YEAR 9
CITRUS BIOSECURITY

2016 Teaching Resources
Secondary Schools

CRC PLANT biosecurity

CONTENTS

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Acknowledgments

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CRC PLANTbiosecurity

SARDI R&D SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

NSW GOVERNMENT Department of Primary Industries

Fresh Growth for your Business
Dianne Fullelove & Associates Pty Ltd

BACKGROUND

BACKGROUND

This unit of work has been designed to allow students to develop an understanding of the Australian agricultural industry and the importance of plant biosecurity in the context of integrated pest management.

AIM

This unit of work has been designed to allow students to develop an understanding of the Australian agricultural industry and the importance of plant biosecurity in the context of integrated pest management. The links between food webs are also explored. Students will undertake an insect surveillance exercise and then learn to identify the insects they collect. They will also learn how to record data and take measurements of abiotic factors.

INSTRUCTIONS

The lesson plans in this resource package are designed to cultivate a student's understanding of biosecurity by investigating what biosecurity is, in the context of a citrus cropping system, and the organisms and processes involved in biosecurity surveillance. They will also explore the concept that biosecurity is a shared responsibility and gain insight as to how biosecurity threats are reported and managed. Whilst examples have been provided on the citrus industry the package can be adapted for local agricultural situations as the principles behind biosecurity management remain the same. All required student handouts have been included and where necessary, designed to be printed back-to-back to reduce paper. Often handouts can be printed as group copies or displayed digitally for students to copy into their notes. A number of PowerPoint presentations have also been compiled to complement the resource to maximise student engagement.

LESSON 1	Overview of the Australian citrus industry
LESSON 2	Introduce the concept of Integrated Pest Management
LESSON 3	Introduce biosecurity and describe how it is applied in real world situations
LESSON 4	Students go into the field to undertake an insect surveillance exercise
LESSON 5	Students complete their field work on insect surveillance
LESSON 6 & 7	Students examine and classify the insects caught during the surveillance activity
LESSON 8	Students collate and examine their findings from the surveillance exercise

SYLLABUS OUTCOMES NATIONAL CURRICULUM

This resource is intended to meet or contribute to the following outcomes for Year 9 Science as outlined in the Australian Curriculum developed by the Australian Curriculum, Assessment and Reporting Authority, 2014.

Science Understanding - Biological Sciences Yr 9

ACSSU175 – Ecosystems consist of communities of interdependent organisms and abiotic components of the environment, matter and energy flow through these systems

Nature and Development of Science

ACSHE157 – Scientific understanding including models and theories are contestable and are refined over time through a process of review by the scientific community
ACSHE158 – Advances in scientific understanding often rely on developments in technologies and technological advances are often linked to scientific discoveries

Use and Influence of Science

ACSHE160 – People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions
ACSHE161 – Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities
ACSHE228 – The values and needs of contemporary society can influence the focus of scientific research

Questioning and Predicting

ACSIS164 – Formulate questions or hypotheses that can be investigated scientifically

Planning and Conducting

ACSIS165 – Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data, assess risk and address ethical issues associated with these methods
ACSIS166 – Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data

Processing and Analysing Data and Information

ACSIS169 – Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies
ACSIS170 – Use knowledge of scientific concepts to draw conclusions that are consistent with evidence

Evaluating

ACSIS171 – Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data

Communicating

ACSIS174 – Communicate scientific ideas and information for a particular purpose, including constructing evidence based arguments and using appropriate scientific language, conventions and representations

SYLLABUS OUTCOMES NSW CURRICULUM

This resource is intended to meet or contribute to the following outcomes for Stage 5 Science as outlined in the NSW Syllabus developed by the Board of Studies, Teaching and Educational Standards NSW, 2012.

Living World

LW1 – There are differences within and between groups of organisms; classification helps organise this diversity
LW2 – Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems
LW4 – Scientific knowledge changes as new evidence becomes available and some scientific discoveries have significantly changed people's understanding of the world
LW5 – Science and technology contribute to finding solutions to conserving and managing sustainable ecosystems

Earth and Space

ES1 – Scientific understanding including models and theories are contestable and are refined over time through a process of review by the scientific community
ES3 – Scientific knowledge influences the choices people make in regard to the use and management of the Earth's resources
ES4 – Science understanding influences the development of practise in areas of human activity such as industry, agriculture, and marine and terrestrial resource management

Questioning and Predicting

WS4 – Students question and predict by formulating questions or hypotheses that can be investigated scientifically

Planning Investigations

WS5.3 – Students choose equipment or resources for an investigation by assessing risks and addressing ethical issues associated with these methods

Conducting Investigations

WS6 – Students conduct investigations by selecting and using appropriate equipment, including digital technologies, to systematically and accurately collect and record data

Processing and Analysing Data Information

WS7.2 – Students analyse data and information by analysing patterns and trends including identifying inconsistencies in data and information; describing relationships between variables
WS7.2f – Students analyse data and information by evaluating conclusions and evidence including identifying sources of uncertainty and possible alternative explanations

LESSON 1

WHAT'S IN MY FOOD?

Aim: To capture student's interest and determine what they know about Australian crops and plant biosecurity and introduce the concept that agriculture is a human influenced ecosystem.

INTRODUCTION

- Introduce the topic of crops in Australia and ask what is a crop? What are some of the different types of crops grown in Australia?
- Show the video/s "Australian Agriculture: The greatest story never told" and/or "Farming for the Future".
- Discuss why agriculture is important to our way of life and display the population growth chart (**Lesson 1: Appendix 1**, also available as a PowerPoint presentation), note the peaks post agricultural revolutions.
- Ask students what a farmer needs to grow a crop? Answer: water, nutrients, sun, healthy plants or seed, no or low pest and disease presence.
- Discuss the implications of biosecurity and pest management on agricultural crops.
- Ask students how a farmer would know if a crop has pests or diseases?
- Add the following words to the word wall: **CROPS, AGRICULTURE, BIOSECURITY, ECOSYSTEM**.

ACTIVITY | WHAT'S IN MY LUNCHBOX?

- Distribute the **Lesson 1: What's in my lunchbox?** worksheet.
- Complete the worksheet exercises looking at the contents of student lunchboxes and diets and establishing what crops produce what types of food products. If access to student lunchboxes is not possible, discuss what the class ate for dinner last night.
- Refer to the **Lesson 1: Teacher Resource - What's in my lunchbox?** in the Background Information for support to complete this exercise.
- Consider displaying the "The Crops in Australia" PowerPoint presentation as background images whilst completing the exercise.

ALTERNATE ACTIVITY | FOOD WEBS

- Write the following terms on a set of sticky notes, cards etc.: wheat crop, locust, aphid, snail, lizard, lady beetle, earthworm, organic matter, snake, centipede, human, bird, sun.
- Take the sticky notes and place randomly on the board and ask students to arrange them from smallest to largest. Discuss food web concepts such as producer, consumer, the difference between primary, secondary and tertiary consumers.
- Pick several volunteers and award them each with a sticky note. Ask students to find what organisms they are connected to and link arms. All students should be linked by the end of the activity.
- Discuss what organisms benefit and conversely what organisms degrade an agricultural system. Discuss how this might affect the cost of farming e.g. place an up or down arrow next to each organism to demonstrate cost or benefit.
- Discuss how agricultural systems differ to natural ecosystems in terms of biodiversity and how this impacts on pest numbers.
- Add any new terms to the word wall.

CONCLUSION

- Discuss the information compiled on the agricultural industry.
- Explain that in the next lesson students will be learning more about insects and how to identify them.
- Hand out the **Lesson 1: Homework** to be completed at home.

RESOURCES

- Hard copies of **Lesson 1: What's in my lunchbox?** and **Lesson 1: Homework**
- (Alternative activity: sticky note set)
- Laptop and smart screen/projector to display videos
- Contact a local farm to organise field work for later in the program (if possible).
- Videos/presentations:
  - Australian Agriculture: The greatest story never told – www.youtube.com/watch?v=fFUZ_j2cCe0
  - Farming for the Future – www.youtube.com/watch?v=OSLNi8in2iU
  - The Crops in Australia – www.crcplantbiosecurity.com.au

NOTE

Where field work within a live commercial citrus crop is not feasible an alternative may be to conduct the insect surveillance exercise within the school agricultural plot. If a crop is not available to use (on or beyond school grounds) consider conducting the exercise on school grounds within a native garden or equivalent.

For the purposes of this unit it would herein be referred to as the "crop". The ultimate purpose of the exercise is for the students to learn what is involved in insect surveillance operations and whilst working in a live crop is ideal it is acknowledged that this is not always possible.

BACKGROUND INFORMATION

KEY MESSAGE

Biosecurity is the protection of the economy, environment and community from the negative impacts of pests and diseases. It is a shared responsibility and requires involvement from everyone in the community including the general public, producers, industry and government.

WHY IS BIOSECURITY NECESSARY?

Australia is an island nation and is naturally free from many pests and diseases that cause significant problems elsewhere in the world.

Australian agriculture interacts with domestic and international markets. Industry demands products that are free from pests and disease in order to maintain market access.

Some pests and diseases can cause severe harm to agricultural industries reducing the quantity and quality of fresh produce and increasing production costs. They can also affect human health and by employing stringent biosecurity protocols we can help prevent harm to human populations.

Australia has unique ecosystems and flora and fauna that are found nowhere else in the world. It is critically important for Australia's biodiversity to protect our natural resources.

HOW DOES BIOSECURITY WORK?

Key biosecurity goals include:

- Preventing the entry of new pests and diseases into Australia (or into a new state or region)
- Quickly finding, containing and eradicating, where possible, new outbreaks before they spread
- Managing established pests and diseases to achieve eradication where possible or at least minimise the harm they cause to industry and the environment
- Ensure that industry is equipped with appropriate surveillance, response and management strategies to respond to biosecurity threats and help to facilitate Australia's current global market access
- Continual review and improvement to Australia's biosecurity mitigation measures, particularly as new information comes to light.

THE AUSTRALIAN CITRUS INDUSTY

Australian Citrus production began in 1787 courtesy of the First Fleet settlement. Lemons, limes, oranges, grapefruit and mandarins were planted in the Sydney area and formed the basis of today's industry.

In southern regions hot dry summers and cool winter rains encourage excellent orange growth. In northern regions summer heat and humidity and dry winters are ideal for producing mandarins.

Oranges and mandarins are the main citrus fruit grown in Australia and account for around 80% of production. Lemons, limes and grapefruit make up the remainder of the industry.

Australia's citrus industry is the largest fresh fruit exporter in the Australian horticultural industry.

The citrus industry is centred primarily along the Murray and Murrumbidgee rivers with over 90% of plantings within the Riverina, Sunraysia and Riverland areas of NSW, Victoria and South Australia and the Central Burnett area of Queensland. There are also small plantings in Western Australia and the Northern Territory, as shown in Figure 1.

SCIENCE JOURNALS

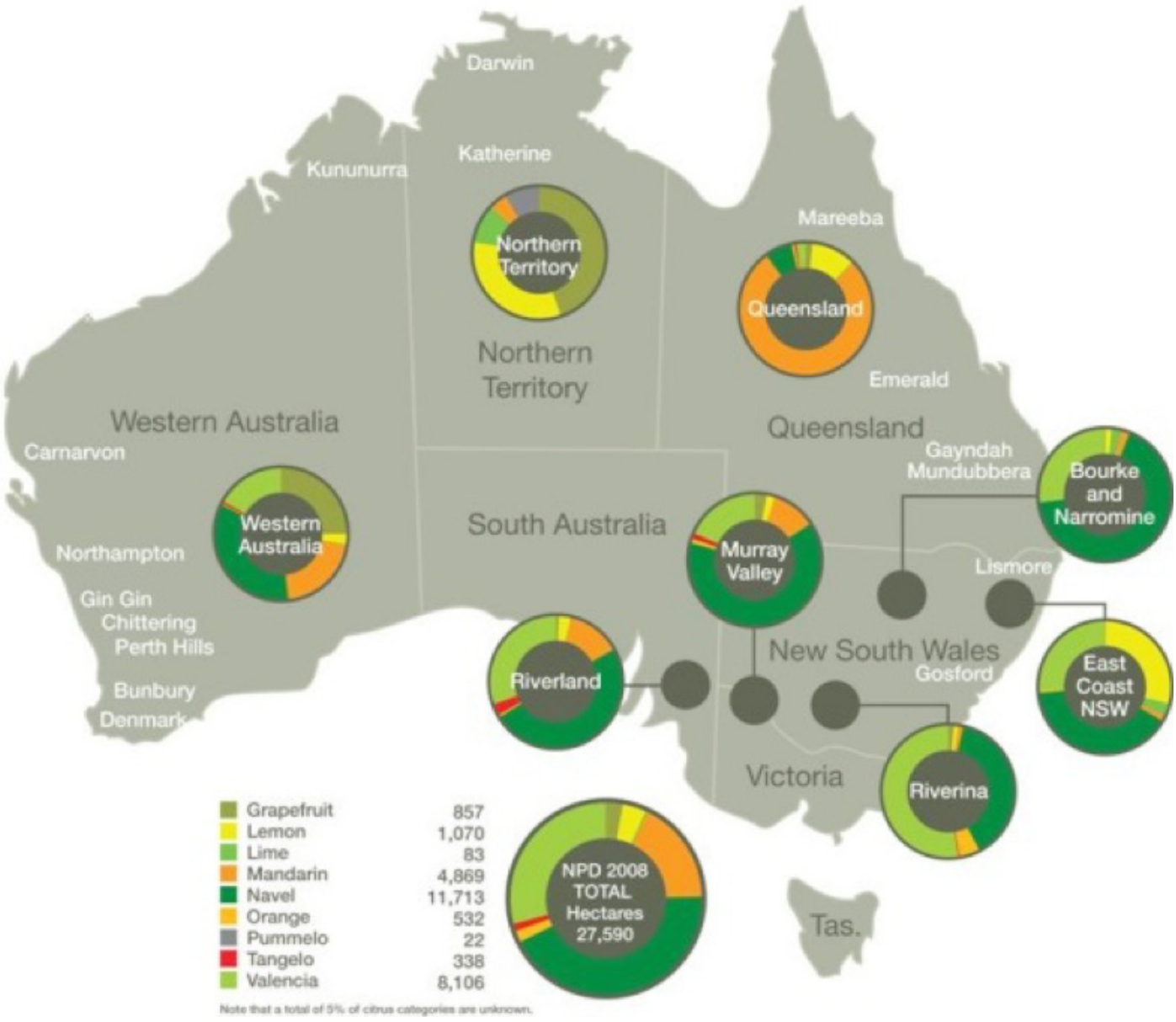
- Scientists used them to record ideas, observations, methods and results of their research.
- Provide each student with a journal at the start of the unit.
- Model a science journal entry for students: it should be dated and contain their ideas and observations. Encourage them to be creative using drawings, diagrams, tables etc.
- Make time each lesson for students to record their ideas, exercises and observations.

WORD WALLS

- An ongoing organised display of key words that provides visual reference for students throughout the unit of study.
- Gradually add new words to the wall as the unit progresses. They can be printed on cards and taped or pinned to the wall.
- Refer to the word wall during the unit, especially for assistance with spelling.

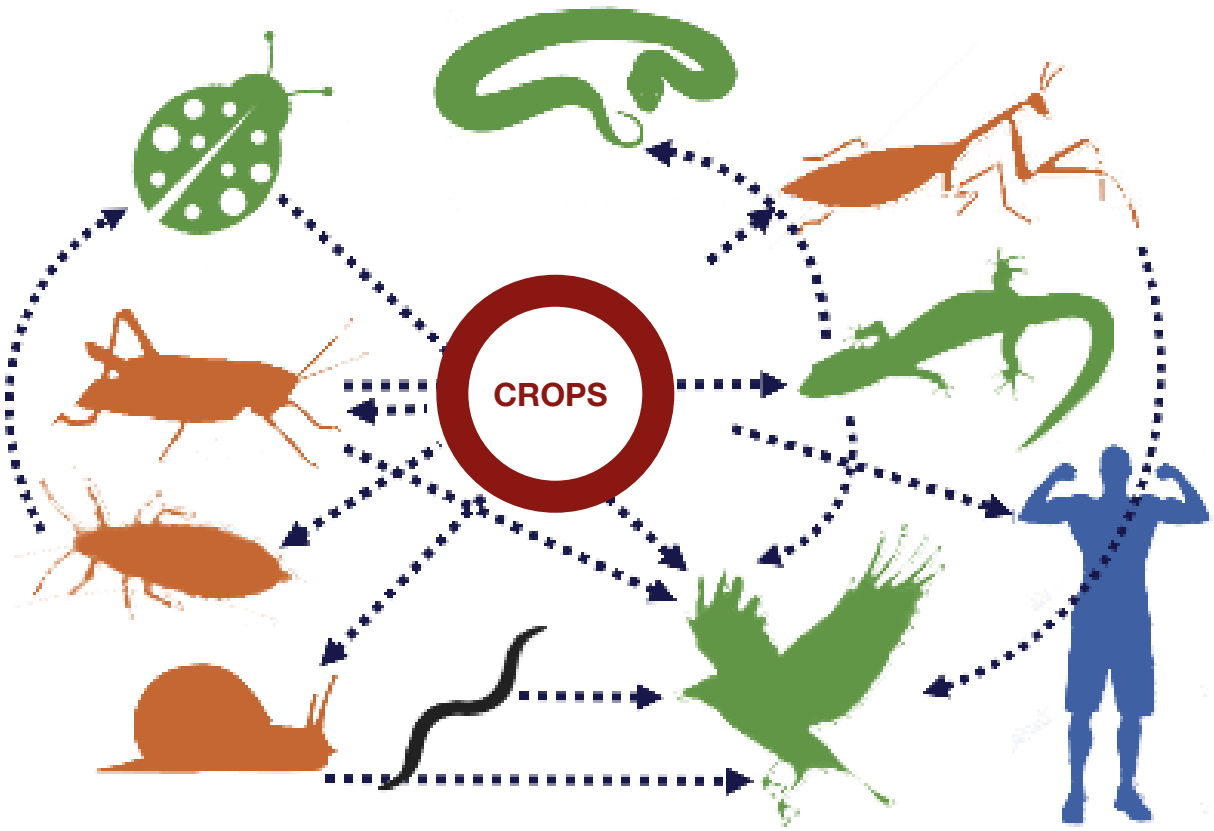
BACKGROUND INFORMATION CONTINUED

FIGURE 1: AUSTRALIA'S CITRUS GROWING REGIONS



ECOSYSTEMS – FOUNDATIONS OF AGRICULTURE

- Agricultural systems are highly modified ecosystems with significant man-made intervention. Plant and animal biodiversity are greatly skewed towards monocultures compared to natural ecosystems.
- Physical factors of ecosystems that affect agriculture include soil, climate and water supply.
- Soil is the foundation for agriculture and whilst often considered as “lifeless dirt” as little as one teaspoon could contain as many as a billion bacteria. Insects, earthworms, fungi, nematodes and protozoa all inhabit soil sustained by the nutrients provided by organic matter.
- The soil food web stores water and stores and cycles nutrients into forms that can be used by plants. Maintaining soil fertility is critical for successful agriculture.
- Continued cultivation of a single crop type deteriorates soil conditions and leads to an increase in pest and disease cycles. Crop rotation can help overcome these problems.
- A region’s climate (temperature, rainfall, humidity) contributes to the suitability of the land for agriculture. There are certain conditions that may favour one type of crop over another or even determines if any farming is possible at all.
- Agriculture depends on reliable water sources from rain, rivers and underground aquifers. Where rainfall is inadequate or unreliable irrigation is used to water fields, however if this is poorly managed it can lead to salination of the soil and depleted natural water resources (e.g. if too much river water is diverted for irrigation not enough is left to facilitate natural flows for the environment and downstream producers).
- The following illustrates a typical agricultural food web.



BACKGROUND INFORMATION CONTINUED

TEACHER RESOURCE | WHAT'S IN MY LUNCHBOX?

The following table lists some of the common foods produced by Australian crops.

Wheat	Bread, scones, pasta, noodles, breakfast cereals, cakes, biscuits, pastries, burghal, semolina, couscous, pizza crust, muffins
Barley	Pearled barley for soup, porridge, bread, biscuits, soup, malt
Rice	Cooked rice, risotto, sushi, breakfast cereals, spirits, bread, congee (rice porridge)
Maize (corn)	Tortillas, polenta, popcorn, hominy, cooked vegetable, corn syrup, cornbread, breakfast cereals (cornflakes), taco shells, cornflour (thickening agent)
Oats	Rolled oats, bread, cookies, oatmeal, muesli, snack bars
Rye	Ryebread (pumpernickel), crispbread
Millet/sorghum	Cooked grain, flat bread, porridge
Lentils	Cooked grain (common in stews and curries)
Chickpeas	Flatbread, cooked grain (used in salads, curries and stews), hummus, felafels
Peas/beans	Cooked vegetables, baked beans, fresh in salads
Soybeans	Tofu, tempeh, soy sauce, miso, soy milk, cooked grain, common food additive, vegetable oil, SoyNut butter, dairy and meat product substitutes (vegie burgers)
Sunflower	Vegetable oil, sunflower seeds
Pears	Raw fruit, juice, dried fruit, stewed
Grapes	Sultanas, fresh fruit, raisins, juice, vinegar, jam
Citrus	Fresh fruit, juice, oil used for flavouring, perfume and aromatherapy, marmalade
Sugarcane	Sugar, molasses, ethanol, bioelectricity, bioplastics

LESSON 1 WHAT'S IN MY LUNCHBOX?

Open a lunchbox within your group and write down what plant crops were used to make each item in the lunchbox. What was the most common food item?

LUNCHBOX ITEMS	DESCRIPTION	WHAT CROP(S) WAS IT MADE FROM?
eg. Rice snax	*Rice biscuits*	*Rice*

LESSON 1 HOMEWORK

Ask your parents or someone involved in the agricultural industry (e.g. farmer, crop association group) the following questions and record the answers in your Science Journal.

? What is the biggest pest found on your farm or home vegie patch? How do you control it?

? Do you have a pest monitoring program on your farm or home vegie patch? What does it involve?

? How much of the crop is lost due to pest insects?

? What do you do to stop pest insects coming onto your farm or home vegie patch?

? Do you use any beneficial insects on your farm or home vegie patch? List them and how they are used.

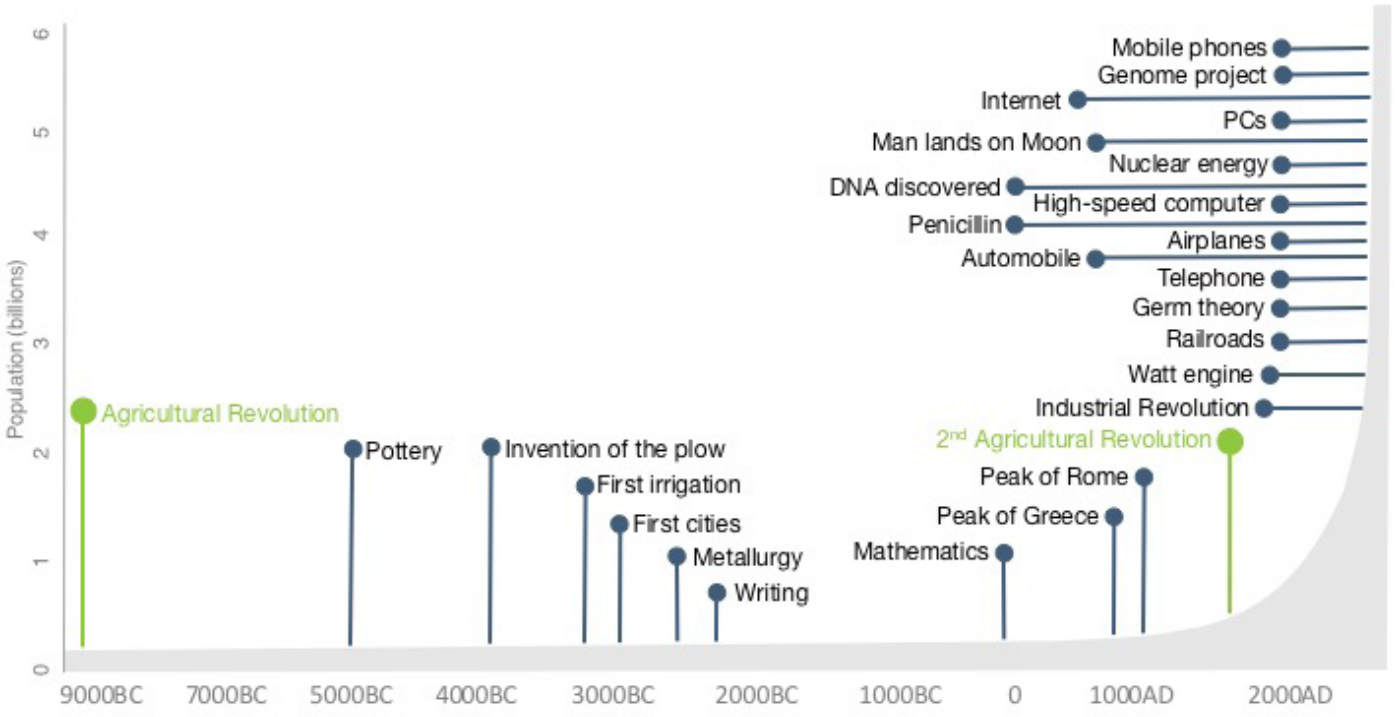
? What do pest insects mean to:
- Farmers?
- Consumers (people who eat the crop)?

? If pest insects are damaging crops how does this affect how much land we need to grow crops?

Industry group contacts for student research:

- Plant health Australia: www.planthealthaustralia.com.au/national-programs
- Citrus Australia www.citrusaustralia.com.au
- State Government Department of Agriculture in your state
- State Primary Industries in your state

LESSON 1 HUMAN POPULATION GROWTH CHART



LESSON 2

PESKY PLANT PESTS

Aim: To introduce the concepts of Integrated Pest Management (IPM) and understand the effects of pests on agricultural systems.

INTRODUCTION

- Revise Lesson 1 and why biosecurity is important to our way of life.
- Review the food web from last lesson and revise the main differences between natural and agricultural ecosystems.
- Explain that this lesson, students will explore the implications of pest insects on crops.
- Ask students:
  - Why is the control of pest insects so important in agricultural crops?
  - How does pest control affect a farmers' profit or loss for their crop?
  - What have farmers traditionally used to help control insect pests?

ACTIVITY | PEST AND BENEFICIALS

- Refer to the food web from **Lesson 1** and ask students to identify the pest and beneficial insects (pest predators). Display the PowerPoint presentation **Lesson 2: Pesky Plant Pests**. The food web is animated to display the pests and profit/loss cycle.
- Discuss the possible impacts of using chemical control methods on the different organisms in the food web. Refer to the PowerPoint presentation.
- Hand out **Lesson 2: Plant Biosecurity** worksheet and allow students time to work through as they watch the video/s "Plant Biosecurity" and/or "Use chemicals or insects to control pests?"

CONCLUSION

- As a group identify some of the pest management options available for the school farm.
- Explain that in the next lesson students will be planning for their field work. Add any new terms to the word wall.

RESOURCES

- Laptop and smart screen/projector to display video presentations to the class.
- Hard copies of **Lesson 2: Plant Biosecurity** worksheet.
- PowerPoint presentation **Lesson 2: Pesky Plant Pests.**
- Videos/presentations:
  - Plant Biosecurity – http://www.youtube.com/watch?v=NBUAsd_2vsg
  - Use chemicals or insects to control pests? – http://www.splash.abc.net.au/media/-/85206

BACKGROUND INFORMATION

STATE GOVERNMENT BIOSECURITY LINKS

- http://www.dpi.nsw.gov.au – NSW Department of Primary Industries
- http://www.agriculture.vic.gov.au – Vic Department of Agriculture and Water Resources
- http://www.daf.qld.gov.au – Qld Department of Agriculture and Fisheries
- http://www.pir.sa.gov.au – SA Primary Industries and Regions
- http://www.agriculture.gov.au – ACT Department of Agriculture and Water Resources
- http://www.nt.gov.au/d/Primary_Industry - NT Department of Primary Industry and Fisheries
- http://www.agric.wa.gov.au – WA Department of Agriculture and Food
- http://www.dpiwe.tas.gov.au/agriculture - Tas Department of Primary Industries, Parks, Water and Environment

ONLINE IDENTIFICATION RESOURCES

- www.mypestguide.agric.wa.gov.au – MyPestGuide app
- www.planthealthaustralia.com.au/wp-content/uploads/2015/01/Biosecurity-Manual-for-Citrus-Producers.pdf - Citrus Biosecurity Manual
- www.youtube.com/watch?v=xzLezgU3MiY
- www.ento.csiro.com.au/education/key/couplet_01.html - CSIRO key “how to”
- www.ento.csiro.au/education/glosary.html - CSIRO key glossary
- www.ento.csiro.au/education/about.html
- www.qm.qld.gov.au/microsites/wild/identify-insects.asp
- www.dpi.nsw.gov.au/agriculture/horticulture/citrus/health
- www.agric.wa.gov.au/pest-insects/citrus-pests
- www.ces.ncsu.edu/depts/ent/notes/O&T/production/stickycard/sticky.pdf

LESSON 2 PLANT BIOSECURITY

WHAT IS PLANT BIOSECURITY?

WHY IS FARM BIOSECURITY SO IMPORTANT?

WHAT ARE SOME SIMPLE STEPS THAT FARMERS CAN TAKE TO ENHANCE THEIR PLANT BIOSECURITY?

NAME A PEST THAT BIOSECURITY OFFICERS ARE TRYING TO STOP THE SPREAD OF AND WHY?

WHAT SHOULD FARMERS DO IF THEY SEE SOMETHING DIFFERENT THAT THEY HAVEN'T SEEN IN THEIR CROPS BEFORE?

LESSON 3

THE THREAT EXPOSED

Aim: Students will gain an understanding of biosecurity in the real world and the need for pest surveillance. Students will also prepare their insect monitoring traps for next lesson.

INTRODUCTION

- Explain to students that this lesson they will be exploring the effects of pests on agricultural ecosystems and the importance of surveillance and eradication programs.
- Scientists called Biosecurity Officers are employed across Australia to help detect new pest populations and help protect Australian farming systems. Biosecurity Officers use a range of sampling techniques, including trapping, to identify if pest species are present in a given area. If they detect new pests, steps are taken to eradicate that pest population before it has a chance to spread and cause harm to the agricultural industry.
- Ask students why is it important to identify and locate exotic insects early in their arrival to Australia? What would happen if this type of surveillance was not done? (you could provide examples of past pest introductions such as rabbits, foxes, cane toads).
- Explain that the class will be conducting a trapping exercise using pitfall and sticky traps. Discuss what type of insect may be trapped by both of these designs.
- Explain that a range of environmental parameters are recorded when conducting scientific work and ask students to brainstorm what kind of data can be collected in the field e.g. temperature, location, crop type and growth stage, humidity, wind speed and direction, height of the sticky trap from the ground.

ACTIVITY | SURVEILLANCE

- Add **BIOSECURITY, SURVEILLANCE**, and **ENTOMOLOGIST** to the word wall.
- Show the video “Collect Insects – Pitfall Traps” and demonstrate how to construct the pitfall traps.
- Hand out **Lesson 3: Field Work Planner** worksheet and allow students time to gather all of their required equipment for the trapping exercise. They will need to construct their trap labels (2 for each trap) and they will also need to prepare the pitfall trap lids. At this time, you can also display the PowerPoint presentation **Lesson 3: Field Work Planner**.
- Display the PowerPoint presentation **Lesson 3: Insect Identification** in preparation for the classification exercise to familiarise students with the classification process

CONCLUSION

- Explain to students that in coming lessons they will be acting as citizen scientists by conducting surveillance within a local crop (or the school).
- As a group brainstorm the types of environments insects live and what may make a good trap location for the coming surveillance exercise. Alternately identify what wouldn’t make a good trap location.

RESOURCES

- Hard copies of **Lesson 3: Field Work Planner** worksheet.
- Laptop and smart screen/projector to display videos and presentations.
- Field equipment as listed in **Lesson 3: Field Work Planner.**
- Videos/presentations:
  - Collect Insects: Pitfall Traps – www.qm.qld.gov.au/microsites/wild/collect-insects.asp
  - PowerPoint presentation: **Lesson 3: Field Work Planner**
  - **Lesson 3: Insect Identification.**

BACKGROUND INFORMATION

INSECT COLLECTION RESOURCES

www.qm.qld.gov.au/microsites/wild/index.asp

www.extension.entm.purdue.edu/401Book/default.php?page=home

www.ento.csiro.au/education/collecting.html

www.australianmuseum.net.au/Uploads/Documents/9382/The%20Invertebrate%20Collection%20Manual.pdf

INSECT IDENTIFICATION

There are hundreds of thousands of insect species around the world but they are all classified using the same basic process looking at key features common to the insect world. The diagram below depicts a "typical" insect. An insect has a 3-part body plan comprised of a head, thorax and abdomen. Many insects have wings; some have 1 pair others have 2 pairs some have none at all. Most insects have eyes and antennae and 6 segmented legs.

Although insects share the same basic body plan there are multitudes of combinations related to the habitat and food resource of each particular species and often include variations of the basic body plan such as reduced, highly modified or absent characteristics. When identifying insects, common components that are referred to include the:

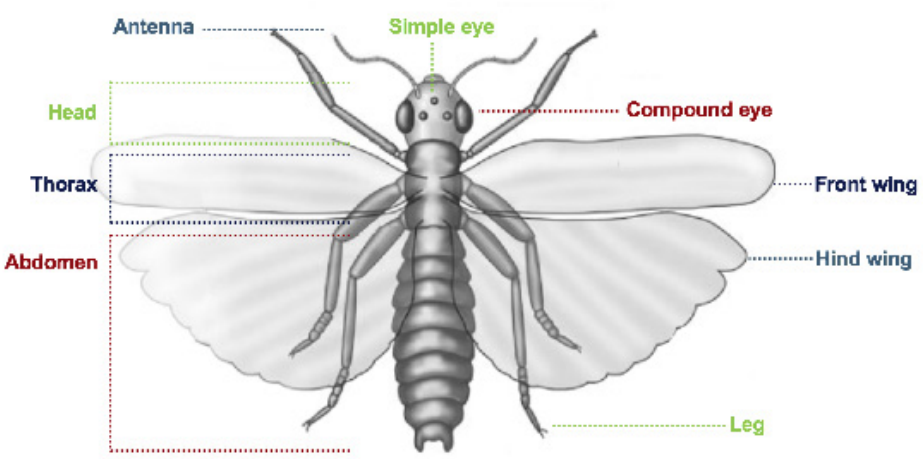
- Wings – number, type and appearance
- Mouthparts – broadly chewing or sucking
- Presence of appendages such as cerci
- Modified body parts unique to that type of insect e.g. enlarged legs for jumping in the case of grasshoppers
- Antennae – size and style.

These basic steps will at least identify the insect in question to Order level. Factors such as size, shape, colour etc. are not considered until classifying down to genus or species level. The insects to be investigated during the course of this activity will only be identified down to Order level hence only an understanding of basic insect anatomy is required.

TRAP TYPES

A pitfall trap is a partially buried container that traps active ground dwelling invertebrates such as beetles, spiders and ants. The organism walks to the edge and falls in and due to the sheer sides cannot get out. Some type of liquid preservative is added to the traps to preserve specimens until collection. There are a range of designs but only one will be used for the class exercise.

A sticky trap is a flat piece of card covered in a non-drying tacky glue that is erected on a garden stake or hung from a tree. They are often yellow in colour to attract insects and generally attract active flying invertebrates, typically plant pests or their predators. Sticky traps can be purchased from hardware or garden stores and come ready to install in the field.



LESSON 3 FIELD WORK PLANNER

CHECKLIST: TRAP SETUP

- [ ] 2 pieces of plain paper
- [ ] HB pencil
- [ ] Scissors
- [ ] GPS
- [ ] Weather data recorder
- [ ] Camera
- [ ] Twist ties
- [ ] String
- [ ] Disposable gloves
- [ ] Preservative (water & detergent)
- [ ] Trowel
- [ ] 2 icecream containers with lids
- [ ] 1 meat tray
- [ ] 2-4 tent pegs
- [ ] 1 sticky trap
- [ ] 3-4 paperclips
- [ ] Box to place equipment in per group

CHECKLIST: TRAP COLLECTION

- [ ] Disposable gloves
- [ ] OHP transparency with grid
- [ ] Specimen bottles
- [ ] Cling wrap
- [ ] Fine sieve
- [ ] Long-term preservative (eg, ethanol)

LABEL PREPARATION

Create two labels for each trap:
- One for set up
- One for collection

Cut copy paper to size and write in HB pencil

- Location
- Date
- Collector's name
- Crop type/stage
- Trap type

Location: Cummins Farm
Date: 11/12/15
Collector's name: J. Smith
Crop type/stage: Oranges/flowering
Trap type: Pitfall trap

TRAP PREPARATION

Ice-cream containers
Cut a hole in the middle of 1 ice-cream lid using scissors. Leave an edge of 1-2cm. You should have one normal lid and one that looks like a donut.

Meat trays
Take the meat tray and cut off the short ends so the tray makes a tunnel along the long sides.

Sticky trap
Add the sticky trap and its labels to the equipment box.

Equipment box
Place all of the traps, labels and other equipment listed above in the equipment box.

LESSON 4

LAYING THE TRAPS

Aim: Students will work collaboratively to undertake their insect surveillance exercise. They will experience hands-on scientific methodologies such as correct sampling and labelling techniques and recording of local abiotic data.

INTRODUCTION

In this lesson the students will travel to the field work site (either a local farm or within the school grounds) to conduct the insect surveillance activity.

Explain to the class that they will be collecting insects that live within and travel through this crop. Their insect samples will then be taken back to the classroom and identified using an invertebrate key.

It is important to bear in mind that in the event the surveillance exercise is being conducted within a live crop the biosecurity needs of the farm must be taken into consideration. Further guidance on this issue is provided in the Background Information.

If time has passed since the last lesson you may need to consider replaying the video *Collect Insects: Pitfall Traps*

ACTIVITY | LAYING THE TRAPS

Travel to the field site with equipment boxes.

Upon arrival ask students what type of crop they are in and its growth stage. You may consider asking the farm manager to discuss the following:

- The crop cycle.
- What has been done to this crop so far this season?
- What and how much does this farm produce?
- What happens to the crop when it is harvested and is it destined for local or international markets?
- What insects does the farmer find most often in the crop and how do they identify them?
- What are the common pests and beneficial insects found?
- How much damage do pests inflict on this crop?
- How does the farmer manage pests within this crop e.g. chemical spraying, IPM etc.?

Hand out **Lesson 4: Field Work – Laying the Traps** worksheets among the groups and work through the labelling and trap installation procedures as outlined.

Lead a brief class discussion to decide on trap locations (refer to Background Information for guidance).

Allow students time to record their trap location (GPS coordinates) and weather data in their Science Journals. Keep a photo journal of the equipment and procedures.

CONCLUSION

Remind students that the purpose of this surveillance exercise is to identify pests within the crop and monitor for any biosecurity threats. Whilst conducting the sampling they too must assist with the biosecurity needs of the farm to ensure they are not accidentally transporting weeds, pests and diseases.

RESOURCES

- Hard copies of **Lesson 4: Field Work** – Laying the traps worksheets to each group.
- Field equipment as listed in **Lesson 3: Field Work Planner**
- Access to a local crop or the school agricultural plot/gardens and the necessary transport for that location.
- If necessary the video Collect Insects: Pitfall Traps – www.qm.qld.gov.au/microsites/wild/collect-insects.asp

BACKGROUND INFORMATION

FARM BIOSECURITY

When conducting any work on an operating farm it is vital to ensure that a few basic protocols are followed to protect the biosecurity of the property. Weeds, pests and diseases are easily and often accidentally transported around the landscape. Biosecurity protocols are designed to reduce the risk of accidental transmission. Farm biosecurity measures include:

- Adopt a “Come Clean Go Clean” policy and ensure that you, your vehicle and equipment arrive (and depart) the property free from mud, dirt and plant material.
- Do not take plant matter to or from the property, it may contain diseases and/or very tiny pest insects.
- Stick to designated roads, parking areas and paths at all times (except for when setting the traps within the crop and then only go in as far as absolutely necessary).
- If provided, utilise wash down bays and foot baths as directed by the farmer.
- Do not visit other farms immediately after conducting the field work.
- Refer to www.planthealthaustralia.com.au/industries/citrus/ for further information on grain farm biosecurity.

TRAP LOCATION

- Traps should be located between 2-5m from the edge of the crop to minimise edge effects.
- Groups should be set about 5m apart and sticky and pitfall traps (from the same group) can be placed about 1m apart.
- In citrus crops sticky traps are tied to a branch with string. The trap should be hung vertically and if possible facing into the breeze. The trap needs to be located just below the leaf line so that it doesn’t easily tangle in the branches of the tree.
- Pitfall traps must be buried so the soil surface is level with the top of the container as demonstrated in PowerPoint Presentation **Lesson 3: Field Work Planner ppt**.
- Place traps in a “typical” part of the crop i.e. not near unusual objects such as buildings, dams, powerlines, fences etc.
- Accurately record the trap location so that it may be found again at collection time.
- Record environmental parameters such as weather observations.

LESSON 4 FIELD WORK LAYING THE TRAPS

1

Location

- Decide on appropriate trap locations
- Place traps 2-5m from edge of the crop (walk between plants not on them)
- Choose a "typical" part of the crop (i.e. not near something unusual)
- Sticky traps and pitfall traps can be set about 1-2m apart
- Place each group about 5m apart

2

Labelling

- Take 2 labels from the equipment box (leave the other 2 labels for collecting the traps)
- Sticky Trap: clip label to the trap with paperclips
- Pitfall trap: place label in the trap in the preservative

3

Sticky trap

- Open the sticky trap as per the instructions on the trap (there are twist ties for this if necessary)
- Tie onto branch using string. Don't get it tangled in the tree branches
- Face trap into the breeze with long size pointing up and down

4

Pitfall trap

- Fit the ice-cream containers together one inside the other
- Firmly attach Lid 1 (with hole) onto the containers. Attach Lid 2 (no hole) over the top of Lid 1
- Dig a hole into the soil big enough to fit the trap so the top is level with the ground. Place trap into the hole and adjust if necessary
- Return soil to the edge of the container DO NOT get soil in the trap or you will have to empty and start over
- Very carefully remove Lid 2, leave Lid 1 in place
- Add preservative to the trap (at least 3 cm deep) and add label
- Cover the trap with the meat tray roof. Peg down with tent pegs or a rock

5

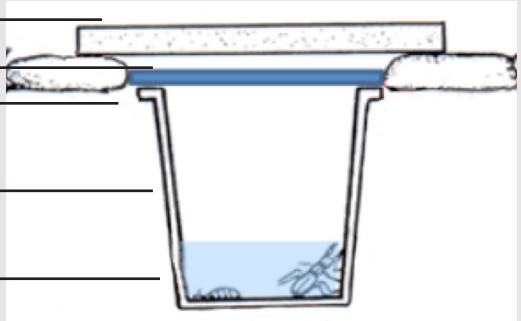
Record

In your science journal:

- Draw a map of the field site and record your trap location
- Record GPS location
- Record weather data (temperature, humidity, wind speed/direction)
- Trap data: trap owners, crop type/growth stage, date

STICKY TRAP

PITFALL TRAP



REMEMBER: Lid 2 (no hole) is removed fromthe trap once in the ground.

LESSON 5

COLLECTING THE TRAPS

Aim: Students will work collaboratively to undertake their insect surveillance exercise. They will experience hands-on scientific methodologies such as correct sampling and labelling techniques and recording of local abiotic data.

INTRODUCTION

In this lesson the students will travel back to the field work site (either a local farm or within the school grounds) to collect their traps used in the insect surveillance activity.

If time permits the students may begin sorting the pitfall trap samples ready for classification of their specimens next lesson, but this will be dependent on lesson duration and the distance to/from the field site.

Sorting can be undertaken next lesson and the traps merely stored once they are collected. Both options have been presented in this lesson plan.

Remind students of the necessary biosecurity protocols required when entering/exiting the farm.

If necessary consider replaying the *Collect Insects: Pitfall Traps* video to refresh students on how to collect the pitfall trap specimens.

ACTIVITY | COLLECTING THE TRAPS

Travel to the field site with equipment boxes.

Hand out **Lesson 5: Trap Collection Methods** worksheet and allow the class time to work through the collection exercise and record their observations.

Make sure students fill in the holes left by the pitfall traps once the traps have been removed.

As a class discuss any unexpected observations of the traps and how effective the traps appear to have been in trapping insects within the crop.

Collect all traps and equipment and return to class to either store or commence sorting the samples.

Storing the Samples

- If, due to time constraints, the specimens are not able to be sorted this lesson they need to be stored correctly in preparation for next lesson.
- Sticky Traps: place trap in an airtight container and leave in a refrigerator;
- Pitfall Traps: ensure specimens are stored within a sealable container (e.g. specimen jar) and there is enough preservative in the jar to cover all of the specimens. Leave in a cool location out of direct sunlight.

Sorting the Samples

- It is likely this will occur next lesson due to time constraints.
- The specimens on the sticky traps are not able to be removed so they do not require sorting.
- The pitfall traps are sorted for easier identification of the specimens. Sorting the specimens into “like” insects assists the students in identifying the differences between different insect Orders and also speeds up the classification process.
- Follow the instructions outlined in **Lesson 5: Sorting the Pitfall Trap Samples**.

CONCLUSION

Explain to students that they have now completed the surveillance exercise and the next step is to classify and identify their specimens in order to determine if they have discovered any pest species.

RESOURCES

- Hard copies of **Lesson 5: Trap Collection Methods worksheet** to each group.
- Field equipment as listed in **Lesson 3: Field Work Planner.**
- Video *Collect Insects: Pitfall Traps* – www.qm.qld.gov.au/microsites/wild/collect-insects.asp
- Access to the crop or the school agricultural plot/gardens used in last lesson and the necessary transport for that location.
- OHP transparencies printed with a grid (enough for 1 per sticky trap) if sticky traps have no grids printed on them. If traps have a grid on them already a roll of cling wrap is used instead of the OHP transparencies.
- If sorting the samples this lesson:
  - Science/laboratory room;
  - Copies of **Lesson 5: Sorting the Pitfall Trap Samples** worksheet for each group;
  - Equipment as listed in **Lesson 5: Sorting the Pitfall Trap** Samples.

BACKGROUND INFORMATION

Collecting the Traps

- www.qm.qld.gov.au/microsites/wild/collect-insects.asp
- www.ento.csiro/education/collecting.html
- www.australianmuseum.net.au/Uploads/Documents/9382/The%20Invertebrate%20Collection%20Manual.pdf

LESSON 5 TRAP COLLECTION METHODS

Data

In your Science Journal record:
- Date of collection
- Name of trap collectors
- Weather data
- Any unusual observations

Prepare collection labels
Be sure to collect all equipment and traps at the end.

Sticky Trap

01 Pick one student to put on disposable gloves

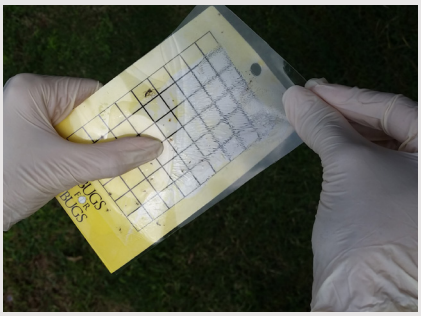
02 This person carefully removes the trap from the tree. Hold the trap with both hands at the non-sticky ends. Attach a collection label to the trap.

03 If the trap has a GRID on it take a piece of cling wrap and carefully place over the trap. Keep it as smooth as possible. Cut off any excess or fold it behind. DO NOT REMOVE once laid as this will pull insects from the trap.

04 If the trap HAS NO GRID on it, take a OHP transparency printed with a grid and place over the trap. DO NOT REMOVE once laid, as it will pull the insects off.

03

04



Pitfall Trap

01 Pour contents of trap (preservative and insects) through a fine sieve into a clean ice cream container. Wash out any soil, sticks and leaves.

02 Wash the dirty water out of the ice cream container

03 Knock the sieve against the side of the clean ice cream container. Add a long-term preservative (eg, ethanol) - just enough to cover the specimens.

04 Pour the preservative along with the specimens into a specimen jar or bottle with a lid. Secure the lid.

03

04

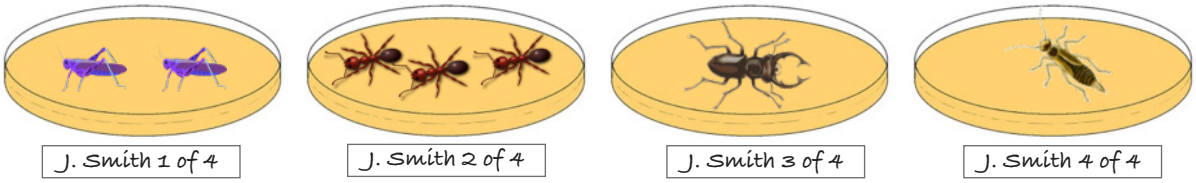
LESSON 5 SORTING THE PITFALL TRAP SAMPLES

EQUIPMENT

- Dissecting microscope with light OR 15X or 10X hand lens
- 1-2 dissecting trays
- 1-2 dissecting tool sets (straight or curved/fine needle, soft tweezers)
- 10-12 petri dishes with lids or a shallow dish
- Masking tape and fine tipped marker pen
- Long-term preservative e.g. ethanol or methylated spirits
- Specimen jars for larger insects/non-insects

METHOD

1. Gently swirl the specimen jar so that the insects are mixed into the preservative
2. Carefully pour some (preservative + insects) into a petri dish – only enough so that the insects form a shallow layer in the petri dish
3. Using a teasing needle or tweezers gently lift into separate petri dishes any large insects or non-insects such as centipedes, spiders or lizards
4. Add preservative so that those specimens are covered. NOTE: if the non-insects/large insects are too large for a petri dish place them into a specimen jar and cover with preservative
5. Under a dissecting microscope sort the insects into groups of similar looking insects and place each new group in a separate petri dish (one petri dish = one type of insect)



6. Place lids on the petri dishes and secure with masking tape (over the lid and sides) to hold it firm (**NOTE**: if classification is to happen straight after the sorting don't tape the petri dishes until the end of the lesson)
7. Label each petri dish (write on the tape with marker pen) with your name and a number each petri dish (e.g. J. Smith 1 of 10, 2 of 10 etc.) so they can be identified next lesson
8. Place all of your group's petri dishes on a dissecting tray and store out of direct sunlight until time to classify

LESSON 6

WHAT BUGS ARE IN THE SYSTEM?

Aim: Students will use an online key to classify the insects they collected in the surveillance exercise.

INTRODUCTION

Students will be using an interactive online classification key developed by the CSIRO to identify their insect specimens collected during the surveillance exercise. Insects will be identified down to Order level to provide students with an insight to the differences between different types of insects.

For the purpose of this exercise only insects will be identified. Spiders, mites, centipedes, millipedes etc. are not covered and if trapped will be set aside in the non-insects category.

The classification tool to be used is the CSIRO Online Invertebrate Key. There are additional resources provided below to assist with the insect identification process.

Due to the complexity of insect classification for the beginner, additional support can be sought from:

- A local entomologist (refer to local farming organisations that assist with pest management e.g. Elders, Wesfarmers, farm produce stores)
- Local tertiary institutions particularly if they offer entomology related subjects
- Online insect identification systems such as the MyPestGuide app developed by the Western Australian Department of Agriculture. It is a free app that can be utilised to submit insect sightings for identification.
- State government departments associated with the management of primary industries (refer to **Lesson 2** for a list of the relevant government departments around the country).

ACTIVITY | CLASSIFICATION

If the class didn't sort their pitfall trap samples in Lesson 5 refer to the notes and instruct the class to sort their samples ready for classification.

Show the videos "Hints on Identifying Insects" and "Using an online Interactive Key" to direct students how to use the online key. Refer to **Lesson 2: Appendix 2** for further assistance using a classification key.

If necessary, consider replaying the **Lesson 3: Insect Identification** PowerPoint presentation to refresh students on how to use a key.

Hand out **Lesson 6: Gotcha! Insect Classification** worksheet. It's advised to demonstrate the classification to the class as a whole before allowing independent work.

To maximise access to the microscope consider splitting the groups into pairs and divide each groups' trap contents amongst the pairs.

Provide the sorted specimens to the class and allow them to commence the classification exercise.

Insects will only be identified to Order level.

Display the CSIRO Online Invertebrate Key for the class to use or print and hand out the hard copy version in **Lesson 2: Appendix 3.**

A Grain Biosecurity Threats poster has been developed for this exercise to assist in identifying any potential biosecurity threats (although it is unlikely that any threats will be found) and a link has been provided in the Background Information for the Biosecurity Manual for Grain Producers provided by Plant Health Australia with further biosecurity threat descriptions.

Hand out the **Lesson 6: Data Sheet** for students to record the results of the classification exercise as they go. The data for each group and the class will be collated and investigated next lesson.

Where possible utilise professional assistance for this exercise. Encourage these assistants to utilise the CSIRO key the class is already familiar with to avoid confusion and improve classification competence.

CONCLUSION

Explain that of the 86,000+ known insect species in Australia less than 1% are considered to be economic pests. Classifying insects within a crop can be used to identify pest species including biosecurity threats and allow for their control.

Discuss with the class their findings. Did one type of trap work better and why? What insects were easier or harder to identify and why?

RESOURCES

- Laptop and smart screen/projector to display the videos and interactive online key.
- If possible class laptops/iPads so students can use the online interactive key alternatively use hard copies of the worksheets.
- Hard copies of **Lesson 6: Gotcha! Insect Classification, Lesson 6: Data Sheet.**
- Hard copies of **Lesson 6: Appendix 3** if required.
- PowerPoint presentation: **Lesson 3: Insect Identification**, if required.
- **Appendix 2: CSIRO Invertebrate Key.**
- **Appendix 3: Hints for using Keys.**
- **Grain Biosecurity Threats** poster – can be displayed digitally or printed and handed out to each group.

BACKGROUND INFORMATION

INSECT CLASSIFICATION

- www.ento.csiro/education/key/couplet_01.html - CSIRO Online Invertebrate Key
- www.ento.csiro.au/education/about.html - CSIRO key support
- www.ento.csiro.au/education/glossary.html - CSIRO key glossary
- www.youtube.com/watch?feature=player_embedded&v=YFNLiTPcaBU
- www.qm.qld.gov.au/microsites/wild/identify-insects.asp
- www.youtube.com/watch?v=YFNLiTPcaBU
- www.planthealthaustralia.com.au/wp-content/uploads/2012/11/Biosecurity-Manual-for-Citrus-Producers.pdf

TIME SAVING HINTS

Sticky Traps: for very tiny insects e.g. thrips, only identify and count insects in ONE vertical column – approx. number insects on trap = insects in ONE column x number columns

- Identify insects in one square of the grid at a time.
- Look over the other columns for any "different" species that may not have been within the counted column and classify them as well.

Pitfall Traps: Most "like" insects are probably in the same insect Order. Identify 2-3 "like" insects to see if they fall into the same Order, if so then extrapolate for the rest of the insects found in that grouping.

If difficulty arises classify insects as a whole class until competency grows.

The purpose of this exercise is to familiarise students with the different types of insect Orders. Rather than trying to identify each individual insect in the traps, which is a time consuming process, instead focus students' attention on identifying the different types of insects and complete the classification for as many specimens as time permits.

FIVE KINGDOM CLASSIFICATION

There are 7 levels of classification: KINGDOM, PHYLUM, CLASS, ORDER, FAMILY, GENUS and SPECIES. The highest classification level, KINGDOM, incorporates organisms that share only a few key features. Modern taxonomy recognises five kingdoms:

- Animalia (animals);
- Plantae (plants);
- Fungi (fungi);
- Procaryota (bacteria);
- Protoctista (algae, protozoans, slime moulds).

Moving down through the levels, organisms are grouped into smaller and smaller groups. Individuals within each group become more alike until one is left with a group of all the same type of organism i.e. all the same species.

LEVEL OF CLASSIFICATION	RELATED GROUPS	
KINGDOM	Animalia	Birds, mammals, worms, starfish
PHYLUM	Arthropoda	Insects, crustaceans, spiders, scorpions
CLASS	Insecta	All insects
ORDER	Hymenoptera	Bees, wasps, ants, sawflies
FAMILY	Formicidae	All ants
GENUS	*Myrmecia*	Estimated 4,000 species
SPECIES	*Myrmecia desertorum*	Only bulldog ants

LESSON 6

APPENDIX 2: HINTS FOR USING KEYS

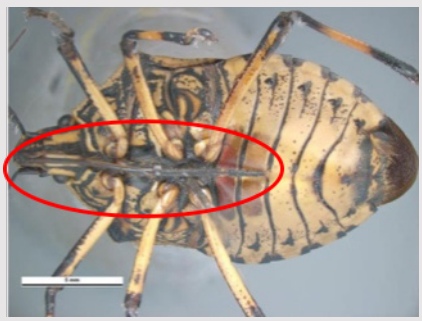
1. Do you have an adult?[1]

a) If you have a nymph of an insect that undergoes gradual or incomplete metamorphosis (e.g. grasshopper, true bug, and stick insect) some keys will work to at least Order. Nymphs may be recognised by the wing buds, or developing wings present in later growth stages.

b) If you have a caterpillar or larvae of an insect that undergoes abrupt or complete metamorphosis (e.g. butterfly, beetle, wasp, ant, beetles, flies) most keys will not work.

2. What is a "true bug"?

There is a group of insects called bugs. Not all insects are bugs, therefore we call the members of the Order Hemiptera 'True bugs' and these include aphids, leafhoppers, cicadas etc. True bugs are characterised by sucking mouthparts called a rostrum, a strong straw like structure usually held between the front pair of legs[2].



3. Does your insect have wings?

a) Can you see segments of the abdomen from above? If so, you may have an adult insect as many insects never have wings.

[1]Text and images are used with permission from the Queensland Museum's "Backyard Explorers" Leaders guide © The State of Queensland (Queensland Museum) 2010-2014) or where otherwise acknowledged.
[2]Image sourced from: www.padil.gov.au

3. Does your insect have wings continued...

b) If not, there may be wings covering the abdomen. The forewings may be hardened into protective coverings called elytra which protect membranous hindwings underneath, such as in beetles.

c) The forewings may be leathery and have the hind wings folded beneath as in grasshoppers and crickets[2]

d) Just the base of the forewings may be leathery. The forewings and hindwings fold over each other forming a cross as in some true bugs2

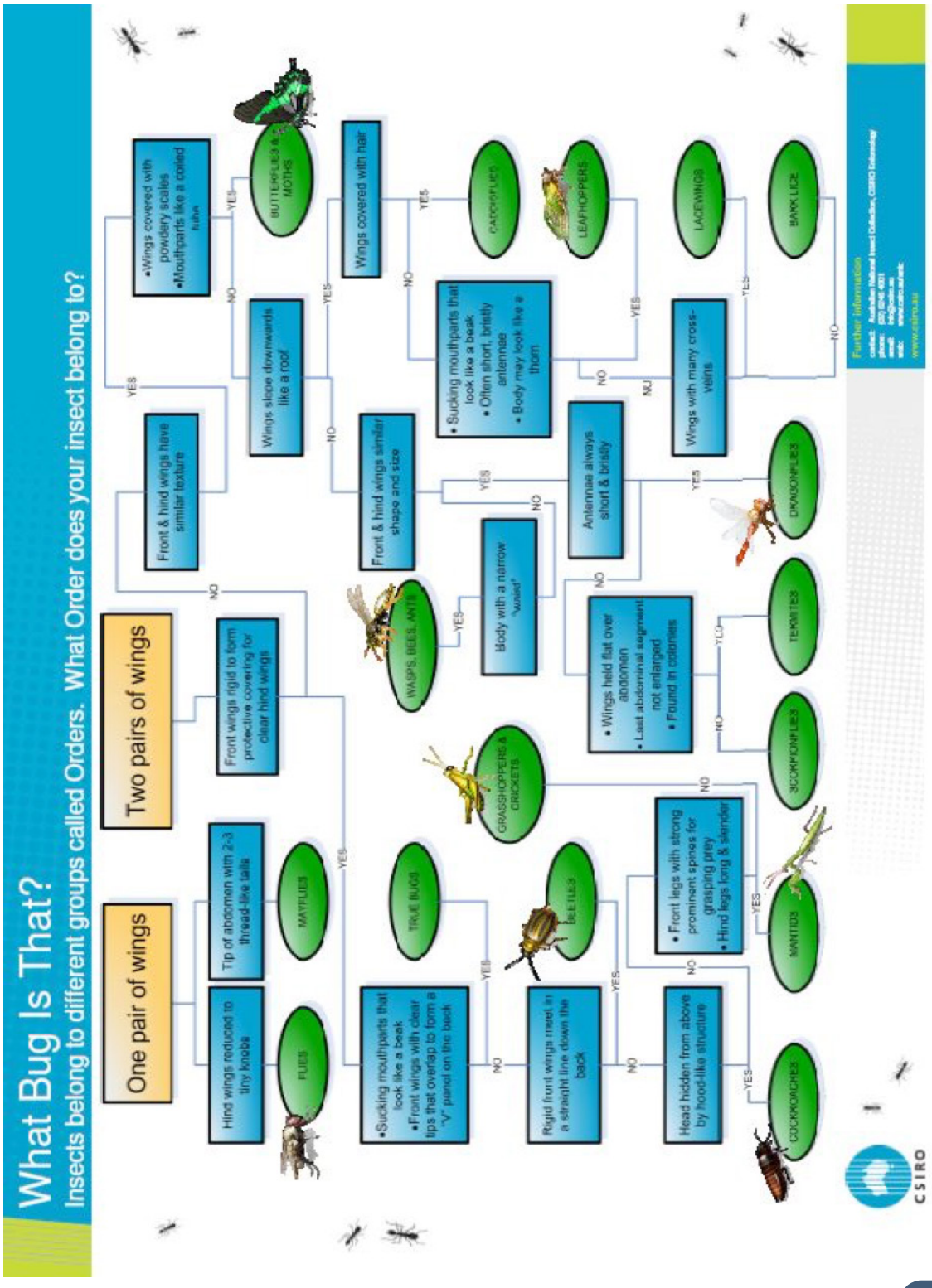
4. How many pairs of wings?

Flies and mosquitos have only one pair of wings. The hind wings have been reduced to halters (little sticks with knobs on the end behind the forewings). Wasps and bees may appear to have only one pair of wings but the 2 pairs of wings are actually hooked together2. Most other flying insects will have 2 pairs of wings.

5. What do the mouthparts look like?

Insects broadly have one of two types of mouthparts: chewing or sucking, depending on their food source. To see the mouthparts of an invertebrate you often need to look at the ventral side of the head, so turn them over. There are several variations of the sucking mouthparts including the siphon as seen in butterflies and the sponge as seen in flies.

LESSON 6 APPENDIX 3: INSECT CLASSIFICATION KEY



LESSON 6 GOTCHA! INSECT CLASSIFICATION

Equipment

- Dissecting microscope with light
- 1-2 dissecting tool sets (teasing needle, soft tweezers)
- Petri dishes of sorted insects
- Sticky traps from the field work
- Long-term preservative e.g. ethanol or methylated spirits

Sticky Trap

01 Select one column on the trap (can be any column)

02 Classify the insects found in each square of that column using the CSIRO Invertebrate Key

03 Mark off your completed squares as you go. Record your results in your data sheet

04 Calculate the total number of insects on the trap for each insect Order

05 Check the rest of the trap for any "new" insects that were not in the "counted" column. Record any new data on your data sheet

06 Be on the lookout for any biosecurity threats as found in the Biosecurity Manual for Grain Producers – Plant Health Australia

01

Pitfall Trap

01 Select a petri dish

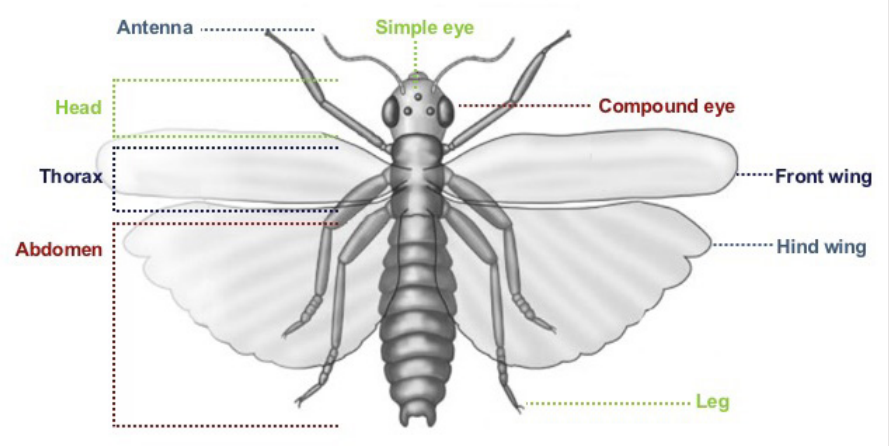
02 Classify the insects found in each petri dish using the CSIRO Invertebrate Key

03 Record your results in your data sheet

04 Calculate the total number of insects in the trap for each insect Order

05 Check the rest of the petri dishes for any "new" insects that haven't yet been identified. Record any new data on your data sheet.

06 Be on the lookout for any biosecurity threats as found in the *Biosecurity Manual for Grain Producers - Plant Health Australia or Grain Biosecurity Threat poster*



LESSON 6 DATA SHEET

Name:	Class:	Crop type:

GPS Coordinates:	Growth Stage:

Weather data:

	Trap Setup	Collection
Date:		
Temperature:		
Wind speed:		
Humidity:		

Trap Type:	Insect Order:	Common name:	Number collected:

ST: Sticky trap
PT: Pitfall trap

Trap Type:	Insect Order:	Common name:	Number collected:

Total number of insects collected: Pitfall traps: _____ Sticky traps: _____

LESSON 7

WHAT BUGS ARE IN THE SYSTEM?

Aim: Students will use an online key to classify the insects they collected in the surveillance exercise.

INTRODUCTION

This lesson is a continuation of the classification exercise from Lesson 6. All reference material and instructions are available in the lesson plan for Lesson 6.

ACTIVITY | DISCUSSION

- Continuation of the insect classification from Lesson 6. Toward the end of the lesson lead a class discussion looking at what the students identified in their traps. Update the word wall.
- Although unlikely, in the instance that a potential biosecurity threat is discovered during the surveillance exercise it should be reported.

A protocol for how to report a suspected biosecurity threat has been outlined below. A list of common grain biosecurity threats can be found in **Lesson 6: Citrus Biosecurity Threats** poster.

CONCLUSION

Insect surveillance is a vital tool for identifying what insects exist in our environment, especially for monitoring biodiversity and biosecurity. If a threat is discovered it must be reported so that appropriate action can be taken.

Explain to students that in the next lesson they will be analysing their data and looking at how the insects they identified fit into agricultural ecosystems.

RESOURCES

- Laptop and smart screen/projector to display the videos and interactive online key.
- If possible class laptops/iPads so students can use the online interactive key.
- Display the poster **Lesson 6: Grain Biosecurity Threats poster.**

BACKGROUND INFORMATION

INSECT CLASSIFICATION

Appendix 2: CSIRO Invertebrate Key
Appendix 3: Hints for using Keys

- http://www.ento.csiro/education/key/couplet_01.html - CSIRO Online Invertebrate Key
- http://www.ento.csiro.au/education/about.html - CSIRO key support
- http://www.ento.csiro.au/education/glossary.html - CSIRO key glossary
- http://www.planthealthaustralia.com.au/wp-content/uploads/2012/11/Biosecurity-Manual-for-Citrus-Producers.pdf

BIOSECURITY REPORTING PROTOCOL

- If an insect is suspected as being a biosecurity threat it should be reported.
- Call the **Exotic Plant Pest Hotline 1800 084 881** and provide details of your find such as the location, plant affected, suspected pest and if possible email clear photos.
- A specialist will confirm the identity of the insect in question.
- If the insect is deemed to be a biosecurity threat government agencies and affected industries are notified and a Response Plan is activated.
- If possible the insect population is eradicated, otherwise it is contained and managed.
- The affected property may have restrictions placed on who and what can come and go from the farm for a time.

LESSON 8

FOOD WEBS IN THE FIELD

Aim: Students will draw conclusions from their findings on the insect surveillance exercise and discuss the function of various ecosystems and the interactions between species in a food web.

INTRODUCTION

- In this lesson students will revise and summarise their findings from the insect surveillance activity. Data will be collated for the class and examined to draw conclusions on the abundance of certain insects and how they form part of a food web.
- Students will look at diets of various insect groups and assess how this affects agricultural food webs.

ACTIVITY | COLLATION

- Briefly collate the class data set using the PowerPoint presentation **Lesson 8: There's a Bug in the System** and/or **Lesson 8: Data Collation** worksheet.
- Teachers can populate the embedded tables and graphs within the presentation (to add data to the graph right click on the graph in the presentation > click on the Design tab > click on edit data > the embedded Excel spreadsheet will open > enter data into the spreadsheet and it will automatically populate the graph).
- Discuss the results of the exercise and any unexpected outcomes.
- Prompt class discussion by referring to the word wall and asking:
  - What are the differences between natural and agricultural food webs?
  - What impact can a pest have on an agricultural food web and what can farmers do to minimise these impacts?
  - What is the impact on Australian agriculture if a new exotic pest is introduced into the country?
- Hand out **Lesson 8: Food Webs in the Field** and **Lesson 8: Insect Orders** and their diet
- Explain that students will be researching the diets or feeding habits of insects they caught in the field to compile a food web for the crop they sampled.

CONCLUSION

Review the exercises in context of Plant Biosecurity. Looking at the class food webs ask the students what would happen if there was an imbalance caused by the presence of a pest?

Why is it important to identify and locate exotic pest species early in their arrival to Australia? What would happen is surveillance of exotic pests was not done?

RESOURCES

- Hard copies of the **Lesson 8: Food Webs in the Field** and **Lesson 8: Insect Orders** and their diet worksheets – print back to back.
- **Lesson 8: Data Collation** worksheets can either be printed and handed out to students out or displayed electronically for the class.
- Laptop and smart screen/projector for displaying Data Collation presentation to the class

BACKGROUND INFORMATION

FOOD WEBS

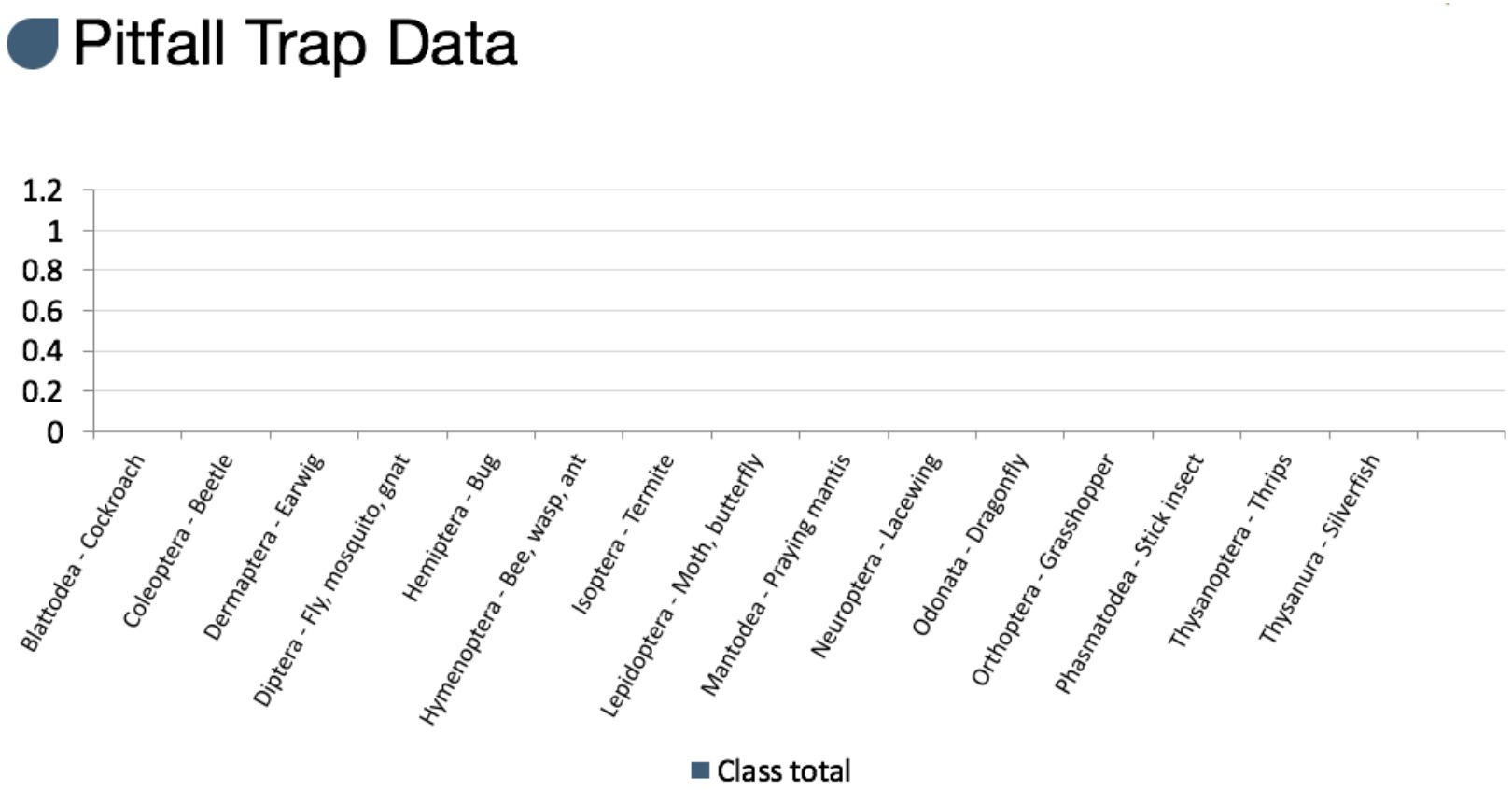
Food webs always start with a producer – a plant. Plants grow using energy from the sun. They are consumed by 1st order or primary consumers (herbivores). They are in turn consumed by 2nd order or secondary consumers (omnivores or carnivores) who are then consumed by 3rd order or tertiary consumers and so on.

Food webs, particularly within an agricultural system, are complex and interconnected. Different types and numbers of consumers can have drastic impacts on the food chain.

LESSON 8 DATA COLLATION

	STICKY TRAP		PITFALL TRAP	
	YOUR GROUP	CLASS TOTAL	YOUR GROUP	CLASS TOTAL
TOTAL NUMBER OF INSECTS TRAPPED:				
NUMBER OF INSECT ORDERS FOUND:				
LIST INSECT ORDERS FOUND:				
MOST COMMON INSECT ORDER TRAPPED:				
ANY POTENTIAL BIOSECURITY THREATS? WHAT ORDER DID THEY BELONG TO?				

Prepare a column graph showing the results of your data compared with the class date for each insect Order, for each trap type




Sticky Trap Data
1.2
1
0.8
0.6
0.4
0.2
0
Blattodea - Cockroach
Coleoptera - Beetle
Dermaptera - Earwig
Diptera - Fly, mosquito, gnat
Hemiptera - Bug
Hymenoptera - Bee, wasp, ant
Isoptera - Termite
Lepidoptera - Moth, butterfly
Mantodea - Praying mantis
Neuroptera - Lacewing
Odonata - Dragonfly
Orthoptera - Grasshopper
Phasmatodea - Stick insect
Thysanoptera - Thrips
Thysanura - Silverfish
Class total

LESSON 8 FOOD WEBS IN THE FIELD

Draw a food web for the grain crop you just sampled
Make sure you show the links between the different organisms and include:

- The producer (the crop);
- Primary consumers (herbivores);
- Secondary and tertiary consumers (carnivores and omnivores).

a) What would happen if all the secondary and tertiary consumers were removed?
b) What would happen if an exotic plant pest was introduced to this agricultural system?
c) What impact would exotic plant pests have on farms and on us as consumers?

LESSON 8 INSECT ORDERS AND THEIR DIET

INSECT ORDER	COMMON NAME	MOUTH TYPE	FEEDING HABIT	TYPICAL FOOD
Thysanoptera	Thrips	Sucking	Omnivore	Plants, insects
Orthoptera	Grasshopper, locust	Chewing	Herbivore	Plants
Lepidoptera	Moth, butterfly	Sucking	Herbivore	Plants
Coleoptera	Beetle	Chewing	Omnivore	Plants, insects
Diptera	Fly, gnat, mosquito	Sucking	Omnivore	Plants, animals
Hymenoptera	Bee, wasp, ant	Chewing	Omnivore	Plants, insects
Blattodea	Cockroach	Chewing	Omnivore	Organic matter, plants, meat
Neuroptera	Lacewing	Chewing	Carnivore	Insects
Thysanura	Silverfish	Chewing	Herbivore	Plants, organic matter
Hemiptera	Bug	Sucking	Omnivore	Plants, insects
Phasmatodea	Stick insect	Chewing	Herbivore	Plant leaves
Isoptera	Termite	Chewing	Herbivore	Grass, organic matter
Odonata	Dragonfly	Chewing	Carnivore	Insects
Mantodea	Praying mantis	Chewing	Carnivore	Insects
Dermaptera	Earwig	Chewing	Omnivore	Plants, insects

Herbivore: eat plant tissue; accounts for about ½ of all insect species
Carnivore: predators that eat only insects/animals; includes parasites
Omnivore: consume more than one of the foods mentioned above

NOTE: There are variations in diet for each insect Order. Identification down to the species level will determine the exact diet of each insect species.