17. How do national parks help maintain biodiversity?

Aim

One of the main reasons put forward for establishing national parks is the protection of native plants and animals. This activity aims to help students evaluate how effective our system of parks and reserves is in coping with natural and human environmental change.

This activity also encourages students to consider the size of parks and reserves in Victoria, particularly in relation to biodiversity (variety and quantity) of plant and animal species.

Materials

- Resource sheet 17a: Biodiversity.
- Resource sheet 17b: National parks: a museum, a garden or an asylum.
- Resource sheet 17c: Edges and their effects of wildlife.
- Workbook and pens.

Activities

1. Read article 1, resource sheet 17a: Biological diversity.

a) Write a brief definition (one sentence or phrase) for the following three levels of biodiversity:

- Genetic level.
- Species level.
- Ecosystem level.

b) Give an overall description of biological diversity.

c) List three reasons why biodiversity is important?

2. Read article 2, resource sheet 17b: National parks: a museum, a garden or an asylum. According to this article, the protection of biodiversity (the country's "natural diversity") can best be achieved by making sure Australia's national parks system meets four main criteria.

a) List the four main criteria for making sure Australia's national parks system protects biodiversity (the country's "natural diversity").

b) Referring to article 2, explain why the following factors are important in protecting species from extinction.
Number of individuals of a species
Size of habitat

c). Look at Figure 1 The extinction process, and consider it together with the information about number of individuals with a species and size of the habitat. Explain why both factors are important to consider.

3. Read article 3, resource sheet 17c: Edges and their effects on wildlife.

a) What is an edge effect?

b) List and briefly explain the kinds of changes that can occur at edges.

c) List 6 reasons why edges can affect wildlife (dot points).

Draw the best shape for a conservation area and explain your choice.

4. Discuss the following statement.
   "Victoria's 11 largest parks cover almost three-quarters of the total area of the parks and reserve system. Yet [about] half of the 311 parks and reserves …, and almost 90% of all parks and reserves, are less than 400 ha in size."

   State of the Parks 2000.
   Parks Victoria.

What are the implications for conservation within 90% of Victoria's reserves? Suggest some ways these parks and reserves could become more effective conservation reserves.

Extension

The complete version of article 2: *National parks: a museum, a garden or an asylum* can be accessed via Environment Australia's website. Refer to the full article for more detail and specific examples.
www.ea.gov.au
Click on 'Publications', then on 'Key Publications for Biodiversity', then under the heading 'Series' click on 'Biodiversity Series'. The article is located under Biodiversity and its value. Biodiversity Series, Paper No. 1

17a. Biodiversity

Adapted from *Biodiversity and its value*. Biodiversity series. Environment Australia. The complete unabridged article is available on Environment Australia's website under Publications.

Biological diversity or biodiversity refers to the variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. Biological diversity is usually considered at three different levels:

- genetic diversity
- species diversity
- ecosystem diversity.

1. GENETIC DIVERSITY
Genetic diversity refers to the variation of genes within species.

This covers genetic variation between distinct populations of the same species, such as the four varieties of white-cheeked rosella. It also covers genetic variation within a population; an example of this would be the many types of eucalypts. Genetic diversity can be measured using a variety of DNA-based and other techniques..

New genetic variation is produced in populations of organisms that can reproduce sexually by recombination and in individuals by gene and chromosome mutations. The pool of genetic variation present in an interbreeding population is shaped by selection. Selection leads to certain genetic attributes being preferred and results in changes to the frequency of genes within this pool.

The large differences in the amount and distribution of genetic variation can be attributed in part to the enormous variety and complexity of habitats, and the different ways organisms obtain their living.

2 SPECIES DIVERSITY
Species diversity is the variety of different species.

Aspects of species diversity can be measured in a number of ways. Two of the most common and straightforward are measurements of i) species richness and ii) species abundance.

Measures of species richness count the number of species in a defined area. Species abundance measures the relative numbers among species.

At the global level, an estimated 1.7 million species have been described to date; current estimates for the total number of species in existence vary from five million to nearly 100 million. In Australia, with an estimated total number of native species (excluding bacteria and viruses) of 475 000, about half are known, but only a quarter formally described.

This knowledge will increase with further study into different species, especially the groups of insects and microorganisms.

On a global scale species diversity is not evenly distributed. The general pattern is for species to be concentrated in equatorial regions, decreasing north and south to the poles. Other factors that influence species diversity are altitude, rainfall patterns and nutrient levels.

3. ECOSYSTEM DIVERSITY
Ecosystem diversity refers to the variety of habitats, biotic communities and ecological processes.

Ecosystem diversity includes both the differences between ecosystem types, and the variety of habitats and processes occurring within each ecosystem type. It is harder to define ecosystem diversity because the 'boundaries' or limits of habitats and ecosystems are more fluid. They can be grouped into broad categories such as temperate rainforests or coral reefs but determining exactly where the edges of each are found can be difficult.

The classification of the Earth's huge variety of ecosystems into a manageable system is a major scientific challenge, and is important for management and conservation of the biosphere. At the global level, most

classification systems have attempted to steer a middle course between the complexities of community ecology and the oversimplified terms of a general habitat classification.

Australia has an enormous range of eco-systems, from alpine regions to arid grass-lands and tropical rainforests, from coral reefs to the deep sea. The degradation or loss of whole ecosystems is in itself a major loss of biodiversity and the single most important factor behind the current extinction of species.

IMPORTANCE OF BIOLOGICAL DIVERSITY

We dependent for our food, health, well-being and enjoyment of life on resources from biological diversity - products from both the wild and domestication. The processes happening within ecosystems – cycling of water, nutrients and other materials – are also basic to our survival. Along with these practical functions, biodiversity is valued by many for the recreational and non-tangible benefits of wildlife and wild areas.

1. BIOLOGICAL RESOURCES

Food is the most obvious of the resources we obtain from species. Over 5000 plant species have been used as food by humans, but less than 20 now feed the majority of the world's population and just three or four carbohydrate crops are staples for a vast majority. One of the important benefits of conservation of biodiversity is maintaining the wild plant gene pool which is available to increase the narrow genetic base of our established food crops, providing disease resistance, improved productivity and different environmental tolerances. The value of the wild gene pool will increase as remaining natural habitats become moire scarce.

Species also provide resources for medicine, wood products, ornamental plants, breeding stocks, and for future resources.

2. SOCIAL BENEFITS

The great variety in our ecosystems is valued for tourism and recreation purposes. The aesthetic qualities of such areas are often strikingly different, in large part due to their biological diversity. Recreational pursuits include photograph, literature or film production based on natural areas and species. It also includes outdoor activities such as bushwalking and bird watching. Research and education is also focussed on biological species and ecosystems. This includes study of our existing genetic base and research into the rehabilitation of degraded ecosystems.

Finally, biodiversity has cultural value. The natural environment provides for many of the inspirational, aesthetic, spiritual and educational needs of people, of all cultures, now and in the future.

3. ECOSYSTEM SERVICES

The supply of clean water in catchments is protected by natural vegetation cover. It regulates and stabilises water runoff and acts as a buffer against extreme events such as flood and drought. Vegetation also helps regulate underground water tables, preventing dryland salinity.

Biological diversity helps in the formation and maintenance of soil structure and the retention of moisture and nutrient levels. Soil protection by maintenance of biological diversity can preserve the productive capacity of the soil, prevent landslides and protect the coasts and coral reefs from siltation. Vegetation also assists in the process of soil formation.

Ecosystems perform the important function of recycling nutrients. Plants are able to take up nutrients from the soil as well as from the air, and these nutrients can then form the basis of food chains, to be used by a wide range of other life forms.

Ecosystems can also help absorb many pollutants created by humans and their activities. These include wastes such as sewage, garbage and oil spills. Excessive amounts of any pollutant, however, can overwhelm the ability of micro-organisms and higher life forms to process this material and result in degradation of the ecosystem itself.

Vegetation influences climate at the macro and micro levels. Atmospheric temperature and global rainfall patterns can be affected by major disturbances of vegetation. At smaller scales, vegetation has a moderating influence on local climates.

17b. National parks: a museum, a garden and an asylum?

Extracts from *A Natural Legacy*. Edited by H. Recher, D. Lunney and I. Dunn. Pergamon Press Australia. 1979.

Selection of parks

The success of a national park system can be judged on the basis of how well it samples and reserves a country's natural diversity. In Australia, existing parks do not sample the full range of distinctively Australian habitats. A survey of the distribution of Australian plant communities completed in 1974 found that few of these were adequately conserved in parks. Which areas should be chosen as national parks? What size and shape should they be? These are difficult questions, but they can be answered by a knowledge of Australia's biological resources and by the use of ecological principles.

Australia's national park system should endeavour to reserve areas that:

1. sample different kinds of habitats so as to guarantee a retention of biological diversity – both the diversity of plant and animal communities within natural ecosystems, and the genetic diversity of each species upon which its continuing evolution depends;
2. are convenient to population centres;
3. allow for the migratory movements of animals;
4. provide duplicate areas as insurance against the total destruction of an area which might, for example, result from fire or mining operations.

Though important, small parks are mot a substitute for large parks, which are necessary for the retention of a diversity of communities and for wilderness – untouched wild areas where people can experience a natural environment away from the sights and sounds of human activities. A large park such as Kosciusko (6000 sq km) accommodates both the ski resorts of Thredbo and Perisher as well as wilderness. A well planned park system would comprise a number of large parks embodying wilderness areas, as well as a large number of small parks. These parks, dispersed throughout Australia, would not only sample major habitats and ensure against catastrophic destruction, but would also provide recreational and educational facilities convenient to all population centres.

The size and location of parks are influenced by the development of Australia. Increasingly parks will become isolated in a sea of urbanisation, agriculture and commercial forestry – and they will resemble a scattering of islands in an ocean.

How big should parks be? Ecologists are able to estimate the minimum size of a park needed to protect individual species or to maintain a natural ecosystems without intensive management. For example, if 10% of a given habitat is reserved as a park and the remainder developed, then about half the birds dependent upon that habitat will survive in the park. The final number of species will depend upon the proximity of the reserved area to similar habitats and the extent of the alteration to the surrounding land. Different species of animals require different minimum areas for survival.

To remain viable, a population must retain enough genetic diversity to respond to changing environmental conditions – that is, if a population is to survive, at least some individuals must be able to adapt to both short and log term changes.

In the short term, to avoid becoming extinct, the population must consist of individuals with varying abilities to adjust to sudden changes; some need to be able to survive the effects of fire or floods.

Although there is some controversy on the subject, it is generally accepted that animal populations need to be in the order of ten thousand to retain their genetic variation. The population densities of some Australian mammals are reasonably well known; for example, it has been estimated that 100 sq km of eucalypt forest is the minimum are required to retain a genetically viable population of the greater glider *Schoinobates volans.* In arid and semi-arid zones the density of animal populations fluctuates markedly in response to rainfall. For example, the population density of red kangaroos during drought is about 1 - 5 sq km, so that 10,000- 50,000 sq km would be necessary to support about 10,000 red kangaroos in times of drought. Although these figures are only approximations they provide, together with data from island studies, a guide to the minimum park sizes needed to conserve Australia's birds and mammals.

Summary

Australia's national parks should be located to sample the full range of the continent's natural diversity and to ensure the survival of wildlife for future generations. The park system should include replicates of each park against such catastrophic events as fire or nationally important development projects such as mining. Parks should be a large as possible and located in such a way as to maximise the rates of re-colonisation.

Ideally each park will encompass the full range of habitats required by the wildlife of the region and have borders that follow natural boundaries or that approximate a circle. Parks, particularly small ones, should be connected by corridors of undisturbed or only moderately disturbed habitat. Large parks should be supplemented by smaller, more intensively managed areas that are reserved specifically for the conservation of a few species or a particular habitat.

Each park should have a plan of management integrated with a regional plan of management. All management plans must be based on ecological principles. The study of ecology has much to contribute to nature conservation by pointing to weaknesses in the current system of parks and reserves by suggesting ways of strengthening it. The existing parks and reserves will not adequately protect Australia’s wildlife.

With increasing development and an expanding population, it is becoming urgent that we develop an adequate systems of parks and reserves for the enjoyment, education and edification of future generations if Australians.

17c. Edges and their effects on wildlife

Extract from article in *Land for Wildlife Note No .23.* May 1993. Stephen Platt.

The “edge effect” is a term used to describe the various consequences, on vegetation and wildlife, which occur as a result of one type of vegetation sharing a border with another. These edges may be natural, such as the edge of a forest grading into woodland, or an edge can be a human-made one, such as pasture next to forest or a road through a forest.

What kind of changes occur at edges?

Edges may affect wildlife through:

1. Micro-climatic changes

Solar radiation, humidity, air temperature, wind speed and soil temperature may all be altered along edges. This can have a dramatic impact on the vegetation and, ultimately, the wildlife. For example, new roadworks through bushland will increase sunlight and air temperature, which raises soil temperature and decreases soil moisture. This may prevent seeds of shade-tolerant species from germinating and favour other plant species (e.g. species which thrive with increased light). The increased exposure can stress vegetation leading to dieback through insect attack, parasites, wind damage or fungal attack. Rainforest species, which normally exist in a shaded environment, are particularly vulnerable.

2. Different inhabitants, edge species

Along with the altered pattern of vegetation, a change in wildlife can occur. Firstly, species that have particular habitat requirements (those usually found in the interior or ‘core’, further away from the edge) may be lost from areas that develop lots of edge. For example, Long-nosed Bandicoots only survive in larger remnants. Secondly, ‘vacancies’ may be filled by species that have a wider range of tolerance and the new edge may introduce species that would not normally be found in the core habitat. Thirdly, aggressive edge-dwelling species, such as Noisy Miners and Bell Miners, may invade the habitat and displace prior inhabitants. Edges provide habitat for species of wildlife that prefer edge habitats, and this is not all harmful. Many birds, such as parrots and cockatoos, will use edges for perching and nesting. Kangaroos and wallabies feed and move out along edges. Because edges are a meeting place between adjacent habitats, they are often rich in species (e.g. mixing of forest species, edge species and farmland species). Edges, especially where there is a scattered open ‘buffer’ type area, are often good places for people to see and experience wildlife.

3. An increase in pest animals

Pest animals such as foxes, cats and dogs tend to move and hide along roads, tracks and cleared areas adjacent to or in bush areas. Edges, by providing improved access, can cause a decline in wildlife populations via predation and competition. Experimental and observational studies have shown that bird nests are more often preyed upon in edge habitats compared with core habitats. Platypus and quolls have suffered from predation by foxes moving along bush tracks, particularly beside rivers.

4. Weed invasion

Edges can provide opportunities for the invasion of natural vegetation by weeds. Disturbance creates opportunities for weeds to establish. Weed seeds are spread by wind, water, animals, people (and their vehicles), soil, livestock and in agricultural products. These movements may be facilitated by edges.

5. Impacts from adjacent land-use

Edges are prone to many disturbances such as chemical and fertilizer drift from adjacent farmland, trampling and grazing by stock, fire escaping into habitat areas, recreational disturbance and littering.

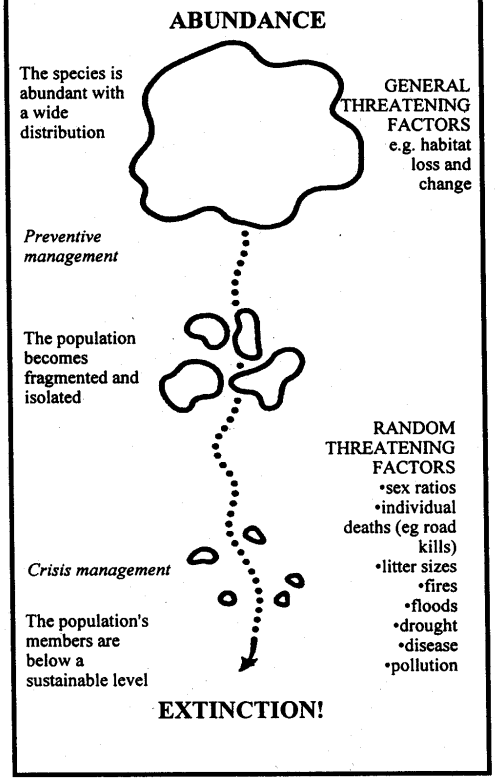
New tracks or clearing of vegetation may also change the hydrology of an area and cause erosion as water runs off compacted soil.

6. Noise and movement

Roads and tracks lead to an increase in traffic and human activities. Many wildlife species rely on the seclusion of undisturbed habitat in order to breed successfully. For example, the Wedge-tailed Eagle has been known to abandon its nest because of disturbance.

Edge effects are likely to be most impact on narrow strips or small areas of habitat. Consequently, they are an important issue in the management of corridors and small bush blocks. Larger areas are also vulnerable where disturbance, track construction and other activities create edges.

Figure 1: The extinction process



Source: Conservation in Victoria Series 1. *Plants and Animals at Risk* 1994 National Parks Service

How do edge effects vary with shape and size?

Generally speaking, the longer the edge, the larger the area disturbed.

The more angular the edges, the greater the edge effect. Corners increase disturbance. Rounded edges and regular shapes minimise edge effects.

The smaller the area, the greater the risk of impact occurring throughout the vegetation, with the core habitat being destroyed.

How far do edge effects extend?

The 'depth' of the effect in habitat varies greatly with the length of the edge, the contrast in edge, the width of the habitat, the type of vegetation, the species of wildlife and the stability of the vegetation. One study showed that in terms of vegetation structure, the width of a forest edge was less than 13 metres, but based upon the distribution of birds' nests, the functional width of the edge ranged from 9 to 64 metres.