Wood Ant Translocation

Good Practice Guidance

Contents

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Background

The aim of this guidance is to encourage a more structured approach to the translocation of wood ant nests and ensure that translocations are based on the most up to date methods. Translocation of wood ant nests is a very specialised area of conservation and it is hoped that this guidance can provide useful tools for non-specialists (land managers, consultants, developers etc.) that may need to carry out this type of work.

Our knowledge of wood ant behaviour and ecology is increasing all the time, as is our understanding of the effects of translocation on colonies and their ability to tolerate disturbance. As such this is seen as a working document that will likely be updated over time as new information becomes available.

There are documented examples of wood ant translocation projects that have been conducted in the UK and further afield. Experiences gained through these projects have helped to shape this guidance.

This guidance will cover the following mound building species of ants: Southern Red Wood Ant *(Formica rufa)*, Scottish Wood Ant *(Formica aquilonia)* and Hairy Wood Ant *(Formica lugubris)*. These species have different habitat requirements and different colony structures (see Appendix 1). For the rest of this report these species will be termed "wood ants".

This guidance also includes Narrow-headed Ant *(Formica exsecta)* which is also a mound building ant and related to the wood ants, but differs in biology and ecology. These differences mean that a different approach to translocation is required for this species, as such it is discussed separately to the wood ants on page 22.

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Wood ant nests

The nests of these species are highly complex structures and are built over years, sometimes decades.

The thatched mound on the surface is only a component of the whole nest and a significant proportion of nest structure also exists underground. A single colony of wood ants can consist of multiple, interconnected nests with established foraging trails existing between them and the surrounding habitat.

Although some nest mounds contain a single queen (known as monogyny), there can be multiple queens within a single wood ant nest mound (polygyny). It is essential to establish whether a nest mound belongs to a population known to be generally monogynous or polygynous (see Appendix 1) and capturing the queens is critical for the ability of the nest to survive – particularly the case in monogynous nests. If the queen is lost or killed the nest will become extinct. Polygynous colonies have the ability to be single nest (monodomy), or multi-nest colonies (polydomy). Polydomous nests result from mated queens returning to their natal nest. One of these queens can then create a "bud" or "satellite" nest nearby which remains connected to the natal nest. Therefore a single related colony can consist of several interconnected nests. A woodland may contain a large number of nests, however if all these nests are related interconnected nests then the actual population size will be low (owing to the ants being genetically related to one another).

To reduce competition for resources, wood ants defend their nests and territories aggressively from other wood ants and also other ant species. Wood ant colonies that are unrelated to each other will fight aggressively when they encounter each other although separate colonies can co-exist in the same area of woodland by maintaining their own territories. The size and quality of habitat will determine how many colonies can co-exist, and how big (sizes of individual nests and numbers of nests) these colonies can be.

Ants are predatory insects, foraging on a wide range of invertebrates at all levels of the woodland, from the ground to the tree canopy. Invertebrate prey is predominantly fed to the developing brood (larvae).

The diet of the workers mostly comprises honeydew from aphids in the tree canopy. Nests will have established foraging routes into the woodland around them. Trees both young and mature are a vital source of aphids. The wood ant workers will often visit particular trees to feed, and not necessarily those closest to the nest.

A Southern Wood Ant *(Formica rufa)* worker guarding a collection of aphids.

© J.M.S.Robinson

The wood ant year

It is useful to understand how the activity of ants changes throughout the season as this often dictates how and when nests can be moved. Opposite is a generalisation and timing of events will vary depending on factors such as species, location within the UK, nest altitude, local climate etc.

More detailed information on wood ants and their ecology can be found in the resources below:

- Cairngorms National Park Authority (2021) Guide to Wood Ants of the UK and related species
- Robinson, E.J.H. & Stockan, J.A. (Eds) (2016) Wood Ant Ecology & Conservation. Cambridge University Press.
- Robinson, E.J.H. & Stockan, J.A. (2021) Wood Ants (Formica rufa Species Group) in Encyclopedia of Social Insects. Christopher K. Starr (Ed). Springer, Germany.
- www.woodants.org.uk
- www.antwiki.org/wiki

Calendar of Wood Ants

Timing	Event
November-March	Hibernation
March-April	Spring swarming. Timing of emergence is dependent on ambient temperature and levels of sunshine. In southern UK wood ants can emerge as early as February, depending on weather. Activity of the workers begins when the internal nest temperature rises to between 25-30°C. Workers will then cluster on the surface of the nest in a dense mass to absorb heat from the sun (see Figure1 below right).
May-October	This is the main season for wood ant worker activities. This includes foraging, aphid farming, repairing and building nest. The number of active workers involved in foraging peaks in mid-summer.
June-September	Raising worker offspring
May-June	Raising sexual offspring (from eggs laid in late winter/early spring).
May-June	Emergence of males and virgin queens, mating flights. This is usually confined to a relatively short window of time. In southern England can be as early as May, in northern Scotland may be as late as July/early August.

Calendar of Narrow-headed Ant

Timing	Event
November-March	Hibernation
March-April	Workers become active again (but do not show swarming/clustering behaviour as seen in wood ants). Spring emergence in Scotland is likely to be later than southern England.
May-October	General worker activity and foraging, aphid farming, repairing and building nest. Number of active workers involved in foraging peaks in mid-summer.
May-June	Raising sexual offspring (from eggs laid in late winter/early spring).
June-September	Raising worker offspring
July-August:	Emergence of males and virgin queens, mating flights. This is usually confined to a relatively short window of time.

Figure 1

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Conservation Status of wood ants

Wood ants are not legally protected. However some of the species are of conservation concern and listed as priority species for conservation. All public bodies have a biodiversity duty* to protect and conserve all wildlife, not just specific protected sites or protected species.

It is considered good ecological practice to avoid deliberately harming wood ants and their nests, particularly in light of their important roles within woodland ecosystems.

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* Environment Act 2021, Natural Environment & Rural Communities Act (2006) Section 40 and Section 42 (England and Wales respectively), Nature Conservation (Scotland) Act 2004 (Scotland), Wildlife and Natural Environment Act (Northern Ireland) 2011 (Northern Ireland)

Overview of the conservation status of each species:

Southern Red Wood Ant *(Formica rufa)*

- IUCN status: "Near Threatened" (last assessed 1996)
- Subject to an action plan in the Warwickshire, Coventry and Solihull Local Biodiversity Action Plan and the Harrow (London Borough) Biodiversity Action Plan.

Scottish Wood Ant *(Formica aquilonia)*

- IUCN status: "Near Threatened" (last assessed 1996)
- Northern Ireland Priority Species (Wildlife and Natural Environment Act (Northern Ireland) 2011)
- Subject to an action plan in the Cairngorms National Park

Hairy Wood Ant *(Formica lugubris)*

- IUCN status: "Near Threatened" (last assessed 1996)
- Subject to an action plan in the Cairngorms National Park

Narrow-Headed Ant *(Formica exsecta)*

- Classed as Endangered in the UK according to the GB Red List.
- Natural Environment & Rural Communities Act (2006) Section 41 – listed under "Species of Principal Importance"
- Nature Conservation (Scotland) Act 2004 – listed as a priority species on the Scottish Biodiversity List under the categories "Conservation Action Needed" and "Avoid Negative Impacts".
- Subject to an action plan in the Cairngorms National Park (2019-2024) and is listed on the "Devon Special Species" by the Devon Local Nature Partnership.

The Shining Guest Ant *(Formicoxenus nitidulus)*

The Shining Guest Ant is an ant species that lives inside wood ant mounds. It creates its own nest inside the wood ant mound and forages within the nest, protected by a cuticle coating that the wood ants find repellent. It is not found within every single wood ant nest and due to its tiny size and secretive lifestyle, very little is known about this species. It is listed as a priority species for conservation in England and Scotland (see below). Its status as a priority species accords priority status to wood ants, as it is dependent upon Southern Red Wood Ant, Scottish Wood Ant and Hairy Wood Ant in the UK for its existence.

Overview of status:

- Natural Environment & Rural Communities Act (2006) Section 41 (England – "Species of Principal Importance")
- Nature Conservation (Scotland) Act 2004 – listed as a priority species on the Scottish Biodiversity List under the category "Watching Brief Only".
- IUCN status: "Vulnerable" (last assessed 1996)
- Subject to an action plan in the Cairngorms National Park

A Shining Guest Ant next to the worker of a much larger wood ant

© Stewart Taylor

Myrmecophiles

In addition to the ants themselves, wood ant nests often play host to other invertebrate species which depend upon the conditions within the nest for all or part of their lifecycle (known as myrmecophiles*), making the nests small ecosystems in their own right.

* For more information on myrmecophiles in wood ant nests, see Robinson, N. A. & Robinson, E. J. H. (2013) and Chapter 8 of Robinson, E.J.H. & Stockan, J.A. (Eds) (2016)

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Clytra quadripunctata, a beetle that lives as a grub inside wood ant nests, protected from attack by a case made from soil particles and excrement

Permissions

Where translocations are necessary, these should be undertaken following the International Union for the Conservation of Nature (IUCN) Guidelines for Reintroductions and Other Conservation Translocations. Translocation of wood ant nests will require the permission of the landowner at the donor and recipient sites.

Where the site is designated, additional consents will be required from the relevant government conservation body: Natural England, Nature Scot, Natural Resources Wales, Council for Nature Conservation & the Countryside (Northern Ireland).

In Scotland the IUCN guidelines have been developed into a code on how to assess and plan conservation translocations in Scotland: Scottish Code for Species Translocations. The code contains forms that must be completed and submitted to Nature Scot for a licence – this must be carried out for all species translocations in Scotland. The form allows you to record the translocation process and steps to reduce risk of negative outcomes.

In England, DEFRA have published Reintroductions and other conservation translocations: code and guidance for England (May 2021). This code is based on the IUCN guidelines and is designed to align with the Scottish Code to encourage consistency across the UK.

Health and Safety

Translocating wood ant nests, nest material and ants is stressful for the ants and they will defend themselves by spraying formic acid and biting. When moving large amounts of nest material, the volume of formic acid can be significant and can irritate the skin, eyes and respiratory system.

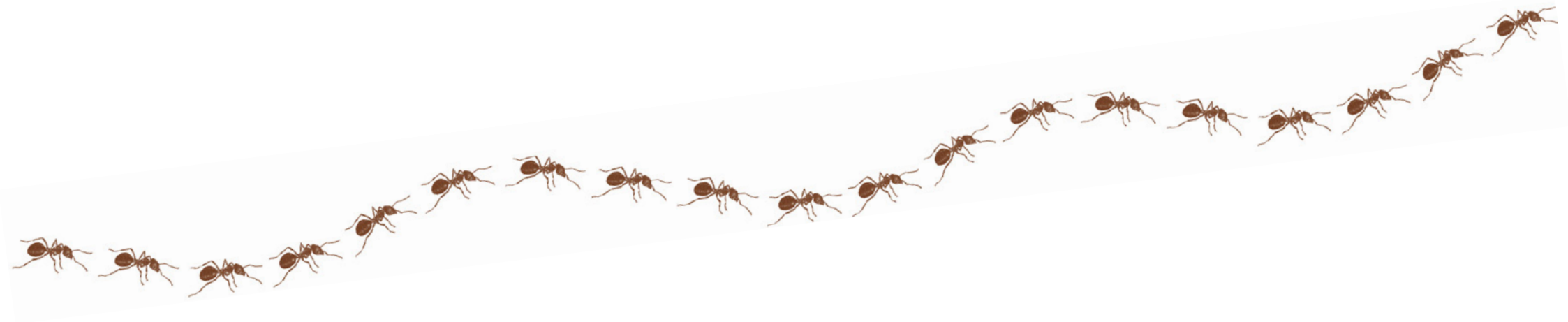
It is therefore strongly recommended that for any wood ant translocation work and handling of ants and nest material, the following Personal Protective Equipment is used:

Safety goggles

A valved face mask to cover the nose and mouth

Gloves (tough gardening gloves recommended for shovelling and moving nest material)

Sturdy footwear, full length trousers and a top that covers the arms. Trousers should be tucked into long socks or gaiters should be worn.



Translocation Principles

Translocation of wood ant nests must always be the last resort. The ecological mitigation hierarchy should be followed (CIEEM 2018), seeking to avoid any impact on wood ant nests as the priority. If this is not possible, mitigation should be designed to limit impacts on the nest while remaining in situ. Only where avoidance and in situ mitigation are not possible should translocation be considered. The aim should always be to design development, forest plans etc. that complement the natural ecology of wood ants and avoid the need to disturb them.

Reasons for translocation of wood ants

Reason 1:

To prevent loss of wood ant colonies due to a direct threat of extinction (e.g. development, tree removal, irreversible habitat change): this must be a last resort only, as it is best practice to leave wood ant nests in their original location and with sufficient habitat to allow colonies to survive.

Reason 2:

To reintroduce wood ants to historical areas to promote ecological restoration and ecological resilience, capitalising on the role wood ants play as keystone species and ecosystem engineers.

For reason 2 there must be clear justification for re-locating wood ant nests and translocation should only be undertaken if wood ants cannot disperse to these areas on their own, there is historical evidence to suggest that wood ants were present in the past, or that the recipient site is within their native range. There must be clear benefits to moving wood ants, both for the wood ant colony and also the ecology of the recipient site. There should be no sensitive species which could be adversely affected (including existing wood ant colonies) and no factors which would affect long term survival of the wood ant colonies at the new location (i.e. future changes in management).

All methods of translocation need to consider the following principles (adapted from Hughes, 2008):

a. Wood ant nests should always be moved in a way that retains at least the nest layers (even if using the German method – see page 13).

b. Recipient sites must be chosen and prepared in advance of the wood ants being moved, with necessary survey work being completed before the translocation (see Appendix 2).

c. Wood ant nests should only be moved during periods of low activity in early spring*. The ambient air temperature should be between 5 and 10°C. Timing must coincide with 2-3 days fair weather post-translocation so that the ants have good conditions to rebuild the nest.

d. Wood ants (and Narrow-headed Ant) should never be moved during the winter hibernation period – at this time the ants are deep inside the nest in the underground component where the temperatures are more stable and they can avoid frost. They enter a period of very low activity, utilising fat stores to survive. Excavation of the nest at this time would expose the wood ants to low temperatures which could kill them. Using up their winter stores at this time when they cannot be replenished would cause the overwintering workers and queens to starve.

e. Translocation must consider the distances that nests can be realistically moved, the terrain and whether nests will be moved by hand or in a vehicle. Distances travelled and the time nests are being moved should be kept to an absolute minimum to avoid too much stress on the ants.

f. Translocated nests must be monitored and integrated into long-term management plans to ensure their survival and ability to thrive.

* Key exception to this is translocation of Narrow-headed Ant nests – see page 18 and the partial nest method

Stages of translocation

When planning a translocation or reintroduction, a method statement should be compiled, covering all key aspects of the translocation. This should include:

- Reason for translocation/introduction,
- Choice of receptor site(s) based on detailed habitat assessment:
- Habitat suitability study in the season prior to translocation. Receptor sites should aim to be as close to the donor site in habitat structure as possible,
- Identifying precise pinpoint locations for translocated nest(s) at the recipient site(s).
- Description of how the nest translocation will be undertaken practically (preparation at the recipient site; timing; equipment used; nest extraction, transport and installation methods)
- Safeguards to minimise disturbance to other wildlife during the translocation operation,
- Consideration of impacts, and repairing any damage from the translocation operation, at the donor site.
- Post-translocation aftercare (programme of supplementary feeding),
- Post-translocation monitoring (at recipient and donor sites),
- Other relevant information: maps, tracking routes across site(s) for any vehicle movements,
- Health and Safety risk assessment.

Translocation of nests requires careful consideration and planning to ensure the best outcome for the ants.

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Site habitat assessment

1) Assessment of donor sites

- Plot the location of all nests requiring translocation and clearly mark them if necessary

- Identify ant species – each species has different habitat preferences (Appendix 1) so it is important to know which species is present. An ecologist with experience of working with ants should be consulted for advice

- Survey and record habitat within 10m and 25m buffer area around each nest requiring translocation (Cathrine 2015a). This will allow the habitat immediately around the nest to be assessed, and also the wider habitat which the wood ants are likely to be foraging in. This detailed assessment is important to ensure a receptor site is chosen that matches the habitat of the donor site as closely as possible. A template for recording this survey information is available in Appendix 2.

If nests or nest material/ants are being translocated to introduce wood ants for reason 2 on page 18, additional factors will need to be considered:

- There must be clear justification for introducing wood ants into habitat where they are currently absent.

- The donor population should be healthy, and removal of individuals or nest material should not have a significant negative effect on the colony's survival. The exception to this would be where the donor population is at high risk of extinction at its current location and the only option is to move the donor population to a site which would increase their chance of survival.

- Reintroduction of wood ants to a new area will require careful consideration of the quality of habitat at the recipient site and ecological implications of reintroducing wood ants to that habitat, including potential impacts on other species.

2) Assessment of receptor sites

The habitat of the receptor site should match the donor site as far as possible. It is highly recommended that the receptor site is assessed at different times of year to establish effects of drainage and shading. As well as meeting the broader habitat requirements of the wider area, the immediate vicinity of the receptor location should be as similar as possible to the donor site. These should aim to be in sunny, sheltered positions where the ground flora and surrounding trees and shrubs will not shade the nest. Suitable habitat at the receptor site should extend to 20m away from the chosen nest microsite, in order to allow the ants to relocate and bud.

It must be noted that the distance between the donor and receptor sites is also an important consideration and will be an important factor in determining the method of translocation chosen. There are cases of wood ants being transported over huge distances successfully, such as the introduction of Hairy Wood Ant nests from Italy to Canada in the 1970s (Finnegan 1975). However, transportation distances should be kept to a minimum and the time ants are captive kept as short as possible to avoid too much stress on the ants and risk of suffocation and crushing caused by the weight of nest material.

A checklist of factors to note and record at receptor sites is given in Appendix 2.

Deciding on method of translocation

Reason 1:
Translocation of nests under direct threat of destruction

Aim:
To translocate all nests and as much of the nest material as possible. It is impossible to collect all of the individual ants and inevitably some will be left behind.

Objective:
To retain the local population and its genetics by establishing viable nests in alternative locations – this is done by capturing queens with enough of a workforce to support them.

Methods:
There are two methods that are likely to be used, both of which aim to collect as much of the original nest material as possible.

Method 1 – GERMAN METHOD

Method 2 – WHOLE NEST EXCAVATION METHOD

See **Appendix 3** for the pros and cons of each of the current documented translocation methods for ants. A flow chart is provided in **Appendix 4** to assist in deciding between translocation methods.

Principles common to both methods:

- Translocation should be carried out in the morning when it is cooler and ants are less likely to be highly active and foraging away from the nest
- Choice of receptor site for the nest must be made prior to translocation – receptor sites for translocated nests should be carefully selected to be as similar to the donor site as possible and must be of sunny, sheltered locations that are south or south-east facing. In advance of the translocation, the individual receptor sites will require some preparation to accept the nest material and accessible bare soil for the ants to tunnel into. Receptor site preparation involves scraping an area of the ground surface to remove surface vegetation, approximate to the size of the nest being moved. The diameter and depth of the depression should reflect the dimensions of the nest being moved. The excavated material can be mounded up on the northern side of the depression and may help to provide additional structure and warmth for the nest (Jukes & Price 2016). Some translocation methods where nest structure isn't retained involve placing tree brash and branches in the created hollow to provide "scaffolding" for the ants to build around (Jukes & Price 2016, Attewell 2020, Attewell 2021).
- When moving multiple nests, sufficient space should be given to each nest – there should only be one nest every 100m where nests are unrelated. This will give individual nests room to relocate and expand and prevents conflict between nests, if nests are not related to each other. Where nests are known to be related to one another (i.e. form part of a polydomous colony) then distance between nests can be much smaller, e.g. 15-20m (Jukes & Price 2016).
- Supplementary feeding post translocation is required to provide an immediate energy source to the ants until they can establish new foraging routes. Supplementary feed can take the form of chopped fruit (apple/pear), a home-made mash (made of bread, honey, raw egg and water), honeybee fondant, or purpose made ant gels*.

* An example of ant gel can be found here

GERMAN METHOD

This method is based on a translation of a method by the Deutsche Ameisenschutzwarte (German Office for the Protection of Ants). It involves scooping up the nest material into containers (such as hessian sacks or large plastic barrels) which are then emptied at the donor site.

© Hayley Wiswell

Translocation of a Hairy Wood Ant nest using hessian sacks – the sacks containing nest material have been transferred to the receptor site using a wheelbarrow and are tipped out in order, deepest layers of the nest first.

Timing:

- Aim to coincide with the swarming behaviour of the ants in early spring, when they start to become active after hibernation. At this time the ants will be higher up within the mound; on top of it or in the topmost layer of soil around the mound. Observational visits to the nests in advance of the translocation will help to determine the activity level of the ants. It is important that queens are captured during the translocation and at this time of the year queens are usually above ground inside the mound and easier to locate.
- Avoid summer months when workers are active and dispersed away from the nest – this risks losing significant numbers of workers. Translocations should only be undertaken at this time of year as a last resort.
- Avoid late summer and autumn as this is when the colony activity starts to slow down and if moved during this period ants may not have enough time to repair the nest and restore foraging routes before winter. Translocations should only be undertaken at this time of year as a last resort.
- Should avoid the hibernation period (November-March) at all costs
- Should be carried out in the morning and completed by midday – this way the ants will be cold and slow and mostly situated within the mound. Choose a day with good settled weather (no frost, warm and dry, between 5 and 10°C). The day of translocation should be followed by 2-3 days of settled weather so that the ants can repair the nest and develop foraging routes.

GERMAN METHOD – continued

Equipment:

- Minimum of 3 people, more depending on size of nest(s).
- Wide, flat, coal-type shovels (potentially less damaging than sharp digging spades) for the thatch, and conventional spades for the subterranean parts of the nest.
- Breathable containers for carrying the ants that protect them from direct sunlight and absorb the formic acid they spray in defence. Old-style hessian potato sacks made from natural fibres work well. A recommended size is 90cm x 60cm (larger sacks may be too heavy to lift when full) (Jukes & Price 2016). Large plastic barrels have also been used successfully and reduces the number of workers lost or escaping during transport (Phil Attewell, pers. comm, and also German Office for Protection of Ants).
- A pen to write the nest number on to the pertaining sack or barrel.
- String or other cord to tie up the sacks (or if using large plastic barrels, FluonTM paint painted below the top of the container can be used to prevent ants from escaping).
- A means of transporting the containers with nest material from donor site to receptor site (wheelbarrow, pick-up truck etc. depending on distances involved and terrain).

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Translocation of a Southern Red Wood Ant nest using the German Method. 60l plastic barrels with lids are used as containers.

Top photo: nest being excavated by hand.

Bottom photo: nest immediately post translocation with material tipped out of containers. Note that there was a significant proportion of deadwood within the nest mound and this was transported as part of the nest material. Additional deadwood has been provided to provide structure for the nest to re-build around.

GERMAN METHOD – continued

Procedure:

1. Prepare the receptor site.

2. Working in pairs, one person holding open the container, one person shovelling the nest, shovel up as much of the massed ants and nest material as possible, in as few scoops as possible to reduce time taken and stress caused to the ants. Depending on the size of the nest, this will likely require several sacks or barrels. Fill containers only half full to avoid crushing at the bottom, adding small branches and twigs whilst the bag is being filled with nest material to help alleviate pressure from the weight of material. Tie up each container as quickly as possible after filling.

3. Saws may be required where there are roots embedded in the nest structure.

4. Excavate the nest as far as the soil structure will allow, until there are no more signs of ant tunnels. Take care to look for queens (see Appendix 6) (it's worth having an assistant who is not shovelling that can focus on doing this) which must be carefully collected by hand or with a small container or into pots for release at the receptor site.

5. Label the containers in the order that they are excavated so that they can be emptied at the receptor site in the correct order (deepest layers first, working up towards the topmost thatch).

6. Transport the containers to the receptor site – the transport route should be planned in advance so that it can be kept as short as possible and avoid bumpy terrain. Depending on the distance between donor site and receptor site this could be done in a wheelbarrow for example or in the back of a pick-up truck, but whichever is chosen the speed of transport should be slow and careful to avoid too much rough handling of the containers. If using sacks, these should be loaded flat on their sides to reduce compression pressure on the ants. Aim to keep the time that the ants are held in the transportation sacks as short as possible.

7. At the receptor sites, open the containers and carefully tip the material over the prepared hollow, in the correct order to maintain the layers of material. If using hessian sacks, each sack should be cut into two or three pieces and placed with the nest material – this will ensure any ants and small invertebrates that live inside the nest are retained. The hessian sack will contribute to the nest framework and will eventually rot away.

8. The ants should be provided with supplementary food immediately after translocation – this sustains the workers while they establish new foraging routes. Record and photograph the new location of the nest. It is likely that the ants will re-assemble the nest in a slightly different position, a short distance away, or split into multiple mounds (if the original nest was polygynous).

9. If the nest is to be situated within proximity of construction work, the nest should be marked and protective fencing or a barrier erected to prevent nest being damaged.

Follow-up care:

1. Check the original donor site for three days after the translocation for any remaining ants – collect these and move them to the new location. Check after three months for any signs of re-establishment at the donor site*.

2. Continue to replenish and provide supplementary food every few days for at least two weeks.

3. Remove any protective fencing, if present, once this is no longer needed.

* If a queen and enough workers are left behind at the original donor site, a nest may re-establish at the original site. This is why it is important to excavate as much nest material and as many ants as possible during the translocation. It is important to check the donor sites after the translocation work – ants left behind may re-establish a nest or wood ants from nearby may also colonise the area. There may be a need to carry out a second translocation if there is a sufficient time delay for wood ants to establish a new nest between the first translocation and site clearance and this should be factored into project plans.

WHOLE NEST EXCAVATION METHOD

Instead of collecting into sacks, the principle is to collect the nest as a whole, as far as is possible and move it as a single mass, retaining structure. If an excavator is already on site, this may be a cost and time efficient approach.

Moving a small nest mound using an excavator.

© Stephen Carroll

Timing:

As German method.

Equipment:

An excavator with a digging bucket exceeding the size of the nest being moved should be used so that it can excavate the nest in a single scoop. Some hand excavation may still be required alongside a mechanical excavation.

Procedure:

1. Prepare the receptor site.
2. Clear the route between the nest and the receptor site so there are no hazards or obstacles (which could increase vibration and damage nest architecture).
3. If the nest is constructed around a feature, such as a dead tree or stump, it may be necessary to undertake some preparatory hand digging and sawing of roots before using an excavator.
4. Excavate using excavator with a digging bucket attachment exceeding the size of the nest being moved. Aim to excavate the entire nest and any feature it may be built around in a single scoop.
5. Move nest as slowly and steadily as possible (around 2.5 mph if using an excavator).
6. Some hand excavation (as German method) and collection of nest material and ants into containers may be required, if the excavation with the digger does not manage to capture the entire nest.
7. Deposit nest in receptor site hollow gently, at same orientation as at donor site.
8. Provide supplementary food (see German method).
9. Mark the nest and provide protective fencing as required.

WHOLE NEST EXCAVATION METHOD – continued

Follow-up care:

1. Check the original donor site for three days after the translocation for any remaining ants – collect these and move them to the new location. Check after three months for any signs of re-establishment at the donor site (see footnote on page 15).

2. Continue to replenish and provide supplementary food every few days for at least two weeks.

3. Remove any protective fencing, if present, once this is no longer needed.

It is not uncommon when using the above methods for wood ants to re-locate their nests shortly after translocation. The ants may find a more suitable location for the nest a short distance away and re-build it there, or the nest may re-form as two mounds rather than one. Nest mounds may relocate several times following translocation before the eventually "settle" (Andy Jukes, Pers. Comm.) therefore it is important that there is suitable habitat within 20m of the chosen micro-site to give the ants space to move about and relocate if they need to.

Both images © Timothy King

Moving a Yellow Meadow Ant nest using a tree spade. Image on left shows nest being carried by a compact loader equipped with a tree spade. Image on right shows nest once deposited by tree spade.

Tree spade

There is no record of a tree spade being used to translocate wood ant nests or nests of Narrow-headed Ant, though there has been success in using this method to relocate nests of Yellow-Meadow Ants *(Lasius flavus)* (King & Balfour 2019) which is a subterranean species and creates hills of excavated soil. There is potential that this could be used to translocate wood ant nests under the right conditions; large machinery is obviously required so access needs to be considered. If this type of machinery is already on site for other purposes it might present a cost-effective option.

King & Balfour (2019) used a tree spade mounted on a compact loader, with a scoop diameter of 1.1 m and produced a conical soil lump 0.85 cm deep. The translocated ant-hills of Yellow-Meadow Ants were up to 0.7 m in diameter. The nests were transported 1 km from the donor site to the recipient site and the compact loader was able to travel at over 20 km/hr which reduced the time taken during translocation. All five of the nests that were translocated were still active and intact 17 months after the translocation.

A variety of spades, grabs and boxes can be mounted on compact loaders offering a variety of scoop sizes and shapes. A four-wheel drive compact loader provides manoeuvrability whilst minimising ground disturbance.

As with the above mechanical excavation method, some hand excavation and collection of nest material and ants into containers is likely to be required, if the nest is very large and the excavation does not manage to capture the entire nest.

The procedure with regards to timing, preparation of receptor site, supplementary feeding etc. would still apply – see German Method and Whole Nest Methods.

Reasons 2:
Translocation to increase resilience or for ecological restoration

Because this type of translocation has the aim of moving nests in order to introduce wood ants into new habitat, the method does not necessarily require the translocation of whole nests but can use material from a selection of nests, leaving the donor population in place.

© Phil Attewell

Excavated nest material containing workers and pupae, contained in a large plastic barrel, ready for transfer. Encased pupae (small white pellets) are visible on the surface.

PARTIAL NEST TRANSLOCATION

Polygynous (nests that contain multiple queens) nests can naturally "bud" to create satellite nests. This methodology takes advantage of polygynous nests by creating a satellite nest from an existing nest mound.

This method can therefore only be applied to species that are known to be polygynous; in the UK most wood ant colonies are considered to be polygynous (Appendix 1). Sorvari *et al.* (2014) used this method to transplant colonies of Formica aquilonia (a highly polygynous and polydomous species) into different forest stands with a high success rate. Prior to this colonies of Formica polyctena (a species of wood ant not found in the UK) were established in the Gorce National Park in Poland in the 1980s (Pisarski & Czechowski, 1990). The following procedure is based on these studies.

Timing:

Sorvari et al. (2014) carried out the transplantation of nest material in June (in central Finland), Pisarski & Czechowski (1990) in June and July (Poland, up to 1,200m a.s.l.). At this time of year, queens will be situated higher in the nest column, and worker brood and pupae will be present, but a large proportion of workers will be dispersed throughout the forest. Nests are most likely to bud naturally during the summer months when the proportion of workers is at its highest therefore it is recommended that transplants from a donor nests are made June – August, rather than in spring when worker numbers will be lower. Presumably in lower latitudes/altitude transplants could be taken as late as September. Taking a transplant in cooler weather in autumn risks disturbing nests as they prepare for winter and may not give the transplanted material enough time and resources to complete nest building.

Equipment:

As German method.

PARTIAL NEST TRANSLOCATION – continued

Procedure:

1. Donor nests need to be large, mature nests with a basal diameter 2m minimum. Using hand tools, approximately 400 L of nest material is excavated from the donor nest (around half the volume of the original nest).

2. It is recommended that excavation includes both the above ground thatch and some below ground nest material, to increase chances of capturing a queen(s), but minimising impact to the donor nest as much as possible.

3. Excavated material should be placed into containers as detailed above, with multiple containers as required, separated based on the depth material was collected from so that they can be and transferred immediately to a prepared receptor site, and placed in the same depth order as at the donor site.

4. Supplementary feeding must be provided, for the nest transplant, as detailed above.

5. Protection and marking of nests as required.

This method was found to be successful in establishing new colonies whilst also retaining the donor colonies which recovered, though they were irregular in shape after the transplant was removed.

Follow-up care

Continue to replenish and provide supplementary food for the transplanted nest every few days for at least two weeks.

Boosting nest transplants with pupae and additional nest material

Additional pupae can be added to the transplanted nest, taken from the donor nest (or other "sister" nests in polydomous colonies) in order to boost the numbers of workers and sexuals in the nest. This was undertaken by Pisarski & Czechowski (1990) with seemingly positive results, though this is only anecdotal.

Using small "tiles" of roofing felt (see figure 2 page 20) to monitor and observe brood production, these are lifted and inspected for pupae. Pupae are carefully collected using a small spoon to scoop the pupae and some nest material and this is transferred to the transplanted nest and placed onto the nest surface.

a. Worker pupae are collected from donor nest(s) June – September

b. Sexual pupae are collected from donor nests(s) May – June

If collecting pupae from the original donor nest, this should only be done the year following transplant extraction, to give the donor nest time to recover.

If augmentation is done using the original donor nest or from related nests, then adult workers and nest material can also be used, as in theory, all would be accepted without aggression. The result should be an extra "boost" – adults and pupae together adding to the population as well as additional nest material. This has been trialled southern England in July 2021 to boost a nest of Formica rufa which was developed from a transplant taken from a large donor nest earlier that year. A proportion of nest material was collected (approximately half the amount that was collected to establish the transplant nest – see photo below) from the original donor nest and placed 5m away, adjacent to an established worker trial. Within 1 hour mass transfer of pupae and material was observed, with no aggression evident. The transfer was completed in a few days and the size of the transplanted nest had visibly increased (Phil Attewell, in prep.).

RELEASE OF MATED QUEENS

This method is based on work carried out on Narrow-headed Ant *(Formica exsecta)*, a mound-building species related to wood ants. Given the similarities in biology, it is considered appropriate for wood ant species.

It involves queens, which have been mated in captivity under controlled conditions that are then released at a suitable receptor site. It must be noted that in order to establish new nests, wood ant queens may require to parasitise other species of ants. Therefore it is essential that suitable host species are present at the receptor site – in the UK these are *Formica lemani*, *F. fusca* and *F. cunicularia*. These species of black formicine ants are generally ubiquitous and nest in deadwood, under loose bark and stones, and occasionally build earth nests. Mated wood ant queens do not need to be released onto host nests (they can be attacked and killed by the host ants) but into habitat where they are present so that they can choose their host nest.

Timing:

There is a restricted time-frame to use this method as it requires the capture of newly emerging sexuals (virgin queens and males) which takes place for only a few weeks in summer. The exact timing will vary depending on the weather and geographic location, but is usually June to August (but can be as early as May in the south of England or in particularly mild conditions in the north of the UK). It is recommended that observations of nests for queens and males are made from late May onwards to identify when emergence has started (see Box 1). Males normally emerge first and it is important to note that not all nests produce sexuals every year, and that some nests only produce males and not queens. Therefore a number of nests should be considered for donorship, and observed to detect emergence of sexuals.

Sexuals will choose particular weather conditions to emerge – still, warm mornings are best for collection.

Both images © J. Walters

Figure 2:

Monitoring nests for brood

Monitoring of nests prior to capturing sexuals can be undertaken earlier in the year using a tile of roof felt (cut to approximately 10 cm x 10 cm or smaller if nest mound is small). Several tiles could be used on large nests.

The roof felt is laid on the thatch in spring and is lifted at intervals through the summer.

The roof felt provides an additional heat source and the workers will often gather brood under the felt. This allows checks to be made of the nest's status in terms of producing brood and sexual stages (which are distinguished from workers by differences in sizes of pupae – see **Appendix 6)**.

RELEASE OF MATED QUEENS – continued

Procedure:

Only an overview of this methodology is given here. A full equipment list and detailed methodology can be found in Painting (2020), Vulliamy (2020) and Perrett (2019).

- Males and queens are taken from multiple nests at a donor site into captivity where they are kept in single containers and stored in the dark at room temperature approx. 19-20°C. To keep the temperature stable, an incubator (such as the type used to incubate reptile eggs) can be used, but kept switched off as the thermal properties prevent temperature fluctuations. The ants are fed every few days with small pieces of apple soaked with honey/water mix or ant gels.
- Several males and queens are released into mating chambers (mesh insect flight cages) for mating – set up early in the morning to simulate dawn when they would naturally emerge in the wild. Mating is allowed to take place for a few hours and observations made.
- Mating can be repeated for a second morning and then queens confirmed to have mated are removed and released at a pre-determined receptor site, with a grid reference taken of the location. Males normally die shortly after mating.

Follow-up care:

Monitoring visits are made to the release site annually following the release to determine if any of the released queens have been successful in starting new colonies. Monitoring visits should take place during the summer months when ants are most active. It may take a couple of years before nests are large enough to be visible, therefore monitoring should take place for 3 years following release before it can be determined that the release was successful or not.

It is likely that large numbers of queens and multiple releases over successive years will be required to increase the chance of success with this method. Nests should be given time to "rest" after 2 years of collection of sexuals – it is important that newly emerged queens can be recruited back into their natal nests and also found new satellite nests so that the donor population can remain healthy.

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Mesh insect flight cages used for captive mating Narrow-headed Ants.

TRANSLOCATION OF NARROW-HEADED ANT NESTS

For translocation of Narrow-headed Ant *(Formica exsecta)* nests a different approach is advised due to marked differences in ecology between *F. exsecta* and wood ants. For instance, nests, numbers of workers within them, and foraging ranges, are significantly smaller in F. exsecta, with implications for the species' life cycle.

Nest mound of Narrow-headed Ant. Nests of this species tend to be smaller on average than wood ant nests and are usually paler in appearance, often built using grasses, heathers and mosses

© Jenni Stockan

Background

In comparison to wood ant nests, reliable translocation techniques for *F. exsecta* nests in the UK are not known, and attempts so far have been experimental only. What follows is not prescriptive but based on a low number of practical examples trialled in England at the single population in Devon. At present, no technique has shown a sufficient level of likely success, and most (70%) translocated nests in field situations have ultimately failed.

- In 1997 one nest under immediate threat of damage and destruction was removed to Paignton Zoo, and kept successfully in an outdoor enclosure for some seven years. However when returned to the original site in 2004, the nest failed within four months, apparently due to serial invasion by *Lasius* ants.

- For the Back from the Brink project, 13 nests were experimentally translocated 2018-2019. Three are currently surviving at their new sites, three years after translocation (2021). Two of the 13 nests were taken into captivity, and are still extant after a similar period, but with much reduced activity. The remaining 8 have failed, 4 in their immediate first seasons post-translocation, after having successfully overwintered. The other 4 nests appeared to survive for up to two years, overwintering twice, and producing brood in both years (showing that a functional queen was present), but however failing during their third seasons. From nest census monitoring, there appears to be a relatively high turnover of existing new and old nests; the loss of translocated nests may reflect this natural turnover to some extent. Reasons for failure of translocated nests have not generally been clear, particularly for nests which appeared to be thriving and producing brood. In three cases, translocated nests were invaded by *Lasius* ants at some point, which did not always result in immediate failure, but may have weakened the nest colony initiating a progressive decline.

- Translocation of *F. exsecta* nests is reported to have been successfully carried out in Germany, though it has not been possible to obtain further information. These may have been substantially larger *F. exsecta* nests, such as can be found in certain locations on the continent, which can approach the size of wood ant nests. Nests of this species in the UK are typically much smaller in size.

TRANSLOCATION OF NARROW-HEADED ANT NESTS – continued

Based on the apparent low long-term survival rates, translocation is not a viable mitigation technique for *F. exsecta* nests or populations, for example, in development scenarios. On current evidence there would appear to be a high risk or probability that nests fail, therefore the priority must be to retain nests in situ wherever possible. Translocation should only be considered as an emergency last resort conservation measure, when a nest is threatened with likely imminent extinction if there is no intervention. This should only be after other methods have first been tried to support the nest, e.g. directed habitat management around the nest and site. If the purpose of nest translocation is introduction of *F. exsecta* to other site(s), other methods than translocation would be recommended such as nest division (see page 18), rearing and release of mated queens (see page 20).

F. exsecta is in a distinct and separate group from wood ants, with certain crucial differences in ecology. In the UK nests are typically much smaller than wood ant nests, the largest *F. exsecta* nests approximately 40cm+ in diameter and to ~30-35+cm tall for the above ground structure, with a subterranean component to perhaps maximum 60-70cm deep, though depth appears to vary according to habitat, soil type, water table, and what the foundation structure for the nest was, whether based on a grass tussock, soil mound or tree root bole. The typical colony size of *F. exsecta* nests reportedly varies around an average of 4000-5000 workers; to some extent nest surface diameter may reflect the population size of the individual nest colony, though not in all cases. *F. exsecta* also appears to have a far smaller foraging range than wood ants, mostly within 5m, and typically no more than 10-15m, from the nest. In respect of yearly life cycle, *F. exsecta* nuptial flight is later than for wood ants (from mid July – early August, as opposed to May – June).

F. exsecta is much less shade tolerant than the wood ants, and requires open, sunny habitat (see Appendix 1). It still depends on woody shrubs as a source of aphids, but will favour areas where it is less likely to be shaded by mature trees.

Narrow-headed ant nest immediately after translocation.

© Stephen Carroll

TRANSLOCATION OF NARROW-HEADED ANT NESTS – continued

The biology and ecology of *F. exsecta* bring a number of implications for nest translocation:

1. Nests are generally compact enough that every effort can be made to lift the surface structure and a depth of the underground component in one complete mass, without needing to divide it up into separate bags or containers. However, this may not be the case where the nest is growing in thick, mature heather and the mound is likely to disintegrate when excavated. In this case the German method may need to be used, where moving the nest as a whole is not possible.

2. The smaller nest population size means that post-translocation nest repair and establishing of new foraging areas will be reliant on fewer workers than for wood ant nests; also there will be proportionally higher impacts through any workers lost or killed during the translocation operation.

3. Because of the more restricted foraging range to 5m, the location at the recipient site must have particular habitat diversity properties and foraging resources all around and close to the nest.

4. Translocation plans should prepare and allow for lengthy post-translocation nest aftercare, for instance, supplementary feeding for several seasons post-translocation.

5. Because of smaller colony population sizes, translocated nests may be more prone to 'priority effect' invasion by other ants, such as by *Lasius* niger group, while the newly translocated nest is trying to establish. Although of smaller individual size, *Lasius* can outcompete through force of greater numbers. *Lasius* impacts have been implicated in nest failures post translocation.

6. Notably, the most suitable time of year for the nest translocation operation is different to that of the wood ants. It is recommended that any *F. exsecta* nest translocation is carried out after the period of main gyne (queen) and male production i.e. after August, to late autumn (late Sept – late October), depending on the climatic conditions that particular year. The rationale for this is that the nest's period of main gyne production would be finished, and worker production would be at its highest to be able to carry out nest repair, maintenance and foraging in the new location. In addition there would be higher chance of cooler conditions, so that workers would be more likely to be within nests than being dispersed through the surrounding habitat.

7. As with wood ants, winter translocation must be avoided: overwintering colonies would be expected to have retreated deepest underground to the lowest levels of the nest, and workers would be at their least active for any nest repair and maintenance post-translocation.

Close-up of the thatch of a Narrow-headed Ant nest.

© Hayley Wiswell

WHOLE NEST TRANSLOCATION METHOD FOR NARROW-HEADED ANTS

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Preparing to translocate a Narrow-headed Ant nest using hand tools – vegetation has been carefully cleared around the nest using secateurs to allow spades to excavate around the thatch.

Timing:

Late summer to late autumn, depending on weather conditions for that year.

Equipment:

- 3-5 people
- Checklist based on method statement
- Shovels and trenching spades
- Tarpaulin
- Wheelbarrow
- Trowels
- Secateurs or loppers for cutting roots
- Several buckets or other containers (rims may need to be escape-proofed with Fluon™)
- Suitable vehicle (depending on distance that nests need to be transported)
- Fruit and / or sugar for supplementary feeding

WHOLE NEST TRANSLOCATION METHOD FOR NARROW-HEADED ANTS – continued

Procedure:

- At the nest selected for translocation, before the day of translocation itself, with a spade/trenching spade, cut slots, to the spade's depth, around each side of the 'nest turf', but do not lift the nest. Recommended clearance around the nest would be at least 15-20cm i.e. if the nest thatch diameter is 30cm, the 'nest turf' would be approx. 70cm x 70cm, with the nest in the middle. Wider is likely to be better, but will add to the weight and size of the turf to be lifted and transported. The reason for pre-cutting the turf slots around the nest is to reduce the vibrations and disturbance caused by digging during the translocation operation itself.

- At the recipient site, prior to day of translocation, prepare a hole to the same diameter as the 'nest turf' to be translocated. It will not be possible to know depth; it would be recommended to dig to roughly 50cm-60cm but keep loose soil to one side for infilling, and be prepared for the eventuality that extra digging maybe be needed on the day. Surface vegetation from the recipient hole is useful for later, so it is suggested this is removed carefully and kept to one side.

- For the translocation, choose a cool cloudy overcast day, preferably in the morning soon after dawn to reduce chance that workers will be dispersed away from the nest. So as to be able to maintain the nest's orientation at the recipient site, a marker pointing south can be laid on the nest surface. Using the pre-cut turfing slots, insert spades as far down as possible, and lift out the nest turf, making sure to keep the surface nest structure intact. It will not be possible to know how far down the subterranean component goes, and there may be roots that need to be cut (with loppers or secateurs) to free the nest turf. Place the nest turf on a tarpaulin and lift this into a wheelbarrow (the tarpaulin makes it easier to lift out the nest at the other end, and also keeps workers from escaping from underneath the nest). Typically the ants will respond to the first digging and nest extraction by attacking and biting; at some point this behaviour may change, with workers congregating towards the centre of the nest (presumably to defend the queen).

- The nest turf, comprising the surface nest and a mass of soil beneath, should now be in the wheelbarrow. The next step is to search for and collect any and all workers from the underground part of the nest. This may take 20-30 minutes or longer, depending on the size and structure of the individual nest.

- Experience from Devon is that obvious subterranean chambers are not visible, instead workers are scattered throughout loose soil, some in small groups in clumps of soil, following plant root tunnels, and under stones. Loose soil containing workers should be scooped out carefully with trowels or gloved hands and collected in containers such as buckets, or large plastic tub trugs. Several containers may be needed. Working space around the hole may be limited and possibly no more than 2-4 people will be able to search for workers in this way. One person can usefully watch over the main nest turf in the wheelbarrow during this time.

- When all workers have been collected from the hole left by the initial nest turf removal, carry out a phased further excavation, searching for workers: with trowels gently scrape away soil layers approx. 5cm at time, collecting workers at each phase. Scrape / dig at the sides of the hole, as well as at the bottom. Continue until no more workers are found [*]. If it has been raining in the days before the translocation, beware of seepage of ground water into and filling the excavated space.

- When finished, there will be the thatched top of the nest, and a quantity of loose soil and workers in buckets / containers, which are now all to be transported to the recipient site. Before leaving, as a suggestion, leave some fruit segments (apples, pears) in and around the hole which in the meantime may help to attract any workers which have been left behind.

[*] In Devon this was most generally at the clay layer around 50-60cm depth. During the only Scottish translocation carried out to date, workers were found up to 30cm deep (below top of thatch) during a translocation in mid-October (Hayley Wiswell pers. Obs.).

WHOLE NEST TRANSLOCATION METHOD FOR NARROW-HEADED ANTS – continued

- During transport, ensure the wheelbarrow is secure and does not tip over. Also watch out for any workers escaping from the wheelbarrow and buckets / containers. In practice we have not seen workers do this but more commonly move towards the centre of the nest. Nevertheless it is worth checking the vehicle afterwards for any escaped workers.
- At the recipient site, lift the main nest turf from the wheelbarrow, lowering it carefully into the prepared hole, and making sure the nest orientation is to the same orientation as at the donor site (which probably will be with the nest dome tilted south). It may be necessary to dig a little more depth, or place some loose spoil, in the prepared hole. When the nest turf is satisfactorily in place, add the soil with workers in and around the nest from the buckets / containers.
- The freshly installed nest will very likely look to be a mess of bare soil and devoid of cover surrounding the nest turf. Where surface vegetation at the recipient site has been kept to one side, this can be placed around the translocated nest to provide some cover. It may be advantageous to take along some pre-prepared snipped up grass fragments and place these on and around the nest: workers can be expected to carry out nest repair and maintenance in their new location, and will make use of this for thatching. If not already done so, it is recommended a small tile of roofing felt in added to the nest thatch, which is helpful for later monitoring. Finally add segments of fruit around the nest as an energy source for workers (juicy apples or pears are ideal; peaches, grapes, nectarines etc. or loose sugar may also be suitable).
- Depending on opportunities, transplanting some separate Molinia tussocks alongside the nest may offer additional or alternative nest structures.
- Take a GPS record of location and photographs
- Return to the donor site to see if any workers are on the fruit left there; if so take these to the new nest location (providing the translocated nest is 10-15m+ away from the next nearest *F. exsecta* nest, it might be assumed that these are not workers from another nest). When there can be reasonable certainly that there are no more workers from the translocated nest, fill in the old nest hole.

Follow-up care:

- Check the translocated nest regularly in the first phase post-translocation:
  > On the next day after translocation;
  > In the first 1-2 weeks every 1-2 days;
  > Thereafter once a week until the end of the active season.
- During this time continue with supplementary feeding, leaving small chunks of fruit around near the nest and also within 3-5m to encourage exploration out from nest. There are several ways of leaving the fruit for this: large slices or halves of apples or pears can be placed face down so to retain moisture; ants will eat out the apple from underneath. Pears, grapes, peaches and other fruit may all be suitable. Small pieces of fruit might also be left under the inspection tile. Sugar-water solutions should be avoided because ants will often drown in dispensers. Beware also that fruit can start to attract crows, foxes, badgers, rabbits, or livestock, which then associate the nest with food and regularly disturb it, as well as removing the energy source for the ants. For this reason try not to place fruit segments in the same places each time. Also note that fruit may attract invading ants such as *Lasius*. In extreme cases it may be necessary to dig out and remove *Lasius* ants, though it may already be too late by the time that *Laisus* invasion has first been noticed.
- It is not unusual for the translocated nest to relocate itself, (in Devon, out of 12 nest translocations, 5 relocated themselves, 2 in response to Lasius invasion). With the exception of *Lasius* invasions, nest re-location, for example moving to be closer to foraging habitat, may be an indication of an active and vigorous colony.
- For longer term monitoring, it is recommended that the nest is checked for activity on one off warm winter days (southern England only), and also that regular (approx. weekly) checking and supplementary feeding resumes in the first spring seasons post-translocation. Protein supplements might also be considered.
- It is recommended that a tile of roofing felt is used; this can be lifted to check if brood are present underneath. During the summer months this may also reveal whether queen and male pupae are present in addition to worker pupae (see Post-translocation Monitoring section page 28).

Recording the translocation

It is strongly recommended that the translocation, however small scale, is fully documented so that as much can be learned from the process as possible. The more information we have about methodologies and success rates, the more we can improve the translocation process.

A template for recording the translocation can be found in Appendix 5.

Post-translocation monitoring

The purpose of monitoring is to assess if the translocation has been successful. Success can be measured in a number of ways. In ecological terms, success is that the colony survives in the long-term, is self-sustaining and is able to produce sexual stages and therefore able to expand in size and disperse from the translocation site.

Using felt tiles

It is recommended that small cut tiles of roofing felt are placed on the thatch of translocated nests (see Figure 2, page 23) – this warms up in the sun and acts as an additional heat source. The workers will often place brood larvae and subsequently pupae under the tile. This can be gently lifted, allowing the surveyor to check if the ants are producing brood, indicating that at least one queen is inside the nest and laying eggs, and that there is sufficient food supply coming to the nest for brood rearing.

Monitoring schedule

It is recommended that the translocated nests are monitored at the following intervals.

For wood ants which are translocated in the spring:

- Every few days for first 2 weeks to provide fresh supplementary feed.
- 1 month after translocation to determine activity, nest re-building, if nest has relocated.
- During June – August check to determine activity and signs of foraging (foraging routes plus aphid farming on nearby trees and shrubs), brood production (using felt tile).
- The first spring in the year following translocation, to determine that the nest has survived its first winter post-translocation (March-April).
- Then 1 year, 2 year, 5 years post translocation.

For Narrow-headed ants translocated in the autumn:

- First day after translocation to assess activity, nest rebuilding, if nest has relocated.
- 1-2 visits per week for the first 2 weeks post translocation to provide fresh supplementary feed and to check if nest has relocated. Weekly thereafter until end of the active season, if this is possible.
- In the spring following translocation to determine if nest has survived winter, weekly visits through March – April to provide supplementary feed, felt tile added.
- From late May onwards, following translocation check for signs of brood (using felt tile), foraging routes and signs of aphid farming on nearby trees and shrubs.
- Conduct visits 1 year, 2 years, 5 years and 10 years post translocation.

Signs of success

Indicators of nest establishment success (and by implication, possible reasons for nest failure) might be:

1. In period **immediately after** translocation, i) nest and thatch maintenance occurs; ii) foraging and aphid farming activity; iii) ability to re-locate nest;

2. In **first season(s) after** translocation: iv) successful overwintering, with worker activity seen in following spring; v) brood production;

(nest might stay cycling round through these first i) to v) for several years);

3. In **same or a subsequent year**: vi) queen and male brood seen (larger pupae); vi) evidence of satellite nest budding; viii) appearance of new autonomous nests.

Other information to note during monitoring visits:

- Habitat – any observed threats or changes to immediate environment need to be noted and resolved.

- Evidence of disturbance (both animal and human) and measures put in place to prevent or reduce this as far as is possible. E.g. if badgers are damaging nests because they are attracted to supplementary feeding, then desist with supplementary feeding or reduce amount of food provided. Interpretation for members of the public may be useful for sites where nests are likely to be highly visible to visitors.

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Appendix 1

Overview UK distribution, habitat preferences and colony structure of each species

Species	UK distribution*	Colony type	Habitat preferences
Southern Red Wood Ant *(Formica rufa)*	England and Wales only	Generally considered polygynous and polydomous in UK	Dependent on high levels of sunshine, therefore clearings, glades, woodland edge, heathland with scattered trees are preferred. Inhabits oak, pine and birch woodland.
Hairy Wood Ant *(Formica lugubris)*	England, Wales and Scotland	Generally considered polygynous and polydomous in UK	Can tolerate more shade than *F. rufa* but still prefers early successional woodland and woodland glades and clearings. Can also colonise heathland with scattered trees. Inhabits coniferous, deciduous and mixed woodland, including plantations.
Scottish Wood Ant *(Formica aquilonia)*	Scotland and a single population in Northern Ireland	Generally considered polygynous and polydomous in UK	The most shade tolerant species and can survive under mature close-canopy woodland. Will concentrate in pockets of sunshine, rides and clearings. Inhabits coniferous, deciduous and mixed woodland, including plantations.
Narrow-headed Ant *(Formica exsecta)*	Scotland – localised populations in the Cairngorms National Park, single population near Rannoch. England – Devon only.	Can be both monogynous and also polygynous (and therefore polydomous)	Intolerant of shade – requires full sun and therefore habitats which can remain open or contain mosaics of open habitat with some tree cover.

* The NBN Atlas should be consulted for detailed species distribution maps at nbnatlas.org/

Appendix 2

What to consider when recording habitat features at donor and receptor sites

DONOR SITE
Habitat in 10m
Canopy shading and tree species
Ground flora and species composition
Aspect and elevation
Habitat in 25m
Canopy cover and tree species composition
Ground flora and species composition
Other key habitats or land use
Wood ants
Record species
Activity level of nest(s) and condition of thatch – translocation is more likely to be successful for large, healthy nests with lots of worker activity
Aspect of nest/orientation to the sun

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Appendix 2 – continued

RECEPTOR SITE	
Habitat assessment	**Requirements**
Distance from donor site	Distance from donor site and accessibility is likely to effect the choice of methodology for translocation
Aspect	All potential nests sites should be: • South or south-east facing • Well drained (water does not collect here in the winter time)
Canopy cover and tree species	To match donor site as far as is possible. Sites should provide habitat suitability for the particular species of wood ant long-term (i.e. for Hairy Wood Ant and Southern Red Wood Ant there should be open pockets and mosaics in the long-term and habitat not likely to become dense close-canopy woodland which would be unsuitable for these species).
Ground flora	To match donor site as far as is possible. Note lack of browsing will cause heather height to increase and can shade out nests, whilst high browsing can lead to disturbance and exposure.
Presence of aphids	Both on mature and seedling trees. There should be suitable within 5m of the proposed micro-site location for donor nests.
Deer, badgers, wild boar, pine martens	Avoid areas of high densities of these species. Avoid sites within proximity to badger setts, as badger predation can affect wood ant establishment at new sites (Attewell 2020).

RECEPTOR SITE	
Habitat assessment	**Requirements**
Presence of existing colonies and proximity	Competition from existing wood ant colonies can cause introduced nests to fail (Fullarton 2012). For wood ants, a minimum of 100m is advised between translocated nests and existing colonies (Cathrine 2015b), as wood ants are considered to have a foraging range between 20m and 100m (Sorvari 2009). Over time the wood ants can spread up to 500m from the original translocation area, therefore a search area of existing colonies* at the receptor site must extend at least this distance (Fullarton, 2012). Narrow-headed Ant – no existing wood ant colonies within 300m. Avoid close proximity to *Lasius* colonies (only an issue in southern England).
Species of conservation concern	No known species or communities of conservation importance which could be predated by wood ants, or otherwise negatively impacted by the introduction of a nest.
Habitat fragmentation/ continuity	Sites that are connected to the wider woodland landscape should be chosen – isolated pockets of woodland are not suitable as this could ultimately result in colonies becoming stagnant and inbred. There should be no barriers (e.g. major road or river) to wood ant dispersal within 100m.
Medium to long-term threats	Long-term management should be beneficial to the survival of the ants and allow them to thrive. If commercial woodland – future felling needs to be considered as presence of wood ants will require changes to the way the woodland is managed.

* Mixing with colonies at the recipient site could be beneficial in some cases if translocation is undertaken for reinforcement purposes where there is potential bottlenecking in the genetics of the local population. Genetic studies will be required to support this.

Appendix 3

Pros and cons of different translocation methods

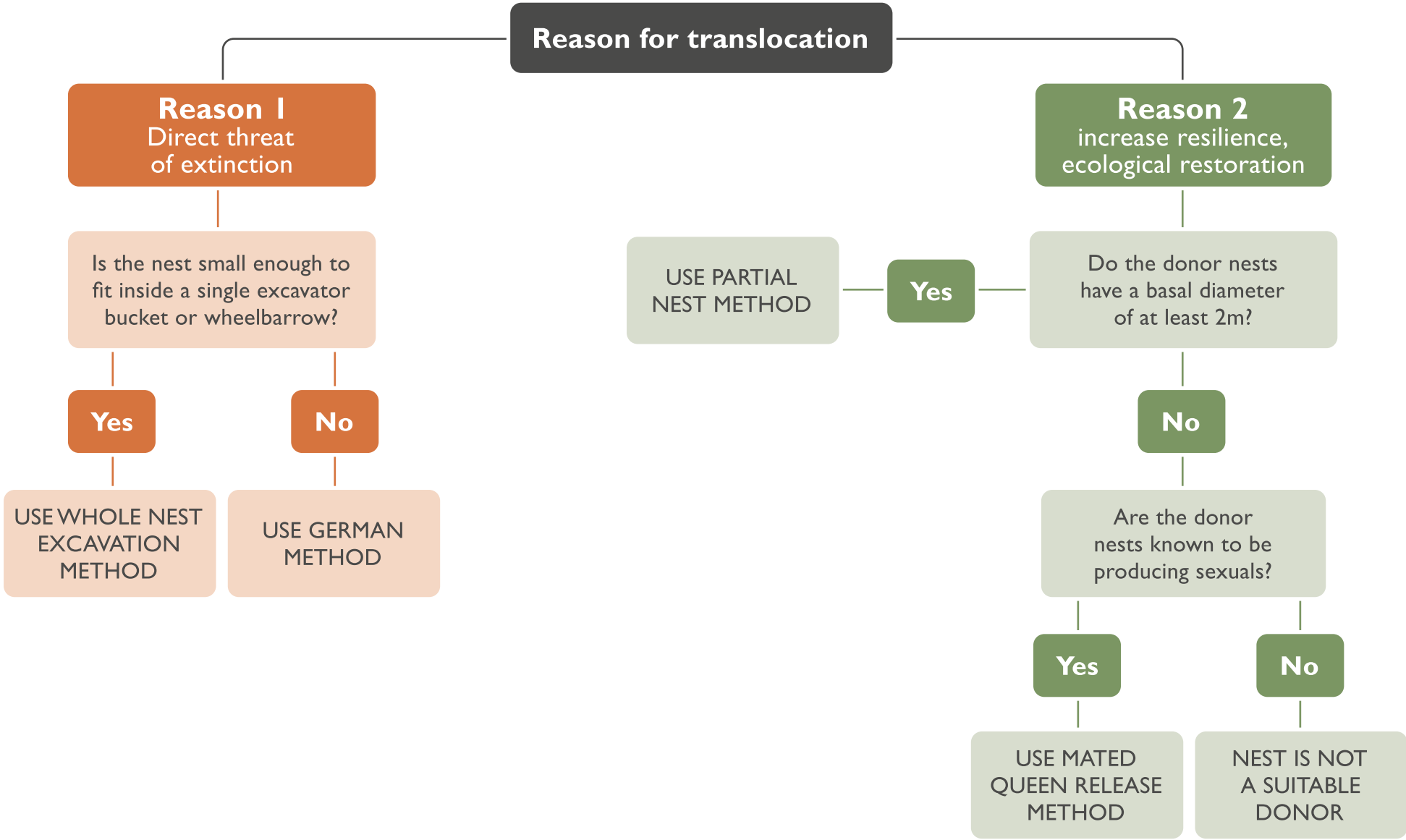
Method	Pros	Cons	Situations when this method should be considered over others	Success rate (estimated) and documented examples of this method being used
German method (extracting nest in sections in multiple containers)	Less reliance on retaining nest as a whole structure. Can allow nests to be moved to a recipient site at greater distance. Can work for any size of nest and particularly useful for large nests where excavating the nest as a whole unit is very difficult or not feasible. Can be done using hand tools and at sites when access for machinery is not possible.	Results in total loss of nest architecture, though the "layers" of material are still retained. Relies on the ability of the ants to rebuild the nest structure and thatch which they can do surprisingly quickly depending on size of colony and time of year. Best timed to seasons when the ants are active and able to recover (i.e. not immediately before hibernation and cold spells of weather).	When conservation of existing colonies is paramount i.e. individual nests are under threat.	Attewell, P. (2020), Attewell, P. (2021). Attewell, P., & Abbott, C. (in prep) On the Pear Wood (Stanmore) translocations 2005-present. Success rate 100%; all nests survived, one merged with a nearby nest.
Whole nest excavation	Can retain nest architecture if done carefully. Can make use of machinery that may already be on site, so can be cost and time efficient.	Should only be used when nests are being moved very short distances, to avoid loss and damage to nest whilst being carried in digger bucket. Best suited to small-medium sized nests.	When conservation of existing colonies is paramount i.e. individual nests are under threat.	Single translocated nest still active 2 years post-translocation, with no reduction in size (McIver 2012). Fullarton (2012) – only 18% of original nests survived translocation. However significant budding of nests occurred in the years following translocation, till number of nests had increased 233% 4 years after the translocation. Wood ants colonised receptor site and up to 500m beyond original receptor site.

Appendix 3 – continued

Method	Pros	Cons	Situations when this method should be considered over others	Success rate (estimated) and documented examples of this method being used
Tree spade (variation of whole-nest method)	In theory would retain nest architecture as collecting nest in one large scoop. Can move nests some distance and minimise damage to nest structure. If a tree spade is already on site it may be a cost and time efficient approach.	Best suited to small-medium sized nests which can be contained easily inside the size of tree spade. Requires large, specialised machinery and therefore more expensive if this equipment is not already on site. Will be reliant on particular access and ground conditions. Hasn't been trialled for wood ants.	When conservation of existing colonies is paramount i.e. individual nests are under threat.	100% after 18 months, based on a single project involving Yellow Meadow Ants by King & Balfour (2019)
Partial nest translocation	Allows a new colony to be created with without the need to translocate a whole nest. Allows donor nest to be retained in situ and therefore donor population is not adversely effected. Prevents loss of structure to colony network of the donor site (in multi-nest colonies).	Requires capture of at least one queen so will only work for polygynous nests and therefore species which are reliably polygynous. Only appropriate for very large donor nests which are robust enough to withstand a large amount of material being removed. Removal of material may weaken the donor nest and may require multiple years to rebuild. May take ants longer to establish as worker numbers are reduced.	Reintroduction projects	77% of nests surviving after 4 years – Sorvari *et al.* (2014)
Release of mated queens	Removes any need to physically disturb existing nests and colonies.	Only carried out for Narrow-Headed Ant and is still experimental. Some specialised equipment is needed but this is readily available and relatively low cost.	Reintroduction projects	Too soon to tell. See Vulliamy (2020) and Perrett (2019)
Queen-less nests		Still experimental, has only been carried out for Narrow-Headed Ant in the UK.	Reintroduction projects	Too soon to tell. See Walters (2020).

Appendix 4

Decision tree to help select method of translocation



Appendix 5

Translocation recording form template – to be used alongside a Method Statement which provides full detail of the translocation process.

Wood Ant Translocation Form Template	
Nest and site variables	**Notes / Answers**
Species to be translocated	
Number of nests to be translocated (provide grid references for each nest and a nest number)	
Provide dimensions of each nest (height and basal diameter), activity level of each nest	
Name of donor site and grid reference	
Date and time of translocation	
Weather conditions	
Method of translocation	
Name of recipient site and grid reference	
Has any management taken place at receptor site prior to translocation? If yes, describe.	
Grid references of nest locations at recipient site	
Has supplementary feed been provided? If so, what type?	

Appendix 6

How to differentiate between wood ant queens, males, workers and pupae. For a guide to separating the different species of wood ants in the UK and how to identify the Narrow-Headed Ant, see Guide to Wood Ants of the UK.

Queen

Virgin queens are winged. The wings are shed after mating so queens that are resident within a nest are wingless.

Much larger than workers.

Abdomen is large and glossy in appearance.

Male

Always winged, wasp-like in appearance.

Body is uniform black in colour, paler legs and genitalia are visible at tip of abdomen.

Abdomen is longer and narrower than that of workers and queens.

Worker

Never winged.

Can vary considerably in size but always smaller than queens and males

Pupae

Usually enclosed in a papery case (top image), but can sometimes be "naked" (bottom image).

Pupae of queens and males will appear significantly larger than those of workers.

Using a small square of roofing felt placed onto the thatch will allow easier inspection of pupae as these are often clustered under the tiles as they provide extra warmth.

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