A Local Ecosystem: Mangroves

Scientific Name: Sesarma erythrodactyla
Common Name: Red-fingered marsh crab
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Program Advice</td>
<td>4</td>
</tr>
<tr>
<td>A Model Report: Mangroves of the Minnamurra River</td>
<td>6</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>6</td>
</tr>
<tr>
<td>Background Information and Initial Observations</td>
<td>7</td>
</tr>
<tr>
<td>Background Information: Abiotic Factors</td>
<td>8</td>
</tr>
<tr>
<td>Using the Scientific Method</td>
<td>11</td>
</tr>
<tr>
<td>Presentation of Data</td>
<td>12</td>
</tr>
<tr>
<td>Analysis of Data</td>
<td>14</td>
</tr>
<tr>
<td>Discussion to Assist Students Formulate Conclusions and Further \</td>
<td>17</td>
</tr>
<tr>
<td>Investigations</td>
<td></td>
</tr>
<tr>
<td><strong>Fact Files on Plants and Animals of the Mangroves</strong></td>
<td></td>
</tr>
<tr>
<td>Grey Mangrove</td>
<td>19</td>
</tr>
<tr>
<td>River mangrove</td>
<td>20</td>
</tr>
<tr>
<td>Swamp she-oak</td>
<td>21</td>
</tr>
<tr>
<td>She-oak mistletoe</td>
<td>22</td>
</tr>
<tr>
<td>Mottled Shore Crab</td>
<td>23</td>
</tr>
<tr>
<td>Red Fingered Marsh Crab</td>
<td>24</td>
</tr>
<tr>
<td>Sydney mud whelk</td>
<td>25</td>
</tr>
<tr>
<td>Grazing Snail</td>
<td>26</td>
</tr>
<tr>
<td>Sydney rock oyster</td>
<td>27</td>
</tr>
<tr>
<td>Local Ecosystem: Student Log Book as Blackline Masters</td>
<td>28-48</td>
</tr>
<tr>
<td>Free Digital Photographs</td>
<td>49</td>
</tr>
</tbody>
</table>
Introduction

This resource has been designed for NSW Board of Studies, Stage 6 Biology students, with specific relevance to the preliminary course module: a local ecosystem. Within the context of the syllabus, students must undertake a first hand investigation of a terrestrial or aquatic ecosystem to record observations of abiotic factors and to study various interactions between organisms in the ecosystem. The specialist teaching staff of the Mt Kembla Environmental Education Centre lead students and teachers upon investigations of ecosystems, to capture snapshots of life on the planet.

This document is intended as a supplement to a day with Centre staff in the dynamic terrestrial ecosystem of the Minnamurra River mangroves. Utilising the scientific method, students are challenged to make inferences and formulate hypotheses to explain perceived patterns or associations. These hypotheses become the focus for further observation, measurement and data collection. The interpretation and analysis of data is conducted back in the classroom.

The information within this package contains a model report for students to examine, as well as a student log book, which offers a scaffold for recording data and report presentation. Background information and digital photos of key species within the mangroves are freely available for students to download into their reports, making this a most comprehensive resource. This resource is not exhaustive in treating all aspects of the local ecosystem module as outlined in the syllabus, teachers are advised that there are a number of elements need to be treated through research of references and class discussion. If we have been successful in nurturing an understanding and appreciation of key environmental concepts, students will formulate more questions and indicate the need for further investigation before offering conclusions.

Many teachers are successfully using this program to satisfy the mandatory syllabus requirement that students complete at least one practical experience, as an open-ended investigation, integrating both knowledge and skill outcomes.

Stuart DeLandre
Teacher in charge
8/01/02
Module Title: A Local Ecosystem

Content Focus

- Abundance, distribution and diversity of species is determined by biotic and abiotic factors.
- There is a flow of energy and matter in an ecosystem.

Outcomes

This program contributes to the following Preliminary course outcomes, where a student:

P2 applies processes that are used to test and validate models, theories and laws of science, with particular emphasis upon first-hand investigations in biology

P7 describes the range of organisms in terms of specialisation for a habitat

P8 analyses the interrelationships of organisms within the ecosystem

P11 identifies and implements improvements to investigation plans

P12 discusses the validity and reliability of data gathered from first hand investigations and secondary sources

P13 identifies appropriate terminology and reporting styles to communicate information and understanding in biology

P14 draws valid conclusions from gathered data and information

P15 implements strategies to work effectively as an individual or as a team member

P16 demonstrates positive values about and attitudes towards both the living and non-living components of the environment, ethical behaviour and a desire for a critical evaluation of the consequences of the applications of science.

Sequence of Learning Experiences

- Students observe and record diagnostic characteristics of two indicator plants of the mangroves. The description will include a labelled sketch and description of: physical features, habitat, adaptations (inferred), interactions with other species, human influences, preferred sampling techniques and speculation as to biotic and abiotic characteristics that may influence distribution and abundance.

- Observe and list plants and animals of the ecosystem.

- In groups, students measure abundance of the two indicator plants in two adjacent habitats.

- In groups, students measure a range of abiotic factors within the mangrove ecosystem using both direct observation and a variety of equipment including the data harvest data logger. This information is recorded in tables.

- In groups, students conduct a variety of sampling techniques such as dip netting, setting fish traps and fishing to observe a variety of fauna within the mangrove ecosystem. Students complete a description of diagnostic characteristics of two animals of the mangroves. The description will include a labelled sketch and description of: physical features, habitat, adaptations (inferred), interactions with other species, human influences, preferred sampling techniques and speculation as to biotic and abiotic characteristics that may influence distribution and abundance.

- In groups, students formulate an hypothesis to explain their earlier observations of plant abundance in the two adjacent habitats. This hypothesis should contain one variable abiotic factor that can be tested.

- Students observe the setting up of a belt transect.

- In groups, students set up their own belt transect which they then use to record the distribution of the two indicator plant species observed earlier. As well as the abiotic factor that is the subject of their hypothesis and recordings of any fauna along the transect. Students tabulate their data.

- Draw a sketch map of the ecosystem.

- Identify examples of allelopathy, parasitism, mutualism and commensalism in the ecosystem and the role of organisms in each of these relationships.
Pre-exursion Activities
• Select an ecosystem type for investigation and use secondary sources to briefly describe the
distribution, biotic characteristics, abiotic characteristics, biodiversity, human uses, threats and
personal concerns of the chosen ecosystem.
• Plan a field trip to investigate the ecosystem for the collection of first hand data.
   Indicate the precise location of the ecosystem being investigated on a map.

Post Excursion Activities
🌟 • Students discuss their fieldwork and examine different styles of presenting reports. Students
   begin to prepare and analyse data in the form of graphs, site maps etc. Students critically
   examine the validity of their data and interpretations information. Design and conduct
   resampling if necessary. Describe trends, patterns and relationships using first hand and
   secondary source information.
• Identify observable and potential sources of pollution. Classify the types of pollutant.
• Identify adaptations of organisms and discuss the problem of inferring adaptations of
   organisms.
🌟 • Define the role of producers, consumers and decomposers in the ecosystem.
🌟 • Classify organisms within the ecosystem according to these roles. Use first hand observations
   and secondary information to prepare food chains, food webs and biomass pyramids to model
   the trophic interactions of the ecosystem.
🌟 • Prepare graphical representation to provide a qualitative model of the efficiency of the cycling
   of matter through the ecosystem.
• Use first hand and secondary resources to describe cause effect relationships of the pollutants
   upon the ecosystem.
• Express and clarify values about the perceived/real impact of the pollutants.
• Identify past and present strategies to minimise the impact of the pollutants upon the ecosystem.
   Assess the effectiveness of these strategies used to date.
🌟 • Prepare a list of possible solutions to reduce the impact of the pollutants upon the ecosystem.
   Tabulate advantages and disadvantages of the solutions. Rank the severity of the
   environmental problem and prioritise potential solutions.

Literacy Activities
🌟 • Students prepare a report on the investigation.
• Students complete posters, signs and/or messages advising suggestions for how the
   environment could be best cared for.
• Students prepare a letter for the local council outlining the findings of their investigations.
• Brainstorm the different stakeholders that have an interest in the future of the ecosystem under
   investigation. Students could write their imagined responses of these stakeholders to a
   proposal to develop the mangroves for a housing development.
• Students could write to the local council to find out how leachates from the nearby tip are being
   contained.
• Students could design a poster to raise the awareness of people about the sensitivity of the
   mangroves and highlight the problems caused by litter.

Assessment
• Possible assessment strategies are indicated by 🌟

Equipment Available from the Centre
Data Harvest data logger with probes for temperature, humidity, dissolved oxygen, sound, salt, Ph
and light; refractometer for measuring salinity; soil test kits; tape measures; quadrat frames; cards
describing the features of key plant and animal species; binoculars; fish traps; prawn nets; sampling
trays; hand lines; specimen bottles
A Model Report: Mangroves of the Minnamurra River

Purpose

To report upon the biotic and abiotic factors associated with the mangroves of the Minnamurra River estuary.

Location

Minnamurra River drains from the Illawarra escarpment and across the coastal plain. The Minnamurra River estuary is situated between Kiama and Shellharbour. Associated with the estuary are extensive wetland areas of Dunmore and Rocklow Creek, a tributary of Minnamurra River. Where the Minnamurra River flows into the sea, deposits of sand extending from the headland of Minnamurra Beach south toward Stack Island, an off-shore island, have formed a sand spit creating a barrier estuary.

The study site is located on the northern shoreline of the Minnamurra River at the northern end of the sand spit. The site is within metres of a small outcrop of volcanic latite at the extremities of the base of the headland.
Background Information and Initial Observations

Mangroves are a type of terrestrial ecosystem. They occur within the inter-tidal zone of the Minnamurra River estuary. This ecosystem is made up of a community of plants and animals interacting with each other and the abiotic environment. The vegetation of the shoreline is dominated by the Grey Mangrove (\textit{Avicennia marina}) and the River Mangrove (\textit{Aegicerus corniculatum}). Adjacent to the mangroves is the marine ecosystem of the river, dominated by the sea grass, \textit{Zostera capricorni}. Whilst landward of the mangroves there are large areas of saltmarsh. Beyond the saltmarsh, stands of Casuarina indicate the upper limits of the high tide mark.

Grey mangrove and river mangrove are the only two mangroves found in temperate regions of southern Australia. While in tropical north Queensland and the Northern Territory there are thirty five different species of mangroves. Cold temperatures are believed to be the primary abiotic factor in limiting the distribution and diversity of mangroves in Australia.

At the study site, both mangroves can be observed growing upon yellow sandy beaches, but more often within grey sands and fine black mud. Other initial observations reveal general patterns of distribution of the two mangroves. Firstly, grey mangrove mostly grows closer toward the low tide mark than river mangrove. Grey mangrove also appears more frequently toward the mouth of the estuary, while river mangrove is more dominant further upstream. This observation leads to the inference that grey mangrove is the more salt tolerant of the two species.

Other general and untested patterns of distribution are: the occurrence of clusters of mangrove seedlings and saplings adjacent to stands of mature mangroves; zonation within saltmarsh communities on the landward side of mangroves; and casuarina forests fringing the high tide mark.

The study site is sheltered from wave action, with low lying areas of the shore line subjected to currents and inundation by the high tide, twice every twenty four hours. The mangroves occur in low energy areas, sediments carried in suspension are deposited across the inter-tidal zone. The extent of tidal inundation is dependent upon the height of the high tide and elevation within the inter-tidal zone.

Various abiotic characteristics, such as annual rainfall, seasonal variations in rainfall, temperature extremes, wind exposure, soil type, soil texture, topography, pH, sunlight and availability of nutrients, to name but a few, influence the diversity, distribution and populations of species within the mangrove ecosystem. Those factors initially suspected of being most influential upon mangroves are localised topography, which determines the frequency and duration of inundation by tidal waters. The tidal inundation in turn influences the exposure to salty water. Whilst the salinity of these estuarine waters is most often the same as seawater, the water can become brackish during times of heavy rainfall.
## Background Information: Abiotic Factors

| Factor: Salinity | Salinity is the total of all the salts dissolved in water. Salinity is measured in parts per thousand (ppt). Salinity in the field can be measured with a hand refractometer. The salinity of ocean water is 35 parts per thousand. The salinity within the estuary where the river meets the sea can range from 0 to 35 ppt depending on the input of freshwater into the system and mixing of sea water due to tidal influence. Salinity greatly influences the distribution of plants and animals depending upon the amount of salinity they can tolerate. |
| Hand refractometer | |

| Factor: Dissolved oxygen | Dissolved oxygen is measured as a % of saturation. Dissolved oxygen concentrations are low in areas where there is decomposition of large amounts of organic material. Water with high levels of dissolved oxygen are most likely to support a diversity of aquatic organisms. Dissolved oxygen is essential to all aquatic plants and animals. The dissolved oxygen is used by living things in respiration. Temperature affects the oxygen holding capacity of water. As temperature increases, the amount of dissolved oxygen increases. |
| Data logger | |

| Factor: pH | Ph is a measure of the acidity or alkalinity of a solution. pH can be measured with Universal Indicator, litmus paper or the data logger. pH measurements are made on a scale from 0 (very acidic) to 14 (very alkaline), 7 is neutral. The pH of ocean water is relatively constant, generally falling between 7.8—8.3. Brackish waters, estuarine waters and harbours and areas of industrial contamination can show differences from the pH of ocean water. |
| Data logger | |

| Factor: Water Temperature | Temperature is an important limiting factor in determining the distribution of plant and animal species. Temperature can be measured with the thermometer or the data logger. Temperature has a significant affect upon water quality. Temperature influences the amount of dissolved oxygen in water, the rate of photosynthesis by plants, and the sensitivity of living things to toxic wastes and diseases. |
| Thermometer, Data logger | |

| Factor: Turbidity | Turbidity is a measure of the light penetration below the water or the relative clarity of the water. Turbidity can be measured with the Jackson tubes. Turbid water is caused by suspended matter such as clay, silt, organic and inorganic matter and plankton. Turbid water can be the result of erosion and urban runoff, algae blooms and disturbance of sediments from the bed of the water body. |
| Jackson tubes | |
**Background Information: Abiotic Factors**

<table>
<thead>
<tr>
<th>Factor: Soil type</th>
<th>Soil texture kit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soils are classified as either sand, silt or clay. Loams are a class or texture of soil that contains moderate amounts of sand, silt and clay. Loams generally contain higher organic matter. The type of soil influences drainage, capacity to hold air and the capacity to hold nutrients. The sedimentation of a soil sample allows for the estimation of sand, silt or clay present. Sandy soil describes soil that contains 85% or more sand. Silt soil contains 80% or more silt and less than 12% clay. Clay soil is described as soil containing more than 40% clay.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor: Organic matter</th>
<th>Hydrogen peroxide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic matter is that part of the soils which results from the decomposition living matter through the action of bacteria. Large amounts of decomposing organic matter can significantly lower the oxygen levels in the soil. Soils rich in organic matter have high water holding capacity. Organic matter in soil can be determined qualitatively by observing the reaction of hydrogen peroxide upon a soil sample. A strong effervescent reaction indicates the presence of large amounts of organic matter.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor: soil pH</th>
<th>Universal indicator, data logger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pH is the degree of acidity or alkalinity of the soil. pH measurements are made on a scale from 0 (very acidic) to 14 (very alkaline), 7 is neutral.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor: soil temperature</th>
<th>Thermometer, Data logger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature is an important limiting factor in determining the distribution of plant and animal species. Soil temperature is critical in the germination of seeds. Temperature can be measured with the thermometer or the data logger.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor: soil moisture</th>
<th>Moisture probe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil moisture is a limiting factor in the growth of plants. Soil moisture that is a consequence of tidal influence is a critical factor in determining the distribution of mangrove and saltmarsh species. Water logged soils cause a slow rate of oxygen and nutrient replacement, as a result the soils surrounding the mangroves are generally low in oxygen and nutrients. While salt within tidal waters is toxic to all but a few plant species. The capacity of soils to retain moisture is greatly increased by high levels of organic matter.</td>
</tr>
</tbody>
</table>
### Background Information: Abiotic Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air temperature</td>
<td>Air temperature is a limiting factor upon plant and animal species. None more so than mangroves. In the cooler temperate southern locations of Australia only two species of mangroves occur, the grey mangrove and the river mangrove. While in the warmer northern parts of Australia the number of mangrove species is close to thirty.</td>
</tr>
<tr>
<td>Thermometer, data logger</td>
<td></td>
</tr>
<tr>
<td>Sunlight intensity</td>
<td>Sunlight intensity and duration influences the levels of photosynthetic productivity.</td>
</tr>
<tr>
<td>Soil salinity</td>
<td>Soil salinity is the amount of salt contained in the soil. Soil salinity within the mangroves/saltmarsh environment is influenced by the frequency of inundation by tides and frequency of flooding with brackish waters after periods of heavy rain. The soil salinity in the field can be measured using the hand held refractrometer. When recording soil salinity note should also be made of the frequency of tidal influence on the location.</td>
</tr>
<tr>
<td>Topography</td>
<td>Elevation and the occurrence of mounds and hollows greatly influences tidal inundation and soil moisture, which in turn affects the soil salinity. A profile of the topography can be prepared along a transect from the shoreline using spirit levels, tape measures and measuring poles. The topography of the shoreline from the low tide level to the high-high tide level (areas only impacted upon twice per year during the highest of tides) is significant in determining patterns of distribution and zonation within the mangrove and saltmarsh communities.</td>
</tr>
</tbody>
</table>
Using the Scientific Method

Observation
Grey mangroves and river mangroves grow in the low to mid tide zones of sheltered shorelines of the Minnamurra River estuary.

Hypothesis
The occurrence of grey mangrove and river mangrove is dependent upon frequency of inundation by tidal waters.

Collecting Data
1. Preparing a Profile of the Topography
The site for data collection was chosen for its conformity with the pre-conceived model of mangrove zonation from sea grasses, through to the grey mangroves and river mangroves, saltmarsh and casuarina. A fifty metre long and two metre wide belt transect was extended across the site during low tide. The topography of the site was mapped by measuring the elevation along the transect every two metres.

2. Locating the Transect
A GPS (Ground Positioning System) was used to locate either end of the transect as two ten digit grid references relating to the Albion Park topographic map 9028-1-N.

3. Recording Vegetation
Occurrence of different species of plants along the belt transect was recorded (diagram 1). Photographs of the vegetation community were taken every five metres as an additional means of recording the structure and composition of vegetation along the transect.

4. Measuring Abiotic Factors
Soil temperature, air temperature, sunlight intensity one metre above the ground and relative humidity one metre above the ground were measured every five metres along the transect using the data logger in snapshot mode. This data logger also recorded the data for later retrieval.

5. Measuring soil Ph
Soil samples were collected every five metres along the transect. The data logger was used to measure pH back in the laboratory.

6. Measuring soil salinity
Distilled water was added to each of the ten soil samples and shaken. Once the samples had settled, several drops of solution were placed on the refractometer to determine salinity.
Distribution of Plant Species

- Bitou Bush
- Swamp She-oak
- Cape Ivy
- Kikuyu
- Cakile
- New Zealand Spinach
- Couch
- Juncus
- Seablite
- Glasswort
- River Mangrove
- Grey Mangrove

Presentation of Data

Preliminary Course: A Local Ecosystem
Presentation of Data

Abiotic Factors

Abiotic factors as measured and recorded with the data logger every five metres along the transect.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Soil Temp. °C</th>
<th>Humidity %RH</th>
<th>Light lux</th>
<th>Air Temp. °C</th>
<th>pH</th>
<th>Salinity ppt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.7</td>
<td>71.8</td>
<td>21112</td>
<td>20.1</td>
<td>7.78</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>14.7</td>
<td>74.1</td>
<td>20304</td>
<td>20.2</td>
<td>7.42</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>14.3</td>
<td>72.3</td>
<td>11284</td>
<td>20.4</td>
<td>7.34</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>14.4</td>
<td>75.3</td>
<td>19237</td>
<td>20.6</td>
<td>7.60</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>14.5</td>
<td>74.5</td>
<td>20336</td>
<td>20.7</td>
<td>7.57</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>14.8</td>
<td>75.1</td>
<td>20304</td>
<td>20.9</td>
<td>7.57</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>14.3</td>
<td>76.6</td>
<td>18978</td>
<td>21.0</td>
<td>8.32</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>14.1</td>
<td>79.1</td>
<td>17814</td>
<td>21.1</td>
<td>8.68</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>14.3</td>
<td>79.7</td>
<td>17782</td>
<td>21.3</td>
<td>8.55</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>15.1</td>
<td>77.1</td>
<td>12609</td>
<td>21.4</td>
<td>7.64</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>16.5</td>
<td>78.3</td>
<td>9247</td>
<td>21.4</td>
<td>6.97</td>
<td>0</td>
</tr>
</tbody>
</table>

![Graphs showing changes in environmental factors over time](image)
Analysis of Data

Soil Temperature
Temperature is an important limiting factor in determining the distribution of plant species. Soil temperature is critical in the germination of seeds. Numerous mangrove seedlings were recorded as growing in open positions within the inter-tidal zone beyond the shadow effect of mangrove saplings and mature mangroves.

Humidity
High humidity levels reduce the rate of transpiration from plants and evaporation from the soil and water bodies. Higher humidity levels over the last ten metres of the transect may have been due to the increased density of vegetation cover and subsequent higher levels of transpiration. Humidity does not seem to be a factor influencing the distribution of plant species across the study site.

Sunlight Intensity
Sunlight intensity and duration influences the levels of photosynthetic productivity. The shade of mature plants restricted the growth and distribution of ground covers, including the growth of mangrove seedlings.

Air Temperature
Air temperature is a limiting factor upon plant and animal species. None more so than mangroves. In the cooler temperate southern locations of Australia only two species of mangroves occur, the grey mangrove and the river mangrove. While in the warmer northern parts of Australia the number of mangrove species is close to thirty five. However at the study site, air temperature would not be a factor that could be considered as influential upon the distribution of mangroves over the gradient from the low to high tide levels.

Soil pH
pH is a measure of the acidity or alkalinity of a solution. pH can be measured with Universal Indicator, litmus paper or the data logger. Ph measurements are made on a scale from 0 (very acidic) to 14 (very alkaline), 7 is neutral. The pH of ocean water is relatively constant, generally falling between 7.8—8.3. Brackish waters, estuarine waters and harbours and areas of industrial contamination can show differences from the pH of ocean water.

Soil pH across the transect was very close to that expected of sea water. The slightly acidic recording made beneath *Casuarina glauca* may possibly be due to the release of acidic allelopathic substances by this plant.

Soil Salinity
Soil salinity is the amount of salt contained in the soil. Soil salinity within the mangroves/saltmarsh environment is influenced by the frequency of inundation by tides and frequency of flooding with brackish waters after periods of heavy rain.
Analysis of Data

Soil Salinity (continued)

Frequency of inundation by salt water is the single most significant factor in determining distribution of vegetation across the gradient from mangroves through the saltmarsh. Those species most tolerant of frequent inundation by salt water in order of tolerance are the grey mangrove, river mangrove, glasswort, couch and seablite.

Salinity is the total of all the salts dissolved in water. Salinity is measured in parts per thousand (ppt). The salinity of ocean water is 35 parts per thousand. The salinity within the estuary where the river meets the sea can range from 0 to 35 ppt depending on the input of freshwater into the system and mixing of sea water due to tidal influence.

Localised Topography

Elevation and the occurrence of mounds and hollows greatly influences tidal inundation and soil moisture, which in turn affects the soil salinity. The profile of the localised topography can be prepared along a transect from the low tide to the high-high tide level (areas only impacted upon twice per year during the highest of tides) is significant in determining patterns of distribution and zonation within the mangrove and saltmarsh communities. Mangroves are restricted to the low to mid tide area, in level low lying areas where the roots of the plants experience complete to partial inundation.

Questions to Support Further investigations and Forming Conclusion

1. Discuss the correlation between the data and text models exhibiting zonation and/or patterns of distribution in the mangroves and saltmarsh.
2. Explain how knowledge of the significance of mangroves has gained mangroves high conservation value.
3. Critically assess cause and effect relationships of human impacts upon mangrove ecosystems.
4. Describe the life cycles of the grey mangrove and the river mangrove.
5. Describe three physiological adaptations of mangroves which enable them to tolerate salty water.
6. Draw and label a diagram to show how pneumatophores enable mangroves to survive in anaerobic soils.
7. How do the allelopathic properties of bitou bush and swamp she-oak impact upon other plant species.
8. Describe the life cycle of the mistletoe which is sometimes found upon the swamp she-oak.
9. Draw a food web to show the relationship between the detritus of the leaf litter from mangroves and other organisms within the Minnamurra estuary.
10. Mangrove soils are rich in organic matter. Describe how the organic matter within the soil might be measured.
11. The results seem to fit the textbook pattern of mangrove distribution. Discuss the validity of the results of the investigation which describes the zonation from the mangroves through to the saltmarsh.

12. Explain how the results of this investigation might be further supported before rejecting or accepting the original hypothesis.

13. Prepare one hypothesis, containing one variable factor which can be tested, that might be posed with regard the distribution of one plant or animal with the mangrove ecosystem.
Discussion to assist students formulate conclusions and further investigations

An ecosystem is a community of organisms interacting with each other and their physical environment. Populations of plants and animals make up the biotic characteristics of an ecosystem. While the abiotic characteristics of an ecosystem describe physical features such as daily and annual rainfall, seasonal variations in rainfall, temperature extremes, wind exposure, soil type, soil texture, topography, pH, turbidity of water and availability of nutrients, to name but a few abiotic characteristics.

The mangrove forests of the Minnamurra River estuary comprise the grey mangrove, *Avicennia marina*, the river mangrove, *Aegiceras corniculatum* and a variety of other plants and animals, including seagrasses and saltmarshes.

Minnamurra River provides a barrier estuary where the development of the sand spit separates the river and the sea.

These are the only two mangroves found in the temperate regions of southern Australia. Australia wide there is about 11500 square kilometres of mangrove (Adam 1994). Within NSW mangroves occupy approximately 107 square kilometres. Mangrove forests are usually located along shorelines sheltered from wave action, growing within sand but more often within mud.

Mangrove trees experience daily variations in marine and terrestrial abiotic conditions. The most significant variation in abiotic conditions is the alternating cycle of submergence of the roots in salty water roots and exposure to the air.

The existence of extensive areas of mangrove can be based upon

- **Air temperature**: Cold is a limiting factor upon the distribution of mangroves. Two or three nights of 2-3 degrees Celsius will kill the hardest species. The greatest variety of species is in tropical north Qld and the Northern Territory where there are about thirty different species. The warmest months are December, January and February with an average January maximum temperature of 26 degrees Celsius. July is the coldest month experiencing an average July minimum of 9 degrees Celsius.
- **Protection from wave action**: Wave action does not allow for the development of seedlings. Mangroves develop best where there is protection from wave action and strong currents.
- **Salt water**: Mangroves are halophytes, salt tolerant. However they do not need salt water to grow and grow in locations often subject to frequent flooding by freshwater following periods of heavy rainfall.
- **Sediment**: Mangroves require sediment in which they can grow. The mangroves of the Minnamurra grow in sediments of sand and black mud.
- **Generally, habitats with extreme abiotic factors have less diversity, this is true of the mangroves and saltmarsh**
- **Grey Mangrove is more common than the river mangrove in the Sydney/Illawarra**
- **Grey mangrove is more salt tolerant than the River mangrove**
Discussion to assist students formulate conclusions and further investigations

- Assess vegetation structure and and biomass by counting the various height classes of trees, seedling and pneumatophore numbers and measure crown diameters, girth at breast height and projective cover. This allows for the comparison of profiles and standing biomass between stands of mangrove forests.
- Most common saltmarsh plants are Sarcocornia quinqueflora, Suaeda australis, Triglochin striatum, Juncus krausii and Sporobolus virginicus (need to confirm). Estimates are made of density and biomass for comparison between sites.
- Zonation within the mangrove/saltmarsh is influenced by small variations in elevation in elevation from the water level. Mangroves mostly occur where there are sections of the tidal gradient that inundated daily, experiencing salinities equal to or less than that of seawater.
- Saltmarsh extend beyond the mangroves, to the limit of the high-high tide (max. twice yearly inundated). Salinity here varies from brackish to almost twice the salinity of seawater, and irregular inundation.
- Within the saltmarsh the topography determines the distribution of individual plants. Hollows and humps in the topography coincide with changes in plant species.
- Some plants like Sarcocia quinquflora have a wide tolerance of the environmental factors, while others such as Sporobolus virginicus are less tolerant and restricted to areas of less frequent inundation and reduced salinity.
- Studies need to include analysis of water content, pH, organic content, conductivity, sediment salinity, tidal influence and soil structure to obtain information on the requirements of the plants.
- Biomass estimates can be conducted in the mangroves by placing five quadrats (0.125 sq. m) at the corners and in the centre of 100 sq. m quadrat to estimate pneumatophore height and density. Fauna can be measured by counting gastropods and crab holes.
- Mangroves occur in the area just above the low tide level to the mean high tide level, while salt marsh extends from the mean high to high-high tide levels.
- Tidal influence can be described as nil, slight, partial, full
- Mangroves are important as they recycle nutrients; trap sediments; provide a habitat for terrestrial and aquatic animals; reduce stream bank erosion
- Grey mangroves are mostly found in situations where the salinity is close to that of seawater while the river mangrove is found in more brackish waters.
- Seeds of mangroves can float. Shaped to anchor themselves within soft substrate. Growth of seedlings is slow. In the competition with mature plants for light seedling remains stunted for five years, if unable to grow because of the competition the seedling may die.
- Mangroves are important fish habitats, both temporary and permanent. Examples: bream, silver biddy, luderick, dusky flathead.
- Common invertebrates crabs, oysters, limpets and mud whelks
- Habitat used by some marine species from the plankton stage
- Most mangrove animals feed on the detritus (decomposing plant material), some detritus feeders are mullets, prawns, and crabs
Plants of the Mangrove Ecosystem

**Scientific Name:** *Avicennia marina*

**Common Name:** Grey Mangrove

**Description:** A shrub from 0.5 m to a 25 m tall tree. Leaves are opposite, glossy green above and pale grey below. Salt secreting glands below the leaves. Small clusters of orange-yellow flowers. Large fleshy green seed. Slender peg roots called pneumatophores protrude like knobbly fingers from soft sediment.

**Range:** *Avicennia marina* is the most widespread mangrove, found in all states except Tas.

**Habitats:** It occurs in a variety of sheltered habitats from creeks and rivers that are influenced by tides to muddy river banks. It is also found in claypan saline areas.

**Adaptations (inferred):** Salt glands mostly on the underside of leaves excrete salt. Roots filter approx. 90% of the salt during the uptake of water. Some salt can be stored in the tissue of the plant. Seeds germinate whilst on the tree, they are described as viviparous (bearing live young). On falling into currents the seed generally floats for three days before embedding in soft sediment. The water logged soils of the mangroves which have low levels of oxygen have led to the development of pneumatophores which allow the plant to take in oxygen.

**Interactions with other species:** Numerous species use the peg roots and trunks as a habitat eg, oysters, limpets, barnacles and bembicium. Leaf litter from the mangrove provides food for zoo plankton within the water. Pollination is mostly by insects, particularly honey bees

**Other plants of this community:** sometimes *Aegiceras corniculatum*

**Human Influences:** Mangroves have been cleared and the wetlands filled for use as urban development or industrial use. Some areas of mangroves upon the Minnamurra River have grown due to recolonisation by mangroves in locations where there has been an accretion of sediment mostly due to earlier land clearing for agriculture.

**Cultural Uses:** Beekeepers use *Avicennia marina* as a source of pollen, the timber can be used for boat building and oyster farmers used the timber for growing oysters.

**Distribution Sampling Technique:** Use a belt transect to determine where mangroves occur.

**Abundance Sampling Technique:** Use 0.25 metre square quadrats to determine the number of seedlings 1 metre square quadrats for the number of saplings.

**Possible Factors Influencing Distribution:** light intensity, soil salinity, soil moisture, organic matter in the soil, soil type, frequency of inundation by salt water, tidal levels
Plants of the Mangrove Ecosystem

Scientific Name: *Aegiceras corniculatum*

Common Name: River mangrove

Description: As small shrub or slender tree, usually 3-4 metres high. The leaves are alternate, blunt, thick and leathery, yellowish green and hairless. Small white flowers form dense clusters during early summer. The fruit are banana shaped about 300 mm long.

Range: River mangrove occurs from Jervis Bay on the south coast of NSW through to Queensland and northern Australia.

Habitats: It occurs sheltered habitats of creeks and rivers that are influenced by tides. It is also found in claypan saline areas. It is found along the landward fringes of mangroves and further upstream in the upper reaches of the tidal influence where the water is less saline.

Adaptations (inferred): Salt glands mostly on the underside of leaves excrete salt that is often visible. Roots filter approx. 90% of the salt during the uptake of water. Some salt can be stored in the tissue of the plant. Seeds germinate whilst on the tree, they are described as viviparous (bearing live young). On falling into currents the seed generally floats for three days before embedding in soft sediment. River mangrove does not have pneumatophores.

Interactions with other species: Leaf litter from the mangrove provides food for zoo plankton within the water. Pollination is mostly by insects, particularly honey bees.

Other plants of this community: often occurs landward from *Avicennia marina*

Human Influences: Mangroves have been cleared and the wetlands filled for use as urban development and agricultural use. This would have particularly impacted upon the River mangrove as it occurs more toward the land. Consequently, habitats occupied by this plant would have been more easily reclaimed for developments. Some areas of mangroves upon the Minnamurra River have grown due to recolonisation by mangroves in locations where there has been an accretion of sediment mostly due to earlier land clearing for agriculture.

Cultural Uses: Beekeepers use *Aegiceras corniculatum* as a source of pollen.

Distribution Sampling Technique: Use a belt transect to determine where mangroves occur.

Abundance Sampling Technique: Use 1 metre square quadrats to determine abundance.

Possible Factors Influencing Distribution: light intensity, soil salinity, soil moisture, organic matter in the soil, soil type, frequency of inundation by salt water, tidal levels.

20
Plants of the Mangrove Ecosystem

**Scientific Name:** *Casuarina glauca*

**Common Name:** Swamp She-oak

**Description:** An erect dull grey-green tree. The branchlets are dull green up to 1.5 mm thick. Small triangular leaf teeth along the branchlets are located at regular intervals in whorls of 12-16. Small woody and rounded fruit has numerous small valves containing seed. *Casuarina glauca* is dioecious, meaning it has both male and female plants.

**Range:** Coastal NSW and Queensland

**Habitats:** Low lying lagoon, estuarine and coastal environments upon poorly drained soils.

**Adaptations (inferred):** The branchlets are modified stems that contain chlorophyll and are the primary site for photosynthesis. These modified stems reduce water loss by transpiration as they do not have stomates. The true leaves are greatly reduced in size forming the small triangular leaf teeth. The hard woody fruit protects the seeds from fire.

**Interactions with other species:** The trunk and branches of *Casuarina glauca* are often encrusted with lichens. The parasitic Sheoak mistletoe uses the *Casuarina glauca* as a host.

**Other plants of this community:** Bitou Bush, Swamp Lilly, Boobialla, Prickly Couch

**Human Influences:** Infilling of wetland areas for houses, roads and industries has reduced the distribution of *Casuarina glauca*.

**Distribution Sampling Technique:** Belt transect

**Abundance Sampling Technique:** Random quadrat sampling

**Possible Factors Influencing Distribution:** requirement for freshwater input, soil moisture, sunlight, drainage, soil salinity, frequency of inundation with saline waters, topography
Plants of the Mangrove Ecosystem

Scientific Name: *Amyema cambagei*
Common Name: She-oak mistletoe

Description: Mimics the thin needle-like growth of the host tree’s branchlets making it appear almost identical to the *Casuarina glauca*. Greyish leaves are covered in microscopic hairs. The red flowers shown above produce a rounded white fruit which is eaten by some birds.

Range: Same as for the host, Coastal NSW and Queensland

Habitats: Same as for the host, low lying lagoon, estuarine and coastal environments upon poorly drained soils.

Adaptations (inferred): Germinates in to the living tissue of the host to obtain nutrients.

Interactions with other species: Produces a sticky fruit which is consumed by birds. However the birds cannot digest the seed within the fruit, consequently the seed is often expelled onto the branch of a potential host which ensures continuation of the parasite.

Other plants of this community: Grasses such as prickly couch, bitou bush, coastal wattle

Human Influences: Destruction of habitats for land reclamation, thereby reducing the distribution and abundance of host plants may reduced the abundance of mistletoe she-oak.

Distribution Sampling Technique: Belt transect

Abundance Sampling Technique: Direct observation and counting

Possible Factors Influencing Distribution: Availability of host plants, sunlight intensity
Animals of the Mangrove Ecosystem

**Scientific Name:** *Paragrapsus laevis*

**Common Name:** Mottled Shore Crab

**Description:** Large purple, dark crab with the mottled patches on the back of the carapace. Nippers are a cream colour on the underside. It has two distinct notches on either side of the carapace. It grows to 35 mm across the carapace.

**Range:** Eastern Australia from Tasmania to Queensland.

**Habitats:** Usually found under debris on the floor of the mangrove forest.

**Adaptations (inferred):** Shelters underneath logs and in cool places to avoid drying out. Uses nippers to obtain food and defend itself.

**Interactions with other species:** *Paragrapsus laevis* are omnivorous, capturing and eating small marine animals, as well as grazing on algae. Like all crabs, they can be preyed upon by bigger crabs, birds and fish.

**Other animals of this community:** The Red-fingered crab, Sydney mud-whelk

**Human Influences:** Infilling of wetlands for urban developments, industry and transport routes may have reduced the habitats available and thereby reduced the abundance of this species.

**Distribution Sampling Technique:** conduct transects across the mangrove

**Abundance Sampling Technique:** capture/recapture using pitfall traps, counting crab holes

**Possible Factors Influencing Distribution:** availability of mangrove forest habitat, debris for sheltering.
Animals of the Mangrove Ecosystem

**Scientific Name:** *Sesarma erythrodactyla*

**Common Name:** Red-fingered crab

**Description:** Adults have a green carapace, nippers are always orange or red. Its carapace is square and up to 25 mm across. It has numerous brown hairs along its legs. Juveniles may be a green brown colour.

**Range:** Mangrove forests and wetter parts of salt marshes from Victoria to Queensland.

**Habitats:** Burrows have been found in the mangrove tree *Avicennia marina*, in the mud of the forest floor, underneath logs and other debris of the forest.

**Adaptations (inferred):** Shelters underneath logs and in cool places to avoid drying out. Uses nippers to obtain food and defend itself.

**Interactions with other species:** *Sesarma erythrodactyla* eat the leaves of the mangroves.

**Other animals of this community:** Mottled Shore Crab, Sydney mud-whelk

**Human Influences:** Infilling of wetlands for urban developments, industry and transport routes may have reduced the habitats available and thereby reduced the abundance of this species.

**Distribution Sampling Technique:** conduct transects across the mangrove

**Abundance Sampling Technique:** capture/recapture using pitfall traps, counting crab holes

**Possible Factors Influencing Distribution:** availability of mangrove forest habitat, debris for sheltering.
Animals of the Mangrove Ecosystem

Scientific Name: *Pyrazus ebeninus*

Common Name: Sydney mud-whelk or Hercules club-shell

Description: Elongated brown shell up to 9 cm long with rounded whorls and irregular bumps. Opening of the shell is almost round.

Range: Queensland to eastern Victoria

Habitats: Muddy/sandy flats within the intertidal zone.

Adaptations (inferred): Like all gastropods, *Pyrazus* has a large muscular foot used for movement and attachment to surfaces. The hard shell which is impervious to moisture reduces water loss through evaporation.

Interactions with other species: Ingesting sediment as they move over the surface they digest micro-algae, detritus and bacteria.

Other animals of this community: mottled shore crabs, soldier crabs, red fingered marsh crabs

Human Influences: Infilling of wetlands for urban developments, industry and transport routes may have reduced the habitats available and thereby reduced the abundance of this species.

Distribution Sampling Technique: Transects across the mudflats

Abundance Sampling Technique: Random quadrat sampling

Possible Factors Influencing Distribution: Regular inundation by tidal waters within the low to mid tide zone.
Animals of the Mangrove Ecosystem

**Scientific Name:** *Bembicium auratum*

**Common Name:** Grazing snail

**Description:** Grows up to 15mm diameter. It has a large, knobbly grey-brown shell. Nodules on the whorl of the shell give it a distinctively bumpy appearance.

**Range:** Temperate mangrove forests of south eastern Australia.

**Habitats:** Various surfaces within the mangrove forests such as the mud, tree trunks, pneumatophores and oyster shells.

**Adaptations (inferred):** Like all gastropods, *Bembicium* has a large muscular foot used for movement and attachment to surfaces. The hard shell which is impervious to moisture reduces water loss through evaporation.

**Interactions with other species:** *Bembicium* feeds upon microalgae. *Bembicium* have been found to be more numerous upon oysters.

**Other animals of this community:** Mottled Shore Crab, Sydney mud-whelk, Sydney Rock Oyster and Barnacles

**Human Influences:** Harvesting of oysters and infilling of mangroves would have adversely impacted upon populations.

**Distribution Sampling Technique:** conduct transects across the mangrove, vertical distribution could also be determined on surfaces such as the trunks of mangroves

**Abundance Sampling Technique:** random sampling using the quadrat technique

**Possible Factors Influencing Distribution:** availability of microalgae on surfaces within the intertidal zone
Animals of the Mangrove Ecosystem

**Scientific Name:** *Saccostrea commercialis*

**Common Name:** Sydney rock oyster

**Description:** The half of the shell containing the body of the oyster is firmly attached to a rock or other structure. The top of the shell with the often fluted and always sharp edge varies in colour from white to yellowy brown and purple. It can grow up to 8 cm wide.

**Range:** The Sydney rock oyster is found along the east coast of Australia from Victoria to Queensland.

**Habitats:** The Sydney rock oyster is most often found on rocky shores or around marine structures from mid to low tide levels, as well as amongst sediments, trunks and pneumatophores of mangroves and mudflats.

**Adaptations (inferred):** The hard shell protects the oyster from drying out in extremely hot and dry conditions. The oyster is able to make a firm attachment and never moves again.

**Interactions with other species:** The oyster is a filter feeder, taking plankton from the water which passes through its body. The oyster is preyed upon by birds such as the oyster catcher, as well as sea stars, oyster borers and bream.

**Other animals of this community:** red fingered marsh crabs; mottled shore crabs; bembicium; limpets; barnacles; bream; Sydney mud whelk

**Human Influences:** Oysters are grown commercially along the eastern sea-board. Oyster populations are often completely destroyed by people moving through oyster beds collecting and eating this shellfish.

**Distribution Sampling Technique:** conduct belt transects across the mangrove

**Abundance Sampling Technique:** random quadrats

**Possible Factors Influencing Distribution:** regular inundation with sea water; suitable surfaces upon which they might attach
A Local Ecosystem

Mount Kembla Environmental Education Centre

“experience the diversity”

Student Log Book

Student Name

_________________________________
Defining an Ecosystem

1. Analyse the definition of an ecosystem to write your understanding of this concept.

   “An ecosystem is a community of organisms interacting with each other and with their physical environment.”

2. Circle the ecosystems.
   a. A colony of termites
   b. A coral reef
   c. The biosphere
   d. A moss covered rock
   e. A field of wheat
   f. A coastal rock pool
   g. A rotting log
   h. A creek

3. Classify the ecosystems of Killalea State Park as either terrestrial or aquatic.

   Killalea Lagoon; saltmarsh, coastal dunes, littoral rainforest, mangroves, subtropical rainforest, grasslands, Rocklow Creek, heath, rock platforms, Minamurra River estuary and low closed forest.

   Terrestrial
   Aquatic

4. List ecosystems that were difficult to classify. Discuss reasons for this difficulty.
Ecosystem Background Information

1. The type of ecosystem chosen for my investigation is _____________________________.
Use the library or internet to compile background information on this ecosystem.

2. Describe the distribution of this type of ecosystem across Australia.

_____________________________________________________________________
_____________________________________________________________________

3 Examples of Biotic Characteristics

Species of Plants  _____________________________________________________
_____________________________________________________________________
Species of Animals  _____________________________________________________
_____________________________________________________________________

4 Examples of Abiotic Characteristics

Climate  _____________________________________________________
_____________________________________________________________________
Topography  _____________________________________________________
_____________________________________________________________________

5 Importance of this ecosystem type

Biodiversity  _____________________________________________________
_____________________________________________________________________
Human Uses  _____________________________________________________
_____________________________________________________________________

6 Threats to this type of ecosystem

_____________________________________________________________________
_____________________________________________________________________

7 Personal concerns or questions

_____________________________________________________________________

8 References
# Planning An Investigation

1. List resources available to you in collecting first hand data of an ecosystem.
   - **Equipment**: 
     - 
     - 
   - **Contacts**: 
     - 
     - 

2. List resources available to assist you collect second hand data.
   - **Texts, web sites, library sources etc.**: 
     - 
     - 

3. What do you hope to discover? 
   - 
   - 

4. What data will be required? 
   - 
   - 

5. What procedures will be used in the field? 
   - 
   - 

6. What time limitations are there:  
   - in the field? 
   - completing the report? 

7. What safety hazards may exist? 
   - 
   - 

8. What approvals are required? 
   - 
   - 

9. What ethical considerations are there? 
   - 
   -
Location

Mark the location of the ecosystem under investigation at Killalea State Park. Indicate North.
Investigating Abiotic Factors

Macroclimate or the overall climate of Killalea, typifies the climate experienced across the geographical area known as the Illawarra coastal plain.

The proximity to the coast moderates temperature extremes. The warmest months are December, January and February with an average January maximum temperature of 26°C. July is the coldest month experiencing an average July minimum of 9°C.

Average annual rainfall is approximately 1100mm with no distinct seasonal variation in rainfall.

Most of the rainfall is a consequence of moisture laden southerly winds moving across the coastal plain. Saddleback Mountain to the south of Killalea which reduces the rainfall on this portion of the coastal plain compared to other locations across the Illawarra.

Measuring and Recording Terrestrial Abiotic Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Equipment Used</th>
<th>Data</th>
<th>Factor</th>
<th>Equipment Used</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td>Light intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil temperature</td>
<td>% Cloud cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic matter</td>
<td>Prevailing wind</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil pH</td>
<td>Wind speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil salinity</td>
<td>Wind exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil carbonates</td>
<td>Slope</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil moisture</td>
<td>Topography</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air temperature</td>
<td>Elevation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measuring and Recording Aquatic Abiotic Features

<table>
<thead>
<tr>
<th>Factor</th>
<th>Equipment Used</th>
<th>Data</th>
<th>Factor</th>
<th>Equipment Used</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water temperature</td>
<td>Nitrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>Salinity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water pH</td>
<td>Water Depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>Flow rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved solids</td>
<td>Pollution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphates</td>
<td>Water colour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Investigating Biotic Factors

Table: Plant Species Observed

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Notes</th>
<th>Common Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td></td>
<td>Shrubs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grasses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (eg vines)</td>
<td></td>
</tr>
</tbody>
</table>

Table: Animal Species Observed

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Notes</th>
<th>Common Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds</td>
<td></td>
<td>Amphibians</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fish</td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td></td>
<td>Invertebrates</td>
<td></td>
</tr>
<tr>
<td>Reptiles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Investigating Biotic Factors - Plant Study

<table>
<thead>
<tr>
<th>Location</th>
<th>Ecosystem</th>
<th>Date</th>
</tr>
</thead>
</table>

**Scientific Name:** __________________________

**Common Name:** __________________________

**Description**

**Growth Habit:** tree / shrub / grass / other

**Average Height:** __________________________

**Average leaf size & shape:** __________________

**Leaf colour above** _________ **below** _________

**Leaf arrangement:** opposite / alternate

**Flowers:** ________________________________

**Fruit:** fleshy / woody

Draw and label the leaves, as well as buds, flowers and/or fruit.

**Habitat Description:** _____________________________________________________________

**Adaptations Inferred:** ____________________________________________________________

_____________________________________________________________________________

**Interactions with other species:** ____________________________________________________

_____________________________________________________________________________

**Human Influences:** ______________________________________________________________

_____________________________________________________________________________

**Technique used to sample distribution:** ____________________________________________

_____________________________________________________________________________

**Technique used to sample abundance:** _____________________________________________

_____________________________________________________________________________

**Possible factors influencing distribution that require further investigation.**

_____________________________________________________________________________
Investigating Biotic Factors - Plant Study

| Scientific Name: __________________________ |
| Common Name: __________________________ |
| Description |
| Growth Habit: tree / shrub / grass / other |
| Average Height: __________________________ |
| Average leaf size & shape: __________________ |
| Leaf colour above __________ below __________ |
| Leaf arrangement: opposite / alternate |
| Flowers: ________________________________ |
| Fruit: fleshy / woody |

Draw and label the leaves, as well as buds, flowers and/or fruit.

Habitat Description: _____________________________________________________________

Adaptations Inferred: _____________________________________________________________

Interactions with other species: __________________________________________________

Human Influences: ______________________________________________________________

Technique used to sample distribution: _________________________________________

Technique used to sample abundance: _________________________________________

Possible factors influencing distribution that require further investigation.
### Investigating Biotic Factors - Animal Study

<table>
<thead>
<tr>
<th>Location</th>
<th>Ecosystem</th>
<th>Date</th>
</tr>
</thead>
</table>

Scientific Name: __________________________

Common Name: __________________________

Diagnostic features

- ______________________________________
- ______________________________________
- ______________________________________
- ______________________________________
- ______________________________________

Size: ___________________________________

Labelled drawing.

Habitat Description: ______________________

Adaptations Inferred:

- ______________________________________
- ______________________________________

Interactions with other species:

- ______________________________________
- ______________________________________

Human Influences:

- ______________________________________
- ______________________________________

Technique used to sample distribution: _____________________________________________

Technique used to sample abundance: _______________________________________________

Possible factors influencing distribution that require further investigation.

- ______________________________________
Investigating Biotic Factors - Animal Study

Labelled drawing.

Scientific Name: __________________________

Common Name: __________________________

Diagnostic features

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

Size: ___________________________________

Habitat Description: ________________________________________________________

Adaptations Inferred: _________________________________________________________

_________________________________________________________________________

Interactions with other species: _______________________________________________

_________________________________________________________________________

Human Influences: ____________________________________________________________

_________________________________________________________________________

Technique used to sample distribution: _________________________________________

_________________________________________________________________________

Technique used to sample abundance: _________________________________________

_________________________________________________________________________

Possible factors influencing distribution that require further investigation.

_________________________________________________________________________
Measuring Abundance

**Background Information** Estimating abundance or the population size of a species of plant or sedentary animal utilises sampling areas called quadrats. The quadrat is a square frame placed on the ground for the purpose of counting the number of target species within the quadrat.

Quadrats need to be placed at random and objectively to provide a representative sample of the entire area under investigation. Abundance estimates require a number of quadrat samples to ensure more accurate results. Accurate data is needed and the techniques need to be consistent.

\[
\text{Abundance} = \frac{\text{Total number of species} \times \text{Percentage cover of species}}{\text{Total area of the quadrats}}
\]

**Purpose** To sample abundance of at least two organisms in adjacent habitats of the ecosystem.

**Method** (describe the method alongside each of the prompts)

Size of quadrats used ______________ The number of quadrats sampled _______________

Placement of quadrats ____________________________________________________________

Alignment of quadrats ___________________________________________________________

Species half in/out? _____________________________________________________________

The two adjacent habitats Habitat 1 ___________________ Habitat 2 ___________________

**Data** Table no. ____ Title ____________________________________________________

<table>
<thead>
<tr>
<th>Species</th>
<th>mean density (plants per m²)</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Habitat 1</td>
<td>Habitat 2</td>
</tr>
</tbody>
</table>

**Conclusion** Compare and describe the abundance of species in the adjacent habitats.

____________________________________________________________________________

____________________________________________________________________________

Other significant species.____________________________________________________________________________

Hypothesis to explain your observation including a single factor that can be tested.

____________________________________________________________________________
Measuring Distribution

**Background Information** Distribution or where a species occurs is measured using a transect. A transect is a straight line along which observations are made in a systematic manner. Transects may be used to relate patterns of zonation to environmental factors.

Two types of transect may be used:

1. A line transect where individual plants or seashore invertebrates touching a measuring tape stretched across an area are recorded at regular intervals for example every 1 cm or 10 cm.
2. A belt transect where one side of the quadrat frame lies next to the tape. The placement of the quadrats along the tape is repeated at regular intervals.

**Purpose** To test an hypothesis designed to explain the different abundance of species in two adjacent habitats and measure at least one variable suspected of influencing the zonation.

**Method** (describe the method alongside each of the prompts)

Length of transect __________________ Belt or line transect? ____________________________

Size of quadrats if a belt transect _______ Interval between sampling _________________

Species being recorded _____________________________________________________________

Animal data being collected _______________________________________________________  

Abiotic factor/s being measured ___________________________________________________

Draw and label a section of your transect starting at the origin, show distances along the tape, the interval between points, the numbering system for sampling points and the quadrat sizes.

**Data** Table no. ____ Title ________________________________________________________

<table>
<thead>
<tr>
<th>Species</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0

<table>
<thead>
<tr>
<th>origin</th>
<th>quadrat</th>
<th>tape measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Data (continued) Table no. ____ Title ____________________________________________

### Site Map

Draw a site map showing zonation, name of the site, North, significant natural and built features and other information such as direction slopes face.

<table>
<thead>
<tr>
<th>Abiotic Factor</th>
<th>Measurements for quadrat number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Animal species</th>
<th>Abundance of animals for quadrat number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

41
Presenting the Data  The abundance of each species recorded for each quadrat should be represented as histograms. Abiotic factors recorded along the quadrat should also be represented as histograms. Prepare as many histograms as possible on the page.

On each histogram, write headings for species of plants, animals and the abiotic factor/s being measured. Label the axes. Axes for several histograms have been drawn for you.
Reporting on Distribution

1. Describe the vegetation along the transect, mention dominant species in different zones and the patterns of distribution. Also comment on transitions, that is where zones merge.

2. Describe relationships between the vegetation and the distribution of animals.

3. Describe changes or gradients in abiotic factors along the transect. Identify possible relationships between abiotic gradients and zonation of vegetation.

4. To what extent can the pattern in vegetation be explained by human activity and related biotic factors. Consider past and present human activities.

5. Write the original hypothesis that was being tested.

6. Explain whether your original hypothesis can be accepted or rejected.

7. Discuss possible changes to the original hypothesis, the experimental design or the techniques that were used.
Abundance of a mobile animal

**Capture—recapture.** This procedure involves capturing, marking, releasing and recapturing animals to estimate the size of an animal population. The capture and marking of the animals must be done so no harm comes to the animal.

**Techniques for capturing animals include:**
1. Tree/brush shakes for invertebrates
2. Light traps for invertebrates
3. Use of nets for freshwater and grass invertebrates
4. Use of pooters
5. Tullgren funnel
6. Pitfall traps

**Marking the animals** may be done with a small dab of paint.

**Formula used to estimate population size is:**

\[ N = \frac{n_1 \times n_2}{m} \]

\[ N = \text{the population} \]
\[ n_1 = \text{the number of individuals caught during the first trapping} \]
\[ n_2 = \text{the number of individuals caught on the second trapping} \]
\[ m = \text{individuals recaptured on the second trapping} \]

Species being sampled is _______________________________________________________

Technique used to capture animals _____________________________________________

Method of marking animals ____________________________________________________

**Data collected and calculations**

\[ n_1 = \]
\[ n_2 = \]
\[ m = \]
\[ N = \]

**Interpreting the data**

1. Discuss the validity of the results if animals move in and out of the sampling area.

____________________________________________________________________________

____________________________________________________________________________

2. The mark on the animals must be small and match the colours of the habitat. Why?

____________________________________________________________________________

____________________________________________________________________________

3. Discuss the random sampling is important in obtaining valid results.

____________________________________________________________________________
Interrelationships Between Species

Write a definition and give an example of each of the interrelationships between organisms. Use examples from the ecosystem being investigated.

**Allelopathy** Definition __________________________________________________________
____________________________________________________________________________
Example _____________________________________________________________________
____________________________________________________________________________

**Parasitism** Definition __________________________________________________________
____________________________________________________________________________
Example _____________________________________________________________________
____________________________________________________________________________

**Mutualism** Definition __________________________________________________________
____________________________________________________________________________
Example _____________________________________________________________________
____________________________________________________________________________

**Commensalism** Definition ______________________________________________________
____________________________________________________________________________
Example _____________________________________________________________________
____________________________________________________________________________

**Extension** A student observes the introduced species *Chrysanthemoides monilifera* or Bitou Bush grows in extensive patches with few other species. The student has read a report on allelopathy and suspects that Bitou Bush may release allelopathic substances.

Write an hypothesis that could be used to test this observation.
____________________________________________________________________________
____________________________________________________________________________

Write a method of testing this hypothesis.
____________________________________________________________________________
____________________________________________________________________________
Trophic Interactions of the Ecosystem

1. Match the terms used in describing trophic (to do with food) interactions in the ecosystem with the correct definitions.

   Producer or autotroph: Animals, fungi and bacteria that breakdown and absorb dead material.

   Primary consumer: Movement of energy as one organism is consumed by an organism of a higher trophic level.

   Secondary consumer: The linking of related food chains to demonstrate more complicated feeding relationships.

   Tertiary consumer: Feeding levels

   Decomposers: Green plants produce their own food from carbon dioxide and water, using sunlight.

   Trophic level: Animals that eat the producers.

   Food chain: Animals that eat the secondary consumers.

   Food web: Animals that eat the secondary consumers.

2. Draw and label organisms at each trophic level for the ecosystem you have investigated.

   Link the organisms to show the variety of food chains that exist, creating a food web. The arrows move from the prey to the predator. Each arrow means "is eaten by."

```
producers
  ↓
primary consumers
  ↓
secondary consumers
  ↓
tertiary consumers
  ↓
decomposers (eg, fungi, bacteria)
```
The one way flow of energy through the ecosystem

As energy that was originally trapped by plants moves from one trophic level to the next much of the energy is lost. This energy is released through respiration. Therefore each consumer needs to have a large number of organisms to eat. As a result, movement from one trophic level to the higher order consumers causes a reduction in biomass (living matter) at each trophic level. This reduction in biomass can be represented by a biomass pyramid.

1. Complete the biomass pyramid for the ecosystem you have investigated by writing in the names of organisms that fit into each of the trophic levels.

   | tertiary consumers |
   | secondary consumers |
   | primary consumers |
   | producers |

The recycling of nutrients in an ecosystem

Elements such as nitrogen, carbon, phosphorus, sulfur and calcium are essential to living things. These elements are transferred from one organism to another through predator/prey relationships. These elements are not used up by living things and are not reduced as they pass from one organism to another. These elements are recycled by decomposers.

Diagram of nutrient and energy movements through an ecosystem.

1. List organisms for the ecosystem you are investigating that would fit into
   A ............................................................................................................. and
Pollution

1. Classify and list the pollution that you have observed in the ecosystem.

Water

Land

Air

2. Identify and write the possible sources of three of the forms of pollution listed above. Alongside each of the sources, describe the possible effects of each of the pollutants upon the ecosystem.

<table>
<thead>
<tr>
<th>Form of pollution</th>
<th>Possible sources</th>
<th>Possible effects upon the ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Rank the pollution 1–3 from most damaging to least damaging upon the ecosystem.

4. a List possible solutions to the problem you have identified as the most damaging.
   b Suggest advantages and disadvantages of each solution.

<table>
<thead>
<tr>
<th>Possible solutions</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Digital Photos

The photos used in this resource are available as JPEG files on another disk that can be purchased disk with this program. Students and teachers can import these photos into reports or as a focal point for recounts and discussion.