New Zealand Certificate in Pest Operations (Level 3)

Pest Animal Operations

Control and Monitoring

Learner Guide

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Main front cover image courtesy of Ngā Manu Nature Images.

Small front cover image courtesy of OSPRI New Zealand.

Contents

Introduction to pest operations

Monitoring or control in a plant or animal context

This Learner Guide provides information that will help you to answer questions in your Evidence Portfolio and can be used as a reference to refer to when working in the role of a pest operator. The first section of this Learner Guide covers information in relation to generic skills for all pest operators. This is applicable to all Learners who are completing a control or monitoring strand in a pest plant or pest animal context. The five generic topics include:

- Workplace health and safety – pest operations
- Hydration, nutrition, and sleep
- Giving and receiving instructions in the workplace
- Weather
- Use of a Global Positioning System (GPS).

▶ Workplace health and safety – pest operations

This section covers information relating to workplace health and safety when working in pest operations. There are many potential hazards and it is vital pest operators look after themselves physically. Pest operators need to manage these hazards and avoid accidents which are often due to tiredness, fatigue, and being generally low on energy.

▶ Hydration, nutrition, and sleep

This section covers information on the importance of hydration, nutrition, and sleep. These are key components to working effectively as a pest operator.

▶ Giving and receiving instructions in the workplace

This section covers information relating to communicating in the workplace, specifically giving and receiving oral instructions. Communicating with your team is an important skill to have and is a vital part of your role as a pest operator.

▶ Weather and climate control

This section outlines ideas and concepts relating to New Zealand's weather systems. Topics such as weather, climate, and interpreting weather information will all help Learners to understand and use weather maps so they can carry out their role in pest operations more effectively and safely.

▶ Global Positioning System (GPS)

This section covers information relating to the use of GPS, how a GPS works, and the relevant menu pages on a common GPS. It also acts as background information and a reference point for pest operators when learning how to use a GPS in the field.

▶ Pest animal species

The second section of this Learner Guide covers information relating to specific pest animal species, including:

- Possums
- Rabbits
- Avian (bird species) – Starlings, Mynas, Rooks, Magpies and Sulphur-crested Cockatoos.
- Predators – Mustelids (ferrets, stoats and weasels), rodents and feral cats.

For each of the pest animals species, information is included on most of the following topics:

- introduction and distribution
- physical appearance
- habitat and diet
- behaviour and home range
- social structure
- signs of presence
- impact on the environment.

▶ Control and monitoring

The final section of this Learner Guide covers information relating to the control and monitoring of pest animals. This includes an overview of the use of traps and toxins.

Glossary of terms

Where necessary, there is a glossary at the end of each topic to help you become familiar with important terms.

Symbols you'll see

Throughout this Learner Guide we've used a set of symbols to help you know what's going on. The symbols we use are:

Alert: watch out for this/you must be aware of this.

Top tip: key information and useful tips.

Question: a question for you to think about.

Reference: refer to other resources for more information.

Search online: refer to online references for information on this topic.

Workplace health and safety – pest operations

Rural pest operators work in the outdoors, in different environments, and under different conditions. It is vital that pest operators are aware of the hazards in these environments and challenges that changing conditions present when working as pest operators.

A hazard is anything that could cause injury or illness. A significant hazard is a hazard with the potential to cause serious harm or injury. This includes amputation, broken bones, poisoning, loss of consciousness, crushing, cuts or burns requiring medical treatment, or any injury that requires you to be in hospital for more than 48 hours.

In your role, you will be required to recognise hazards and manage the risks they present. Your employer will be responsible for outlining and encouraging you to follow health and safety protocols and the risk management plan specific to your workplace.

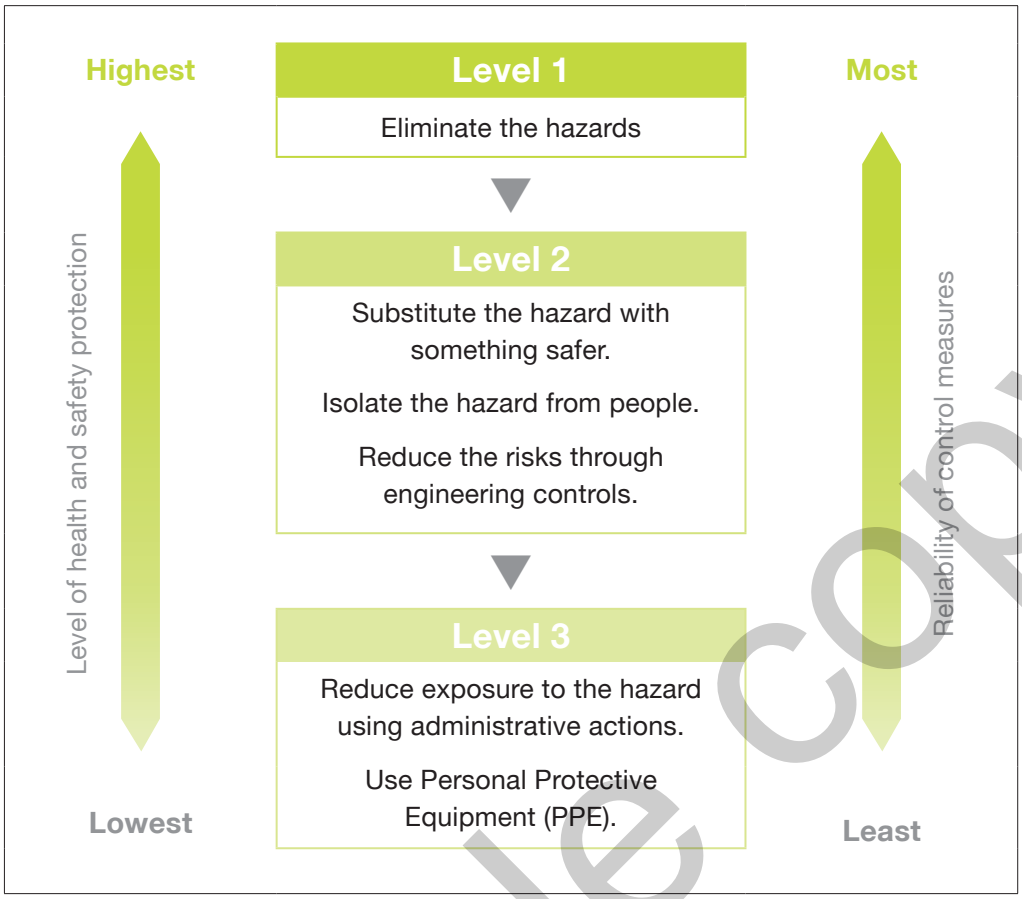
Potential hazards in pest operations include dealing with:

- adverse weather conditions
- water bodies (rivers, streams, lakes)
- hazardous substances
- machinery, including traps and vehicles
- difficult terrain
- unpredictable animals
- unpredictable land owners

and carrying out physically demanding work.

Courtesy of OSPRI New Zealand.

Managing hazards – Hierarchy of controls



Responsibilities and obligations in the workplace

It is important that you understand and apply workplace health and safety protocols to your role as a pest operator. You need to be an active participant with your workplace health and safety practices. Risk assessment and risk management strategies need to be applied to all potential hazards. This course addresses training in pest operations to a certain level, but some of the hazards mentioned above may require further training and input from outside specialists. Ultimately, your employer will be required to assess your capabilities in relation to the work environment and manage these in an appropriate way.

Leading indicators

Leading indicators are used in the workplace to help measure safety performance and manage safety in a proactive manner. These measures report what employees are doing on a regular basis to prevent injuries. For example, a toolbox meeting at the start of each day with everyone – this gets the team to participate in a discussion of possible risks that might be encountered that day, i.e. wet weather.

Health and Safety at Work Act 2015

In April 2016, the Health and Safety at Work Act 2015 replaced the Health and Safety in Employment Act (1992).

Also referred to as the HSW Act, and HSWA, it sets out principles, duties and rights in relation to workplace health and safety, with the aim of 'getting people home healthy and safe'.

It is important that you know and understand what your responsibilities and your employer's responsibilities are under this Act.

▶ Responsibilities of employers

- Keeping up to date with health and safety matters.
- Understanding the hazards and risks in the workplace.
- Ensuring that appropriate reporting and investigation processes are in place.
- Having the appropriate health and safety resources and processes (including providing PPE).
- Having a regime for monitoring that health and safety practices are effective.
- Providing appropriate training.
- Engaging with workers on health and safety issues that impact on them.

▶ Responsibilities of employees

- Must look after your own safety.
- Must follow all workplace safety procedures and use the safety equipment and/or gear you've been issued.
- Should take care not to cause harm to anyone else.
- Must not do anything that is unsafe and you should tell your Supervisor if you think the job is unsafe.

- Must tell your Supervisor about hazards or anything you think could result in someone being hurt.
- Should speak up if you think something could be done to make the workplace safer.
- Must report all incidents no matter how small.

▶ Responsibility of land owners

To inform visitors about the known hazards on their property.

Workplace safety organisations

There are several organisations that play a part in workplace health and safety.

▶ WorkSafe New Zealand (WorkSafe)

WorkSafe administers and enforces HSWA. WorkSafe's role is to:

- monitor and enforce compliance with work health and safety legislation
- provide guidance, advice and information on work health and safety
- foster a co-operative and consultative relationship between the people who have health and safety duties and the persons to whom they owe those duties and their representatives
- collect, analyse, and publish statistics and other information relating to work health and safety.

▶ Accident Compensation Corporation (ACC)

In New Zealand, employers are responsible for providing a safe and healthy workplace for their workers. ACC's role is to work with New Zealand businesses and agencies and provide information to help prevent injuries both in and out of the workplace.

All New Zealanders and visitors to New Zealand who get injured can apply for help from ACC. ACC's role, which is set out by the government, is to:

- prevent injury
- make sure people can get treatment for injury, if it happens
- help people get back to everyday life as soon as possible.

Being fit to do the job

If you're working in the outdoors carrying out physically demanding work it is important you are fit and ready to do the work. If you are not focused on the task at hand you are more prone to hazards, and being injured in the workplace.

Always ensure you are well prepared, fit, and ready for work.

Hydration, nutrition, and sleep

Introduction

Just as good health and safety practices in the workplace are important to your wellbeing, good health, nutrition, and sleep have a huge effect on how safe you are at work.

In this section you will learn about:

- fluid loss when doing physical work
- hydration and types and volumes of fluids required to maintain adequate **hydration**
- the role of diet in maintaining physical well-being
- the importance of rest and sleep in maintaining physical well-being.

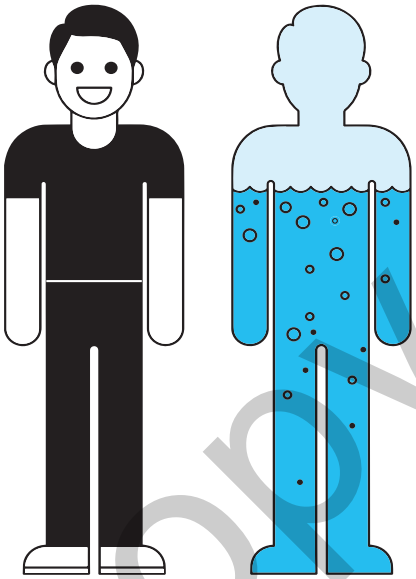
What you eat and drink, plus how much and how good your sleep is, has a huge effect on how your body and mind operate.

These factors also affect how well you do your work and how good and safe your decisions are.

Not taking care of yourself can make you feel tired and unmotivated, which can affect how well you do your job.

Fluids and hydration

Water is essential for human life. In fact, the human body is 50–70% water. Your body uses water in all its cells, organs, and tissues to help regulate its temperature and maintain other bodily functions.



The human body is 50–70% water

Water is important for healthy skin, hair, and nails, as well as controlling body temperature, heart rate, and blood pressure.

Because your body loses water through breathing, sweating, and digestion, it's important to drink fluids to replace the lost water.

The amount of water you need depends on a variety of factors, including how hot it is and how physically active you are.

If you don't replace the fluids you have lost, you risk becoming **dehydrated.** Dehydration is a potentially dangerous condition.

Dehydration is bad for your health, your safety, and how well you do your job.

Signs of dehydration

These are some of the signs you might notice if you get dehydrated.

Muscle cramps

Dizziness

Dark, strong smelling urine

Headache

Dry mouth/intense thirst

Racing heart

Dehydration will make you:

- perform poorly
- become uncoordinated
- less keen to do the job
- have difficulty thinking and working things out.

If you keep losing water without replacing it, you will:

- become totally exhausted
- suffer heat stroke
- have a collapse of body circulation.

Staying hydrated at work

You must drink fluids before you start work, all through your working day and then continue to drink after work to stay hydrated.

If you have ever watched a marathon race, you will have seen people giving the athletes water to replace the fluid they have lost through sweat.

‘If you go from 8 in the morning until 4 in the afternoon without peeing, then you’re dehydrated.’ ~ Nancy Clark, Sports Dietitian.

Think of the effort you have to put into doing your work, and the amount of fluid you sweat during the day.

We lose more water when:

- we work hard on the job
- it is hotter
- it is hot and windy
- **humidity** is low
- we have a fever.

Pest workers who do not take the right fluids with them when they are working are at risk from dehydration.

Keep hydrated

Have your water bottle with you at all times and drink from it often.

The effect of climate on dehydration

▶ Summer

In summer your body has to work twice as hard to cool you. Sweat cools the body as it evaporates from your skin.

If you are doing hard physical work on a calm humid day in the full sun then you could be losing up to 6 litres a day in fluid. Think of three large (2 litre) bottles of soft drink – that's a lot of fluid to replace.

To make up for this you need to:

- drink more fluid (4–6 litres a day)
- drink water regularly through the day
- try to spend part of your day in the shade or out of the wind
- protect yourself from the sun; wear suitable clothing, a hat, and apply sunscreen.

▶ Winter

When you are working hard in winter you will still lose fluids through sweat (up to two litres of fluid a day).

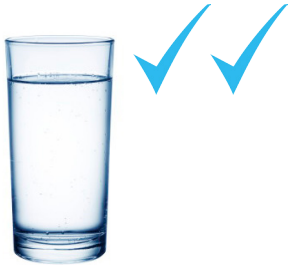
You may be drinking less as you don't feel so thirsty, and you are probably wearing more layers of clothing. Dehydration still does happen.

▶ Spring/Autumn

Sweating may not be as high in spring and autumn as in summer. However weather can change from quite cool to warm or hot and this will increase the amount you sweat, and you will need to increase fluid intake.

Fluids for rehydration

▶ Water



- is the best fluid for you to drink
- quickly replaces lost fluids and helps stop dehydration is free – if you refill your water bottle from the tap.

▶ Diluted fruit juice

- is better than pure fruit juice for rehydrating. Undiluted fruit juice uses water from your body to help with **digestion.** This will increase your dehydration.
- should have at least as much water as fruit juice, i.e. half and half.

▶ Sports drinks

- can quickly rehydrate your body and replace lost energy to muscles
- usually contain salts (electrolytes) to replace salts lost in your sweat
- contain **carbohydrates,** which provide energy but also calories – so don't overdo it.

▶ Tea and coffee

- will help rehydrate you but they contain caffeine. Too much can cause similar problems as energy drinks.
- can be full of calories if you add sugar.

Other drinks

Some drinks will help rehydrate you but they are not good for your health and should be kept to a minimum or avoided completely.

▶ Soda/Soft drinks

- generally contain a lot of sugar. Even diet (no sugar) soft drinks contain chemicals that can be bad for your health.
- can increase risk of heart disease and diabetes, and can cause liver damage, bone density loss and tooth decay.

▶ 'Energy' drinks

- contain high levels of caffeine, which cause your body to lose more fluid
- usually contain a lot of sugar
- can cause headaches, anxiety, insomnia, jitters and nervousness, and heart problems.

▶ Alcohol

- causes your kidneys to lose more water, increasing dehydration
- reduces energy in your muscles and can cause you to become tired
- slows down your thinking, which can lead to work accidents.

How much fluid do I need?

How much fluid you lose through sweat depends on the way your own body functions, what job you are doing, what the weather is like, what your place of work is like, and how hard you are working.

Drink enough to keep your urine pale or clear. You can lose as much as three litres of fluid an hour when doing hard physical work.

Pest operations compared to other jobs

Occupation	Fluid loss caused by energy used
Office worker	Low
Truck driver	Low → Moderate
Mechanic	Moderate
Fencing	Moderate → High
Pest operator	Moderate → High
Shearing	High → Very high

Different types of activities in pest operations

Activity	Workload	Fluid loss	What can you do?
Driving in ute to site	Low	Low	Even though fluid loss is low it is important to maintain your fluid intake
Walking on flat terrain laying transects	Moderate	Varies	Drink enough to prevent thirst
Walking in steep bush with a load of traps	High	High → Very high	Drink regularly and frequently

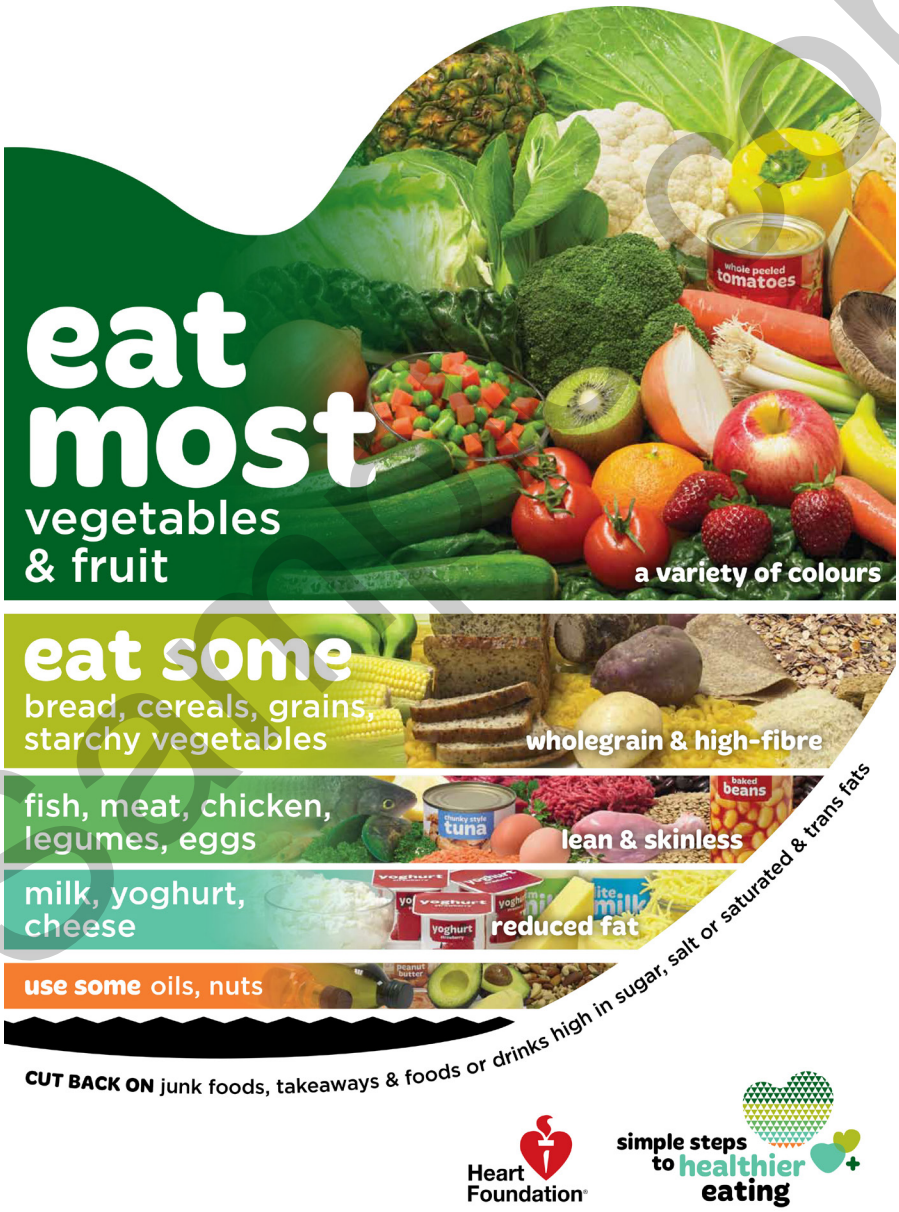
Healthy diet

As well as water, our bodies need food for energy and nutrients. We need a range of food types for our bodies to work properly.

Food groups

In our bodies, food is broken down into different nutrients, such as carbohydrates, proteins, fats, vitamins, minerals.

We need a mixture of these different nutrients – as well as **fibre** – to keep us healthy and able to work hard.



What is a healthy diet?

To get all these nutrients, the New Zealand Heart Foundation recommends that we:

▶ Eat most:

A variety of colourful vegetables and fruit

- Fruit and vegetables are power-packed foods – they are full of valuable nutrients which have lots of health benefits.
- All fruit and non-starchy vegetables – fresh, frozen, canned (in natural juice), and dried – are part of this food group.
- Eat at least 2 servings of fruit and 3 servings of vegetables every day.

▶ Eat some:

Wholegrain and high-fibre breads and cereals

- Breads and cereals give us most of the carbohydrates we need for energy to see us through the day.
- They contain B vitamins which help our body use the energy from food, fibre (especially from 'brown' wholegrain varieties), and minerals.
- This food group includes breads, rice, pasta, noodles, grains (e.g. oats, corn, maize, quinoa, cornmeal/polenta), and breakfast cereals.

Lean meat and chicken, fish, legumes, and eggs

- This food group includes a wide range of foods which give us many important nutrients, such as protein, iron, zinc, B vitamins, and fats (which contains fat soluble vitamins and omega fatty acids).
- Together, they are often referred to as the 'protein group'.

Milk and milk products

- These foods (also called dairy products) are an important source of calcium, helping to give us strong bones and teeth.
- They also provide protein (for growth and repair), carbohydrate and fat (for energy), as well as many important vitamins (such as vitamins A and B12) and minerals (including zinc).

Nuts and seeds

- Nuts (almonds, brazil nuts, cashews, hazelnuts, pecans, walnuts) are a good source of protein, fibre, vitamins, and minerals but are high in fat so only eat a few.
- Seeds (pumpkin, sunflower, flax, chia, sesame) are packed with nutrients.
- Raw nuts and seeds are best but avoid the salted variety.

Rest and sleep

Your body needs rest breaks and sleep to restore and repair itself. If you don't take proper rests and sleep, it leads to fatigue that slows you down at work, and leads to unsafe work practices.

Fatigue

Fatigue is extreme tiredness. This can be caused or made worse by:

- poor nutrition
- poor hydration
- lack of sleep
- lack of rest breaks
- stress
- poor physical fitness
- poor work methods.

Short-term fatigue may follow a burst of hard work over a few days. Once the job is over you can take a break and recharge.

Long-term fatigue comes from not having time to recover from short-term fatigue. This tiredness carries over from one day to the next and starts to build up.

The symptoms are headaches, digestive problems, bad temper, being snappy or depressed, and not being able to work hard.

Sleep

Sleep is needed for our physical, mental and emotional well-being. Too little sleep or poor quality sleep has bad effects on our mental and physical performance. It will affect how well we work and keep ourselves safe.

▶ Normal sleep patterns

- Medical research shows that we need about eight hours of sleep a night.
- This can vary with age and activity levels – younger people need more sleep than older people.

Rest breaks

Rest breaks are needed during the day as these help you to:

- lower your heart rate
- digest any food you have eaten
- improve your mental alertness.

Research has shown that two 30 minute breaks are better than a single break of an hour's duration. With rest breaks:

- your productivity goes up
- your attitude at work improves
- you are less likely to make a mistake.

The afternoon break is very important as fatigue sets in during the afternoon. This break is when you refuel your body and wake yourself up. Afternoon work goes better if you are rested, alert, and relaxed.

Did you know there are more accidents in the afternoon when energy levels and your state of alertness are low?

Hydration, nutrition, and sleep glossary

Carbohydrate	A component of food that supplies energy (calories) to the body.
Dehydration	When the body loses a lot of fluid especially from illness or hard work.
Digestion	Process where food is broken down in our stomach and intestines.
Fibre	The part of plant food that is indigestible by humans, but is needed for good digestive health.
Humidity	Amount of water in the air.
Hydration	Keeping a good level of fluids in the body.

Giving and receiving instructions in the workplace

Understanding what is being said and being understood is often overlooked as part of the skill set needed to be an effective team member. Verbal communication is important in just about every workplace and giving and receiving instructions is a vital part of the job when working as a pest operator. Every day tasks become much easier to perform when it is clear what you are meant to be doing, with whom, when you are meant to be doing it, and how you are meant to be doing it.

It is important that a few simple steps are followed when giving and receiving instructions.

▶ When giving instructions

1. Think before you speak
    - Work out what you are going to say – make sure you cover all the relevant points
    - Make the purpose of your instructions clear
    - Make sure you cover them in a logical order
    - Avoid jargon – use words the listener will understand
2. Watch for body language

See if the listener looks like they understand.

3. Use appropriate voice delivery
    - Use an appropriate volume and speed
    - Don't speak in a monotone – vary your voice
    - Be aware of the environment you are in – is it noisy/windy?
4. Use appropriate language for the audience

Include verbal and non-verbal (body language – not everyone appreciates an eyebrow salute).

5. Encourage feedback

   - Does everyone understand?
   - Are there any questions?
   - Can someone sum up what I've said?

▶ When receiving instructions

1. Listen to the whole message

Don't assume you know what the speaker is going to say before they say it.

2. Use positive body language

Show that you are interested and taking in what they are saying.

3. Ask questions

Clarify any points you don't understand.

4. Give feedback

   - Restate in your own words what you think the speaker is saying
   - Check that they agree with you
   - Summarise the instruction that has been given.

Weather and climate control

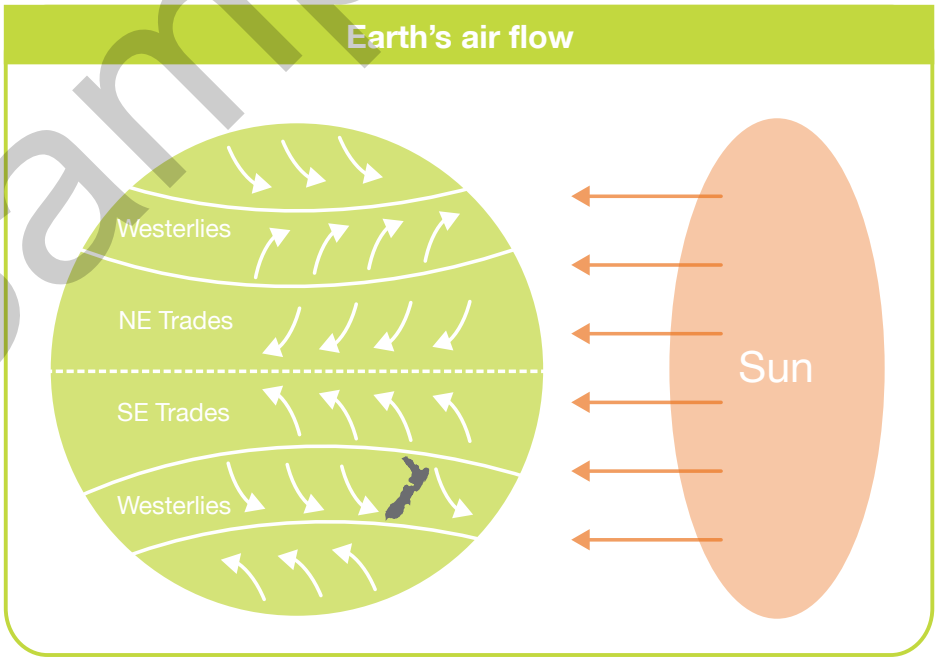
The impact of the weather in New Zealand

New Zealand's climate ranges from being warm and subtropical in the far north to a cool temperate climate in the far south, and severe alpine conditions in the mountainous areas.

Weather fundamentals

The starting point for weather systems begin with the sun's rays hitting the globe. The sun's rays strike the Earth directly (square on) at the equator, and obliquely (at an angle) at the poles. Air at the equator is hotter than air at the poles. Air at the equator rises and air at the poles sinks — this creates a cycle of air mass movement or wind. Because of the Earth's rotation, global airflows veer to produce circular motions around high and low pressure systems.

In the diagram below you can see that New Zealand is in a predominately westerly airflow.

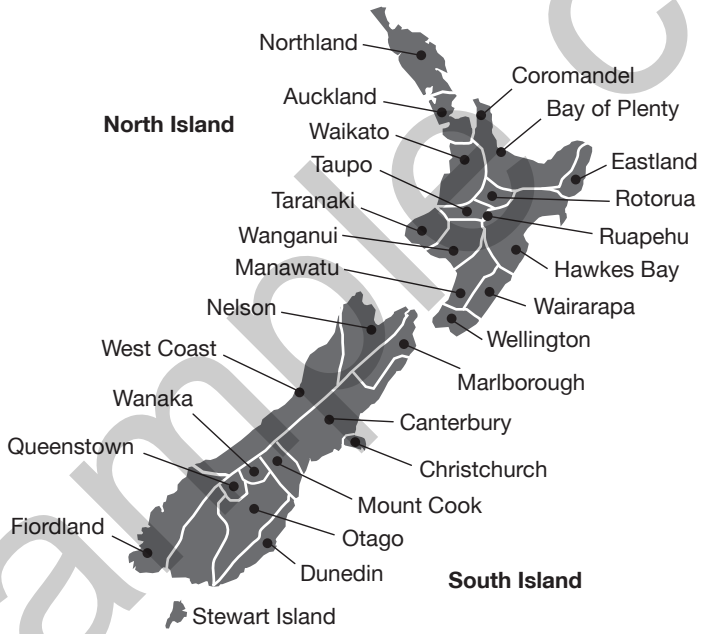


Source: http://calspace.ucsd.edu/virtualmuseum/climatechange1/08 1.shtml

‘Lift’ is air moving from low altitude to high altitude and can be caused a number of ways by:

- a depression
- mountains
- fronts (when two air masses meet)
- thermals – solar heating.

The mountain ranges running the length of New Zealand act as a barrier for winds – our most common wind being a westerly. These ranges also divide the country into dramatically different climatic regions. The West Coast of the South Island is the wettest area of New Zealand, whereas the area to the east of the mountains, just over 100 km away, is the driest.



Temperatures drop about 0.7°C for every 100 m of altitude.

What is weather?

Weather is the short-term differences that occur in the air around us. Weather is usually referred to in terms of sunshine, cloudiness, humidity, rainfall, temperature, wind, and visibility.

Put simply, the weather is what happens outside. The air (or atmosphere) around us behaves in different ways. It changes when it's hot or cold, and when it's wet or dry. It acts differently when it's calm or stormy, and clear or cloudy. A snow flurry is weather, and thunder and lightning are weather, too. Sometimes the air around us behaves violently, and sometimes it's peaceful and quiet. Either way, it's weather.

Temperature

The average annual temperatures range from 10°C in the south to 16°C in the north of New Zealand. New Zealand has relatively small differences between summer and winter temperatures, compared to places that experience a continental climate, e.g. North America. A possible exception is in the South Island where the area inland and to the east of the ranges, such as the McKenzie Country, has a seasonal variation of up to 14°C.

Rainfall

Most areas of New Zealand have between 600–1600 mm of rainfall, spread throughout the year with a dry period during the summer. Over the northern and central areas of New Zealand more rainfall occurs in winter than in summer. For much of the southern part of New Zealand, winter is the season of least rainfall.

Wind

Wind is air that flows from an area of high pressure to an area of low pressure. It is measured by speed and direction. Winds are named by the direction they blow from, i.e. southerly winds blow from the south.

- A **gust** is any sudden increase of wind of short duration (usually just a few seconds).
- A **gale** is a very strong wind of at least 28 knots (51 kph) and up to 55 knots (102 kph).

Sunshine

Sunshine is the light and heat energy from the Sun in form of sun rays. Direct sunlight is unbroken by the presence of cloud. Sunshine can be considered in terms of the intensity or the number of hours received.

What is climate?

Meteorologists record the weather every day. The constant recording of weather information helps to determine the long-term weather patterns or climate of an area.

Climate is the average weather in a location over a long period of time. A place that doesn't get much rain over many years would have a dry climate. A place where it stays cold for most of the year would have a cold climate.

Understanding the climate is useful for weather forecasting and is particularly important when working in rural New Zealand. If you have a good understanding of weather forecasting and the climate of the area in which you work, you will be able to better manage risks such as, rising rivers and streams, wind chill, extreme cold, and exposure.

In other words, look out your window any day, at any time, and you see weather. Look out your window every day for a month or longer, observe the weather each day, and you can start to get a feel for the climate.

Climate is what you expect, weather is what you get.

Factors affecting climate

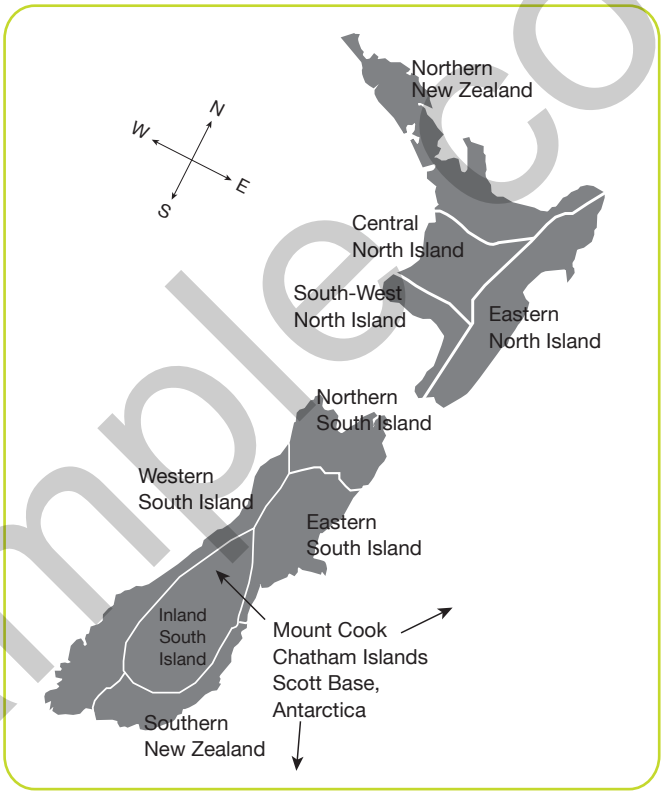
The climate of a location is affected by:

- latitude (distance from the equator and the hottest area of the Earth)
- altitude (height above sea level)
- how close it is to ranges
- how close it is to the ocean.

Meteorologists have developed models of the climate based on historical weather patterns and the knowledge they have of the factors affecting the climate. They use these elements to predict the likely climate patterns for today and the future.

If you know the climate of a place, you have powerful information about what the weather may be like today, tomorrow, or next summer.

The map below highlights the different climate zones as they are recognised in New Zealand. Climate zones that are close together may be only slightly different. However as you move from the far North to the far South the differences in the climate become more pronounced. This also is often the case as you move from West to East.



Climate zones of New Zealand

What is a micro-climate?

A micro climate exists within a climate zone when specific features of the landscape influence the weather in that area. Features may include hills, gullies, lakes, flat plains, or even a shelter belt which have the affect of modifying the general climate within a region.

These micro-climates can affect large areas of several hundred hectares or very small areas of less than a hectare. Examples of micro-climates include:

- the Manawatu Gorge and the effect it has on the wind in the Tararua district
- orchards and shelter belts
- hills or ranges that create a rain shadow or that have an effect on wind speed and direction
- a glasshouse which is a totally artificial micro-climate.

How is weather created?

The Earth is a rotating sphere, heated more by the Sun near the equator than near the poles.

Circulations in the Earth's atmosphere try to even out the difference in temperature between equator and poles, by transporting heat away from the equatorial region. These circulations characterise the weather of the mid-latitudes, which is where New Zealand is located.

In the mid-latitudes, the general wind flow is from west to east. The weather systems (e.g. highs and lows) are carried along in this flow, which means they generally pass from west to east across New Zealand. How rapidly the weather changes has a lot to do with how fast the highs and lows are passing across New Zealand.

Air arrives over New Zealand after blowing across long stretches of ocean from which it picks up moisture. Since no place in New Zealand is more than 145 km from the sea, most of the country has reliable rainfall. But some of New Zealand's mountains are long and tall enough to interfere with air flowing over them by removing its moisture as rain, so what arrives on the other side is drier and less cloudy.

Since New Zealand's wind comes most commonly from the Tasman Sea, the hilly West Coast (of the South Island) is the wettest area of the country and the central interior of Otago is the driest.

The air's ability to hold water is dependent on its temperature (warm air can hold more water than cold air). Air from the tropics is generally more moist than air from Antarctica (polar origin). Air masses from tropical and polar regions are generally so different in character that they tend not to mix.

Think of some factors that affect weather in your local area.

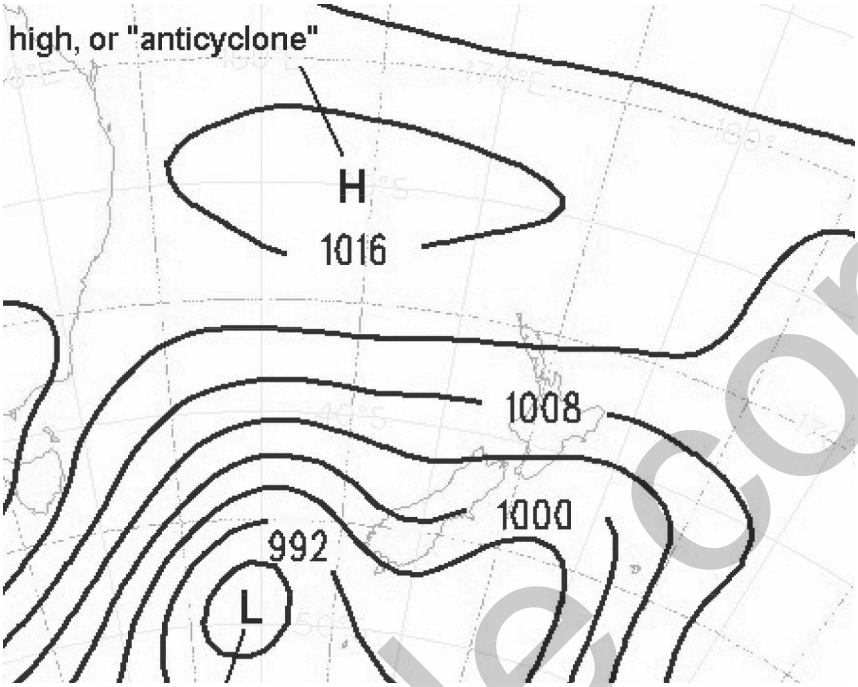
Weather maps and symbols

For almost a century the main tool used to forecast the weather has been the weather map. These maps are drawn every six hours and are based on reports received from about 200 stations over an area extending from the equator to Antarctica, and from Western Australia to Pitcairn Island (which lies well to the east of New Zealand in the Pacific). The reports contain details of cloud, visibility, and weather conditions, wind speed and direction, and atmospheric pressure at Mean Sea Level (MSL).

Because these maps are based on conditions at MSL, they are referred to as MSL charts and include air temperature, dew-point, rainfall, and the state of the sea (from coastal stations). These measurements are then plotted on the weather map in a kind of meteorological shorthand with the forecaster drawing in the isobars (joining places with equal mean-sea-level pressure) and the fronts (the boundaries along which large air-masses of different temperature come together).

Anticyclone

As seen on the map below, when isobars enclose an area of high pressure this is called an anticyclone or High, and its centre is labelled on a weather map by an ‘H’. The term anticyclone is a bit of meteorological jargon.



Highs and lows

The central pressure of a weak High is about 1015 hPa, while a strong or intense High has a central pressure above about 1030 hPa.

An intensifying High has a rising central pressure, while a weakening High has a falling central pressure.

Near a High’s centre are light winds and sometimes areas of low cloud called anticyclonic gloom. Round the edge of a High, the winds are sometimes strong. Intense Highs tend to squeeze the isobars together, creating areas of strong winds. Winter Highs often bring frost; summer Highs may bring thunderstorms and hail. The bigger Highs are, the slower they tend to move, sometimes blocking the fronts that are trying to follow them.

A depression

Isobars make shapes and patterns. When they enclose an area of low pressure, this is called a depression or Low and its centre is labelled on a weather map with an 'L'. The term depression is also a bit of meteorological jargon.

A low pressure system is like a giant funnel of wind spiralling inwards, and upwards forcing warmish air in the centre to rise. As air rises it cools and clouds form.

The central pressure of a shallow Low is above 1000 hPa, of a moderate Low 980–1000 hPa, and of a deep or intense Low below 980 hPa. If there are two or more centres the Low is said to be complex. If the central pressure is rising the Low is said to be filling or weakening. If the central pressure is falling the Low is said to be intensifying or deepening.

Fronts, troughs and convergence zones

A front marks the boundary between two air-masses, and appears on the weather map as a line with triangles or semi-circles attached.

Common weather symbols used on MSL charts

▶ Cold front

The leading edge of an invading colder air-mass, marked by a line with triangles pointing to where it is moving.

Cold fronts push in underneath the warmer air ahead of them, forcing the warm air upwards and making cloud and areas of rain. The cloud band is usually about 50–400 km (30–200 nautical miles) wide.

As a cold front passes by:

- any rain clears but showers may appear
- humidity drops
- air temperature usually drops
- pressure rises
- the wind changes direction.

Warm front

The leading edge of an invasion of warmer air. Its surface position is marked by a line with semi-circles pointing to where it is moving.

The advancing warm air rises over a zone of retreating cooler air, making a cloud bank that slopes forwards from ground level upwards, often bringing prolonged steady rain.

This cloud bank can be 500–1000 km (270 to 540 nautical miles) wide.

As a warm front passes by:

- any rain becomes patchy but humidity remains high
- air temperature may rise a little
- pressure steadies
- wind changes direction.

Occluded front (or 'Occlusion')

Occurs when a cold front overtakes a warm front, so all that remains of the original warm air is trapped above, where it cools making dense cloud and rain. It is marked by a line with triangles and semi-circles on the same side, pointing to where the front is moving.

As an occluded front passes by:

- any rain becomes patchy
- wind eases

- the rate of pressure fall may level out
- air temperature does not change much.

▶ Stationary front

A front which has lost its impetus for movement, so neither air-mass is making much progress. It is marked by a line with alternate triangles and semi-circles on opposite sides.

The triangles protruding into the warmer air-mass and the semi-circles protruding into the cooler air-mass.

It takes a while for a stationary front to pass by, any rain clears slowly, and temperature and pressure do not change much.

▶ Trough of low pressure (or 'Trough')

When isobars make a sharp bend around a Low, this is the name given to the bend.

Troughs are also often shaped like tongues and usually contain weather similar to lows and fronts.

Horizontal convergence

The coming together of two flows of air. When these two flows of air are from different air masses and there is significant cloud and weather, the resulting line of convergence is commonly drawn as a front.

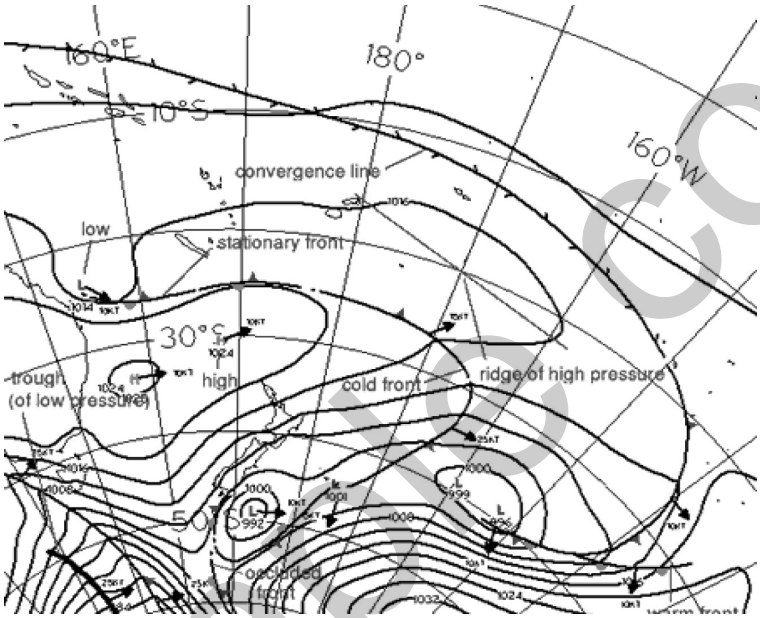
However, when these two flows of air are in the same air mass and significant cloud and weather result, the weather feature is drawn as a convergence line.

Convergence lines are only drawn in the tropics.

Ridges and cols

When isobars turn a sharp corner around a High they form what is called a ridge of high pressure, which is often shaped like a tongue extending from the High centre. The weather in a ridge is an extension of the weather in the High.

A col is the name for the area of light variable winds that lies between two neighbouring pressure systems. Often this area contains either fog or thunderstorms.



MSL chart showing a wide range of weather features.

Courtesy of Meteorological Service of NZ Ltd.

The weather map above shows:

- cold, warm, occluded and stationary fronts
- highs and lows
- troughs of low pressure and ridges of high pressure
- convergence lines.

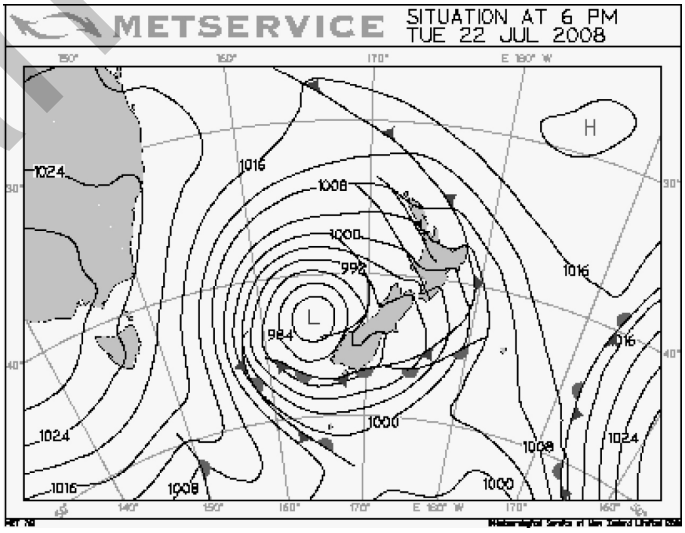
Interpreting weather information — Weather forecasting

Many years ago weather forecasters identified that large-scale weather systems were closely related to the pattern of the isobars. It was found that over areas of high pressure (Highs), the weather is mainly fine, while the low pressure systems (Lows) are associated with strong winds and unsettled weather.

They also recognised that wind flow follows the direction of the isobars, with low pressure on the right (in the southern hemisphere), and is strongest where the isobars are closest together. Since these pressure systems tend to change rather slowly and retain their identity for some days, their progress can be followed from map to map. This serves as a rough basis for weather prediction.

The MSL chart below provides an example of how weather forecasters use the information collected to gain an understanding of the weather at a particular place and time.

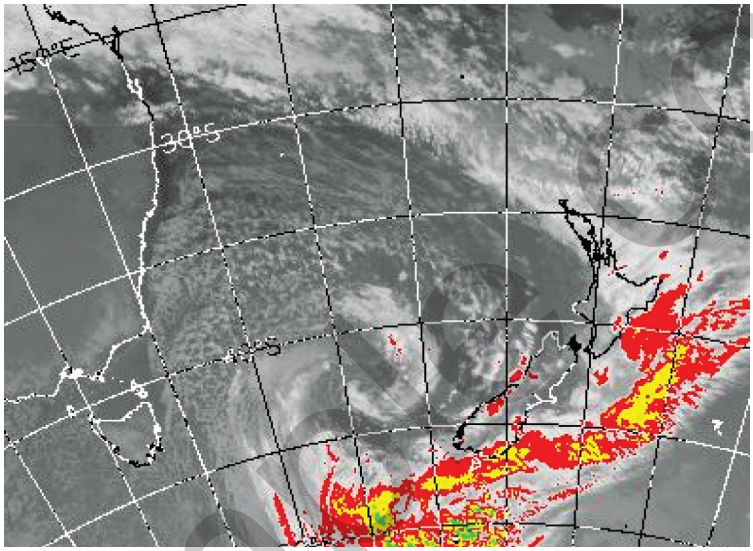
This chart shows a very deep depression (or cyclone) spreading across New Zealand. In fact this was the first of two very severe storms that hit New Zealand in July 2008, leaving widespread flooding and wind damage to much of the country.



MSL chart

Weather maps as they appear on television and in the newspaper, are called ‘surface charts’ or, more correctly, MSL charts. They show what is happening at a set time where most of us need it — at the Earth’s surface. They do not show what is happening at higher levels, where the wind flow may be doing something entirely different.

With the aid of MSL charts and satellite imagery, forecasters were able to predict the effects of these storms and provided early warning to farmers and the country as a whole of what to expect. As a consequence, the population was well prepared and the loss of life and livestock was minimised.



New Zealand-Tasman Satellite Map

The map above shows what the satellite map was showing during the bad weather at this time.

The bright-coloured band highlights the intensity of rainfall with this depression as the storm front moved off the East Coast of New Zealand.

A satellite map provides images of cloud cover and temperature.

Weather glossary

Condensation	When water vapour changes into a liquid.
Cloudy	More cloud than clear sky (e.g. the sun being obscured by cloud for long periods of time).
Dew-point	The temperature at which dew begins to form.
Drizzle	Rain made up of small water droplets that are close to one another.
Dry	Free from rain.
Evaporation	When liquid changes to gas. Water changes into water vapour (clouds).
Fine	Dry weather with mainly sunny or bright conditions.
Fog, mist, haze	Terms to describe reduction in visibility. Fog limits visibility to less than 1 km, while in mist or haze you might be able to see as far as 10 km.
Meteorologist	Person who studies atmospheric conditions and weather.
Patchy	Occurs irregularly over a particular area.
Precipitation	When water particles fall from the atmosphere and reach the ground (rain, hail or snow).
Rain	Precipitation from dense, continuous clouds.
Settled	A period of several days during which the weather is either dry, fine, or dry apart from a few patches of rain. If it does rain, the rain either falls as morning drizzle or as afternoon showers near the high country. It is unlikely to be windy.

Shower	Rain from individual clouds. Relatively short-lived and punctuated by periods of blue sky.
Snow	Frozen precipitation in the form of ice.
Stormy	A period during which rain and high winds predominate.
Unsettled	A period of several days during which rain is likely to occur. Although there may be breaks in the rain, these breaks will not often last more than a day. Strong winds may occur at times.
Wet	A period during which rain or showers occur most of the time.

Global Positioning System (GPS) for pest controllers

The GPS satellite constellation

The GPS uses a constellation of satellites in different orbits. Each satellite orbits the Earth at an altitude of approximately 20,000 km.

The accuracy of a position determined with GPS depends on the type of receiver, the number of available satellites, and their relative position. Most hand-held GPS units have about 5–20 m accuracy. While that might not be good enough for a surveyor, it is great for pest operations.

The GPS constellation was designed so that wherever a person stood on the Earth's surface, at least four GPS satellites would be visible at any time. A GPS receiver can determine a two dimensional position when three satellites are available, and a three dimensional position (including altitude) with four satellites.

For pest operations we only need a two dimensional position, although the more satellites are available, the better the accuracy.

How GPS works

At the heart of GPS technology are the astonishingly accurate atomic clocks. These clocks are carried in the satellites and keep time accurate to within 150 billionths of a second.

Each satellite is also in contact with ground stations on the Earth, so the satellites 'know' their precise location in space at any given time. The five ground stations maintain each satellite's orbital data and precise time.

The five ground stations are located in Colorado Springs, Hawaii, Ascension Island in the South Atlantic Ocean, Diego Garcia in the Indian Ocean, and Kwajalein in the North Pacific Ocean.

Each satellite then transmits data that indicates its location and the current time. All satellites are synchronised so these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The GPS receiver can interpret these extremely small differences in arrival times of the different satellite signals, and so calculates the distance to the various satellites.

A GPS receiver 'knows' the location of the satellites, because that information is included in satellite transmissions. By estimating how far away a satellite is, the receiver also 'knows' it is located somewhere on the surface of an imaginary sphere centred at the satellite. It then determines the sizes of several spheres, one for each satellite. The receiver calculates its position where these spheres intersect using triangulation.

Three spheres are necessary to find position in two dimensions – four are needed in three dimensions.

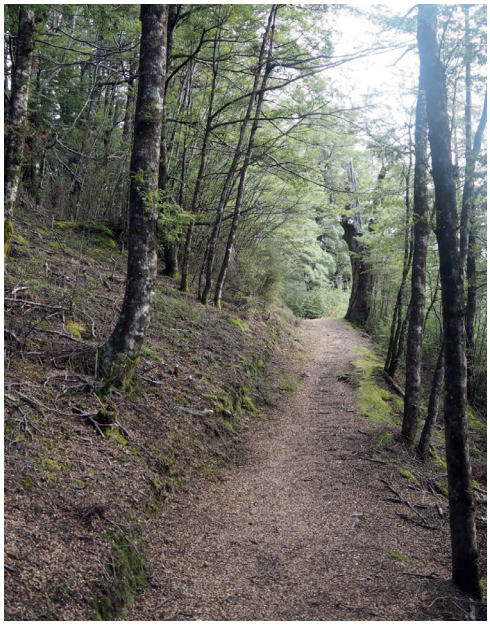
If you are familiar with map and compass techniques for finding your position, you might wonder why three satellites are needed to determine position?

The difference is that two lines can only intersect at one point, but if you imagine two overlapping circles, there are two intersection points, and in the case of two intersecting spheres there are an infinite number of intersecting points. Four intersecting spheres are necessary to describe a unique point, and that is why four satellites are required before the GPS can report a three dimensional position, both location and altitude. The reason the GPS can get away with reporting a position when only three satellites are available is because the GPS assumes it is located on the Earth's surface, and so it uses the Earth itself as the fourth sphere.

The accuracy of a position determined with GPS depends on:

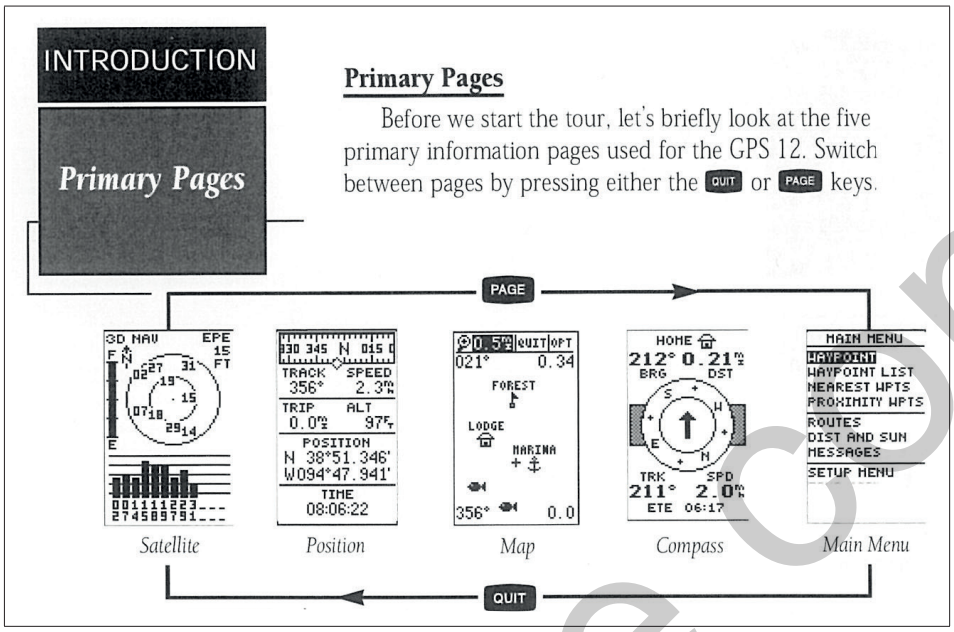
- the type of receiver
- the number of available satellites and
- their relative position.

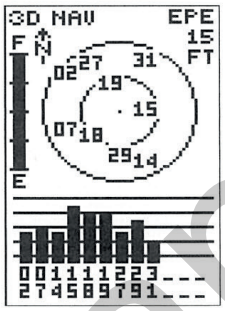
GPS receivers require an unobstructed view of the sky, so they are used only outdoors and they often do not perform well within forested areas or down steep sided gullies. However, recent advances in GPS receiver chipset technology have greatly improved the effectiveness of GPS receivers, which is a real bonus for pest operations, e.g. a modern GPS unit, incorporating a 'SiRFstarIII' chip can reliably report positions even under forest canopy.



Primary pages on the GPS receiver

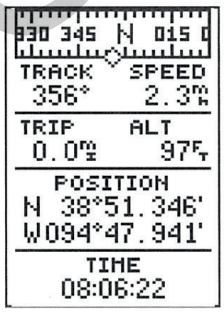
Most GPS receivers have five different pages. These pages are described below using page descriptions from the 'Garmin GPS 12 Personal Navigator Owner's Manual' as an example.





Satellite Page

The Satellite Page will allow you to monitor satellite signal reception and strength.



Position Page

Satellite Page

The **Satellite Page** shows satellite positions and signal strength. Satellite positions are displayed using two circles and a center point. The outer circle shows satellites on level with the horizon; the inner circle is 45° above the horizon; and the center point represents satellites directly overhead. Knowing satellite positions will show you the direction of any blocked signals.

The bottom of the page contains a row of signal strength bars corresponding to each satellite being used.

Position Page

The **Position Page** shows you where you are, what direction you're heading and how fast you're going.

The top of the page contains a compass tape which is a graphic representation of your heading (or 'track'). Your track and speed are indicated immediately below.

> ⚠ *The graphic compass tape reflects your actual heading (track) only while you are moving.*

The rest of the page shows your current position in three dimensions: latitude, longitude, and altitude. A trip odometer and 12/24-hour clock are also provided.

6

GPS

Map Page

The **Map Page** acts as a window. It allows you to view your position, the "path" you have traveled over, and nearby waypoints.

A diamond icon in the center of the screen represents your current position. As you move, you will see a thin line—called a *track log*—appear along the path you have just covered. Names of stored waypoints and nearby cities can also be shown on the map.

The bottom corners of the map will always display your current track and speed. When going to a waypoint, highlighting an on-screen waypoint, or using the panning target crosshair, the corresponding distance and bearing are shown at the top corners of the map. The top of the screen contains the zoom, pan, and configuration fields.

Navigation Page

A navigation page gives you steering guidance when going to a waypoint. The GPS 12 has two navigation page choices: the Compass Page and the Highway Page. The Compass Page is the default and will be briefly explained here. The Highway Page is covered on page 34.

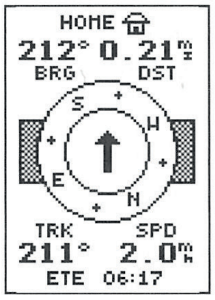
The **Compass Page** shows the destination waypoint at the top of the page with the bearing (BRG) and distance (DST) to the waypoint shown below. The center of the page contains a compass ring and arrow to show you the direction of the waypoint from the direction you are moving. The bottom of the page gives your track (TRK), speed (SPD), and a selectable field for estimated time to arrival (ETA), estimated time enroute (ETE), course to steer (CTS), crosstrack error, (XTK), velocity made good (VMG), or turn bearing (TRN).

Main Menu Page

The last primary page is the **Main Menu Page.** The Main Menu Page gives you access to the GPS 12's waypoint management, route, track log, and setup features through a list of submenus.

Map Page

The Map Page shows your progress on a moving map plotter and gives a bird's-eye-view of surrounding waypoints.



Compass Page

The Compass Page is the default navigation page and will show you the way to the waypoint from the direction you are moving.

For most pest operations, the GPS has two primary purposes:

1. Firstly it is used to navigate to a prescribed point
2. Secondly it is used to record the actual location of line start and end points, and the location of control devices.

The menu page, navigation page and position page are the main pages you will use. The satellite page is not particularly useful. Either your GPS can acquire a position, or not. If it cannot, looking at the satellite page is not going to help a great deal. Similarly, the map page is not often useful in the smaller handheld GPS units, because the screens are too small and the topo maps are not able to be displayed.

GPS glossary

Determine NZTM position	Go to the 'position' page — the NZTM easting and northing are displayed. NZTM is the new mapping format that replaced NZMG in the early 2000s. This should be the format used when gathering data.
Waypoint	A position stored in the GPS memory. It can be given a name or number code for reference. Waypoints are used in two ways: 'Destination' waypoints can be entered or uploaded into the memory if you wish to navigate to a control line start point. 'Feature' waypoints can be collected in the field to record the actual line start and end points.
Goto	A navigation function which allows you to navigate to a waypoint in the GPS memory. Select the desired destination waypoint (accessed from the menu page) and select 'Goto'. The screen will automatically change to the navigation page and display the bearing and distance from your current location to the destination waypoint.
Tracking	Can be selected if you need a record of the actual route you have travelled. An associated function is 'trackback' which allows you to navigate back the way you came.

Routes	A collection of waypoints which can save time when navigating. Rather than selecting and navigating to one waypoint at a time, you can pre-select the waypoints you will navigate to, in the correct order, and the GPS will guide you along the route.
Crosstrack error (XTK)	Indicates how far you have moved away from the intended path, e.g. if you select a waypoint and use 'Goto', the GPS assumes you will travel to the waypoint in a straight line from your present location. XTK tells you how far you have moved sideways off that line. For the purpose of possum control, this function is almost useless, as the New Zealand landscape seldom allows travel in a straight line anyway.
Time of arrival (ETA) and time enroute (ETE)	These functions predict travel time to the destination waypoint based on present speed and direction of travel. This is not useful for pest control, where both speed and direction of travel tend to vary quite widely.

For more information on the functions available on your GPS receiver, read the instruction manual.

Introduction to pest animals

This section covers information in relation to the pest animal control sector. Pests that are covered include possums, rabbits, some pest bird (avian) species, and predators including mustelids, rodents and feral cats. Mustelids, rodents and feral cats are grouped as predators, which means they are carnivores, which eat other animals, particularly native species. It should be noted that while possums eat mostly vegetation, they also eat or scavenge other animals. Like rodents, possums are therefore omnivores, eating both plants and animals.

Possum

Stoat

Rat (Ship rat)

In New Zealand introduced vertebrate pests are a major problem for our native ecosystems. They also have an impact on social and economic values, such as damage in gardens, and possums and ferrets can act as carriers of Bovine Tuberculosis (TB).

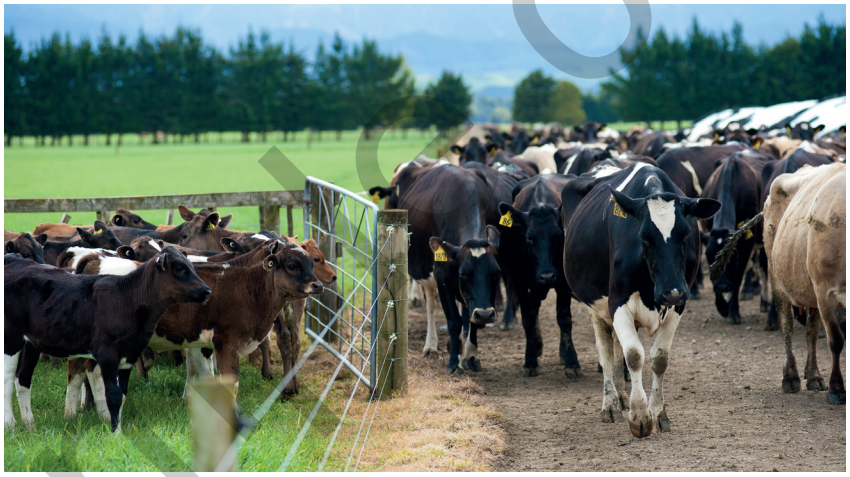
The worst pests in relation to our native ecosystems are called the 'Big Three'. They are possums, stoats, and rats. Possums are the main introduced plant eater that damages native vegetation, causing long-term forest damage. Possums are also a main vector (a vector is a carrier of disease) of Bovine TB. Stoats and rats are numerous and widely spread throughout New Zealand, eating many species of native birds, snails, lizards, and other insects. Many of these native species have become extinct as a result, and the damage continues. Of course, possums also like to eat native insects, birds or their eggs or chicks, any chance they can get.

Possum image (top right) courtesy of Ngā Manu Nature Images. Stoat and Ship rat images courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai.

The role of animals in the spread of Bovine Tuberculosis (TB) in New Zealand

Introduction into New Zealand

Bovine TB arrived in New Zealand with the cattle of the first European settlers. It was a serious problem by the 1940s. Its presence reduced productivity and put people's lives at risk. Today it is still a disease of concern for both cattle and deer farming in New Zealand.



Bovine TB is a wasting disease in both cattle and deer, leading to weight loss and sometimes death. In cattle, milk production will often decline.

Effect on humans

Bovine TB is similar to human TB and can move from livestock to humans with potentially fatal results. The symptoms in humans are lethargy, weight loss, and a persistent cough.

Prior to widespread pasteurisation of milk, transmission of TB between dairy animals and humans occurred periodically. However, since the introduction of better milk treatment processes and infected herd management processes, this path of transmission has virtually ceased.

Cost

The main problem with TB these days is its affect on New Zealand's livestock industries, and exports. International animal health standards have risen since the 1960s and are now a major factor governing access to our overseas markets. This is an issue as the export of livestock farming products is one of New Zealand's most valuable industries.

As market conditions internally become more competitive it has become even more important that New Zealand clears TB infection from its remaining herds. Currently the presence of TB in our national cattle and deer limits live export to other countries.

Role of possums in the spread of TB

In the late 1960s, veterinarians in the Westport area found that chronic infection in cattle herds could not be cleared by standard tests and slaughter methods. Researchers linked the problem to high levels of TB infection in possum populations living adjacent to these herds. Since then, possums with Bovine TB have been identified in different areas in New Zealand.

Possums with huge TB lesions.

Courtesy of OSPRI New Zealand.

How do possums infect livestock?

Possums with advanced TB are inclined to wander out of cover onto pasture in the daytime. This is unusual behaviour considering possums are nocturnal animals.

This is one of the classic symptoms of a possum infected with TB. Cattle and deer being the curious animals they are, will investigate the possum

closely, nuzzle it, lick it, or even pick it up by the mouth. This provides the ideal route for infection transmission. If you come across any possums acting in this manner they should be treated with extreme care.

Distribution of infected possums

Areas where possums are thought to carry TB are called Vector Risk Areas, and cover about 8 million hectares of New Zealand. This is made up of much of the West Coast, western and central Southland, Otago, north-west Canterbury and south-west Marlborough in the South Island. In the North Island the Vector Risk Areas include the Central Plateau and surrounding forests, and the main ranges south to Wellington. By 2017, all of the Vector Risk Areas in New Zealand will be under some form of TB vector control or disease surveillance.

For further information on TB vector control areas throughout New Zealand visit the TBfree website www.tbfree.org.nz/

Suspected sources of TB other than cattle

While several wild animal species can be infected with TB, research suggests that possums are likely to be the main carriers of TB. In some parts of New Zealand, TB infected ferrets are common, especially in areas with high rabbit numbers. Feral red and fallow deer have also been identified as possible local vectors of TB.

Role of ferrets in the spread of TB

The first TB infected feral ferret was identified in Taumaranui in 1982. The difference between possums and other wildlife, such as ferrets, is that while possums are a maintenance host, ferrets are a spill over host. What that means is that TB can be maintained indefinitely in a possum population, regardless of whether other species carry the disease. However, spill over host species only tend to carry TB if their prey species (such as possums) also carry TB. In this way, ferrets become infected as they scavenge the TB carcasses. Ferrets also pick up the disease from improper disposal of offal from infected livestock, and other spill over hosts such as pigs. Spill over hosts can be useful as indicator species due to their large home ranges.

As there can be substantial possum-to-ferret transmission of TB, controlling possum populations is the logical first step to managing TB infection in ferret populations, especially at sites with low ferret density. At higher ferret densities there is evidence of possible ferret to ferret transmission of TB, although this seems to die out over several generations once the source of infection is removed.

Ferrets

Courtesy of Ngā Manu Nature Images.

In areas with extremely high ferret populations there have been reported cases of ferrets infecting herds with TB through interaction with sick ferrets. Once gain, this issue seems to resolve itself once the primary infection source is removed.

Domestic deer are sometimes directly infected by contact with infected wild deer. However, the main problem with infected wild deer is their possible role in spreading the disease to uninfected possums, as possums will scavenge dead animal matter – especially if the gut sack has been removed from the animal and left.

Role of the National Pest Management Strategy for Bovine TB

The National Pest Management Strategy for Bovine TB is a collective and national approach to eradication of bovine TB in cattle and deer herds in the shortest time possible.

It aims to:

- protect New Zealand's overseas markets for beef, dairy, and venison products and
- protect human and animal health and productivity.

The main objectives of the strategy are to:

- biological eradication of TB from New Zealand by 2055 with TB freedom in livestock by 2026 and 'statistical freedom' in wildlife (i.e. high confidence the disease is gone) by 2040, and
- ensuring the annual infected herd prevalence stays at or below 0.2% throughout the term of the plan.

Further information

For further information on TB visit the TBfree website www.tbfree.org.nz/

Possums

Possum introduction and distribution in New Zealand

Possums were brought to New Zealand in 1837 from Australia. Possums are native to Australia and are not a problem there in most areas, mainly because many trees in Australia have possum defences such as spines, prickles, or poisonous leaves.

Courtesy of Astrid van Meeuwen-Dijkgraaf, 2015, and the Pest Detective website.

Possums were brought to New Zealand to start a fur industry. At the height of the fur trade, trappers killed 20 million possums a year.

The early settlers were enthusiastic about 'artificial enrichment' of New Zealand fauna and flora so they believed the possum would be of great benefit to the wildlife that was already here. The settlers also believed that existing native fauna was on the way to extinction because of the way some species had already become extinct, and therefore the fauna that remained was of little value.

By the 1860s acclimatisation societies were formed. They were concerned with introducing new species into New Zealand. They introduced animals for sport such as deer, game birds, and trout, in addition to the possum. They introduced some animals for novelty, and some animals for economic purposes – namely the possum.

Distribution

In New Zealand possum numbers have increased quickly because they have no natural enemies, and because the vegetation is so lush. Because our conditions are so favourable, possums will sometimes breed twice in one year.

Brushtail possum in an apple tree

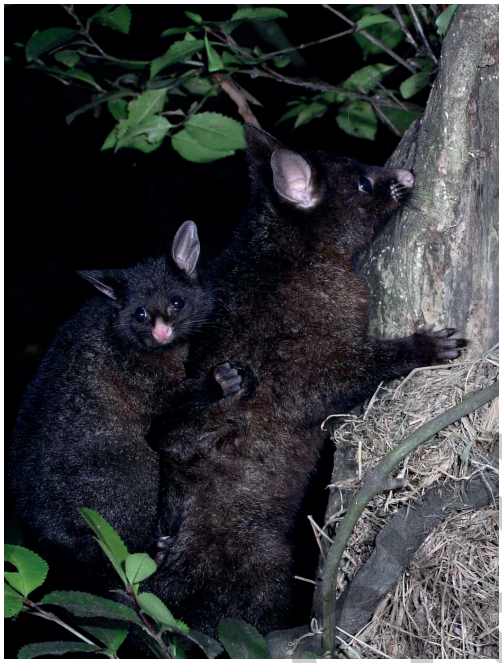
Courtesy of John Hunt, Landcare Research New Zealand.

The number of possums in New Zealand at present is around 30 million. This has reduced considerably from around 70 million 10 years ago due to widespread control programmes.

This huge number of possums occupies more than 90% of the New Zealand mainland. Possums are found throughout the North Island, and except for parts of South Westland, western Fiordland, and in the upper catchments of a few rivers in South Canterbury and north-west Otago, they are also widespread in the South Island.

For further information on possum population refer to the paper 'How Many Possums Are Now in New Zealand Following Control and How Many Would There Be Without It? B. Warburton, P. Cowan and J. Shepherd, 2009'. This paper is available on the Envirolink website www.envirolink.govt.nz/

Possums were also introduced onto 17 offshore islands. However, the good news is that since 1990, possums have been eradicated from many offshore islands – notably Rangitoto, Motutapu, Kapiti, Codfish, Whanganui and Tarakaipa, all of which have outstanding conservation importance. So there has been a lot of work done, and is still being done, to create possum free areas to ensure the survival of native fauna and flora.



Possum and young

Courtesy of Ngā Manu Nature Images.

Density

The density of possums varies with the type of habitat they are occupying (see section for habitats). Densest populations occur in mixed hardwood forest and forest/pasture margins and can be as high as 25 per ha.

Physical appearance

- Possums are marsupials – a marsupial is an animal that carries its young in a pouch.
- Adult possums are about the size of a cat and have a small head, large eyes and ears, sharp claws, and catlike whiskers.

Dark form of possum

Courtesy of Astrid van Meeuwen-Dijkgraaf and the Pest Detective website.

- A possum's thick woolly fur is usually dark brown, black, grey, or a combination of these colours.
- Possums have long bushy black tails.

Habitat and diet

Possums are found in a wide range of habitats. The only criteria seem to be that there is cover and plenty of food. The only large areas which they have avoided so far are the high rainfall, mountainous areas of south-west Fiordland.

Possums live in all types of habitats from sea level to tree line:

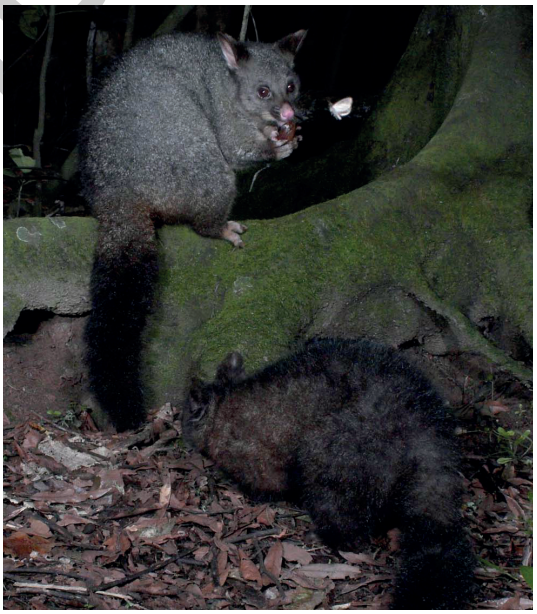
- scrublands, and tussock grasslands
- indigenous grasslands
- exotic forests
- shelter belts
- orchards and cropping areas
- thermal regions
- swamp and pakihi country
- sand dunes
- urban areas.

However, forests are their main habitat, especially mixed hardwood forests where possum densities are higher than beech or exotic pine forests.

Food and feeding

Possums are best described as opportunistic ominvores, and feed mainly on leaves. They also like buds, flowers, fruits, ferns, bark, fungi, and invertebrates such as stick insects, cicadas, snails, and wetas.

Possums are known to eat cultivated grain and vegetable crops, horticultural produce, introduced ornamental shrubs and flowers, animals such as small birds and mice, as well as eggs and fledglings, carcasses of deer, other possums, and rabbits.



Possums feeding on snails.

Courtesy of Ngā Manu Nature Images.

As a result they have become happily established in almost every New Zealand habitat on land, and their diets are as varied as the habitats they occupy.

Behaviour

Activity

Possums are nocturnal, that means they are active at night and mostly sleep during the day.

Female possum and her young at night.

Courtesy of Ngā Manu Nature Images.

Nesting patterns

Possums live in dens under cover. 95% of these dens are above ground in hollow tree limbs or trunks; in clumps of vines or epiphytes (fern-like plants that grow up tree branches); in ceiling cavities of buildings; clumps of flax or toe-toe; in blackberry and gorse; under logs; underground among tree roots; in the den of other animals; in haystacks; or old wood sites. They will live anywhere there's cover.

In forest, possums use 5–10 different dens at any one time, but dens are not usually shared except by females with young. Possums will actively defend their dens against other possums.

Den sites are usually on the edge of a possum's nightly range. Possums change to another den on average two nights in three. On farmland, den sharing is more frequent, and up to five possums may be found in one hollow willow tree.

Possums have also been known to push kiwi out of their burrows so they can have a dry place to sleep.

Home range and movement

Home range is the area in which the possum lives, feeds, and breeds. Where possums live on farmland with scattered patches of forest or scrub, they show two types of ranging behaviour:

1. Some have small ranges centred on preferred habitats such as stream-side willows or swamps and never venture far out into farmland.
2. Others range up to 1600 m over open pasture, and have an annual home range of up to 60 ha in pastoral areas. This allows possums to take advantage of patches of higher quality, seasonally available foods.

Most home ranges in forested areas are typically 1–4 ha, and overlap each other with males having larger home ranges than females. Once a possum has established a home range, it will tend to remain there for its lifetime.

Female possums usually take up the home ranges that overlap with that of their mothers, but male possums will gradually shift their ranges away from their mothers.

Possums will normally feast on seasonal foods such as flowers, apples, or flowers of native trees if these are part of their home range. They will not tend to travel long distances to reach seasonal foods.

Dispersal

This is the movement of the possum from its place of birth to the place it reproduces. Movements have been recorded of up to 3 km in a night and up to 10 km in a week.

Dispersing possums are usually less than two years-old and male, although young females occasionally move long distances too. They may make several consecutive moves before settling into a new area.

There does not appear to be any relationship between dispersal and density. For example, after a control operation killed more than 90% of possums, the proportion of possums that dispersed did not change.

Social structure

- Possums do not spend much time on active social interaction, except during the breeding season.
- Possums will usually go out of their way to avoid members of a different species (unless they are small enough to eat).
- When two possums meet and interact, one is dominant over the other.
- Older, heavier possums are usually dominant over smaller, younger possums, and females are generally dominant over males.

Possum and rat face off over thrush nest.

Courtesy of Ngā Manu Nature Images.

Signs of presence and field signs

While possums are rarely seen during the day, distinctive evidence of their presence can be seen. The most obvious signs are:

- Pad runs: (tracks) used by possums travelling to and from feeding areas (most obvious in pasture).
- Footprints: five-toed fore-feet, different hind-feet, and claw marks.
- Kill signs: messy eaters, regurgitated pellets, and bird egg shell fragments are often pushed into the egg (possums are known to prey on eggs and chicks of endangered bird species like the kiwi, kokako, and kereru).
- Droppings: possum droppings (scats) scattered under food trees and in the forks of trees. They are crescent-shaped pellets, found singly or in groups, around 2.5 cm long, and slightly thicker than a pencil.
- Vegetation damage: Ragged edges on leaves, partially eaten leaves, leaf stems, fruits and flowers on the ground. Bark bites (small horizontal marks) on trees, and claw marks on trees, fence posts and gates.

Possum droppings

Image courtesy of Astrid van Meeuwen-Dijkgraaf, 2015, and the Pest Detective website.

Possums are messy eaters and also leave behind partially eaten leaves, flowers, and fruit. They usually feed on foliage by holding branches in their paws and using their teeth to tear the leaves. They often leave behind the leaf stalk, base, and midrib, and tattered leaf remains.

Possum control

Conventional control

Possum control using poison baits relies on possums being able to find the baits and then to eat a lethal dose.

Possums generally locate and consume more bait from stations placed at or near ground level that from raised locations in trees. If bait stations do need to be raised, then try to choose their favourite, often heavily marked trees for maximum effectiveness.

Possum foraging on forest floor.

Courtesy of Ngā Manu Nature Images.

Use and location of toxins, baits, and traps

Possums can be controlled by shooting, trapping, and poisoning. A range of toxic bait formulations are available, containing one of the five poisons currently registered for possum control: 1080, cholecalciferol, cyanide, brodifacoum, or zinc phosphide. There are advantages and disadvantages for using different traps and toxins.

For more information on traps and toxins, see the Traps and Toxins sections of this Learner Guide.

▶ Behaviour of possums at baits and traps

Dominant female possums appear to prevent some subordinate animals from using bait stations through direct interactions.

Impact of possums on primary production and native ecosystems

Impact of possums on primary production

One major impact of possums on primary production is as a vector of Bovine TB. Although possums eat or damage crops and pasture, their impact on pastoral farming, horticulture, and forestry overall is less significant, and these impacts are not well quantified nationally.

For more information on TB see the Bovine Tuberculosis (TB) and Possums in New Zealand section of this Learner Guide.

Pastoral farming

Eight possums is equivalent to one stock unit in terms of pasture feed consumed, so two or three possums per hectare of farmland can represent quite a significant loss of production. Loss of grazing potential is most obvious to those farmers who practice intensive grazing and feed budgeting.

Following possum control, there can be a noticeable increase in the amount of grazing available in pasture adjacent to bush/pasture margins.

Horticulture

The effect of possums on horticulture production is even less well documented than damage to pasture, but just as widespread. Possums feed on horticultural crops such as kiwifruit, avocados, pip and stone fruits, macadamia nuts, walnuts, vegetables, and flowers.

They damage horticultural crops by:

- eating the bark of fruit trees and vines
- breaking branches
- rating buds, fruit, flowers, and leaves
- spoiling fruit.

Damage tends to be patchy and seasonal, and is most common when crops are maturing. The damage is most common in areas close to trees and native forests.

Possums can also damage willows and poplars planted as shelter belts around orchards and market gardens. Shelter belts are a good habitat for possums, and allow populations to establish amongst neighbouring crops or orchards.

Forestry

Most possum damage to forestry in New Zealand affects Pinus radiata, although possum damage has been recorded in other species of pine, i.e. eucalypts, poplars, and willows.

Possum bite marking on pine tree.

Image courtesy of Dean Roughton, Hawke's Bay Regional Council.

Young trees are the most vulnerable. Possums cause damage in new plantations by:

- browsing, bending, and breaking terminal shoots
- breaking leaders and upper laterals
- stripping bark.

Older trees (14 years-old onwards) are less vulnerable to this type of damage, and possums have little effect on these trees. Possum damage in New Zealand plantations peaked in the 1930s, 1960s, and the 1990s because this was when new plantings and replanting of harvested areas occurred.

Possum bite marking on pine tree.

Courtesy of Dean Roughton, Hawke's Bay Regional Council.

Possums in New Zealand native forest

As you will recall from the first section, possums were introduced to New Zealand in the early 1840s. However, it took another 100 years before the major damage to native ecosystems was widely acknowledged.

Possums cause damage to native forests by concentrating on individual plants of their favourite species. They can kill trees by defoliation over a couple of years.

Possums prefer to feed on the tall canopy trees such as tawa, northern rata, kohekohe, southern rata, kamahi, pohutakawa, and ignore others. In some areas possums have eaten whole canopies of rata, totara, titoki, and kohekohe. After two years of heavy possum browsing, a tree will often die. Tall forest is then replaced by shrublands. You might have seen this in some forests in New Zealand.

Severe possum damage on kohekohe.

Courtesy of Ian Barton and the Pest Detective website.

They also feed on the smaller trees, such as tree fuchsia and wineberry, mistletoe, forest herbs, some ferns, and several endangered shrubs.

Possums can eat a huge amount of vegetation. In one night an adult possum eats about 160 gm of dry matter. Imagine 20 possums eating around 6 kg of vegetation in one night. That is enough leaves, fruit, and vegetation to fill three plastic shopping bags.

In one week those 20 possums would have eaten 42 kg of vegetation, or 21 shopping bags full. This means that each night tens of millions of possums are eating their way through thousands of tonnes of vegetation.

Although possums have had a visible and dramatic impact on canopy trees, they also have a less obvious, but just as serious, impact on native forests in general because they eat other things besides the leaves of trees. They enjoy eating flowers, fruit, leaf buds, fungi, and insects.

The results of possums eating these foods are:

▶ Loss of fruits which reduces:

- food supplies for birds and invertebrates
- bird nesting success through affect on bird breeding condition
- or eliminates seed dispersal
- the ability of native plants to regenerate.

Possum eating kiekie fruit.

Courtesy of Ngā Manu Nature Images.

▶ Loss of new shoots reduces:

- the ability of plants to overcome leaf loss from weather and seasonal patterns
- numbers of new leaves, which has a detrimental effect on plant health.

Possum damage to mahoe leaves.

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai.

▶ Loss of flowers which reduces:

- and prevents the formation of seeds
- the food supply for birds and bats
- the nectar sources for birds and bats
- food supplies for chicks through nectar loss.

Possum feeding on Dactylanthus (Woodrose).

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai.

Further information

For further information on possum pests, see 'The Handbook of New Zealand Mammals', King, C.E. (ed.) 2005. Oxford University Press 2006. ISBN-10: 0195584775.

There are various best practice resources available from npca.org.nz, associated website pestdetective.org.nz, and doc.govt.nz

For information on TB visit the TBfree website www.tbfree.org.nz/

Rabbits

Rabbit introduction and distribution in New Zealand

The rabbit was originally from the Iberian Peninsula (Spain and Portugal), and has been successfully distributed around much of the world over the past two thousand years.

Courtesy of Astrid van Meeuwen-Dijkgraaf, 2015, and the Pest Detective website.

The first rabbits known to have arrived in New Zealand were two pairs of domestic rabbits released by Captain James Cook on Motuara Island in Queen Charlotte Sound in 1777. Rabbits were important items of trade in early settler days, as they were valuable for their meat and fur, and rabbit hunting was a good sport.

It is unknown when domesticated rabbits became established in the wild. However, in the 1850s, wild rabbits were imported from both Britain and Australia, rapidly displacing domestic varieties, and they became widely established by the 1870s.

Early settlers were enthusiastic about 'artificial enrichment' of New Zealand fauna and flora, and actively sought to introduce species not only for economic reasons or for sport, but also because they sought to transform the New Zealand countryside into something resembling their homeland. The settlers believed that existing native fauna was on the way to extinction because of the way some species had already become extinct, and there was little value in the fauna that remained.

Rabbits quickly reached plague proportions and many farmers had to abandon their land since farming sheep in the presence of high rabbit numbers proved to be unprofitable.

The speed with which rabbits could establish was demonstrated on a large Southland station where the first rabbit was seen in 1872. Just four years later, 26,000 rabbits were killed.

Distribution

With the assistance of ongoing releases, rabbits quickly established themselves throughout New Zealand in varying densities. They thrive in dryland and semi-arid environments, especially in the South Island.

Density

The density of rabbits varies with the type of habitat they are occupying, and can fluctuate dramatically between seasons, and in different years. Highest densities are in areas of Central Otago, the McKenzie Basin, North Canterbury and Marlborough, where the climate, soil type and land use are particularly favourable.

Young rabbits at the entrance to their burrow.

Courtesy of Ngā Manu Nature Images.

Rabbit densities are generally much reduced since the illegal introduction of Rabbit Haemorrhagic Disease (RHD) in 1997.

Rabbit Haemorrhagic Disease (RHD)

Unlike Australia, myxomatosis was never established in New Zealand as a biological control agent for rabbits. However, in 1991 a joint research effort between Australia and New Zealand was established to investigate the viability of RHD, a disease first identified in China in 1984. RHD escaped from containment on Wardang Island in 1995 and soon spread to mainland Australia. That same year a consortium applied to MAF to have RHD released into New Zealand also.

That application was declined in July 1997, but seven weeks after that decision RHD was identified on several South Island farms, having been illegally introduced from Australia. This caused intense and polarised public debate, but no one was ever prosecuted.

The spread of the virus was assisted by farmers, and spring of 1997 saw rabbit densities declining when they would normally be increasing rapidly and this continued through 1998. Since then effects have been variable, with epidemics in localised areas. Populations remain much lower generally, and while up to 500 kg of 1080 per year was used against rabbits prior to release of RHD, it is now around 20 kg per year. However, it is not known how long this disease will remain effective, and in some areas the disease is no longer killing rabbits even though many of them are infected.

Rabbits that survive RHD may remain infectious, and may also lose parts of their ears. Rabbits can pick up RHD from food sources contaminated by flies.

Physical appearance

- Sexes are alike but females have narrower heads.
- Coat colour is mainly buff, sprinkled with black, a reddish neck, white underparts, and black fur on the upper tail with white below.
- There is much colour variation in body fur, from white to light sandy to black.
- Length of adults is up to 400 mm and weight is 1400–2500 g.
- Rabbits have long ears and rodent-like incisors.

Habitat and diet

Rabbits are associated with lighter soils in open country, amongst scrub, in rocky places and in plantations. While rabbits do not mind the cold, ranging from sea level right into sub-alpine tussock grasslands (but mostly below 1200 m), they cannot tolerate persistently damp conditions (young rabbits will not survive persistently damp conditions).

Rabbit at entrance to burrow.

Courtesy of Ngā Manu Nature Images.

Desirable features of rabbit habitat include:

- annual rainfall of less than 1000 mm
- a sunny aspect
- light soil
- adequate cover close to feeding grounds kept closely grazed.

Some localised habitats such as sand dunes, riverbeds, and limestone country are also favourable in certain conditions.

Food and feeding

Rabbits are herbivores and they eat a wide range of plant species including leaves, shoots, and bark. They prefer variety and the high fibre plant varieties of the harsh semi-arid environments in which they thrive. Rabbits are adapted to dry conditions and can concentrate their urine and survive without water as long as their food contains at least 55% water (and in New Zealand it usually does).

Daily food requirement is approximately 500 g wet weight of vegetable matter. They can survive on browned-off pasture in a drought, but require green growing feed for reproduction.

Rabbit feeding her young.

Courtesy of Ngā Manu Nature Images.

Rabbits reingest special faecal pellets, principally during the day. This is called coprophagy, or refection. The soft pellets are small, dark, membrane covered and are swallowed whole from the anus without breaking the membrane. Inside the membrane there is a high bacterial content and undigested cell walls of plant food grazed by the rabbit. The bacteria continue to ferment the vegetable content until the membranous wall dissolves and the contents mingle with the freshly ingested plant material. This releases phosphorus, sodium, potassium and lactic acid to aid digestion and nutrition. The process is similar to rumination in sheep and cattle.

Behaviour

Activity

- Rabbits are nocturnal or active in twilight, spending most of the day below ground or resting in cover, and emerging in the late afternoon or evening.
- Most are active all night, returning to cover by morning.
- Feeding during the day may be observed when there is food shortage.

Home range and movements

Home range is the area in which the rabbit lives, feeds, and breeds.

- A rabbit's home range is 2–3 hectares, with males tending to have a slightly larger area.
- Adult rabbits rarely shift their ranges.

Dispersal

This is the movement of the rabbit from its place of birth to the place it reproduces. Most juveniles disperse less than 100 m after weaning when they are driven away from the parental home range. Some have been recorded moving up to 3 km. Disturbance from control operations seems to make little difference to dispersal behaviour.

Rabbit feeding

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai; Photographer: D.P. Murray.

Social structure

Rabbits live in colonies or warrens with a strict social hierarchy. They make well marked runways and deposit faeces or urine at communal latrines or in mounds (buck heaps).

Common latrine, or buck heap.

Courtesy of Bay of Plenty Regional Council.

At low densities, the group may be just the male/female pair, and bucks (male rabbits) may be solitary for some time before they can join another group, or establish their own. In larger groups a dominant pair can usually be identified. There are two separate hierarchies, one among the males, and one among the females. Antagonistic behaviour between males and females is rare.

The social group, hierarchies, and pair bonds are all quite changeable, with pair bonds often only lasting one season as bucks court newly mature does.

Rabbits do not interact with other species, other than being extremely wary of potential predators.

Signs of presence

Rabbits are generally nocturnal, but are frequently seen outside their burrows during the day, particularly dawn and dusk. The most obvious signs are:

- Footprints: Four toes show on front and rear feet. The rear feet are much longer than front feet.
- Tracks: In good conditions you may be able to make out four toes on both the forefoot and hindfoot prints, but often all that is visible is the outline of the foot.
- Droppings: Small dark pellets, oval-shaped and approximately 8–10 mm in length. Can be found in small heaps or scattered throughout their feeding areas.
- Vegetation damage: Pasture grazed right to the ground, ring-barking the base of saplings and small trees, growing tips of short saplings eaten.
- Scratchings, small holes, and diggings in the ground.

Small holes with the excavated soil dug out by scratching are a sign that rabbits are about.

Courtesy of Bay of Plenty Regional Council.

Rabbit control

Poisoning

August to February is the main breeding season for the rabbit. Poisoning during this time is difficult because intense territoriality means all territories have to be identified and have bait placed in them, and the bucks are not feeding intensively. Rabbits are not drawn out of their territories to bait placed elsewhere and, in fact, the rabbit's territory reduces to the core of their usual territory.

Also, while kittens 14 days-old and over are capable of feeding on grass should their mother be poisoned, they are less likely to be poisoned themselves as they stay close to cover and may not encounter bait.

Accordingly, March to September is the optimum time for poisoning, immediately prior to breeding. The population is at its lowest from other mortality factors and every female killed would have had the potential to produce many offspring.

Control history is also relevant. If previous control has been unsuccessful, bait shyness may be developing and an alternative poison and/or bait matrix should be used. In any case, pre-feeding with non-toxic bait must occur twice to get the rabbits used to eating the bait. Rabbits are very wary of novel objects in their environment and will not tuck straight into even the most attractively presented toxic bait without prior pre-feeding.

Seasonal effects are also relevant; carrot bait is not ideal in hot summer conditions because it dries out and becomes unpalatable. Oats are traditionally used during this time as it is a bait that tolerates heat. It is also a time when other seeds are naturally available to the rabbit.

Rabbits are fussy eaters, so bait quality and presentation must be excellent. Carrot bait should be good quality, for example, sweet table carrots and not stringy old horse carrots. Paste baiting onto overturned spits takes advantage of a rabbit's inclination to investigate newly disturbed soil, but the bait must be carefully placed as rabbits will be put off if the bait is covered in dirt.

Trapping

Trapping is rarely undertaken in New Zealand, as rabbits are extremely wary of traps. However, leghold trapping is useful for dealing with small numbers of rabbits where alternative techniques are not viable. Effectiveness depends on the skill and experience of the operator.

Because rabbits are so wary, traps must be buried just under the surface and preferably in pairs so that the rabbit is likely to be held by two traps. The disturbed earth where traps are buried takes advantage of a rabbit's tendency to investigate newly disturbed soil in their territory.

Impact of rabbits on primary production and native ecosystems

Impact of rabbits on primary production

The impacts of rabbits are not well quantified nationally. Much information is based on best estimates, rather than hard data, as it is difficult to accurately separate the effects of rabbits from all the other complex interaction in pastoral and native environments.

In high numbers, rabbits cause a great deal of damage to pasture, field crops, vegetables, and trees by gnawing and nibbling shoots and bark.

The pasture on the right of this image is protected by a rabbit-proof fence. This image shows the impact that rabbits can have on farmland.

Courtesy of Landcare Research, New Zealand.

Pastoral farming

At high density (perhaps 50 ha) rabbits reduce pasture to a short sward, and woody species and weeds such as hieracium become dominant. Winter mortality is high at this density. It is estimated that 10–15 rabbits eat the same amount of grass as one sheep.

At these high densities pastoral sheep farming becomes uneconomic, and as previously mentioned, farmers in rabbit prone areas have been driven off their land by extreme rabbit problems.

The alternative to abandoning the land was to farm rabbits instead, and this was common in the late 1800s, but declined through to 1950. While millions of skins were exported, as well as canned and frozen meat, the damage from sheep and rabbits to the native grasslands and soil structures of the semi-arid high country was extreme, resulting in completely changed vegetation.

Horticulture and forestry

At lower densities commonly seen through most of New Zealand, rabbits are not a serious problem. However, in some places and at some times, even a few rabbits can be a problem. Plants in vegetable and flower gardens, and small trees may be eaten, and trees may also be ring-barked by having the bark chewed off by rabbits. New forestry plantings can fail to establish properly due to rabbit damage.

Rabbit nibbling has ‘clipped’ the lower growth but the gorse bush is sprouting vigorously above rabbit reach.

Courtesy of Landcare Research, New Zealand.

Rabbits can chew the bark, or eat the branches, causing ‘multicrowning’, which means the tree does not have a single dominant leader and is unable to grow straight and true.

Rabbits in native ecosystems

Some sensitive ecosystems such as sand dunes can suffer from the effects of rabbits, and similarly, restoration plantings may not establish in the presence of rabbits. In one instance on the Kapiti coast, rabbits were thought to prevent the regeneration of nikau in the forest remnants that they used for cover by nipping off all new seedlings.

Most impacts on native ecosystems occur, not surprisingly, where most rabbits occur – the native tussock grasslands. However, the effects of rabbits are difficult to separate from the other effects such as burning, sheep grazing, and invasive weed species.

Where weed species are not well established, the grasslands tend to benefit from lower rabbit numbers. However, where weeds are prevalent it may be that light grazing by rabbits actually prevents the weeds taking over completely.

By significantly altering the vegetation composition, there are likely to have been significant effects on the native birds and insects that originally lived there. A more direct and ongoing consequence of rabbits is that their presence encourages predators such as ferrets and cats. After rabbit control, or after a local RHD epidemic, the rabbit population suddenly declines, and predators look elsewhere for dinner. This is called 'prey-switching', and can have a significant effect on native bird populations, particularly along riverbeds.

Further information

For further information on rabbit pests, see 'The Handbook of New Zealand Mammals', King, C.E. (ed.) 2005. Oxford University Press 2006. ISBN-10: 0195584775.

There are various best practice resources available from npca.org.nz, associated website pestdetective.org.nz, and doc.govt.nz

Avian

This section introduces the five pest birds covered in this Learner Guide: Starlings, Mynas, Rooks, Magpies and Sulphur-crested Cockatoos.

Starlings

Male starling

Courtesy of Landcare Research, New Zealand.

▶ Introduction to New Zealand

- Starlings were first introduced in 1862 from Britain by the Acclimatisation Society.
- Starlings were introduced to control insect pests on agricultural land.
- Starlings live in any reasonably open environment — agricultural land or urban areas.
- Starlings are not forest birds.

▶ Physical appearance

The starling is a small bird approximately 20 cm long, and weighing around 70–100 g. Iridescent green glossed feathers cover the nape, breast, and back of the bird, while the wings are black, sometimes with a green or purple veneer. During the winter white flecking may appear on the starling's breast.

▶ Habitat and diet

The diet of starlings is a mix of invertebrates such as grass grubs, caterpillars, moths, worms, snails and spiders, fruit and nectar from flax and pohutakawa flowers, and cultivated grain and horticulture crops (particularly grapes and olives). In urban areas starlings will scavenge food waste. Birds feed mainly on the ground by picking at the soil with their beaks.

▶ Behaviour and home range

In flight a starling flock looks like a disorganised ball shape and starlings will return to their communal roost site each evening. They will forage far and wide during the day, taking advantage of any likely food source they can find.

Seasonal movements to food sources are dictated by availability, e.g. ripening grapes or olives, cultivated grain or horticultural crops, or the availability of soil invertebrates when soil conditions are reasonably moist. Daily movements are quite variable, depending on availability of food sources.

Mynas

▶ Introduction to New Zealand

- Mynas are native to India, and were first introduced in 1870 by the Acclimatisation Society.
- The primary reason for introducing mynas was to control insect pests on agricultural land.
- Mynas can be found in any reasonably open environment – agricultural or horticultural land, and urban areas.

Myna

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai; Photographer: Kendrick, J. L.

- They prefer a warmer climate and are most common in the upper North Island.
- Mynas are part of the starling family and are not a forest birds.

▶ Physical appearance

Approximately 25–26 cm in length with a relatively heavy build. The head, neck and upper breast of the adult is glossy black, while the undertail coverts, tail tip and the outer feathers are white. The bill, legs and feet are bright yellow, while the adult iris is reddish brown. As with starlings, Mynas are distinctive in that they move about in a walk rather than a hop.

▶ Habitat and diet

Like most starlings, the Myna is omnivorous. It feeds on insects and fruits, and discarded waste in urban settings. It forages on the ground among grass for insects, tending to target above ground species. They are opportunistic feeders, and will move to seasonal food sources, such as ripening fruits or crops. However, they are primarily insect eaters throughout the year, targeting invertebrates found at the soil surface.

▶ Behaviour and home range

Mynas may roost in flocks, though in numbers far smaller than starlings. They will forage away from the roost site during the day, taking advantage of any likely food source they can locate. Data indicates daily movements up to 3 km from the roost sites can be expected. The flock will usually disperse into numerous smaller gangs.

Rooks

▶ Introduction to New Zealand

- Rooks were first introduced in 1862 from Britain by the Acclimatisation Society.
- The primary reason for introducing rooks was to control insect pests on agricultural land, particularly grass grub.
- Rooks can be found in reasonably open environments, mainly agricultural land.
- Rooks are not forest birds.

Rook on a perch.

Courtesy of Taranaki Regional Council.

▶ Physical appearance

The rook is black with a violet blue glossy sheen. It is approximately 50 cm long, and weighs 350–500 g. Adult birds are typically crow-like in appearance, and can be distinguished from younger rooks by conspicuous grayish white bare skin at the base of the beak.

▶ Habitat and diet

Rooks like to eat cereals at all stages of the crop, emerging maize crops, pumpkins and potatoes, recently cultivated land, and walnut trees. Foraging on pasture for invertebrates also provides much of their food.

In Hawke's Bay, gizzard contents taken throughout the year contained a diverse range of foods, dominated by fly larvae and adult beetles in the summer months, and by earthworms during all but the driest or coldest months. Walnuts and acorns were eaten in autumn and winter, cereals and peas in late summer, autumn, and winter, and carrion from the carcasses of stock, as well as grass and clover throughout the year. Rooks will travel to these food sources as they become available seasonally. Food fed to nestlings is mainly invertebrates.

▶ Behaviour and home range

Rooks roost communally, and the flock tend to forage together during the day. Flock sizes can number in the thousands, although ongoing control of rooks in New Zealand ensures that large flocks are rarely seen. A flock of rooks is also called a 'parliament'. As an indication of home range, rooks can forage up to 20 km from their roost, wherever a suitable supply of food can be found.

Magpies

▶ Introduction to New Zealand

- Magpies were first introduced in 1864 from Australia by the Acclimatisation Society.
- The reason for introducing magpies was to control insect pests on agricultural land, particularly grass grub.
- Magpies can be found in reasonably open environments, mainly agricultural land.
- Magpies are not forest birds.

Australian magpie

Courtesy of Landcare Research, New Zealand.

▶ Physical appearance

There are two sub-species of magpie, the white-backed and black-backed magpie, which do interbreed. Adult magpies are fairly solid, well-built birds ranging from 36–44 cm in length. Plumage is pure black and white; males and females of all races have black heads, wings, and underparts, with white napes and shoulders. Tails are white with a black terminal band.

Plumage of juveniles contains lighter greys and browns amidst the starker blacks and whites. Mature magpies have red eyes.

The magpie's most distinctive characteristic is its flute like call, best heard soon after daybreak or in the evening.

▶ Habitat and diet

The magpie is omnivorous, with most of its varied diet made up of invertebrates. Other small animals such as frogs, mice, and chicks of other bird species are also occasionally eaten. The magpie is usually a ground feeder, pacing open areas methodically searching for insects and their larvae.

Being territorial birds, up to ten magpies will sometimes group together in a 'tribe' to defend their home. Most territories are, however, 'owned' by a male and female pair. The pair usually mates for life; but a missing mate is quickly replaced. A territory will have reliable feeding and watering areas, tall trees for shelter and nesting, and the home range may only measure a few km across. Usually there are more females than males in a group territory. Magpies do not tend to move out of defended territories to take advantage of seasonal food sources.

▶ Behaviour and home range

Young magpies and less successful mature birds band together in large transient flocks of up to several hundred birds. The areas that these birds live in are unsuitable as breeding territories so the flock must move from place to place in search of food and shelter, consequently having no fixed home range. Individual birds in the flock will only breed and nest if they can replace a bird in a breeding territory.

Sulphur-crested cockatoo

▶ Introduction to New Zealand

Sulphur-crested cockatoo

Courtesy of Ngā Manu Nature Images.

- It is not known when sulphur-crested cockatoos were initially introduced to New Zealand, but they came from Australia.
- Cockatoos are one of many popular cage birds, introduced as pets and companions for people. Their release into the wild is not intentional, and will have occurred when the birds escaped from captivity.
- Cockatoos can be found in forest margins and open woodlands.

▶ Physical appearance

The sulphur-crested cockatoo is a large white parrot, measuring 45–50 cm and weighing about 800 g. It has a dark grey-black bill, a distinctive sulphur-yellow crest and a yellow wash on the underside of the wings.

Sexes are similar, although the female can be identified at close range by its red-brown eye (darker brown in the male). This is a noisy and conspicuous cockatoo, both at rest and in flight. The most common call is a distinctive loud screech, ending with a slight upward inflection.

▶ Habitat and diet

The sulphur-crested cockatoo's normal diet consists of berries, seeds, nuts and roots. The species is sociable, sometimes forming flocks of several hundreds, though generally New Zealand has much smaller flocks. Flocks may split into small groups and travel up to 6 km to forage for food, coming together again at the evening roost site. Home range encompassing the roost sites is around 25–45 km^2. Feeding is often done on the ground, and when this happens some of the flock will be on guard in nearby trees to alert of any approaching danger. Communication is noisy, easily attracting attention.

▶ Behaviour and home range

Birds form life long pair bonds, showing sociable and affectionate behaviour throughout the year.

Avian control

The saying ‘bird-brain’ is rudely used to mean ‘stupidity’. However, it is wrong to associate this term with the birds described here.

Starling

Courtesy of Landcare Research, New Zealand.

All five species, some more than others, have:

- intelligence
- wariness
- good memories
- an ability to learn from experience.

This causes some real challenges for control. In general, there are a range of approaches that will not work well:

- Shooting — If a bird is shot, others will become wary and stay out of range
- Repeated poisoning attempts — Birds can easily pick up on the harmful effects of poisoning. If poisoning is used it must be done well but not very often, ensuring almost all of a flock is targeted at once.

Poor control efforts can make things worse, e.g. rooks are harassed with poor control methods, such as shooting up rook nests with a shotgun, causing rookeries to be abandoned, and the birds to set up camp in lots of new locations. Now you have more rookeries than you started with, possibly in unknown locations, and comprised of birds which have learned to be careful.

Despite the challenges of controlling these birds, they do tend to roost in flocks, and in the same place each night. This provides a good opportunity for targeting effective control.

Impact of avian pests on primary production and native ecosystems

Impact of avian pests on people and primary production

All five bird species discussed, except cockatoos, were introduced to control insect pests on pasture. However, while the birds do eat invertebrate pasture pests, they do not eliminate all insect pests. Some species like grass grub spend much of their time buried too deeply in the soil for the birds to access.

What became apparent in most cases, and not long after their introduction, is that these birds do not focus their attention exclusively on pasture pests. Their other feeding habits, and behavioural traits, have proved to be pest-like as well.

Starling flocks can be huge, descending on cultivated grain and horticulture crops (particularly grapes and olives), completely destroying them in the worst case scenario. Their roosting sites are noisy, heavily soiled with faecal matter, and contain large numbers of mites. These kinds of roosts can be used for no other purpose.

Starling nest

Courtesy of Landcare Research, New Zealand.

The myna has less impact on grain and horticultural crops, due mainly to the much smaller flock sizes.

While rooks will target freshly ploughed fields for insects, planted seed is also taken in such huge quantities that re-sowing is often needed. Rooks damage a wide range of crops such as newly sown cereals, ripening peas, potatoes, harvest walnuts, acorns, and fruit. The greatest damage to crops, particularly maize, is very early, when the young plant is pulled from the ground to get the sprouting seed.

Rook

Courtesy of Waikato Regional Council.

Magpies have little impact on primary production, with their main social impact being their aggression towards anyone intruding on their territory during breeding season. This is quite disturbing, especially for children, and while most attacks involve swooping and dive bombing, they sometimes meet their target and draw blood.

Black-backed magpie

Courtesy of Landcare Research, New Zealand.

Sulphur-crested cockatoos have little impact in New Zealand, as their non-domestic numbers remain low at this time. Some effects can occur on cereal, fruit, and nut crops, but experience overseas has shown that these effects are only substantial where large flocks of cockatoos exist.

None of the bird species discussed has any effect on production forestry.

Avian pests in native ecosystems

Of the five species discussed, Sulphur-crested Cockatoos are the only species which invade New Zealand forest ecosystems. They have little effect at this stage due to their limited numbers and distribution. However, they may potentially compete with native cavity nesting bird species, even though there has been little competitive interaction shown.

The remaining four species are not forest birds, and have minimal impact on native species.

- Starlings have no real impact on native species, other than removing native birds from starling roosts.
- Mynas can perhaps prey on chicks of other species, but this effect is not well documented, and unlikely to be significant to population.
- Rook impact is limited to agriculture, and not native species.

Magpies have been known to kill native birds and their chicks, as well as ridding them from magpie territory. When magpies are removed from an area, more native birds are likely to be seen. However, of the numerous predation events captured on video, magpies are responsible for only a very small proportion, indicating that they pose little real threat to native bird populations. The effect of magpies may be seen to be worse than it is, because they also attack people, and all their activity is done during the day in plain view.

Most native birds live in forest environments, where the agricultural pest bird species do not occur.

Further information

For further information on avian pests, there are various best practice resources available from npca.org.nz, associated website pestdetective.org.nz, and doc.govt.nz

Predators

Mustelids

Mustelid introduction and distribution in New Zealand

Mustelids are a diverse group of small to medium sized carnivores distributed throughout the world. Three species are found in New Zealand; the ferret, stoat, and the weasel.

Weasels

Courtesy of Brent Higham.

Ferrets were introduced to New Zealand from the late 1870s. Stoats and weasels arrived from the mid 1880s to control the burgeoning rabbit problem. Whilst they weren't effective in controlling rabbit populations, their own status as pests was quickly recognised, and all legal protection of mustelids was removed around 1900.

Species	Origin	Year of introduction to New Zealand	Main area of distribution
Ferret	Britain	1879	Released into the Conway River Valley (South Island)
Stoat	Britain	1884 (by Mr Rich of Palmerston)	South Island
Weasel	Britain	1885	Throughout New Zealand

Physical appearance

All mustelids have a characteristically long body, short legs, and sharp pointed faces. Ferrets are by far the largest, followed by stoats, and then the smaller weasel. Ferrets have a creamy yellow woolly undercoat, sprinkled with long contour hairs which are black at the tip, giving a general dark appearance. The legs and tail appear darker than the body. The lighter facial area has a dark mask around the eyes and across the nose.

Stoats and weasels are similar looking with brown fur on top, and white below, brown face and legs. The easiest way to distinguish stoats and weasels is by the tail. The stoat has a thin brown tail with a distinctive bristly black tip, while the weasel has a thin pointed tail, which is always brown. The males of all species are significantly larger than the female.

Ferret (back), stoat (centre) and weasel (front).

Courtesy of John Innes, Landcare Research, New Zealand.

Habitat and diet

Mustelids are widespread in the North and South Islands. Ferrets are uncommon in forest areas but often found in association with rabbits in developed and rough farmland habitats, and high country where they are more abundant than stoats. Ferrets are rarely found in areas with more than 1500 mm annual rainfall.

Stoats are the most common forest species, and distributed throughout most habitats, being able to handle extremes of rainfall and temperature. Stoat populations are naturally unstable and determined mainly by food availability. Their short life-spans, combined with typically high and variable birth and death rates, make stoats very difficult to manage with anything other than continuous control.

In New Zealand weasels are rarely seen. They are known to be found in forests, in tussock grasslands, and on farmland.

▶ Food and feeding

Stoats are the most opportunistic of these carnivores, taking a wide range of prey, which may explain why they are more widespread than ferrets and weasels. While ferrets and weasels will also both take a range of prey, ferrets tend to rely more on rabbit populations, and weasels on mice populations. Weasels are thought to be prone to localised extinction over a season if numbers of mice and other small prey are low.

Behaviour and home range

Ferret home ranges overlap each other and are not usually actively defended, unless there is a food shortage. A food shortage is also likely to lead to an increased home range size, although the adult ferret will stay in the general area.

Rabbit control, for instance, may cause ferrets to increase their home range and target alternative prey, which is called 'prey-switching'.

Stoat and weasel home ranges also overlap, and tend to increase in size as seasonal food shortages decrease, though they will usually return to their core range.

▶ Activity

Ferrets are mostly nocturnal, while stoats and weasels can be active during the day or night.

	Ferrets	Stoats	Weasels
Average male weight	1200g	324g	126g
Average female weight	600g	207g	57g
Average life span	< 1 year (max 5–10)	< 1 year (max 3–8)	< 1 year (max 2–3)

	Ferrets	Stoats	Weasels
Breeding season	Usually September to October, but can last longer	September to November	September to March
Usual number of litters per year	1 (max 2)	1	1–2 (max 3)
Usual litter size	4–8 (max 12)	8–10 (max 20)	3–6 (max 11)
Juvenile dispersal	February–March	Most often December to January but sometimes can start in November	January–May
Known dispersal distances	Up to 45 km	Up to 65 km	None published
Average home ranges (min–max)	Males 200 ha (80–760) Females 122 ha (45–230)	Males 147 ha (16–313) Females 79 ha (9–127)	Males 1–192 ha Females from less than 1–29 ha (Not averages but min–max from overseas)

Social structure

All mustelids primarily communicate by 'olfactory' (smell) communication. Their ranges are marked using anal gland secretions, applied by 'anal dragging', typically followed by defecation. Other scent glands found elsewhere in the skin are applied by rubbing. This lets other mustelids know the home range, sex, and breeding condition of other mustelids, and helps to prevent damaging conflicts. Similar to the behaviour of dogs, dominant mustelids actively mark over the top of other markings.

At close range a selection of vocal sounds are used to communicate. Friendly encounters are accompanied by high pitched trilling, or a submissive trilling if the subordinate animal is not immediately threatened.

A sharp explosive chirp or shriek is a defensive threat. Ferrets make a high pitched barking noise when frightened. They also have a defensive hiss and confident chatter in their repertoire.

Stoat

Courtesy of Ngā Manu Nature Images.

Face of a weasel

Courtesy of Brent Higham.

Stoats and weasels tend to be solitary animals, while ferrets sometimes hunt in pairs. When encountering other species, mustelids will either try to kill them for food, or avoid them if they are too large to tackle.

Ferrets

Courtesy of Ngā Manu Nature Images.

▶ Predators

Stoats and weasels are often attacked by falcons, wekas, feral cats, and possibly ferrets. However, predator impacts are low and have no real effect on the population. Ferrets have no natural predators.

The main predator of all mustelids is humans, by their poisoning and trapping control programs.

Signs of presence

▶ Ferrets, stoats and weasels

- Droppings: Black, long, thin, twist at each end.
- Footprints: Five toes each foot, fur between toes, and non-retractable claws.
- Kill signs: Messy eaters, and usually hide their food. Bite marks can sometimes be seen on the back of the neck.

Weasel with young rat.

Courtesy of Ngā Manu Nature Images.

Mustelid control

▶ Mustelid behaviour and characteristics relevant to control

Successfully maintaining mustelid control is a real challenge. Firstly, each female mustelid can breed numerous offspring in a year, so the population can quickly recover after control.

Secondly, mustelids display a range of behaviours which make ongoing control difficult:

- large home ranges are maintained, which means small areas cannot be effectively controlled
- reinvasion is a problem because juvenile mustelids will disperse large distances, and prefer to settle in areas of lower population density (i.e. the control area)
- ferrets, particularly females, tend to avoid bait and traps during the breeding season.

Subsequently, control needs to be continuous, or targeted to specific times when mustelids are likely to do the most damage to the species being protected. For example, to protect kaka, stoats should be controlled while female kaka are on the nest until the chicks fledge. However, to protect kiwis, ferrets and stoats need to be controlled all year because adults, chicks, and eggs are vulnerable.

For ferrets, which usually breed only once per year, annual control over large areas is carried out.

One other relevant behaviour that affects mustelid control is their hunting and scavenging of prey species, which may themselves have been poisoned. This can result in secondary poisoning of mustelids. Secondary poisoning following 1080 or brodifacoum operations against possums or rabbits can reduce mustelid populations significantly. However, possum and rabbit control operations are not usually repeated often enough to ensure low mustelid populations are maintained.

Dominant and subordinate behaviour between mustelids is not relevant to trapping or baiting because they have a habit of being solitary creatures.

Poisoning

No toxin is currently registered for use in stoat or weasel control. In fact, weasels are rarely targeted for control as they present little threat to the survival of any native species. Their populations are naturally unstable and prone to frequent local extinction. While they are captured in traps set for stoats and sometimes ferrets, the trapping grids for those species are not likely to be spaced closely enough to target all weasels in their smaller home range. A rat trapping grid is probably more suitable.

For ferrets, poisoning is best done in autumn after juveniles have settled into a new location, to minimise reinvasion of an area by more juveniles. Poisoning is most effective from late summer through autumn, and poisoning remains effective into early winter. Poor poisoning success of any ferrets in the winter, and of female ferrets during the breeding season, is believed to be due to avoidance of new objects in the environment. This may be partly overcome by leaving bait stations in place continuously, but successfully targeting breeding females remains a problem.

Trapping

Trapping is an effective tool for mustelid control, particularly where a permanent trapping grid is maintained. Because live traps require daily checking, kill traps are recommended. Kill traps should be placed in tunnels to minimise non-target captures.

For ferrets, trapping is best done in autumn, after juveniles have settled in a new location, to minimise reinvasion of an area by more juveniles. Poor trapping success of any ferrets in the winter, and of female ferrets during the breeding season, is believed to be due to avoidance of new objects in the environment. This may be partly overcome by leaving traps in place continuously.

Because of the large home ranges of stoats and ferrets, traps can be spaced quite far apart, and along readily accessible routes. Trap lines should follow habitat perimeter, ridges, tracks, altitude contours, waterways and the most practical access, as long as trap spacing does not exceed 500 m.

Impact of mustelids on native ecosystems

▶ Mustelids in native ecosystems

Ferrets have a significant effect on many riverbed breeding birds, e.g. black stilt, dotterel species and pied oystercatchers. Ferrets are known to prey on royal albatross chicks, yellow-eyed penguin and little blue penguin, weka, North Island kiwi (including adults), and numerous freshwater wetland birds. They are considered as one of the major causes of decline of the white-flippered penguin, and as a significant and probable main cause (along with cats) of massive range reductions for grand and Otago skinks.

Ferret scavenging body of dead rabbit.

Courtesy of Ngā Manu Nature Images.

When rabbit numbers are lowered with a control programme, ferrets will change their diet to other species, which increases the risk to native species temporarily. This behaviour is another example of prey switching.

Stoats are considered to be the most destructive predator of native birds in New Zealand forests, implicated in the extinction of up to 30 species. Birds that nest in tree holes, such as mohua and yellow-crowned parakeet, are particularly at risk. And there is good evidence that trapping stoats can make a big difference to the survival of native birds. For example:

- Low intensity stoat control was initiated in the Eglinton Valley (13 000ha) using a single 40 km line of traps spaced 200 m apart and set continuously. 25 Kaka nests in the control area produced 55 fledglings compared to a 90% fledging failure where there was no control.

Stoat hunting

Courtesy of Ngā Manu Nature Images.

- Stoats are a common predator of kiwi chicks, and without active stoat control, only as few as 5% of chicks each year are likely to survive to a safe weight.
- Stoat trapping at Craigieburn resulted in an 80% survival rate for bellbird chicks, and the population size also increased by 80%. Again, where no trapping was carried out, fledgling survival was only 8%.

Being more patchily distributed, and at much lower density, weasels are not thought to pose a significant conservation risk. They may, however, damage small and localised populations of endangered species for example, the Whitaker's skink.

Rodents

Rodent introduction and distribution in New Zealand

Rodents are the largest order of mammals, comprising about 2000 species worldwide. This extremely successful group has adapted to practically every land-based and freshwater habitat.

Ship rat at fantail's nest.

Courtesy of Ngā Manu Nature Images.

New Zealand has one species of mouse and three species of rat: the Kiore, the Norway rat, and the Ship rat (also known as the black rat or bush rat).

Of the rats, the Ship rat is by far the most common, with Kiore and Norway rats largely restricted to some offshore islands, with some appearing sporadically on the main islands. This Learner Guide covers the mouse, Ship rat, and Norway rat.

▶ Introduction to New Zealand

The ship rat originated in India and spread to Britain by the 3rd century AD. Both Norway and ship rats first came to New Zealand as unwanted stowaways on ships. Ships arriving in New Zealand in the late 1700s mostly carried Norway rats, rather than Ship rats. The precise time at which ship rats got to New Zealand is not known, but Ship rats became the most common rats aboard ships around 1830–1850, spreading through the North Island from 1860, and the South Island from 1890.

Mice, like ship rats, were carried to New Zealand as stowaways on Australian and European ships. Mice were first recorded in New Zealand on Ruapuke Island in Foveaux Straight after a ship wreck in 1824, and mice arrived at the Bay of Islands by about 1830. Mice were not found in the South Island until 1850.

▶ Distribution

Ship rats are found in the North, South, and Stewart Islands, wherever suitable habitat is available. They are also present on most offshore islands, except those where they have been successfully eradicated. They are found from the coast to the tree line, but less often at higher altitudes, and seldom in the alpine tussock.

Mice are found throughout the North and South Islands, from the coast to high altitude (they have been observed on Mt Ruapehu, as high as 2300 m). They have failed to establish wild populations on Stewart Island, and some other offshore Islands (though mice may live in places in close association with humans).

Mice have been eradicated from 14 islands since 1983, but other attempts weren't so successful because mice are much more difficult to eradicate than rats.

Physical appearance

The Ship rat is sleek and slender with a scaly and sparsely haired tail, and large sparsely haired ears, which if pulled forward, will cover their eyes. The Ship rat can be easily distinguished from the Norway rat. The Norway rat's tail is shorter than its head and body, while the Ship rat's tail is longer than its head and body combined. The front feet of Ship rats have four clawed toes, and the hind feet have five. Eyes are small and beady, sensitive to light, but their eyesight is not particularly good. Hearing and smell are excellent. The normal number of nipples is 10.

The Norway rat can be distinguished from the ship rat by its 'shaggier' look, tail shorter than body, broader snout, and smaller ears. The normal number of nipples is 12, where Ship rats have 10.

The mouse has a thin tail about the same length as its head and body, large prominent black eyes, round ears and a pointed snout with long whiskers. Colouring is grey-brown on the back, and grey, white or brown on the belly. Mice have 10 nipples.

Ship rat

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai.

Norway rat

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai; Photographer: D. Garrick.

Mouse

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai; Photographer: Don Merton.

Habitat and diet

Rats are commonly found in diverse lowland forests, but are found in all forest types, parks, hedgerows, farmland, and in buildings. Their climbing ability means that their habitat is three dimensional, incorporating everything from the ground to the treetops. They are also found where humans are, especially where food resources are abundant, such as at rubbish dumps.

Mice are typically thought to be associated with urban environments, reaching high numbers when both food and shelter from predators are available such as houses, stores, factories, and rubbish dumps. Mice are also found in native and exotic forest and shrublands, rank grass, pasture, croplands and subalpine tussock. In general mice reach highest population densities in areas with dense groundcover.

Ship rats suppress mice in mainland forests. Therefore, rat control 'releases' the mouse population.

▶ Food and feeding

Rats eat both plant and animal matter, depending on availability. Commensal rats (living in association with humans) eat almost any animal or grain product, fruit, or any edible stored product or refuse to which they can access.

In forests, rats rely on both plant and animal food, including weta, and other large invertebrates such as beetles, spiders, stick insects, and cicadas.

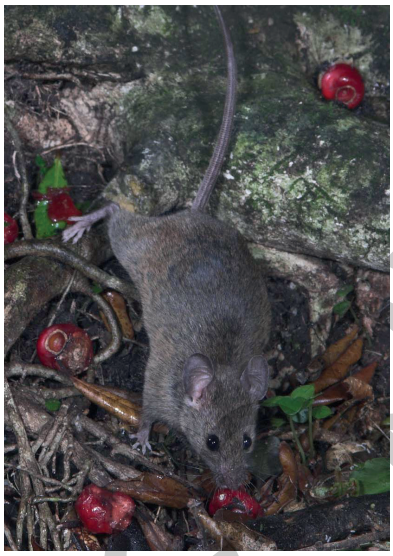
Birds and their eggs are usually not preferred in the diet, but because there are so many rats and they climb so well, they still have a major impact on bird populations.

Ship rat eating thrush egg at nest.

Courtesy of Ngā Manu Nature Images.

Other prey items of conservation concern are native snails, slugs, and lizards. Important fruits and seeds in their diet include karaka, rimu, hinau, kiekie, pigeonwood, kawakawa, miro, matai, nikau, pate, and kohia.

Mice have a very flexible diet, including small invertebrates and plant material. Caterpillars are the most common invertebrate eaten, followed by spiders, beetles and weta, and any other invertebrate of 3–12 mm length. Mice eat a range of seed species including hard beech, mountain beech, and rimu. Mice manipulate seeds with their forepaws, chew open the husk and eat out the nutritious contents.



Mouse foraging for fruit.

Courtesy of Ngā Manu Nature Images.

Behaviour

Rodents have well developed systems for communicating with other rodents.
The system is based mainly on smell (through scent marking), as well as visual (aggressive postures) and auditory. This includes both audible and ultrasonic sounds (sounds at very high frequency and beyond human hearing).

All rodents scent mark using urine. The various hormones in the urine allow other mice to recognise the breeding condition, home range, and social dominance of other rodents in the area. The characteristic and unpleasant smell of rodents is mostly associated with male mice. Female mice, and rats of either sex, do not smell nearly as strong as male mice.

▶ Activity

Both rats and mice are mostly nocturnal, which means most activity and feeding is done at night. However, while the main periods of activity for mice are at dawn and dusk, mice do continue to feed less intensively during the day.

▶ Nesting patterns

Rats have many nest sites available in epiphytes and tree hollows of mature forests. In habitats where no natural shelters are available, they may dig burrows (mostly Norway rats do this), or build ball shaped shelters 30–100 cm across in hedges or young trees. Rats may use from 2–9 different nests, and up to three rats may nest together at any one time (males and females).

In the wild, mice generally dwell in cracks of rocks or walls or make underground burrows consisting of a complex network of tunnels, several chambers for nesting and storage, and three or four exits. When living with humans, mice nest behind rafters, in woodpiles, storage areas, or any hidden spot near sources of food. They construct nests from rags, paper, or other soft substances.

Home range and movement

The home range of rats in forests is three dimensional, including the trees. Most of the home range is covered each night. If a rat disappears from an area, that range is soon taken over by neighbouring rats, which means re-invasion after a control programme can be rapid. Mean home range size usually ranges from 100–200 m.

Mice tend to have smaller home ranges than rats, with a typical length of about 60 m. At higher numbers, home ranges overlap, and mice do not defend territories. Mice cover most of their territories on most nights.

Rat climbing tree, preying on fantail's nest.

Courtesy of Ngā Manu Nature Images.

Social structure

Forest living rats tend to be quite evenly distributed throughout the available habitat, either as individuals or family groups. Female distribution depends mainly on food availability. No long term male/female bonds are formed, and females look after the young with no help assistance from males.

Wild living mice are mostly non-territorial, and do not live in groups unless the population density is high. As with rats, female mice distribution depends mainly on food and shelter availability. No long term male/female bonds are formed, and females look after the young with no assistance from males.

Rodents do not interact with other species, other than being wary of potential predators.

Signs of presence

- Droppings: Size depends on rodent but can be up to 19 mm long.
- Footprint: Four-toed forefeet and five-toed hind feet.
- Kill signs: Double incisor marks in food remains, droppings around kills, and leftover shell fragments in nests.
- Vegetation damage: Seeds with neatly chewed holes to access contents, larger fruit may show distinctive parallel double incisor marks.

Weasel with mouse.

Courtesy of Ngā Manu Nature Images.

Rodent control

Rodents are susceptible to trapping and poisoning during all seasons, and so there are no behavioural influences which indicate a better time of year for control. However, many control operations of wild rodents tend to be carried out in the late winter/early spring, and early summer period, because this is an important (breeding) time for native species. This is also because winter food stress encourages bait consumption. Active control can slow or prevent the population increase that would otherwise be seen in rodent populations.

Because of the rather small home range of rats and mice, control efforts must be intensive, to ensure traps or poison get into every home range.

▶ Predators

While rodents are predators themselves, they also feature on the menu of many other predators, including:

- cats
- stoats, ferrets, weasels
- kingfisher
- falcon, harrier hawk
- morepork, little owl
- weka
- possums.

Possum and rat at thrush nest.

Courtesy of Ngā Manu Nature Images.

Impact of rodents on primary production and native ecosystems

▶ Impact of rodents on primary production

Rodents have long been regarded as pests, destroying and fouling both human and stock food. Grain silos, for example, provide a warm sheltered environment, with plenty of hiding places, and lots of food. If rodents are allowed to live in such stores, the entire stock may be spoiled by the characteristic and offensive smell of rodents.

Similarly, rodents are completely unacceptable in the dairy industry which relies on high levels of hygiene of all food contact surfaces. Other intensive farming operations, such as pork and poultry production, can also be badly affected in terms of hygiene and disease if rodents are allowed access to the animal facilities.

Compared to other countries, rodents pose little risk to pastoral farming, horticulture, and forestry. However, closer to home, rodents tend to invade houses, especially during winter, and so create direct health risks and annoyance to humans. Restaurants and other food distribution sectors suffer likewise.

▶ Rodents in native ecosystems

Ship rats pose a serious threat to wildlife in New Zealand forests, and may threaten the seed survival of some plant species. Ship rats are probably the most widespread and significant mammal predator on the mainland, even more so than possums and mustelids.

Although the history of native species extinction in New Zealand cannot be linked to any one species, events on Big South Cape Island (just off Stewart Island) give us an idea of the damage done. Rats arrived at Big South Cape Island in 1962 or 1963, and were the first and only mammal predator there.

And it happens that at about the time ship rats were spreading through the rest of New Zealand, numerous species of birds became much reduced or went extinct, including the:

- Bellbird
- Stitchbird
- Robin
- Saddleback
- Thrush
- South Island Kokako
- Yellowhead
- Red and yellow-crowned parakeets.

Kingfisher in flight

Courtesy of Ngā Manu Nature Images.

During that period many large flightless invertebrates such as weevils, snails, and giant weta have also been eliminated, or can now only be found on rodent-free offshore islands.

The impact of mice on native ecosystems is possibly less than rats, but is not really known. Because of their smaller size, direct predation is rare in relation to birds, although populations of skinks, geckos, and invertebrates can be affected by mouse predation.

Perhaps of greater significance is the effect on forest regeneration, because of mice eating seeds.

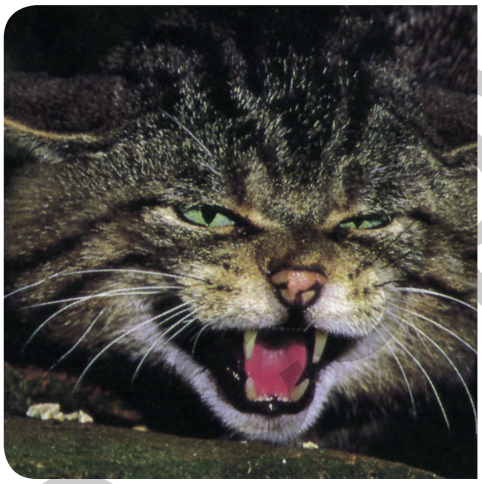
Feral cats

This section of the Learner Guide has been adapted from the publication *'Feral and Stray Cats: Monitoring and Control, a Preliminary Guideline towards Good Practice'* produced by National Pest Control Agencies (NPCA).

Cat introduction and distribution in New Zealand

▶ Introduction

Cats were deliberately introduced to New Zealand from 1769 onwards by European explorers. They often gifted or left cats in New Zealand, and ships visiting New Zealand carried cats to control on-board rat and mice infestations. Despite this cats may not have become fully feral until 50 years later.



Feral cat

Courtesy of Northland Regional Council.

Feral cats probably became established in the North Island by the 1830s and in the South Island by the 1840s. By the 1860s they were reported as being numerous in the Canterbury area. Cats were moved around by settlers and were further spread around the country to try and control large rabbit populations. Cats were introduced to many offshore islands by sealers, whalers, settlers, farmers, and others. Fortunately, the majority of feral cats have died out on a number of offshore islands, although they have not been fully eradicated.

▶ Distribution

New Zealand, cats are widespread in the North, South, and Stewart Islands. They range from fully feral, to reliant on human settlements for food, to fully domestic. They are found living in a range of terrestrial habitats from sand dunes to tussocks, exotic or native forests and scrub, and from sea level to 3000 m.

Physical appearance

Within New Zealand, feral cats tend to fall into one of six distinctive coat patterns:

- striped tabby (the basic type)
- blotched tabby
- black
- grey
- ginger
- tortoiseshell.

Feral cat
Image courtesy of Northland Regional Council.

They all can have white patches on the body and the most dominant patterns are the two tabby and black coat colours.

Cats have sensitive hearing, being able to hear frequencies up to 65 kHz. They have well-developed night vision (with a green eye shine). They can see colour in daylight but do not usually respond to colours. Female cats weigh around 70–80% of the weight of male cats.

Behaviour

▶ Activity

The activity patterns of cats ranges from diurnal to nocturnal, depending on season, habitat and the presence of a litter. Some can be active throughout the whole 24 hour period.

Home range

The home range of cats depends largely upon three factors (although other factors can also affect it):

1. Cat density
2. Prey density
3. Habitat type.

Feral cats are usually solitary and sparsely distributed, with measured home ranges in excess of 200 ha. Domestic cats maintain a much smaller home range compared to feral cats. In times of prey scarcity, home range size increases as cats are forced to travel further for food resources. Cats will tolerate some overlap between home ranges, but maintain a core area that will be aggressively defended.

Home range boundaries are marked using scent glands, claw sharpening on particular trees, spraying urine and leaving scats in conspicuous places. While domestic cats usually bury their scats within their own territory, they often leave them unburied when further afield.

Habitat and diet

Cats are well known predators. In mainland New Zealand, where there is a range of (introduced) mammal species present, cats feed predominantly on rabbits and rodents. Birds do make up a part of the diet, and reptiles are important prey species at low latitudes. Other species preyed upon include invertebrates, frogs, and fish; however, these are less common. Diet depends a lot on the cat's habitat. In forested or agricultural areas, rabbits can be a dominant part of the diet, with possums, stoats, hedgehogs, and dead carcasses also comprising a small component.

On Stewart Island and offshore islands where prey availability is often limited, cat diet tends to rely heavily on rodents, especially ship rats or kiore rather than Norway rats. Juvenile Norway rats are taken but adults are often left as they can be very aggressive towards predators. In these island locations, birds make up a much larger component of the diet compared to mainland populations. Seabirds and perching birds commonly fall victim to cat predation and the species taken can vary considerably in size.

In Central Otago and the McKenzie Basin, lizards and skinks are frequently preyed upon. Invertebrates are also taken, but usually only larger species such as weta, black field crickets, and cicadas. Small or juvenile cats often eat more invertebrates and smaller prey, possibly because they have not developed the hunting skills of adult cats.

As well as being expert predators, cats are also opportunistic scavengers and will scavenge dead carcasses. They can contribute to the spread of some livestock diseases. Interestingly, healthy feral cats do not need access

to drinking water as they obtain all they require from the prey they eat. However, in times of prey scarcity, or when suckling young, some drinking water is required.

Social structure

Kin groups will sometimes be established, especially in areas such as farm buildings or food waste dumps. These are often female kin groups, with a single male included or a number of males loosely associated with the group. Young males are driven out of the group as they near sexual maturity.

Sexual maturity is reached at around 8–12 months of age. Feral cats have smaller litters compared to domestic cats, producing a maximum of five kittens, but often not all of these survive. Pregnant and lactating cats are often found from October to April or May, however some cases of pregnant or lactating feral cats found in winter have been recorded.

The kittens of feral cats reach 500 g in around five to six weeks. Feral cats keep their kittens in the den where they were born until this weight is attained and then move to temporary dens, staying only a matter of days at each. Thereafter, feral kittens grow much more slowly compared to domestic kittens.

▶ Population densities

Population densities of feral cats vary greatly in New Zealand, as elsewhere in the world. Estimates for different habitats in New Zealand range from 0.17 to 5.6 cats per square km.

Signs of presence and field signs

- Droppings: 3–6 cm round to elongated segments, which contain matted fur, feathers and bones and are dark in colour. Often scats are the only sign of a cat, due to their secretive behaviour. They are buried close to home, but left exposed further afield. If exposed, they are often left in a conspicuous place.
- Footprints: 'Heart-shaped' central pad with three parts and four separate toe pads, retractable claws.
- Kill signs: Attacks back of neck, bits of chest feather, tail, wing-tips, feet and beak often left uneaten, rabbit skin turned inside out over the skull.

- Vegetation damage: scratches on bark.
- Eye shine: Bright green (usually) or red.

Benefits and negative impacts on the New Zealand environment

Feral cats potentially benefit New Zealand as predators on rabbits and rodents. It has been noted in many areas that rabbit and rodent numbers increase dramatically upon cat eradication; conversely, the numbers of these pest species are kept stable and relatively low in the presence of cats.

Apart from this potential benefit to the environment, feral cats mainly cause negative impacts. Feral cats have been pinpointed as playing key roles in both the local and widespread decline of native birds and, in some cases, their extinction. This effect is particularly evident on offshore islands, one example being the accelerated extinction of the Little Barrier Snipe on Little Barrier Island.

Cat in cage trap.

Courtesy of Crown Copyright: Department of Conservation Te Papa Atawhai.

Many offshore islands in New Zealand are used in recovery programmes for threatened native bird species; however, the presence of cats, regardless of density, is highly detrimental to this effort. Thus, a large amount of money and effort is spent eradicating cats as well as other introduced mammals from these environments.

Further information

For further information on predator pests, see 'The Handbook of New Zealand Mammals', King, C.E. (ed.) 2005. Oxford University Press 2006.
ISBN-10: 0195584775.

There are various best practice resources available from npca.org.nz, associated website pestdetective.org.nz, and doc.govt.nz

For information on TB visit the TBfree website www.tbfree.org.nz/

Traps used to control pest animals

This section covers the following types of traps used for control of pest animals:

- leghold
- kill (including self-resetting kill traps)
- cage.

Each of the above trap types will be covered under the following headings:

- target species
- situations best suited for their use
- modes of action
- advantages and disadvantages for their use
- societal effects of use of traps.

The following laws are relevant to using traps to control possum pests. It is recommended that you become familiar with these laws, if you are not already:

- Health and Safety at Work Act 2015
- Wild Animal Control Act 1977
- Conservation Act 1987
- Wildlife Act 1953
- Animal Welfare Act 1999 (and the Animal Welfare (Trapping) Order 2007)
- Trespass Act 1980
- Biosecurity Act 1993

and their associated regulations, orders, and subsequent amendments.

Common use of traps types by target pest animal

	Leghold trap	Kill trap	Kill trap (self re-setting)	Cage trap
Possum	✓	✓	✓	✓
Rabbit	✓ (Rarely used)			✓ (Rarely used)
Avian (birds)				✓
Rodents		✓	✓	
Mustelids	✓ (Ferrets only)	✓	✓ (Stoats and weasels only)	✓
Feral cats		✓		✓

Societal effects of use of traps to control pest animals

Introduced animal pests are a major problem in New Zealand, and pest control in rural environments and native habitats is a big job. One of the most obvious effects on our society is the burden of cost and effort required to deliver ongoing pest control programmes. In fact, much of the New Zealand landscape needs more pest control work done, but it is simply not affordable. Compared to use of toxins, trapping is particularly labour intensive and costly.

A further societal effect is that some people dislike the use of traps being used for pest control, and believe traps, or some particular kinds of traps, should not be used. The old style 'gin' trap has been banned for example.

When traps are used, this creates may create conflict in our society. We are all entitled to our opinions. Some reasons people may believe or perceive traps should not be used include:

- some people believe we don't have the right to kill animals at all, including introduced pest animals
- consider that use of some traps causes unnecessary suffering for the animals
- consider that the risk of catching non-target species or domestic pets is too great.

Leghold traps

Leghold traps are triggered by the animal placing its foot or leg between two spring loaded jaws. Leghold traps will catch animals alive, and this means you will have to dispatch the animal humanely, and dispose of the carcass.

Leghold traps are widely used for possum control in New Zealand, and they are also used to target ferrets.

Possum leghold trap

Images courtesy of Pestgard www.pestgard.co.nz/traps

The law requires that any trap which catches the animal alive (i.e. leghold or cage) **must** be checked every day within 12 hours of sunrise. Any animals caught must be released unharmed, or killed quickly and humanely.

The law also requires that permission of the landowner or occupier must be obtained before setting any trap on any land. And leghold traps may not be set within 150 m of a house without the occupier's permission, even if the house is on a neighbouring property. This is to ensure traps aren't set where they are likely to catch people's pets, and in fact you may not set a leghold trap anywhere there is a probable risk of catching people's pets.

No.1 size traps are most commonly use, and it is illegal to use any trap larger than size 1.5. Long spring traps, commonly know as the 'gin' trap are also illegal.

These traps can be dangerous if care is not taken when handling them. Follow these simple guidelines when handling traps.

1. When traps are not in operation, leave unset **and**
2. Handle traps from underneath at all times.

Leghold traps have advantages and disadvantages for their use.

Advantages	Disadvantages
• Possums do not have to take a bait in order to be successfully trapped. • Probably the most effective trap available for possums. • Less bulky than most other types of trap.	• Legal requirement to check once a day makes this a reasonably labour intensive (expensive) control method. • Less publicly acceptable than some other methods because possums have to spend an uncomfortable night caught by the foot. • Not suitable in areas close to town or houses where pets might be caught. • Non-target animals such as kiwi and weka can be also be captured (raised sets can avoid this problem).

▶ The most common types of baits or lures used for leghold traps are:

- For possum control a mixture of flour and icing sugar is usually spread on the tree to which the trap is attached. Sometimes a cinnamon or fruit lure is also mixed in.
- For ferrets a fresh, dried or salted meat bait is often used, or a commercial ferret paste bait.

▶ Leghold traps are most suitable for use in the following situations:

- areas where pesticides cannot be used
- areas where possums are 'bait shy'.

Kill traps

Kill traps are a device used for killing animal pests. Kill traps can be dangerous for the user, especially as the mechanisms are under tension to kill the possum. When handling kill traps, always keep your fingers and hands away from the action of the trap.

Possum Master kill trap set.

Possum trapped in Possum Master kill trap.

Images courtesy of Dean Roughton, Hawke's Bay Regional Council.

There are many different kill traps available. For larger species such as possums, feral cats and ferrets, the Timms trap or the Possum Master kill trap are popular choices, especially for the public as they are easy to set. Another example is the DOC 200 and 250 traps, the smaller 200 being suitable for rats, stoats and weasels, while the 250 is effective for smaller cats and ferrets as well. A lightweight option for smaller species such as rats and stoats is the modified Victor Ezy-set trap.

The main advantage of kill traps over live capture traps is that they do not need to be checked every day. This makes their use much less labour intensive (cheaper).

Advantages	Disadvantages
• No need to check traps daily. • More humane than live capture traps as the animal is quickly killed. • Well suited to being used in trees (they are off the ground and don't kill non-target species).	• May require other structures to be effective, e.g. boxes to prevent non-target animals from being trapped, and to position the target pest animal correctly for a humane kill. • Can kill domestic animals depending on the type of bait used. • Some landowners don't like seeing dead possums hanging from kill traps for a period of time.

▶ The most common types of baits or lures used for kill traps are:

- for possums, fresh cut vegetables and fruit such as carrot or apple
- for other pest species, hens eggs or some form of meat bait are popular.

Apple used as bait Possum Master kill trap.

Image courtesy of Dean Roughton, Hawke's Bay Regional Council.

▶ Kill traps can be used where toxins are not appropriate, such as:

- around built up areas
- in areas where pesticides cannot be used
- in areas where leghold traps cannot be used (particularly for possum control)
- where there are domestic animals.

Kill trap

Image courtesy of Northland Regional Council.

Self-resetting kill traps

Some special types of kill traps are able to automatically reset themselves once they have killed an animal, so they don't need to be checked as often. This can mean substantial savings in the cost of pest control.

Most of the aspects of kill traps described in the previous section apply equally. Two popular models of self-resetting traps available are the A24 and the A12 manufactured by Goodnature Limited. The smaller A24 is suitable for rat and stoat control, while the larger A12 can be used to target possums.

A24 Rat and stoat trap

A12 Possum trap

Images courtesy of Goodnature Limited.

Cage traps

Cage traps are devices that trap the animal pests alive. They operate by the animal triggering a mechanism which closes a door.

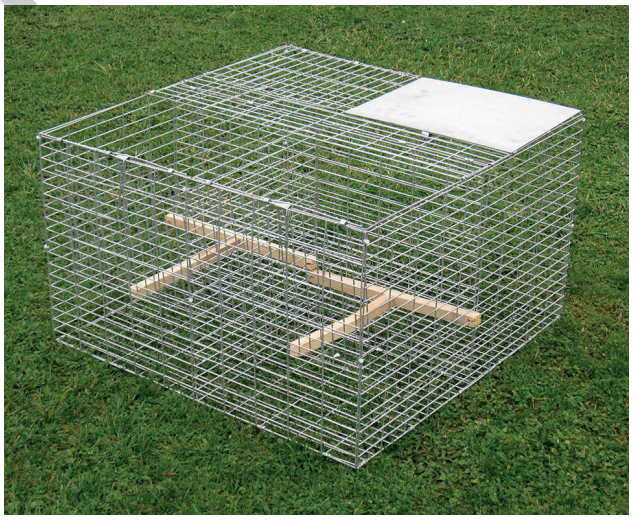
Professional cage trap

Image courtesy of Pestgard www.pestgard.co.nz/traps

As with all live capture traps, cage traps must be checked every day within 12 hours of sunrise. This makes it a rather labour intensive control method. Any animals caught must be released unharmed, or killed quickly and humanely.

Cage traps are particularly suited to capturing larger animal pests such as possums, feral cats and ferrets close to houses as any pets inadvertently caught can be released unharmed.

Cage traps are also the main method used in New Zealand to capture pest bird species such as magpies or rooks.



Larsen type bird trap

Image courtesy of Pestgard www.pestgard.co.nz/traps

Advantages	Disadvantages
• Animals are captured alive and unharmed. • More socially acceptable. • Safe for non-target animals. • Easy and safe to handle. • Can be set in any situation including open spaces and built up areas, e.g. ideal for catching feral cats in built-up areas.	• Has been found to be less efficient than leghold traps. • Animals could escape while operator is attempting to dispatch it. • Animals would be stressed and frightened, and could injure person attempting to dispatch it. • Larger and bulkier than other types of traps. • Can be more expensive than other types of traps. • Legal obligation to inspect traps daily within 12 hours of sunrise, making this a labour intensive control method.

▶ The most common types of baits or lures used for cage traps are:

- for possums, fresh cut vegetables and fruit such as carrot or apple
- for other pest species, hens eggs or some form of meat bait are popular.

▶ Cage traps can be used where toxins are not appropriate, such as:

- around built up areas
- in areas where pesticides cannot be used
- in areas where leghold traps cannot be used (particularly for possum control)
- where there are domestic animals.

For further information on traps, refer to the manufacturer's instructions. There are also various best practice resources available from npca.org.nz and doc.govt.nz

Toxins used to control pest animals

This section covers the types of toxins and baits used to control pest animals and includes for each the:

- target species
- modes of action
- best practice considerations
- societal effects of use of toxins.

In order to handle most toxins, you must hold an Approved Handler Certificate, and often also a Controlled Substances license.

The following laws are relevant to using toxins to control animal pests. It is recommended that you become familiar with these laws, if you are not already:

- Hazardous Substances and New Organisms Act 1996
- Agricultural Compounds and Veterinary Medicines Act 1997
- Health and Safety at Work Act 2015
- Resource Management Act 1991
- Wild Animal Control Act 1977
- Conservation Act 1987
- National Parks Act 1980
- Reserves Act 1977
- Wildlife Act 1953
- Animal Welfare Act 1999
- Trespass Act 1980.

and their associated regulations, orders, and subsequent amendments.

Mode of action

Toxins are chemicals given in a dose (usually very small) which will cause the death of animals. Toxins can be broadly grouped into two categories:

1. Chronic and
2. Acute (see table on page 128).

▶ Chronic toxins

Chronic toxins are slow acting, which means animals can continue to eat baits for quite a while without starting to feel any effects. And when they do start to feel effects the animal is less likely to associate that with the bait. Most Chronic toxins are called anti-coagulants which act by preventing blood clotting. Too much thinning of the blood causes death. Warfarin is an anticoagulant rat poison, which is also a blood thinner prescribed by doctors to prevent blood clots in patients. Brodifacoum, pindone and diphacenone are examples of chronic anticoagulant toxins used for pest control in New Zealand.

▶ Acute toxins

Acute toxins are fast acting. Usually only quite small doses are required to cause death, and the onset of symptoms is rapid. Pre-feeding is often done before laying acute toxins, to make sure the animals eat a lethal dose of toxic bait in the short time before they start to feel ill, and stop eating the bait. If animals don't get enough of an acute toxin to kill them in that short time, they will typically become 'bait-shy'. Because acute toxins act quickly to kill the animal, they are generally considered to have a better welfare profile than slow acting chronic toxins. Some examples of acute toxins include:

- cyanide
- 1080
- zinc phosphide.

▶ Alphachloralose

Alphachloralose is unusual and it neither acute nor chronic. Alphacloralose is a narcotic, while it acts reasonably quickly, it only puts the birds to sleep. If the birds are not collected and disposed of in time, they will usually wake up again.

You will learn more detail around signage, notification, storage, and tracking for the toxins you will be using, through the Approved Handler certification process.

Best practice considerations

Some target animals may survive a control operation for any of a number of reasons, including:

- some animals have a higher tolerance for the toxin and therefore have a better chance of surviving the dose eaten
- toxic bait is not found by the animals
- not enough toxic bait is eaten by the animal, either because there is not enough, or they don't particularly like the bait
- animals are 'bait shy' from surviving previous control operations, and so won't eat the bait anymore.

For all these reasons it is very important that when toxins are use to control animals, special care is taken to ensure high standards are maintained, including:

- sometimes pre-feeding with non-toxic bait to get the animals used to eating the bait
- good quality bait, fresh, which the animals will want to eat
- correct amount of toxin in the bait
- good coverage of the control area, take the bait to the pests ensuring almost all pest animals will find bait, and there is enough bait for them to eat.

You will learn more detail around bait delivery on-job.

Common use of toxins by target pest animal

	Possum	Rabbit	Avian	Rodents	Mustelids	Feral cats
1080 (Acute)	✓	✓		✓		✓ (DOC use only)
Cyanide (Acute)	✓					
Cholecalciferol (Chronic)	✓			✓		
Diphacenone (Chronic)				✓	✓ (Ferrets)	
Brodifacoum (Chronic)	✓			✓		
Pindone (Chronic)		✓		✓		
Magtoxin (Acute)		✓ (Fumigation of burrows)				
Zinc Phosphide (Acute)	✓			✓		
PAPP (Acute)					✓ (Stoats)	✓
DRC 1339 (Acute)			✓ (Rooks)			
Alphachloralose (Narcotic)			✓			

Societal effects of use of toxins to control pest animals

Introduced animal pests are a major problem in New Zealand, and pest control in the rural and environment and native habitats is a big job. One of the most obvious effects on our society is the burden of cost and effort required to deliver ongoing pest control programmes. In fact much of the New Zealand landscape needs more pest control work done, but it is simply not affordable.

A further societal effect is that some people dislike the use of toxins being used for pest control, and believe toxins, or some particular kinds of toxins, should not be used. When they are used, this may create conflict in our society. We are all entitled to our opinions. Some reasons people may believe or perceive toxins should not be used include:

- some people believe we don't have the right to kill animals at all, including introduced pest animals
- consider that use of some toxins causes too much pain for the animals
- consider that adverse environmental or human health effects may be caused by toxin use.

For further information on toxins, refer to product labels and safety data sheets. There are also various best practice resources available from npca.org.nz and doc.govt.nz

Monitoring pest animals

Monitoring of animal pest populations is an important part of pest management in New Zealand. We need to know where pests are, and have some reasonable knowledge of the size of the pest population, to help us make good management decisions.

Image courtesy of OSPRI New Zealand.

Monitoring information can be used to:

- decide whether the pest population is high enough to need a pest control operation
- confirm that a pest control operation was effective, that is, it killed most of the pests in the target area
- in research to compare how effective different control methods are.

Types of monitoring

Monitoring methods can be grouped into two main types. Transect monitoring, and Inspection monitoring. ‘Transect’ is basically a fancy word for ‘line’.

Transect monitoring is where some type of devices are laid out in lines at pre-determined spacings, and following a set of prescribed rules detailing

precisely how the lines and devices should be deployed, and for how long. For example, monitoring possums using trap-catch, we place lines of 10 traps, with traps 20 m apart, and trapped for 3 nights. The number of devices detecting pest presence provides a relative measure of the size of the pest population. Because the monitoring is done following a precise protocol, results can be compared between areas and over time.

Transect monitoring for different species is very similar, with the type of 'detection device' used being the main difference.

Inspection monitoring has the same purpose as transect monitoring – to determine the relative size of the pest population. It can be useful to gain monitoring information over large areas quickly where evidence of pest presence is obvious. With inspection monitoring, the 'detection device' is basically the operator's eyes and ears.

While inspection monitoring is not as strictly regimented as transect monitoring, there are still rules and protocols which guide the process. This ensures that results obtained by different operators can be compared reasonably well.

Night count transects used for rabbit monitoring are a blend of transect and inspection monitoring.

Possum teeth marks on chew card.

Image courtesy of Dean Roughton, Hawke's Bay Regional Council.

The following table gives an overview of some of the main monitoring methods and detection devices used.

	Transect monitoring	Inspection monitoring
Possum	✓ (Leghold traps, waxtags, chewcards)	
Rabbit	✓ (Night count routes)	✓ (Day inspections using the modified McLean scale)
Avian (birds)		✓ (Day inspections)
Rodents	✓ (Tracking tunnels, traps)	
Mustelids	✓ (Tracking tunnels, traps)	
Feral cats	✓ (Tracking tunnels, traps)	

For further information on monitoring, there are various best practice resources available from npca.org.nz and doc.govt.nz

Resource Feedback

In order to keep our resources as up-to-date and relevant as possible we would appreciate any comments, feedback or suggestions you may have with regard to this particular resource or others that you have used.

Please contact us via email **product@primaryito.ac.nz** if you have any suggestions that you feel would be useful.

Please remember to indicate the resource you are giving feedback on in your email, and please provide your contact details.

Thank you for taking the time to provide us with feedback.