# Invertebrates: light trapping

Version 1.0

This specification was prepared by Brian Patrick in 2016.

## Contents







Department of Conservation
*Te Papa Atawhai*

# Synopsis

The use of light for sampling night-flying insects is a long-standing technique. Light traps are most commonly used to sample moth fauna but they also collect other insects, including adult aquatic insects (e.g. mayflies, dobsonflies and caddisflies). Depending on the objectives of your study, there are many methods and variations, which use an ever-changing technology (Heath 1976). Light trapping is most useful for inventory work or to help determine the geographical distributions of night-flying insects. This is because many species that are trapped at night are practically undetectable by other sampling methods.

Light trapping for native insects potentially reveals a rich diversity of many different insects. It provides information about biodiversity across all seasons, landscapes, ecological areas, altitudes and times of night (Patrick et al. 1992).

Light does not attract insects—it confuses them and intercepts them from their chosen flight path. Some insects fly repeatedly around the light, others simply settle at varying distances from the light and may fly off after varying times (Fry & Waring 1996).

Insects see green, blue and near ultraviolet (UV) light very well, but they see yellow and orange light poorly and they cannot see red or infrared light. Different types of light sources produce light of different wavelengths (colours) and hence their effectiveness varies for catching insects.

Light trapping is most effective for sampling night-flying insects in the immediate vicinity—up to 500 m from the light source. A light can work over greater distances—up to 1 km or more—when slightly elevated. The effectiveness depends on the direction of the wind as insects fly upwind, and on wind speed as many insects settle in strong wind. Flight activity is also dependent on temperature and humidity, and rain can stop or reduce it. As a result, care must be taken when using light trap catches for comparative purposes such as monitoring. For this, as many variables as possible need to be kept the same or as near the same as possible each time. This is termed standardisation.

There are many types of light trap design; they can be operated off 240 V AC or 12 V DC supplies, using UV or white light (full spectrum) bulbs, and they can collect insects live or act as kill traps.

# Assumptions

Light trapping projects assume that the target night-flying insect species are trappable. (Many night-flying insects do not come to any sort of light.)

# Advantages

- Easily repeatable.

- Cost-effective in terms of labour and skills required.
- Many types of insect specimens are undamaged and so are good for identification.
- Specimens are easily contained for collection and identification.
- Portability of light traps.
- Reward for effort is very good—only a few hours can give much data.
- Components of light traps are easily obtained.

Additionally, light trapping can be a particularly enjoyable social occasion with people sitting around a bright light awaiting the target species.

## Disadvantages

- Light trapping is less productive when it is cold, wet and windy.
- It is less effective near bright artificial lights or when there is bright moonlight.
- It is sometimes less effective when the traps are set too close to fresh water.
- There are minor safety issues associated with this method.
- This method requires a source of electric power, which may be heavy to transport.

## Suitability for inventory

Appropriate for inventory of most night-flying insects including beetles, moths, and aquatic insects.

## Suitability for monitoring

Light trapping, once standardised and targeted to the species of interest, is very suitable for ongoing monitoring of that species.

The method must be simple, repeatable, fully documented and standardised to be effective. The trapping must be done at the appropriate time of year (and same time of year between surveys), in the appropriate place and when the weather is suitable, particularly the wind and temperature.

## Skills

- Running a light trapping programme requires attention to detail, concentration, and patience.
- If live trapping for particular species, then being able to identify the target species is essential. If the light trapping is being done for general inventory purposes then kill trapping is required and analysis of the sample usually requires specialist entomologists.
- Actual operation of the trap is straightforward but as the operator is dealing with potentially 240 V of electricity, care and safety are essential.

# Resources

- Personnel—ideally at least two people required for safety, collecting invertebrates and to record data.
- Notebook and pencil to record date, position and data associated with the collection of invertebrate specimens.
- Accurate map of area to identify the geographical boundaries of land and habitats.
- Torches and/or headlamps to assist when setting up and removing equipment. Also useful for identifying specimens that come to the light.
- Watch or stopwatch to record time and duration of capture session/s.
- GPS to record position of study site and individual lights.
- A large umbrella or Perspex vane to shelter from the wind or keep rain off the light bulb.
- Invertebrate collecting equipment—including vials, tubes, soft-touch forceps, fine paint brush, pooter, sweep nets, chilly bin, zip-lock bags, marker pens, 99% ethanol, labels, detergent, and egg cartons—to collect and store invertebrates for identification on subsequent sampling occasion/s.
- Lighting equipment—including white sheets, plastic trays, Perspex vanes, spare bulbs, and light fittings associated with the light trap—to 'attract' insects.
- Generator, fuel or heavy duty batteries as a power source for the lights.
- Thermometer, relative humidity meter and anemometer to measure environmental conditions at the time of capture session/s.
- Camera to record information on vegetation or habitat type and to take photos for presentations or reports.
- Safety equipment—such as cell phone, VHF radio and first aid kit—to contact emergency services if necessary or administer basic first aid.
- Identification guide (see 'Invertebrate identification aids'—doccm-388198) to determine which groups of insects are being collected.

Light trapping requires suitable and safe equipment, access to an energy source and human resources. Certain light traps can be left unattended to collect insects but we recommend for conservation purposes that the traps are attended by at least one person, and set for specified periods and in standard weather conditions.

If the trapping is for monitoring, then experience in visually identifying the species is essential or a clear identification guide will be required.

The human resources required will depend on the predetermined length of time the trap will run for. On the night of trapping only one person is required with the relevant skills. In calculating the time required take into account the time the trap is running, add travel time to site return, and an additional hour in total for set-up.

The cost of electricity to run a light trap is small, but a reliable generator will cost upwards of $2000. The alternative is to use batteries—either a 12 V car battery or similar, or a combination of batteries giving in total 12 V.

Identification of insects by specialist entomologists is expensive and therefore it is advisable to explore costs before taking the samples. However, costs can be reduced if the collector can sort the sample into at least orders (e.g. flies or Diptera, beetles or Coleoptera).

## Minimum attributes

Consistent measurement and recording of these attributes is critical for the implementation of the method. Other attributes may be optional depending on your objective. For more information refer to 'Full details of technique and best practice' below.

DOC staff must complete a 'Standard inventory and monitoring project plan' (doccm-146272).[1]

Minimum attributes to record on the collection label:

- Name of location – be as precise as possible
- Altitude
- GPS position
- Type of sample (i.e. light trap)
- Dates when sample was started and collected
- Full name of collector

The following minimum information must also be recorded accurately:

- Weather conditions: humidity, temperature and wind description at beginning and end of trapping
- Start and finish time
- Any other relevant factors that may influence the samples (e.g. failure of bulb)

## Data storage

Forward copies of completed survey sheets to the survey administrator, or enter data into an appropriate spreadsheet as soon as possible. Collate, consolidate and store survey information securely, also as soon as possible, and preferably immediately on return from the field. The key steps here are data entry, storage and maintenance for later analysis, followed by copying and data backup for security.

[1] http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-standard-inventory-and-monitoring-project-plan.doc

Summarise the results in a spreadsheet or equivalent. Arrange data as 'column variables', i.e. arrange data from each field on the data sheet (date, time, location, plot designation, number seen, identity, etc.) in columns, with each row representing the occasion on which a given survey plot was sampled.

If data storage is designed well at the outset, it will make the job of analysis and interpretation much easier. Before storing data, check for missing information and errors, and ensure metadata are recorded.

Storage tools can be either manual or electronic systems (or both, preferably). They will usually be summary sheets, other physical filing systems, or electronic spreadsheets and databases. Use appropriate file formats such as .xls, .txt, .dbf or specific analysis software formats. Copy and/or backup all data, whether electronic, data sheets, metadata or site access descriptions, preferably offline if the primary storage location is part of a networked system. Store the copy at a separate location for security purposes.

Data from light trapping can be of fundamentally different types:

- Voucher specimens for curation, identification and storage
- Numerical data (number of species or morpho-species collected)
- Descriptive data (location of trap, weather conditions, time of day, vegetation, etc.)

For inventory, dead voucher specimens will be necessary so that accurate identification can be made by a specialist taxonomist in the particular insect groups. Moths and other species should be kept alive and put in a freezer as soon as practical after trapping to preserve their condition. Freezing is the most humane method of killing insects. These specimens can be set and labelled when convenient following freezing.

Ultimately insects collected for inventory should be deposited in a museum or in the National Arthropod Collection administered by Landcare Research.[2] Institutions should be contacted first to find out their requirements. See 'Invertebrates: advice and diagnostic support' (doccm-2686377)[3] for more information about depositing specimens and the availability of taxonomic expertise.

For monitoring a particular species then no actual specimens need be collected, as long as observers are very confident of its identification, but it is important that each specimen is temporarily contained during the evening so that it is not recorded more than once.

Data from both methods should be stored in Excel spreadsheets for ease in manipulation and interpretation. DOC staff should enter records of species sightings into the BioWeb database.

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[2] http://www.landcareresearch.co.nz/resources/collections/nzac

[3] www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-invertebrates-advice-diagnostic-support.pdf

# Analysis, interpretation and reporting

## Introduction

The following outline is intended to highlight some of the practical considerations of dealing with light trap data and to provide an overview of the types of analysis appropriate for this collection method. Once the data have been collected and sorted into recognisable taxonomic units (RTUs), it is recommended that the data are summarised and presented either in a table or graphically (see 'Introduction to statistical analysis of invertebrate monitoring data'—doccm-525907)[4]. It is imperative that statistical advice is obtained from a biometrician during the planning stage before any data are collected. This will ensure that the study design is appropriate for the hypothesis being tested and that the results are meaningful. It is also important to seek statistical advice from a biometrician or suitably experienced person prior to undertaking any analysis. The information provided in this section and in the 'Introduction to statistical analysis of invertebrate monitoring data' is intended to familiarise staff with some of the analysis options available so that informative discussions can be held with a statistician. The information is not intended to be a comprehensive guide to data analysis.

## Practical considerations

Light trapping studies are difficult to replicate, and for this reason they are more suitable for inventory work or for determining the presence of threatened species, particularly moths. This method is suitable for measuring relative abundance only and the results must be interpreted with caution. Catch rates differ depending on the activity of the insects (which can vary with season) and the 'attractiveness' of the light source to individual species. The chance of an insect being collected is not equal for all individuals and this limits the usefulness of this methodology for quantitative studies. Local conditions such as wind speed, temperature and humidity as well as the amount of time that the trap is operated for also influence the trap efficiency (Southwood & Henderson 2000). A light trap is more attractive to some species than others and as with other methods, only collects a small proportion of the total fauna occupying the habitat. The variation in efficiency of the light trap between different species, between different locations in a habitat, between different occasions and different trap designs can lead to serious biological bias (Southwood & Henderson 2000). One of the more extensive studies using light traps to assess a moth fauna in New Zealand was conducted by White (1991) (see 'Case study A'). He used multiple light traps set on timers to examine long-term trends in the changing abundance in tussock grasslands in the South Island.

## Analysis of light trapping data

### Sorting and identification of specimens

Moths are identified as dry specimens from the colours and patterns on their wings (see 'Invertebrate identification aids'—doccm-388198). Other invertebrates can be stored in liquid for

[4] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-statistical-analysis-of-invertebrate-monitoring-data.pdf

later sorting and identification (see ‘Preliminary sorting of invertebrate samples’—doccm-388193). There are a number of keys available to assist with identification and sorting the specimens into families will be a good start. Check with an entomologist or an insect taxonomist how to best preserve the specimens to allow for identification.

### Analysis

The analysis of light trapping data is limited due to the issues raised above regarding standardising the conditions and environmental variables. Once the data have been checked and summarised in a table or graph, it may be possible to group the data into taxonomic groups, functional groups or guilds (see ‘Preliminary sorting of invertebrate samples’—doccm-388193). For example, an assessment of the moth fauna can provide an understanding of the role that they play in the local environment. The following issues should be considered when summarising data collected from light traps:

- The results are a reflection of insect activity and the relative abundance of the species present at the time that the trap was active.
- Light traps are rarely used to compare invertebrate fauna between sites or different treatments due to bias in the samples.
- It is difficult to know what area light traps collect from and if additional traps are set up, it is important to ensure that they are set up some distance away so that they collect independently.
- The sampling unit (point) for a light trap is ‘one’ for each discrete collection.
- Long-term data sets are required to reliably show trends over time.

# Case study A

**Case study A: long-term trends of tussock grassland moths**

## Synopsis

White (1991) used light traps to assess changes in the abundance of common moths in tussock grassland habitats over time. He assessed the moth fauna between 1961 and 1963 and again between 1987 and 1989 at Cass in Arthur’s Pass, New Zealand. The results from his study indicated a decline in common moth abundance between the two sampling periods and a change in the composition of the moth fauna. White (1991) concluded that these changes were primarily due to a change in vegetation type from native herb species to adventive grasses (primarily browntop—*Agrostis capillaris*).

## Objectives

- To quantify long-term trends in grassland moths.
- To determine whether temporal changes were associated with coincident changes in vegetation type.

## Sampling design and methods

White (1991) used a Robinson light trap at two sites (separated by 4 km) to assess the moth fauna. Collecting took place at approximately 2-week intervals during the sampling periods. The light traps were used for 3 hours from dusk and were operated simultaneously at both sites. Each light trap used 60 W 12 V tungsten bulbs powered from batteries. Moths were identified and divided into three classes: heavy, medium and light fliers. Observations such as temperature, wind velocity, amount of moonlight and vegetation dampness were used to rank the suitability of the trapping conditions. Only samples collected under ideal conditions were used in the data analysis. Notes regarding the grazing history and pasture management of the two sites were also recorded.

## Results

The total number of moths collected at both sites under ideal conditions declined from 31 032 to 13 574 between the two sampling periods (1961–1963 and 1987–1989). This represents a 56% decline in total abundance of moths collected. In particular, *Helastia corcularia* (Geometridae), *Orocrambus cyclopicus*, *Orocrambus vittellus*, *Eudonia submarginalis* (Crambidae), *Graphania mutans* and *Tmetolophota propria* (Noctuidae) declined in abundance. Declines in abundance were noted in several other rarer species as well. The number of species collected (species richness) remained relatively constant between the trapping periods, but the composition of the moth community changed. A total of 15 species that were present in the first sampling period were not present in the second sampling period. Further analysis of the moth fauna indicated that 3 of the 4 common moth species known to feed on native herbs were no longer present in the second sampling period. In addition, 7 previously unrecorded species were present in the second sampling period.

White (1991) concluded that the change in moth fauna between sampling periods was due to coincident changes in the plant community and that the exotic grass browntop (*Agrostis tenuis* Sibth) had become the dominant plant species. Changes in pasture management, such as grazing intensity, also reduced the availability of native herbs to moth larvae.

## Limitations and points to consider

This study provides an example of how to compare changes in a moth fauna over a relatively long period. It is an example of how bias can be minimised when it is associated with variability in sampling conditions such as temperature or wind velocity, which can affect the activity of moths and the efficiency of the traps. The study also highlights some of the technical difficulties associated with operating light traps. These included lamp and battery failure, interference by stock, and changes in chemicals used to ‘knock down’ moths once they entered the light trap. The data analysis is detailed and the author offers explanations for the decline in abundance of moths between the trapping periods. However, the study lacks replication of sites which limits the level of statistical ‘power’ and interpretation of the results. There is also a heavy reliance on historical information regarding pasture management and ideally the study should have included vegetation plots to accurately record changes in plant composition between the two sampling periods. The study was strengthened by the ability of the author to accurately identify the moths collected.

### References for Case Study A

White, E.G. 1991: The changing abundance of moths in a tussock grassland, 1962–89, and 50- to 70-year trends. *New Zealand Journal of Ecology 15(1)*: 5–22.

# Full details of technique and best practice

## Preliminary considerations

Issues that need to be considered in deciding if light trapping is the appropriate method of sampling are weather conditions, safety issues involved with working at night and avoiding the harmful effects of insecticides and light bulbs that emit dangerous UV wavelengths.

- Weather conditions—is it suitable or predictable within the sampling period?

Light trapping results are particularly sensitive to the prevailing weather conditions. It can prove frustrating trying to find an acceptable match for weather conditions encountered in a prior monitoring period.

Light trapping is not suitable in the following situations:

- Windy or excessively wet conditions
- Too close to other sources of bright light
- Clear, cold nights, especially with a full moon
- Too close to large rivers and lakes because of enormous numbers of freshwater insects encountered

### Safety issues

- There are safety issues with working at night, so take appropriate health and safety precautions and procedures.
- We recommend not using insecticides for knocking down the target species for later examination. Alternatives for killing or knocking down insects other than moths are:
  - Ethanol (70%), but it evaporates quite quickly
  - Soapy water
- If using 240 V electricity then use an isolating transformer or earth leak detector.
- Do not operate a 240 V light trap outside on wet nights to minimise electrical safety issues.
- Important: Use only bulbs which emit relatively safe UV light. Do not use bulbs such as metal halides which produce dangerous UV-B or UV-C wavelengths (Fry & Waring 1996). It is vital that manufacturer’s recommendations on the use of bulbs are followed.
- The operator should avoid looking directly at the UV light source.
- Do not handle the bulb or electrical parts close to bulb when it is on.
- Let extremely hot high-pressure bulbs cool down before moving and storing them.

- Fix any electrical problems immediately.
- Place generator well away downwind from the operator to reduce noise and fumes.

## Types of light trapping

For practical purposes there are two basic types of light trapping powered equipment:

- Mains or portable generator sourced power (240 V AC)
- 12 V DC batteries

There are a range of different light bulbs for use with either of these options. Bulbs that produce both UV and light that is visible to humans are the most effective. All light will work to some degree, but light with some UV will give far better results.

Trap design varies considerably. The simple and cost-effective design recommended here has been extensively used under New Zealand conditions and is particularly effective.

Check that the equipment works several hours before use and fix any problems before going into the field.

## Collection methods

A mains-operated or portable generator-powered light trap can be set up to automatically collect alive or dead catch over a set number of hours using a timer. However, we recommend watching the insects arrive on the white sheet at the trap, and catching them by hand. This allows you be selective and only catch what you need to keep, thereby avoiding over-collecting. You can also collect insects that settle in shadows adjacent to the light which would not be collected by automatic methods.

Collecting the target insects by hand is the most appropriate and accurate collection method for most conservation objectives. If you wish to count certain insects then they will have to be caught and kept temporarily in containers away from the light to ensure that specimens are only counted once.

If the light trap is left unattended and live insects are required then adding crumpled newspaper (or egg cartons) to the container under the light helps to retain those that fall in. For live trapping aquatic species and beetles, use a small amount of detergent in the water (to break the surface tension of the water) (Fig. 3). This will not kill the insects unless they are left in it for over 24 hours. Release any insects that are not required into the nearby vegetation so that they are not exposed to predators. NB: This is not a suitable method for collecting moths which need to remain dry.

For kill trapping, substitute soapy water with alcohol (70% ethyl alcohol) when used overnight or with propylene glycol if an automatic light trap (turns on at night) is left for several nights.

## Where to trap?

Trap as close as practical to the target insect community or host plants. This will ensure more target insects are exposed to the light and hence increase the success rate. If possible, set up the trap where it is sheltered from the wind. The best position for the operator is with their back to the wind so they can see what comes into light as the insects fly upwind.

If your target is moths, **do not** trap close to freshwater rivers, ponds or lakes on warm summer nights because huge quantities of flies and caddis will be attracted and these will interfere with the trapping of other groups.

To be effective, the light of the light trap must be brighter than the surrounding nightscape. Choose a site where the background is as dark as possible. Using a light trap in a lit-up suburb at night will be less effective, as is placing two light traps near each other.

## When to trap?

Each species has its own distinctive behaviour in the way it responds to different coloured lights and weather conditions. The best nights to trap are warm, humid nights with cloud cover and little wind. Different species are also active at different times of year and night: some are trapped at dusk, others are caught at different times during the night, and others are trapped as daylight appears. Light trapping from dusk till midnight is usually sufficient and cost-effective for inventory purposes. Begin light trapping as dusk begins, and do not wait till it is fully dark at the site.

In general, avoid light trapping during a full moon, although it can still work if the night is sufficiently hot and calm.

## What insects come to light?

Flies, moths, mayflies and caddis are by far the most consistently trapped insects at light in New Zealand, and this is true for all altitudes and locations.

The following 11 insect orders regularly come to light:

- Caddisflies (Trichoptera)—many families of both marine and freshwater species
- Stoneflies (Plecoptera)—a few species only, particularly the genera *Stenoperla* and *Megaleptoperla*
- Dobsonflies (Megaloptera)
- Mayflies (Ephemeroptera)
- Lacewings (Neuroptera)
- Wasps (Hymenoptera)—particularly some ichneumonids
- Moths (Lepidoptera)—most families with night-active adults, but particularly Geometridae, Noctuidae, Crambidae, Tortricidae and Hepialidae

- Beetles (Coleoptera)—a few families only, particularly flighted scarabs, click beetles and longhorns
- Flies (Diptera)—many families
- Bugs (Hemiptera)—a few families but not consistently; e.g. water boatmen and backswimmers on extremely hot nights
- Praying mantids (Mantoidea)—only on the warmest summer nights

## Standardising the method

Using light trapping to monitor a particular species or group of insects is straightforward but the method must be standardised so that the results can be compared validly.

Aspects of the method that need to be standardised are:

- Type and wattage of bulb
- Bulb age (less than 500 hours use)
- Sheet size and colour
- Trap design
- Start-up time and duration
- Weather conditions—as near as possible
- Time of year
- Location

Ideally, the same personnel should also be involved each time.

The 'Patrick' trap design is recommended for both inventory and monitoring (Fig. 1). There are many other designs but this one works well under New Zealand conditions, from coastal to alpine environments.

Figure 1. The ‘Patrick’ light trap recommended for collecting moths. The light trap is placed on a white sheet and insects of interest are collected manually in suitably sized containers as they arrive. Note the generator in the background. This light trap is designed to be low to reduce the effect of wind on the catch.

There are many other light trap designs. For example, Fig. 2 shows a modification that allows insects to be caught alive overnight without having to attend the trap. In this case the collecting bucket is loosely filled with crumpled newspaper to increase the surface available for insects to rest on. If no paper is provided the insects disturb each other by fluttering and moving about with the result that they become damaged. If necessary, the bucket can be set into the ground to reduce the effect of wind. A recommended design for a portable and battery-operated light trap is shown in Fig. 3.

Figure 2. A modification of a light trap for catching live insects when an attendant is absent. Note that the bucket should be filled with loosely packed crumpled newspaper and that this trap is not very efficient in windy conditions unless the bucket is set into the ground.


Figure 3. Portable battery-operated light trap. This light trap uses a commercially available lantern with one of the fluorescent light tubes replaced with a UV one. Note that this light trap is used with a pan of soapy water for collecting the insects. The soap causes the insects to sink after which they soon stop struggling. However, the insects will remain alive for many hours and even moths will fly off again after they dry out.

## Generic instructions

- Place the light in the middle of a standard white sheet on a level surface.
- Place the generator as far away as possible downwind.
- The operator should be positioned about 1 m from the light source with their back to the wind, and with collection vials and short-handled net handy.
- If interested in any non-target insects then a vial of 70% alcohol should be kept handy in which to put them. Moths should be kept dry.
- The operator must remain vigilant for collecting target species from outside sheet area (many species do not land or crawl onto the sheet).
- For each monitoring session, trap for the same number of hours starting from the same time of night—say 3 hours from dusk (i.e. do not wait for full darkness) (White 2002). The number of hours sampled is optional but subsequent samples must be the same duration.

## Light bulb specifications

We recommend the following Philips high pressure lamps for use with mains power or generator:

- ML Edison screw lamp of 100 W or 160 W
- HPL-N Edison screw lamp 125 W

Low pressure, fluorescent, black-light tubes are suitable for 12 V systems. These actinic tubes come in various lengths related to wattage:

- 6 W is 22.5 cm long
- 15 W is 45 cm long
- 20 W is 60 cm long

Note: There are many light bulbs on the market to choose from, and all will intercept insects to some degree. The consensus is that the self-ballasted bulbs produced by both Philips and Osram companies are best suited for light trapping studies. Both are available in New Zealand. For most efficient results, bulbs with a UV content are preferable, and a wattage of between 100 and 160 W for 240 V, and between 6 and 20 W for 12 V systems.

In addition, be aware that as light bulbs age, their spectrum (colour) alters, so bulbs should be changed at about 500 hours use (White 2002).

## Light trap specifications

Figure 1 shows the recommended trap design. The 'Patrick' trap is a combination of earlier Robinson, Rothamsted and Skinner traps as outlined in Fry & Waring (1996). The 12 V alternative is a variant of the Heath or Actinic traps.

A summary of the design based on Figure 1:

- The baffles and base are all of 1-cm-thick clear Perspex glued into place.
- A Perspex rain shield (not pictured) can be added to keep rain off the light bulb.
- The clear Perspex baffles are important in the interception of the insects and also give the trap stability and strength.
- The base is 40 cm square.
- The bulb holder, flexible cord and plug to generator are standard electrical fittings.
- A 12 V powered fluorescent tube can be used if a generator is not a practical option.

### Consideration for others

- Do not operate light traps in close proximity (say less than 50 m) to neighbours or built up areas.
- Inform neighbouring landowners what you are doing where appropriate.

## References and further reading

Fry, R.; Waring, P. 1996: A guide to moth traps and their use. *The Amateur Entomologist 24*: 1–60.

Heath, J. 1976: Insect light traps. The Amateur Entomologists' Society leaflet 33. 16 p.

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White, E.G. 1991: The changing abundance of moths in a tussock grassland, 1962–89, and 50- to 70-year trends. *New Zealand Journal of Ecology 15(1)*: 5–22.

White, E.G. 2002: New Zealand tussock grassland moths. Manaaki Whenua Press, Lincoln. 362 p.

## Appendix A

The following Department of Conservation documents are referred to in this method:

| | |
|---|---|
| doccm-525907 | Introduction to statistical analysis of invertebrate monitoring data |
| doccm-388198 | Invertebrate identification aids |
| doccm-2686377 | Invertebrates: advice and diagnostic support |
| doccm-388193 | Preliminary sorting of invertebrate samples |
| doccm-146272 | Standard inventory and monitoring project plan |