# Levels 9/10 Science Activity

## Habitat Modelling Following Fire

## Introduction to Numeracy in Science

Mathematics, science, and technology are so pervasive in everyday life that it is important for students to be literate in each of these areas. A scientifically literate person has the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in society, and economic productivity. Clearly, scientific literacy is linked to the application of mathematics in science. In the Victorian Science Curriculum, scientific literacy is addressed in the Science Inquiry Skills, where students are expected to make measurements and to collect, represent, and interpret data. The term for the use of such mathematics in everyday life, and the ability to appraise the use of mathematics for appropriateness, is *numeracy*. Numeracy is considered as one’s ability use, interpret, and communicate mathematical information and ideas. It is seen as a general capability, whereas mathematics is a body of knowledge. To be numerate is to confidently and effectively use mathematics to meet the everyday demands of life (Goos et al., 2019). Numeracy involves the affective dimensions of confidence with mathematics, cultural appreciation, interpreting data, and logical thinking (Ruthven, 2016). The focus is on understanding the cultural scope of quantitative reasoning and developing critical habits. Numeracy extends well beyond the foundational components of mathematics that are more central to arithmetic (Ruthven, 2016).

Numeracy in science is about solving numerical problems and understanding the ways in which numerical information is gathered by counting and measuring. Numeracy also involves understanding how data are analysed, described, and presented in graphs, charts, and tables. Thus, there is a wide range of knowledge, skills, behaviours, and dispositions relevant to science that is enhanced through developing numeracy.

A short audit of the numeracy demands relating to these understandings in Science Levels 7 to 10, as preparation for success in Levels 11 and 12 Sciences (Biology, Chemistry, Environmental Science, Physics, and Psychology), highlighted the following six competencies:

1. Gather data by making observations and taking measurements
2. Process data using calculation, tabulation, and graphing skills
3. Interpret data by identifying patterns and trends
4. Calculate and predict values
5. Make judgments about accuracy of data
6. Consider issues of uncertainty and reliability

In upper primary school, the science curriculum involves the students’ mathematical knowledge and thinking processes. Levels 7 to 10 teachers are expected to build on these processes through developing students’ science inquiry skills. There is an increasing importance of:

1. Creating visual representations to display and describe data
2. Interpreting data
3. Providing explanations for results
4. Understanding social and cultural conditions that impact explanations

In science, numeracy involves the full range of mathematical capabilities: understanding, fluency, reasoning, and problem-solving. These mathematical ways of working are essential as the science concepts and investigations become increasingly more complex, subtle, and sophisticated. For example, being able to predict, to include the possibility of chance, and to measure and generalise from evidence, are the foundational skills of scientific inquiry and have been consistently across all societies throughout history.

## Developing Numeracy Understanding in Science

Teachers are required to provide opportunities for students to develop numeracy skills in an applied environment. Students need to be able to generate and analyse primary data, as well as analyse secondary data. On this basis, the science curriculum is an important site for the development of students’ numeracy capabilities, contextualising numeracy in both the syntax of scientific activity and the substance of particular scientific domains. In the *Numeracy Learning Progression and Science* document(ACARA, n.d.), an outline statement of achievement standards for six numeracy sub-elements is provided:

1. Quantifying numbers
2. Operating with percentages
3. Number patterns and algebraic thinking
4. Comparing units
5. Understanding units of measurement
6. Interpreting and representing data

An exploration of the *Numeracy Learning Progression and Science* document shows that the main emphasis is in the area of data handling. Orton and Roper (2000) and more recently, Ruthven (2016), identified a disappointing scarcity of research attention to the development of numeracy through science. Rather, the research emphasis is the development of numeracy through mathematics. Thus, this mathematics research tends to guide the development of numeracy understanding in science.

Highlighted in Ruthven’s (2016) research, are the affective dimensions of confidence with mathematics and cultural appreciation, indicating an understanding of the cultural scope of quantitative reasoning is of relevance. Goos et al. (2019) argue that attitudes are critical to developing numeracy across the curriculum. All teachers should reinforce positive feelings towards mathematics, encouraging students to use their numeracy skills to interpret their scientific work. Further, data relating to students’ prior experiences, which they have generated themselves through classwork and investigations, have personal meaning, which will also contribute to a more positive attitude towards the use of mathematics.

Numeracy in science is not just using mathematics to understand science (i.e., mathematicising science). Instead, it can be considered to be a two-way process (New Zealand Ministry of Education, 2019) to develop students’ numeracy and mathematical skills, by changing information from text to data and data to text. There are several ways that a teacher can do this, by having their students:

* Interpret data in a table or on a graph to describe apparent trends
* Identify information in text and representing it as a table or graph
* Use information from text to solve a scientific problem

As a science teacher, it is important that your lessons assist students to develop their numeracy capabilities. In order to support students’ numeracy development in science, it is important to:

* *Develop students’ mathematical and numeracy confidence* – teachers may have emphasised a right or wrong answer during prior mathematics learning experiences. By considering and fostering the development of Dweck’s (2006) growth mindset, students who have struggled in mathematics in the past, can become more confident in using mathematics and increase their belief in their mathematical abilities.
* *Improve the perception of mathematics* – teachers can help students to recognise that mathematics derives from sensible concepts and ideas and underpins much of what we do in science and real life. As such, teachers will challenge perceptions that mathematics is abstract, and unrelated to real life.
* *Use and explain mathematical language* – the use of mathematical conventions, symbols, and interpretation can be cryptic to many students. Misunderstanding may develop due to the presence of homonyms in mathematics (e.g., volume: the amount of three-dimensional space that an object takes up) that mean something quite different in science (e.g., volume: perception of loudness). Teachers should always explain terms, especially where they have multiple meanings.
* *Increase students’ familiarity with mathematical concepts and skills – s*tudents may not have familiarity with a mathematics concept, which can cause problems for the science teacher who might assume that students understand the concept.

## Lesson Plan: Habitat Modelling Following Fire

To understand the impact of ecosystem regeneration following a catastrophic occurrence, mathematical modelling is readily available through the use of computer animations. In this activity, students will explore the regeneration of the spinifex mallee of south-eastern Australia following fire damage. An animation of an ecological study is available at [https://ianluntecology.com/2014 /05/25/animated-fire-ecology/](https://ianluntecology.com/2014%20/05/25/animated-fire-ecology/). Researchers surveyed over 500 sites across 100,000 square kilometres of tree mallee. The sites last burnt from 1 to over 160 years ago. Ecologists counted thousands of reptiles, mammals, plants, and birds. Habitat features (e.g., tree heights, leaf litter, fallen logs, grass species) were measured. In the laboratory, ecologists analysed the data to see when – in the decades after fire scorched the landscape – each species and habitat feature is most and least abundant. Ecologists have used modelling to examine factors that affect the population sizes of the legless lizard (*Delma australis*) following the destruction of its habitat by fire.

In the following activity, students focus on this modelling. In the animation, change over time for habitat features and the abundance of *Delma* *australis* (legless lizard) are shown.

## Prerequisite/Corequisite Knowledge: Science

* Understanding of an Australian mallee habitat
* Understanding of the ferocity of an Australian bush fire
* Familiarity with animal habitats in the Australian bush
* Familiarity with the amount of time needed for post-fire regeneration

## Background Mathematical Skills and Understandings

Science teachers are not expected to teach the mathematical knowledge and skills that students will draw on when engaging with this activity. The students will have learnt and should be adept with the required mathematical knowledge and skills to complete the activity. According to the Victorian Curriculum Mathematics, the required mathematical knowledge and skills should have been developed in earlier years of schooling, that is, by the end of Level 8.

For this activity, the background mathematical knowledge and skills needed to complete the activity are:

* Knowledge of column (bar) graphs
* Knowledge that data can be represented in different ways (including via the use of technology) to provide the same information
* Interpretation of changes in the height of columns in a column graph over time
* Identification of maxima and minima of column graphs over time
* Interpretation of the relationship between the changing height of columns in a column graph and time
* Comparison of the relationships between time and the heights of columns in multiple column graphs

## Lesson Description

In this lesson, students explore habitat modelling and will need to work in pairs.

Ensure that each pair of students has access to their own animation to investigate. It is important the students can stop and start the animation when they need to do so. If you can only run the animation on a projector, then ensure that you extend the time of the analysis to allow each pair to do their analysis, controlling the speed if necessary. There are two animations on the *Ian Lunt Ecology* website ([https://ianluntecology.com/2014 /05/25/animated-fire-ecology/](https://ianluntecology.com/2014%20/05/25/animated-fire-ecology/)). Use the first one to familiarise the students with the animation. The students will use the second one to do their own analysis.

1. Start a discussion using the first of the two animations – mallee post-fire habitat changes (This animation has logs as a habitat feature in the right-hand column). Discuss that the animation presents each of seven habitat features, showing what occurs as their values increase and decrease over a 110-year time period.
* Discuss each habitat feature to ensure that students understand the terminology and what each feature entails (e.g., What is stem density? What are live hollows?). Clear descriptions are provided on the website.
* Discuss the obvious trends, like tree height and bark, and the not so obvious trends, like logs. In the discussion, discuss why some trends are as we might expect, whilst other trends are not.
* Discuss the red line, which indicates the maximum level that a habitat feature reaches over time (the vertical scale).
* Discuss the red line that is the year counter (the horizontal scale) and make students aware that, in their analysis, they will need to consider the approximate year on the horizontal scale in conjunction with the level of habitat maturation (e.g., tree cover matured after 70 years).
1. Once you feel that the students are comfortable analysing the seven habitat features over time, instruct the pairs to analyse the second of the two animations – mallee fire, habitat, and *Delma australis* (This animation has *Delma australis* in the right-hand column in red).
* Have the students respond to the following questions:
* Is *Delma australis* an early riser or a late starter? (*Early riser* is the term used to signify a species, plant or animal, that responds to regeneration soon after a fire has impacted upon the habitat. *Late starter* is the term used to signify a species, plant or animal, that responds to regeneration slowly after a fire. It requires its habit to return before it can begin to flourish.).
* When does *Delma australis* downsize? (*Downsize* is the term used to signify when there is a population decline – i.e., the number of a particular species decreases).
* What do you think causes the *Delma australis* to downsize?
* With which habitat feature is *Delma australis* most closely associated?
1. Select a few students to report their answers to the class.
2. Conclude the lesson with a predictive question: If a fire rages through a Mallee habitat in Victoria later this year, what will happen to the *Delma australis* populations in the area – both short term and long term? On what evidence do you base your answer?

Table 1: Links to the Victorian Curriculum – Science

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| --- | --- | --- |
| Strand and Sub-Strand (if applicable) | Content Description (Code) | Elaboration(s) |
| Science Inquiry Skills | Construct and use a range of representations, including graphs, keys, models and formulas, to record and summarise data from students’ own investigations and secondary sources, to represent qualitative and quantitative patterns or relationships, and distinguish between discrete and continuous data (VCSIS137) Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence (VCSIS138) | Using spreadsheets to present data in tables and graphical forms and to carry out mathematical analyses of dataDesigning and constructing appropriate graphs to represent data and to look for trends and patternsExploring relationships between variables using spreadsheets, databases, tables, charts, graphs and statisticsDescribing data properties (for example mean, median, range, outliers, large gaps visible on a graph) and their significance for a particular investigation sample, acknowledging uncertainties |
| Science Understanding | Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (VCSSU121) | Exploring interactions between organisms, for example: predator/prey, parasites, competitors, pollinators and disease vectorsUsing modelling to examine factors that affect population sizes, for example: seasonal changes, destruction of habitats, introduced speciesInvestigating how ecosystems change as a result of environmental change, for example: bushfires, drought and flooding |

Table 2: Links to the 21st Century Numeracy Model (Goos et al., 2014)

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| Aspect of the Model |  How This Aspect is Addressed by the Lesson |
| Attention to Real-Life Contexts* Citizenship
* Work
* Personal and Social Life
 | Students will apply mathematics relevant to interpreting mallee scrub regrowth following fire destruction. Reading, hypothesising, and analysing the animation modelling are the context for numeracy in this activity. |
| Application of Mathematical Knowledge* Problem Solving
* Estimation
* Concepts
* Skills
 | Students can make use of, and sense of, the mathematics represented in the animation – percentage, time, and proportion. Students will observe a time scale of 110 years, interpret changing percentage of habitat maturation, and predict impact and recovery times (in years).  |
| Use of Tools* Physical
* Representational
* Digital
 | Students will use digital tools (computers, iPads, etc.) to explore data presented using representational tools (column graphs). |
| Promotion of Positive Dispositions* Confidence
* Flexibility
* Initiative
* Risk
 | Students will feel confident to show initiative to interpret the modelling animation of seven bars changing simultaneously over time. Students will engage with, and then persist, when challenged by graphical representations of authentic scientific data. The links to real life phenomenon will enhance their disposition towards mathematics. |
| Critical Orientation* Interpreting Mathematical Results
* Making Evidence-Based Judgements
 | Students will develop an interpretive, evaluative, and analytical stance towards ecological modelling by providing explanations for the patterns observed. They will form evidence-based opinions and make judgements or decisions about mallee regeneration. Using their critical orientation to numeracy, students will be able to present alternative arguments by exploring relevant data and information in an informed way. |

## References

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