# NON-TARGET ARTHROPODS: RECOVERY & REPRESENTIVITY


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## Abstract

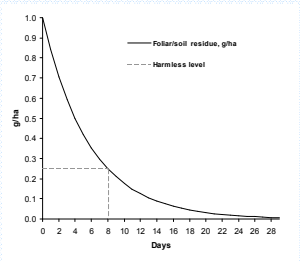
Acceptable risk to non-target arthropods (NTAs) in regulatory risk assessments may be concluded where recovery occurs within season. Data used to investigate recovery include aged residue studies, residue decay rate on leaves (foliar $DT_{50}$) and semi-field and field (plot-scale) studies. Each data type, however, represents an approximation of the full-field scenario – uncertainties with regards to presence and recolonising ability of arthropods remain. In addition, the arthropods used in laboratory testing and those present in field studies are currently considered to represent the wider arthropod fauna. NTA life histories are diverse, however, and uncertainty surrounds the extent to which the standard test species and in-field fauna represent the wider (off-field) community. This work was funded by the UK CRD (PS2355 recovery; PS2356 representivity) and was presented to the recent ESCORT 3 workshop.


## Use of recovery in NTA risk assessments – Introduction & Methods

According to ESCORT2: "*If higher tier testing demonstrates effect values below a set threshold value or indicates an acceptable potential for re-colonisation/recovery, no additional testing is required and low risk to the habitat of concern can be concluded*".

Study Objective: What factors may affect the detection and demonstration of recovery? Where does uncertainty exist?

The data types used to demonstrate recovery and the associated uncertainties were explored.

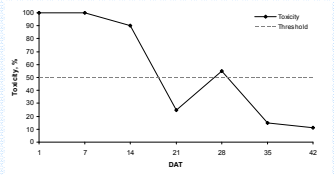


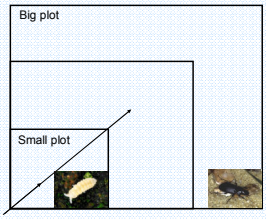

**What is recovery?** For recovery to occur, two key requirements must be met - decline of harmfulness and presence of recolonising individuals. The requirements must be met in sequence. Recolonising individuals may 're-invade' from off-field areas or regenerate from protected life stages/survivors in-field.

Recovery is usually understood to be the end of statistically significant differences between numbers in the treatment and control groups.

This can be investigated with laboratory and field studies.

**Laboratory aged residue studies** demonstrate the decline of harmful residues and therefore only the *potential* for recovery.
Uncertainties include: 1) Variation in toxic response between assessment events due to heterogeneity in leaf residue.
2) The studies do not provide information on the recolonising potential of arthropods.
**Semi-field studies** also assay the decline of harmful residues



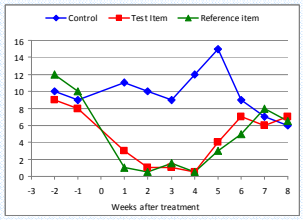

**Plot-scale field studies** demonstrate recovery under the limitations of the study design. One key concern is scale. The scale of the study (plot size) relative to the mobility of the sampled arthropods may affect the duration of effects and time to recovery. For more mobile species, larger plots reduce this uncertainty. Small plots may be more suited to mesofauna studies.

**Taxonomic resolution in field studies.** Different responses may occur within a Family due to differences in life history or biochemical sensitivity. Studying arthropods at coarse levels of taxonomy may mask effects. Compare Family level effects (above) to those at species level (below). Numerically dominant species may drive responses at the Family level.

| Family | Insecticide 1 Drift rate | Insecticide 1 Field rate | Insecticide 2 Field rate |
|---|---|---|---|
| Carabidae Coleoptera | Reduction 3% Recovery 1 week | Reduction 20% Recovery 8 weeks | Reduction 33% Recovery 8 weeks |
| Staphylinidae Coleoptera | Reduction 1% Recovery 1 week | Reduction 77% Recovery 8 weeks | Reduction 82% Recovery 8 weeks |

Brown & Miles, 2006.

| Example species | Insecticide 1 Drift rate | Insecticide 1 Field rate | Insecticide 2 Field rate |
|---|---|---|---|
| *Asaphidion curtum* Col: Carabidae | No reduction | No reduction | Reduction 90% Recovery not seen |
| *Bembidion lampros* Col: Carabidae | No reduction | Reduction 96% Recovery 6 weeks | Reduction 99% Recovery 6 weeks |
| *Nebria brevicollis* Col: Carabidae | No reduction | No reduction | No reduction |
| *Stenus clavicornis* Col: Staphylinidae | No reduction | Reduction 100% Recovery 8 weeks | Reduction 100% Recovery 8 weeks |




**Types of recovery.** This is an example of recovery by redistribution. This is relevant for mobile species. Following a decline in harmfulness of residues in the treatment plots, individuals from control plots and off-field areas recolonise the depleted area. Density is reduced in the donor (control) plots.

Other uncertainties with regards to field studies include **background heterogeneity** of arthropod distributions. Arthropod density and distribution may be influenced by landscape and micro habitat cues, such that distribution across field plots is not even. This may affect the power of studies to detect effect and recovery.

## Conclusions – use of recovery in NTA risk assessments

Recovery is a valid concept for use in risk assessments. The limitations of the data types used must be understood. Laboratory and semi-field data may indicate the potential for recovery but do not provide information on the recolonising or regenerating ability of arthropod populations.

For field studies with surface active arthropods, time to recovery is linked to linked to plot scale. Therefore, plot scale must be linked to arthropod mobility in field study designs.

## Representivity of tested arthropods – Introduction

The standard test species used in laboratory and semi-field studies are drawn from a pool of 'beneficial' arthropods – predators or parasitoids of pest species. The Tier 1 species, *Typhlodromus pyri* and *Aphidius rhopalosiphi*, whilst demonstrated to be the most sensitive from a range of beneficial arthropods, represent only two arthropod life histories. Herbivorous species are not considered. Tier 1 laboratory studies consider only contact exposure to dried residues; oral exposure is not included. Risk assessment schemes now include the wider NTA fauna in the off-field area and there is potential for herbivores to receive relatively high exposure due to a high food intake rate – for example chewing leaves as larvae. These arthropods have been largely overlooked. The extent to which the laboratory test species and those which occur in field plot studies represent the wider NTA fauna is an area of uncertainty.

Study questions: To what extent do the current sentinel species represent the range of sensitivity of wider arthropod fauna? Which life histories are covered? Are herbivores at elevated risk due to their feeding mode? What are the implications for risk assessment?

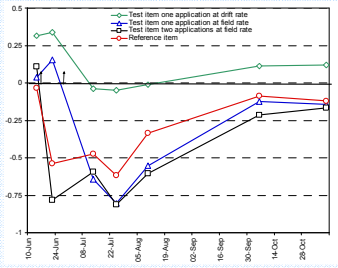
## Methods

Five regulatory field studies were made available, summarised below.

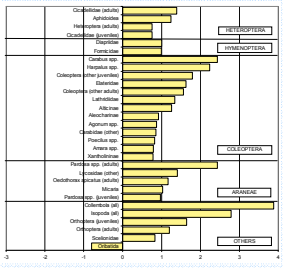
| Study type | Location | Field rate | Drift rate | Multi-rate |
|---|---|---|---|---|
| Off-field (meadow) | N France | | | ✓ |
| Off-field (meadow) | S France | | | ✓ |
| Orchard | N France | ✓ | ✓ | |
| Cereals | UK | ✓ | | |
| Sorghum | S France | ✓ | ✓ | |

A principal response curve (PRC) analysis was available for each study. The analyses allowed the response of species closely related to the current sentinel species to be compared to those of the wider NTA fauna, including herbivores.

**Example PRC diagram**




**Example species scores**




The species scores from PRC1 were taken as a measure of response of that taxon. An inherent limitation was the number of regulatory field studies available. Nonetheless, a useful analysis was considered possible. The suite of studies represented a variety of habitats. The cereal, meadow and sorghum studies were considered to represent field crops. The orchard study included both full field and drift rates – therefore, this was considered to represent both in-field tree crops and off-field woody areas (such as hedgerows). This is because the life histories found in an orchard would, to a certain extent, include those found in other woody areas. Taxa with very low numbers were not included in the analyses. The open literature was also surveyed in order to gather information relating to the sensitivity of various arthropods (not reported here).

## Results

The taxa with the higher species scores are summarised below for each study type.

**Off-field** (meadow) studies (N & S France): Collembola and predatory mites responded most (soil exposure occurred).

**UK cereal** study: Collembola, less mobile Carabidae and Staphylinidae and wingless parasitoid wasps responded most (soil exposure occurred).

**Sorghum** study (S France): In-field, Collembola and *Pardosa* responded most (soil exposure occurred). At drift rates, soil surface dwellers were less impacted due to reduced soil exposure.

**Orchard** study (N France): Coccinellidae, Oribatidae, Anthocoridae, Braconidae responded most. Only the more sensitive species responded in the drift rates where exposure was reduced.

## Conclusions

The arthropods which responded most in the five studies were broadly similar to the current suite of test species (including Collembola). Where soil exposure occurred (cereals, meadow, sorghum), Collembola and less mobile (typically small) Staphylinidae and Carabidae responded most. In drift rates, where soil exposure was reduced, these groups responded to a lesser extent. In woody habitats (orchard), foliar dwelling predators and parasitoids responded most. Of these, only the most sensitive responded in drift rates where exposure was reduced. Further research is required to determine the arthropod fauna of the diverse off-field areas of the EU.


Brown, K. and Miles, M. (2006) How much precision does a regulatory field study need. *Pesticides and Beneficial Organisms, IOBC/wprs Bulletin*, **29:** 43-52