Date: 2021-01-27	*Version:* 1	*Authors:* O.P. Vindstad, J.U. Jepsen

Title: Saproxylic insect trapping

Motivation

Saproxylic insects (mainly coleoptera) are involved in the decomposition of dead wood and are expected to play an important role in decomposing the large quantities of dead mountain birch wood generated by outbreaks of geometrid moths. Community composition and abundance of saproxylic insects is a target in the forest-tundra ecotone module of COAT.

State variables:

Trapping of saproxylic insects is conducted to estimate the following state variables:

Community composition and abundance of saproxylic insects (V73).

Reference to method:

Insects are trapped using window traps, which intercept adult insects in flight. This is standard methodology for monitoring saproxylic coleoptera (Kaila *et al*. 1997). Details of how the traps are employed in COAT can be found in Vindstad *et al*. (2014).

Spatial study design

Saproxylic insect trapping is conducted in the COAT Varanger regional design at two localities: Kirkenes and Tana. Each locality has a large-scale transect of 20-25 km length with 10 replicated sites. All sites are placed in mature mountain birch forest at altitudes ranging between 60 and 120 m. a. s. l. Site 1-4 in Kirkenes and site 1-6 in Tana are placed in forest that has been heavily damaged by moth outbreaks during the mid-late 2000's, while the remaining sites are placed in undamaged forest. The design thus provides a spatial contrast between damaged and undamaged forest within two regions that are otherwise expected to have relatively homogeneous environmental conditions.

Design within site:

Sampling at all sites is conducted by means of 3 window traps, each with its own GPS coordinate. The traps are denoted as "A", "M" and "B". The M trap represents the centre point of the site, while the other two traps are located about 50 m to the north and south, respectively. Traps are mounted between two birch tree trunks, as close as possible to the GPS point. Trees are not permanently marked, so the trees that are used to mount a given trap may vary slightly between years in dense stands.

locality	section	site_id

tana	NA	TA1A, TA1M, TA1B, TA2A, TA2M, TA2B, TA3A, TA3M, TA3B, TA4A, TA4M, TA4B, TA5A, TA5M, TA5B, TA6A, TA6M, TA6B, TA7A, TA7M, TA7B, TA8A, TA8M, TA8B, TA9A, TA9M, TA9B, TA10A, TA10M, TA10B
kirkenes	NA	KI1A, KI1M, KI1B, KI2A, KI2M, KI2B, KI3A, KI3M, KI3B, KI4A, KI4M, KI4B, KI5A, KI5M, KI5B, KI6A, KI6M, KI6B, KI7A, KI7M, KI7B, KI8A, KI8M, KI8B, KI9A, KI9M, KI9B, KI10A, KI10M, KI10B (from 2019 onwards, the following traps have been discontinued: KI10A, KI10M, KI10B)

Temporal study design

Starting in 2011, the trapping has followed a rotation design, where trapping is conducted for two consecutive years, followed by two years without trapping. Within years, trapping proceeds from the last week of May/first week of June to the first week of August. Traps cannot be mounted before snowmelt, which may delay the onset of trapping somewhat in cold years.

Procedure

Within a season, each site must be visited three times to conduct the following activities:

1. Mounting of traps (last week of May/first week of June).
2. First collection of insect samples (first week of July).
3. Second collection of insect samples and dismounting of traps (first week of August).

Visit 1. Mounting of traps: To mount a trap, first walk to its GPS coordinate. The trap should be mounted as close as possible to the coordinate, preferably within a radius of about 5 meters. Traps should be mounted between a pair of birch trunks that are separated by 1-2 meters (plate 1). It is important that the trunks are sturdy enough to carry the weight of the trap without bending. Trunks with a diameter of =>8 cm are typically required to ensure this. When a suitable pair of trunks has been located, tie a rope tightly to one of the trunks about 2 m above the ground. Then pull the rope through the two holds (white nylon rope) on the upper side of the plexiglass plate of the trap. The rope should be fastened to each hold with a knot, so that that the trap cannot move along the rope. Subsequently, tie the free end of the rope to the other tree trunk at the same height as on the other trunk. The goal is to ensure that the plexiglass plate hangs suspended between the trunks, without being obstructed in any way, and with a roughly 1-m clearing to the ground. Also, the plexiglass plate should be as level as possible.

When the plexiglass plate has been secured, the funnel of the trap can be attached. The funnel has 4 holes along its upper edge, corresponding to holes in the four corners of the plexiglass plate. Attach the funnel to the plate at each of the four holes with a short piece of steel wire (6-8 cm). The funnel must be securely attached, so that the trap can move in the wind without losing the funnel.

After attaching the funnel, the flask of the trap can be attached. Before attachment, add about 0.25 litres of glycol to the flask (filling about ¼ of the volume of the flask). The flask is attached using the white screw cork at the lower end of the funnel. Slide the cork a short distance up the funnel and insert the lower end of the funnel a few centimetres into the flask. Then bring the cork down on the flask and screw it tightly in place. Subsequently, it is important to check that there is a clear path from the funnel and down into the flask, so that insects can fall into the glycol.

The last step of the mounting operation is to secure the trap to the ground. To do this, attach a nylon rope to upper end of the funnel, e.g. where the steel wire has been attached. Then tie the rope to a piece of wood weighing 5-10kg and lying on the ground directly under the trap (in most cases, this wooden weight will already be available where the trap has been mounted before). The rope must

be tight enough to stabilize the trap, so that it will not move to strongly in the wind but must not be so tight that it pulls at the trap and makes it tilt.

In damaged forest, traps may have to be mounted on dead tree trunks. In this case, make sure that the trunk is so solid that it will not fall during the season. If there is doubt about the suitability of the trunks closest to the GPS point, the trap should be moved until a suitable pair of trunks can be found. If this brings the trap outside of the 5-meter radius of the point, record a new GPS point for the new location of the trap.

Plate 1. A window trap mounted between two birch trunks. This trap has all components attached and is fully operational.

Visit 2. First collection of insect samples: All traps should be visited to retrieve insect samples approximately 1 month after mounting. Samples are collected in 0.75-litre plastic boxes with watertight lids. To collect a sample, unscrew the flask from the trap and sieve off some of excess liquid with a piece of nylon mesh. Pour the remining 0.4-0.5 litres of liquid into the plastic box, taking care to not leave any insects behind in the flask. The nylon mesh should also be put into the box. The following information should be written on the lid of the box with a permanent marker:

- Location (Kirkenes or Tana)
- Site number (1-10)
- Trap identity (A, M or B)
- Month (July or August)

When the flask has been emptied, fill it with glycol again as described above and screw it back onto the funnel of the trap. Before leaving, make sure that the funnel is not obstructed by twigs, leaves, etc.

Visit 3. Second collection of insect samples and dismounting of traps: Before taking down the traps, collect the insect samples as described for visit 2 above. The traps can then be dismounted by

untying or cutting down the ropes. The plexiglass plates, funnels and flasks should be taken apart, as they are stored separately.

Equipment needed

Visit 1:

- Plexiglass plates (1/trap)
- Funnels (1/trap)
- Flasks (1/trap)
- 8 mm polypropylene rope (approx. 6 m/trap)
- 2 mm nylon rope (approx. 2 m/trap)
- 0.9 mm steel wire (approx. 40 cm/trap)
- Glycol thinned down with 1/3 water (approx. 0.25 liters/trap)
- Pliers for cutting steel wire
- Knife for cutting rope
- A handheld GPS with all trap sites loaded

Visit 2:

- 0.75-litre plastic boxes with watertight lids (1/trap)
- 15×15 cm squares of nylon mesh (1/trap)
- Permanent marker pens
- Glycol thinned down with 1/3 water (approx. 0.25 liters/trap)
- A handheld GPS with all trap sites loaded

Visit 3:

- 0.75-litre plastic boxes with watertight lids (1/trap)
- 15×15 cm squares of nylon mesh (1/trap)
- Permanent marker pens
- Pliers for cutting steel wire
- Knife for cutting rope
- A handheld GPS with all trap sites loaded
- Bags for carrying thrash (cut ropes and steel wire)
- Sturdy boxes for storing trap components and samples (can be left in the car)

Information recorded in the field

No information needs to be recorded in the field, except for the marking of the plastic boxes used to store the insect samples and any anomalies regarding the traps, e.g. traps that have fallen down.

Sample processing after field work

Immediately after fieldwork, all samples should be inspected to see if the liquid is very thinned out by rain water (i.e. it has largely lost the blue colour of the glycol). If this is the case, some additional glycol should be added to the sample box before it is put away. This helps to ensure the preservation of the insects.

During the field campaign, plastic boxes with samples can be stored in a sturdy cardboard box. The samples should be kept as cool as possible and can usually be left in the storage room of a car. However, during warm and sunny days, keeping the samples in a cabin is preferable to leaving them in a sun-heated car. When arriving at the lab, the samples should immediately be put in a cold-storage room (<8 °C).

As soon as possible (preferably within the first month of returning from the field), insects should be picked out from the glycol and transferred to 96% ethanol for preservation. All coleoptera individuals should always be picked out and stored in this way. In some years, other insect groups should also be picked out, but this is decided on a yearly basis. The easiest way to sort the samples is by transferring small amounts of liquid from the plastic box to a petri dish and searching through the petri dish with a featherweight forceps under a stereo microscope. The square of nylon mesh in the box must also be searched. Insects are stored with ethanol in dram vials. For each sample, there should be a separate vial for large (>5 mm) and small (<5 mm) coleoptera. Vials must be labelled with all the sample information on the plastic box:

- Location (Kirkenes or Tana)
- Site number (1-10)
- Trap identity (A, M or B)
- Month (July or August)

The liquid that is left after picking out the relevant insects must be treated as special waste as it contains glycol. Storage and disposal of this waste must be arranged with the permanent staff at the lab. The insects that are left after picking out relevant groups can be thrown away with the glycol.

Equipment for post processing in the lab:

- 8-10 cm diameter petri dishes (1/person)
- Stereo microscope with up to 40x magnification (1/person)
- Featherweight forceps (1/person)
- Adhesive labels for labelling vials (1/vial)
- 41 × 21 mm dram vials (2/sample)
- 96% ethanol (about 2 liters is required for all the samples of a season)
- Pipettes for transferring ethanol to vials (1/person)

Data processing

When all samples have been processed, the vials with insects are sent to a taxonomy expert for identification. The expert provides species lists per sample in excel format. The species names in these lists need to be checked against the current taxonomic status in the database of the Norwegian Biodiversity Information Centre (https://www.artsdatabanken.no/). This process is automated with the script “Coleoptera_deadwood_check_species.R”, which is stored at https://github.com/COATnor/data_preprocessing_scripts. After completing the taxonomic check, the data should be stored as a txt-file in standardized format. The formatting is done automatically with the script “reformat_insect_commun_deadwood_coleoptera.R”.

Training requirements and specialized skills

Mounting and emptying of traps requires some very basic training. This can usually be obtained by practicing on a few traps together with experienced personnel. Sorting of insect samples in the lab requires enough knowledge of insect taxonomy to be able to reliably distinguish coleoptera from other insect orders. Some practicing together with experienced personnel is usually necessary to ensure that students and assistants can recognize all types of coleoptera. Additional taxonomic knowledge will be necessary to sort out other insect groups in years where this is relevant. Detailed manuals for identifying these groups will be provided by the permanent COAT staff.

References

Kaila L, Martikainen P and Punttila P (1997). "Dead trees left in clear-cuts benefit saproxylic Coleoptera adapted to natural disturbances in boreal forest." *Biodiversity & Conservation* 6(1): 1-18 DOI: 10.1023/A:1018399401248.

Vindstad OPL, Schultze S, Jepsen JU, Biuw M, Kapari L, Sverdrup-Thygeson A and Ims RA (2014). "Numerical Responses of Saproxylic Beetles to Rapid Increases in Dead Wood Availability following Geometrid Moth Outbreaks in Sub-Arctic Mountain Birch Forest." *Plos One* 9(6): e99624 DOI: 10.1371/journal.pone.0099624.