Ministry of the Environment Project to Promote Monitoring of Important Ecosystem Surveillance Areas (Monitoring Site 1000)

Monitoring Site 1000: Forest and Grassland Surveys

Manual on Ground Dwelling Beetles Survey

Revised in April 2022

Nature Conservation Bureau
Ministry of the Environment
Biodiversity Center of Japan

Japan Wildlife Research Center

This manual is an English translation of the Japanese version and has not been reviewed by experts. Some technical terms and expressions may not exactly capture the intended nuances.

1. Introduction

Insects are major constituents of biodiversity on the earth and play an important role in ecosystems. However, as the number of species is enormous and an individual size is small, it is difficult to conduct a species-level survey. It is essential to investigate insects in the Monitoring Site 1000 project, but it is required to be able to examine at a taxonomic group level and include groups with important ecosystem functions. Thus, this project includes ground dwelling beetles as such a group to conduct a survey using pitfall traps. A pitfall trap can collect ground prowling invertebrates, among them, carabid, silphid, and staphylinid beetles are the majority. The range of activities of many of beetles collected by a pitfall trap is narrow due to the loss of flying ability, so they draw the attention as living organisms representing a forest floor environment of the relevant region. Therefore, it is significant to monitor diversity of beetles nationwide. Moreover, since beetles investigated in this survey are temperature-sensitive and short-lived, it is possible to detect the effects of global warming at an early stage.

Ground dwelling beetles collected by a pitfall trap live on forest floors where litter is accumulated. In the forestry ecosystem, a decomposition system is so outstanding that about 90% of aboveground production volume of plants is supplied to soil. A forest degradation system is very important in that it drives the forestry ecosystem as a recycling system of nutrient salts. Beetles are upper-level predators in this system. Therefore, in this survey, ground dwelling beetles are supposed to involve in a forest floor environment and the decomposition function as part of the degradation system of forest floors. In addition to a population survey of beetles, abiotic environmental factors and the degradation function of forest floors are measured to reveal a correlation between forest floor environment and the degradation function. The volume of litter accumulated on forest floors is a key indicator to identify the cumulative volume and the circulation volume of nutrient salts, since it is closely related to biotic degradation activity. Moreover, surface soil has high bioactivity and its volume of organic matters is evaluated as a feeding source for soil animals eaten by ground dwelling beetles. Since what type of beetle species appear varies depending on season, a survey is conducted four times a year to evaluate local populations and diversity of the survey site. The volume of accumulated litter and the quality of soil and litter are measured as environmental factors.

Supplement) This manual is to survey ground dwelling beetles under the Monitoring Site 1000: Forest and Grassland Survey. However, the method mentioned in this manual is not the best. We plan that this survey be simplified so that it is conducted on a long-term basis by taking in opinions from you in the next few years. Moreover, we aim to realize long-term dynamic prediction in the future by integrating the discovery of correlation between dynamics of beetle populations and environmental factors for the purpose of accumulating more significant data.

2. Survey method

2.1. Installation of pitfall traps

The pitfall trap method is to collect animals that fall in a pitfall-type trap installed on forest floors. The number of animals collected depends on habitat density and activity.

A polypropylene container (hole diameter: 90 mm, depth: 120 mm) is used as a trap. Make about six drainage holes whose diameter is around 1 mm on the bottom surface of the trap container. 20 trap containers per plot are sent by the Monitoring Site 1000 Network Center (A department handing samples and data of the Monitoring Site 1000 Forest Survey (excluding bird species) established in the Hokkaido University Tomakomai Experimental Forest. Hereinafter referred to as the "Network Center").

The procedures for installing a trap are shown below.

1. Establish five sub-plots (5m x 5m) randomly at intervals of 15 m~20 m within a forest plot (tree census site) established in each site. Measure (visually) the X and Y coordinates (by 1 m) in the center of each sub-plot with the same coordinate system as the position measurement of trees in tree census (See 4.1 Method of First Tree census in the Monitoring Site 1000 Manual on Setting and Survey of Forest Core Sites (Ver.2)).
2. Install four traps in each of the five places (Fig. 1, the total number of traps within one plot is 20).

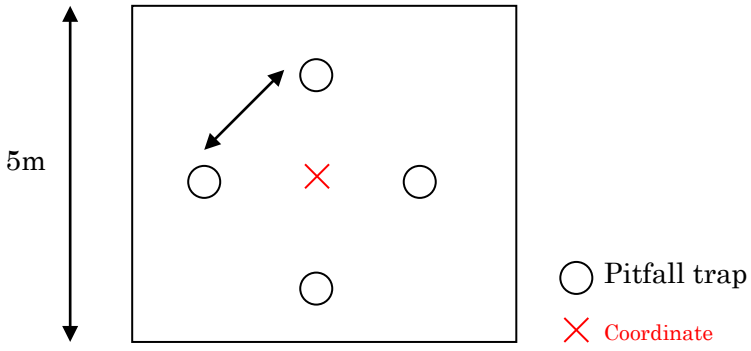


Fig.1 Layout of pitfall traps in each sub-plot

3. To bury a trap, remove a litter layer on the land surface at an area of about 100 cm^2 and dig a 15 cm-deep-hole using a small shovel (Fig. 2a).
4. Backfill and fix the trap with surrounding soil to prevent the upper end of the trap from protruding from the ground, because it becomes difficult for small ground dwelling beetles to fall into the trap if there are bumps near its opening.

5. Cover the trap with a litter layer so that land surface conditions near the opening of the trap are not different from surrounding environments (Fig. 2b).



b)



Fig. 2 Method of burying a trap container. a) A hole to bury a trap container. b) Forest floor with a trap container buried

*In cases where a trap is likely to be pulled out by large animals, fix the trap using pegs, etc. (Fig. 3a).

*In cases where rainwater is accumulated in a trap and causes a trouble, it is allowed to make the following modifications.

(1) Set up a roof-like rain cover directly above the trap (Fig. 3b)

The rain cover's size should be within an area of 20cm x 20cm and leave a distance of more than 5 cm from the ground in order not to obstruct the movement of ground dwelling beetles.

(2) Drill big water drainage holes on the bottom face of the trap (Fig. 3c)

Attach a mesh whose opening size is less than 1 mm over the water drainage holes so that small beetles cannot enter. In cases where a site cannot do this work, please contact the Network Center.







Circle each sub-plot with ropes, etc. Don’t enter a sub-plot except when conducting a survey. Even if you enter a sub-plot for the purpose of conducting a survey, strive to minimize the effect of disturbance of accumulated litter layers and understory vegetation by following the same route every time to minimize soil compaction.

2.2 Sampling

[1] Sampling of beetles

A survey is conducted four times a year between May and November when beetles are active leaving at least an interval of one month. Since beetles are less active when it is raining, avoid a rainy day as much as possible. Before a survey is conducted, the Network Center sends five sample collection containers per plot.

The procedures for pitfall trap survey are shown below.

1. Open the pitfall trap lid and leave it for 72 hours (Each pitfall trap has a lid. It should be closed unless it is surveyed for subsequent surveys).
2. Collect only invertebrate in the trap 72 hours later.

*In any of the following cases (1) ~ (4), a capture rate of beetles may change while a trap is opened, captured beetles may have escaped, or captured beetles may have been preyed, enter the phrase in [ ] in the remarks field of "pitfall survey" sheet in the survey sheet (Excel file) (See 2.3). Enter the number of traps in "x" and specific reasons in "~".

(1) [Buried: x trap(s)] Example: A trap was buried or its depth was too shallow due to mixture of dirt or litter.

(2) [Submerged: x trap(s)] Example: A trap was submerged or its depth was too shallow due to waterfall or flood.

(3) [Disturbed by vertebrates: x trap(s)] Example: A trap was moved by an animal. A vertebrate was in a trap such as lizards.

(4) [~: x trap(s)] A trap is supposed to have been disturbed for other reasons.

3. Put the contents of four traps installed at one site in one collection bag (five collection containers are required because there are five spots in one plot).

*A collection container has a few pieces of paper impregnated with ethyl acetate which has antiseptic and insecticidal effects. Since the effects of ethyl acetate are easily lost due to volatilization or hydrolysis, be careful not to open the lid unless you put collected animals and tightly close it after collection. Moreover, in cases where rainwater is accumulated in a trap, make sure to prevent water from entering in the collection container as much as possible.

*In cases where it is possible to freeze the contents in one day after collection, it is allowed to put them in a container without ethyl acetate. In that case, freeze them as soon as possible and try to keep a frozen state until they are shipped to the Network Center. In cases where it is not possible to freeze the contents within a few hours after collection, transport and store them under refrigerated conditions, etc. until they are frozen to avoid cannibalization, escape, or decomposition.

4. Remove foreign objects such as litter, stones, and soil from the contents in the trap.

5. Enter the date of collection and the name of one investigator (in Roman characters) on a label on the collection container (this name is printed on the beetle sample label created by the Network Center as a collector's name).

6. Enter **the starting and end time of survey, climate, and coverage rate per sub-plot** in a "pitfall survey" sheet in a survey sheet (Excel file), and enter **survey records** in a "all survey records" sheet (See 2.3.).

7. After a survey completes, send the collected animals immediately to the Network Center use refrigerated transportation service in summer). In cases of cold storage, make sure to use refrigerated transportation service regardless of season.

8. When sending the collected animals by mail, send a **survey sheet (Excel file)** with necessary information entered together with a work report (date of sample shipment, **estimated date of arrival**, remarks, etc.) to the person in charge of the Network Center by email.

9. Leave a meteorological data section in the survey sheet blank if much time is required to extract meteorological data such as temperatures and send a complete file with all required information by plot **by the end of December**. In cases where it is not possible to send data within December due to any special circumstance, please notify the person in charge of the Network Center of that effect.

[2] Collection of samples other than beetles

In order to figure out dynamics of an accumulated litter layer (A_0 layer), collect litter layers around the trap at five sites where traps were buried. Litter layers are collected once a year (June ~ August). Soil underneath the litter layer is collected every three years at the same time as the collection of litter layers.

The procedures for collecting accumulated litter layers (A_0 layer) are shown below.

1. Select a site where litter layers are collected at a spot about 3 m away from the trap. Litter layers are collected at a site where they are not trampled when a pitfall trap survey was conducted or disturbed by the collection of litter layers in the past.
2. Cut fallen leaves or branches using a pruning shear within the range of 25 cm x 25 cm of forest floor and collect litter layers in that range to the depth where soil particles become visible.
3. When collecting litter layers, **remove branches, pebbles, and stones whose diameter is 5 mm or more**. Moreover, collect litter layers to the depth where soil particles become visible so that those at the bottom of litter layers are not mixed. Remove attached soil as much as possible.
4. Collect samples from five sites per plot following the procedures 1~3 above.
5. Put collected litter layers in an envelope and clearly write down (1) Survey plot name, (2) Spot number (1~5), and (3) **Collection date**.
6. Put the envelope with litter in a fan dryer at 60 degrees C to dry it for more than 48 hours. In cases where soil particles are separated into the bottom of the envelope after drying, **dispose of soil particles before sending** dried litter layers. Send dried litter layers to the Network Center by mail.
7. **Enter survey records such as the collection date** in a “all survey records” sheet of a survey sheet (Excel file) and send it to the Network Center by email (See 2.3.).

The procedures for collecting soil are shown below.

1. Collect soil directly under collected accumulated litter layers using a soil collection cylinder (100cc) (five sites per plot in the same way as litter layer samples).
2. Soil collected by the soil collection cylinder should be brought back in a plastic bag and then put into an envelope.
3. Clearly write down on the envelope (1) Survey plot name, (2) Site number (1~5), and (3) **Collection date**.
4. Put the envelope with litter in a fan dryer at 60 degrees C to dry it for more than 48 hours. Send dried soil to the Network Center.
7. **Enter survey records such as the collection date** in a “all survey records” sheet of a survey sheet

(Excel file) and send it to the Network Center by email (See 2.3.).

2.3. How to fill in survey sheet file

A survey sheet (Excel file) should be filled in for each plot. **It should be filled in every time a survey is conducted and sent to the person in charge of the Network Center**. Firstly, fill in the "plot information" sheet. When a pitfall trap survey was conducted, fill in the "pitfall survey" sheet. Furthermore, when a pitfall trap survey and another survey were conducted, fill in the "all survey records" sheet to reveal who conducted these surveys when, where, how, and what for as well as what was measured on a long-term basis.

The following information should be filled in the "pitfall survey" sheet.

(1) Survey plot name
(2) Survey period
(3) Weather during the survey
(4) Cumulative precipitation (cumulative value within the time when the pitfall trap is opened (72 hours))
(5) Maximum and minimum temperatures (those within the time when the pitfall trap is opened (72 hours))
(6) A plant coverage rate of herb layers of each sub-plot (herb layers whose ground height is less than 60 cm, including seedling/young trees of bushes and arbors as well as bamboos. The investigator determines a plant coverage rate visually in the range of 5 m x 5 m where the trap is buried (Fig. 4))
(7) Name of collection representative (the name entered in this field is printed on the beetle sample label)
(8) Remarks (enter any unusual point or any point that requires attention to interpretation with respect to the information described in (1) ~ (7) above and capture data of beetles, observations at the time of survey about the traps and their surroundings other than the information described in (1) ~ (7) above. See p.6 for how to fill in when any trap was disturbed)

a) b)



Fig. 4 Plant coverage rate of herb layers on forest floor. a) 65%, b) 10%

Fill in the following information in the “all survey records” sheet.

(1) Date of survey
(2) Survey plot name
(3) Name of investigator
(4) Survey content
(5) Remarks (observations during survey, significant changes in environment and biotas before and after the survey period and near the plot, particularly notable events)

The survey records should be filled in every time the following works are carried out.
(1) Starting date of pitfall trap survey (Four times a year)
(2) Collection date of pitfall trap survey (Four times a year)
(3) Collection of litter layers (Once a year)
(4) Installation of cellulose filters (Twice a year)*
(5) Collection of cellulose filters (Six times a year)*
(6) Collection of soil (Every three years)

*For the installation and collection of cellulose filters, see “Manual on Installation and Collection of Cellulose Filters”.

3. Storage of samples

Beetles, litter layers, and soil collected from each site should be sent to the Network Center. The Network Center takes the responsibility for identifying beetles down to family (species as much as possible) and measures dry weight. Moreover, the Network Center prepares samples (extending their legs if necessary) and then store them in specimen boxes. The dry weight and carbon and nitrogen concentrations of litter layers are measured. As for soil, its carbon and nitrogen concentrations are measured.

The Biodiversity Center of Japan stores up to ten pieces per species of each survey site. It is allowed for each site or another organization (hereinafter referred to as “requesting site, etc.”) to store samples other than those stored by the Biodiversity Center of Japan upon request. A requesting site, etc. should notify the Network Center in advance, and in cases where it desires to store any sample other than those collected by itself, it should obtain consent of the representative of the relevant site. The proprietary right of samples stored by a requesting site, etc. shall belong to the requesting site, etc. that stores those samples.

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