QUT YOUNG ACCELERATORS

A Field Exercise About Edges

Biology: Unit 3 Mandatory Practical

September 2020

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CONTENTS

Introduction

This resource has been developed to assist teachers facilitating the Unit 3 summative assessment tasks for the Senior Biology Syllabus. This field exercise in Ecology examines the way animals might use two adjacent habitats and the edges between them. This assessment task is based on QUT research undertaken through QUT's School of Biology and Environmental Science. Additional stimulus material based on real-world examples are listed on page 8.

This resource was developed QUT's School of Biology and Environmental Science in partnership with the QUT STEM High School Engagement to provide teachers with valuable resources based on the latest real-world research at QUT.

This resource is available on the STEM High School Engagement Learning Hub at https://www.qut.edu.au/study/career-advisers-and-teachers/stem-for-schools/stem-learning-hub

Overview: A field exercise about edges

This document is an overview of a field exercise in ecology that examines the way animals might use two adjacent habitats and the edges between them. The document is in three parts.

Part 1: Background Information	Part 2: Template	Part 3: Example Field Exercises
• What are edges and why they might influence the ecology of animals. • Why and how animal signs can be a useful way of assessing animal activity. • General methods used for assessing animal activity in edges and adjacent habitats.	• A general template, along with notes about logistics, methods and other things to consider when setting up the field exercise.	• Two example field exercises: • Red Necked Pademelons using clearing adjacent to closed forest • Bandicoot use of edge and adjacent habitat

Depending on the region in which you live and the availability of suitable sites for the field exercise, you may be able to use one of the two provided exercises with minor modifications to suit the site and species. If these species, or similar species, do not occur in your region you may need to either:

(i) make more extensive modifications to one of these two exercises

(ii) use the general template provided adding information about your site and species and specific methods, or

(iii) write your own field exercise based on the template points.

Information for teachers

This resource provides an example of a summative assessment task for the Senior Biology Syllabus, specifically *Unit 3: Topic 1: Describing Biodiversity*.

There are several ways teachers can use this resource:

- Use the **ecological data sets provided in PART 3** for question content in the final IA1 (*Data test Assessment Instrument*) for Unit 3 endorsement.
- Use the **ecological data sets provided in PART 3** for question content for exam practice for students.
- Use **PART 1 & 2** for students in their own school grounds or on a local field trip to complete the requirements of 1A2 (*Research Investigation Assessment Instrument*).
- Utilise this resource so students can independently learn the knowledge content descriptors for Unit 3: Topic 1.
- **Book a field trip to Samford Ecological Research Facility (SERF)** to complete the Bandicoot practical with QUT researchers before students complete their own modified investigation on your school site.
- Use the **provided links and other resources** to support students researching their own investigation question on Biodiversity for IA2.
- Use as a tool for teachers to **model the inquiry skills** required for students to successfully carry out a research investigation and to **model how students can structure a scientific report**.

Note — As per the QCAA Biology 2019 v.1.2 syllabus teachers must run an example practical first in class or on a trip, and then the required assessment task for students is to '*modify (i.e. refine, extend or redirect) an experiment in order to address their own related hypothesis or question.*

Curriculum links

School subject areas	Senior Biology
Link to QUT course/major	Bachelor of Science (including majors in Biological Sciences, Earth Science or Environmental Science). Other majors and dual degree options are also available
Links to QCAA	Biology v1.2: Unit 3: Topic 1: Classification Processes
Subject content descriptors	This resource covers the following learning content directly: ▪ understand that ecosystems are composed of varied habitats (microhabitat to ecoregion) ▪ interpret data to classify and name an ecosystem ▪ explain how the process of classifying ecosystems is an important step towards effective ecosystem management (consider old-growth forests, productive soils and coral reefs) ▪ describe the process of stratified sampling in terms of purpose (estimating population, density, distribution, environmental gradients and profiles, zonation, stratification) site selection choice of ecological surveying technique (quadrats, transects) minimising bias (size and number of samples, random-number generators, counting criteria, calibrating equipment and noting associated precision) methods of data presentation and analysis. ▪ **Mandatory practical: Use the process of stratified sampling to collect and analyse primary biotic and abiotic field data to classify an ecosystem.** The Part 3 examples also provide an example activity for teachers to cover some learning content and a suggested practical for *Unit 3: Topic 1: Biodiversity*: ▪ use species diversity indices, species interactions (predation, competition, symbiosis, disease) and abiotic factors (climate, substrate, size/depth of area) to compare ecosystems across spatial and temporal scales ▪ explain how environmental factors limit the distribution and abundance of species in an ecosystem. ▪ **Suggested practical: Measure abiotic factors in the field (e.g. dissolved oxygen, light, temperature, wind speed, infiltration rate).**
Achievement standard and learning outcomes	Students will develop skills in sampling ecological systems, organising and analysing data and developing ecological models to describe and explain the diversity and interconnectedness of life on Earth. Biology helps develop the following 21st century skills: critical thinking, creative thinking, communication, collaboration and teamwork, personal and social skills, and information & communication technologies (ICT) skills.

Additional resources

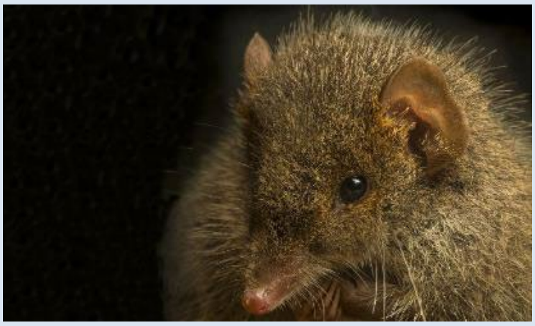
Kerrie Mengersen on the use of virtual reality to track Jaguars in the Amazon

➔ Watch on ScopeTV

➔ ePrints

Bandicoot habitat analysis on Totally Wild

➔ Watch the episode



Antechinus lost?

QUT mammalogist Dr Andrew Baker is concerned the endangered black-tailed dusky antechinus may be lost from its known Springbrook mountain habitat, after two recent research field trips failed to capture the small marsupial, or any of its common antechinus cousins.

➔ QUTube video

➔ News article

➔ ePrints

Tracking koalas and working for a leading research centre

Grace Heron has always loved maths and is about to finish her degree in mathematics and engineering at QUT. She never imagined she'd be helping to track and protect koalas and their habitats or working with researchers from one of Australia's leading statistical science research centres.

➔ Read about Grace's research

➔ Read about Grace's student journey

More resources over page

Additional resources

World's first acoustic observatory

Wild and remote areas around Australia are part of the Australian Acoustic Observatory, the world's first 'Google maps for sound' – hundreds of solar-powered sensors that continuously record the sounds of wildlife for five years. As a citizen scientist you can get involved.

➔ QUTube video

➔ News article

➔ The Australian Acoustic Laboratory website

Drones to seek out surviving koalas in bushfire zones

➔ QUTube video: Virtual reality

➔ QUTube video: Finding koalas

➔ QUT News article

➔ ZDNet article

➔ 7News video

Part 1: Background and a General Method

Background

The earth is a patchwork of different environments created by varying physical and biological conditions. A consequence of this patchwork is the existence of transition zones between different ecosystems and ecological communities. In natural systems these transition zones are often called ecotones – ecological communities that contain elements of each of the two ecological communities that overlap. The size and nature of these ecotones will vary depending on the distance over which physical and biological conditions change. Some transition zones can be abrupt, especially where physical conditions change quickly, for example in coastal environments where exposure to wind and salt spray diminishes with distance from the ocean. Very narrow zones of change in ecological communities are often called edges. There are many naturally occurring edges, but many edges have been created by human land management practices, a common example being the sudden transition from agricultural fields or pasture to adjacent forest (see Figures 1 and 2).

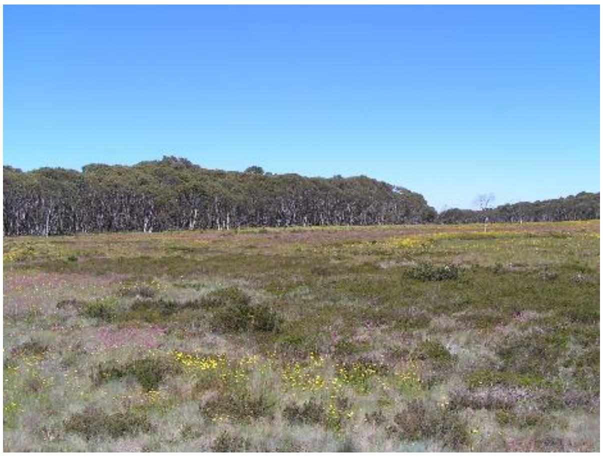



Figure 1: Two examples of natural sharp ecotones: a coastal dune system in south east Queensland (left) and high-country example from Kosciusko National Park, NSW (right).

A simple satellite view provided by any web mapping service will reveal the patchy nature of the current Australian landscape, and the abundance of edges between different ecological communities.

An edge is a transition from one ecological community to another, and it may contain species not found in either community. However, one aspect of edges is that their existence can impact beyond the edge itself. This is especially so for edges created by land management practices. In Australia, these human created edges have been part of the landscape for thousands of years. First as a part of traditional land management, particularly with the controlled use of fire, and more recently as part of more intensive forms of land use. It is therefore not surprising that these edges have influenced the ecology and behaviour of many Australian animal species.

Individuals of all animal species require food and shelter resources, and must acquire these resources while at the same time avoiding being food themselves. The behaviour of a species in relation to edges will depend on the nature of the food and shelter that they require, and the species of predator that are likely to prey on them. Some species may avoid edges and remain exclusively in either the open habitat or in the forest. Others may favour the edge environment itself. There may also be species that thrive when both habitats are available.

Figure 2: Typical scene in eastern Queensland showing a landscape of patches and edges created by human land management practices.

Species that avoid edges and avoid venturing out into open areas are likely to do so because the risks of predation outweigh any benefit obtained by foraging in these open areas. This could be because food resources required by the species are adequate or better in the forest than they are in the open. Similarly, species that are found mainly in open areas are likely to favour the food resources found in these areas and have a predation risk in these environments that is low enough not to impact their populations. In either of these cases we would expect to see greater levels of activity in one ecological community, and avoidance, or much lower levels of activity in the edge and adjacent ecological community.

Species that favour edges may do so because their food and shelter requirements are associated with the unique physical and biological conditions in this transition zone. For example, subtle changes in light, temperature and moisture conditions that occur along edges may favour growth of particular plant species that are important as food or cover for some animal species. Therefore, in these species, we would expect to see high levels of activity in edges and less or no activity in adjacent ecological communities.

Other species may thrive in places where they have access to both ecological communities, for example because they provide food resources in the open area, and protection from predators provided by cover in the adjacent forest. For these species, the quality and availability of food resources in open areas may outweigh the risks of predation, provided they have quick access to cover. In these cases, the risk of predation may increase with distance from an edge out into the open. Individuals feeding near the edge can move to forest cover quickly and may be at a lower risk of predation than individuals feeding a long way from the cover provided at the edges.

Examining the way a species uses two adjacent ecological communities and the edge between them will provide information about the importance of these habitats for the species and therefore useful information in terms of the conservation or management of this species. For example, suppose you are studying a pasture and an adjacent forest, and you find that the species you are examining shows no signs of activity in the pasture, and no or very little activity at the edge or up to 50 metres into the forest, but high levels of activity 50 metres or more into the forest. This would suggest that the species prefers the forest ecosystem and avoids the edge, and the impact of the edge extends at least 50 metres into the forest. So, the effective area that this species can use is not the area of the whole forest, but the area of the forest minus a 50-metre boundary. If you are planning to conserve habitat for this species you would have to consider that the usable area of a patch you conserve is actually smaller than the total area of that patch because of the impact of the edge.

Many animals can be difficult to study because they are cryptic, nocturnal, live in dense habitats, or for other reasons. Even the act of observing an animal species can be difficult because the presence of the observer might change the behaviour of the animal. To minimise these problems, ecologists often use the signs left behind by these animals, rather than the animals themselves, when they are seeking information about the way these animals interact with their environment. Signs left by feeding activity (diggings and scratchings), and faecal pellets are common animal signs used when researching these animals. For example, bandicoots make distinctive conical shaped holes when they are foraging, and many studies of macropods show that they tend to defaecate where they feed. So, the distribution of holes left by bandicoots, or faecal pellets left by macropods can provide information about the way these species use a landscape. Studying animal signs does not provide detailed information on individual animals, but it does have the advantage of providing information on the way a group of animals have behaved over a period of time. The main assumption of these methods is that the higher the density of the animal sign, the higher the level of activity of the species that leaves that sign.

General Methods

A general method for examining the activity of a species in relation to edges is to run transects from one ecological community, through the edge and into the adjacent ecological community (see Figure 3). Ideally the transect should be perpendicular to the line of the edge between communities. At predetermined points along the transect an assessment can be made of the density of the animal sign. This is usually done using quadrats, with the size of the quadrat being determined by the nature of the animal sign being quantified. For example, if examining the way bandicoots respond to edges, 5m x 5m quadrats could be placed every 20 metres along a 200 metre transect that runs from a pasture area, through an edge and into a forest. The number of bandicoot diggings in each 5m x 5m quadrat is counted. If three or more replicate transects are assessed then the average density of diggings at each point along the transect can be compared.

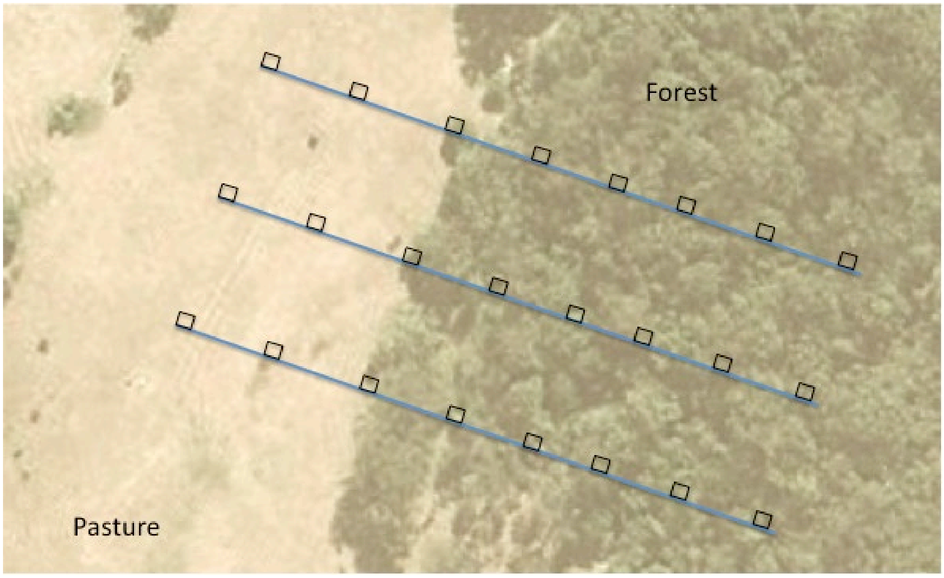


Figure 3 An example of the arrangement of transects and quadrats.

Note that distance from an edge might not be the only factor that influences the density of animal signs. In the case of bandicoots, it may be the levels of shrub or ground cover, either for protection from predators, or because their food is associated with high levels of leaf litter. (Soil properties might also influence feeding.) For macropods feeding in pasture adjacent to forest, their feeding activity might be higher in areas with more grass cover. Cover can generally be easily assessed by simple visual estimates to the nearest 10%. For example, a 5m x 5m quadrat might be visually assessed and estimated to have 10% shrub cover, 20% grasses and forbs, 50% cover of leaf litter, and 20% bare ground.

In some cases, it might be more appropriate to assess food quality rather than just level of cover. For example, for macropods feeding in pasture you could rank the quality of feed in a quadrat where both the amount of grass cover, and the quality of grass is considered. Think of the difference between a square metre of lawn before and after it is mown. The percent cover will not differ, but the quality and quantity of forage will be different. Note that these ranks can be a little subjective, but they are a useful starting point in understanding animal foraging.

Part 2: Template and Important Considerations

The basic template structure and a more detailed template for this exercise are outlined below. Some additional information is also provided relating to logistics and methods. The basic template can be modified by adding appropriate information where indicated by *[blue text and comments].*

In addition, two example field exercises are provided (Part 3) that examine how a species forages in relation to a patch of habitat and its edges (example A a small macropod; example B a bandicoot). These macropod and bandicoot examples can be used virtually “as is” by simply changing the *blue text* to suit the system you are working with. Note that the macropod species in the example occurs only in coastal south east Queensland. Bandicoots are more widely distributed along the coast and ranges, but are absent from drier parts of the state. However, there will be other candidate species found in your region. For example, studies have shown that the feeding behaviours of eastern grey kangaroos and red necked wallabies are influenced by proximity to cover. (see Van Dyke et al, 2013 listed in note 2 below for species in your area).

Note — If preferred the field exercise can be conducted with a focus on one or more plant species. Weed species would make good candidates as they might be more prevalent at edges where light, moisture and temperature conditions favour their germination and growth. However, there will also be native plant species that are suited to conditions at edges. Measurement of plant density (in terms of number of individuals, number of stems, or percent cover) could be recorded in suitable size quadrats, instead of animal signs.

Template: Basic structure

For additional considerations, see corresponding superscript numbers in the important notes section on page 18.

The basic template structure is as follows:

Introduction [1]

- brief background about ecotones and edges
- brief background about how animals might respond to edges
- brief background about using signs left by animals to study some aspects of animal ecology
- introduce species and system [2]
- state the specific questions for this study

Methods [1]

- brief description of the study site [2]
- state how the data will be collected - including transect position / orientation [3], size of quadrat [4], interval along transect for quadrat placement [3]
- state the data that will be recorded (density of animal sign, vegetation attributes)[5]
- brief statement on how the data might be collated [6] and analysed [7]

Template: Detailed

Introduction

In ecology, an edge can be broadly defined as a sharp boundary between two different ecological communities. In nature, edges are everywhere. They may be the result of relatively abrupt transitions between different ecological communities that occur when physical and biological conditions change quickly (e.g. in coastal habitats). Alternatively, they may be the edges created by human land management practices (e.g. pasture adjacent to forest).

Typically, these edges are a transition zone between different ecological communities, and will have different physical conditions (e.g. light, temperature, moisture), and may contain species not found in either of the adjacent communities. Different animals will respond to edges in different ways associated with their ecology. Some species may avoid edges, some may favour edges, and others thrive when both ecological communities occur together. Understanding how animals respond to edges can provide important information for the conservation and management of those animals.

Many animals are difficult to study directly because they are cryptic or nocturnal. When seeking information on such animals, an examination of animal signs can be an effective and efficient way of assessing the way these animal species use different habitats. *[add sentence or two about animal sign being used [1]]*

[introduce species and system [2]]

The aims of the exercise are therefore to *[add specific aims [1]]*

Methods

The practical exercise will be conducted *[add location of study]. [add brief description of site [2]].*

You will work in small groups *(4-6 per group)* and make a series of measurements in a number of *[add quadrat size [4]]* quadrats placed in different locations along a *[add length [3]]* transect.

Data will be collected at *[add interval [3]]* intervals along transects that run perpendicular to the line of the edge of the patch of *forest*, starting *[…]*, and running *[…]* into the forest.

Your group will be allocated *[…]* transects. From your starting point at the edge, determine the orientation of your transect (using a compass) and, using a *[50m tape]*, locate the position of the first point on your transect. The starting point of your quadrat should be at the required distance *[…]* and one side of the quadrat should run from that point for a further *[x m]* along the tape *[give example [1]]* Once the first quadrat is assessed, complete the remaining quadrats moving systematically along the transect.

In each quadrant you need to record the following data:

[include table or list with each data item to be recorded at each point along the transect - this will include the number of animal signs in the quadrat and whatever vegetation assessment you decide on [5], plus any abiotic factors you elect to measure [5]].

Analysis

Combine the data from the different transects and [6,7]:

- plot the density of *[animal sign]* (Y axis) against the distance along the transect (X axis)
- plot the density of *[animal sign]* (Y axis) against the *[vegetation attribute measured]* (X axis)
- abiotic factors (if recorded) can be plotted (y axis) against distance along the transect (x axis) to assess how these change with position.

Do the plots show any trends, and if there are trends, do they match your predictions?

End detailed template.

Notes and Considerations

1. General background

See text above (Part 1) or the two examples below (Part 3) for additional or alternative text.

2. Selecting a system

You will have to consider the habitats / ecological communities that might be available and the species in those habitats. Logistically it may be easier to select a site and then work out what species might be utilising that site. Any open space (generally a managed open space such as pasture or large area of mown or slashed grass) adjacent to a patch of forest should suffice. For example, State Forest and National Parks often have an open space for picnicking or camping that abuts an area of forest (note - permits are generally required). A scan of the ground in the open area should reveal some macropod scats, or perhaps some bandicoot diggings. Alternatively searching the ground in the adjacent forest may reveal bandicoot diggings.

Often there can be thick border of lantana or other shrubs between open and forested areas, especially in wetter environments. Another clue to an animals presence will be runways or tunnels often visible in the lantana or bordering shrubs – these are used by small macropods as pathways out of the forest and into the open (see Figure 4).

Figure 4: Photos showing typical runways or tunnels through lantana at the boundary between an open grassy area and a closed forest. The runways in these photos are used by Red Necked Pademelons (Thylogale thetis)

Two guides may assist in identifying the species that you have in your area:

- ➔ Trigg, B. 2004 Tracks, Scats and other Traces. A field guide to Australian mammals. Revised Edition. Oxford University Press. Melbourne. Vic.
- ➔ Van Dyke, S., Gynther, I. and Baker, A. (eds.) 2013 Field Companion to the Mammals of Australia. New Holland, Chatswood, NSW.

Trigg (2004) provides information and guides on how to identify species from traces (e.g. dung or diggings), and Van Dyke et al (2013) has distribution maps and other information for all Australian mammal species.

3. Length of transect

The transect should be orientated at right angles to the edge and needs to be long enough to detect any likely spatial pattern of habitat use. Generally, 80 to 100 metres in either direction from the edge, with measures taken every 10 or 20 metres, should be enough to pick up any trends for smaller mammals. Larger animals such as kangaroos or wallabies might require longer transects. Ultimately the total length of the transect examined and the interval at which measures are taken will depend on the system being examined. If you are focusing on smaller animals (e.g pademelons) using an open area to feed and the adjacent forest as refuge then a 100 m transect starting at the edge and moving out into the open area, with measures taken every 10m should be sufficient. If you are focusing on a species that avoids the open and edges then starting at around 40 metres into the open area and moving across the edge and 80 to 100 metres into the adjacent forest, with measures taken every 20 metres, should work.

Different groups of students can be highly variable in the time taken to complete a task in the field. However, a group of four students working in open woodland would probably generally take a little over an hour to set up and take measurements in six to seven 5x5m quadrats spaced at 20 metre intervals along a 100 to 120 metre transect. Thicker vegetation will make the task more time consuming. In a mainly open environment, a group would generally take less than an hour to set up and take measurements in 2x2m quadrats placed every 10m along a 100 metre transect. In the unlikely event you have spare class time you could run a trial exercise setting up transects and quadrats along a compass bearing on the school oval to see how long it takes.

4. Quadrat size and shape

Much has been written about sampling using quadrats and determining the most appropriate size and shape for estimating density of a particular species. Species or attributes that have a very patchy distribution are the main problem. Fortunately for measuring densities of animal signs this is not generally an issue. The main thing to consider is that the quadrat has to be small enough that it is feasible to find and count every item without losing track, but big enough to encompass a range of values across the system being examined. For example, it would be difficult and time consuming to count every piece of macropod dung in a 5m x 5m quadrat. At the other extreme, the range of values encountered in a 0.5x0.5m quadrat might be only from 0 to 1 or 2. You generally need a range of values from about 0 to 10 or more to be able to have a chance of answering your question.

In the example field exercises detailed below, a 2x2m quadrat (see Figure 5) has generally worked for assessing variation in dung density in an area with reasonable levels of macropod activity. Similarly, a 5x5m quadrat (see Figure 6) has worked for assessing variability in the density of bandicoot diggings. You may want to vary this a little depending on the system you are working with, but make sure you consider how long it might take to search a larger quadrat if you want to increase the quadrat size. And, if you reduce the quadrat size make sure you are not just getting lots of zeros and ones, and virtually no higher numbers.

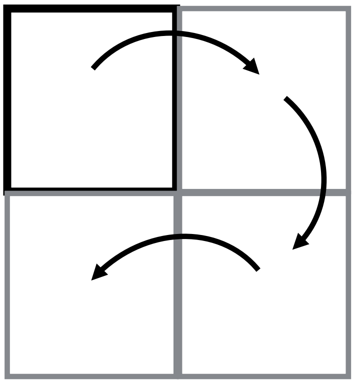


Figure 5: A simple 1m x 1m quadrat can be used as is for a 1m2 area, or to assess a 4m2 area by simply flipping the quadrat and tallying up the number of animal signs each of the four 1m2 squares that make up the larger quadrat.

Figure 6: A typical 5m x 5m quadrat set out in open woodland. One side of the quadrat is positioned along the transect (dashed red line) and other tapes or string used to mark out the other sides.

5. Counting animal signs and measuring and assessing vegetation.

Animal signs:

Once you have identified the animal sign that you will count, you will have to decide about whether all signs will be included in your tally. For example, it may become difficult to identify animal dung that has started decomposing, or diggings that have been affected by rain or wind. Dung and diggings can also be affected by the activity of other animals. Therefore, you should decide on a level “freshness” of the sign to include, or what level of degradation of the sign to be excluded. This level can be arbitrary, but as long as all groups collecting data apply the same standard, then you should be able to answer your question.

Vegetation:

Counts of upper canopy or mid canopy trees are easily made in quadrats. The important thing is to clearly define your categories. Counts of the number of species are also relatively easy to make, especially if you do not attempt to name each species, but rather just count them as different (e.g. species 1, species 2 etc). In this latter example some coordination might be needed among groups if data are to be combined.

One other common assessment method is to determine the percent of vegetation or ground cover. Methods for estimating vegetation or ground cover range from detailed and time consuming (e.g. use of photos and image analysis software, subdividing quadrats into smaller sections, using a pin-frame) to broader and less time consuming methods (e.g. visual estimates to nearest 10%). Surprisingly, visual estimates can be reasonably accurate for many studies. For example, a 5m x 5m quadrat might be visually assessed and estimated to have 10% shrub cover, 20% grasses and forbs, 50% cover of leaf litter, and 20% bare ground. These estimates work best when more than one person makes an independent estimate because estimates of cover made by individuals are generally terrible, even estimates made by experienced scientists. However, many studies have shown that taking the average of the independent estimates from a number of individuals provides a reasonably reliable estimate. Hence, an average of three independent estimates of cover can generally provide a reasonably reliable estimate.

Abiotic factors:

Note: An important property of ecotones and edges is the change in abiotic conditions that occur as you move from one habitat / ecosystem to another. Therefore, you may wish to describe or assess the nature of these differences by measuring abiotic factors at each point along the transect. Generally, we would expect to see differences across the ecotone in light, temperature, humidity, wind speed, and possibly soil moisture. These factors show considerable temporal variation, so it is the relative difference at any one time that is important.

6. Variables measured

It may be useful to prepare a table with the data values to be recorded. If the students know they have to have a value in each cell of the table it saves them having to backtrack to complete the data collection.

7. Analysing the data

It is difficult to make any strong conclusions about patterns based on only one or a couple of transects so combining information from different transects can be useful.

The most useful method of summarising the data would be in scatterplots with a response variable (e.g. number of animal signs) (Y axis) plotted against distance along transect (X axis). Trends can be assessed by using lines of best fit or correlation. Alternatively, a similar plot can be made but rather than using raw data, the average number (e.g. average number of animal signs +/- an error term) can be calculated for each point along the transect, and this average value can be plotted against distance. Density of animal signs can be plotted against vegetation attributes in a similar way.

Part 3: Specific Examples

Example A - Habitat use by red neck pademelons

Introduction

In ecology, an edge can be broadly defined as a sharp boundary between two different ecological communities. In nature, edges are everywhere. They may be the result of relatively abrupt transitions between different ecological communities that occur when physical and biological conditions change quickly (e.g. in coastal habitats). Alternatively, they may be the edges created by human land management practices.

Typically, these edges are a transition zone between different ecological communities, and will have different physical conditions (e.g. light, temperature, moisture), and may contain species not found in either of the adjacent communities. Different animals will respond to edges in different ways associated with their ecology. Some species may avoid edges, some may favour edges, and others thrive when both ecological communities occur together. Understanding how animals respond to edges can provide important information for the conservation and management of those animals.

Many animals are difficult to study directly because they are cryptic or nocturnal. When seeking information on such animals, an examination of animal signs can be an effective and efficient way of assessing the way these animal species use different habitats. Faecal pellets generally can be easily identified as being from a particular species, and are therefore a common animal sign used for studies of relative density and habitat use. Studies of macropods indicate that these species generally defecate while feeding, and differences in the density of their faecal pellets should reflect differences in how they feed over a particular area.

The feeding behaviours of many macropods species are influenced by edges, and animals are often found feeding in open areas adjacent to forest edges. If open grassy areas are important for foraging, but foraging in this space is influenced by perceived predation risk, then individuals should spend more time feeding close to the edge where there is potential cover and refuge, and less time feeding a long distance from the edge. We can assess this question by setting up transects running perpendicular from the edge and into the open area and measuring the abundance of animal signs at different points along the transects. If individuals are spending more time feeding closer to the edge then there should be higher densities of dung close to the edge, and lower densities further away.

Red necked pademelons (Thylogale thetis) are a small macropod found in closed forests of north eastern NSW and south eastern Queensland. The are generally more common in forest adjacent to open grassy areas. In this exercise we will use faecal pellets to assess the way in which *the red necked pademelon* uses different ecological communities - an open grassy area and an adjacent forest - and the impact that edges have on this species.

In addition to perceived predation risk, another important factor that will influence feeding activity is the availability and quality of food resources. *For pademelons the main food will be grasses and forbs.* We will make a general assessment of the amount and quality of these food resources at each point where dung density is measured. If food availability and quality is more important than distance away from cover then we would expect to see higher densities of dung in areas with better food, independent of distance from cover.

The aims of the exercise are therefore to assess whether the level of feeding activity (as measured density of dung) by red necked pademelons is highest close to the refuge (edge) and diminishes with greater distance from the refuge. And to determine whether level of feeding activity is influenced by the quality of the vegetation.

Note — *CAUTION should be exercised when dealing with faecal pellets. Many animals carry parasites that may be harmful to humans and careless handling may result in infection. In particular scats of dingoes and dogs should never be touched with bare hands. Although you will not need to handle these macropod dung pellets, disposable plastic gloves are provided for your use (in case your pointing is excessive).*

Methods

The exercise will be conducted in a large grassy clearing adjacent to a closed forest (rainforest). In this case the opposite side of the clearing is bordered by a creek. The area contains a long section of edge habitat where the environment changes abruptly from the open grassy area to closed forest.

Transects will be set up running perpendicular to the line of the edge, and extending from the edge 100 metres into the open grassy area. At each 10m along the transect (starting at 0m) record the number of dung pellets in a 4 sq m quadrat (2x2m).

In the same $4m^2$ quadrat, make a visual assessment of the grass quality on a ranked scale from 1 (mostly bare dirt and poor quality grass) to 5 (lush grass cover in most of quadrat). You can also take notes. For example, if there are any shrubs or other structure near your transect that might offer temporary cover for an animals. The table below shows the data to be collected.

Table 1: List of data to be collected. The number of rows of data collected will correspond to number of 4m2 quadrats for which you collect data.

Group Name	Transect No.	Distance from edge	Number of scats	Grass quality	Notes

Analysis

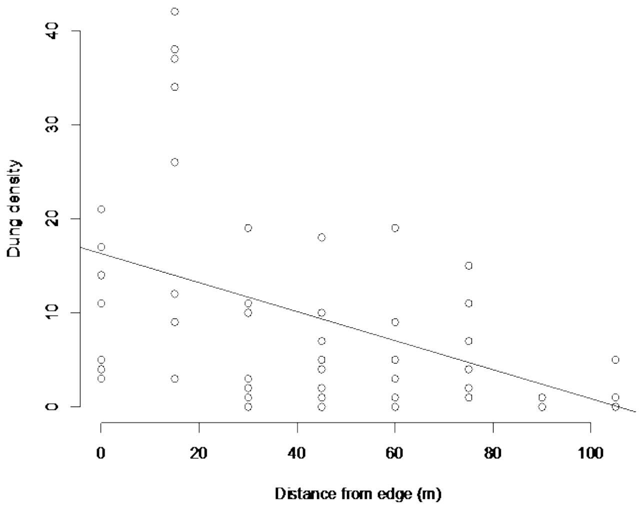
Combine the data from the different transects and:

- plot the density of dung (Y axis) against the distance from the edge (X axis)
- plot the density of dung (Y axis) against the grass quality scores (X axis)

Do the plots show any trends, and if there are trends, do they match your predictions?

Example results - Pademelon

Some example results are provided. Note that there will be a lot of variability, but generally, if a species is favouring areas close to edges, you will see some trends in the data. The figures below result from a small study of pademelons in the area described in the methods above - a small clearing adjacent to closed forest in the Conondale Ranges of south east Queensland.



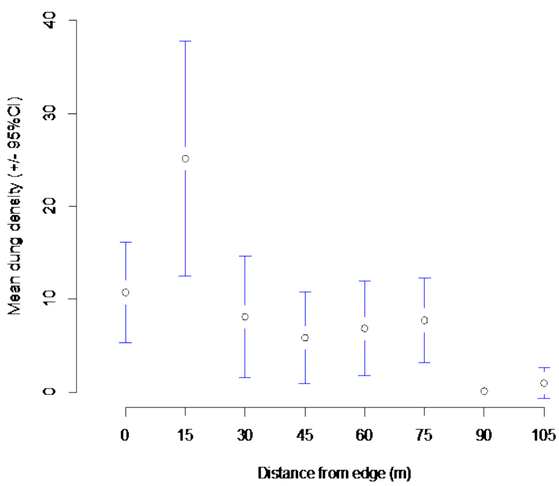


Figure 7: The two figures above show the relationship between distance from edge and dung density. The figure on the left is a simple scatterplot of each value of number of dung per 4m2 against distance from edge. The figure on the right is the same dung density data but this time expressed as a mean for each distance from the edge.

The first two figures (Figure 7) show the relationship between dung density and distance from the edge. The first is a simple scatterplot (with line of best fit) showing that there is a general trend for dung density to decline with increased distance from the edge. There is a lot of variability, but the general trend is significant (in a statistical sense - as determined by a significant correlation of r = -0.56). The second figure plots the same data but dung densities are expressed as means (+/- an error term) for each distance from the edge. This suggests little feeding right at the edge, most feeding at 15 metres from the edge, and lower but similar levels from 30 to 75 metres. Lowest values are at 90 and 105 metres. The general theory that this species tends to feed close to cover is supported.

The role of food or grass quality makes interpretation a little cloudier, but there is still evidence of the expected trends. In the next pair of figures (Figure 8) the first plot shows mean dung density against grass quality (note - there were no measures of grass quality 5). There does tend to be more dung (so more feeding activity) at grass quality 3 (and perhaps 4), and less dung at grass quality 1. So feeding might be targeted to areas with more food. The second plot shows average grass quality in relation to distance from edge. Grass quality is clearly lower right at the edge, and this might explain less feeding activity at that distance. Grass quality is highest at 15 metres from the edge, but is only slightly lower at 30, 45 and 60 metres. So the very high level of dung at 15 metres cannot be explained solely by better grass quality there and much lower quality elsewhere.

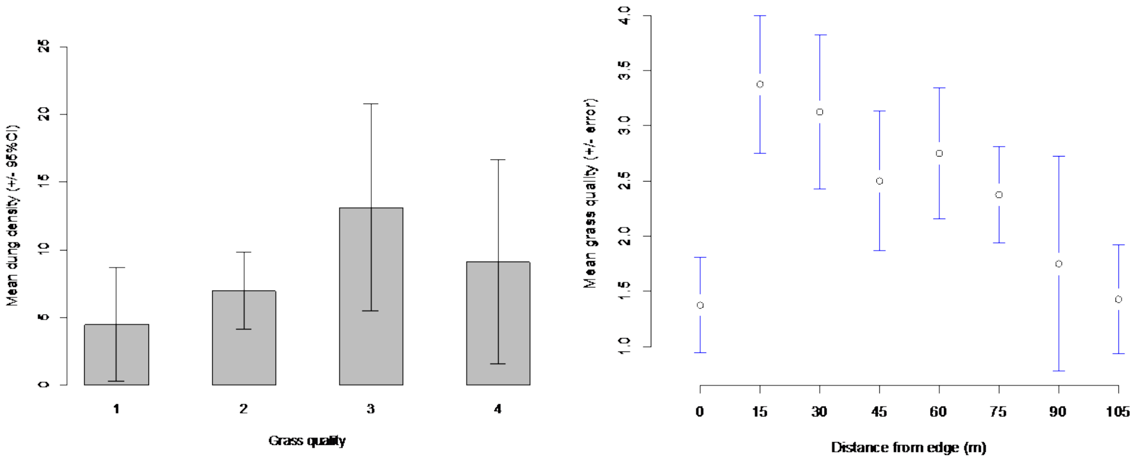


Figure 8: The plot on the left shows the average density of dung (number / 4m2) for each level of grass quality. The plot on the right shows the average grass quality for quadrats at different distance from the edge.

It seems reasonable to conclude that distance from the edge influences the feeding behaviour of red necked pademelons. The quality and / or quantity of food is also having some influence but not enough to result in higher levels of feeding activity 30 metres or more from the edge. Distance to refuge is important and individuals trade off feeding and predation risk.

End example A.

Example B - Influence of habitat and edges on bandicoot foraging activity

Introduction

In ecology, an edge can be broadly defined as a sharp boundary between two different ecological communities. In nature, edges are everywhere. They may be the result of relatively abrupt transitions between different ecological communities that occur when physical and biological conditions change quickly (e.g. in coastal habitats). Alternatively, they may be the edges associated with habitat patches created by human land management practices and urban expansion.

All species will be affected in some way by the disturbance and habitat loss associated with urban expansion. Some species adjust to these disturbances and are commonly associated with urban environments. Other species may utilise human modified environments but still require patches of habitat that contain components that are lost from highly urbanised environments. For example, pasture and other open grassy habitats (e.g. lawns) may be suitable habitats for foraging, but the species might also require particular vegetation for cover and refuge in non-foraging periods, or to avoid predators or harsh conditions. Finally, there will be a group of species most impacted by habitat loss and urban expansion. These species require a relatively unmodified environment and spend all their time in remaining patches of native habitat, avoiding both the edges and the adjacent human modified habitat.


Figure 9: Two photos showing the typical conical hole left by bandicoot feeding activity.

Two native species often associated with the margins of urban environments in eastern Australia are *the Northern Brown Bandicoot (Isoodon macrourus) and the Eastern Long-Nosed Bandicoot (Perameles nasuta).* These are both medium sized (1-2kg) nocturnal, omnivorous marsupials that forage on and below the soil surface. Their presence in an area can be seen from the conical shaped holes left by their digging to find subterranean invertebrates and other food (see Figure 9). Studies by ecologists have suggested that these species may be able to persist in urban environments where development is not too intense and where a mosaic of habitats is available, and/or where habitat patches remain and have some connection with other patches.

To understand how disturbance and habitat loss might affect a species it is important to know something about the way individuals use their environment. For example, where do individuals forage and how is this related to proximity to edges and vegetation cover and structure. In this exercise we will examine the foraging pattern of bandicoots in relation to vegetation structure and disturbance *at a 50ha patch of habitat in a peri-urban site just west of Brisbane*.

Many animals can be difficult to study because they are cryptic or nocturnal, or live in dense habitats. Even the act of observing an animal species can be difficult because the presence of the observer might change the behaviour of the animal. When seeking information on such animals, an examination of animal signs can be an effective and efficient way of assessing the way these animal species use different habitats. For bandicoots, the signs left by feeding activity (diggings and scratchings) provide an effective way of assessing how active they are in different habitats.

Therefore, the aim of this exercise is to determine whether vegetation structure (canopy cover, ground layer cover) and proximity to forest edges and disturbance influences bandicoot foraging, as measured by the number of diggings.

Methods

The practical exercise will be conducted *in a 50ha patch of remnant forest and adjacent pasture and other human modified habitats in the Samford Valley, west of Brisbane*. You will work in small groups (4-6 per group) and make a series of measurements in a number of 5m x 5m quadrats placed in different locations. *Analysis and write-up will be based on class data, so all group data needs to be entered into a class data file.*

Given that bandicoots are nocturnal, evidence of the foraging activity will be based on the presence of animal signs; i.e. the presence of their conical shaped holes or diggings. It is not possible to distinguish between the two species of bandicoot on the basis of the conical shaped diggings, however only the Eastern long-nosed bandicoot has been recorded on this site, so we will assume that all diggings on this site relate to that species.

Data will be collected at 20m intervals along transects that run perpendicular to the line of the edge of the patch of forest, starting in the open habitat 40m from the edge (point -40m), running through the edge (point 0m), and 100m into the forest. *Note - it will not be possible to sample both positions in the open habitat for some sites (e.g. road edge because there is a road; grazed pasture edge because there is a fence and private property), and measurements will start at either -20m or 0m, depending on the site.*

Note — The reason we allocate minus values to the open habitat is that it makes it easier to plot our data using basic spreadsheet or statistical software.

Your group will be allocated either one or two transects, depending on the site. From your starting point at the edge, determine the orientation of your transect (using a compass) and, using a 50m tape, locate the position of the -20m point and the -40m point. The starting point of your quadrat should be at the required distance (e.g. -20m) and one side of the quadrat should run from that point for a further 5m along the tape (e.g. at -20m one side of the quadrat should be from -20 to -25m. Once these two quadrats are assessed, complete the remaining quadrats moving systematically into the forest.

In each quadrat you need to record the following data:

1. The location of your transect.
2. The position of quadrat along transect (open (-40m, -20m), edge (0m), 20m, 40m, 60m, 80m, 100m).
3. The number of separate diggings (0 to n).
4. The number of upper canopy trees in your 5 x 5m quadrat (trees above 5m tall)
5. The number of mid canopy trees in your 5 x 5m quadrat (trees 1-5m tall)
6. *The % cover of shrubs (to nearest 10%)
7. *The % cover of grasses / forbs (to nearest 10%)
8. *The % cover of debris (to nearest 10%)
   (Debris is any dead organic material – leaf litter, twigs etc.)
9. *The % of bare dirt in the 5m x 5m quadrat.

* The average of three independent estimates of cover can generally provide a reasonably reliable estimate of cover, so the % cover variables should be independently estimated by three people, and the average (to nearest 10%) recorded.

Analysis

Analysis for this exercise will be conducted "back in the lab". Data should be entered into the class data file before the next lab session.

The general question we were examining was to determine whether vegetation structure (canopy cover, ground layer cover) and proximity to forest edges and disturbance influence foraging. *We had three types of disturbed or edge areas (road, and two pasture edges).* Quadrats were placed at different distances from edges, into the open pasture and into the adjacent forest. We can assume that the number of diggings in a 5x5m quadrat should reflect the level of foraging in that area – more diggings = more foraging.

So, we could break the problem down into the following questions:

- **Question 1**
  In general, where were the diggings found, and where were the highest numbers and in lowest numbers of diggings?
- **Question 2**
  Does the number of diggings change with distance from the edge into the forest, independent of edge type? Plot the number of diggings per 5x5m quadrat (y axis) against the distance from the edge (x axis). You could also plot the average number of diggings for each distance.
- **Question 3**
  Does the number of diggings differ between the different types of "edge" (road v mown pasture v grazed pasture)?
- **Question 4**
  Does the number of diggings vary in relation to the type and amount of vegetation (i.e. is the number of diggings related to any of the measures of vegetation cover – for example, are there more diggings in places where tree density was high?) Note that if diggings vary with distance from edge, you may need to take this into account when you compare number of diggings with different vegetation levels. You will need to look at the number of diggings in relation to each of the vegetation variables.

Example results – Bandicoots

The following results relate to data for 24 transects running from 20 metres into pasture, through a pasture – forest edge and 100 metres into the forest in the Samford area just west of Brisbane. Digging density and vegetation attributes were recorded in 5x5m quadrats.

The first plot (Figure 10) shows the average number of diggings (+/- 95% confidence intervals) for each distance from the edge (-20 means 20 metres into the pasture). The data show that no diggings were found in the pasture, and digging density was low at the edge. Density was higher at 20 metres and higher again at 40 metres but did not change beyond 40 metres. This suggests that bandicoots at this site generally avoid edges and are more likely to forage away from the open and edges.

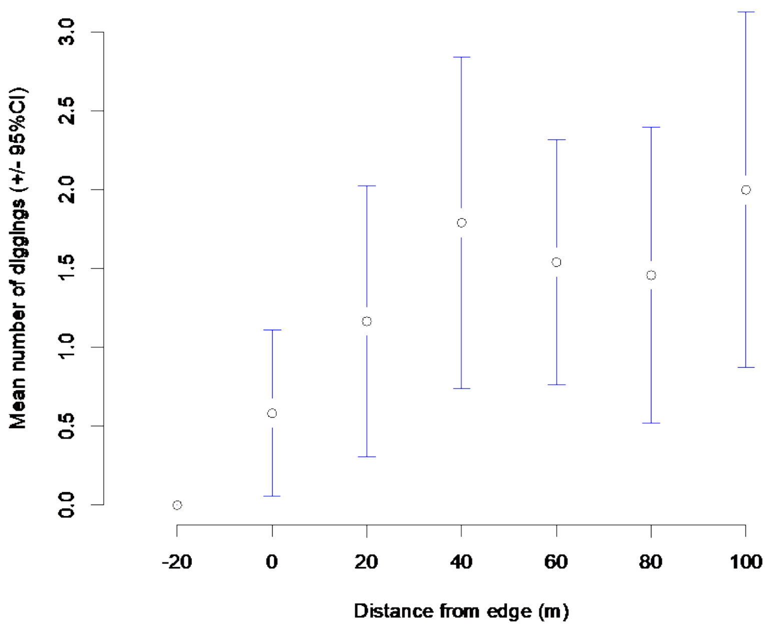


Figure 10: The mean number of diggings per 25m2 (+/- 95% confidence limits) for each distance from the pasture-forest edge.

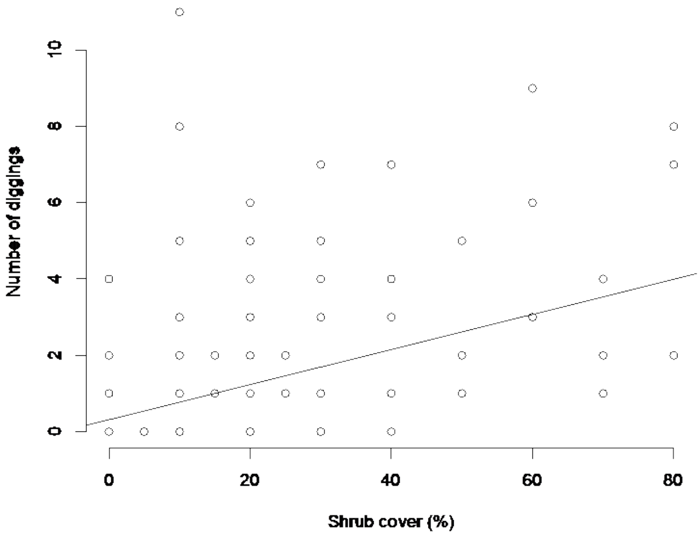


Figure 11: The number of diggings per 25m2 plotted against the

The second figure (Figure 11) is one of a handful of possible plots looking at whether digging density varies in relation to vegetation attributes. This figure show digging density plotted against % shrub cover. There is a weak positive relationship between the two variables. Similar trends are seen for some other vegetation variables, suggesting the possibility that vegetation attributes influence bandicoot feeding activity. However there may be some confounding influence of edges, and vice versa. The role of vegetation attributes might be better examined by only considering data from at least 40 metres into the forest.

A key finding though is that bandicoots seem to avoid edges at this site. Data for other sites would be needed to determine whether this species is consistently an edge avoider.

End example B.

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