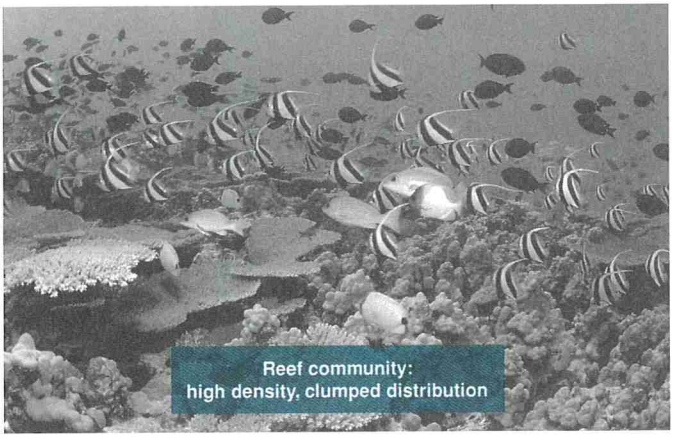
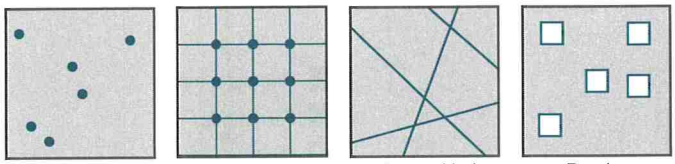
Sampling Populations

In most ecological studies, it is not possible to measure or count all the members of a population. Instead, information is obtained through **sampling** in a manner that provides a fair (unbiased) representation of the organisms present and their distribution. This is usually achieved through **random sampling**, a technique in which every possible sample of a given size has the same chance of selection. Most practical exercises in community ecology involve the collection or census of living organisms, with a view to identifying the species and quantifying their abundance and other population features of interest. Sampling techniques must be appropriate to the community being studied and the information you wish to obtain. Any field study must also consider the time and equipment available, the organisms involved, and the impact of the sampling method on the environment. Often indicator species and **species diversity indices** are used as a way of quantifying biodiversity and ecosystem "health". Such indicators can be particularly useful when monitoring ecosystem change and looking for causative factors in species loss.

Quantifying the Diversity of Ecosystems



The methods we use to sample communities and their constituent populations must be appropriate to the ecosystem being investigated. Communities in which the populations are at low density and have a random or clumped distribution will require a different sampling strategy to those where the populations are uniformly distributed and at higher density. There are many sampling options, each with advantages and drawbacks for particular communities. How would you assess aspects (e.g. species richness, abundance, or distribution) of the reef community above?



Random point sampling | *Point sampling: systematic grid* | *Line and belt transects* | *Random quadrats*

Photo: www.coastal planning.net

Marine ecologists use quadrat sampling to estimate biodiversity prior to works such as dredging.

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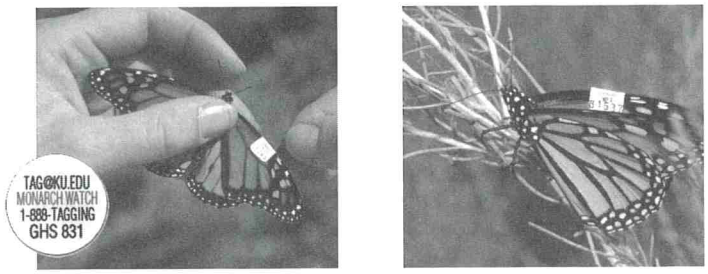
Line transects are appropriate to estimate biodiversity along an environmental gradient.



Tagging has been used for more than 30 years to follow the migration of monarch butterflies. The photograph here depicts an older tagging method, which has largely been replaced by a tag on the underside of the hindwing (inset). The newer method results in better survival and recapture rates and interferes less with flight.

Which Sampling Method?

Field biologists take a number of factors into consideration when deciding on a sampling method for a chosen population or community. The benefits and drawbacks of some common methods are outlined below:

Point sampling is time efficient and good for determining species abundance and community composition. However, organisms in low abundance may be missed.

Transects are well suited to determining changes in community composition along an environmental gradient but can be time consuming to do well.

Quadrats are also good for assessments of community diversity and composition but are largely restricted to plants and immobile animals. Quadrat size must also be appropriate for the organisms being sampled.

Mark and recapture is useful for highly mobile species which are otherwise difficult to record. However, it is time consuming to do well. **Radiotracking** offers an alternative to mark and recapture and is now widely used in conservation to study the movements of both threatened species and pests.

Sensors and Measures

Various meters can be used to quantify aspects of the physical environment, including the pH, temperature, light levels, and turbidity. Meters that measure single factors have now largely been replaced by multi-purpose meters.

Total dissolved solids (TDS) meter: Measures the content of dissolved solids (as ions) in water in mgL^{-1} giving an indication of water quality. The probe measures the conductivity of the water to approximate the level of TDS. TDS can also be measured gravimetrically by evaporating a sample leaving the residue behind.

Quantum light meter: Measures light intensity levels but not light quality (wavelength). Light levels can change dramatically from a forest floor to its canopy. A light meter provides a quantitative measure of these changes, many of which are not detectable with our own visual systems.

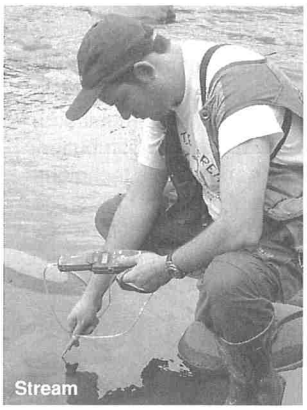
Dissolved oxygen meter: This measures the amount of oxygen dissolved in water (as mgL^{-1}), which gives and indication of water quality and suitability to support organisms such as fish. The **Winkler** method uses a titration of $MnSO_4$, KI, and $K_2S_2O_3$ to determine the concentration of O_2.

All photos: Campus photography University of Waikato

Using Dataloggers in Field Studies

Usually, when we collect information about populations in the field, we also collect information about the physical environment. This provides important information about the local habitat and can be useful in assessing habitat preference. With the advent of **dataloggers**, collecting this information is straightforward.

Dataloggers are electronic instruments that record measurements over time. They are equipped with a microprocessor, data storage facility, and sensor. Different sensors are used to measure a range of variables in water or air. The datalogger is connected to a computer, and software is used to set the limits of operation (e.g. the sampling interval) and initiate the logger. The logger is then disconnected and used remotely to record and store data. When reconnected to the computer, the data are downloaded, viewed, and plotted. Dataloggers make data collection quick and accurate, and they enable prompt data analysis.



Datalogger photos courtesy of PASCO

Dataloggers fitted with sensors are portable and easy to use in a wide range of aquatic (left) and terrestrial (right) environments. Different variables can be measured by changing the sensor attached to the logger.

1. Explain why we **sample** populations: _____

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2. Describe a sampling technique that would be appropriate for determining each of the following:

   (a) The percentage cover of a plant species in pasture: _____

   (b) The density and age structure of a plankton population: _____

   (c) Change in community composition from low to high altitude on a mountain: _____

3. Explain why it is common practice to also collect information about the physical environment when sampling populations:

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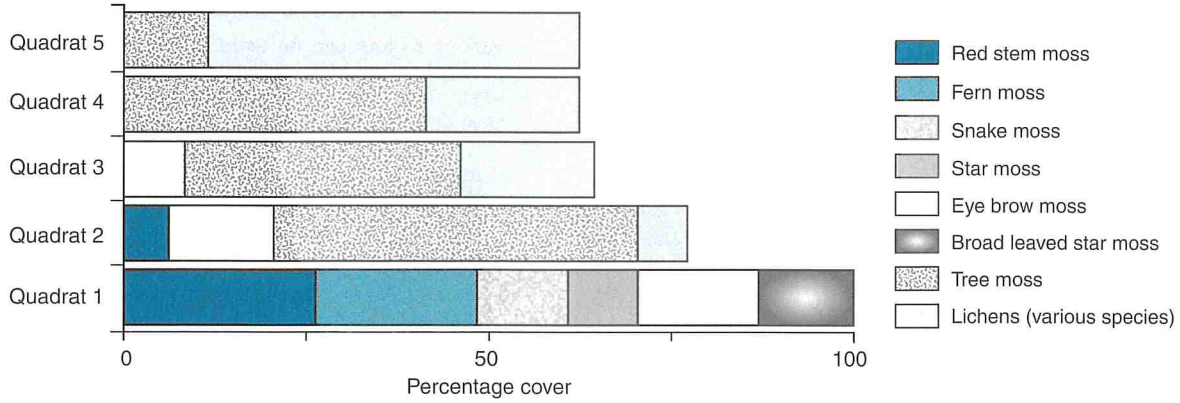
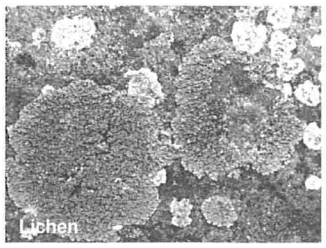
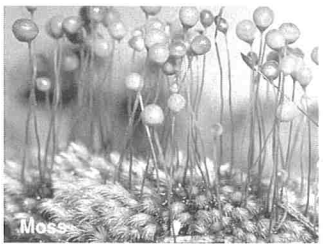


QUADRAT	1	2	3	4	5
Height / m	0.4	0.8	1.2	1.6	2.0
Light / arbitrary units	40	56	68	72	72
Humidity / percent	99	88	80	76	78
Temperature / °C	12.1	12.2	13	14.3	14.2





4. The figure (above) shows the changes in vegetation cover along a 2 m vertical transect up the trunk of an oak tree (*Quercus*). Changes in the physical factors light, humidity, and temperature along the same transect were also recorded. From what you know about the ecology of mosses and lichens, account for the observed vegetation distribution:

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