. camera with a time/date stamp that imprints on the film is useful

2. All data should be standardized by 100 camera-trap nights (a trap night is one camera trap operated for a 24-hour period).
3. Trap nights (TN) are calculated as TN= N*T where N= the number of camera traps and T= 24 hour periods that each camera traps is operative. This is rounded to the nearest quarter of a 24 hr period (6 hours) to avoid unnecessary time calculations over long survey periods
- Example: 4 camera traps are activated on Day 1 between the hours of 1000 and 1200. The camera traps are removed on day 14 between the hours of 1500 and 1700.
- If all camera traps were fully functional during the survey time each trap would have operated for 14.25 trap nights, T=14.25.
- With 4 camera traps (N=4) the resulting total trap nights is TN= 4 × 14.25, which equals 57.
- However, if it is determined that one trap ceased functioning after day 9 at 2015, the trap nights for this camera trap would only equal 9.5. The total TN for the survey will then be the sum of the three camera traps that were fully functional plus the reduced time from the trap that malfunctioned. E.g. TN= (3* 14.25 + 1*9.5)= 52.25 TN

4. Data is then standardized by 100 trap nights.
- Example: using the 52.25 trap nights for 3 occurrences of a brocket deer; (3 / 52.25)*100= 5.74. The result is 5.74 brocket deer per 100 camera trap nights to be recorded on the data sheet

5. Camera traps that include a data logger can simplify calculation of trap-nights and indicate camera "down time" if any component of the unit malfunctions (e.g., animal chews camera cable, batteries fail in sender or receiver, film jammed in camera, etc.)

E. Types of camera traps. There are a number of types of camera traps on the market. Our experience is with TrailMaster. A good description of the range of devices can be found in Wilson et al. 1996.
1. The most useful are battery powered infrared-based that use either active or passive infrared as triggering mechanisms
2. Only TrailMaster manufactures active infrared camera traps (2 models)

a. Advantages:

- Programmable for sensitivity, assists in avoiding non-target animals
- Programmable for number of photographs taken per event period (e.g., only one photo per every minute) saves film
- Triggering device can be accurately set for target animals
- Data event logger can be downloaded to PC for analysis

b. Disadvantages:

- Complex set up with three pieces per trap, sender, receiver and camera takes some training
- Higher initial cost than some other units

3. TrailMaster Passive infrared units (TM-700)

a. Advantages:

- Programmable for sensitivity
- Programmable for number of photographs taken per event period (e.g., only one photo per every minute) saves film
- Data event logger can be downloaded to PC for analysis
- Easy setup with only two pieces (camera and TM unit)
- Lower initial cost

b. Disadvantages:

- Area of coverage can not be set as accurately as active units
- The rate of "false" or non-data events is much higher

4. Trailtimer and Camtrakker also manufacture passive trigging devices

a. Advantages -Trailtimer

- Lightweight
- Low-cost

b. Disadvantages- Trailtimer

- Need to supply the autofocus camera
- Not moisture proof

c. Advantages - Camtrakker

- Moisture resistant
- Theft-proof
- Delay programmable

d. Disadvantages Camtrakker

- Expensive
- Needs silica gel for housing which will require regular drying in damp climates in order to remain effective

F. Film recommendations: the choice of print or slide film should be based upon ease of processing for those using camera traps

1. Higher speed film (ASA 200 or 400) is recommended for dark conditions found in most forested areas.
2. Color film offers better differentiation of subtle differences than black and white

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**La Selva Maya Site Mammal Survey Form**
**Walking transect 1999**

| | | | | | |
|---|---|---|---|---|---|
| Site ID: | Survey Date: | Observer(s): | Start Time: | End Time: | |
| Distance: 2 km | Other: | Disturbed | Undisturbed | day/night | Survey time |
| Weather Notes: | | | | | °C |
| Comments: | | | | | |

| SPECIES NAME | NUMBER | COMMENTS |
|---|---|---|
| Agouti paca | | |
| Alouatta pigra | | |
| Ateles geoffroyi | | |
| Canis latrans | | |
| Mazama americana-(M. pandora) | | |
| Odocoileus virginianus | | |
| Panthera onca | | |
| Procyon lotor | | |
| Tapirus bairdii | | |
| Tayassu pecari | | |
| Tayassu tajacu | | |
| Urocyon cinereoargenteus | | |
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| | | |
| | | |
| | | |
| Total species | | |
| Total individuals | | |