National Strategy for Sustainable Wildlife Use, Commonwealth of Dominica

Phase One: HUNTING ASSESMENT

Training and Methods Manual

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Project Ref. 162 / 10 / 010

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DOMINICA HUNTING ASSESSMENT OBJECTIVES AND FOCAL SPECIES

Objective of project:
To reduce direct threats of over-exploitation facing the wildlife of Dominica, through the participatory development of a National Strategy for Sustainable Wildlife Use, and building the in-country capacity for its long-term implementation, in partnership with the Government and communities of the Commonwealth of Dominica. Collection of novel biological and social data will provide a sound basis to future decision-making, and the work aims to draw on and develop models of best practice for the region.

Current phase:
1. Improve the baseline level of information on resource-species use in Dominica.
- Available data (*partially completed*)
- Social assessments (*as soon as possible*)

2. Improve the understanding of the biology and status of selected key resource species.
- Determine distribution and relative abundance of key resource species, to determine key sites and their spatial relationship with protected areas & buffer zones (*current work to establish protocol and confidence for this*).

Thus, what are we going to concentrate on during this phase of the project?

They are the **key resource species**, and in order to illustrate the potential for management of these species we are going to look across the taxa and thus select one species from each major use group.

Current suggestions are:
Mammals – **agouti** *Dasyprocta antillensis* – due to hunting pressure and an expressed aim of sustainable off-take.
Birds – **ramier** *Columba squamosa* – because it is a species preferred by hunters.
Amphibians – **mountain chicken** *Leptodactylus fallax***,** because it is also a potentially endangered species, and is currently awaiting CITES listing due to the trade threat
Crustacea – **black crabs** *Gecarcinus ruricola*, because though a crustacean, the human consumption of the species coupled with increasing mortality can lead to population declines.

In the future there may be potential to look at a tree too:
Tree – *Phoebe elongata* or *Pseudophynix* sp. palm

Future work will concentrate upon:
- formally assessing the current sustainability of off-take of all the focal species,
- using this information as that basis of an awareness programme amongst hunters, consumers and decision makers,

and using this information as the basis for a national sustainable-use strategy that identifies future research and enforcement needs.

WHAT IS SUSTAINABILITY?

Hunting can be defined as sustainable *when the number of animals being killed is no greater than those being produced from the population over a given period of time, so long as this population is not reduced to a point at which it is unable to fulfil its role in the ecosystem involved.*

WHY IS HUNTING IN TROPICAL FORESTS OFTEN UNSUSTAINABLE?

Rates of production in tropical forests are low thus, in comparison to temperate domestic livestock production or wildlife production in savannah regions, the amount of meat that can be hunted sustainably per square kilometre of rainforest is very low, limited to about 200kg/km^2/year.

Most animals feed from the forest canopy where the majority of foliage is concentrated so terrestrial animals, such as ungulates, do not have the same ability to browse as in a savannah, and these are the main game species.

The low wild animal density limits the number of humans that a km^2 of forest can support sustainably, given minimum protein requirements. Calculations of minimum protein requirements are often based upon the US Recommended Daily Amount (RDA) of 0.28kg per person per day, which equates approximately to consumption in many developing countries. Hence, one km^2 of forest can, theoretically, support sustainably one person's consumption requirements per year. Most indigenous forest groups live at well below this density when hunting purely for subsistence, although additional agriculture may allow increased human density. Modern-day agriculturalists live at higher densities without the same subsistence needs (because of the nutritional value of crops) but still hunt, both for commercial reasons and because they want to eat game.

HOW DO YOU ESTIMATE SUSTAINABILITY OF OFF-TAKE?

The main method of assessing sustainability comes from a formula, developed by Robinson and Redford (1991), that gives an estimate of optimum sustainable harvest, which can then be compared with actual harvest rates.

The key variables on which the estimate of optimal harvest is made are:

1. *Maximum population increase* – the maximum number of offspring that an individual can produce in a year
2. *Population density* – the number of animals per given area

The figure generated gives the maximum production at the densities involved. The number of animals that can be harvested per unit area per year is only a percentage of this figure. It is usually estimated as 20% of the maximum production for long-lived, 40% for short-lived, and 60% for very short-lived species

What are the assumptions involved in this assessment?

There are a number of assumptions that underlie this, the most commonly used method of assessing sustainability of off-take.

1. The percentage that can be harvested per year is based upon an arbitrary division of species into the different age categories and the idea that long-lived species annual mortality is low, and thus there is less to exploit from what would be 'natural wastage', and vice versa with short-lived species.
2. Maximum productivity is assumed to occur at 60% of the *carrying capacity* (the number of animals a given habitat naturally supports) because slightly lower densities of animals allow higher rates of reproduction through reduced competition, etc. (*density dependent* effects).

How confident is the assessment of unsustainability made using this method?
The results of this method of assessing optimum sustainable harvest reflect a best-case scenario. If the rate of population increase is *density dependent* then it is likely to correlate well with the model's prediction. However, accurate biological data from many species are lacking. Robinson and Redford developed their model for Neotropical ecosystems where this was a problem. It is even more problematic for much of West and Central Africa's little known fauna. For example, maximum reproductive rate is often taken from zoo data (which may vary from rates in the wild), and density estimates generated in the field often vary widely. In addition, population densities have been shown to vary widely with differing habitat, and data on this variation within the region are very limited.

The model is therefore likely to generate optimum sustainable harvest figures above actual potential sustainable off-take – particularly because actual populations are often below 60% of carrying capacity to start with.

When figures of *actual harvest* are generated for comparison with the optimum they are often an underestimate because:

- Data are often from commercial markets, which do not include village consumption;
- There are high levels of wastage (meat rotting before it can be smoked or consumed) that occur when snaring in areas where this is practiced.

All of these calculations are based on local productivity. At a macro level it has been shown that dispersal could be a key element in recovery of animal populations. The authors described models that included the effect of *sources* of wildlife in evaluation of hunting sustainability.

The comparison of *optimal sustainable harvest* with *actual harvest* rates is a conservative way of determining whether off-take is *unsustainable*.

Therefore there are two key questions:

1. ***How can we determine population densities for our focal species?***
2. ***How can we estimate the actual harvest for our focal species?***

In both cases different methods may be needed for different species.

QUESTION 1: How can we determine population densities for our focal species?

WHY DO WE CONDUCT BIOLOGICAL SURVEYS?

Biological surveys can be used to:

- Describe and define the importance of a site
- Establish population size
- Determine habitat requirements of a species
- Identify ecological relationships

Repeating biological surveys over time can:

- Determine if a population is changing
- Determine why a population is changing

Getting Added Value From Baseline Surveys

Baseline surveys can be used to:

- Provide initial information to guide establishment and monitoring
- Determine monitoring protocols
- Provide baseline assessments for monitoring
- Increase understanding of ecological relationships, habitat associations, inter-specific relationships and potential threats to the system
- Identify needs for specific ongoing research

In most biological surveys, it will not be possible to find and record every individual plant or animal in the survey area. To understand the richness, abundance and distribution of wildlife, researchers have to make do with investigating only sub-sets, or samples.

If studies are carefully planned, researchers should be able to use their samples to make general statements about the animals and plants of the whole area.

PRINCIPLES OF SURVEY DESIGN

Ask yourself the following questions

1. Why you are you doing the survey?
2. How you will analyse the data before you collect it, and what depth of analysis is required – the reasoning behind this may be pragmatic, or even political rather than biological.

Next determine how you are going to meet these requirements

1. Think about your sample size.
2. Try to sample randomly because this gives more robust results.
3. Survey many small areas rather than one or a few large ones.
4. Find out as much as possible about the biology of the species to ensure maximising your chances of surveying it properly.
5. If you change the survey methods, tell those you are working with.
6. Be precise about the methods used.

QUESTION 1: How can we determine population densities for our focal species?

Think about the potential problems associated with given methods
1. You need to avoid counting the same individual twice transects.
2. Do not deviate from transect routes.
3. Don't make the mistake of thinking that the density of trapped animals is the same as the absolute density (without calculating your effective grid size).
4. Do not assume that sampling efficiency will be the same in different habitats.

When analysing you data
1. Be critical about your own results.
2. Attach confidence intervals to population estimates wherever possible.
3. Store information so that it can be easily accessed.

Collect data on data sheets
Researchers should record their observations on standardized data sheets. These can include boxes, ready-prepared lists of species etc. Their purpose is to act as an "*aide-memoire*" to ensure that the researcher records all the required information and does so efficiently.

Site & habitat description
A site or habitat description is needed for EVERY survey (including botanical surveys), and if possible should comprise a section at the top of every data sheet – this is expanded on in a later section. Give precise geographical and habitat information about where the sampling occurred.

COUNTING ANIMALS - POPULATION CENSUS TECHNIQUES

What is a census?
A complete count or tally of animals over a particular area at a specified point in time (or over a certain interval at a specified point). A census is therefore a specialized population survey.

When are censuses needed?
To determine the following:
i) Population number / size
ii) Population dynamics (population structure, age-sex class distribution)
iii) Population density and distribution (seasonal / lifetime use of range for example to aid in fixing National Park or Protected Area boundaries)
iv)Effects of disease outbreaks / parasites (veterinary interest)
v) Impacts of populations on habitat.

Types of count
i) Guess (also known as informed estimate or guesstimate)

ii) Individual recognition by natural markings (only useful for small populations). Example: scaring and shape of cetacean fins.

This technique, of gradually over time recognizing all the individuals in a population, can also be carried out by capturing animals and artificially marking them e.g. with ear tags or notches, toe clipping of small mammals, coloured rings on birds legs, etc.

iii) Mark - recapture (Petersons estimate, also known incorrectly as the Lincoln index)
Capture animals and mark them in some way, e.g. collaring, ear tags, branding. Then allow them to mix with the rest of the population, and recapture a sample.

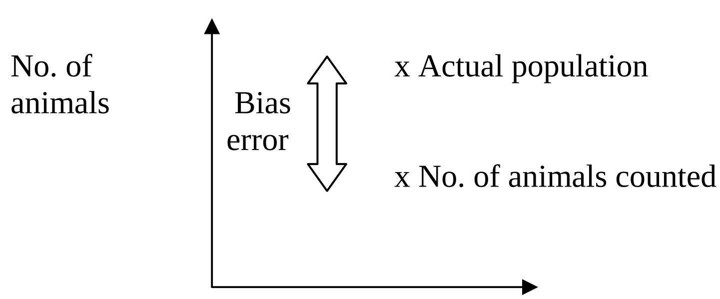
iv) Indirect evidence
a) Pellet or dung count. Count dung piles. You have to know a bit about the biology of your species, e.g. elephants defaecate 11 times a day. Dung piles disappear completely in 93 days (on average) so: No. of elephants in an area = no. of dung piles counted / 11 x 93
b) Track counts often very difficult to differentiate individuals.
c) Territorial calls or displays (very useful for bird songs, can be used for some mammals e.g. lions roaring).

v) Direct counts
There are two main types of direct count, total and sample. *Total counts* and *sample counts*.

<u>Total counts</u> of all the animals in a given area are very useful when:

a) The population is small
b) The population is confined to a small area.
c) The species is easily recognisable
d) The species is large and conspicuous

We assume that there is no sample error because all the animals are counted. In reality there is a bias error (the difference between the actual count and the real population), the magnitude of which determines the accuracy of the count.



<u>Pros & cons</u>
In theory a total count is very simple!
Can be used for determining population trends
Can be very accurate (for example if exterminating a species!)
Observers are almost certain to miss some animals. Therefore, you are actually taking a sample of the population
It is difficult to be sure that you have covered all of a given area, even if you have good maps
There are no confidence limits or control of biases
Some researchers have said that "the only certain thing about a total count is that it is wrong"

QUESTION 1: How can we determine population densities for our focal species?

With sample counts the census zone is the whole area of, for example, a national park in which animals are to be counted. The sample zone is that portion of the census zone that is searched and counted.

Pros & cons

Can chose sample area to get the best estimate of the population, that is sample intensively where the population is densest. This procedure, as before, is called stratification.

Can cover a large area cheaply.

Can estimate errors and see if numbers change from year to year.

There is often a conflict between obtaining adequate statistical sample and money available.

Non-biologists (e.g. politicians) like certainty in an estimate.

GENERAL SAMPLING / SURVEY TECHNIQUES

Wide patrolling versus systematic sampling

There is no single 'best way' to sample an area. The appropriate strategy depends on what your objectives are (e.g., whether you are trying to find as many species as possible, or get detailed information about one species), the size of the area and its terrain, and the resources you have available (e.g., number of people, time, money, equipment).

The first decision we have to make is should we try to simply wander around, recording whatever we see? Or should we sample in a systematic, replicable manner (for example, by devoting equal effort to different parts of the area according to a carefully planned protocol)? Both approaches have advantages and disadvantages:

1) The 'Wandering Biologist' or 'Wide Patrol'

Walking around a given area using a variety of searching and collection techniques can produce data on the species in occurrence. The approach can potentially produce a more extensive species list than other more systematic methods since using past experience and knowledge of particular taxa, biologists will be able to focus on areas that are likely to be particularly species-rich, such as areas around rivers.

The approach is rather subjective, but if time is very short, or if the sole objective of the survey is to find as many species as possible, then this is probably the best approach. It is also useful for doing quick presence/absence surveys and can be combined with data from interviews (*see later section*).

But the wide patrol approach does have some serious drawbacks:

- It may be difficult to plot exactly where the biologist has been, and hence exactly where habitats or species have been found (although this can be mitigated by taking point locations where observations, etc. are made).
- The findings from the areas visited will not necessarily be representative of the whole area: certain habitats and hence key species and even whole communities may be completely overlooked altogether. (Thus, if used in a serious manner effort should be used to visit all major habitats visible on topographic or vegetation maps).
- It is not possible to accurately repeat the survey in the future. Thus, it is not a suitable method for monitoring change.

- It is also difficult to accurately estimate abundance or distribution of particular species.

2) The Systematic or Scientific Approach
The systematic approach to surveying usually entails putting equal survey effort (amount of time, number of observers etc) into different parts of the area and is usually required if you are trying to establish the number of individuals of a species in a given area, i.e. a population estimate.

Scientific methods should try to avoid bias and, if necessary, allow estimates to be quoted at a defined confidence level (usually 95%). Data that is collected in a systematic and replicable way will be more amenable to statistical analysis, and can be used to compare different areas or monitor changes over time.

The scientific approach has a number of advantages, for example:
- It ensures comparability of surveys in different areas or carried out at different times
- Quality of data collection can maintained at a given level.
- It may be important for the biologists to be seen to have worked in a scientific way: decision-makers may be more convinced by quantitative data that has been rigorously collected and analysed than by subjective ‘general impressions’.
- Systematic surveys require discipline, but force us to look at material which may have been overlooked through more subjective data colleciton.

The two methods can be combined to good effect
- the ‘wide patrol’ survey method can be used for a preliminary investigation into the area to gain some idea of the terrain, the variety of habitats and some of the more conspicuous species.
- the biologists can use this information to plan and implement a more rigorous, systematic survey e.g. covering the full range of habitats.
- further wide patrolling can be used to pick up data not found using more systematic survey techniques, but care must be taken to keep the data separate.

Sampling units for systematic surveys and monitoring

Having decided to adopt a systematic approach, it is necessary to decide what sampling unit to use. A sampling unit is the study area or plot that will be investigated.

Units can be squares marked out in the forest and the area enclosed by the square is studied in detail, or it could be a line, such as a path which the observer walks along.

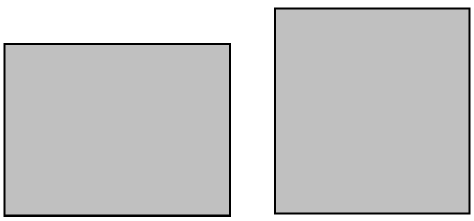
The best sampling unit in each case is one that produces an unbiased and representative sample of the area within your constraints of time, personnel and other resources. Each unit has its pros and cons and is more suitable for some organisms than others.

Once decided on a sampling unit stick to it. This will enable you to compare survey results from different areas or to monitor areas over time. Such comparison is impossible between different units e.g. a square quadrat and a transect.

It is possible to try different sampling units and may be useful to do so, but their results will need to be analysed separately.

Popularly Used Sampling Units (Plots)

1) *Quadrats (or square plots)*



The quadrat, is a sampling unit with four corners and parallel sides – either a perfect square or an elongated rectangle. Its size can range in size from a few centimetres to several kilometres across. Square plots are most often used in forest surveys. The shape of the plot you choose will influence the results which you get - i.e. a plot of 20 m by 500 m is more likely to pick up the presence of species with clumped (uneven) distributions than a plot of 100 m by 100 m, it can also be useful for sampling animals and plants across different habitats.

For large quadrats, a plot is chosen, and marked out with coloured string tied to stakes. Tape measures and a compass will be necessary for ensuring that the desired shape and size of the plot is achieved. The plot may then be sub-divided into sub-plots (20 m by 20 m or smaller) to aid the survey process.

<u>Survey techniques:</u> Walk all over quadrat looking for plants/animals (best done by systematically walking up and down to be sure of covering it thoroughly). Techniques can include listening for vocal animals such as birds and frogs or trapping in a grid within the quadrat e.g. for small mammals.

<u>Pros and cons</u>

Easy to calculate abundance of sessile (non-moving) organisms (such as plants and certain animals).

Abundance of plants can be recorded as number of individuals or as a percentage cover of the quadrat.

A popular and often used sampling unit, allowing comparison with other surveys.

Appropriate for searching for animal signs (such as burrows, nests and droppings) or looking for animals under rocks or logs.

Relatively low ratio of perimeter edge to plot area, which helps to reduce risk of individuals being wrongly included or excluded

or Very large or elongated quadrats may cover more than one habitat (species diversity and abundance may change between them)

Care needed to ensure that quadrat is completely covered.

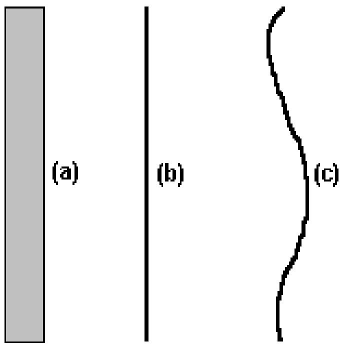
Care needed to avoid counting same individuals twice (especially mobile animals).

Time consuming to set up large quadrat in dense forest and may be almost impossible in rugged terrain.

More timid animals are likely to run away or hide before search has been completed

QUESTION 1: How can we determine population densities for our focal species?

2) Transects



The transect is often for animal surveys or when time is too short or animals or too mobile to allow effective sampling in a quadrat. The belt or strip transect (a) can be regarded as an elongated quadrat of known length, width and, hence, area. Only animals/plants found inside the strip are recorded. This is a good method when measures of abundance or density are required. The straight-line transect (b) is similar but the observer must decide whether to record only plants/animals actually on the transect line, seen within a fixed distance from the line, or at any distance from the line. With use of geometry, it is possible to calculate abundance or density. In order to calculate absolute density observers must estimate the distance from themselves to each animal, and the angle of it from the transect. Therefore straight transects are easier to work from.

The meandering line transect (c) could follow an established feature such as a footpath or stream, so is quick and easy to set up. Again, the observer decides whether to record only individuals on the transect line, seen within a fixed distance from the line, or at any distance from the line.

<u>Survey technique:</u> walk, ride or drive along the transect at fixed speed looking for plants/animals. Can survey by listening for vocal animals such as birds and frogs. Could also set animals traps along the transect at fixed intervals but the sampling area covered by the traps will be of uncertain size (not sure how far animals travelled to get there).

<u>Pros & cons</u>

Easy to calculate abundance of non-mobile organisms (plants, certain animals) if the transect is straight and of a fixed width.

By covering the transect fast or quietly, may catch sight of more timid and mobile animals.

Less chance of counting same individual twice than in the quadrat

Cover ground more quickly than points, so may detect more animals per unit time

Generally more efficient than quadrats for sampling species with a patchy or clumped distribution.

Can set transect along existing paths and streams

or Transects may pass through more than one habitat, and species diversity and abundance may change along transect

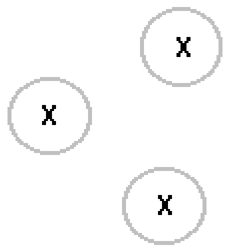
or May require distance estimation (how far the animal is from the mid-line of the transect)

Difficult to calculate density of animals seen, heard or trapped from the transect (the length of the area sampled should be measurable, but it may be of variable width because animals may come from near and far).

However sometimes only practical way to estimate density, and software available to perfom calculations (e.g. DISTANCE).

Relatively high ratio of perimeter edge to plot area may lead to individuals (especially the more mobile animals) being wrongly included or excluded – depending whether using fixed or variable width

3) Point counts with fixed or variable radius



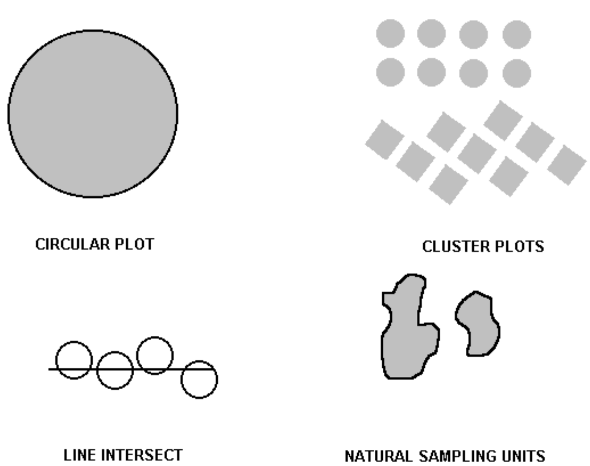
A very useful sampling unit for surveys of very active and timid animals (such as most birds).

<u>Survey technique:</u> sit at point X for period of time and look or listen for the target animals. (The sampling area is circular if the observer looks all around, and semi-circular if they only look ahead). The observer must decide whether to record only those seen (or heard) within a fixed radius or at any distance (in which case you can estimate how far away the animal is). When the observer first arrives, it is a good idea to wait 10 minutes before recording any data to allow animals to approach. Alternatively, the observer can set a trap or group of traps at the point although the sample area covered will be of unknown radius (because we can’t be sure how far animals travelled before capture).

<u>Pros & Cons</u>

- Can concentrate fully on recording observations rather than watching where you are walking
- Often easy to study species occurrence in relation to habitat features
- More time to identify mobile species seen (e.g., birds)
- More likely to detect active, but wary animals
- The observer gets the chance to rest his or her feet, and thus may have more energy to spend more time in the field.
- Less ‘trampling’ entailed and hence less disturbance to the environment.
- If stay still to allow timid animals to approach, cannot get up to catch unknown species.
- May count same individual twice
- Difficult to calculate density of animals seen, heard or trapped from the point if sampling area is of variable radius.
- Not appropriate for searching for animal signs or turning over rocks.
- Uncomfortable in mosquito or fly infested areas!

More Examples of Sampling Units



QUESTION 1: How can we determine population densities for our focal species?

CHOOSING THE RIGHT SURVEY TECHNIQUE

The choice of right technique will depend on the species, and whether you want to measure abundance or density of animals.

Definitions

Spatial distribution = The area where the species or population occurs at a given time (e.g. "throughout the Caribbean")
Absolute abundance = Number of individuals in the whole population (e.g. 250 sisserou?)
Absolute density = Mean number of individuals in a given area (e.g. 3.2 manicou per hectare).
Relative abundance = A count that is often linearly correlated with the species' absolute abundance (e.g. 4 manicou seen per night)
Relative density = A count that is positively and (usually) linearly correlated with the species' absolute density (e.g. 47.5 rats trapped per hectare)

☹ *It is generally harder to assess the abundance or density of animal species than plant species*

The individuals seen, caught or heard are normally only a fraction of those in the vicinity. Are we finding 90% of the animals present or fewer than 1%?

The 7 most important factors affecting animal observability are:

- Characteristics of the animal.
- Medium between the observer and the animal.
- Visual background 'noise'.
- Temporal (time) factors.
- Relative spatial positions of the observer and the animal
- Characteristics of the observer.
- The observer's rate of travel

Determining the <u>absolute abundance</u> of an animal species is difficult, costly and time-consuming. It is rarely feasible in a Rapid Assessment Survey, but measures of <u>relative abundance</u> *(the number seen, caught or heard per unit effort)* can be rapidly recorded, and can be just as useful for:

1) Comparing the abundance of a given species in different areas

Example: An endangered parrot occurs in a park. An ornithologist spends a month rapidly assessing the park. In the upland rainforest, he sees 4 of these birds per day of searching; down in the lowland forest he counts an average of 1 bird per day, while in the mangroves he sees only 0.5 per day on average. The ornithologist does not know how many birds he missed, but, because his search methods were consistent, he concludes that the density of birds in the upland forest is approximately four times as high as in the lowland and 8 times higher than in the mangroves. So to conserve the rare bird the manager of the park might decide to concentrate his resources on the upland forest.

2) Comparing the abundance of two different species in the same area
Example: Using the same search methods, a biologist searching in a wetland might find one hundred times as many frogs of Species A as frogs of Species B. Species B is unlikely to be exactly 100 times less numerous, but this finding certainly suggests that B is genuinely more scarce than A.

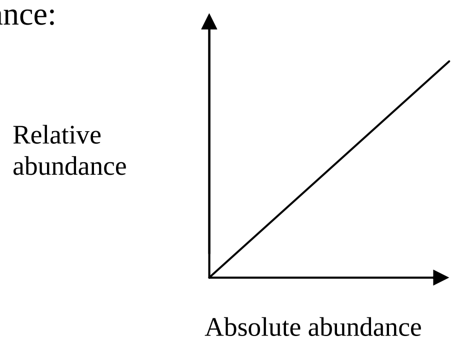
3) Monitoring changes in abundance over time
Example: A bat biologist sets up 5 mist nets in 10 sites and catches an average of 8 fruit bats per net. Two years later, he returns to the same sites and finds that people have encroached into much of the area and have cut down many trees. The bat biologist repeats the survey and this time, the average number of fruit bats caught per net is only 4. Although the absolute abundance of bats is not known, the drop in relative abundance suggests that the number of fruit bats has approximately halved since the first survey.

Ways of recording relative abundance.

Direct methods include:

Number of individuals seen per unit area;
Number of individuals caught per trap;
Number of individuals heard per unit time,

We assume that relative abundance is positively, linearly correlated with absolute abundance:



Indirect indices of abundance are similarly useful and can include sounds - ‘auditory indices’ of abundance. This may be measured as the number of individuals heard calling, or the total volume of sound produced by the species. But it is important to remember that most species have peaks of calling activity during 24 hours, and calls are harder to hear in some habitats (e.g., beside a rushing river) than others. Animals also leave a variety of signs, such as tracks and scats. The quantity of these signs may be positively correlated with absolute abundance:

Example: Using radiotelemetry, evergreen forest in a national park is known to contain an absolute abundance of 3.5 deer per hectare. In this forest, an average of 50 piles of deer droppings per hectare is found in rapid surveys. In the semi-deciduous forest in the same park, the absolute abundance of deer is not known. However, rapid surveys find an average of 100 piles of deer droppings found per hectare. If the number of droppings found is assumed to be *positively & linearly* correlated with the number of deer at large, *then* would indicate an absolute abundance of [(100/50)x3.5] = 7 deer per hectare in the semi-deciduous forest.

Choosing the right survey technique

	Presence, relative abundance, or density	Habitat use and population structure
Line transects	D, R	H, S
Arial surveys	D, R	H (S maybe?)
Trapping	R	H (S maybe?)
Capture-mark-recapture	D	H (S maybe?)
Quadrat transects	D, R	H, S
Mist netting	R	(S, H maybe?)
Pellet/scat counts	R	H (S maybe?)
Spot light survey	D in theory, R in practice	H
Radio tracking	P	H
Point counts (birds, some mammals)	D, R	H, S
Calling surveys	R	H
Track (spoor) counts	R	H, S
Den/burrow counts	R	H
Nest surveys	R	H
Camera trapping	P (D possible)	H (S maybe?)
Wandering biologist	P	H

Whether using indirect indices or other counts of relative abundance, it is crucial to use a systematic and replicable methodology. Unlike species diversity, the abundance of individual species cannot and should not be measured haphazardly. A **systematic method** is necessary:

To compare abundance in different habitats;
To compare abundance of different species;
To monitor changes in abundance in the future;
and To convince other people of your findings

Once the method is decided, stick to it.

Sampling protocol

What size should the sampling unit be?

- Sampling units can vary in size by orders of magnitude. The optimum size largely depends on the organisms being surveyed, their size, mobility, pattern of distribution and abundance. A 0.5m x 0.5m square plot would be adequate for sampling mosses and lichens on a boulder, but not trees or deer.

- If the plot is small in relation to the whole area you want to investigate then its representative value is small. Generally speaking, the larger/longer the unit the better, but the survey is likely to be constrained by the amount of time or number of people available.
- The variability of the environment is also important and should be considered in relation to why you are surveying. Do you want to look at one habitat type (such as grassland) or cover several different types (such as grassland, forest and a river)? The latter may create complications when trying to interpret data, because a different array of species will be found in the different habitats.

How many samples should be taken?

Once more this depends on what your reasons for surveying are:

- If you are trying to assess variables such as *species diversity, abundance or habitat associations*, you should not rely on taking just one sample. E.g., if we are a forest reserve of $100km^2$, we should not focus all our attention on a sample quadrat of 1 hectare since it would not necessarily be representative of the whole area.

How many samples are needed to be able to make general statements about the whole area?

- Common and widespread species may be found in the first few samples, but many samples may be needed to detect very rare or patchily distributed animals or plants. The more samples taken from an area, the closer their average species richness (diversity) or abundance will be to the average of the whole area. The best way to find out how many samples are needed is to take a few and see how varied they are.
- As a general rule, the more samples the better, but more samples will take more time to survey. There will have to be a compromise between the size of sampling units used and the total number of samples surveyed.
- For statistical reasons, it would be better to make a large number of small samples than just one or two large ones (e.g., ten 1-ha quadrats instead of one 10-hectare quadrat).
- For the same reasons a good minimum number of units to sample is seven since this gives you greater ability for statistical analysis.

What is the total area that should be sampled?

- The total area sampled should not be too small to prevent making reasonable general statements about the whole survey area.
- The minimum acceptable size partly depends on your objectives. If you wish to record every single species or count every bird nest, then it will be necessary to search every part of the area. In most cases, however, a smaller sampling effort should suffice. Aim to survey 5% of the total area, but in practice the area covered is likely to be less.
- Another very important consideration is the natural variation in the park – if it is very diverse in terms of altitude, vegetation type, soil, distribution of water courses etc, then more sampling will be required than in a more homogenous area such as a conifer plantation.

- In some cases, the total area sampled will be impossible to measure. This is especially true of animal surveys, where animals may travel long distances before they are seen or trapped.
- If the total sampled area is small, it does not mean that the findings are useless, but you should be cautious about making general statements about the whole area.

Where should sampling units be placed?

There are two basic approaches to choosing where to place the sampling units (quadrat, transect, survey point, etc) in the park. One approach, non-random sampling, relies on a subjective choice of sampling localities; whereas the other, random sampling, chooses localities based on some probability (chance) based scheme.

1. Non-random sampling

This is the subjective and deliberate choice of sampling unit location based on prior information, experience, convenience or related criteria. These can be divided into:

- Purposive nonrandom sampling with sites chosen because they appear to be representative, or are thought to be representative habitat for a target species
- Haphazard non-random sampling, where sites are picked through haphazard contact or unconscious planning.
- Convenience non-random sampling, where sites are chosen because they are easily accessible.

<u>Pros & cons</u>

All of the above methods will not yield fully representative results.

Such sampling is also considered less scientific than random sampling and is less amenable to statistical analysis.

It may be impossible for other observers to repeat the methodology precisely.

If the observers are experienced, it can be the most efficient way of gathering data in a short time and for finding specific animals or plants in a short time. A fish biologist, for instance, would obviously be more productive if he or she sampled areas with water only than a random mixture of aquatic and terrestrial areas!

2) Random sampling

This entails selecting sampling sites on the basis of chance. A common method is to divide the survey area into equal-sized numbered squares

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48

Some method of chance is then used to pick numbers which will determine which squares are sampled. This could be reference to a random numbers table (given in most statistics books) or using a computer or pocket calculator to generate a series of random numbers (e.g., using Random Number Generation function of Microsoft Excel). This is suitable for picking a random sample for quadrat sampling.

If the sampling units are survey points, then the bottom border of the area can be numbered and treated as a *x* axis while the left vertical border is numbered and treated as the *y* axis. A random numbers table can then be used on both axes to choose point co-ordinates. Topographical maps can be used for the same purpose if they are available.

Since the survey area is unlikely to be perfectly square or rectangular selected sites that fall outside its boundaries can be ignored.

There are two main forms of random sampling:

- **Simple random sampling**, where any part of the survey area has equal chance of being sampled. However, this may lead to small but important habitats being missed out.
- **Stratified random sampling**, where the survey area is first divided into zones and the areas within the zones are randomly sampled. This helps to ensure that small but important habitats do not get overlooked. E.g., if 10 samples are taken in a reserve comprised of 80% grassland and 20% forest, 5 samples could be randomly located in the grassland and 5 in the forest (the allocation to different zones could be equal, as in the former example, or proportional, reflecting the area covered by each zone, e.g., 8 samples in the grassland and 2 in the forest). For general surveys, stratified random sampling is probably the best approach to employ:
    - the technique ensures that scarce habitats don't get overlooked while allowing meaningful statistical analysis of the data collected.
    - if carrying out comparison keep the analysis simple by concentrating on 2 – 5 main variables e.g. habitat types.
    - if studying a given species sample all habitats where the species might be common or very scarce, but don't bother with habitats if there is definitely <u>zero</u> chance of finding the target species.

Describing the sampling unit

Having decided which sampling unit(s) to use and their location, it is important to describe them. This will help you or others to repeat the survey in the future, and to interpret differences between samples taken from different areas. Describing the sampling unit entails recording as much information as possible, depending on time, equipment, etc., including:

2. Location to 6 figure grid reference. Work out from known feature, triangulation or GPS. (In forest areas the last of these options is often easiest, although satellite reception can be a problem and thus you may have to take your position from the nearest clearing. GPSs have a built in inaccuracy of 15m so this is often unimportant).
3. The sampling unit's size and shape (e.g., length of transect, quadrat area, etc)
4. Date, time and weather conditions.
5. Altitude (m). (Either taken from a detailed map, altimeter or GPS (although the latter is often the most inaccurate method).
6. Slope (%).
7. Aspect using a compass e.g. south facing.
8. Rock type can be done retrospectively using a geological map and grid reference.

9. Cover (%) of bare soil and exposed rock (often not applicable in forest).
10. Habitat condition (e.g. primary forest, secondary re-growth (with estimate of age) or agricultural mosaic, etc).
11. Type of habitat (being as accurate as possible e.g. lowland broadleaf rainforest, lowland semi-deciduous rainforest, sub-montane forest, elfin forest, etc).
12. Vegetation cover (%).

- This is to be recorded separately for trees, shrubs and grass (i.e. in the case of forest understory).
- For the understorey, one of the key variables is density. This can be recorded as an index by ranking from very dense to less dense (e.g. 5 – 1) or can be measured through use of quadrats or a metre rule to count the number of 'stems' in a metre. If possible also record the three most common species as % composition for that community (so all the tree species would add up to 100%).
- Record average height for each species recorded, and for understorey. Measure if possible but estimation better than not recording data so long as you specify that figures are estimated.

13. A list of other species / taxa seen that are not being recorded by your current survey.
14. Observations of human disturbance such as:

- Hunting - normally just absence/ presence but in this case since it is the main focus of the work, there will be greater detail involved.
- Grazing (none/low/moderate/high) and number of livestock
- Woodcutting (none/low/moderate/high), Mining (absence/ presence), other resource extraction.
- Evidence of agriculture (none/low/moderate/high)
- Distance to nearest human settlement or road; with identifiers and size.

If working from a single point, then one description taking in the above variables is sufficient.

However, if working over a number of sites within a given area this protocol should be repeated at each sampling unit (e.g. traps or mist-nets). This can lead to useful information being generated on the overall structure of the area – which is very important with regards community composition.

The exact variables recorded will depend on the emphasis of the study and its whereabouts. If in a totally flat area of lowland forest do not bother to measure aspect.

Example from FFI work in Belize:
This was carried out as part of a general biodiversity survey - this was repeated for all survey sites:

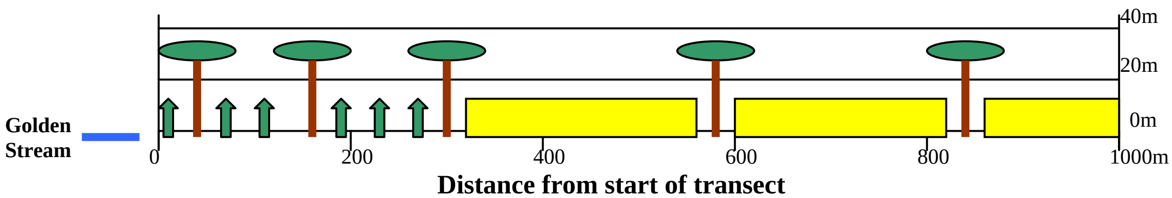
Site descriptions: Below are diagrammatic representations of the structure of forest from each of the transects that were used to assess habitat quality and compare avian and mammalian species richness at each of the sites. These are presented together with general site descriptions covering habitat quality and other aspects.

Tree heights are approximate, and **distance apart of crowns** indicates extent of canopy.

The dominant vegetation in the **understorey** is indicated by for cohune palm (*Orbignya cohune*), for bay-leaf palm (*Sabal morisiana*), and for young trees and bushes, indicates cutting-grass dominated scrub – often on logging-compacted soils.

Site 1: Fig Tree

Vegetation height



The survey site was approximately 2km east of the Southern Highway at GPS coordinates 16Q 0309147, UTM 1804866. The vegetation here was composed of undercut but intact forest near the river's edge, with a near canopy, giving way to five year-old scrub regrowth further into the property. This 'habitat' represents five years recovery from full clearance, and is dominated by cutting grass and xerophytic epiphytes. There is no canopy further in from the river but the species composition remains mixed, although there are almost no large trees after the first 300m nearest the river, which was spared the worst of the cutting. Timber species are present throughout, but as very young specimens, and there is some relict pine. Hunting and fishing is, both potentially and actually, the highest in the area due to ease of access crossing the northern boundary of the property.

MINIMISING ERROR WHEN SAMPLING

The 'scientific approach' to sampling means keeping mistakes and bias to a minimum to make results reliable, comparable and replicable. If a source of error cannot be avoided, then at least its impact must to be recognised and mentioned in the report.

1. Avoid ‘sampling error’, which can result from taking too few samples (such surveying only two or three transects, irrespective of their size) or biased sampling (e.g., only visiting accessible places and ignoring all the steep and thickly forested parts).
2. Maintain equipment and ensure that it is properly calibrated, and that survey team members know how to use it. Remember, for instance, that metals and power lines can distort compass readings.
3. Avoid misidentifying plants and animals – try to learn the calls, recognise droppings and tracks, etc, before starting the survey. It is also important to avoid mistakes caused by fatigue (do not work too long or when feeling ill).
4. Record potential sources of variation, including time of day, season or year, weather and sampling method. These can affect findings from same sample area. For example, most birds become less active and hence harder to see during heavy rain. Bias can even result from who conducted the work. We could remove this possible source of bias by each team or individual surveying each area and pooling their findings.
5. Be consistent in the manner with which data are recorded. At what size does a shrub or sapling become counted as a tree? If a vine creeps into a plot and out again, how is this recorded? If you are counting bees, how would you score a whole hive? Define parameters before embarking on the survey.
6. Re-measure, if possible, e.g. resurvey a transect and see whether you get the same results.
7. Check data carefully to avoid obvious mistakes, especially when copying from rough notes to final data set.
8. Use good, clear labelling for any specimens collected.
9. Be precise and honest when reporting methodology. Otherwise, other observers trying to repeat your work as part of a monitoring programme may go awry, and your findings will not be comparable.

MONITORING POPULATIONS

The simplest type of monitoring populations consists of repeatedly censusing over time. Counts could be repeated at different time intervals.
For example: *Someone monitoring the population of breeding birds might want to carry out daily or weekly counts*

Monitoring always gives more information than one-off counts or surveys. Repeated counts give trends in populations. All good natural resource managers should monitor the populations of key species in their areas since information on population sizes may be required for: conservation, harvesting (setting hunting quotas) or control (of problem animals or over-abundant species)

The main requirement of any monitoring programme is to systematically use the same techniques from one survey or count to the next.

QUESTION 2: How can we estimate the actual harvest for our focal species?

POTENTIAL METHODS FOR ESTIMATING OFF-TAKE

The estimation of off-take in hunting is in some ways more problematic than estimating population. We are trying to get the best estimate possible and the two sources of data are biological and human.

Biological data

This could come in the form of a comparison. Given that some of the techniques for estimating density allow for this, e.g. use of stratified standard transects, why not compare densities in areas thought to be heavily hunted with those thought to be little or un-hunted?

Of course there should be no assumption made that there is no hunting in a given site, even in strictly protected areas, therefore any data that can be gathered to gauge the level of actual hunting should be used to support these estimates.

Additionally, there are some potential complications with assuming that differences in density are purely due to hunting:

- One would expect hunted areas to have lower densities of agouti, but these could also be caused by: variability of food, amount of shelter, degree of competition, etc.

- Densities may also not be reduced as much as one would expect because: immigration from nearby areas may in fact maintain populations, even if hunting is locally unsustainable. *This has been shown in small forest antelope in Africa, and with animals with the breeding potential of both agouti and crabs this could also apply on Dominica.*

Therefore, we also need some **spatial data** to extrapolate from the smaller scale of individual sampling areas to the island as a whole. This means that we need to know the distribution of our focal species, as well as the area of which they are hunted.

Once we have worked out the average difference between hunted and non-hunted areas sampled, and the distribution of the focal species we then need to know the amount of land that is hunted over, and roughly to what degree. This information can come from two sources: FWD and other groups working in the field, and hunters themselves.

Human data sources

In the past many biologists have under-estimated the usefulness of information provided by local people. However, increasingly it is being proven to be, as common sense dictates, an important, and if collected properly, reliable, source of data even when quite complex.

QUESTION 2: How can we estimate the actual harvest for our focal species?

Example: it has now been proven that bushmen in the Kalahari desert can interpret tracks of leopard kills precisely in as much detail as a trained observer actually watching the kill could.

Local people often know:

- Which species are present (if only by their local names).
- Ecological interactions between species e.g. food plants of animals.
- Relative abundance of larger species of bird and mammal.
- Medicinal uses of plants.
- And obviously, how and how much different species are used by the community and outsiders.

In order to collect good data the issue is often more of how to ask the questions, and how to interpret the answers.

If we can determine where is being hunted, and to what degree then we can start to estimate:

- The total populations of the focal species from the distribution in unhunted areas.
- An approximate off-take from the hunted areas sampled.

However, to double check this we also need to gather some independent data on off-take. This can be done in various ways including:

- Recording the number of carcasses at markets on a regular basis
- Interviewing hunters, villages, and traders about the number of animals they see/take
- Going with hunters into the field and observing how many animals they catch per unit of time (Catch per Unit Effort).

This is crucial data if we are to succeed with the project objectives.

Additionally, it is absolutely **critical to engage people in the process of making decisions** about resources that they ultimately control e.g. game animals, at the earliest possible opportunity. If they can be made to understand a project, and become committed to it then the chances of success are much higher.

- Are farmers/ DCT potential sources of information?
- Are the other organisations that can help with this ‘intelligence’?
- Can we actually get some of this data from the hunters themselves?