Descriptive animal behavior: sampling techniques and time/activity budgets

There has been a dramatic shift in emphasis in studies of animal behavior during the development of the science of ethology. In the early stages (the 1930's through the 1960's), most work was primarily descriptive, and there was relatively little attention to quantitative data or statistical analysis (although there were some notable exceptions). Beginning in the 1960's there was considerable (and in some cases warranted) criticism of the descriptive approach, in that it was (or at least could be) subjective and tainted by anthropomorphism and teleology. This is not to say that "classical ethology" as a whole is tainted, but only that the emphasis in ethology (and in all of field biology) has shifted to better-controlled, more rigorous, and quantitative studies. In recent years, there has been considerable emphasis in studies of animal behavior on systematically conducted field observations, or on controlled laboratory or field experiments, that generate quantitative data that can be analyzed statistically.

However, much of the scientific study of animal behavior relies on qualitative descriptions of causative factors, fixed action patterns, feeding techniques, communicative behaviors (vocalizations, postures, displays) and various types of social interactions (aggression, courtship, cooperation). These observations were (and still are) generated by careful observation of wild animals under natural conditions (as opposed to captive animals in cages). Without this basis of knowledge about the fundamental aspects of behavioral biology in nature, much of our understanding and explanations of causation and function would be ungrounded. We must understand the environmental selective pressures that shape behavior to fully understand its functional significance. The purpose of this lab exercise is to give you some experience with observational and sampling techniques used in the study of behavior, to generate some qualitative descriptions of specific behavior patterns, to practice recording quantitative data in the field, and to develop a "time/activity budget" for a common local species.

Classical ethologists distinguish between **states** of behavior and behavioral **events**. States of behavior may be thought of as general categories of activity, for instance "foraging" versus "resting" or "flying." Events are often changes from one behavioral state to another ("flying" changes to "perching" upon "landing") or they may be specific behaviors within the more general type described by the state ("step" is an event within the state of "foraging"). Events often come in **bouts**, which are sessions of repeated occurrences of the same event. We may observe bouts of stepping or pecking while observing foraging Snowy Egrets. Deciding which events are to be included in a particular record of a "bout" is not always an easy task. As general rules, if the intensity or level of motor activity changes noticeably (e.g. the stepping ceases for a period noticeably longer than the typical period between steps) or if the orientation of the subject under observation changes noticeably (e.g. the subject turns from stepping in one direction to another), animal behaviorists would recognize a shift from one bout to another. Obviously these criteria are subjective, and depend on considerable knowledge of the natural history of the study animal in question.

There are a number of sampling techniques used in the study of animal behavior. These range from very unstructured to very rigorously structured, and each has value in specific situations. The type of observational technique employed by the curious naturalist is called ***ad libitum*** sampling. As the name implies, there are no constraints on the duration of the observation period, how many individuals are observed, or what data or observations are recorded. This type of sampling results in a naturalist's field notes, which are useful in that they may contain observations of rare events, observations of common properties or patterns of behavior or other phenotypic characteristics, or observations of interactions between species that are ecologically important. The naturalist's observations may (and often do) direct more rigorous observations using other sampling techniques. Niko Tinbergen recognized the value of *ad libitum* sampling when he wrote that "an extremely valuable store of factual knowledge is picked up by a young naturalist in seemingly aimless wandering in the field." Edward Wilson (undoubtedly the greatest living naturalist and ethologist) also recognized the importance of knowledge of basic natural history when he wrote that "naturalists are the perfect people to study animal behavior." However, *ad libitum* sampling is so unstructured that it cannot result in any kind of rigorous, quantitative analysis of behavior, and it cannot be used to test hypotheses. This technique may be used to generate qualitative descriptions of specific behavior patterns, but other techniques are more useful for this.

Focal animal sampling involves observing a single individual of a particular species, usually for a specified period of time. This technique is often used to study specific behavior patterns. The observer records all instances of the behavior under study within a given time interval (for instance

flowers visited per unit time by a foraging halictid bee). This technique generates data on frequency of behaviors that can be used to make comparisons between species (great egrets vs. snowy egrets), or between groups of individuals within a species (for instance males vs. females, alates vs. workers, adults vs. juveniles, etc.). Another use of focal animal sampling is to generate qualitative observations of various types that can be used to produce an "ethogram." An ethogram is a description and inventory (usually with some information on relative frequency or sequence of expression) of all (or at least most) of the behavior patterns exhibited by a species. The production of an ethogram requires considerable effort and numerous observation periods throughout the life cycle of the species in question.

What, you may ask, is the use of a detailed description of the behavior patterns of a particular species, say a small songbird or a longhorned beetle? Ethologists recognize two broad categories of behavioral studies, the "species-oriented" and the "concept-oriented." The latter is in vogue among many behavioral biologists. The concept-oriented study asks specific questions, usually about the functional significance of behavior, which are (or at least should be) independent of the taxon one studies. For instance, if one is interested in the effect of the spatial distribution and abundance of resources on territorial behavior or mate-acquisition strategies, the effect should be similar whether one studies red-winged blackbirds, long-eared sunfish, collared lizards, or *Trachyderes mandibularis*. In spite of the value placed on concept-oriented studies, many ethologists (especially those with a strong background in natural history) still consider "species-oriented" studies worthwhile. For instance, studies (recent studies to boot) of acorn woodpeckers have revealed much information of considerable interest about the breeding and social biology of this species, and have led to conclusions that were unexpected, broadly applicable, and surprised even the "concept-oriented" behavioral biologists.

Another sampling technique that is important in some specialties within behavioral biology is **sequence sampling**. The focus here is on a chain or sequence of specific behavior patterns that are generally exhibited in a particular sequence. This technique is similar to focal animal sampling, in that a specific individual is observed (or in some cases a pair of individuals, as in a courtship sequence). However, in sequence sampling, the observation period does not have an arbitrary beginning and end, but rather begins when the observer thinks the behavioral sequence begins, and ends when the observer thinks the sequence ends. Obviously there is the potential for subjectivity and bias in this technique, because the observation period relies on the judgment of the observer. In this situation, a careful and well-trained observer can usually recognize changes ("events") in the behavior of the observational subjects, and use these as beginning and ending points for an observation period. The result of such studies is a description of the sequence of behaviors that are expressed in some type of activity or interaction.

In **scan sampling** an observer censuses a large number of individuals and records their behavior at the instant they are observed. Because scan sampling must be done quickly (otherwise it becomes focal animal sampling with short but variable sampling periods), it is usually restricted to broad categories of behavior such as "foraging," "flying," or "resting." Scan sampling can be vital for estimates of time/activity budgets or sex ratios. If the sample size is large enough, a scan sample gives a representative value of what individuals in the group under study are doing at any given time, and this can be translated into an estimate of the time an individual spends on various activities. Essentially, if 100 individuals are observed , and 70 are resting, 25 are foraging, and 5 are interacting aggressively, the assumption is that any given individual spends 70% of its time resting, 25% foraging, and 5% interacting aggressively.

An alternative to scan sampling is **instantaneous sampling**. In this technique, a particular individual is observed repeatedly, but the behavioral state is recorded at specified intervals. The specific behavioral activity the individual is engaged in at the instant of observation is recorded (hence the name "instantaneous sampling"). For instance, one might observe a fox squirrel at 15 second intervals. At one instant, the squirrel might be searching for food, at another, feeding, at another, chasing a conspecific. The result of this type of observation will also be a time/activity budget, which is derived from the proportion of instantaneous observations in which an individual is engaged in various activities. Preferably, several individuals of the same species would be observed, to get average proportions of time spent on different activities.

One of our goals for this lab is to use scan sampling and instantaneous sampling to generate a time/activity budget for a local species. We will compare the outcome of the two sampling techniques to assess their relative effectiveness. There are a variety of species that might serve as observational subjects. The most likely are the great egret, the snowy egret, the great blue heron, the killdeer, and the Canada goose. Which we concentrate on will depend on which we can find.