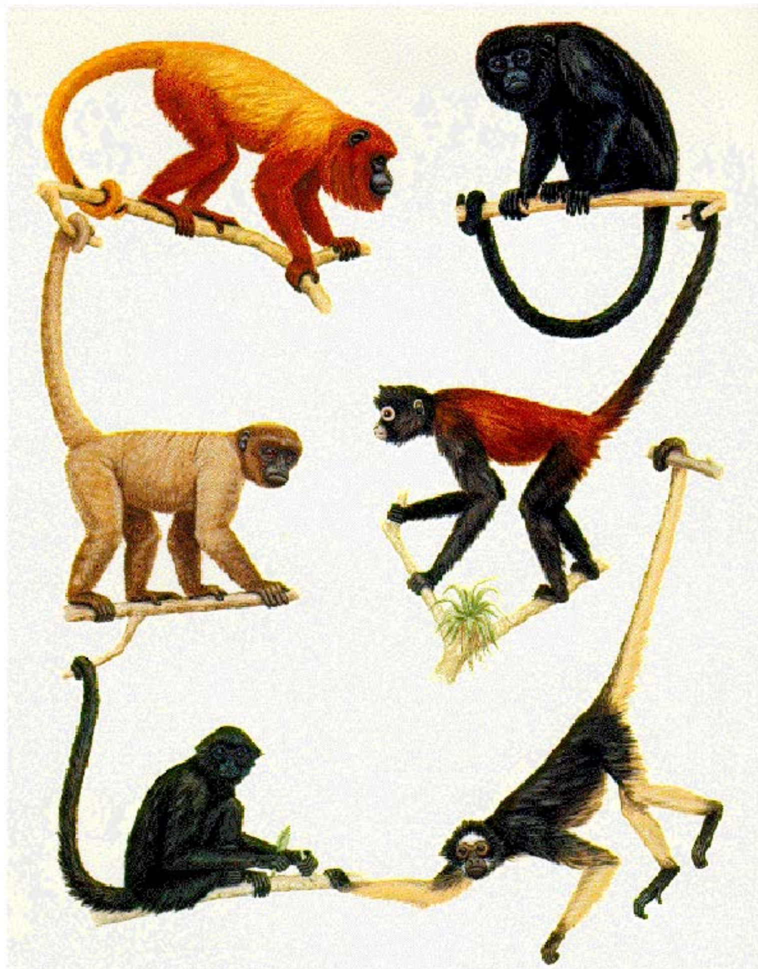
PRIMATE ECOLOGY and ANIMAL BEHAVIOR

Institute for Tropical Ecology and Conservation



North American Address:
ITEC, Inc.
Dr. Peter Lahanas
Executive Director
1023 SW 2nd Ave.
Gainesville, FL 32601
Tel. (352) 367-9128
Fax: (352) 367-0610
e-mail: itec@itec-edu.org
Web: www.itec-edu.org

Panamanian Address:
Bocas del Toro
Isla Colon
Republic of Panama
Fax: (507) 757-9541

Instructor:
Alain Houle, Ph.D.
Post-doctoral Fellow
Peabody Museum
Department of Anthropology
Harvard University
11 Divinity Ave.
Cambridge, MA 02138, USA
Phone: (514) 802-4822 (cell Montreal)
Phone: (617) 717-9997 (cell Cambridge)
Phone: (617) 496-3809 (Office Harvard)
Fax: (617) 496-8041 (Office Harvard)
e-mail: houle@fas.harvard.edu

Course Description

The purpose of this course is to give the student a foundation in primate ecology, primate and animal behavior, field techniques and analytical tools in a tropical setting. The material covered is equivalent to a university upper level course in primate ecology. The course is divided into five distinct components: classroom lectures, classroom presentations by students (based on assigned readings), discussions and exercises in the field, one written exam, and one individual project based on data collection techniques learned in the field and in the classroom.

Lectures/Readings

There will be lectures on ecological concepts, primate ecology, primate behaviour, field techniques, behavioural sampling techniques, and analytical tools. Readings corresponding to lecture topics will be assigned from selected papers.

Required Textbook:

- Karen B. Strier (2003). *Primate Behavioral Ecology*. 2nd edition. Allyn and Bacon.
- A set of papers derived from articles or book chapters is provided with this syllabi.

Group Field Exercises:

Students will learn the following field techniques, which will assist them in setting up their own independent field projects:

- Constructing habitat profiles. Plant phenology profiles.
- GPS exercise (Garmin 12XL)
- Behavioural observations (behavioural sampling techniques)
- Statistics (SPSS 8.0)
- Development and management of a primate behavioural database (Access 2000)
- Development and management of a bibliographic database (Reference Manager 10.0)
- Establishing study group day ranges (map and trails system; if we have time...)

Individual Research Projects:

With the assistance of the instructor, each student will develop and carry out their own field research project on a topic of their choice. Each topic must be approved by the instructor prior to beginning data collection. Each student will be required to write a research proposal, collect and analyse their data, write up their findings, and present their results to the class. A text about the art of publishing is provided.

Grading:

All assignments must be completed before leaving the field station, so that a final course grade can be assigned. Course grades are proposed to be calculated as follows:

- Individual Research Project - 40%
- Written Exam - 30%
- Classroom Presentation - 20%
- Participation - 10%

The course schedule will be determined on site as a function of student needs and preferences. It will most probably be weather-dependant.

HABITAT PROFILE

The objective of this exercise is to compare the habitats of three different areas of the forest. We will do it using the following concepts: 1) species richness, 2) species dominance, 3) plant diversity, and 4) habitat similarity. Determine these values for three habitats, but only for species of trees with a DBH (Diameter at Breast Height) equal to or greater than 20 cm, along a transect of 50 m long by 10 m wide. If the work to do necessitates too much time, we will shorten the transect length or width, or simply increase the DBH value. Moreover, primate ecologists should determine general characteristics of food trees. From this perspective, we will describe canopy cover and the physical characteristics of the most intensively used food trees of primates.

Species richness

The species richness is simply the number of plant species present in the habitat. This is a presence versus absence analysis. If you are unable to determine taxa to the species or genus levels, you can give them a number and identify them as “unknown plant # xx”. How many species have you found in your three transects? Which habitat out of the three presents the highest tree species richness?

Species dominance

When a single or few species predominate within a community, these organisms are said to be **dominants**. We will explore one measure of species dominance: **relative density** which is defined as “total individuals of tree species A divided by total individuals of all tree species”. Is the dominant species of trees the same for all three habitats?

Plant diversity

A community that contains a few individuals of many species is said to have a higher diversity than a community having the same number of individuals with most of them belonging to a few species. For example, a community of 10 species of 10 individuals each has a higher diversity than another community also with 10 species but with the 100 individuals apportioned 91, 1, 1, 1, 1, 1, 1, 1, 1, 1. In a collection of species, high dominance means low diversity. We will use data taken from your own transects. However, if it is not possible for us to do so (like we don’t have enough data, or taxonomic identification is too difficult according to time we have), I will provide data taken from two deciduous forests in West Virginia, USA (see Tables 20.1 and 20.2 which can be found in the Appendix of the present document; they are derived from R.L. Smith and T.M. Smith (2000), Elements of Ecology, 4th edition, Addison Wesley Longman, Inc.). The most widely used plant diversity index is the Shannon index. The formula is:

$$H = -\sum_{i=1}^{s} (p_i)(\log_n p_i)$$

where H is diversity of species, s is the number of species, and p_i is the proportion of individuals in the total sample belonging to the i^{th} species (= relative density). Don't let yourself be impressed by the formula if you never used such mathematics before. It is very easy to apply, as we shall see in the course. Please note that sometimes $\log_2$ rather than $\log_n$ is used in calculations. Your data sheets should normally look like this:

Taxa	**Number**	**Relative Frequency (p_i)**	**$\log_n p_i$**	**$\log_n p_i * p_i$**
Genus species Aa	8 individual trees	0.029 (for example)	-3.54	-0.103

Then you sum all products of ($\log_n p_i * p_i$), inverse the sign, and you get the Shannon species diversity. You are required to prepare your own datasheets.

Community similarity

This method is available for measuring similarity of communities. It describes the similarity versus differences between two habitats. It is referred as Sorensen's coefficient of community. To find the coefficient of similarity, apply the following equation:

Coefficient of similarity = $\frac{2(S)}{(A+B)}$ [or A+C, B+C]

where

S = # of species common to 2 different habitats
A = # of species in Habitat A
B = # of species in Habitat B
C = # of species in Habitat C

Using the above formula, calculate and determine habitat similarity between the 3 habitats. After calculating the index of similarity, which of the habitats were most diverse from one another? Which were more similar? How might such diversity affect the feeding and ranging behavior of your study group?

Characteristics of habitats

It is important to determine general characteristics of habitats such as water and drainage, soil types, canopy cover and vegetation. Your goal for the present purpose will be to quantify physical characteristics of the 10 mostly used food trees of the primate of your choice. It must include crown volume, tree height, crown depth, DBH and a phenology assessment. Also, try to evaluate the canopy cover (a percentage of sunlight that reaches the ground, say every 10%).

PHENOLOGY PROFILE

Species and tag	Location	DBH	RF	UF	ML	YL	FL	Comments

GPS Group Exercise

KEEP IN MIND THAT YOU CAN CANCEL ANY OPERATION SIMPLY BY PRESSING THE "**Quit**" BUTTON.

1) Open the GPS, get a 3-D lock with the highest number of satellites in view. Write which satellites are in view and note their strength to the nearest 25%. Write down the Estimated Position Error.

2) Double-check your datum (!). Which datum was set on? Which one have you chosen for the present exercise?

3) Use the "GoTo" function and go to the restaurant. The waypoint has been named "Cafe". Before starting to walking, write down the Bearing and Distance.

4) Once at the restaurant, erase the waypoint "Alain".

5) Walk to the very end of the boat dock where we were two days ago, and Mark your position. Name this waypoint "Boat". If this waypoint already exists, name it "Dock". Use the boat symbol/icon to illustrate this waypoint on the map. What is the longitude and latitude of this position in the following format: hddd° mm.mmm' .

6) What is the Bearing and the Distance <u>from</u> Panama City <u>to</u> our base camp. The waypoint are respectively "Panama" and "Camp". Be careful in that the question is not about the bearing and distance from the camp to Panama, but the other way around.

7) Create manually a waypoint for Beijing, the capital of China. Name it "Beijng". Choose the house as the symbol/icon for this waypoint. The coordinates are N 39° 54.493' E 116° 23.499'. Save it.

8) At what time will the sunset and sunrise occur in Beijing, <u>Jan 1st 2006</u>, <u>local time</u>. The time zone of Beijing is 8 hours west of Greenwich (+08:00). Be careful in that the question is for the New Year at Beijing time, not today at Panamanian time.

GPS Group Exercise

Point A	Longitude	Latitude	Point B	Longitude	Latitude	Distance

<u>TREE CLIMBING EXERCISE</u>

(<u>optional</u>)

☐ Naming the gear: static/dynamic ropes
☐ The use of a bow and arrows / slingshot / crossbow / spike boots
☐ Installation of a climbing rope
☐ Fall factor theory :

Fall Factor = Length of Fall / Length of rope which absorbs the fall

Fall Factor : 0 to 0.5 = safe
0.5 to 1.0 = risky
1.0 to 1.5 = dangerous
1.5 to 2.0 = extremely dangerous or fatal

Height above last anchor	Fall length	Length of absorbing rope when <u>NO</u> knot at anchor	Fall Factor	Length of absorbing rope <u>WITH</u> knot at anchor	Fall Factor
1	2	1+25 = 26	0.08	1	2
10	20	10+25 = 35	0.57	10	2

☐ Fall factor practice (theoretical problems / while in tree)
☐ Knots: Figure-8 loop, Prusik, Double Fisherman's, Stopper knot
☐ Preparation for a complete set of climbing material
☐ Preparation for an ascent - Double-check
☐ Ascending
☐ Autoanchoring
☐ Moving horizontally
☐ Rappelling system - Double-check
☐ Emergency descent while ascending

☐ Safety recommendations:
1- No knot at the anchor
2- Climbing rope over two anchors
3- Daisy chain in autoanchoring
4- Mechanical autoblocker during rappelling

Instructor's Evaluation:

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BEHAVIOURAL OBSERVATIONS

The goal of the present exercise is probably the one you shall mostly enjoy: primate behavioural observations. It will allow you to practice many forms of behavioural sampling techniques used by modern primate behavioural ecology. The proposed behavioural datasheet can be found in the Appendix of this document.

1) Focal-animal sampling

During *focal-animal* sampling, one individual is the focus of observation during a particular sample period. You need a watch with a timer set to 60 seconds to do this job. For our study, we will measure how often primates scan the environment per minute (vigilance rate). We will also evaluate their feeding rate for a specific food-item, which is calculated as the number of food-item (say fruit) put in the mouth per minute. Finally, we will explore the feeding cost for a specific food-item, which is defined as the distance moved by focal for one food-item put in the mouth. Note that if the focal individual disappears during observations, the whole observation is cancelled and another one is started.

2) Instantaneous sampling

Instantaneous sampling is a special type of time sampling in which the observer scores the animals' behaviour at predetermined 'points' in time. This method works well with behavioural states but it is not recommended for use with events. We will use it to determine how often different primate species associate together in the forest. An association is defined as two groups of different species being together at a distance 50 m or less. We will record polyspecific associations every 15 minutes. At the same time we will make a record of the group spread (in m) to test the null hypothesis that primate groups do not modify their group spread when they are in association versus when they are not.

3) Scan sampling

Scan sampling is simply a form of instantaneous sampling in which several individuals are 'scanned' at predetermined points in time and their behavioural states are scored, that is instantaneous samples are taken on several individuals at the same time. We will use this method to measure the feeding height preference of primates (by age-sex classes).

4) *Ad libitum* sampling

As *ad libitum* implies, no restraints are employed in sampling with this method. These are opportunistic observations. However, these observations must be **coded** to ease analyses. For the purpose of our study, we will use this method to establish the dominance hierarchy of each primate society we will study. To do so, we will record *ad libitum* all conflicts we can see, and classify the antagonists by age-sex classes. Note that the most important behavioural determinant is not the aggression but the submission. We will classify aggressions and submissions by their intensity. Moreover, because conflicts are rare and difficult to observe in the wild, we will give to them an absolute priority during our observations. That means that should a conflict arise between any subjects, we will stop and cancel whatever we are doing and collect *ad libitum* every information we can get, before resuming our previous observation (starting a new one actually). We will thereafter build a sociometric matrix of dominance relationships by age-sex classes. Finally, we will try to correlate the feeding height preference to the dominance hierarchy.

5) Inter-observer reliability

For this exercise, you are asked to pair with another observer, start an observation of the same focal individual for the same behaviour with the same observational condition and technique, and test for inter-observer reliability. Suppose you and a colleague both agree to measure the vigilance rate of an adult male feeding at the very top of a tree. This individual primate is somehow benefiting from his/her activity (he/she is getting food) but at a cost (facing a risk of predation). Do you both of you get the same vigilance rate? Quantify your degree of reliability (see text by Lehner).

STATISTICS

The academic objectives here are to determine which statistical tests should be used as a function of the null hypothesis and data that were gathered. Moreover, one must demonstrate that data and chosen statistics really answer the question that was asked at the beginning of the field study. We shall see differences between parametric versus non-parametric tests, and conditions that must be fulfilled to use parametric tests. We will perform statistical tests using your own data, otherwise data from an African primate community will be provided on a needed basis. The following tests must be mastered: Mann-Whitney for independent samples, Wilcoxon test for paired samples, t-test, ANOVA, post-hoc multiple comparisons, correlation, regression, and general descriptive statistics. You will also be asked to perform an advanced statistics, namely a two-way ANOVA, and interpret the results derived from it.

The following set of tables will guide you through the statistical process during your analysis. First have a look a the following table to determine what you want to do. Then, go to the table that refers to your objective (tables have been numbered according to what you want to do, from objective 1 to 6).

What do you want to do?
1. Summarize, describe or present data
2. Look at variance and distribution of data
3. Compare groups for significant differences
4. Identify significant relationships between variables
5. Identify groups for similar cases
6. Identify groups for similar variables

Table 1. Summarize, describe or present data (to be filled by the student)

Table 2. Look at variance and distribution of data (to be filled by the student)

Table 3. Compare groups for significant differences

What kind of data do you want to compare? **3.1 Data in categories (nominal, ordinal)** **3.2 Continuous, numeric data divided into groups**
3.1 Data in categories (nominal, ordinal) Example: Sex (Male-Female) and Activity (Feeding, Travelling, Resting, Grooming)
☛ **Chi-square**: Tests the hypothesis that the row and column variables are *independent*, without indicating strength or direction of the relationship. For 2x2 tables, Fisher's exact test should be computed when a table has a cell with an expected frequency of less than 5. Yates' corrected chi-square should be computed for all other 2x2 tables.
☛ **McNemar**: A nonparametric test for two *related* dichotomous variables. Tests for changes in responses using the chi-square distribution. Useful for detecting changes in responses due to experimental intervention in "before-and-after" designs. Typically, a significance value less than 0.05 is considered significant.
3.2 Continuous, numeric data divided into groups Example: Sex (Male-Female) and Activity (Feeding rate, Grooming duration)
How many groups or variables do you want to compare? **3.2.1 One group or variable compared to a known value** **3.2.2 Two groups or variables** **3.2.3 Three or more groups**
3.2.1 One group or variable compared to a known value
☛ **One-sample t-test**: This procedure tests whether the mean of a single variable differs from a specified constant. Example. A researcher might want to test whether the average body weight for a group of living monkeys differs from 1 kg (the mean body weight of the first platyrrhine monkeys as deduced from the fossil record), at the 95% confidence level.

3.2.2 Two groups or variables

How are your data organized?

3.2.2.1 One continuous, one numeric variable divided into two <u>independent</u> groups
3.2.2.2 Two continuous, numeric variables that represent <u>related</u> data

3.2.2.1 One continuous, one numeric variable divided into two <u>independent</u> groups

Test that assumes data are normally distributed within groups

☛ **<u>Independent t-test</u>**: The independent-samples t test procedure compares means for two groups of cases. Ideally, for this test, the subjects should be randomly assigned to two groups, so that any difference in response is due to the treatment (or lack of treatment) and not to other factors.

Test that assumes data are not normally distributed within groups

☛ **<u>Mann-Whitney test</u>:** A nonparametric equivalent to the t test. Tests whether two independent samples are from the same population. It is more powerful than the median test since it uses the ranks of the cases. Requires an ordinal level of measurement. U is the number of times a value in the first group precedes a value in the second group, when values are sorted in ascending order.

☛ **<u>Kolmogorov-Smirnov test</u>:** A test of whether two samples (groups) come from the same distribution. It is sensitive to any type of difference in the two distributions-- shape. location, etc. The test is based on the largest difference between the two cumulative distributions.

3.2.2.2 Two continuous, numeric variables that represent <u>related</u> data

Test that assumes both variables have a normal distribution

☛ **<u>Paired-samples t-test</u>:** The Paired-Samples T test procedure compares the means of two variables for a single group. It computes the differences between values of the two variables for each case and tests whether the average differs from 0.

Test that does not assume both variables have a normal distribution

☛ **<u>Wilcoxon two-related-samples test</u>:** A nonparametric procedure used with two related variables to test the hypothesis that the two variables have the same distribution. It makes no assumptions about the shapes of the distributions of the two variables. This test takes into account information about the magnitude of differences within pairs and gives more weight to pairs that show large differences than to pairs that show small differences. The test statistic is based on the ranks of the absolute values of the differences between the two variables.

3.2.3 Three or more groups

How many grouping (factor) variables do you have?

3.2.3.1 One (e.g. feeding rate for three groups defined by age category)
3.2.3.2 Two or more (e.g. feeding rate for groups defined by categories of age within categories of sex)

3.2.3.1 One

Test that assumes data are normally distributed within groups

☛ **<u>One-way ANOVA (analysis of variance)</u>:**The One-Way ANOVA procedure produces a one-way analysis of variance for a quantitative dependent variable by a single factor (independent) variable. Analysis of variance is used to test the hypothesis that several means are equal. This technique is an extension of the two-sample t test. In addition to determining that differences exist among the means, you may want to know which means differ. There are two types of tests for comparing means: a priori contrasts and post hoc tests. Contrasts are tests set up before running the experiment, and post hoc tests are run after the experiment has been conducted. You can also test for trends across categories.

Test that assumes data are not normally distributed within groups

☛ **<u>Kruskal-Wallis non-parametric test for several independent samples.</u>** A nonparametric equivalent to one-way ANOVA. Tests whether several independent samples are from the same population. Assumes that the underlying variable has a continuous distribution, and requires an ordinal level of measurement.

3.2.3.2 Two or more

☛ **<u>General Linear Model Factorial procedure (Factor analysis)</u>**. This procedure provides regression analysis and analysis of variance for one dependent variable by one or more factors and/or variables. The factor variables divide the population into groups. Using this General Linear Model procedure, you can test null hypotheses about the effects of other variables on the means of various groupings of a single dependent variable. You can investigate interactions between factors as well as the effects of individual factors, some of which may be random. In addition, the effects of covariates and covariate interactions with factors can be included. For regression analysis, the independent (predictor) variables are specified as covariates. Both balanced and unbalanced models can be tested. A design is balanced if each cell in the model contains the same number of cases. In addition to testing hypotheses, General Factorial produces estimates of parameters. Commonly used a priori contrasts are available to perform hypothesis testing. Additionally, after an overall F test has shown significance, you can use post hoc tests to evaluate differences among specific means.

Table 4. Identify significant relationships between variables

What kind of data do you have? **4.1 Data in categories (nominal, ordinal)** **4.2 Rank order data (ordinal data with cases ranked from lowest to highest)** **4.3 Continuous, numeric data (interval, ratio)**
4.1 Data in categories (nominal, ordinal) Example: Sex (Male-Female) and Activity (Feeding, Travelling, Resting, Grooming)
☛ **<u>Chi-square</u>**: Tests the hypothesis that the row and column variables are <u>*independent*</u>, without indicating strength or direction of the relationship. For 2x2 tables, Fisher's exact test should be computed when a table has a cell with an expected frequency of less than 5. Yates' corrected chi-square should be computed for all other 2x2 tables.
☛ **<u>McNemar</u>**: A nonparametric test for two <u>*related*</u> dichotomous variables. Tests for changes in responses using the chi-square distribution. Useful for detecting changes in responses due to experimental intervention in "before-and-after" designs. Typically, a significance value less than 0.05 is considered significant.
4.2 Rank order data (ordinal data with cases ranked from lowest to highest)
☛ **<u>Correlations</u>**: The Pearson correlation coefficient r, a measure of linear association between two variables, and the Spearman correlation coefficient, a measure of association between rank orders. Values of both range between -1 (a perfect negative relationship) and +1 (a perfect positive relationship). A value of 0 indicates no linear relationship.

4.3 Continuous, numeric data (interval, ratio)

How many variables do you want to evaluate?
4.3.1 Two (or multiple pairs of variables)
4.3.2 Two, controlling for the effects of one or more additional variables
4.3.3 One dependent variable and two or more independent (predictor) variables

4.3.1 Two (or multiple pairs of variables)

☛ **Linear Regression**: The Linear Regression estimates the coefficients of a linear equation, involving one independent variable, that best predicts the value of the dependent variable. **Example:** You want to predict the feeding rate of an animal (the dependent variable) from independent variables such as age **or** body weight **or** rain.

4.3.2 Two, controlling for the effects of one or more additional variables

☛ **Partial Correlations**: The Partial Correlations procedure computes partial correlation coefficients that describe the linear relationship between two variables while controlling for the effects of one or more additional variables. Correlations are measures of linear association. Two variables can be perfectly related, but if the relationship is not linear, a correlation coefficient is not an appropriate statistic for measuring their association. **Example:** Is there a correlation between birth rate and death rate? An ordinary correlation reveals a significant correlation coefficient (0.367) at the 0.01 level. However, when you take into effect (or control for) an economic measure, birth rate and death rate are no longer significantly correlated. The correlation coefficient drops to 0.103 (with a p value of 0.304).

4.3.3 One dependent variable and two or more independent (predictor) variables

☛ **Multiple Linear Regression**: Multiple Linear Regression estimates the coefficients of the linear equation, involving at least two independent variables, that best predict the value of the dependent variable. **Example:** You want to predict the feeding rate of an animal (the dependent variable) from independent variables such as age **and** body weight **and** rain.

DISTINCTION BETWEEN CORRELATIONS AND REGRESSIONS

In **Regression**, we estimate the relationship of one variable (the dependant variable) with another (independent variable) by expressing one in terms of a linear function of the other. One also uses regression to predict values of one variable in terms of the other. The regression equation normally takes the following form: $Y = a + bX$, where Y is the value of the dependant variable, X the value of the independent variable, a is a constant known as the Y-intercept, and b the slope of the linear regression (also called the regression coefficient).

In **Correlation**, we estimate the degree to which two variables ***co-vary***, or vary **together**. There is **NO** cause-effect relationship in a correlation.

Table 5. Identify groups for similar cases (to be filled by the student)

Table 6. Identify groups for similar variables (to be filled by the student)

BEHAVIORAL DATABASE

You will be introduced to the development and management of a primate behavioural database. We will illustrate our case with Access 2000 for Windows.

BIBLIOGRAPHIC DATABASE

You will be introduced to the development and management of a bibliographic database. We will use Reference Manager 10.0 for Windows.

Thank you for participating to ITEC's programme. We wish you a nice, enjoyable, memorable and safe field experience. Alain Houle and Peter Lahanas.

IPS International Primatological Society

RESEARCH EDUCATION CONSERVATION

PRIORITY TO CONFLICTS: **A) Actors (Species+Age-Sex) and Intensity (①=Without physical contact; ②=Chas**

Vocalizations; ④= Physical contact). B) Source of conflict. Example: AL-AM ② AL-AF flees from the tree, Food. D

Time	**Species Age-Sex**	**Vigilance in 60 sec.**	**Feeding in 60 sec.**	**Food Species**	**Part**	**NN Dist. Same Species**	**PSA 50 m**	**3 Species: Nearest Other Sp.**	**3 Species: Distance Other Sp.**

RF: Ripe Fruits; **UF**: Unripe Fruits; **IN**: Insects; **YL**: Young Leaves; **ML**: Mature Leaves; **FL**: Flowers; **SE**: Seeds; **LB**: Leaf Buds;

TENTATIVE COURSE SCHEDULE
for Primate Ecology and Animal Behavior Winter 2005-2006
Alain Houle, Harvard University

Abbreviations
m = morning (6:00 a.m. - noon)
a = afternoon (1:00 p.m. - 6:00p.m.)
e = evening (7:00 p.m. - 9:00 p.m.)

DAY		ACTIVITY	SUBJECTS	READINGS
Dec. 20	m a e	arrive in Bocas arrive in Bocas orientation lecture	 Station policies, safety, syllabus, student lectures, etc.	 none
Dec. 21	m a e	orientation walk orientation walk lecture	Field work (in forest) Field work (in forest) Intro. to tropical forests & primate community	none for this topic (but prepare your next student lecture, 23rd)
Dec. 22	m a e	group project Habitat Profile group project Habitat Profile lecture	Theory (in class) Field work (in forest) Measures of behaviour	Smith & Smith, National R. Council Lehner & Martin and Bateson
Dec. 23	m a e	group project Habitat Profile group project Habitat Profile lecture student lecture	Field work (in forest) Field work (in forest) Behavioural database Platyrrhine behaviour	 none Refer to the list (Rowe, Kinzey)
Dec. 24	m a e	group project GPS/Phenology group project GPS/Phenology lecture	Theory (1 hour in class) Field work (in forest) Behavioural database	Prepare next student lecture (Jan. 2nd). none
Dec. 25	m a e	group project Primate Behaviour group project Primate Behaviour lecture	 Platyrrhine evolution & adaptation Hypothesis testing	 Fleagle (1999) none

Dec. 26	m a e	group projects analysis group projects writing group projects presentation **individual project 1st draft due 6:00 p.m.**		Prepare next student lecture (Jan. 2nd).
Dec. 27	m a e	individual research - writing individual research - writing lecture **individual project final draft due 6:00 p.m.**	Tree climbing	none
Dec. 28	m a e	trip to cloud forest settle in, R&R lecture	Tree climbing	none
Dec. 29	m a e	cloud forest cloud forest lecture, night walk	Tree climbing	none
Dec. 30	m a e	cloud forest return to Bocas lecture	Introduction to GIS	Prepare next student lecture (Jan. 2nd). none
Dec. 31	m a e	5:30 a.m. individual research **Is the project working??** rest New Year's Eve party		
Jan. 1	m a e	10:00 a.m. individual research individual research lecture	Food availability Fruit productivity	
Jan. 2	m a e	5:30 a.m. individual research individual research lecture student lecture	Database & Statistics Various subjects	none Refer to the list (Strier, Garber and Bicca, Terborgh)
Jan. 3	m a e	5:30 a.m. individual research individual research lecture	Database & Statistics	none
Jan. 4	m a e	5:30 a.m. individual research individual research lecture	Statistics	none

Jan. 5	m a e	project analysis project analysis **EXAM**	 **EXAM**	
Jan. 6	m a e	Bird Island or Bastimentos Trip trip (weather permitting) lecture	 How to write a research report (chapter 3)	 Hailman and Strier
Jan. 7	m a e	project write up project write up lecture	 Bibliographic database Biodiversity database	 none none
Jan. 8	m a e	**Final project write up** **Due at 6:00 p.m.** individual project presentations		
Jan. 9	m a e	Free time Free time End of course party	coral reef exploration? coral reef exploration?	
Jan. 10	m	**Departure for Panama City**		