Controlling Large Pine Weevil using EPN's applied using Drone technology

Koppert

CONFOR - Hylobius Industry Research Programme (HIRP) Conference, Perth, Scotland

24th April 2025

Koppert at a glance

Global market leader

In biological crop protection and pollination

Family company

Established in 1967

450 million

Turn over 2023

30

Subsidiaries

2750

Employees worldwide

11

Production sites

100

Countries using our solutions

>400

Advisors

120

Natural solutions

Koppert EPN development

Nematodes have existed for over
375 millions years

Discovered & studied since 19th C
1st species described as Aplectana kraussei (now Steinernema kraussei)

1985
Pioneer : Koppert starts mass production & formulation

2017.2020
Koppert launch new gel formulations
Since 2023 have become the worlds largest producer

Biology Facts

What are EPNs?

- Insect-parasitic or entomo-pathogenic nematodes
- Natural enemy of soil foliar dwelling insect larvae
- Only infectious juvenile, so called Dauer or L3 stage, is free living; all other stages inside insect
- Carries a species-specific symbiotic bacteria in its gut
- Depending on nematode length varies 0.4 – 1.1 mm
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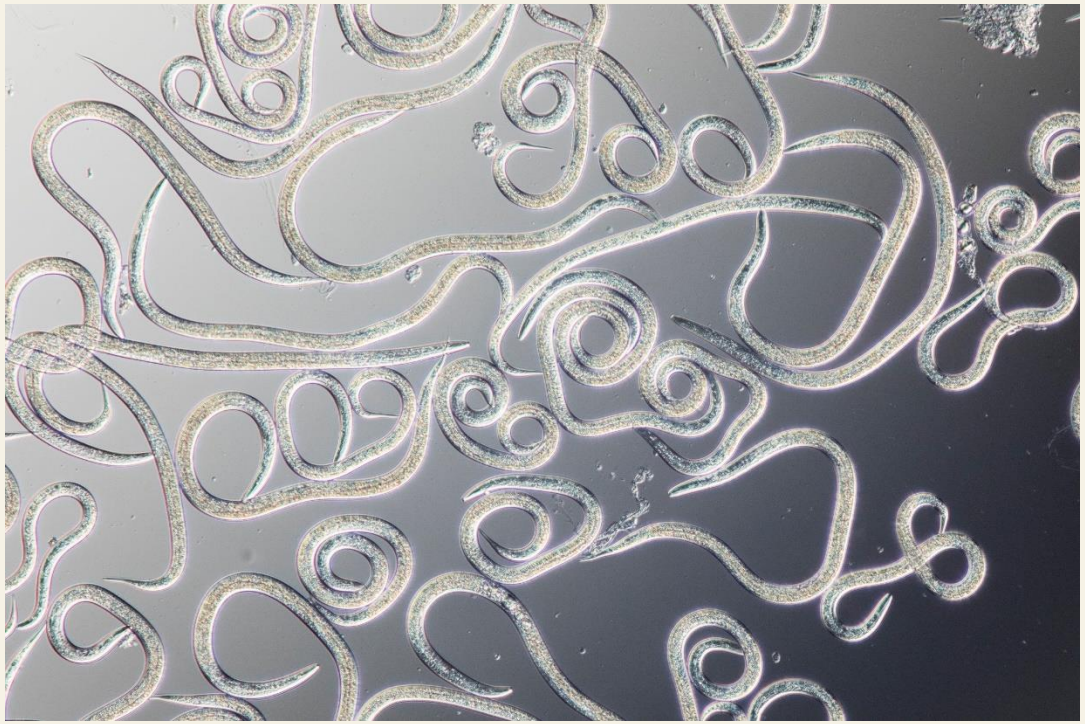
- Finds, penetrate and kills → death in 24-48 hours



3 species

- ***Heterorhabditis bacteriophora***

Super cruiser

- ***Steinernema feltiae***

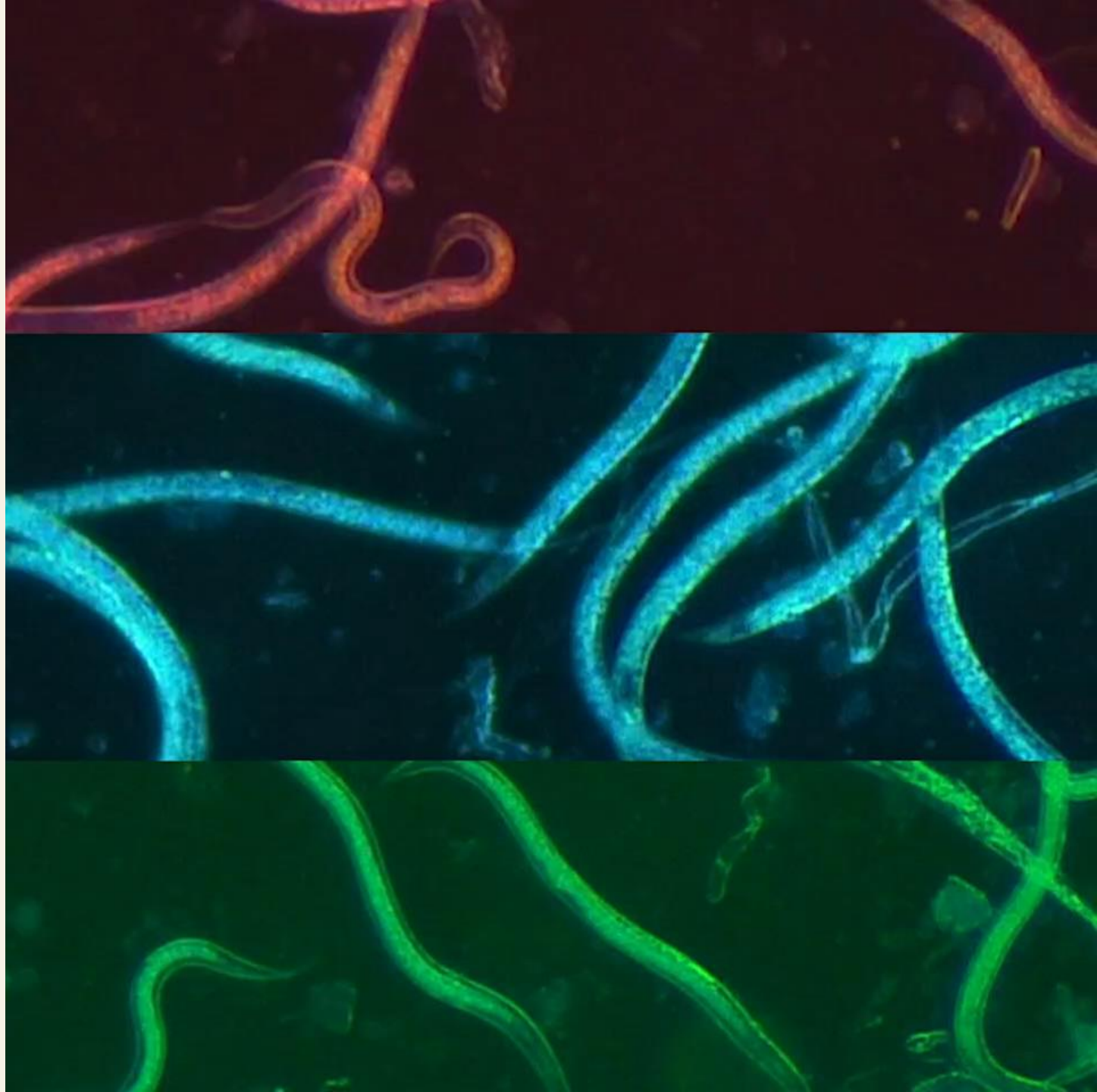
Cruiser / ambusher

- ***Steinernema carpocapsae***

Ambusher

Can parasitize larvae and pupae of pine weevil (*Hylobius abietis*) which live under the bark of tree roots. **So can also exhibit foraging behaviour.**

438-650 microns (0.4 to 0.7 mm)



Protected crops

Sciarids / fungus gnats
Cutworms
Thrips
Black vine weevil
Duponchelia

Mushroom industry

Mushroom fly
Phorids fly

Fruits

Codling moth
Oriental fruit moth
Plum moth
Fruit tortrix
Red palm weevil
Clearwings
Apple sawfly
Citrus root weevil
Hazelnut weevil
Pecan weevil
Cranberry girdler
Navel orange worm
Chestnut moth
Flatheaded root borer

Home & garden
Turf and amenities

Leatherjackets (Tipulids)
White grubs
Swift moth
Gryllotalpa
Red palm weevil
Palm moth
Sycamore lace wings
Bill bugs
Japanese beetles
Ants

Outdoor vegetables & row crops

Asparagus beetle, root flies
Cutworms
Western corn rootworm

Forestry

Large pine weevil

Biology Facts

How do they work?

Formulation and Storage

Biodegradable & long shelf-life carrier

Biodegradable

No visible spray residue on leaf and fruit

Compact

Long shelf life

Good solubility and low viscosity

Logistics and Storage

Take the nematode boxes out of the shipment parcel and refrigerate at 2-6°C (36-42°F) immediately upon receipt.

Never keep the boxes in a sealed shipment coolbox; if you cannot do this for space reasons, keep the shipment cool box open, and stack them up as shown in picture.

Store in a well-ventilated refrigerator/cold room.

Store the product in the original box, away from direct sunlight.

Average shelf life for *S. feltiae & S. carpocapsae*: 3 months at 4°C

Check for expiry date on packaging

Field Trials

Durnock, Scotland 2024

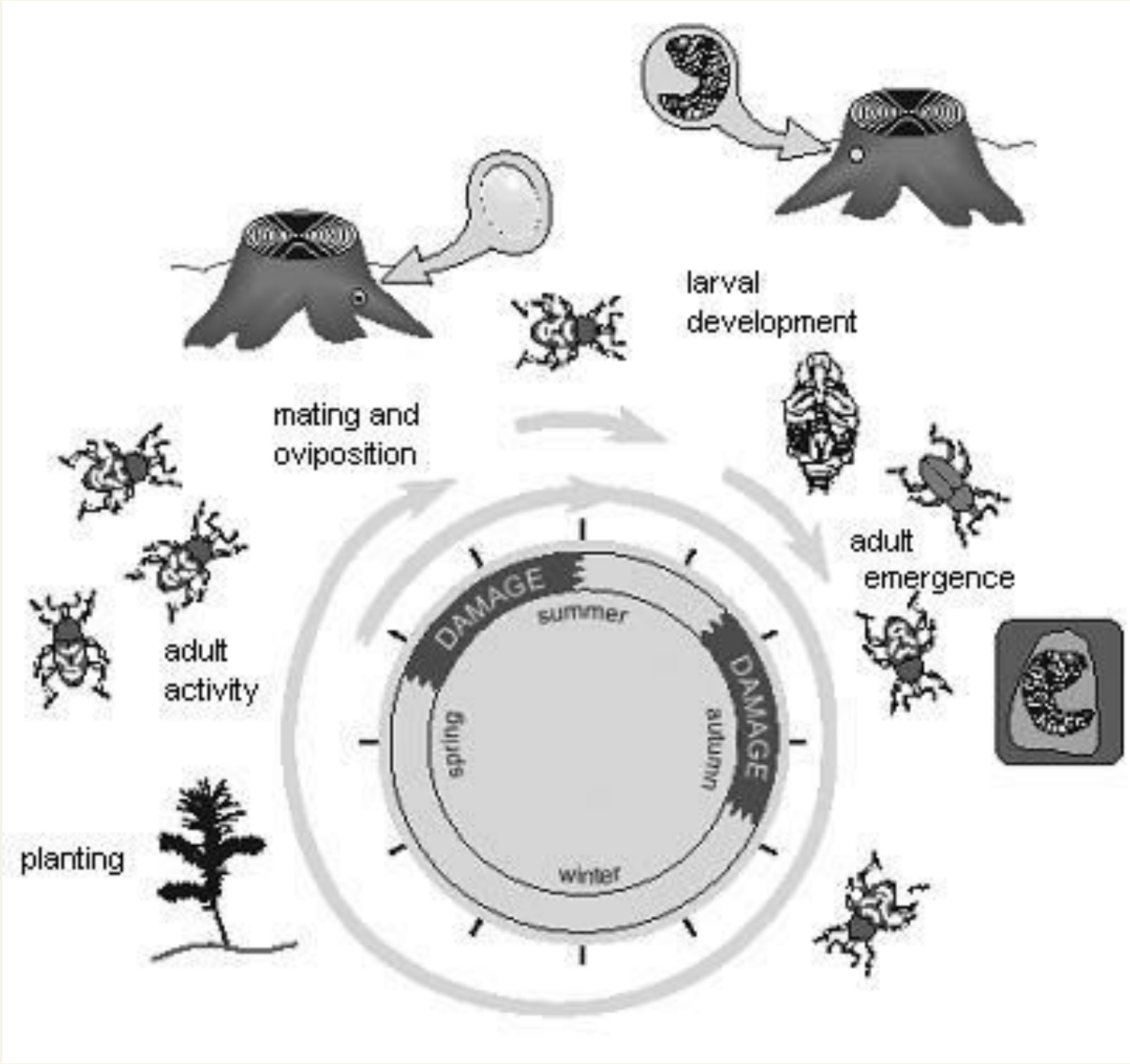
The Problem

- The large pine weevil, an insect pest of many species of young trees in addition to pine trees (in the genus, Pinus).
- It is a particular problem in the UK and other parts of Europe during the first five years after restocking (replanting) of commercial conifer forests, and occasionally also of recently restocked broadleaved forests.
- It is especially destructive of seedlings of pine and spruce, some species of which are widely grown in the UK for the softwood timber market.

Adult Large pine weevil *(Hylobius abietis)*

Large Pine weevil (*Hylobius abietis*)

5th instar larvae pre pupation


larval
development
mating and
oviposition
adult
emergence
adult
activity
planting
DAMAGE
summer
DAMAGE
autumn
spring
winter

Plant Protection Products

Protected Trees

Coragen (M19498) (chlorantraniliprole)

Outdoor Tree production

Lazarta (chlorantraniliprole)

Once per season in the forest between 15 April and 30 September, with knapsack application treatment of planted saplings or natural regeneration.

Forrester (cypermethrin)

UK National Environmental and Social Risk Assessment (ESRA) !

Source: Liaison data base 22.04.25

Biological control solution

- Entomopathogenic nematodes (EPN) are capable of locating *Hylobius* in their galleries and pupation chambers.

- Nematodes are applied to stumps in early/ mid- summer when the first batch of 4-5th instar weevil larvae and pupae are present.

- Research has already demonstrated that nematodes can reduce the number of adults emerging by up to 85% in small scale trials in which nematode suspension was applied by hand.

- Nematodes have been applied in larger trials using a spray rig mounted on a forwarder and fitted with flexible hoses and spray.

- However, in the UK the only area where nematodes have been regularly used is in Wales, where clear-fell areas have been treated with nematodes.

Why drones?

- Pesticide applications labour intensive
- Limited equipment availability and running costs i.e. forest forwarders
- Challenging terrain in clear-fell sites

- Drones offer a potential solution to some of these logistical problems and the costs of EPN’s are now more comparable to current insecticide treatments.

- 2/3-man operation
- Drones can be flown to fly at night
- Drones can be flown during rain events
- Drone can be flown beyond line of sight

*

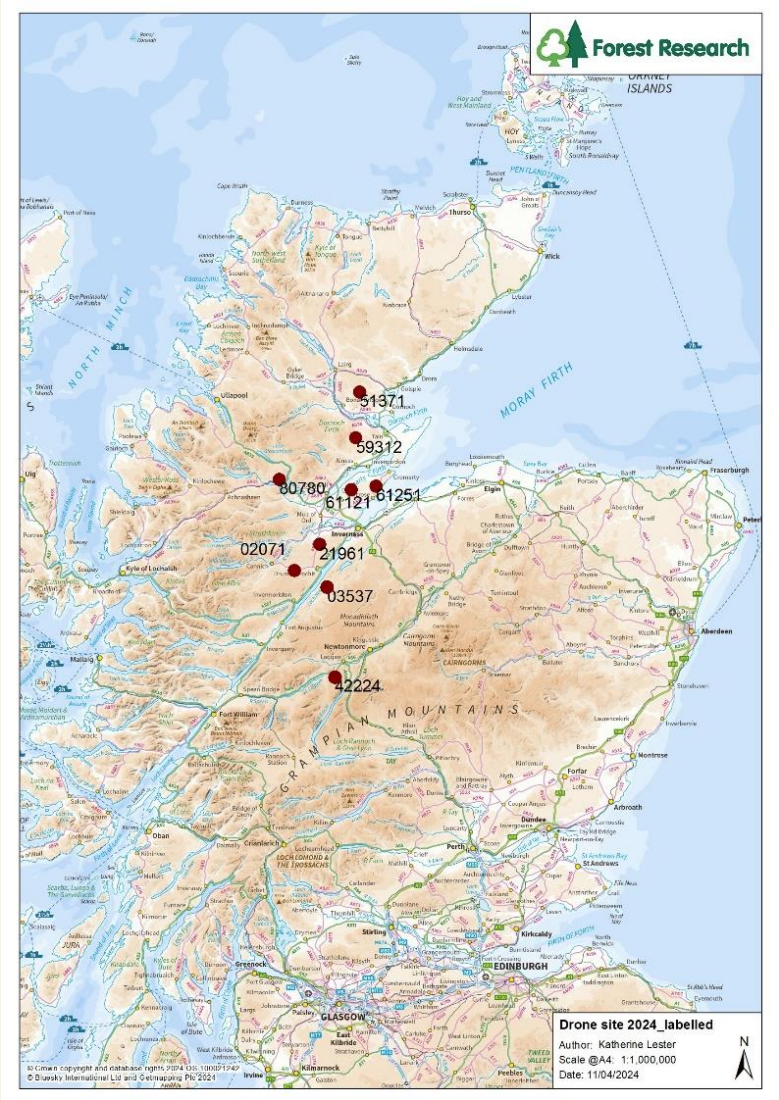

XAG
TOTAL NITROGEN

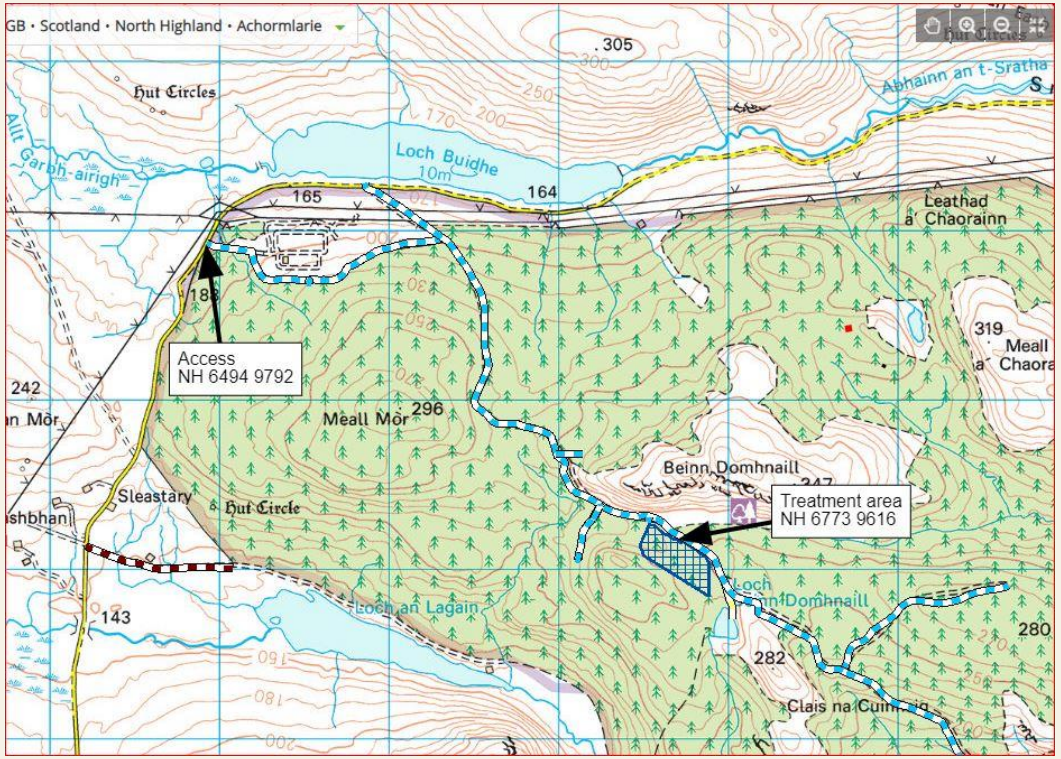
Assessment of drone application of *Steinernema carpocapsae* nematodes to stumps to control the large pine weevil, *Hylobius abietis*

Objectives

- Determine if drone application of nematodes to stumps can infect *Hylobius* larvae
- Compare number of *Hylobius* infected using two different application methods (knapsack and drone)

Location of trials





1.5ha pine clearfell site, felled 15-20 months previously, available Summer 2024

Product treatment

Nematode species *Steinernema carpocapsae*

(Koppert's *Capsanem)*

Pack size: 4x 750 million Infective third-stage larvae (L3).

Capsanem can be used for biological control of various insect pests in protected and outdoor crops.

Effective in a wide temperature range

Application rates

- 2.5 million in 2L (one pack = 2.5 million nematodes)
- 500ml per stump (6.25 x 10^5 nematodes per stump)

Method

Application technology

Knapsack sprayer

Petratools PD4000 Battery powered

Calibrated to apply 500ml per stump over a 13 sec period)

Drone

- XEG P100 pro drone (50 litre tank)

Apply treatments:

- Stumps were treated once with nematodes. A minimum of 100 stumps were treated using each application method. The applications were made in June (2024) - second year after felling (when *Hylobius* are known to be present as fully-grown larvae or pupae).
- Temperature and rainfall was monitored using a Tiny Tag data logger.

Assessments

Infection of *Hylobius* was assessed by de-barking a minimum of 10 stumps, 10m from the edge of the plot.

Debarking only took place around the bole of the stump and not along the roots.

Assessments were carried out in July when at least 50% of the larvae have pupated.

From each stump record:

- number of insects collected,
- life stage of each insect (larvae, pupae, adult, empty pupae chamber)
- visual record of health (alive/healthy, parasitized by nematode, parasitized by fungi, dead by undetermined reason),
- location (approximate depth- vertical distance from the soil surface)
- stump information - (stump girth or categorise- small/medium/large)

On return to the lab each insect collected was frozen (-20°C) and tested by molecular assay for infection/parasitisation.

Results

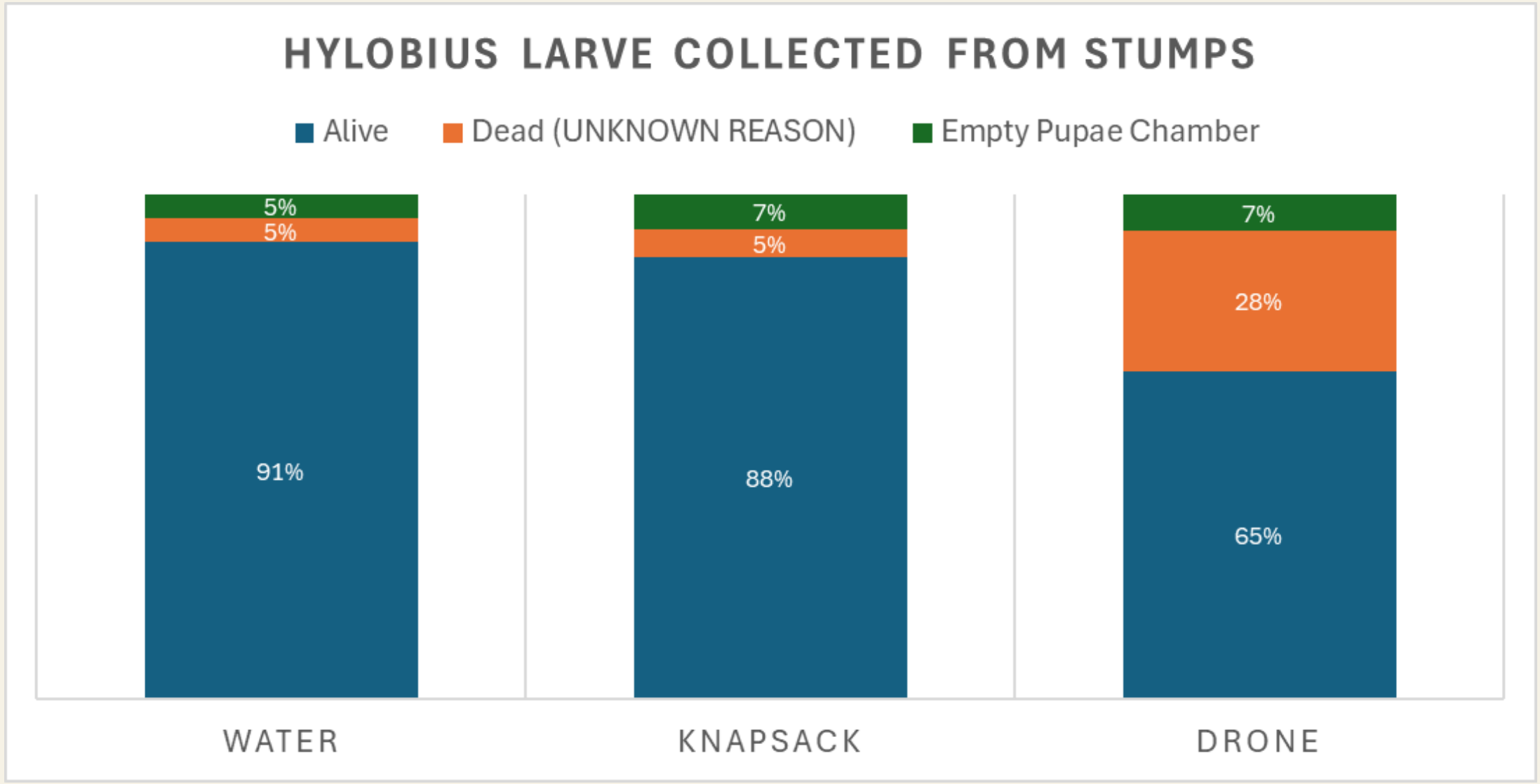
Nematode viability

Nematodes were both intact and active in the samples taken both before and after knapsack application. No extremes of temperature were recorded.

Infection of Hylobius larvae in stumps

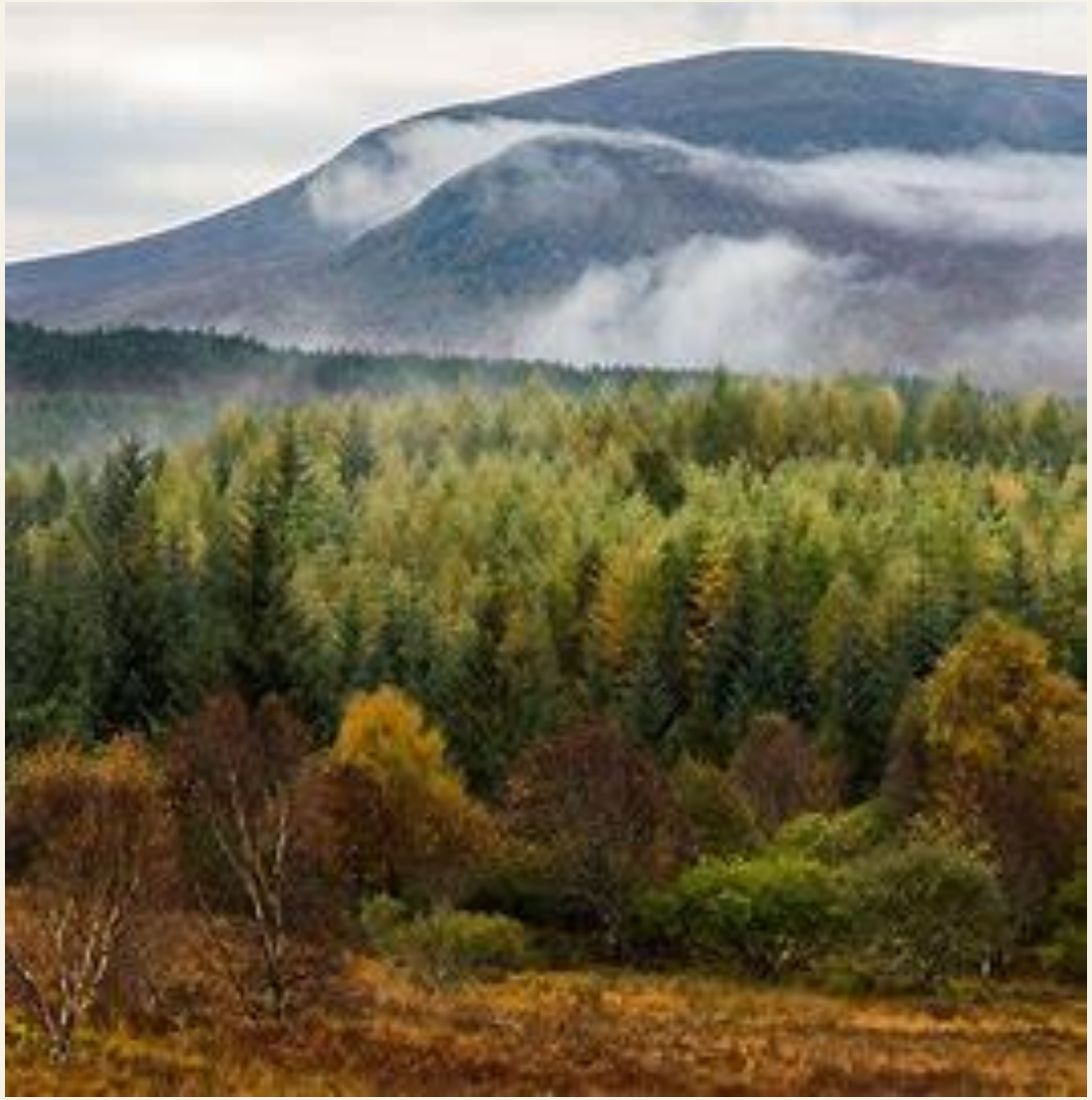
There were no signs of nematode infection in either treatment group. **There was a higher number of dead larvae recovered from the drone treatment group but no signs of visible infection.** Additionally, after molecular testing none of the dead larvae tested positive for *Steinernema carpocapsae* or the associated bacteria, *Xenorhabdus nematophila*.

There were also no signs of infection in other larvae present in the stumps e.g. *Hylates* sp, longhorn (Cerambycidae). These are generally located higher in the stump than *Hylobius* which tend to be located below soil level. This may be further indication that the nematodes did not penetrate the soil or the bark.


HYLOBIUS LARVE COLLECTED FROM STUMPS
Alive
Dead (UNKNOWN REASON)
Empty Pupae Chamber
5%
5%
91%
7%
5%
88%
7%
28%
65%
WATER
KNAPSACK
DRONE

Future studies

- Investigate varying application rates and water volumes – 70 litre drone available in 2025
- Investigate efficacy of *S. feltiae* (cruising habit)
- Time of day ?
- Include Adjuvants to preserve EPN’S – abiotic factors
- Application during rainfall – drones able to fly in rain
- Drone flight height?
- XEG Drones can be flown at night – improved humidity
- Beyond line of site – extended application areas



Thank you

- Dr Roger Moore (Forest Research)
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- Scott Dowell (Auto Spray Systems)

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AUTOSPRAY SYSTEMS

Forest Research

How do you partner with nature?

Koppert