**PESTICIDE RISK ASSESSMENT FOR BIRDS AND MAMMALS**

**Selection of relevant species and development of standard scenarios for higher tier risk assessment in the Northern Zone**

**in accordance with Regulation EC 1107/2009**

**April 2020**

**Version 2.0**

**Editing log – Higher Tier Risk Assessment for Birds and Mammals in Northern zone.**

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| 2017-02-16 | 1.5 | Blue tit and chaffinch: PT in orchards may also be used in bush berries and ornamentals/nursery (same read-across as accepted for linnet).  Brown hare: Text adjusted to ensure consistency between sections 5.2.2 and 6 with respect to relevance in maize.  Field vole: Information on relevance in fruit trees and bush berries in different Member States included.  The above changes are highligted in yellow.  Editorial changes (not highlighted):  "Risk assessment" sections moved to the beginning of each species account to facilitate use; numbering of tables adjusted accordingly.  Minor editorial corrections. | Bo S. Petersen (DK-EPA) | Date of issue |
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The correct reference for the NZ work sharing GD:

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Northern Zone B&M GD version 2.0, 2020

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**Contents**

[1 Background and introduction 6](#_Toc35331445)

[1.1 Background for Danish version 7](#_Toc35331446)

[1.2 Revision 2019/2020 8](#_Toc35331447)

[2 How to use this higher tier guidance 9](#_Toc35331448)

[3 Selection of focal species 11](#_Toc35331449)

[4 Risk assessment for birds and mammals 15](#_Toc35331450)

[4.1 Estimation of Daily Dietary Dose 15](#_Toc35331451)

[4.2 Derivation of crop and growth stage specific PD values 16](#_Toc35331452)

[4.3 Residue per Unit Dose (RUD) 17](#_Toc35331453)

[4.4 Recommendation for residue decline refinements (DT50) 19](#_Toc35331454)

[4.4.1 Substance- and use-specific residue decline studies 20](#_Toc35331455)

[4.4.2 Use of MRL-trials to refine residue decline 21](#_Toc35331456)

[4.4.3 Evaluation of appropriate DT50 kinetic for MAF × TWA calculations 21](#_Toc35331457)

[4.5 Interception 21](#_Toc35331458)

[4.6 Use of PT data 23](#_Toc35331459)

[4.7 Dehusking 26](#_Toc35331460)

[5 Seed Treatment 28](#_Toc35331461)

[5.1 Focal species for seed treatment scenarios 28](#_Toc35331462)

[5.2 Refinement data 28](#_Toc35331463)

[5.3 Foraging Area Approach 29](#_Toc35331464)

[5.4 Seedling scenario 32](#_Toc35331465)

[6 Selected focal species 33](#_Toc35331466)

[6.1 Introductive information on additional ‘crop groups’ 33](#_Toc35331467)

[6.2 Birds 34](#_Toc35331468)

[6.2.1 Bean goose *Anser fabalis* (herbivore) 34](#_Toc35331469)

[6.2.2 Pink-footed goose *Anser brachyrhyncus* (herbivore) 37](#_Toc35331470)

[6.2.3 Grey partridge *Perdix perdix* (omnivore) 41](#_Toc35331471)

[6.2.4 Woodpigeon *Columba palumbus* (omnivore) 44](#_Toc35331472)

[6.2.5 Skylark *Alauda arvensis* (omnivore) 49](#_Toc35331473)

[6.2.6 Yellow wagtail *Motacilla flava* (insectivore) 55](#_Toc35331474)

[6.2.7 White wagtail *Motacilla alba* (insectivore) 57](#_Toc35331475)

[6.2.8 Robin *Erithacus rubecula* (insectivore) 60](#_Toc35331476)

[6.2.9 Whinchat *Saxicola rubetra* (insectivore) 62](#_Toc35331477)

[6.2.10 Whitethroat *Sylvia communis* (insectivore) 65](#_Toc35331478)

[6.2.11 Willow warbler *Phylloscopus trochilus* (insectivore) 68](#_Toc35331479)

[**6.2.12** Goldcrest *Regulus regulus* (insectivore) 70](#_Toc35331480)

[6.2.13 Blue tit *Cyanistes caeruleus* (omnivore) 72](#_Toc35331481)

[6.2.14 Starling *Sturnus vulgaris* (omnivore) 75](#_Toc35331482)

[6.2.15 Chaffinch *Fringilla coelebs* (omnivore) 78](#_Toc35331483)

[6.2.16 Linnet *Carduelis cannabina* (granivore) 82](#_Toc35331484)

[**6.2.17** Siskin *Carduelis spinus* (granivore) 85](#_Toc35331485)

[6.2.18 Yellowhammer *Emberiza citrinella* (omnivore) 88](#_Toc35331486)

[**6.2.19** Ortolan bunting *Emberiza hortulana* (omnivore) 94](#_Toc35331487)

[6.3 Mammals 100](#_Toc35331488)

[6.3.1 Common shrew *Sorex araneus* (insectivore and worm/snail eating) 100](#_Toc35331489)

[6.3.2 Brown hare *Lepus europaeus* (herbivore) 103](#_Toc35331490)

[6.3.3 Field vole *Microtus agrestis* (herbivore) 110](#_Toc35331491)

[6.3.4 Wood mouse *Apodemus sylvaticus* (omnivore) 114](#_Toc35331492)

[7 Summary tables 121](#_Toc35331493)

[8 References 137](#_Toc35331494)

[Appendix 1 151](#_Toc35331495)

[Appendix 2 155](#_Toc35331496)

[Appendix 3 159](#_Toc35331497)

[Appendix 4 168](#_Toc35331498)

[Appendix 5 179](#_Toc35331499)

# Background and introduction

Regulation EC 1107/2009 concerning the placing of plant protection products on the market in the EU entered into force on 14 June 2011. A central aspect in the new regulation is the principle of mutual recognition, which aims at reducing the administrative burden for industry and for Member States and also provides for more harmonized availability of plant protection products across the Community. To facilitate this, the Community is divided into three administrative zones.

Environmental risk assessment is a tiered approach where the initial risk is assessed based on conservative assumptions regarding expected exposure and effects on non-target organisms. If the initial assessment indicates a potential risk, a more refined (“higher tier”) risk assessment is often provided based on more realistic assumptions regarding exposure and/or effects.

The risk assessment for birds and mammals is one of the areas where higher tier risk refinements are often needed. Whereas the initial risk assessment for birds and mammals is common between Member States, based on the EFSA Guidance Document (EFSA 2009), it has been recognized that common ground needs to be developed for the refined risk assessment in order to facilitate a harmonized zonal risk assessment.

The need for **a common strategy** for higher tier risk assessment for birds and mammals within the Northern Zone was discussed at a workshop held 7-9 June 2011 in Copenhagen. At the meeting it was agreed that the focal species and scenarios described in the Danish report on higher tier risk assessment for birds and mammals (Danish Environmental Protection Agency 2009) and the accompanying calculator tool could be considered a valid starting point for developing a common tool for the Northern Zone (i.e. Denmark, Estonia, Finland, Latvia, Lithuania, Norway and Sweden).

The necessary amendments to the Danish report and calculator tool were discussed at another workshop, held 8-9 May 2012 in Copenhagen with participation of Northern Zone member states and ECPA. It was decided to include a number of additional species to ensure proper coverage of the entire Zone. The new species to be included, and the focal species to be used in higher tier risk assessment for each combination of crop and growth stage, were agreed upon at the workshop. It was further agreed that the exposure scenarios, particularly the composition of diet to be used for all relevant combinations of focal species, crop and growth stage, should be specified in more detail than in the Danish report. For the 2.0 version (April 2020) it was agreed to use exclusively the diet given in this guidance per species and crop scenario, and that further higher tier refinement of PD is not accepted.

The present document is a strongly revised version of the Danish report (Danish Environ­mental Protection Agency 2009), and subsequent extended and updated versions to cover the entire Zone and to comply with the decisions at the workshops.

**A calculator tool** (Excel spreadsheet) was developed for use in connection with the Danish report. Like the report, the calculator tool has been updated to include the new species and to comply with the above-mentioned workshop decisions. The calculator tool is a flexible tool, which complements the EFSA Calculator Tool for Tier 1 risk assessment, providing a range of refinement options for many species required for higher tier risk assessment.

Extension and revision of the report and the calculator tool were made possible by a grant from the Nordic Chemical Group under the Nordic Council of Ministers (Project No. 1662).

The project was conducted by:

* Bo Svenning Petersen, Orbicon A/S (Denmark)

in co-operation with the members of the Steering Group:

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* Rasmus Søgaard (Denmark)
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Comments and supplementary information to the report were kindly provided by:

* Åke Berg, Swedish University of Agricultural Sciences
* Juha Tiainen, Finnish Game and Fisheries Research Institute

## Background for Danish version

This document was originally initiated by the Swedish Chemicals Agency (KemI) in December 2004 in order to develop national scenarios for refined risk assessments for birds and mammals at registration of plant protection products in accordance with Directive 91/414. The Swedish project was conducted by Jan Wärnbäck, in co-operation with KemI and the Department of Conservation Biology at the Swedish University of Agricultural Sciences, Uppsala.

Following its publication in 2006, the report by KemI was used also by the Danish Environmental Protection Agency (DEPA). In the autumn of 2008, the DEPA however decided to develop specific Danish scenarios for higher tier risk assessment. This was done with an update of the information in the Swedish report. The project was conducted for DEPA during 2009 by Orbicon A/S.

The original report was prepared for use under Directive 91/414 (SANCO 4145/2000 Guidance Document for Risk Assessment for Birds and Mammals). However, in 2009 SANCO 4145/2000 was replaced by the current GD (EFSA 2009). The associated changes, notably a revision of the standard Residues per Unit Dose, were partly incorporated in the Danish report.

## Revision 2019/2020

The present document has been updated considering new refinement data (if relevant for the Northern Zone).

The project revision was conducted by:

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in co-operation with the members of the Steering Group:

* Alf Aagaard (Denmark, chairperson)
* Signe Pedersen (Denmark)
* Sandra Boline Lassen (Denmark)
* Mariana Ledesma (Sweden)
* Audun Storset (Norway)

The revision process began in January 2019 and ended in April 2020. A hearing process with the Northern zone member states was included in the end of 2019.

Besides a comprehensive literature survey conducted, the data intended to be used for the revision of the current EFSA guidance (2009) compiled by Lahr et al. (2018) and data provided by ECPA on request were evaluated and considered if appropriate. In several areas this revised 2.0 version will be updated again when revision of EFSA (2009) is completed to be consistent with the most current EFSA Bird and Mammal guidance document.

However, for some aspects the most recent technical report on the outcome of the PPR Meeting on general recurring issues in ecotoxicology (EFSA 2019) and previous issues were already reflected.

New ‘crop groups’ (Christmas tree plantations or tree plantations for taking branches for decorative purposes (‘decorative greenery’ hereafter), and forestry uses), which are of particular interest for the Northern Zone were added, and some guidance about how to conduct a risk assessment relevant for seed treatment uses for large and small seeds categorized according to EFSA (2009) is included. A review of Red List species in the Northern Zone, and if these are covered by existing focal species led to assess ortolan bunting (*Emberiza hortulana*) as a new species for some crop groups, and to consider lesser white-fronted goose (*Anser erythropus*) due to its lower body weight (Northern Zone 2020). For termination use in grassland the field vole need to be assessed in addition to wood mouse.

Due to a lack of (as a result of the literature survey and data request to ECPA), and subsequent need to provide species-, crop-, zone- and/or compound-specific data for higher tier refinement, which is not publically available for several species, crops, compounds etc. this revision starts setting requirements for GLP field studies (PT, DT50 and dehusking) to be followed, if specific applicant-owned data will be submitted. In this context, such higher tier data should consider locations, typical climate including precipitation and other (biotic and abiotic) factors representative for the Northern Zone, or arguments why the data is representative for the Northern Zone.

This revision was made possible by a grant from the Danish EPA (Project No. MST-665-00031).

# How to use this higher tier guidance

This document on higher tier risk assessment for birds and mammals in the Northern Zone comes with a calculator tool which has been developed to provide standard scenarios for higher tier risk assessment in the Northern Zone. The scenarios shall be used whenever the standard tier 1 scenarios (EFSA calculator tool) do not indicate safe use. It is highly recommended that the calculator tool is always used, in order to avoid mistakes and ease assessment and evaluation.

The intention is to provide risk assessments for birds and mammals, based on Northern Zone focal species relevant for the scenario and crop type and its growth stages. Biological background information on crop-stage-specific relevant focal species and available refinement options are presented in this document and are applied in the calculator tool. Guidance on use of the calculator tool is given in an introduction page of the calculator tool (Excel spreadsheet). Note, that it is important to state in the RR which version of the calculation tool has been used in the risk assessment (version number is part of the spreadsheet name and when it is published is given in the link (DEPA webpage)).

For all Northern Zone member states, higher tier refinement options given in this document are agreed among the Northern Zone member states and are as such accepted in the core assessment (see chapter 3). The basis is the summary tables in chapter 7, associating crop, growth stage and focal specises (FS). Fixed PD values and body weights are given for each FS in chapter 6, while possible refinement options are given in chapter 4. The only exception is for Denmark where some further refinements may be applicable. Guidance on these further options can be found in the Danish Framework for assessment of pesticides on the Danish EPA homepage and such refinements should be provided in the national addendum.

Risk assessments for **reproductive effects** should be provided even if the exposure window is outside the breeding season. Avian gonads are developing during the whole season and adverse effects might therefore be manifested from exposure at a sensitive stage during that development.

Due to uncertainties when using **body burden modelling** approaches (availaibilty, quality and quantity of data per species, and models to use and data interpretation, particularly in birds), these acute higher tier refinement options are not considered appropriate for the Nothern Zone until valid and agreed models and more guidance for use are available.

Note that in the long term risk assessment, a TWA period of 21 days can be used. If the study for deriving the endpoint demonstrates that an exposure time for onset of toxic effect is shorter than 21 days (e.g. developmental study results) this shorter TWA-period should be used.

Risk assessment calculations including PT refinements should comply to the recommendations of EFSA (2009) and always cover the period of the intended use, particularly for any new data submitted (i.e. PT data from June should not be used for applications intended in other months), except if crop-specific parameters are comparable, e.g. spring and winter drilling seasons of the same crop. Nevertheless, appropriate argumentation has to verify the worst-case nature of data used in higher tier assessments.

When further refinements of the risk assessment are necessary, the relevant scenarios from the Northern Zone higher tier guidance document should be used together with the associated spreadsheet (both available at the Danish EPA webpage, see link above) and based on the same endpoints as in the Tier 1 risk assessment. All species required for the crop and growth stage in question according to the Northern Zone higher tier guidance document are relevant, even if the species were already assessed as generic focal species at tier 1. The main reason for this is that the tier 1 scenarios are not necessarily worst-case with respect to diet in the Northern Zone. Higher tier TER calculations are however not required for species which passed the trigger by a factor of 2 or more at tier 1. (i.e. acute ≥ 20, and chronic ≥ 10).

# Selection of focal species

The agricultural landscape holds a wide range of both bird and mammal species that may be exposed by the use of plant protection products. However, there is a great variation in the use of agricultural land by different species. Some species live their entire life in agricultural habitats while others are mainly present during breeding or migration. Another important factor in determining whether birds and mammals are present and to which extent and in what densities is the actual crop, the growth stage, and adjacent habitats. Furthermore, it is known that wildlife preference for different crop types varies between geographical areas and seasons. Therefore, some criteria were set up in order to be able to select relevant standard species for higher tier risk assessment of plant protection products to be protective for all bird and mammal species using agricultural habitats.

The species selected as focal species should be:

1. Commonly found in agricultural land across major parts of the Northern Zone.
2. Abundant and prevalent in relevant crop types.
3. Satisfying a major part of their nutritional need in the crop type at least during parts of the season.
4. Relatively small in body size since energy expenditure and the exposure are decreasing in relation to increasing weight. Smaller animals are therefore worst case and can be considered as representative for all larger species potentially exposed.
5. It was intended to cover red-listed and endangered species of Northern Zone member states, particularly if the above mentioned criteria are largely valid for a specific threatened species considered to be exposed in a given scenario.

Although when selecting focal species special consideration needs to be paid to the treatment of the crop, the time of year and the likelihood of finding a species in the treated field, the diet composition also needs to cover potential food items with different residue levels (e.g. vegetative plant tissue, seeds, insects). Thus, not all of the species that have been selected comply with all of the set criteria. In such cases the species have been selected due to other features that are considered important in risk assessment. These features might be feeding habits that make the species particularly exposed (e.g. grazing birds), or species that can be found in a specific form of cultivation (e.g. orchards or Christmas tree / ‘decorative greenery’ plantations).

The major challenge when choosing which species should be considered in the risk assessment of birds and mammals is the lack of public and sufficiently detailed data for all scenarios and across the entire Northern Zone, especially on exact time budgets, crop use and feeding behaviour of the species and crop-related diet (but see Prosser 2010 for PT and Holland et al 2006 for diet data reviews of publically available data). Scientific research projects as main source for peer-reviewed publications usually have a different aim than trying to establish the exact behaviour or registration-relevant time budgets of species and individuals in different crop types. However, useful information is currently available for a number of crops and for a number of both bird and mammal species. In particular, several projects conducted by Fera Science Ltd. (formerly the UK Food and Environment Research Agency, and until 2009 Central Science Laboratory) are publically available and might be considered useful.

For simplicity, the list of proposed focal species should not be too long. Therefore, as a general rule only one representative for each feeding guild and stratum (i.e. main foraging area within the crop) has been selected for each crop type and season. The selected species should be those that are considered worst-case representatives, i.e. usually the smallest species fulfilling the above criteria. Larger species and/or species whose diet contains lower pesticide residues will be covered by the risk assessment for such worst-case species. In case several species may be equally worst-case, the more well-studied species were generally selected.

Using these criteria, species such as lapwing *Vanellus vanellus*, rook *Corvus frugilegus* and hooded crow *Corvus cornix* were eliminated due to their large size, and the well-studied and abundant linnet *Carduelis cannabina* and yellowhammer *Emberiza citrinella* were preferred to similar-sized species such as goldfinch *Carduelis carduelis* and tree sparrow *Passer montanus*.

Among **small mammals**, the ecological traits within the groups of shrew and mouse species are quite similar. Available data on diet composition and habitat use are, however, more extensive for common shrew *Sorex araneus* and wood mouse *Apodemus sylvaticus* than for their ecologically similar but less well known relatives (i.e. pygmy shrew *Sorex minutus*, various *Apodemus* species and eastern house mouse *Mus musculus*), making the former more suited as focal species. Because common shrew and wood mouse are clearly the most abundant representatives in agricultural land across the Northern Zone (Mitchell-Jones et al. 1999) they are appropriate representatives for both small mammal groups to be addressed in environmental risk assessments.

For **voles**, the EFSA Guidance Document (EFSA 2009) requests the common vole *Microtus arvalis* as generic focal species for Tier 1 in all crop groups (except *Bare Soils*), and for some crops even from BBCH stage 10 onwards (see Appendix A of EFSA 2009). However, the common vole is absent from most parts of the Nothern Zone (with the exception of the Baltic States, see Balčiauskas et al. 2019) and consequently no generally appropriate Northern Zone species, even if common vole habitats are summarized in Mitchell-Jones et al. (1999) as open cultivated agricultural land, grazed pastures and also short meadows (i.e. a species common in agricultural land). In contrast, the field vole *Microtus agrestis*, are found in arable crops only at peak populations when they immigrate from moist habitats with rich grass cover, woodlands, marshes, peat-bogs, wet meadows, river banks etc., and the animals occurring in arable fields are probably of little or no importance for the total population. This is also confirmed by Tattersall et al. (2002) defining field voles as species which can be present in farmland, but almost exclusively in the surroundings of arable crops, in leys and set-asides especially in fields that have been cultivated this way for many years. Other authors summarized that field voles are very dependent on rough grassland, though if this habitat is not grazed it can revert to unsuitable scrub, and if it is grazed too much, the sward can become too short to attract voles (Boatman et al. 2007). Cover is essential and population estimates of field voles approximately doubled under reduced grazing by sheep in natural upland grassland habitats in the UK (Wheeler 2008). Within intensive agro-ecosystems, narrow strips between crops are important links for field voles between wider margins and other more suitable habitats (Renwick and Lambin 2011). Therefore, no small herbivore is considered relevant for risk assessment in arable crops within the Northern Zone. Because field voles are frequent and can be abundant in some grassland, if the grass is high enough (> 10 cm) to provide sufficient cover (see also Borowski 2003), it is considered a relevant focal species in grassland, orchards, Christmas trees and ‘decorative greenery’ plantations and forestry habitats with vegetation cover.

Despite differences in primary habitat preferences, both common and field voles are rather similar in their general requirements and dietary demands. This allows the two species to replace each other in a risk assessment and, at the same time, does not fundamentally modify the basic conclusion of a risk assessment. Both vole species can be found in agricultural areas at peak populations, except grassland where permanent populations exist. Field voles are present in farmland, but almost exclusively in the surroundings of arable or horticultural crops, in leys, set-asides and in grassland (Tattersall, Macdonald et al. 2002), but due to the fact that more data is available about common vole ecology in farmland (i.e. it is the better investigated species), and the species’ lower body weight, common vole higher tier data (i.e. PT) can be considered for vole scenarios in general alongsite argumentations why such data can be extrapolated to the Northern Zone countries. Generic data (PT) should be related to agricultural practise and to the GAP in the relevant region. Furthermore, the weight of common voles (25 g) referred to in the EFSA Guidance Document (EFSA 2009) should be used in the risk assessment.

The bank vole *Myodes glareolus* (formerly *Clethrionomys glareolus*) has a close resemblance to the wood mouse in terms of habitat, size and feeding behaviour (opportunistic and mixed diet). However, the wood mouse is more abundant in agricultural fields than the bank vole. Taken together, the risk assessment of the wood mouse is considered to cover that of the bank vole.

The water vole *Arvicola terrestris* is known to feed on potatoes in autumn, but there is no evidence of water voles feeding on newly sown potatoes in spring. It is assumed that residues in potatoes in autumn are low and that toxicological assessments for the sake of consumer safety are sufficient to protect also the water vole. Thus, the species is not included as a focal species.

For risk assessment of plant protection products used in **orchards**, **Christmas trees and ‘decorative greenery’** plantations and **forestry** uses, the true farmland species are usually not relevant. The main bird species to be used for these particular habitats are robin *Erithacus rubecula*, blue tit *Parus caeruleus*, chaffinch *Fringilla coelebs* and others, which are common in habitats of similar structure, such as gardens and city parks. Furthermore, information on the time budgets of these species in orchards is available from radio-tracking studies conducted in UK (Crocker et al. 1998, Finch et al. 2006, Prosser 2010). In Christmas trees and ‘decorative greenery’ plantations and forestry scenarios, some conifer specialists need to be considered, e.g. siskin *Carduelis spinus* and goldcrest *Regulus regulus* (see section 6.1 et seq.).

During the revision process the question arose whether recommended focal species for higher tier risk assessments in the Northern Zone sufficiently cover the risk of exposure for endangered species listed in the Red Data Books for Northern Zone countries or not. In total, 228 species are included in the Red Lists of the Northern Zone countries of which 103 species might be considered potentially at risk from plant protection products used in farmland (Northern Zone 2020). The comparison of Red Listed species with recommended focal species indicates an adequate representativeness by body weight, i.e. most focal species candidates represent rather small species within their respective foraging guilds or strata. Until official guidance from EFSA is available (possibly after the forthcoming revision of the EFSA (2009) guidance document), the lesser white-fronted goose (*A. erythropus*) body weight should be considered in the risk assessment for application schemes in grassland/cereal, and among omnivorous birds, the ortolan bunting (*E. hortulana*) represents a more conservative representative than the yellowhammer *E. citrinella* and should be considered as a worst-case – also in Denmark for reasons of harmonization in lower tiers. For mammals, the recent recommended focal species cover the risk of Red List species (Northern Zone 2020). Mountain hare mean body weight is lower compared to brown hare body weight, but the species is only very little connected to agricultural land, and only in some small parts of the Northern Zone, and was not considered to be included within this revision of the Northern Zone Guidance document.

Table 3.1 *change of recommended focal species under consideration of Red Listed species otherwise not sufficiently protected by the risk assessment scheme (see also section 6.2 below).*

|  |  |  |
| --- | --- | --- |
| **Crop** | **Exposure scenario** | **New Focal species (or bw data)** |
| spring cereals, winter cereals, grass | Large herbivorous bird | Lesser white-fronted goose *Anser erythropus* (instead of Bean goose *A. serrirostris* or Pink-footed goose *A. brachyrhynchus*) |
| beets, spring cereals, orchards, grass, maize, oilseed rape, potatoes, pulses | Small omnivorous bird | Ortolan bunting *Emberiza hortulana* (instead of yellowhammer *E. citrinella*) |

# Risk assessment for birds and mammals

## Estimation of Daily Dietary Dose

Irrespective of the tier (screening step, tier 1 or higher tier), risk assessment for birds and mammals is performed by calculating the toxicity-exposure ratio (TER), which is given by the following equations:

Acute TER = LD50 / DDD

Reproductive (long-term) TER = NOAELrepro / DDD

Estimation of the Daily Dietary Dose (DDD) of the active substance in question is thus a key element in risk assessment. In higher tier risk assessment, as dealt with in the present document, the DDD is calculated for one or more real species (“focal species”) that are known to occur in the crop(s) in question. Calculation of the DDD shall as far as possible be based on diet compositions, which have actually been measured in the field (as opposed to the generic diets used at tier 1).

Basically the DDD is given by the following equation:

DDD = ((FIR × C × PD) / BW) × PT, where

FIR = Food intake rate of the focal species in question (g fresh weight per day)

BW = Body weight of focal species (g)

C = Concentration of active substance per fresh diet fraction (mg/kg)

PD = Fraction of a particular potentially contaminated food type in diet (PD = 1 for single diet)

PT = Fraction of diet obtained within treated area.

The food intake rate (FIR) depends on the daily energy expenditure (DEE) of the species, which is again related to the body weight. FIR (g) is calculated by dividing DEE (kJ) by the energy content in 1 g of diet.

The concentration C is directly available in the special case of treated seeds, but in all other cases C must be calculated from the residue per unit dose (RUD), application rate, number of applications[[1]](#footnote-2), half-life (DT50) of compound etc. (cf. EFSA 2009).

For a mixed diet, (C x PD) must be calculated separately for each food type (PDi) with respective residue concentration (Ci), and the resulting DDDtotal is the sum of the contributions from each food type in the diet (sum of different PD = 1):

DDDtotal = (FIR × ∑i(Ci × PDi) / BW) × PT.

In the remaining sections of this chapter, estimation of PD and PT and a few other issues of relevance for higher tier risk assessment and the use of this document are briefly discussed.

As mentioned in the introduction, an updated calculator tool (Excel spreadsheet) is available to facilitate the calculation of DDD and TER for each of the selected focal species. Please refer to the introductory page of the calculator tool for specific guidance on how to use this tool.

## Derivation of crop and growth stage specific PD values

In this document, species-specific diets (PD values) to be used in higher tier risk assessment have been defined for each relevant combination of focal species, crop, growth stage and time of the year. Further refinement of PD values beyond the studies considered in this documenet is not accepted. However, robust PD data for species relevant for forestry use may be accepted. This is straightforward for single-diet species and also fairly easy for other species that occupy rather narrow food and/or habitat niches. It is more difficult, however, to specify crop- and growth stage-specific diets for omnivorous species which show a common and abundant occurrence in farmland, like skylark *Alauda arvensis* and wood mouse *Apodemus sylvaticus*, and represent opportunistic foragers (i.e. their diet depends on what is on offer in their activity ranges). Major published studies of diet (e.g. Green 1978 for skylark, Pelz 1989 for wood mouse) elucidate the diet in agricultural fields of specific landscapes, but these data are up to more than 45 years old and likely no longer representative for the situation today.

The following example illustrates the problem. Skylark diet in April is specified as follows by Green (1978):

* Invertebrates 14% of dry weight
* Cereal grain 30%
* Small seeds (grass and weed seeds) 22%
* Monocotyledonous (cereal and grass) leaves 24%
* Dicotyledonous leaves 10%

However, cereal grain and monocotyledonous leaves are mainly available in cereal fields and therefore their share of the diet will probably be much smaller in, e.g., oilseed rape fields where grasses occurring as weeds or grasses in field margins are the only monocotyledons present. Furthermore, within the landscape of Green’s (1978) study in the early 1970s grain was available as food for live stock on grassland or by well exposed seeds after drilling of spring cereals. As mentioned above, nowadays, drilling machineries are more precise, spring cereals are much less abundant than winter cereals, and livestock (cattle and horses) on grassland in close vicinity to cropped land is very limited. Therefore, in modern agricultural landscapes or in a specific crop like winter oilseed rape in April, the skylark diet would most probably look different than 40 years ago (cf. pages 120-26 and 156-58 in Donald 2004). The DDD of skylarks foraging in a landscape dominated by pesticide-treated oilseed rape fields (or any other crop) will therefore be biased if PD data equivalents are estimated directly from Green (1978).

However, basically two different (and mutually exclusive) approaches might be used to overcome this problem. One approach would be to assume that the diet in each month is fixed and that those food items which are not available in rape fields will be obtained elsewhere. Thus, PD is retained and a residue of zero is assigned to those food items which are assumed to be obtained outside the treated field. Calculation of DDD is rather straightforward and no PT factor shall be used (because foraging outside the treated area is already accounted for by assuming zero residues in some food items). *However,* *this approach is not recommended, and therefore not accepted.*

An alternative and accepted approach assumes that the animal adjusts its diet according to availability in the crop in question. Therefore, PD is adjusted to reflect availability in, e.g. oilseed rape fields. This makes estimation of DDD less straightforward and the adjustment may introduce an element of subjectivity. However, this approach is more in line with the official definition of PD (“composition of diet obtained from treated area”, EFSA 2009) and is the approach used in the present context. Standard (or measured) RUD values are used for *all* food items occurring in the diet. Foraging outside the treated field can be accounted for by applying a PT factor (preferably derived via radio-tracking of focal species in the respective crop, cf. section 4.6 below).

Following this approach, the published PD values which apply to arable land in general were adjusted for each relevant combination of crop, growth stage and month, taking the relative availability of different food items in the crop and growth stage in question into account. Furthermore “invertebrates” were split into foliar and ground-dwelling arthropods and “vegetative plant tissue” was split into mono- and dicotyledonous plants because rather different RUD values apply to each of these groups.

To deal with this issue in an objective way, a set of fixed criteria was developed and applied to the data. For skylark, in non-cereal crops the share of cereal grain in diet was e.g. reduced to 6%, corresponding to the minimum level found by Green (1978) [[2]](#footnote-3), and the relative share of the other food items was increased proportionally.

The criteria used for skylark and wood mouse are specified in Appendix 1 and 2, respectively.

The major published studies of the diets of important focal species such as skylark (Green 1978) and wood mouse (Pelz 1989) rely on field data from the 1970s and 1980s. As mentioned above agricultural practice, conditions, and the overall landscape and diets of key farmland species, particularly opportunistic feeders, have changed, reflecting the great changes in landscape and as a consequence in food availability. Some recent diet data available is incorporated in this revised version, and the Northern Zone Guidance Document will be updated regularly as new valid PD data will be considered, for example in accordance with the upcoming revised EFSA guidance document. The PD data derived in this way (see chapter 6 below) are to be considered in both tier 1 and higher tier risk assessments, similarly.

## Residue per Unit Dose (RUD)

During preparation of the proposal for the current EFSA Guidance Document (EFSA 2009) the food categories and RUD values in SANCO/4145/2000 were revised, based mainly on new or updated databases provided by Baril et al. (2005), ECPA and FERA. The food categories and RUD values, which are included in the EFSA (2009) and which shall also be used as the basis for higher tier risk assessment in the Northern Zone, are shown in Table 4.1. After revision of EFSA (2009) the updated RUD values (if appropriate for the Northern Zone) will be changed accordingly in the Northern Zone Guidance document version 2.1.

Table 4.1 *Food categories and Residue per Unit Dose (RUD) values according to the Guidance Document on Risk Assessment for Birds and Mammals, Appendix F (EFSA 2009) – for completeness diet fractions, which are not part of Northern Zone animals diet are included.*

|  |  |  |
| --- | --- | --- |
| **Food category** | **90th percentile**  mg/kg fresh weight | **Mean**  mg/kg fresh weight |
| Grass and cereals (BBCH 10-30) | 102.3 | 54.2 |
| Non-grass weeds 1) | 70.3 | 28.7 |
| Cereal grain/ear 2) | 13.0 | 15.0 3) |
| Seeds | 87.0 | 40.2 |
| Large fruits from orchards (e.g. apple, pear) | 41.1 | 19.5 |
| Small fruits from orchards (e.g. plum, cherry) | 6.5 | 3.3 |
| Berries | 16.7 | 8.3 |
| Tomatoes | 30.6 | 12.8 |
| Gourds | 61.5 | 34.3 |
| Foliar arthropods | 54.1 | 21.0 |
| Ground-dwelling arthropods (without interception) 4) | 13.8 | 7.5 |
| Ground-dwelling arthropods (with interception) 5) | 9.7 | 3.5 |

1)  It is assumed that these RUD values may also be used for leafy crops.

2)  Only includes cereal grain/ear exposed on the plant. Cereal grain exposed on the ground are assumed to have the same RUD as other seeds – therefore these values cannot be used for seeds in diet of omnivore or granivore species in the Northern Zone

3)  The mean exceeds the 90th percentile because of a few, very high values. The median (50th percentile) is 8. It is recommended that the median value is used in the calculations of DDD.

4)  Applications to field crops (BBCH 00-39) and ground directed applications in orchards, vineyards etc.

5)  Applications to field crops (BBCH ≥ 40) and applications to crop canopies in orchards, vineyards etc.

Based upon data from ECPA and FERA, residues in ground-dwelling arthropods have been estimated separately for application scenarios with and without interception in the crop (cf. footnote to Table 4.1). Alternatively, specific interception factors may be applied to the “no interception” RUDs (cf. section 4.4).

The PPR Panel emphasizes that a large number of studies have been used to generate the generic RUD values in Table 4.1. Especially the values for grass and cereals and non-grass herbs are derived from many GLP studies. EFSA (2009) states that any additional residue study would tend to rather broaden the existing database than to replace a RUD derived from it. However, particular RUD values for arthropods are based on low numbers of studies. In addition, all the RUD (and DT50) defaults are biased towards specific crops (mainly cereals) and pesticide types (i.e. herbicide, fungicide, insecticide) and their specifics are not equally distributed within the samples, resulting in smaller sub-sample sizes for specific diets and pesticide types. Based on Lahr et al. (2018) and ECPA data (e.g. Hahne et al. 2019), EFSA will revise the current RUDs summarized in Table 4.1 as part of the revision. The resulting values then also will be valid for the Northern Zone, if appropriate for zonal conditions.

EFSA (2009) recognizes that the RUD estimate for seeds, which is unchanged from SANCO/4145/ 2000, is unsatisfactory. Based on these on the one hand robust, but otherwise less certain RUD and half-life (DT50) defaults, residue refinement (RUD, but particularly DT50) based on wildlife relevant compound-specific residue decline studies to determine compound- and diet-specific higher tier data, can be submitted particularly for arthropods (ground and foliar) and seeds (see section 4.4).

However, such higher tier studies need to be relevant for the Northern Zone, and should follow recommendations given for arthropod residue decline study design in EFSA (2009), Appendix N.

Residues in earthworms and other soil invertebrates, which occur in the diet of species such as common shrew and wood mouse, are not included in the standard tables. The residues in earthworms and other organisms that spend most or all of their time buried in the soil are usually negligible but may be computed from the following equation:

PECworm = PECsoil × (0.84 + 0.01 × Pow) / (0.02 × Koc), where

PECsoil (Predicted Environmental Concentration) is calculated as a time-weighted average after the last application, using an averaging period equal to the interval between applications (or 21 d for single application)

Pow is selected from the List of Endpoints (Pow = 10log Pow)

Koc is selected as the geomean Koc value from the List of Endpoints (same value as used for FOCUS groundwater modelling).

Alternatively, the pore water approach may be used (see section 5.6 in EFSA 2009).

Estimation of residues in earthworms would be relevant mainly for potentially bioaccumulating substances with high predicted concentrations in soil (log Pow > 3).

## Recommendation for residue decline refinements (DT50)

Additional information provided by applicants on substance- and use-specific residue decline data may be used to refine the residues for relevant food categories in higher-tier assessment. In principle there are two sources to refine residue data: a) substance- and use-specific residue decline studies (chapter 4.4.1) or b) MRL trials available for plant material and/or fruits (chapter 4.4.2). The former are preferred, the latter are only available for crop plant material (i.e. monocot, dicot and fruits), and rather useful for RUD definition, because MRL trial DT50 refinement is often based on poor data with few samplings after application (i.e. only low numbers of data points on residue decline over time are available).

In any case, residue studies used for refinements of the default DT50 of 10 days must be considered representative for the Northern Zone conditions and should be conducted according to guidance given in EFSA (2009, and Appendix N therein). The following parameters have to be declared and related to Northern Zone conditions and the respective GAP:

* experimental design;
* climatic factors (e.g. temperature, rain and/or irrigation related to application[[3]](#footnote-4));
* application time relevant growth stages;
* the crop group of concern for arthropod residues
* other parameters relevant for the validity of the study.

Furthermore, first samples need to be taken as soon as possible after application or at the day of application, and sufficient samples over time are needed to apply appropriate kinetics for DT50 calculations (see table below for details)

In addition, to cover for between-site variations of degradation times of residues in diet fractions data must be available from at least four different sites. It is agreed that concentration dependency should not be taken account of in degradation studies (cf. EFSA 2019).

### Substance- and use-specific residue decline studies

For refinement of residue decline in higher tier risk assessment, higher tier residue decline studies for wildlife diet fractions following study design recommendations given for arthropods in EFSA 2009, Appendix N (applicable to all wildlife diet fractions) are preferred.

These studies, in contrast to MRL trials, focus on use in wildlife risk assessments (i.e. covering parameters required and being more specific than MRL trials). If wildlife relevant residue decline studies according to EFSA 2009 (Appendix N) are available, the number of studies per diet fraction to derive a compound-specific DT50 and instructions on use in the risk assessment should follow the requirements given in EFSA (2019; see also Southern Zone work sharing document, Southern Zone MS 2017, page 86 therein). If relevant crop- and growth stage-specific results are available from 4-9 sites, the longest DT50 value (worst-case) should be used in the risk assessment. If 10 or more relevant DT50 values are available, the geometric mean DT50 value can be used.

Table 4.2 *Summary of higher tier residue decline data on wildlife diet fractions (available and submitted by notifyers), and needs and standards for application in ERA*

| **Parameter** | **Wildlife diet fraction residue decline studies following EFSA 2009, Appendix N 1** |
| --- | --- |
|  |
| **First sampling** | At the day of application |
| **Application timing** | Need to be within the month(s) of intended appliactaion |
| **Number of sites 2** | ≥ 4 |
| **Minimum samplings per study** | ≥ 9  (e.g. -1, 0, 1, 2, 3, 5, 7, 10, 14 days after application, depending on diet fraction and active substance degradation) |
| **Sampling matrix** | The specific wildlife diet to investigate (plant matter, fruits, seeds, arthropods etc.) |
| **Kinetic** | SFO, best fitting kinetic (see EFSA 2019) or AUC can be applied due to better data quality |
| **DT50 for use in higher tier RA** | Default DT50 (=10 d), if number of sites < 4  Max. DT50 (worst-case), if number of sites ≥ 4-9  Geometric mean DT50, in number of sites ≥10 |
| **Extrapolation** | Never extrapolate between mono- and dicotyledonous plants or different diet fractions (e.g. from seeds to green parts) |

**1 –** data from MRL trials are available and is often used for wildlife ERAs, whereas wildlife relevant residue decline studies following EFSA (2009, Appendix N) for all diet fraction taken by birds and mammals (not only plants) are of higher quality and preferred to refine default decline. Please note, that after revision of EFSA (2009) and possibly new and e.g. PPP class-specific DT50 defaults the NZ guidance will be updated accordingly.

**2** – Sites are geographical locations characterised by unique geo-climatic conditions. As a rule of thumb, two independent sites should be separated by approx. 100 km, but in the case of diverse landscapes and topography, smaller geographical distances can still be appropriate (see EFSA 2019 for details).

If residue decline studies are accepted to refine the DT50 in the risk assessment, the MAF × TWA factor must be calculated using Appendix H of EFSA 2009 (moving time window). This approach is used in the calculator tool.

If a toxicological study for deriving the endpoint for TER calculations demonstrates that an exposure time for onset of toxic effect is shorter than 21 days (e.g. based on developmental tox studies) this shorter TWA-period should be used to stay conservative.

### Use of MRL-trials to refine residue decline

For fruit and foliage diet (monocot and dicot plants), MRL trials (based on OECD 2009, and currently following EFSA 2017) are often available and might be used for refinement of RUD or DT50 *when* specific decline studies are not available. However, in MRL trials, DT50 refinement is often based on poor data with few samplings after application (i.e. only low numbers of data points on residue decline over time are available). A minimum of four time points after application is mandatory (cf. EFSA 2019). If less than nine samplings after application are available a sufficient number of study sites (at least 10) should guarantee robustness of data. For herbicides, also information on wilting rate may be useful for the estimation of possible exposure to herbivorous animals. Due to the uncertainties regarding the relevance of such data under field conditions, a significant margin of safety must, however, be demonstrated in the risk assessment.

### Evaluation of appropriate DT50 kinetic for MAF × TWA calculations

In the current MAF and TWA calculation model, residue decline follows the Single First Order (SFO) kinetics (see EFSA 2009). In the context of a higher tier assessment, residue decline data may be generated in order to incorporate realistic and conservative decline estimates of an active substance. However, due to the influence of biotic and abiotic factors, it is common that the residue decline observed in such field studies does not always follow SFO kinetics and hence cannot be used in current Multi-Application Factor (MAF) and Time-Weighted Average (TWA) models. Therefore, the best fit kinetic for the DT50 decline should be determined according to FOCUS (2014) and be integrated in the MAF × TWA moving time window approach. A minimum of five time points always should be available for fitting of kinetics. However, in some exceptional cases four points may be enough (e.g. fast dissipation of the active substance or metabolites with slow formation) but there should never be fewer than four time points (cf. EFSA 2019).

The rules for applying kinetic fits should follow recommendations of EFSA (2019) or the default values provided by EFSA (2009) should be taken.

## Interception

The residue unit doses (RUDs) for vegetation, as described in section 4.3, are derived from trials in which the plants are directly oversprayed. However, there will often be situations where particular food items for birds and mammals have lower concentrations due to the compound being partly intercepted by the crop before it reaches the food item. It may therefore be appropriate to include an interception factor (or rather its complement, a deposition factor) in the estimation of residues and the Daily Dietary Dose.

Interception by the crop shall be considered as a minimizing factor for residues on food items exposed on or near the ground when canopy-directed applications of insecticides and fungicides to orchards, vineyards etc. are performed and undergrowth vegetation (assumed to be mainly grass) is present. Conversely, no interception factor shall be applied for herbicide applications in those crops, since these are typically made directly to the undergrowth vegetation.

In field crops, the crop itself may be assumed to receive the full application rate. However, other plants will usually also be available as food. At certain stages, the crop intercepts some of the applied product and hence the amount of pesticide deposited on food items below the crop will be less than the application rate. Since measured residues of such food items at the appropriate growth stage of the crop are not available in detail, only estimates can be used. Estimates of the deposition on the soil surface below crops of different structure and growth stages are available in the FOCUS reports (FOCUS 2001, 2014). However, deposition on 3-dimensional structures (e.g. weeds) above the ground is probably different from the deposition on the 2-dimensional soil surface.

According to EFSA (2009), estimation of residues on undergrowth vegetation using FOCUS interception factors becomes increasingly uncertain with decreasing soil cover of the crop and increasing height of weeds. Thus, reliable predictions are only deemed possible where the largest part of the soil surface is actually covered by the crop and the undergrowth vegetation is clearly smaller than the crop plants.

Based on this assessment, EFSA (2009) concludes that the crop interception values used in the FOCUS surface water report (FOCUS 2001) for Step 2 PECSW calculations can be considered acceptable also in the context of bird and mammal risk assessment, provided that the growth stage is sufficiently advanced. These figures are likely to be conservative estimates and are thus mainly suitable for tier 1 assessments. In the context of a higher tier assessment, the more detailed values of the FOCUS groundwater report (FOCUS 2014) may also be used.

In higher tier risk assessment for birds and mammals within the Northern Zone, the interception values in Table 4.3 and Table 4.4 shall be used in higher tier risk assessments.

Table 4.3. *Interception (percent) at different combinations of crop and growth stage according to FOCUS groundwater.* Source: FOCUS 2014 *– for completeness crops, which are not cultivated in the Northern Zone were not removed.*

| **Crop** | **BBCH** (indicative value) | | | | |
| --- | --- | --- | --- | --- | --- |
|  | **0-9** | **10-19** | **20-39** | **40-89** | **90-99** |
| Beans | 0 | 25 | 40 | 70 | 80 |
| Cabbage | 0 | 25 | 40 | 70 | 90 |
| Carrots | 0 | 25 | 60 | 80 | 80 |
| Cotton | 0 | 30 | 60 | 75 | 90 |
| Grass\* | 0 | 40 | 60 | 90 | 90 |
| Linseed | 0 | 30 | 60 | 70 | 90 |
| Maize | 0 | 25 | 50 | 75 | 90 |
| Oilseed rape (summer) | 0 | 40 | 80 | 80 | 90 |
| Oilseed rape (winter) | 0 | 40 | 80 | 80 | 90 |
| Onions | 0 | 10 | 25 | 40 | 60 |
| Peas | 0 | 35 | 55 | 85 | 85 |
| Potatoes | 0 | 15 | 60 | 85 | 50 |
| Soybean | 0 | 35 | 55 | 85 | 65 |
| Spring cereals | 0 | 0 | 20 (20-29)\*\*  80 (30-39)\*\* | 90 (40-69)  80 (70-89) | 80 |
| Strawberries | 0 | 30 | 50 | 60 | 60 |
| Sugar beets | 0 | 20 | 70 (rosette) | 90 | 90 |
| Sunflower | 0 | 20 | 50 | 75 | 90 |
| Tobacco | 0 | 50 | 70 | 90 | 90 |
| Tomatoes | 0 | 50 | 70 | 80 | 50 |
| Winter cereals | 0 | 0 | 20 (20-29)\*\*  80 (30-39)\*\* | 90 | 80 |

\* An interception value of 90% may be used for applications to established turf.

\*\* BBCH code of 20-29 for tillering and 30-39 for elongation.

Table 4.4. *Interception (percent) by fruit trees (apples), bush berries and vines at different growth stages according to FOCUS groundwater.* Source: FOCUS *2014 for completeness, crops which are not cultivated in the Northern Zone were not removed.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Crop** |  |  | **Stage**  Interception (%) |  |  |
| **Apples** | BBCH 0-9\* | BBCH 10-69\* | | BBCH 71–75\* | BBCH 76–89\* |
| Without leaves | Flowering | | Early fruit development | Full canopy |
|  | 50 | 60 | | 65 | 65 |
| **Bush berries** | BBCH 0-9\* | BBCH 10-69\* |  |  | BBCH 71-89\* |
| Without leaves |  | Flowering |  | Full foliage |
|  | 40 |  | 60 |  | 75 |
| **Citrus** | All stages: 80 | | | | |
| **Vines** | BBCH 0-9\* | BBCH 11-13\* | BBCH 14-19\* | BBCH 53-69\* | BBCH 71-89\* |
| Without leaves | First leaves | Leaf developm. | Flowering | Ripening |
|  | 40 | 50 | 60 | 60 | 75 |

\* The BBCH code is only indicative.

It should be noticed that the FOCUS groundwater values are intended to be realistic (as opposed to conservative) estimates of the amount of pesticide that actually reaches the soil surface. Using these values may therefore lead to a (probably slight) underestimation of residues in weeds and other bird and mammal food items below the crop plants.

## Use of PT data

In the EFSA Guidance Document, PT is defined as “the proportion of an animal’s daily diet obtained in habitat treated with pesticide”. As a worst-case assumption, animals are supposed to find all of their food in the treated area (PT = 1). In higher tier risk assessment, more realistic estimates of PT may be used (EFSA 2009).

According to decisions at the workshop in Copenhagen 8-9 May 2012, PT = 1 shall be used for assessment of acute risk. In the assessment of long-term (reproductive) effects more realistic estimates of PT may be used, if such estimates are available for the species and crop scenario in question. Because PT data are generally sparse, some read-across between structurally similar crops is acceptable. All cases of read-across between crops must be duly justified.

PT is the **proportion of an animal’s daily diet obtained in habitat treated with pesticide**, and according to EFSA (2009), it is assumed that this is equal to the proportion of time an animal spends (being active) in treated habitat per day. Furthermore, EFSA (2009) assumes that food obtained on treated fields follows the same dietary composition as measured for the general population in all habitats. Therefore, PT (i.e. animal’s daily diet obtained in treated habitat) can be estimated indirectly by radio-tracking of individuals, and EFSA (2009) set the following requirements for PT field studies:

* Continous telemetry for one full 24h activity period of the species (per single PT session)
* Landscape is representative for the crop of concern
* Time of year is representative for the intended application of the respective chemical application
* Definition of clear locations (in- or off-crop) of the tracked individual is needed
* Definition of being active (i.e. potentially foraging) or inactive of the tracked individual is needed

At the workshop in Copenhagen 8-9 May 2012 it was agreed to follow the EFSA recommen­dations concerning the use of PT estimates. It was further agreed to use the 90th percentile of PT distributions for the core risk assessment (Northern Zone registration report).

Publically available radio-tracking studies (Crocker et al. 1998, Finch et al. 2006, Prosser 2010) do not comply entirely to these requirements for all tracked animals. They neither represent continously tracked animals covering a full activity period within 24 h in all cases, nor do they consist of animals exclusively caught in (or in close proximity to) the crop of concern, but rather in general farmland only. Therefore, by estimating PT the whole sample of individuals tracked (“all animals”) or only the subsample of individuals, that actually visited the crop of concern during tracking (i.e. “consumers”) can be considered. The latter more realistically reflect a crop-specific PT for publically available data sources like Finch et al. (2006). In contrast, species- and crop-specific PT field studies in most cases cover animals trapped exclusively in or at the border of the crop of concern. Thus, all tracked animals are ‘potential consumers’ based on study design according to EFSA (2009), even if they do not use the crop of concern during a specific tracking session.

Therefore, and in line with recommendations of EFSA (2009), focal species caught within (or in close proximity to) the target crop, resulting PT values should be estimated from the total sample of individuals tracked – whether they used the crop of concern or not. For focal species reported to be caught in the general farmland, only those individuals proved by radio-tracking to visit the crop of concern (‘consumers only’ as defined by Finch et al. 2006) should be included in the estimation of PT.

Of any PT data source, the 90th percentile of the PT distribution should be used to be protective for 90% of the population[[4]](#footnote-5).

New PT field studies should be species- and crop-specific, cover the time of intended applications (see above), and need to consist of a minimum of 10 different individuals caught within (or in close proximity to) the target crop, tracked continuously over an entire activity period per day and include multiple sessions per tracked individual (i.e. resulting in more tracking sessions than individuals tracked). If this is ensured also non-consumers might be considered for PT estimates if trapped in or in close proximity to the target crop.

If 10 or more PT consumer (according to EFSA 2009) values for species, crop and intended application period are available the 90th percentile of the PT distribution can be used (cf. Wassenberg and Zorn 2012). If less than 10 single PT values are available, the maximum is considered to be representative. If more than one empirical PT value covering a full activity within the intended application period is available for a tracked individual, the mean of this animal should be considered to derive an overall 90th percential PT factor (for ≥10 animals tracked) or maximum PT factor for the higher tier risk assessment (see Table 4.5).

Quantity and quality of available studies and PT values therein (referred in this GD) for refinement of PT should be considered within the environmental risk assessment. Refinement of PT based on observation data, scan sampling or calculation of Jacobs’ Index are not accepted.

Table 4.5. *Summary of higher tier PT data quality and quantity (available and submitted by notifiers), and needs and minimum standard for possibly intended new PT studies*

| **Parameter** | **PT data source** | | |
| --- | --- | --- | --- |
|  | **Public data 1** | **Available industry studies** | **New studies** |
| Continous telemetry | likely not the case | in majority of cases | Need to be considered |
| Duration per session is one daily activity period | likely not the case | in majority of cases | Need to be considered |
| Crop-related | partly the case | yes | Need to be considered |
| Application related | not the case | in majority of cases | Need to be considered |
| Number of individuals | various | various | ≥10 (then 90th % of the PT distribution can be used) |
| Multiple tracking per tagged individual | mainly not the case | various | needed to be considered |
| Application in ERA | Quality and quantity of data should be considered and explained | Quality and quantity of data should be considered and explained | For new studies species, crop, sample, and tracking scheme can be discussed beforehand with MSs |

**1 -** if different from data incorporated in this document and the calculation spreadsheet new data will be updated according to EFSA (2009) after it’s revision.

## Dehusking

Dehusking is a refinement both applicable to treated seeds and to seeds contaminated by spray applications. Both mammals and birds are known to dehusk seeds prior to intake. This behaviour might reduce the exposure depending on the kind of seed and the feeding behaviour. Dehusking is thus sometimes used to refine the risk assessment for both birds and mammals.

Prosser (1999) estimated dehusking behaviour (whether a species dehusk seeds or not and how much of seeds taken) in different (including non-dehusking) species.

To quantify the residue reduction through dehusking (dehusking factor) for wildlife or species-/seed-related risk assessments the following values are necessary:

* Amount of seeds dehusked (of total seeds taken)
* Residues on seeds and seed husk to get data about exposure reduction by dehusking behaviour

EFSA (2009) recommends that dehusking factors are not routinely applied in risk assessment. If dehusking is to be considered in a higher tier risk assessment, except for the wood mouse scenarios specified below, case-specific evidence must be provided that dehusking actually plays a role under field conditions for the focal species in question, and experimental data must be available for the relevant type of seed. In particular, the use of dehusking factors for weed seeds will not be accepted without case-specific experimental evidence. New studies conducted to investigate species and seed type-related dehusking factors should follow recommendations given in the revision of EFSA (2009) and consider requirements mentioned above to gather compound-, seed- and species-specific data. It is highly recommended that new case-specific experimental data or the study design of such approaches should be agreed on in advance with the Northern Zone Member States. The following issues have to be considered in any case:

* + Exposure reduction should be calculated for each seed type and species.
  + Animals should be subjected to a food deprivation before the trial starts.
  + All husk remains and not de-husked seeds need to be recorded.
  + Analytical method is needed to analyse treatment substance most accurately.

It is not known to what extent dehusking is triggered solely by the structure of the seed or to what extent impalability of a seed treatment also plays a role. Also for this reason, particular care should be taken when risk assessment is performed for seed treatments with a high toxicity per single seed.

For birds, a risk assessment for a dehusking species shall always be accompanied by an assessment for a second species that does not dehusk (EFSA 2009).

Brühl et al. (2011) summarized own experiments and reviewed other studies about dehusking behaviour and residue intake reduction by wood mice and found dehusking efficiencies of 60-80% in cereals and c. 99% in sunflower (Table 4.6). Notably dehusking efficiency was higher in barley than in wheat and maize. Dehusking efficiency was approximately the same, no matter if the seed was treated with a fungicide or a generic pigment and no matter whether the mice were starved before the experiment or not.

**Table 4.6** *Seed consumption and exposure reduction through dehusking behaviour of individually caged wood mice. Results are presented separately for seeds treated with red pigment and with fungicide (prothioconazole). N = no. of mice.* Source of original data: Brühl et al. (2011); 10th percentiles were estimated for the present report.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Pigment** | | | |
|  | Wheat  (N = 12) | Barley  (N = 11) | Maize  (N = 12) | Sunflower  (N = 11) |
| Consumed seeds  (g, mean) | 2.672 | 2.585 | 4.917 | 2.390 |
| Exposure reduction (%, mean ± SD) | 58.04 ± 14.55 | 83.95 ± 9.28 | 58.97 ± 13.08 | 98.78 ± 2.03 |
| 10th percentile\* (%) | 38.2 | 71.2 | 41.1 | 96.0 |
|  | **Fungicide** | | | |
|  | Wheat  (N = 13) | Barley  (N = 14) |  |  |
| Consumed seeds  (g, mean) | 1.66 | 1.67 |  |  |
| Exposure reduction (%, mean ± SD) | 61.38 ± 15.12 | 79.47 ± 7.50 |  |  |
| 10th percentile\* (%) | 40.9 | 69.3 |  |  |
|  | **Dehusking Factors for wood Mouse Risk Assessments** | | | |
| Crop | Cereal | | Maize | Sunflower |
| Dehusking factor | 0.62 | | 0.59 | 0.04 |

\* Reduction estimated assuming a normal distribution.

To account for uncertainties, within the Northern Zone the 10th percentiles of the exposure reductions found by Brühl et al. (2011) is considered suitable for higher tier risk assessment of wood mice feeding on cereal grain, maize or sunflower seeds. Assuming a normal distribution, the 10th percentiles have been estimated and are included in Table 4.6.

# Seed Treatment

## Focal species for seed treatment scenarios

Following relevant omnivorous/granivorous focal species are based on summary tables of chapter 7 (i.e. focal species per crop group growth stage BBCH 0-9 *sowing and pre-emergence*). So, in contrast to EFSA (2009; focusing on linnet, woodpigeon, skylark and wood mouse) different species per crop group need to be assessed. If no strictly granivorous species is relevant, seed-eating small omnivorous species are most relevant. After EFSA (2009) revision, focal species might be adapted accordingly.

Tabel 5.1 *Relevant granivorous and omnivorous species for the risk assessment of treated seeds according to Chapter 7 summary tables listing species to be assessed for BBCH growth stage 00-09*

|  |  |  |
| --- | --- | --- |
| **Crop** | **Avian Focal Species** | **Mammal Focal Species** |
| Beets + | Skylark | Wood mouse |
| Cereals +  Spring +  Winter + | Yellowhammer  Skylark  Pink-footed goose \*/ wood pigeon  Bean goose \*\* |
| Grass + | Linnet  Skylark |
| Maize ++ | Woodpigeon |
| Oilseed rape + | Skylark |
| Pulses/Peas ++ | Pink-footed goose \*\* |
| Vegetable + | Skylark |

+) Small seed (according to EFSA (2009)

++) Large seed (according to EFSA 2009)

\*) See section 6.2.2 for information on body weight to be used

\*\*) See section 6.2.1 for information on body weight to be used

## Refinement data

For applicability of dehusking data please see section 4.7. Please note, as worst-case assumption for the acute exposure assessment PD and PT are set to 1 (i.e. diet of 100% treated seeds from drilled fields) is considered. For the long-term exposure, the actual diet composition (PD) can be used in the risk assessment as presented in the species sections. Regarding proportion of diet obtained from treated area (PT) see section 4.6.

Daily exposure of terrestrial vertebrates to seed treatments is estimated according to EFSA (2009), and possible changes during revision of EFSA (2009) will be adapted to this document during the next revision process if appropriate for NZ conditions. Refinement of the nominal application rate (NAR) is not accepted, and storage stability of the active substance on the treated seed should have been tested and demonstrated that there is stability of the substance. Higher tier refinement options given in this document are agreed among the Northern Zone member states and are as such accepted in the core assessment.

**Averaging interval**

The exposure time to residues on seeds depends on the time until germination. For many seeds, the germination time is less than 14 days, and hence, regularly shorter, but can also even exceed 21 days in the Northern Zone. Because of this inconsistency, the averaging interval of 21 days is considered also for seed treatments.

If respective specifications of the upcoming and revised EFSA (2009) guidance considers this as well, the Northern Zone will follow, if Northern Zone conditions are considered.

**Residue decline data (DT50)**

Residue decline data on treated seeds may be included for the higher tier risk assessment and the same requirements as for residue decline data on other diet items and as detailed in section 4.4 should be considered. In order to simulate the field situation for birds and mammals, meaning that animals will feed mostly on seeds from the soil surface, the seeds in wildlife-relevant seed residue decline studies should be sown on top of the soil surface. This is the easy access situation occurring under natural conditions. For the residue analysis, the whole seed should be sampled and analysed, and samples should be collected until germination. The compound-specific DT50 value can be used for estimation of the TWA factor. Please note, a default TWA of 0.53 as for spray application and other wildlife diets can not be used.

## Foraging Area Approach

Beside the classical TER calculation the foraging area approach (FAA) to evaluate the potential risk of seed treatments according to EFSA (2009) can be added. This approach addresses the number of seeds a species needs to feed on per day to reach the LD50/10 for acute and the NOEL/5 for long-term exposure in relation to the availability of treated crop seeds as food item on freshly drilled fields. The area in which the number of seeds is available to reach this endpoint is put into relation to the species capability to collect all seeds from the respective area on a daily basis. This approach for surface exposed seeds fits well to the acute exposure scenario. Regarding the long-term exposure scenario, additional digging after seeds as food source in some species might be considered. Nevertheless, the availability of seeds on the soil surface can conservatively be used for the long-term exposure as well.

Even if there is data about seeds on the surface in relation to seed type, drilling equipment, drilling type, soil type, application time etc. no specific data for the Northern Zone is publically available. However, of data sets for seed availability publically available, the most reliable data is from De Snoo and Luttik (2004) from the Netherlands, which gives number of seeds and the respective percentages of the sowing densities considering seed type, drilling equipment, drilling type, soil type, application time, and location at field. Hence, seed availability can be adopted to given sowing densities according to the actual GAP of the seed treatment product under evaluation.

Further, data on seed availability is published by DEFRA (2009), Lopez-Anitia et al. (2016), Pascual et al. (1999) and Tamis et al. (1994). However, some of these data does not give specific sowing densities and seed availability per area surface can not be set directely in relation to sowing density. Table 5.2 summarizes all available data from public literature.

The availability of seeds on the soil surface depends on sowing technique (Table 5.2). Much less seeds are available if the crop is precision-drilled instead of standard drilled. As mentioned above, the soil type, seedbed preparation and the sowing depth influences the number of seeds on soil surface as well (Pascual et al. 1999, De Snoo and Luttik 2004).

Therefore, current seed- and treatment-specific field data based on representative and drilling techniques, soil types, seedbed preparation and sowing depth will improve the information on nowadays seed availability.

**Table 5.2** *In-field values are taken form Table 2 and headland values were derived from Figure 1 in (\*) De Snoo and Luttik (2004), (\*\*) DEFRA (2009)a), (#) Pascual et al. (1999) and (##) Tamis et al. (1994)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Crop** | **Field area** | **Number of fields** | **Sowing technique** | **Mean percentage seeds of seeds/ha on surface [%] b)** |
| \* | onion | in-field | 5 | precision-drilled | 0.06 |
| headland | 1 | **0.19** |
| \* | sugar beet | in-field | 6 | precision-drilled | 0.17 |
| headland | 0.50 |
| \*\* | sugar beet | in-field | 19 | precision-drilled | 0.16 |
| headland | **1.32** |
| \* | maize | in-field | 6 | precision-drilled | 0.18 |
| headland | 1.38 |
| \*\* | maize | in-field | 20 | precision-drilled | **3.61** |
| headland | 2.68 |
| \* | alfalfa | in-field | 6 | standard-drilled | 0.09 |
| headland | **0.50** |
| \* | flax | in-field | 6 | standard-drilled | 0.33 |
| headland | **1.13** |
| \* | pea | in-field | 7 | standard-drilled | 1.39 |
| headland | 6 | **8.43** |
| \* | spring wheat | in-field | 7 | standard-drilled | 0.52 |
| headland | 6 | **3.14** |
| \* | winter wheat | in-field | 31 | standard-drilled | 5.89 c) |
| headland | 8 | **9.18** |
| \*\* | winter wheat | in-field | 20 | standard-drilled | 0.90 |
| headland | 3.85 |
| # | winter wheat | In field | 31 | standard-drilled | 1.25 |
| headland | 2.63 |
| ## | winter wheat | In field | 6 | standard-drilled | 4.20 |
| headland | 9.09 |
| \*\* | spring barley | in-field | 22 | standard-drilled | 2.44 |
| headland | **5.98** |
| \*\* | winter barley | in-field | 19 | standard-drilled | 1.16 |
| headland | **3.77** |
| \*\* | oilseed rape | in-field | 16 | precision-drilled | 5.81 |
| headland | **10.29** |

1. DEFRA (2009) gives only the range of sowing densities of the observed fields; therefore, the mean sowing density was used to calculate the mean percentage of seeds on the surface.
2. Bold values are worst-case per crop recommended for use in risk assessment
3. Mean percentage from 1993 (4.29 in 17 fields) and 1994 (7.49 from 14 fields)

The worst-case value for seeds available on the soil surface (usually headland area) from Table 5.2 is to be considered in a higher tier risk assessment. This is based on the assumptions that animals prefer to forage in areas with higher food density and they are closer to some sort of cover (field margins, hedges) to retreat to in case of predation.

**Calculation of the foraging area approach (FAA)**

Even if not presenting numbers or threshold values for foraging areas per species or scenario needed to conclude no or low risk EFSA (2009) gives details about how to conduct the FAA as follows

1. Calculate the number of seeds required to reach the LD50/10 and the NOEL/5
2. Check seed availability on soil surface (Table 5.2) and the respective area which needs to be searched to collect this number of seeds
3. Compare this area with the assumed foraging area of the species. The latter needs to be smaller than the area to reach toxicity impacts (i.e. endpoints/trigger values).

As there is no official reference point regarding foraging areas per species, which needs to be searched, and because the area depends on the scenario (acute/for one day or long-term exposure/the area need to be searched by the animal day by day for 21 days), here we give the following values of

> 70 m² for acute

> 35 m² for long-term

exposure of small granivorous and omnivorous species (i.e. passerines & wood mice) as minimum areas necessary to exceed; twice as large areas need to be considered for wood pigeon and geese. However, any FAA calculation and assumptions need to be explained and substantiated with species-specific data about ecology and foraging behaviour. These reference values, based on expert judgment, should in future be underpinned and possibly updated by scientific data.

**Formula search area:**

= search area [m²]

((Endpoint [mg/kg]/Trigger) × bw focal species [kg]) / (NAR [mg/kg] × (TGW [kg] / 1000) × TWA))

(Sowing density [seeds/m²] × (seeds on surface [%] / 100))

**Stepwise procedure:**

First step: **Toxicity value** for focal species under consideration is needed [mg/kg]

* Endpoint/Trigger is LD50/10 for acute or NOAEL/5 for the reproductive risk assessment
* Toxicity related to body weight of the focal species need to be cacluated
* **Endpoint/Trigger [mg/kg] × bw of focal species [kg]**

Second step: **Seed loading** is needed [mg a.s./seed]

* Weight of one seed [g] is needed: TGW (thousand grain weight) [g] / 1000 (see Appendix 5)
* Seed loading [mg a.s./seed] need to be calculated
* **NAR [mg/kg seeds] × one seed weight [g]**
* TWA has to be considered in the reproductive risk assessment, either default value or based on appropriate degradation rates of the active substance if available

Third step: **Number of seeds to reach the endpoints** needs to be calculated:

* **Toxicity value [mg/kg] / Seed loading [mg a.s./seed]**

Fourth step: **Exposure** to treated seeds is needed [seeds/m²]

* Based on sowing density expressed in seeds/m²
* Availability of seeds on soil surface is expressed as percentage of sowing density (taken from Table 5.2.) or needs to be submitted

Fifth step: The ‘area’ in which the number of seeds is available to reach the toxicity value for the species (i.e. all seeds from this area need to be collected on a daily basis is the rationale) needs to be larger than foraging areas proposed above for passerines, wood mice and larger bird species.

**Mixture toxicity of seed treatments**

In the foraging area approach it is not possible to calculate the mixture toxicity according to the guidance document on work-sharing in the northern zone (Version 8.0, June 2019), because no TER values are calculated. However, the mixture toxicity in seed treatments can be addressed with the approach given in EFSA (2009). For the acute assessment, a surrogate LD50 can be calculated or if appropriate, the formulation LD50 can be used. On the exposure side, the use rates of the active substances in the formulation should be summed up and expressed as ‘virtual compound’, or in the case that the formulation endpoint is used, the application rate of the compound is appropriate. Regarding the reproductive risk assessment, the toxicity value of the most toxic active substance should be applied and all active substances should be expressed in terms of the most toxic substance. Details on this mixture toxicity approach for the acute and reproductive risk assessment are outlined in Appendix B of EFSA (2009).

## Seedling scenario

The seedling scenario is relevant for systemic active substances. EFSA (2009) states that the seedling scenario addresses species feeding on the whole seedling (seed + green plant part) or grazing on seedlings (green plant part only). The concentration of active substance is reduced via dilution by growth, which is represented in a NAR/5 for the seedling scenario (EFSA 2009). Hence, exposure of omnivorous species partly feeding on seedlings, which are focal species for the seed risk assessment (cf. Table 5.1 and 5.3) are already covered by the risk assessment for seeds as worst-case. However, the grazing herbivorous/omnivorous species must be included for the seedling scenario.

**Table 5.3** *Relevant species for the seedling risk assessment according to Chapter 7 summary tables listing species to be assessed for early psot emergence BBCH growth stages (cf. Table 5.1)*

|  |  |  |
| --- | --- | --- |
| **Crop** | **Avian Focal Species** | **Mammalian Focal Species** |
| Beet (BBCH 10-19) | Skylark | Brown hare  Wood mouse |
| Cereal  Spring (BBCH 10-29)  Winter (BBCH 10-19) | Bean goose \*  Pink-footed goose \*\*  Skylark / Grey partridge | Brown hare  Wood mouse |
| Grass (short) | Bean goose \*  Pink-footed goose \*\*  Skylark | Brown hare  Wood mouse |
| Maize (BBCH 10-29) | Skylark | Brown hare  Wood mouse |
| Oilseed rape (BBCH 10-19) | Woodpigeon  Skylark | Brown hare  Wood mouse |
| Pulses (BBCH 10-19) | Woodpigeon | Brown hare  Wood mouse |
| Vegetable (BBCH 10-19) | Skylark | Brown hare  Wood mouse |

\*) See section 6.2.1 for information on body weight to be used

\*\*) See section 6.2.2 for information on body weight to be used

Residue and residue decline data in seedlings and ecological data on focal species (e.g. PT) can be applied as for spray applications and seed treatment uses. Since dilution by growth influences concentration of substances in seedlings, residue samples should include a range of BBCH growth stages.

# Selected focal species

## Introductive information on additional ‘crop groups’

Two additional ‘crop groups’ of particular interest in the Northern Zone are included, i.e. **Christmas trees and ‘decorative greenery’** plantations and **forestry** scenarios (including power line cutting and reforestation uses). Both are quite different from traditional field crop or orchard scenarios. Additional species as representatives for specific foraging guilds and strata in these habitats come along with these new exposure scenarios. Since these scenarios are not part of the current EFSA (2009) guidance document, Table 6.1 below provides information on avian and mammalian foraging guilds to be addressed in the tier 1 risk assessment for registration of plant protection products in Christmas trees and ‘decorative greenery’ plantations and for application scenarios in forests. Data for reliable and approved higher tier refinements for most new species with regard to environmental risk assessments (e.g. PT values) are not available. Consequently, use-specific recommendations for refinement (as detailed below) cannot be provided yet for all focal species. Some species are, however, also relevant for other crop uses as detailed in the following species chapters. All species requested for the Christmas trees and decorative greenery uses were already represented by a species chapter or added in this revised document. For additional species to assess for forestry uses, currently no robust higher tier data is available. Refinement is generally permitted for all relevant species, provided that recommendations of this updated Norther Zone GD Document 2.0 are recognised and proposed refinements are supported by convincing and preferably use-specific data. If appropriate for the Northern Zone, useful data of the revised EFSA (2009) guidance document will be added during the next revision of the NZ GD.

**Table 6.1.** *Generic species for tier 1 risk assessment in Christmas tree and decorative greenery plantations and forestry uses*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Generic species** | **Crop use** | **Foraging guild** | **Body weight [g]** | **Diet** |
| Blue tit | Forestry 2) | Canopy insectivore | 11 | 100% foliar insects |
| Bullfinch | Forestry 1) 2) | Frugivore | 27 | 100% fruits |
| Chaffinch | Christmas trees and decorative greenery; Forestry 1) 2) | Insectivore/granivore | 21 | 50% foliar arthropods, 50% seeds |
| Common redstart | Forestry 1) 2) | Ground insectivore | 14.6 | 100% ground insects |
| Common treecreeper | Forestry 1) 2) | Canopy insectivore | 9.5 | 100% foliar insects |
| Goldcrest | Christmas trees and decorative greenery,  Forestry 1) | Canopy insectivore | 5.7 | 100% foliar insects |
| Hawfinch | Forestry 2) | Canopy granivore | 54 | 100% tree seeds |
| Robin | Christmas trees and decorative greenery | Ground insectivore | 16.5 | 100% ground insects |
| Siskin | Christmas trees and decorative greenery,  Forestry1, 2) | Granivore (tree canopy, weeds) | 13.1 | 100% seeds |
| Stock dove | Forestry 2) | Herbivore/granivore | 280 | 50% seeds, 50% weeds |
| Willow warbler | Forestry 2) | Canopy insectivore | 9.5 | 100% foliar insects |
| Wood pigeon | Forestry 1) | Herbivore/granivore | 435 | 50% seeds, 50% weeds |
| Wren | Forestry 1) 2) | Insectivore (ground, weeds, bushes) | 8.9 | 50% ground, 50% foliar insects |
| Common shrew | Christmas trees and decorative greenery, Forestry 1, 2) | Insectivore | 8.1 | 100% ground insects |
| Wood mouse | Christmas trees and decorative greenery, Forestry 1, 2) | Omnivore | 18 | 25% weeds, 50% seeds, 25% ground arthropods |
| Field vole | Christmas trees and decorative greenery, Forestry 1, 2) | Herbivore (small) | 30 | 100% grass |
| Brown hare | Forestry 1, 2) | Herbivore (medium) | 3800 | 100% weeds |

1) Coniferous forest.

2) Deciduous forest.

## Birds

### Bean goose *Anser fabalis* (herbivore)

****

Bean goose (*Anser fabalis*), Photo: C. Dietzen

**Risk assessment**

The bean goose is relevant for the following crop scenarios in Sweden, Finland and the Baltics:

* winter cereals, freshly drilled (BBCH 0-9)
* winter cereals, BBCH 10-29
* spring cereals, freshly drilled (BBCH 0-9)
* spring cereals, BBCH 10-29
* grass, short

A body weight of 1,622 g (see section on body weight below) and a Daily Energy Expenditure (DEE) of 969 kJ/day (from the allometric equation) must be used in risk assessment.

In any case it is assumed that within the treated area, the birds feed entirely on the treated crop or seed (PD = 1).

For birds feeding on freshly drilled seeds, a DEE of 969 kJ/day is equivalent to an intake of 74 g seed/day (fresh weight) [[5]](#footnote-6). However, this is almost certainly an underestimate of the actual intake of birds feeding on freshly-sown spring cereals (cf. the studies for pink-footed goose referred to below). A FIR of 225 g seed/day (fresh weight), as used in the pink-footed goose, will probably also represent the worst-case situation for bean goose.

There is no species-specific information allowing a refinement of PT. PT information from other *Anser* species, e.g. greylag goose *Anser anser*, may in principle be extrapolated to cover bean goose (Å. Berg pers. comm.). However, the available data on greylag goose (Prosser 2010) do not distinguish between active and inactive time and are therefore not considered suitable for risk assessment.

The relevance of reproductive risk assessment may be doubtful as the bean goose does not breed in agricultural areas within the Northern Zone. In any case, reproductive risk assessment will mainly be relevant for applications performed shortly before departure in spring, i.e. in April.

**General information**

The bean goose (subspecies *A. f. fabalis*) breeds in small numbers (few thousand) within the taiga zone of Norway, Sweden and Finland. The main breeding areas are in Russia where it is replaced by the more numerous subspecies *rossicus* within the tundra zone. Main wintering areas (both subspecies) are in Germany and the Netherlands but some 30-40,000 birds (mainly *fabalis*), or c. 10% of the European wintering population, usually winter in Denmark and southern Sweden (BirdLife International 2004). Occurrence in other parts of the Northern Zone is chiefly on passage during spring and autumn (Table 6.2).

Table 6.2 *Population size and trends of bean goose (wintering population) in the Nordic and Baltic countries. ”–”: not present.* Source: BirdLife International 2004.

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Population size**  (midwinter, individuals)\* | **Year(s) of estimate** | **Trend**  (1990-2000) |
| Denmark | 10,000-12,000 | 1999-2000 | Stable |
| Estonia | 0-5 | 1998 | New occurrence |
| Finland | – |  |  |
| Latvia | 0-10 | 1990-2000 | Unknown |
| Lithuania | 1-10 | 1992-2002 | Increase; > 80% |
| Norway | – |  |  |
| Sweden | 15,000-30,000 | 1998-2001 | Increase; < 20% |

\* See text for migrant numbers.

Departure from the breeding grounds is usually in late August to mid-September, with arrival in winter quarters from late September to early October, but passage may occur throughout October (Cramp and Simmons 1977). Numbers in Sweden peak in September-October (Nilsson 2004). Further dispersal towards the southwest may occur during cold spells. In eastern Denmark, most bean geese arrive during December-January, indicating cold flight from Swedish wintering areas. The bean geese depart from the wintering areas from mid-March, with spring numbers in Sweden usually peaking during April (Nilsson 2004). From the beginning of May most birds have left for the breeding grounds.

The number of bean geese staging in Sweden in autumn varies in different years from 40,000 to 80,000 individuals (Nilsson 2004), with a peak in October (Wallin and Millberg 1995). In spring the number of staging birds is much lower (Nilsson and Persson 1984) and the birds also stay for a shorter period of time compared to autumn.

**Agricultural association**

Bean geese use agricultural land for foraging during migration. In a Swedish study, bean geese were found using mainly autumn sown cereals and stubbles in September-October (Axelsson 2004). Stubbles were used mostly in September with a shift towards cereals later in the month (Axelsson 2004). In early autumn (before 10 October), 8% of the geese were found on autumn-sown cereals (Nilsson and Persson 1984), while in late October 60% of the geese in the study area were found on this habitat (Gezelius 1990). In spring (March-April), the bean geese are mainly found in cereal fields. It is reasonable to assume that the crop type used by foraging geese also constitutes the main nutritional intake.

**Body weight**

Body weight (subspecies *fabalis*) ♂ 2,690-4,060 g, ♀ 2,220-3,470 g (Snow and Perrins 1998).

However, the endangered lesser white-fronted goose (*Anser erythropus*) is not covered by the clearly larger bean goose (see Chapter 3). Ecology of *Anser* geese is similar and due to the lack of specific data for endangered lesser white-fronted geese it is recommended to consider the body weight of the lesser white-fronted goose in combination with refinement data (PT) from closely related species (e.g. bean goose) in higher tier risk assessments. The mean body weight of male lesser white-fronted geese is 1,900 g (1,800-2,000 g), of females 1,622 g (1,400-1,843 g; Dunning 2008). The mean value of the smaller sex (♀: 1,622 g) must be used for risk assessment.

**Energy expenditure**

No specific studies of energy demands have been conducted on bean geese, but see below for studies on the closely related pink-footed goose.

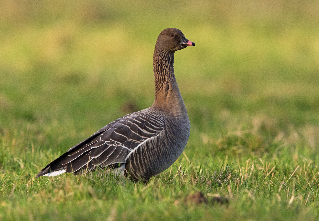
Because no species-specific data are available, daily energy expenditure may be calculated allometrically using the equation for non-passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009). The allometric equation gives an estimate of the energy required for subsistence but does not allow for pre-migratory fattening in spring. Using the allometric equation therefore leads to an underestimation of the energy demand in spring, especially in April (cf. pink-footed goose).

It should be noticed, though, that bean geese wintering in Fennoscandia (including Denmark) mainly breed within the Russian taiga zone; hence their journey towards the breeding grounds is shorter and the possibilities for feeding *en route* and after arrival to the breeding area are probably better than in the pink-footed goose. Therefore, the need for pre-migratory fattening is assumed to be less pronounced in the bean goose.

**Diet**

The feeding during migration and in the winter quarters is performed on arable land and pastures, and especially in late autumn (from mid-October) cereals are predominantly used (Nilsson and Persson 1984; Axelsson 2004). The main diet is various green plant material and, if available, wheat, rape, and peas (Nilsson and Persson 1984; Axelsson 2004). Also feeds on newly sown grain (cf., e.g., Danish/Swedish/German names “seed goose”).

### Pink-footed goose *Anser brachyrhyncus* (herbivore)



Pink-footed goose (*Anser brachyrhynchus*), Photo: J. Gerlach

**Risk assessment**

The pink-footed goose is relevant for the following crop scenarios in Denmark and Norway:

* winter cereals, freshly drilled (BBCH 0-9)
* winter cereals, BBCH 10-29
* spring cereals, freshly drilled (BBCH 0-9)
* spring cereals, BBCH 10-29
* pulses (peas), freshly drilled (BBCH 0-9)
* grass, short

A body weight of 1,622 g (see section on body weight below) and a Daily Energy Expenditure (DEE) of 969 kJ/day (from the allometric equation) must be used in risk assessment.

In any case, it may be assumed that within the treated area, the birds feed entirely on the treated crop or seed (PD = 1).

For birds feeding on plant leaves (cereals BBCH 10-29, short grass) the allometric equation can be used to estimate the DEE and FIR.

For birds feeding on freshly drilled seeds, a DEE of 969 kJ/day is equivalent to an intake of 74 g seed/day (fresh weight) [[6]](#footnote-7). However, this is almost certainly an underestimate of the actual intake of birds feeding on freshly-sown spring cereals, e.g. for birds feeding on freshly drilled seeds in spring, a 2,450 g goose ingesting 225 g seed/day (fresh weight) is assumed to represent the worst-case situation (but see **Body Weight**).

A PT value of 0.79 is assumed for birds feeding on newly-sown fields. There is no particular information on time budgets of birds feeding on plant leaves in late spring, but a PT of 0.79 will probably also be worst-case for these scenarios.

The relevance of reproductive risk assessment may be doubtful as the pink-footed goose does not breed in agricultural areas within the Northern Zone. In any case, reproductive risk assessment will mainly be relevant for applications performed shortly before departure in spring, e.g. in Denmark for applications taking place between mid-April and early May.

**General information**

The pink-footed goose is a fairly common migrant and wintering species in Denmark (mainly in western Jutland where the species is locally abundant) and a fairly common migrant at a few sites in central and northern Norway. It is a rare migrant and winter visitor in Sweden, a rare migrant in Finland, and a rare or very rare visitor in the Baltic countries. In eastern Denmark, Sweden and further east, the pink-footed goose is replaced by the slightly larger bean goose (cf. above), with which it was formerly considered conspecific.

Pink-footed geese breed in Svalbard, Iceland and eastern Greenland, but only birds from the Svalbard population occur regularly within the Northern Zone. The geese arrive to western Norway and Denmark in late September, and by mid-October all of the Svalbard population (c. 50,000 birds) probably stay in Denmark. Previously, most of the population moved further south from mid-October, but during recent decades an increasing part has remained in Denmark in winter, except during cold spells (Table 6.3). During March and the first half of April, the whole Svalbard population is again assembled in Denmark. The departure for the breeding grounds may start in mid-April and the last flocks leave Denmark in early or mid-May. In Norway, 10-20,000 birds stage in the Trondheim Fjord area between late April and mid-May before moving on to staging areas in Lofoten-Vesterålen, where probably the entire population stays at some time during May (although not all birds at the same time) (Fox et al. 1997, Madsen et al. 1997).

Table 6.3. *Population size and trends of pink-footed goose (wintering population) in the Nordic and Baltic countries. ”–”: not present.* Source: BirdLife International 2004.

| **Country** | **Population size**  (midwinter, individuals) | **Year(s) of estimate** | **Trend**  (1990-2000) |
| --- | --- | --- | --- |
| Denmark | 21,000-23,000\* | 1999-2000 | Stable |
| Estonia | – |  |  |
| Finland | – |  |  |
| Latvia | – |  |  |
| Lithuania | – |  |  |
| Norway | – \* |  |  |
| Sweden | 30-80 | 1998-2001 | Increase; < 20% |

\* See text for migrant numbers.

**Agricultural association**

Pink-footed geese usually occur in flocks of more than 100 individuals and often in flocks of several thousands. The geese prefer to feed in large fields and other areas with an open view. They feed in salt marshes, rough and cultivated pastures, stubble fields (sometimes with undersown grass), winter cereal fields and newly-sown cereal and pea fields.

During late winter and spring, the geese use different habitats in sequence. In a Danish study (Madsen et al. 1997), the geese were foraging mainly on grassland from mid-March to early April, followed by stubble and, to a minor degree, winter cereals. From mid-April onwards, stubble fields were ploughed and thus lost their importance as foraging areas. The grasslands likewise decreased in importance as the geese increasingly used newly-sown cereal or pea fields for feeding. To prevent crop damage, alternative food (cereal grain) is now offered to the geese at several sites.

In a local study at Filsø, Denmark (Lorenzen and Madsen 1986), the geese used mainly stubble fields in autumn, stubble with undersown seed grass in autumn and spring, and newly-sown barley fields in spring.

Time and energy budgets of pink-footed geese have been studied in Denmark (see below).

**Body weight**

Body weight ♂ mostly 1,900-3,300 g, ♀ 1,800-3,100 g (Snow and Perrins 1998), but the endangered lesser white-fronted goose (*Anser erythropus*) is not covered by the larger pink-footed goose (see chapter 3). However, as stated above (bean goose chapter) ecology of *Anser* geese is similar and due to the lack of specific data for endangered lesser white-fronted geese it is recommended to consider the body weight of the lesser white-fronted goose in combination with refinement data (PT) from closely related species in higher tier risk assessments. The mean body weight of male lesser white-fronted geese is 1,900 g (1,800-2,000 g), of females 1,622 g (1,400-1,843 g; Dunning 2008). The mean value of the smaller sex (♀: 1,622 g) must be used for risk assessment.

**Energy expenditure**

The energy expenditure may be calculated allometrically using the equation for non-passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009); this gives a Daily Energy Expenditure (DEE) 969 kJ/day for a 1,622 g goose (see body weight). However, the information below should also be taken into account, and the maximum value of 2,824 kJ/day to be considered in the risk assessment for spring uses.

During spring, the geese gain weight, partly in preparation for the long-distance migration to their arctic breeding grounds, and partly because the females require sufficient energy and nutrient reserves to produce eggs as food is very scarce at their arrival in Svalbard. Thus, the birds, and especially the females, experience an increased energy and nutrient demand during their stay in Denmark in spring (Madsen et al. 1997). To meet these requirements, the geese forage on the new growth of grass on pastures and salt marshes and gradually shift to newly-sown fields as these become available. The preference for newly-sown fields compared to pastures can be explained by the more efficient daily energy intake rate there (Madsen 1985).

The daily net energy intake of a 2.5 kg goose has been estimated at 1,267 kJ/day for a bird feeding on grassland and at 2,824 kJ/day for a bird feeding on newly-sown spring barley fields; these figures are said to be equivalent to a daily consumption of 793 g (fresh weight) of grass leaves or 225 g (fresh weight) of barley grain, respectively (Madsen 1985).

In another study (Madsen et al. 1997), the daily energy intake in late April was estimated at 1,834-2,011 kJ/day for birds feeding on grassland and newly-sown fields. In early May, the corresponding figure was 2,238 kJ/day for birds feeding on newly-sown cereal fields, grasses, and cereal grain offered as bait.

**Diet**

Pink-footed geese feed exclusively on vegetable material, including parts of plants from both above and below ground. In the winter quarters, the geese feed mainly on farmland, including grassland, but the exact composition of diet differs according to local and seasonal variations in crop-plant availability and nutritional demand.

On pastures, the geese eat leaves of common agricultural grasses and leaves and stolons of clover and other herbs. In the Netherlands, wintering geese (of different species) prefer feeding on improved grassland with short vegetation of grasses and dicotyledons. Pink-footed geese may also feed on roots and tubers (e.g. carrots, potatoes) as well as on leaves of oilseed rape.

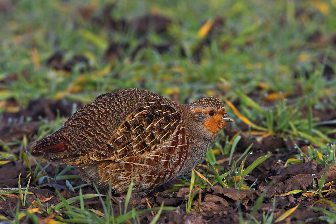
When feeding on newly-sown cereal fields in spring, the geese primarily take the ungerminated grain on the surface and in the upper 2-3 cm of the soil (Madsen et al. 1997). In some areas, the geese abandon a site when the grain is sprouting, but in other areas it is reported that the geese also take the sprouting grain but clip off the stem before ingesting the seed (Madsen et al. 1997).

A daily intake of 2,238 kJ (cf. above) is equivalent to the consumption of 172 g of grain (fresh weight)[[7]](#footnote-8). However, the daily consumption of grain may be even higher as direct observations of geese indicate that they may consume between 179 and 291 g of newly-sown grain per day. The latter figures are probably slightly too high, however, as they are based on the assumption that each observed peck represents the ingestion of a grain (Madsen et al. 1997).

Time and energy budgets have been studied in NW Jutland in the second half of April. In the morning, the geese start to feed on newly-sown cereal fields and forage intensively here for 2-3 hours. They then move to grassland (either salt marsh or cultivated pasture) and stay there during most of the day, feeding less intensively and spending most of their time roosting. On half of the observation days, the geese returned to the newly-sown fields in the evening, to feed intensively for c. 2 hours before flying to the roost. The geese spent 27-48% of the feeding day length in the newly-sown fields, but due to higher feeding intensity and much higher profitability of the grain compared to grass, the geese gained 53-79% of their daily energy intake from the newly-sown fields (Madsen et al. 1997).

In areas where cereal grain is offered as bait this can profoundly change the daily rhythm, time and energy budget of the geese.

### Grey partridge *Perdix perdix* (omnivore)

****

Grey partridge (*Perdix perdix*), Photo: M. Schäf

**Risk assessment**

The grey partridge is relevant for the following crop scenario:

* winter cereals, applications in autumn and winter (BBCH 10-19)

A body weight of 380 g must be used in risk assessment (see section on body weight below).

The grey partridge would also be relevant for other crop scenarios and seasons, but in those cases other omnivorous bird species, first of all the smaller skylark, represent the worst case.

For this particular scenario, the diet composition in Table 6.4 may be used in case refinement of PD is needed.

Table 6.4. *Estimated diet composition of grey partridges in cereal fields in late autumn and winter (expert judgement based upon Table 6.6. and Steenfeldt et al. 1991).*

|  |  |
| --- | --- |
| **Food category** | **PD (fresh weight)\*** |
| Grasses and cereals (BBCH 10-30) | 0.60 |
| Non-grass weeds | 0.26 |
| Cereal grain on ground | 0.06 |
| Small seeds | 0.08 |

\* In the original study (Steenfeldt et al. 1991), diet composition is presented as “% of fragment area”. It may be assumed that this roughly corresponds to percent of fresh weight because the material was soaked in water before analysis.

As 97% of all fixes in a radio-tracking study were from cereal fields, PT shall not be refined unless fully justified by case-specific data.

**General information**

The grey partridge is a widespread and fairly common species in Denmark and Lithuania. It also occurs, although more scarcely, in Latvia and Estonia and in farmland areas of southern and central Sweden (incl. islands of Gotland and Öland) and Finland (Table 6.5). Almost everywhere, numbers have declined strongly in recent decades; e.g. in Denmark an average decline of 3.2% per year was estimated for the period 1976–2011 (Heldbjerg and Lerche-Jørgensen 2012). In many areas the natural population is reinforced by releases for hunting purposes; in Denmark between 20,000 and 70,000 birds are released annually (Kahlert et al. 2008).

Table 6.5. *Population size and trends of grey partridge (breeding population) in the Nordic and Baltic countries. ”–”: not present.* Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Tiainen et al. (2010), Ottosson et al. (2012).

| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| --- | --- | --- | --- | --- |
| Denmark | 10,000-15,000 | 2000 | Decline; 20-49% | Decline; c. 50% |
| Estonia | 4,000-7,000 | 1998 | Decline; 20-49% | Fluctuating |
| Finland | > 10,000 | 2010 | Decline; c. 90% | Fluctuating\*\* |
| Latvia | 500-5,000 | 1990-2000 | Decline; ≥ 50% | Decline; < 20% |
| Lithuania | 10,000-20,000 | 1999-2001 | Decline; 20-49% | Decline; 20-29% |
| Norway | – \* |  | Extinct | – |
| Sweden | 14,000 | 2008 | Decline; 20-49% | Decline; 10-19% |

\* Re-introduction has been attempted.

\*\* C. 50% increase 1990 – 2010.

Partridges are sedentary birds that gather in small flocks of up to 20-30 birds in winter. Flocks break up in early spring (March to early April) as the territories are established. Breeding is usually in May-June, but re-layings may extend the season into August (Snow and Perrins 1998). Single-brooded; clutch size is usually 10-20, occasionally larger, making quick recovery of populations possible after cold winters.

**Agricultural association**

Partridges are strongly associated with farmland, especially of the “old-fashioned” type with small fields surrounded by stripes of rough vegetation and hedgerows. The species occupies cereals and other arable crops as well as grassland. If present, early successional stages of set-aside (including game stripes) are probably favoured (Kahlert et al. 2008). Crop preferences do not seem strong as different studies have given different results.

In an English study of radio-tagged birds (Green 1984), 97% of all fixes were from cereal fields and 40% of fixes were from within 25 m of the field boundary. Unsprayed headlands are preferred (Rands 1986).

**Body weight**

Body weight of ♂ mostly 350-450 g, ♀ 340-420 g (Snow and Perrins 1998). Mean body weight of the smaller sex (♀: 380 g) to be used for risk assessment.

**Energy expenditure**

Estimates of daily energy intake in winter for wild birds range between 300 kJ/day at an ambient temperature of +15 °C to 650 kJ/day at −15 °C (Christensen et al. 1996). The energy expenditure can also be calculated allometrically using the equation for non-passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet consists chiefly of vegetable matter. Green plant parts are probably staple food of adults throughout the year, but there is a marked annual cycle in the relative importance of food items, partly associated with farming practice. During winter and spring, the diet consists mainly of leaves of cereal crops, grasses and dicotyledonous weeds. In late spring, summer and autumn, seeds are often a major component of the diet and waste grain may dominate for some time after harvest. Insects may also be important in late spring and summer and are the main food of the chicks. In Finland, grey partridges foraged almost exclusively on plant matter (28% cereal seeds) outside the breeding season (Holland et al. 2006). Also in Finland, a study by Pulliainen (1984) found in autumn (Oct. 1979-81) in the stomachs of killed grey partridges 42.7% (dry weight) barley, 28.1% oats, 17.6% seeds of *Galeopsis* spp., 5.9% weed seeds (mainly *Spergula arvensis* and *Polygonum convolvulus*), 4.3% leaves, 1.2% animal matter and 0.3% grit.

Steenfeldt et al. (1991) studied the diet composition of partridges in Danish farmland during two years. A total of 2,112 faeces samples were collected from different crops. The results are expressed as percent of fragment area (roughly equivalent to volume-%). The results indicate that the diet composition is highly variable between crops and seasons (Table 6.6.).

Table 6.6. *Grey partridge diet in farmland, analysed from faecal samples* (Steenfeldt et al. 1991)*1.*

| **Time of year** | **Food type** | **% of diet fragment area** |
| --- | --- | --- |
| **Autumn** | Green plant material | 52-73 |
| **(Aug.-Nov.)** | Seeds/grain | 23-47 |
|  | Insects | 0-3 |
|  | Flowerbuds/roots | – |
| **Winter** | Green plant material | 16-99 |
| **(Dec.-Feb.)** | Seeds/grain | 1-83 |
|  | Insects | – |
|  | Flowerbuds/roots | 0-3 |
| **Early spring** | Green plant material | 51-99 |
| **(Mar.-Apr.)** | Seeds/grain | 1-49 |
|  | Insects | – |
|  | Flowerbuds/roots | – |
| **Late spring** | Green plant material | 11-90 |
| **(May-June)** | Seeds/grain | 10-84 |
|  | Insects | 0-25 |
|  | Flowerbuds/roots | 0-4 |
| **Summer** | Green plant material | 19-98 |
| **(June-July)** | Seeds/grain | 2-74 |
|  | Insects | 0-20 |
|  | Flowerbuds/roots | 0-32 |

1 Approximate percentages calculated from figures 1 and 2 in Steenfeldt et al. (1991). Range shows variation between crop types.

Other studies have shown greater importance of waste grain in autumn (October); from 60-71% of dry weight of crop contents in Finland (Pulliainen 1984) to 94% of dry weight in England (Potts 1970).

Insects are an important component of chick diet and contribute more than 50% (by volume) of the diet in the first few weeks of life. In chicks foraging in cereal fields, the proportion of plant material in diet increases rapidly with age from about 20% (dry weight) at age 1-5 days to approx. 80% at age 20-25 days (Christensen et al. 1996). Beetles are usually the dominant insect food items, with Chrysomelidae, Curculionidae, Carabidae and Nitidulidae being most important.

The chicks apparantly feed opportunistically. In a Danish study (Rasmussen et al. 1992), the proportion (by volume) of insects in the diet of small chicks varied from 3% in birds feeding in hedgerows to 69% in birds feeding in beet fields. Seeds and cereal grain made up between 4% in spring-sown rape fields and 86% in field boundaries. The volume of green plant parts in chick diet ranged from 11% in field boundaries to 88% in rape fields.

Potts (1970) collated data from studies of chick diet in the UK (Table 6.7.). The results are presented as percent of food items; please notice that small items such as aphids and ants are less important in terms of biomass.

Table 6.7. *Grey partridge chick diet in cereal fields and grassland, analysed by dissection of crops (Potts 1970).*

|  |  |  |
| --- | --- | --- |
| **Habitat** | **Food type** | **% of food items** |
| **Cereal fields** | Plant material | 47 |
|  | Aphids | 25 |
|  | Other invertebrates | 28 |
| **Grassland** | Plant material | 14 |
|  | Ants | 31 |
|  | Aphids | 9 |
|  | Other invertebrates | 44 |

### Woodpigeon *Columba palumbus* (omnivore)

**Risk assessment**

The woodpigeon is relevant for the following crop scenarios:

* winter cereals, freshly drilled
* maize, freshly drilled
* winter rape, BBCH 10-19
* spring rape, BBCH 10-19
* pulses (peas), BBCH 10-19
* pulses (peas), BBCH 80-99
* forestry (broad-leaf), young/clear-cut, all season
* forestry (conifer), young/mature/clear-cut, all season

A body weight of 435 g must be used in risk assessment (see section on body weight below).



Wood pigeon (*Columba palumbus*), Photo: M. Grimm

Woodpigeons are highly mobile and may cover large areas of land in their search for food (Prosser 2010). Therefore the available data on diet composition (Table 6.12., Table 6.13.) do not reflect foraging in any particular crop. To deal with this, the published diets were used as a starting point, whereupon the food items not available (or less available) in the crop in question were deleted (or their share was reduced) and the relative shares of the other components of diet were increased proportionally. In this process, the generic “pigeon” diets in EFSA 2009 were also taken into account.

It is proposed that the diets specified below (Table 6.8.) are used in higher tier risk assessment for sprayed compounds.

**Table 6.8.** *Estimated diet composition of woodpigeons feeding in different crops (expert judgement based upon Table 6.12.*.*, Table 6.13.* *and EFSA 2009).*

|  |  |
| --- | --- |
| **Winter cereals, freshly drilled** | |
| **Food category** | **PD (fresh weight)** |
| Large seeds | 0.97 |
| Small seeds | 0.02 |
| Ground arthropods | 0.01 |
| **Maize, freshly drilled** | |
| **Food category** | **PD (fresh weight)** |
| Non-grass weeds and leafy crops | 0.05 |
| Large seeds | 0.92 |
| Small seeds | 0.03 |
| **Winter rape, BBCH 10-29** | |
| **Food category** | **PD (fresh weight)** |
| Non-grass weeds and leafy crops | 0.80 |
| Large seeds | 0.10 |
| Small seeds | 0.10 |
| **Spring rape, BBCH 10-29** | |
| **Food category** | **PD (fresh weight)** |
| Non-grass weeds and leafy crops | 0.80 |
| Large seeds | 0.05 |
| Small seeds | 0.14 |
| Ground arthropods | 0.01 |
| **Pulses, BBCH 10-19** | |
| **Food category** | **PD (fresh weight)** |
| Non-grass weeds and leafy crops | 0.60 |
| Large seeds | 0.25 |
| Small seeds | 0.14 |
| Ground arthropods | 0.01 |
| **Pulses, BBCH 80-99** | |
| **Food category** | **PD (fresh weight)** |
| Non-grass weeds and leafy crops | 0.24 |
| Large seeds | 0.60 |
| Small seeds | 0.14 |
| Ground arthropods | 0.02 |

In risk assessment for seed treatments, the following values may be used (Table 6.9.).

Table 6.9. *Estimated amounts of treated seed consumed by a 435 g woodpigeon fulfilling its daily requirements by feeding on freshly drilled winter cereals or maize. PD for mixed diets as in Table 6.8. Note that either the PD or the fresh weight value should be included in the higher tier risk assessment; if both are used at the same time the refinement will count as double (not acceptable).*

|  |  |  |
| --- | --- | --- |
|  | **PD (fresh weight)** | **Fresh weight (g)** |
| **Winter cereals**  (autumn) | 1.00 | 33.7 |
| 0.97 | 32.7 |
| **Maize**  (spring) | 1.00 | 33.7 |
| 0.92 | 32.2 |

Due to their high mobility, it is unlikely that woodpigeons will be foraging in any single crop for a longer period of time. It is therefore considered appropriate to refine the risk assessment by adjusting PT, using the radio-tracking data in Table 6.11. PT data are however not available for all relevant crops. Particularly **stubble fields** are of high attractiveness for woodpigeons (and other species) and PT should not be refined there without crop-specific data from radio-telemetry studies.

**General information**

The woodpigeon is a widespread and common or abundant species in agricultural and forested landscapes, and partly also in urban areas, throughout the Northern Zone. It extended its range northward during the 20th century and now also occurs commonly within the boreal zone. Populations are assumed to be stable or increasing throughout the Northern Zone, except in Sweden where the species has apparently declined following an increase until 1970-80 (Snow and Perrins 1998, Table 6.10.).

Table 6.10. *Population size and trends of woodpigeon (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| --- | --- | --- | --- | --- |
| Denmark | 250,000-350,000 | 2000 | Increase; 20-49% | Increase; 10-19% |
| Estonia | 40,000-80,000 | 1998 | Stable | Stable |
| Finland | 150,000-200,000 | 1998-2002 | Stable | Increase; c. 10% |
| Latvia | 40,000-60,000 | 1990-2000 | Stable | Increase; 20-29% |
| Lithuania | 80,000-120,000 | 1999-2001 | Stable | Increase; 20-29% |
| Norway | 100,000-500,000 | 1990-2002 | Increase; 20-49% | Stable |
| Sweden | 980,000 | 2008 | Stable | Decline; 28% |

Woodpigeons are migratory in northern and eastern Europe but are partly sedentary in Denmark and in southernmost Norway and Sweden. The northern and eastern boundaries of the normal winter distribution lie close to the 0 °C January isothermal line (Snow and Perrins 1998). Northern and eastern populations leave the breeding areas from mid-September to early November, with huge numbers passing in October through southern Sweden and Denmark, and along the eastern Baltic coastline. Spring migration occurs mainly in March-April (Cramp 1985).

The breeding season is very long, stretching from mid-February to November in north-west (atlantic) Europe. Urban populations lay significantly earlier than rural populations, the latter usually start breeding from late March to mid-April (Snow and Perrins 1998). In Central Europe, laying begins mid-April and in north-eastern Europe even later. In Denmark, most layings occur between May and July and nestlings may still be found until October. Breeding pairs make on average four breeding attempts per year (information on ‘ringdue’ (= woodpigeon) at http://www.dofbasen.dk/ART).

**Agricultural association**

Woodpigeons occur in most terrestrial habitats but seem to prefer a mosaic landscape with woods and agricultural land. In farmland, woodpigeons breed in hedgerows, coverts etc. but forage in open fields. Woodpigeons breeding in forest or urban areas also frequently fly to adjacent farmland to feed. Broad-leaved crops seem to be preferred feeding sites but crop preferences during summer are not strong (Petersen 1996b). Pigeons foraging in British farmland showed season-dependent preferences: cereal stubble in November-January, winter rape in January-February and pasture in February-May; in addition, newly-sown cereal and pea fields were exploited when available (October-November and March-May) (Inglis et al. 1990). Woodpigeons have also been recorded feeding in freshly-drilled rape fields (Petersen 1996a). In a British study of birds feeding at bait stations with different seeds, pigeons seemed to prefer peas but also took rape and barley (Prosser 1999).

British data on proportion of time (PT) individual woodpigeons spent in different crops have been consolidated by Prosser (2010) and are summarized in Table 6.11. These data indicate that oilseed rape is a preferred crop during most of the year.

Table 6.11. *Percentage of active time spent by radio-tagged woodpigeons in different crops in the UK, presented as 90th percentile of the modelled PT distribution. The birds were caught in general farmland (not in specific crops); therefore only values for the subsample of birds who actually used the crop in question (“consumers only”) are suitable for use in higher tier risk assessment (bold).*

| **Crop** | **Period** | **No. of birds** | **90th percentile** | **Reference** |
| --- | --- | --- | --- | --- |
| ***Consumers only:*** | | | | |
| (Winter)  cereals | Summer  (Jun.-Aug.) | 8 | **0.36** | Prosser 2010 |
|  | Autumn  (Sep.-Nov.) | 11 | **0.10** | Prosser 2010 |
|  | Winter  (Dec.-Feb.) | 7 | **0.61** | Prosser 2010 |
| (Winter)  oilseed rape | Spring  (Mar.-May) | 8 | **0.84** | Prosser 2010 |
|  | Summer  (Jun. and Aug.)\* | 13 | **0.77** | Prosser 2010 |
|  | Autumn  (Sep.-Nov.) | 11 | **0.29** | Prosser 2010 |
|  | Winter  (Dec.-Feb.) | 8 | **0.68** | Prosser 2010 |
| Potatoes  and beet | Autumn  (Sep.-Nov.) | 18 | **0.08** | Prosser 2010 |

\* July was excluded as oilseed rape is normally harvested during this month in the UK.

PT analysis of radio-tagged woodpigeons in stubble fields in the UK by Ludwigs et al. (2016) revealed a 90th percentile PT of 0.53 (for details see Ludwigs et al. 2016).

**Body weight**

Body weight is rather variable: ♂ 325-614 g, ♀ 284-587 g (Snow and Perrins 1998); low values (< 350 g) are possibly from exhausted birds (Cramp 1985). Mean body weight of the smaller sex (♀: 435 g) shall be used for risk assessment.

**Energy expenditure**

The daily energy expenditure can be calculated allometrically using the equation for non-passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

Woodpigeons feed on a wide range of plant material, with seeds or green leaves dominating, depending on season. Seeds from newly-sown cereal, pea or rape fields and all types of grain from stubble fields are apparently preferred when available. In winter, green leaves of broad-leaved crops (oilseed rape) and different weeds are important but beech mast, acorns etc. may also be significant during autumn and winter. The summer diet is highly variable and may include up to 5% invertebrates (Christensen et al. 1996; Holland et al. 2006).

Woodpigeons often feed by gorging themselves while on the ground, then moving to safer locations (usually in hedges or trees) to digest their food and rest (Prosser 2010).

Adult pigeons feed their nestlings with a secretion from the crop, amounting to 92% of the diet in newly hatched chicks and gradually decreasing to 21% of diet in chicks ≥ 15 days old. The balance is made up by the same food as that of adults, except that invertebrates and weed seeds are more frequent (Christensen et al. 1996).

British studies indicate that a significant shift in the feeding habits of woodpigeons has occurred in recent decades. Before the 1970s, cereal stubbles, clover leys and pasture were preferred foraging sites during winter but as the stubble fields were replaced by autumn-sown crops, woodpigeons moved to newly-sown cereal fields in autumn and oilseed rape in winter (Inglis et al. 1990).

Ljunggren (1968) studied crop contents in a rural population of adult woodpigeons in SW Sweden. The results are presented as percentage of food items (by number) (Table 6.12.).

Table 6.12. *Woodpigeon diet in SW Sweden, analysed from crop contents (n = 728 crops) (Ljunggren 1968).*

| **Time of year** | **Food type** | **% of food items** |
| --- | --- | --- |
| **Jan.-Apr.** | Plant leaves | 52 |
|  | Cereal grain | 46 |
|  | Weed seeds | 2 |
|  | Rape seeds | 1 |
|  | Peas | 1 |
| **May-Aug.** | Rape seeds | 28 |
|  | Cereal grain | 26 |
|  | Peas | 16 |
|  | Weed seeds | 15 |
|  | Plant leaves | 13 |
| **Sep.-Nov.** | Cereal grain | 68 |
|  | Peas | 12 |
|  | Plant leaves | 9 |
|  | Rape seeds | 7 |
|  | Weed seeds | 3 |

Schnock and Seutin (1973, cited in Cramp 1985) studied woodpigeon crop contents in Belgium (Table 6.13). The results are presented as percentage of fresh weight.

Table 6.13. *Woodpigeon diet in Belgium, analysed from crop contents (n = 673 crops) (Schnock and Seutin 1973 cited in Cramp 1985).*

| **Time of year** | **Food type** | **% of fresh weight** |
| --- | --- | --- |
| **April to mid-May** | Cereals or legumes | 91 |
|  | Leaves of clover and dicot. weeds | 4 |
|  | Beech flower buds | 3 |
|  | Weed seeds | 2 |
| **mid-May to mid-July** | Fruits and seeds (e.g. Caryo­phyllaceae, Ranunculaceae) | 45 |
|  | Leaves (clover, lucerne, *Fraxinus*) | 33 |
|  | Rhizomes and bulbs | 10 |
|  | Cereals or legumes | 6 |
|  | Flower buds | 4 |
|  | Animal matter | 3 |
| **mid-July to mid-October** | Cereals or legumes1 | 97 |
|  | Weed seeds (*Vicia*) | 2 |
|  | Animal matter | 1 |
| **mid-October to March** | Fruits and seeds (esp. acorns and beech mast) | 45 |
|  | Cereals or legumes | 362 |
|  | Green leaves | 19 |

1  Including 53% wheat, 29% peas, 11% barley.

2  Up to 83% during periods of snow cover.

### Skylark *Alauda arvensis* (omnivore)

****

Skylark (*Alauda arvensis*), Photo: M. Grimm

**Risk assessment**

The skylark may be considered a relevant focal species in all field crops including grassland.

A body weight of 35 g must be used in risk assessment (see section on body weight below).

Crop-specific PD adjustments are described in Appendix 1 and the PD values to be used in higher tier risk assessment are shown in Appendix 3 and in the accompanying data sheet and calculator tool.

For any month, the diet composition (PD values) might in principle be taken directly from Table 6.17.. However, these PD values apply to arable land in general and should be adjusted to allow for differences in food availability between crops. Furthermore, the relative amounts of foliar and ground-dwelling arthropods in the diet do not appear from this table. If foliar arthropods are present in the crop during the period in question, they may be assumed to constitute up to 50% of the invertebrate part of the diet, or less during the period of crop development. The occurrence of foliar arthropods in the diet is documented in Table 6.19. and Table 6.20.

For those elements of the diet which are obtained from the ground, interception in the crop canopy shall be taken into account as appropriate for the crop and growth stage in question.

In risk assessment for seed treatments, the values in Table 6.14. may be used. For each exposure scenario, the amount of ingested seed is computed from PD for cereal grain or small seeds, estimated as described in Appendix 1 (cf. above). PD for grass is calculated from the scenario (April) where grass seeds make up the largest share of the diet, using the ratio between grass and dicotyledonous weed seeds found by Green (Table 6.17).

Table 6.14. *Estimated amounts of treated seed consumed by a 35 g skylark fulfilling its daily requirements by feeding in newly-sown cereal, rape or grass fields.*

*Note that either the PD* or *the fresh weight value should be included in the higher tier risk assessment; if both are used at the same time the refinement will count as double (not acceptable).*

|  | | **PD (dry weight)** | **Fresh weight (g)** |
| --- | --- | --- | --- |
| **Spring cereals** | Acute | 1.00 | 9.48 |
| Long-term | 0.46 | 3.98 |
| **Winter cereals** | Acute | 1.00 | 9.48 |
| Long-term | 0.74\* | 6.71\* |
| **Spring rape** | Acute | 1.00 | 7.61 |
| Long-term | 0.57 | 4.39 |
| **Winter rape** | Acute | 1.00 | 7.61 |
| Long-term | 0.51 | 3.93 |
| **Grass** | Acute | 1.00 | 7.61 |
| Long-term | 0.42 | 3.17 |

\* Includes harvest spillage from a possible preceding cereal crop.

Skylarks may obtain almost all of their food from a single (large) field. If deemed appropriate, PT may be refined using the information in Table 6.16.

**General information**

The skylark is a widespread and abundant species in farmland across most of Europe. The highest densities are found in lowland areas within the temperate zone. In the boreal zone, it occurs wherever there are larger areas of arable land or pasture. Being originally a bird of steppe grasslands the skylark spread with deforestation and the expansion of agriculture, especially during the 19th century. From approx. 1970 onwards population declines have been recorded almost everywhere, incl. e.g. Sweden (Wretenberg et al. 2007), most probably as a result of agricultural intensification.

Table 6.15. *Population size and trends of skylark (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 1,100,000-1,300,000 | 2000 | Decline; 20-49% | Decline; < 10% |
| Estonia | 150,000-300,000 | 1998 | Decline; 20-49% | Stable |
| Finland | 300,000-400,000 | 1998-2002 | Decline; 20-49% | Stable\* |
| Latvia | 1,100,000-1,800,000 | 1990-2000 | Stable | Stable |
| Lithuania | 1,100,000-1,500,000 | 1999-2001 | Stable | Decline; < 20% |
| Norway | 100,000-400,000 | 1990-2001 | Stable | Decline; < 20% |
| Sweden | 800,000 | 2008 | Decline; 20-49% | Decline; 28% |

\* Increasing after 2000 (Tiainen et al. 2012b).

Skylarks are migratory throughout the Northern Zone, with just some few thousand birds remaining in Denmark and southern Sweden during mild winters (Petersen 2006). The birds arrive at their breeding grounds from late February to early April. In the southern part of the Northern Zone, skylarks breed from April to July and may produce 2 or 3 clutches per year. Further north, breeding starts from early May and only one or maybe two clutches are produced. At the end of the breeding season in August, the breeding grounds in farmland are usually vacated. Autumn migration takes place during September to early November.

**Agricultural association**

The skylark is a pronounced farmland bird and is almost exclusively found in arable land using a wide range of crop types for breeding and foraging (Mason and Macdonald 2000). In a study in Finnish farmland, one important factor for the presence of skylarks in fields was the distance to nearest forest and the openness of the area (no birds were found in areas smaller than 11.5 ha) (Piha et al. 2003). In a similar Danish study (Petersen 1998), skylark densities were negatively associated with the presence of buildings, woods, hedgerows, coverts and other habitat islands.

In farmland areas in the southern and central parts of Sweden, mean skylark densities were 0.26 territories/ha (Robertson and Berg 1992). Densities are affected by crop type as shown by inventories in SW Sweden with the highest skylark density in peas (0.82 territories/ha), followed by rape (0.61), winter cereals (0.53), spring sown cereals (0.37), oat (0.32), cabbage (0.25) and flax (0.09) (Lindqvist et al. 2000). Skylarks are also found at high densities in set-asides (0.80) and early stages of energy forest (0.37 territories/ha respectively) (Berg and Pärt 1994, Berg 2002). In Finland, the density depends on the size of the farmland patch (Piiroinen et al. 1985). In large open areas, the average density was 0.64-0.72 territories/ha in south­western Finland and 0.45 territories/ha in southeastern Finland (Tiainen and Seimola 2010). The density can be as high as 1.2 territories/ha in plots of over 100 ha in organic farms (Tiainen and Seimola 2010). In Åland, the average density of skylarks was 0.68 territories/ha with maxima in winter cereals and winter oilseed rape (> 1,2 territories/ha, Tiainen et al. 2012a). In a Danish study, the highest densities were found on set-aside, followed by cereals and rotational grassland, and the lowest densities were found on permanent grassland (Petersen 1996b).

The home range size of skylarks depends on both crop type and landscape structure (Jenny 1990; Poulsen et al. 1998). Average home-range size in winter cereals is 4.6 ha and between 2.4 and 2.6 ha in sprayed spring cereal fields (Odderskær et al. 1997a, Poulsen et al. 1998).

Skylarks are present on arable fields from March until late July and early August when the breeding grounds are largely abandoned (Odderskær et al. 1997b, Esbjerg and Petersen 2002). Densities are changing over the growth period in spring and summer, with decreasing numbers of skylark territories in winter cereals and winter rape and increasing numbers in spring cereals and, towards the end of the season, in sugar beet (e.g. Toepfer and Stubbe 2001, Esbjerg and Petersen 2002). In central Europe (including the British isles) and also in the southern part of the Northern Zone, winter cereal fields usually grow too high and dense for successful breeding early in the season (i.e. during the first half of May), while further north where crop growth is slower, winter cereals may be a suitable breeding habitat until June (Hiron et al. 2012). In autumn, skylarks are commonly recorded on stubble fields (e.g. Esbjerg and Petersen 2002, J. Tiainen pers. comm.) and on winter cereal fields (Crocker and Irving 1999).

The time a bird spends in one field is to some degree depending on where the nest is situated. It has been shown that birds with nests in the centre of a field are more likely to forage in the same field compared to birds nesting closer to the field edge which to a greater extent forage outside the field (Donald et al. 2001). From studies using both radio-telemetry and intensive visual observation, it has been shown that skylarks use arable crops and single fields for foraging (Crocker et al. 2002; notifier study summarized in EFSA 2004). Thus, skylarks might be present in one field during the whole breeding season spending nearly all their time there.

The proportion of time (PT) spent in different crops by individual skylarks has been estimated by Finch et al. (2006) and Prosser (2010), based upon British radio-tracking data. The results are summarized in Table 6.16. *It should be noted that the British data may under­estimate the skylarks’ use of winter cereals during summer within the Northern Zone (cf. above) and that it is doubtful to what extent PT data for winter cereals may be extrapolated to spring cereals.*

Table 6.16. *Percentage of active time spent by radio-tagged skylarks in different crops in the UK, presented as mean and 90th percentile of the PT distributions. The birds were caught in general farmland (not in specific crops), and were not all tracked continuously or for a full daily activity period; therefore only values for the subsample of birds who actually used the crop in question (“consumers only”) (bold) are suitable for higher tier risk assessment. Data basis of . Finch et al. 2006 and Prosser 2010 are the same.*

| **Crop** | **Period** | **No. of birds** | **Mean** | **90th percentile** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| ***Consumers only:*** | | | | | |
| Winter cereals | Winter  (Sep.-Mar.) | 10 | 0.34 | 0.94 | Finch et al. 2006 |
|  |  | 10 |  | **0.96** | Prosser 2010 |
|  | Summer  (Apr.-Aug.) | 26 | 0.42 | 0.97 | Finch et al. 2006 |
|  |  | 26 |  | **0.99** | Prosser 2010 |
| Winter rape | Winter  (Aug.-Mar.) | 4 | 0.36 | 0.98 | Finch et al. 2006 |
|  |  | 4 |  | **0.89** | Prosser 2010 |
|  | Summer  (Apr.-Jul.) | 7 | 0.33 | 0.57 | Finch et al. 2006 |
|  |  | 7 |  | **0.57** | Prosser 2010 |
| Beet  (+ potatoes) | Apr.-Nov. | 18 | 0.35 | 0.88 | Finch et al. 2006 |
|  |  | 18 |  | **0.84** | Prosser 2010 |

**Body weight**

Body weight ♂ mostly 34-50 g, ♀ 26-43 g (Snow and Perrins 1998). Mean body weight of the smaller sex (♀: 35 g) must be used for risk assessment.

**Energy expenditure**

Alternatively, the energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009; see also Topping and Odderskær 2004).

**Diet**

The diet of skylarks is depending on season and availability of different food types. Cereal grains and leaves form a large part of the diet in winter, while invertebrates are the most important part of the diet in summer (Green 1978). Skylarks do not dehusk seeds before swallowing them (Buxton et al. 1998). The chicks are almost entirely reared on invertebrates (Green 1978; Donald 2004). The diet composition of adults and chicks of skylark in arable land are presented separately for different times of year in the tables below.

Green (1978) studied skylarks in three farmland areas in east England between November 1974 and June 1977. In the three areas the dominating crops were cereals and sugar beet (Tabel 6.17).

Table 6.17. *Skylark diet in arable land (Green 1978)1.*

| **Time of year** | **Food type** | **% of diet dry weight** |
| --- | --- | --- |
| **April** | Invertebrates | 14 |
|  | Cereal grain | 30 |
|  | Grass flowers and seeds2 | 15 |
|  | Dicotyledonous weed seeds2 | 7 |
|  | Monocotyledonous leaves | 24 |
|  | Dicotyledonous leaves | 10 |
| **May** | Invertebrates | 28 |
|  | Cereal grain | 11 |
|  | Grass flowers and seeds2 | 11 |
|  | Dicotyledonous weed seeds2 | 12 |
|  | Monocotyledonous leaves | 24 |
|  | Dicotyledonous leaves | 14 |
| **June** | Invertebrates | 40 |
|  | Cereal grain | 6 |
|  | Grass flowers and seeds2 | 6 |
|  | Dicotyledonous weed seeds2 | 17 |
|  | Monocotyledonous leaves | 17 |
|  | Dicotyledonous leaves | 14 |
| **July** | Invertebrates | 51 |
|  | Cereal grain | 27 |
|  | Grass flowers and seeds2 | 2 |
|  | Dicotyledonous weed seeds2 | 5 |
|  | Monocotyledonous leaves | 10 |
|  | Dicotyledonous leaves | 5 |
| **August** | Invertebrates | 24 |
|  | Cereal grain | 56 |
|  | Grass flowers and seeds2 | 5 |
|  | Dicotyledonous weed seeds2 | 9 |
|  | Monocotyledonous leaves | 1 |
|  | Dicotyledonous leaves | 5 |
| **September** | Invertebrates | 13 |
|  | Cereal grain | 71 |
|  | Grass flowers and seeds2 | 1 |
|  | Dicotyledonous weed seeds2 | 12 |
|  | Monocotyledonous leaves | 2 |
|  | Dicotyledonous leaves | 1 |

1 All data on% of diet calculated approximately from figure 3 in Green (1978).

2 For risk assessment purposes, “grass flowers and seeds” and “dicotyledonous weed seeds” may be merged into the category “small seeds”.

Green (1980) studied skylark feeding habits in two consecutive years on nine sugar beet fields in England. Faeces samples were collected from the fields and observations were done in April and May (Table 6.18).

Table 6.18. *Skylark diet on sugar beet fields (Green 1980).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of diet dry weight** |
| **April-May** | Seedlings1 | 63 |
|  | Weed seeds | 21 |
|  | Invertebrates2 | 16 |

1 Weed and sugar beet cotyledons and leaves.

2 Ground-dwelling arthropods.

Navntoft et al. (2003) performed a detailed study of the arthropod part of the skylark diet in organic cereal fields (winter wheat and spring barley) in Denmark. A total of 1,296 faecal samples were analysed. The results were expressed as both number and biomass of food items and are summarized in Table 6.19.

Table 6.19. *Arthropods in the diet of skylarks in cereal fields (Navntoft et al. 2003).*

| **Time of year** | **Food type** | **% of diet** | |
| --- | --- | --- | --- |
|  |  | **by number** | **by biomass** |
| **May-July** | Carabidae img.1 | 16 | 25 |
|  | Staphylinidae img. 1 2 | 15 | 8 |
|  | Chrysomelidae img. 2 | 14 | 5 |
|  | Syrphidae juv. 2 | 9 | 22 |
|  | Symphyta juv. 2 | 1 | 16 |
|  | Lepidoptera juv.2 | 2 | 8 |
|  | Other arthropods | 43 | 16 |

1 Ground-dwelling arthropods.

2 Foliar arthropods.

Smith et al. (2009) also indicated yearly variations in diet composition in the UK: In 2002, Araneae, Diptera and Coleoptera were the most frequent prey classes, forming approximately 78% of the diet. Coleoptera was largely composed of Carabidae (adults + larvae; 69%), Staphylinidae (adults + larvae; 5%), Curculionidae (4%), Elateridae (4%), Chrysomelidae (0·8%), Nitidulidae (0·6%) and others (17%). Lepidoptera and Hymenoptera together formed 8% of the diet. Very little cereal was found in the faecal material, only three samples contained grain. In 2003, Araneae, Diptera and Coeleoptera were still the most frequent prey classes, but together formed only 58% of skylark diet, less than in the previous year. Coleoptera was composed of Carabidae (adults + larvae; 65%), Staphylinidae (adults + larvae; 9%), Curculionidae (9%), Elateridae (5%), Chrysomelidae (0·5%), Nitidulidae (0·2%) and others (3%). Together, Lepidoptera and Hymenoptera formed 20% of the diet and occurred in 77% and 41% of the samples, respectively. Although cereal comprised only 7% of the diet, it occurred regularly in samples, unlike the previous year. So, skylarks need to be opportunistic feeders, and depend on arthropods (and their availablility) during the breeding season (see also Odderskær et al. (1997a).

Odderskær et al. (1997a) studied the diet of skylark chicks in spring barley fields in a Danish farmland. The food analysis was made from 249 faecal samples and included arthropod food remains only (Table 6.20).

Table 6.20. *Arthropods in skylark chick diet in spring barley fields (Odderskær et al. 1997a).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of diet dry weight** |
| **May-June** | Carabidae1 | 49 |
|  | Lepidoptera2 | 17 |
|  | Heteroptera2 | 8 |
|  | Coleoptera (Elateridae) 1 2 | 6 |
|  | Other insects | 21 |

1 Ground-dwelling arthropods.

2 Foliar arthropods.

Diet composition in the Netherlands in winter depended on crop types with 35% grass seed, 16% weed seed, 16% weed leaf, 15% monocot leaf, 14% cereal grain and 3% invertebrate in cereal stubbles, opposed to 48% weed seed, 30% grass leaf, 14% grass seed, 5% weed leaf and again only 3% invertebrate in potato stubbles (Geiger et al. 2014).

### Yellow wagtail *Motacilla flava* (insectivore)



Yellow wagtail (*Motacilla flava flava*), Photo: M. Grimm

**Risk assessment**

The yellow wagtail is relevant for the following crop scenario:

* grassland, all stages
* sugar beets, potatoes and onions (BBCH stages where the crops is above 20 cm)

A body weight of 17.5 g must be used in risk assessment (see section on body weight below).

As described below, yellow wagtails prefer dipterans, which are partly foliage-dwelling. Populations of foliar insects are, however, not well presented in short grass. Therefore, the diet is assumed to be composed as shown in Table 6.21.

**Table 6.21.** *Estimated diet composition of yellow wagtails feeding in grassland at different stages.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Crop** | **Stage** | **PD (fresh weight)** | |
|  |  | **Foliar arthropods** | **Ground-dwelling arthropods** |
| Grassland | Sowing and  pre-emergence |  | 1.00 |
|  | Short | 0.25 | 0.75 |
|  | Medium and long | 0.50 | 0.50 |
|  | Termination use | 0.25 | 0.75 |

For ground-dwelling arthropods, interception in the crop canopy may be taken into account as appropriate for the growth stage in question.

**General information**

The yellow wagtail occurs in open country, especially meadows and pastures, across most of the Northern Zone. Most populations have declined in recent decades, and in Denmark – and maybe also in other parts of the Northern Zone – occurrence is rather scarce and local (Table 6.22).

Table 6.22. *Population size and trends of yellow wagtail (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 5,000-10,000 | 2000 | Decline; 20-49% | Decline; 30–49% |
| Estonia | 10,000-20,000 | 1998 | Stable | Decline; 20-29% |
| Finland | 250,000-400,000 | 1998-2002 | Decline; 20-49% | Decline, 50% |
| Latvia | 10,000-25,000 | 1990-2000 | Stable | Stable |
| Lithuania | 20,000-30,000 | 1999-2001 | Stable | Decline; 30-49% |
| Norway | 100,000-500,000 | 1990-2002 | Stable | Stable |
| Sweden | 360,000 | 2008 | Increase; 20-49% | Decline; 55% |

The birds generally arrive at their breeding grounds during May, with egg-laying occurring mainly from late May to June. Yellow wagtails are usually single-brooded within the Northern Zone, but two broods have been reported from Denmark and may also occur elsewhere in the southern part of the Northern Zone. Autumn migration may begin as early as late July but main migration continues from mid-August until late September. European birds winter in Sub-Saharan Africa.

**Agricultural association**

In the breeding season, yellow wagtails prefer riversides, lakesides, pastures and similar habitats with low, dense and moist herbage or turf (Cramp 1988). In the northern part of the range, the subspecies *thunbergi* (grey-headed wagtail) is also found in peat bogs (mires) and grazed fens.

Locally, especially in Central Europe, yellow wagtails seem to have adapted to intensive agriculture and occur in arable fields, particularly in row crops like potato and beet but also in cereals (Glutz von Blotzheim and Bauer 1985). Yellow wagtails showed a preference for winter cereals during the entire breeding season in the Netherlands, but the preference for this crop type decreased as the breeding season progressed, whereas potatoes were only preferred during the second half of the breeding season, while sugar beet and onions were not preferred (Kragten 2011). The determining factor seemed to be a crop height of 20-40 cm for all crops being a suitable habitat for breeding, and grassland with livestock being an important foraging habitat. In North European farmland, the species is mainly found in permanent grassland, although before the decline it was common in spring-sown fields, e.g. in southern Finland (Piiroinen et al. 1985, Tiainen et al. 1985).

Population densities in farmland may generally reach 2-4 breeding pairs per 10 ha under optimum conditions, i.e. in extensively managed grassland. In arable fields, maximum densities of 0.5-0.7 pairs per 10 ha have been reported from Central Europe (Glutz von Blotzheim and Bauer 1985).

**Body weight**

Body weight of both sexes varies from 14-21 g (Snow and Perrins 1998). Mean body weight (17.5 g) need to be used for risk assessment.

**Energy expenditure**

The energy expenditure may be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

Yellow wagtails feed almost exclusively on arthropods, mainly Diptera. They prefer small food items (2-7 mm) but may also take larger insects such as dragonflies (Odonata). Three main foraging techniques are used: (1) picking from ground or water surface while walking; (2) run-picking, where the prey is picked from the surface (ground, plant or water) or when it takes off; (3) flycatching after short flight from ground or perch (Cramp 1988). Occasionally, yellow wagtails take insects from plants in hovering flight (Glutz von Blotzheim cited by Cramp 1988). Thus, both ground-dwelling and foliar insects occur in the diet.

In England during April-May, birds feeding in flocks at pools took predominantly Diptera (91-98% by number) and small numbers of Coleoptera, Aphididae and Ichneumonidae. Birds feeding singly at dung pads also took mainly Diptera, with beetles Coleoptera making up 6.4% of the diet (by number) (Davies 1977). In Russia (Moscow region) in June, jumping plant lice Psyllidae comprised 83% of the diet (by number), followed by beetles (7%, mostly Chrysomelidae), while Diptera comprised only 2.3% of diet (Ptushenko and Inozemtsev cited by Cramp 1988). In other studies, especially from more southern and less humid areas, Coleoptera make up a larger part of the diet (Glutz von Blotzheim and Bauer 1985).

Nestling diet is similar to that of adults. In a study from the St. Petersburg region, Diptera comprised 44.8% (by number) and Ephemeroptera 24.2% of nestling diet; other items brought to the nests were mainly Odonata*,* Coleoptera*,* Trichoptera and small molluscs (Gastropoda) (Prokofieva cited by Cramp 1988).

### White wagtail *Motacilla alba* (insectivore)



White wagtail (*Motacilla alba*), Photo: C. Dietzen

**Risk assessment**

The white wagtail is a relevant focal species in early stages of all field crops and in most or all stages of crops where bare soil is present between the plants (row crops). In grassland, assessment for white wagtail is covered by the smaller yellow wagtail.

A body weight of 21 g must be used in risk assessment (see section on body weight below).

The diet consists entirely of insects and other arthropods. Many of the preferred prey items, i.e. dipterans, are foliage-dwelling, so foliar arthropods are assumed to be included in the diet as soon as their populations are established in the fields during spring. For risk assessment puposes, their share of the diet may be assumed to be 25% during development and 50% at later stages.

The relevant scenarios are specified in Table 6.23.

**Table 6.23.** *Estimated diet composition of white wagtails in different crops and growth stages.*

| **Crop** | **Growth stage (BBCH)** | **PD (fresh weight)** | |
| --- | --- | --- | --- |
|  |  | **Foliar arthropods** | **Ground-dwelling arthropods** |
| Winter cereals | 0-9 |  | 1 |
| Spring cereals | 0-9, 10-14\* |  | 1 |
| Maize | 0-9 |  | 1 |
|  | 10-29 | 0.25 | 0.75 |
| Winter rape | 0-9, 10-19\*\* |  | 1 |
|  | Post-harvest (stubble) |  | 1 |
| Spring rape | 0-9 |  | 1 |
|  | 10-19 | 0.25 | 0.75 |
|  | Post-harvest (stubble) |  | 1 |
| Beets | 0-9 |  | 1 |
|  | 10-19 | 0.25 | 0.75 |
|  | 20-49 | 0.50 | 0.50 |
| Potatoes | 0-9 |  | 1 |
|  | 10-19 | 0.25 | 0.75 |
|  | 20-89 | 0.50 | 0.50 |
|  | Pre-harvest desiccation | 0.25 | 0.75 |
| Pulses | 0-9 |  | 1 |
|  | 10-19 | 0.25 | 0.75 |
|  | 20-79 | 0.50 | 0.50 |
| Field grown vegetables | 0-9 |  | 1 |
|  | 10-19 | 0.25 | 0.75 |
|  | 20-89 | 0.50 | 0.50 |
| Strawberries | Planting (10-19) | 0.25 | 0.75 |
|  | 20-89 | 0.50 | 0.50 |
|  | Post-harvest | 0.50 | 0.50 |

\* Tillering occurs from stage 13-14, making the field unsuitable for white wagtails.

\*\* In autumn-sown rape, BBCH 10-19 is available in autumn or early spring when foliar arthropods are not present in the field.

For ground-dwelling arthropods, interception in the crop canopy shall be taken into account as appropriate for the crop and growth stage in question, cf. section 4.5.

Species-specific data allowing a refinement of PT are not available.

**General information**

The white wagtail is a widespread and common species across most of Europe and occurs in farmland and other open habitats all over the Northern Zone. European breeding populations appear to be mainly stable (BirdLife International 2004, Table 6.24).

Table 6.24. *Population size and trends of white wagtail (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 100,000-150,000 | 2000 | Increase; 20-49% | Stable |
| Estonia | 100,000-150,000 | 1998 | Stable | Stable |
| Finland | 600,000-900,000 | 1998-2002 | Stable | Decline, 10% \* |
| Latvia | 150,000-300,000 | 1990-2000 | Stable | Decline; 30-49% |
| Lithuania | 400,000-500,000 | 1999-2001 | Increase; 20-49% | Stable |
| Norway | 100,000-500,000 | 1990-2003 | Stable | Stable |
| Sweden | 410,000 | 2008 | Stable | Decline; 19% |

\* A moderate increase was found for the farmland population 2001-2011 (Tiainen et al. 2008, 2012b).

Arrival at the breeding grounds is earlier than in yellow wagtail, the white wagtails arriving during late March and April across most of the Northern Zone, stretching to early May in the northernmost parts of the range. In Denmark, white wagtails breed from mid-April or May to July or (rarely) August and usually produce two broods per year. In the northern parts of the Northern Zone, white wagtails are usually single-brooded although two broods may occur. In central Finland, the first eggs are laid in early May, with the main breeding period being mid-May to early June and the last clutches appearing in the 2nd week of July; in southern Finland, breeding occurs up to one week earlier (Cramp 1988). Autumn migration takes place from late August until mid-October, usually peaking in mid-September. The winter quarters are in the Mediterranean area and Northern Africa.

**Agricultural association**

The white wagtail occurs in a wide range of open habitats, often near water. It is very common in the cultivated landscape, where it is often found in association with human settlements and along roads, tracks and larger ditches. Patches of bare ground or areas with very low vegetation seem essential. The species is to some extent associated with grazing livestock, also in farmyards and small pens. Tall or dense vegetation is avoided. In farmland, white wagtails tend to prefer grassland with short turf and avoid tall, autumn-sown crops (Cramp 1988, Buxton et al. 1998).

In a Danish study in freshly drilled spring rape (Petersen 1996a), white wagtails were second only to skylarks in prevalence and abundance; the mean number of white wagtails foraging on the study fields was 0.045/ha/minute.

**Body weight**

Body weight of both sexes reaches 17-25 g (Snow and Perrins 1998). Mean body weight (21 g) must be used for risk assessment.

**Energy expenditure**

The energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

White wagtails feed almost exclusively on invertebrates, mainly Diptera but also Coleoptera and other insects. They prefer small food items (2-7 mm). In farmland, white wagtails frequently forage in pastures, newly-sown fields, ploughed fields, along ditches and other waterside habitats, in farmyards and along roads (Christensen et al. 1996).

In Western Europe, major studies of adult diet are available from England in late winter (Davies 1976, 1977) and from Austria all year (Glutz von Blotzheim and Bauer 1985). In England in March, birds feeding in flocks at pools took mainly Diptera (97% by volume), while the diet of single birds feeding at dung pads comprised more than 75% Diptera and 13% Coleoptera (by number). In Austria, all year diet consisted of Diptera (37% by number), Trichoptera (27%), Coleoptera (16%), Lepidoptera (11%) and Orthoptera (5%); a few seeds were also found.

There is no information on nestling diet from Western Palearctic. Studies from Kirgiziya indicate that the diet of nestlings is similar to adult diet (Christensen et al. 1996).

Like the yellow wagtail, white wagtails use three main foraging techniques: picking, run-picking and flycatching. In southern England, flock birds feeding at shallow pools employed picking exclusively, while single birds (feeding mainly at dung pads in pasture) used greater variety of techniques: picking (67%), run-picking (14%) and flycatching (19%). Single birds took fewer, but probably larger, food items per minute than flock birds (Davies 1976, 1977).

There is no specific information on the diet of white wagtails feeding in arable land.

### Robin *Erithacus rubecula* (insectivore)



Robin (*Erithacus rubecula*), Photo: M. Grimm

**Risk assessment**

The robin is a relevant focal species in orchards (fruit trees), ornamentals and nursery cultures, as specified below:

* Fruit trees: ground-directed applications (herbicides)
* Ornamentals and nursery: pre-emergence, small plants (all treatments), large plants (ground-directed applications)
* Christmas trees and decorative greenery: ground-directed applications small and large plants (all season)

A body weight of 16.5 g must be used in risk assessment (see section on body weight below).

As a ground feeder, the robin is particularly relevant for ground-directed applications, including applications to small plants. For canopy-directed applications blue tit represents the worst-case.

For all exposure scenarios, the diet may be assumed to consist entirely of ground-dwelling invertebrates (PD = 1). No interception shall be taken into account for the above-mentioned scenarios.

PT may be refined using the information in Table 6.26..

**General information**

The robin is widespread and abundant all over the Northern Zone, except in the northernmost parts. Its primary habitat is forest and woodland (coniferous, deciduous or mixed) but robins are also common in parks, gardens and other humanly managed and disturbed habitats (Snow and Perrins 1998), except in the north (Finland). Population fluctuations, partly related to the winter temperatures, are not infrequent, but overall North European breeding populations seem to be largely stable (Table 6.25)

Table 6.25. *Population size and trends of robin (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 200,000-300,000 | 2000 | Fluctuating | Fluctuating |
| Estonia | 250,000-500,000 | 1998 | Stable | Stable |
| Finland | 1,200,000-3,300,000 | 1998-2002 | Fluctuating | Increase; 65% |
| Latvia | 700,000-1,000,000 | 1990-2000 | Stable | Stable |
| Lithuania | 800,000-1,500,000 | 1999-2001 | Stable | Stable |
| Norway | 500,000-1,500,000 | 1990-2002 | Increase; 20-49% | Stable |
| Sweden | 3,800,000 | 2008 | Stable | Decline; 20% |

Robins breeding within the Northern Zone are generally migratory, but a minor part of the Danish, southern Swedish and Norwegian populations stay in the area throughout the year, particularly in mild winters. Winter quarters are in W and SW Europe and NW Africa. The migrants arrive in late March and April and depart from mid-August to mid-November (Snow and Perrins 1998). Breeding takes place from late April to end of July in the south but does not start until mid- or late May in the northern part of the Northern Zone. Usually double-brooded in the south and single-brooded in the north (Snow and Perrins 1998).

**Agricultural association**

Although robins are not infrequent in hedgerows and coverts in farmland, the species is not considered relevant for field crops due to its habitat preferences of forest, parks and gardens (Svensson et al. 1999, Larsen and Heldbjerg 2009).

The species is, however, fairly common in orchards and nurseries. In a study of orchards in the UK, 29 robins were radio-tracked to estimate the active time spent in this habitat (Crocker et al. 1998, Finch et al. 2006, Prosser 2010). The results are summarized in Table 6.26.

Table 6.26. *Percentage of active time spent by radio-tagged robins in orchards in the UK, presented as 90th percentile of the modelled PT distribution. The birds were caught inside the orchard or along the orchard edge; it is therefore recommended to use the values for the total sample of tracked birds (bold). Data basis of Finch et al. 2006 and Prosser 2010 are the same.*

| **Crop** | **Period** | **No. of birds** | **Mean** | **90 percentile** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| ***All birds:*** | | | | | |
| Orchard | Apr.-Sep. | 29 | 0.21 | 0.53 | Finch et al. 2006 |
|  |  | 29 |  | **0.51** | Prosser 2010 |
| ***Consumers only:*** | | | | | |
| Orchard | Apr.-Sep. | 24 | 0.25 | 0.56 | Finch et al. 2006 |
|  |  | 24 |  | 0.54 | Prosser 2010 |

**Body weight**

Body weight of ♂ mostly 15-21 g, ♀ 14-19 g (Snow and Perrins 1998). Mean body weight of the smaller sex (♀: 16.5 g) must be used for risk assessment.

**Energy expenditure**

No species specific data available, therefore calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet during the breeding season consists of invertebrates both for adults and nestlings. Foraging is done mainly on ground-living invertebrates, but robins sometimes take prey from branches or leaves. In a study of hedgerow inhabiting robins between March-May in northern Germany, faecal samples showed that Coleoptera constituted the main part of the diet (Table 6.27). Other data from northern Europe are apparently not available.

Table 6.27. *Diet composition of adult robins in a hedgerow habitat (Grajetzky 1993).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of diet** |
| **March-May** (n=445) | Coleoptera | 61 |
|  | Diptera | 18 |
|  | Diplopoda | 6 |
|  | Hymenoptera | 5 |
|  | Arachnida | 4 |
|  | Collembola/Others | 6 |

### Whinchat *Saxicola rubetra* (insectivore)



Whinchat (*Saxicola rubetra*), Photo: M. Grimm

**Risk assessment**

The whinchat is relevant for the following crop scenarios (except Denmark (DEPA 2014)):

* cereals (winter and spring), BBCH 40-89
* cereals (winter and spring), pre-harvest desiccation

A body weight of 16.5 g must be used in risk assessment (see section on body weight below).

Based on the studies summarized below, the diet may be assumed to consist of 75% foliar arthropods and 25% ground-dwelling arthropods. Following pre-harvest desiccation with herbicides, the crop in most cases will be wilted, and associated foliar arthropods will be gone, within one week. The proportion of foliar arthropods in the diet will therefore be strongly reduced; Table 6.28.

**Table 6.28.** *Estimated diet composition of whinchats feeding in cereal fields at different stages.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Crop** | **Stage** | **PD (fresh weight)** | |
|  |  | **Foliar arthropods** | **Ground-dwelling arthropods** |
| Cereals | BBCH 40-89 | 0.75 | 0.25 |
|  | Pre-harvest desiccation | 0.35 | 0.65 |

Interception shall be considered for ground-dwelling arthropods, as appropriate for the growth stage in question. There are no species-specific data allowing a refinement of PT.

**General information**

The whinchat occurs in open areas, from semi-dry heathlands and clear cut forest to humid meadows and edges of marshes with suitable perches such as fences, bushes and tall weeds. It may be found all over the Northern Zone although its occurrence in Denmark is now rather sparse. Whinchat populations have declined strongly across Western and Central Europe during recent decades (BirdLife International 2004); e.g. in Denmark the average annual decline during 1981-2011 was as high as 5.56% (Heldbjerg and Lerche-Jørgensen 2012). Northern and eastern populations have apparently fared better (Table 6.29.), maybe partly as a result of large-scale abandonment of arable land in the Baltic States during the 1990s. In Finland, the farmland population has been more or less stable at least since the early 1980s (Tiainen et al. 1985, 2008, 2012a,b), probably due to a still heterogenous landscape structure.

Table 6.29. *Population size and trends of whinchat (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 5,000-10,000 | 2000 | Decline; 20-49% | Decline; 50% |
| Estonia | 50,000-150,000 | 1998 | Increase; 20-49% | Stable |
| Finland | 300,000-400,000 | 1998-2002 | Decline; 20-49% \* | Decline; 30% \* |
| Latvia | 300,000-500,000 | 1990-2000 | Stable | Increase; 20-49% |
| Lithuania | 50,000-120,000 | 1999-2001 | Decline; 20-49% | Increase; < 20% |
| Norway | 50,000-300,000 | 1990-2003 | Stable | Stable |
| Sweden | 250,000 | 2008 | Stable | Increase; 11% |

\* Farmland populations have been more or less stable since at least the early 1980s (Tiainen et al. 2008, 2012b).

Whinchats are long-distance migrants wintering in tropical Africa. They arrive at the breeding grounds mainly during May and depart in August-September. Breeding begins soon after arrival in May, or in early June in the northern part of the Northern Zone. Whinchats are usually single-brooded in northern Europe, but re-layings occur in case of nest loss, implying that breeding activities may take place until mid-July (Glutz von Blotzheim and Bauer 1988).

**Agricultural association**

In Western and Central Europe, whinchats are mainly associated with extensively managed grassland types, especially extensively grazed pasture and hay meadows which are not mown before July. Intensively managed grassland and arable crops are avoided, although exceptionally breeding has been recorded in cereal, potato and clover fields (Cramp 1988, Glutz von Blotzheim and Bauer 1988).

Whinchats seem to occur more frequently in arable or mixed farmland in northern Europe. In a Latvian study, the species was strongly associated with abandoned fields (Aunins et al. 2001). In Finland, the CAP set-asides, and since 2008 the environmental fallow scheme, has favoured the whinchat, which also benefits on eutrofication of verge vegetation of larger drainage ditches (Herzon et al. 2011, Tiainen et al. 2012a). In Norway, whinchats were frequently recorded in cereal fields from mid-summer until the onset of autumn migration (Hage et al. 2011). In Poland, birds frequently occurred in *Miscanthus* fields during the breeding season (Kaczmarek et al. 2019).

Population densities in northern Europe are mostly between 0.1 and 1.3 pairs per 10 ha (Glutz von Blotzheim and Bauer 1988).

**Body weight**

Body weight of both sexes is mostly 14–19 g (Snow and Perrins 1998). Mean body weight (16.5 g) must be used for risk assessment.

**Energy expenditure**

No species-specific data is available. Therefore, energy expenditure is calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet in Europe consists almost exclusively of invertebrates. A few seeds also occur in the diet and berries are taken during autumn migration. It hunts from a perch, flying to and taking prey mainly from the ground or in the vegetation (Cramp 1988).

Adult diet consists mainly of insects and is often dominated by Coleoptera*,* Hymenoptera and/or Diptera, but also Orthoptera*,* Dermaptera*,* Heteroptera and Lepidoptera (imagines and larvae) occur frequently. Other animal food items occurring in adult diet are spiders, snails and Oligochaeta (Glutz von Blotzheim and Bauer 1988). Quantitative studies of adult diet are apparently few; in a Ukranian study 98% of the food items were insects, mainly Coleoptera (70%) (n = 14 stomachs, Kusmenko 1977 cited by Glutz von Blotzheim and Bauer 1988).

Nestling diet has been studied in Poland and in Switzerland. In the Polish study, the most common food items in diet were adult Lepidoptera (24.8% by number), Lepidoptera and Symphyta larvae (15.9%), Tipulidae (14.5%) and Orthoptera (12.8%) (Steinfatt 1937 cited by Glutz von Blotzheim and Bauer 1988). The results of the Swiss study are summarized in Table 6.30.

**Table 6.30.** *Whinchat nestling diet in two areas of canton Waadt, Switzerland* *(Labhardt cited by Glutz von Blotzheim and Bauer 1988).*

| **Time of year** | **Food type** | **% of diet (by number)** | |
| --- | --- | --- | --- |
|  |  | **Les Moulins/Pays d’Enhaut** (n = 4198) | **Les Mosses**  (n = 1531 items) |
| **Breeding season** | Hymenoptera1 | 27 | 60 |
|  | Coleoptera | 27 | 2 |
|  | Diptera | 21 | 12 |
|  | Lepidoptera2 | 14 | 19 |
|  | Orthoptera | 3 | 3 |
|  | Heteroptera | 1 |  |
|  | Gastropoda | 3 | 2 |
|  | Araneidae | 2 | 2 |
|  | Oligochaeta | 1 |  |

1 almost exclusively Symphyta larvae

2 mainly larvae.

### Whitethroat *Sylvia communis* (insectivore)

****

Whitethroat (*Sylvia communis*), Photo: C. Dietzen

**Risk assessment**

The whitethroat is relevant for the following crop scenarios:

* winter rape, from development of flower buds to laying in swaths (BBCH 40-89)
* spring rape, from development of flower buds to laying in swaths (BBCH 40-89)
* bush berries, during development and ripening of fruits (BBCH 70-89) (canopy directed applications)

A body weight of 15.5 g must be used in risk assessment (see section on body weight below).

In rape fields, the diet of whitethroats may be assumed to consist entirely of foliar arthropods (PD = 1). In bush berries, when fruits are present, the diet may be assumed to consist of 50% berries and 50% foliar arthropods (by fresh weight).

Whitethroats holding territories in rape fields may be assumed to perform almost all of their feeding within the field (PT ≈ 1), but for the general farmland population PT may be as low as 0.08 (cf. Sell and Odderskær 1990).

There are no species-specific data allowing a refinement of PT for whitethroats feeding in orchards.

**General information**

The whitethroat is widespread and abundant in Denmark, the Baltic States, southern and western Norway, southern Sweden and southern Finland. It is generally absent from the boreal and montane parts of the Scandinavian peninsula (north of the 14 °C July isothermal line), where its occurrence is largely limited to areas near the coast (Cramp 1992).

Whitethroat populations in western and central Europe crashed around 1970, due to several years of serious drought in their Sub-Saharan winter quarters (e.g. Marchant et al. 1990), while east European populations were less affected. Since the mid-1970s whitethroat populations have been rather stable with some tendencies of increase (Table 6.31). Whitethroats in south Finnish farmland show an increasing trend before 1984, stability in 1984-2000 and moderate increase in 2001-2011 (Tiainen et al. 2008, 2012b).

Table 6.31. *Population size and trends of whitethroat (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 300,000-450,000 | 2000 | Decline; 20-49% | Fluctuating |
| Estonia | 100,000-200,000 | 1998 | Increase; 20-49% | Stable |
| Finland | 250,000-400,000 | 1998-2002 | Stable | Decline; 10% |
| Latvia | 300,000-500,000 | 1990-2000 | Stable | Increase; 50-79% |
| Lithuania | 400,000-500,000 | 1999-2001 | Stable | Stable |
| Norway | 50,000-300,000 | 1990-2003 | Stable | Stable |
| Sweden | 250,000 | 2008 | Increase; 20-49% | Increase; 31% |

The whitethroats arrive at their breeding grounds during May, with arrivals stretching into June in the northernmost part of the range. They start breeding shortly after arrival, i.e. from mid-May in Denmark. In Finland, egg-laying may occur from the 3rd week of May and normally peaks during the first half of June (von Haartman 1969). Whitethroats are usually single-brooded in northern Europe although two broods may occur. The breeding season ends in July and the birds leave mainly between early August and early September.

**Agricultural association**

Whitethroats are found chiefly in open countryside with hedgerows, shrubs and bushy verges of larger drainage ditches, but also occupy early successional woodland, forest edges and clearings. In farmland, whitethroats are usually dependent on the presence of hedgerows, scrub or rough herbage for breeding but they may also establish territories and attempt nesting in winter rape (Persson 1971, Cavallin 1988). The species may also occur in orchards (Cramp 1992).

The general density in large agricultural landscapes in Finland was 0.12-0.25 territories/ha (Tiainen and Seimola 2010). In Åland, the density was 1.7 territories/ha in bushes in open agricultural landscape, 0.6 in environmental fallow fields, 0.55 in dry meadows, 0.12 in field pastures, 0.044 in leys, 0.015 in spring cereals and 0.006 in dicotyledonous crops (Tiainen et al. 2012a).

Whitethroats breeding in winter rape fields probably perform most of their foraging inside the field. Apart from this, the species forages mainly in hedgerows, scrub and tall herbage. Various agricultural crops are also used, especially where adjacent to hedgerows, coverts etc. In a Danish study, whitethroats breeding in hedgerows spent only 8% of their foraging time in crops (Sell and Odderskær 1990), but the percentage may be somewhat higher where suitable conditions prevail. Esbjerg and Petersen (2002) found that whitethroats increased their use of the fields for feeding significantly if herbicide and insecticide use was reduced.

With the exception of winter rape, the crop preferences of whitethroats are not strong. The main requirement may be that crop density and biomass shall be sufficiently high to provide cover and hold an ample population of arthropods. Leafy crops may be preferred. Esbjerg and Petersen (2002) found densities of foraging whitethroats of up to 1 per ha in beet fields during the 2nd half of July; densities in winter and spring cereals were somewhat lower.

After the breeding season, i.e. from about mid-July, whitethroats frequently feed in orchards with bush berries.

**Body weight**

Body weight of both sexes achieves mostly 13-18 g (Snow and Perrins 1998). Mean body weight (15.5 g) must be used for risk assessment.

**Energy expenditure**

The daily energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

In spring and during the breeding season, whitethroats feed almost exclusively on arthropods, particularly Heteroptera, Coleoptera, Hymenoptera and Lepidoptera. In late summer, fruits and berries enter the diet. Nestlings are fed insects and other invertebrates.

Whitethroats forage mainly in low trees, bushes and herbage (including agricultural crops) by searching the foliage and small branches. Less frequently, insects are taken in flight or from the ground (Christensen et al. 1996).

The occurrence of fruits and berries in the diet has been studied in East Germany (Emmrich 1973 cited in Cramp 1988). The results are presented as the percent of stomachs containing the fruit type in question (Table 6.32); all other food items were invertebrates.

Table 6.32. *The occurrence of fruits in stomachs of whitethroats from East Germany. n = no. of stomachs analysed.* (*Emmrich 1973 cited in Cramp 1988).*

| **Time of year** | **Food type** | **% of stomachs with food item** |
| --- | --- | --- |
| **4-31 May** | *Ribes* fruit | 18 |
| (n=11) |  |  |
| **18 Jul.-19 Aug.** | *Rubus* fruit | 52 |
| (n=32) | *Ribes* fruit | 28 |
|  | *Hippophaë* fruit | 6 |
|  | other fruits | 3 |
| **22 Aug.-11 Sep.** | *Sambucus* fruit | 56 |
| (n=9) | *Ribes* fruit | 44 |
|  | *Rubus* fruit | 22 |
|  | other fruits | 11 |

### Willow warbler *Phylloscopus trochilus* (insectivore)



Willow warbler (*Phylloscopus trochilus*), Photo: C. Dietzen

**Risk assessment**

The willow warbler is relevant for the following crop scenarios:

* maize, BBCH 30-39, BBCH ≥ 40
* forestry (broad-leaf), canopy directed application, mature stands, April-September

A body weight of 9.5 g must be used in risk assessment (see section on body weight below).

The diet may be assumed to consist almost entirely of foliar arthropods; judged from the study mentioned below (Table 6.34.) ground arthropods make up ≤ 5% of diet.

There are no species-specific data allowing a refinement of PT.

**General information**

The willow warbler is a widespread and abundant species throughout the Northern Zone. Its main habitat is birch forest, where it may be extremely numerous, but it also occurs in other types of forest and woodland, scrub (including willows) and secondary growth. It is often attracted to fringe areas, including forest clearings, especially with birches. Being a forest generalist species, it readily responds to small and shifting ecological niches (Snow and Perrins 1998).

Willow warblers are Trans-Saharan migrants and, as in many other species wintering in tropical Africa, the European populations have suffered some recent declines. Still, it may well be the most numerous bird species in Fennoscandia (Table 6.33).

Table 6.33. *Population size and trends of willow warbler (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 400,000-600,000 | 2000 | Stable | Decline; 10-19% |
| Estonia | 800,000-2,000,000 | 1998 | Stable | Increase; 20-29% |
| Finland | 7,000,000-11,000,000 | 1998-2002 | Stable | Decline; 15% |
| Latvia | 500,000-600,000 | 1990-2000 | Stable | Stable |
| Lithuania | 400,000-600,000 | 1999-2001 | Stable | Stable |
| Norway | 2,000,000-10,000,000 | 1995-2002 | Stable | Stable |
| Sweden | 13,000,000 | 2008 | Increase; 20-49% | Decline; 14% |

Willow warblers arrive at their breeding grounds from mid-April until the end of May. Main arrival is from 21 April to 15 May in southern and central Sweden, 11-25 May in northern Sweden. At Lake Ladoga, near the Gulf of Finland, most local birds arrive 15-20 May (Snow and Perrins 1998). Egg-laying occurs mainly between late May and mid-June in Fennoscandia, with an average delay of 1.0–1.5 days per degree of latitude (Tiainen 1991). Willow warblers are considered single-brooded in Fennoscandia, but in case of nest loss re-layings may occur until early or mid-July (Tiainen 1991). Autumn migration begins in late July, peaks during the 2nd half of August, and the last birds leave the breeding areas in late September.

**Agricultural association**

In the Central European lowlands and the British Isles, and also in the southern part of the Northern Zone, willow warblers are linked with arboreal habitats and in farmland areas the species occurs in hedgerows, trees and shrub around ponds, and other non-crop habitats (Glutz von Blotzheim and Bauer 1991, Petersen 1998). Williow warblers may occur in orchards (Cramp 1992) but are apparently not reported from arable crops. Further north the niche is broader, reflecting more generalistic habits. In Norway, the species is frequently found in maize fields and also occurs, albeit less frequently, in oilseed rape, field grown vegetables and bush berries (Hage et al. 2011).

**Body weight**

Body weight is mostly 7-12 g (Snow and Perrins 1998); females are c. 10% lighter than males (J. Tiainen pers. comm.). Mean body weight (9.5 g) must be used for risk assessment.

**Energy expenditure**

The daily energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet consists of insects and spiders, and in autumn also some berries. Food is obtained mostly by picking from leaves, twigs and branches, but hovering, fly-catching in air and ground feeding are also used (Cramp 1992). Food choice largely reflects availability but Diptera, Hymenoptera and larval Lepidoptera seem to be preferred (Glutz von Blotzheim and Bauer 1991).

Many quantitative studies of diet exist, but in almost all studies diet composition was reported as percent (or number) of food items. Furthermore, these studies are assumed to reflect diet composition in wooded habitats. However, in a study of spring migrants on a Danish island, willow warbler diet composition (as determined by stomach flushing) was also reported as percent of dry weight (Table 6.34).

Table 6.34. *Diet composition of willow warblers staging on the island of Hjelm, Denmark (Laursen 1978 cited by Buxton et al. 1998).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of diet dry weight** |
| **May** | Homoptera (Aphididae, Psylloidea) | 37 |
|  | Diptera | 24 |
|  | Lepidoptera larvae | 21 |
|  | Coleoptera (mainly Curculionidae) | 7 |
|  | Hymenoptera (mainly Tenthredinoidea) | 7 |
|  | Araneae | 5 |

* + 1. Goldcrest *Regulus regulus* (insectivore)

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Goldcrest (*Regulus regulus*), Photo: J. Gerlach

**Risk assessment**

The goldcrest is relevant for the following crop scenarios:

* Christmas trees and decorative greenery (all stages, canopy-directed applications)
* forestry (conifer), young/mature stands, all season (canopy-directed applications)

A body weight of 5.7 g must be used in risk assessment (see section on body weight below).

The diet of goldcrests may be assumed to consist entirely of foliar arthropods (PD = 1).

Goldcrests holding territories in Christmas trees and decorative greenery plantations may be assumed to perform almost all of their feeding within the plantation (PT = 1).

There are no species-specific data allowing a refinement of PT for goldcrests feeding in Christmas trees and decorative greenery plantations. Refinement of PT has to be supported by appropriate data.

**General information**

The goldcrest breeds in middle and upper temperate and boreal latitudes between July isothermal lines of 13 and 24 °C (Cramp 1992). It is a widespread and abundant inhabitant of coniferous forests in Denmark, the Baltic and Fennoscandia. The northern distribution appears to be limited by the breeding season mean temperature, which, if lower than 10 °C, reduces breeding success (Hagemeijer and Blair 1997). A northward spread was recorded in Norway and Finland during late 20th century (Cramp 1992).

Its European breeding population is extremely large, and was stable between 1970-1990. Although there were some declines, e.g. in Sweden, during 1990-2000, populations were stable or increased across most of the rest of Europe (BirdLife International 2004; Table 6.35).

**Table 6.35.** *Population size and trends of goldcrests (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 50,000-150,000 | 2000 | Stable | Decline; 30-49% |
| Estonia | 100,000-300,000 | 1998 | Increase; 20-49% | Fluctuating |
| Finland | 600,000-1,600,000 | 1998-2002 | Fluctuating | Increase; 25% |
| Latvia | 500,000-700,000 | 1990-2000 | Fluctuating | Stable |
| Lithuania | 400,000-600,000 | 1999-2001 | Stable | Stable |
| Norway | 500,000-1,000,000 | 1990-2002 | Stable | Fluctuating |
| Sweden | 2,000,000-4,000,000 | 1999-2000 | Stable | Decline; 30% |

European race, nominate *regulus*, winters within and south of the breeding range, and vacates entirely only the extreme north of the range in Fennoscandia and USSR; data from Finland show that proportion of residents increases progressively southward. Main movement in northern Europe occurs from late March to late April or early May, peaking early to mid-April; median passage date 13 April at Ottenby (Sweden); on Lågskär island (south-west Finland), average 1st record over 11 years was 25 March (Cramp 1992).

Breeding starts shortly after arrival, i.e. from early May, with main season from mid-May until early July. Two broods are the norm, breeding season usually ends in July or early August the latest. Migratory birds leave the breeding areas from late August onwards (Cramp 1992) while sedentary populations may stay year-round with only small scale movements in the immediate neighbourhood.

**Agricultural association**

In the breeding season, strictly arboreal, attached to more or less dense stands of well-grown conifers, whether in lowlands or on mountains up to treeline. Prefers spruce *Picea abies*, silver fir *Abies alba*, and mountain pine *Pinus mugo*, and in artificial situations also Douglas fir *Pseudotsuga taxifolia* and some other introduced conifers (e.g. Sitka spruce *Picea sitchensis*, Caucasian (Nordmann) fir *Abies normanniana*). Larch *Larix*, Scots pine *Pinus sylvestris*, and other conifers are less attractive (Cramp 1992) but inhabited nevertheless (Donald et al. 1997, Gillings et al. 2000, Hansson 1983, Suhonen 1993). Goldcrests were frequently recorded even in young conifer plantations and successions in Scandinavia (Jansson and Andren 2003) and other parts of Europe (Bibby et al. 1985, Donald et al. 1998, Gillings et al. 2000, Insley and Wood 1973). Will inhabit broad-leaved woods only when at least a few spruce or firs are mixed in, and will colonize parks, cemeteries, and similar artificial areas only when they offer suitable conifers which are not otherwise locally available (Cramp 1992). During migration and outside breeding season foraging birds will also visit broad-leaved trees, often in association with other species in mixed flocks.

The general density in coniferous forests or plantations in southern Finland was 4-6 territories/10 ha in spruce (Glutz and Bauer 1991). In Estonia, densities of up to 19-32 (average 25-27) pairs/km² are reported in spruce-dominated nemoral forests (Leibak et al. 1994).

**Body weight**

Body weight of nominate males (average 5.7 g, range 4.0 – 7.7 g) and females (average 5.6 g, range 4.0 – 7.8 g) is similar (Cramp 1992). A mean body weight of 5.7 g must be used for risk assessment.

**Energy expenditure**

The daily energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

Goldcrests forage alsmost exclusively on insects (especially Hemiptera, Collembola, and larval Lepidoptera) and spiders (see below). Food obtained mainly from twigs in tree-crowns; less often from herb layer or ground (mostly during late autumn and winter) (Cramp 1992). Captive birds given choice of feeding in beech *Fagus* or spruce *Picea* spent c. 7% of time in beech and c. 93% in spruce. In coniferous trees, prefers to forage among denser branches. In Finland, spruce and pine are preferred, birds were only rarely feeding in birch *Betula* (Cramp 1992).

Food obtained from upper and lower surface of branches, where birds are fluttering and climbing about. Four main feeding methods are reported: (1) standing on upperside of branch, c. 23% of feeding time; (2) moving upwards on vertical twig, c. 58%; (3) moving downwards on vertical twig, c. 16%; (4) hovering in front of branch, c. 3%. Flying insects taken in hovering flight but not pursued, and will hover in front of spider's web to take trapped insects (Cramp 1992).

Diet in west Palearctic includes the following. Invertebrates: springtails (Collembola), damsel flies and dragon-flies (Odonata), stoneflies (Plecoptera), crickets, etc. (Orthoptera: Gryllidae, Tettigoniidae), Psocoptera, eggs, nymphs, and adult bugs (Hemiptera: Lygaeidae, Cynipidae, Fulgoroidea, Psyllidae, Cicadidae, Jassidae, Coccoidea, Pentatomidae, Reduviidae, Nabiidae, Tingidae, Coreidae, Aphidoidea, Adelgidae), thrips (Thysanoptera), lacewings, etc. (Neuroptera: Hemerobiidae, Chrysopidae), larval Lepidoptera (Pyralidae, Psychidae, Tortricidae, Noctuidae), adult caddis flies (Trichoptera), adult and larval flies (Diptera: Mycetophilidae, Trichoceridae, Tipulidae, Culicidae, Bibionidae, Syrphidae, Phoridae, Chironomidae, Empididae, Cecidomyiidae, Muscidae, Tachinidae), adult and larval Hymenoptera (Cephidae, Tenthredinidae, Ichneumonoidea, Chalcidoidea, Proctotrupoidea, ants Formicidae, bees Apoidea), adult and larval beetles (Coleoptera: Carabidae, Staphylinidae, Scarabaeidae, Lathridiidae, Elateridae, Dermestidae, Tenebrionidae, Coccinellidae, Cerambycidae, Chrysomelidae, Curculionidae, Scolytidae), spiders (Araneae: Pisauridae), harvestmen (Opiliones), mites (Acari: Ixodidae, Oribatidae), snails (Gastropoda). Plant material: seeds of spruce *Picea* and pine *Pinus* (Cramp 1992).

### Blue tit *Cyanistes caeruleus* (omnivore)

****

Blue tit (*Cyanistes caeruleus*), Photo: M. Grimm

**Risk assessment**

The blue tit is relevant for the following scenarios:

* fruit trees, canopy directed applications
* bush berries, canopy directed applications
* ornamentals and nursery, canopy directed applications
* forestry (broad-leaf), canopy direted applications, young stands, all season

A body weight of 11 g must be used in risk assessment (see section on body weight below).

During March-September, the diet may be assumed to consist entirely of foliar arthropods (PD = 1). Outside this period, nuts and seeds from trees enter the diet but probably never make up more than 50%; this part of the diet shall be regarded as unsprayed.

For applications in (March) April-September, PT in orchards, bush berries and ornamentals/ nursery may be refined using the information in Table 6.37..

**General information**

The blue tit is widespread and common throughout the Northern Zone south of the July isothermal line of 14 °C (Snow and Perrins 1998). Its primary habitat is deciduous woodland but it also occurs in coppice, overgrown marshes and mires etc. The species is frequent in parks, gardens and other man-made habitats, provided suitable nest-holes are available.

Blue tits are resident in the southern part of the Northern Zone while birds from northern populations are partial migrants. Northern birds make irregular eruptive movements, mainly towards south-west (Snow and Perrins 1998). Populations may be somewhat fluctuating, perhaps related to winter temperatures, but overall numbers have probably increased during recent decades (Table 6.36).

Table 6.36. *Population size and trends of blue tit (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 200,000-250,000 | 2000 | Fluctuating | Fluctuating |
| Estonia | 50,000-100,000 | 1998 | Increase; 20-49% | Increase; 20-29% |
| Finland | 400,000-650,000 | 1998-2002 | Increase; ≥ 50% | Increase; 220% |
| Latvia | 100,000-140,000 | 1990-2000 | Stable | Stable |
| Lithuania | 70,000-110,000 | 1999-2001 | Stable | Stable |
| Norway | 100,000-200,000 | 1990-2002 | Stable | Increase; < 20% |
| Sweden | 700,000 | 2008 | Stable | Decline; 3% |

Over much of central and northern Europe egg-laying begins mostly in the last week of April and the first few days of May (Snow and Perrins 1998), maybe a little later further north. Median laying date is 7 May in south-west Sweden and southern Finland (Cramp and Perrins 1993, Glutz von Blotzheim and Bauer 1993). Blue tits are usually single-brooded, but in some populations 10 to 50% of the breeding pairs may produce a 2nd clutch in some years (Cramp and Perrins 1993, Glutz von Blotzheim and Bauer 1993). Clutch size (mostly 10-12, occasionally 16-18) is the largest among European passerines.

**Agricultural association**

Blue tits are fairly common in rural gardens, deciduous hedgerows and habitat islands, but the species is not considered relevant for field crops due to its habitat preferences of broad-leaved forest, parks and gardens (Svensson et al. 1999, Larsen and Heldbjerg 2009). The habitat preferences include orchards and nurseries, provided suitable nest-holes are available. The mean density of blue tit territories in small forest patches of Swedish farmland were 0.4 territories/ha (Loman 1999).

In a study of orchards in the UK, 20 blue tits were radio-tracked to estimate the active time spent in this habitat (Crocker et al. 1998, Finch et al. 2006, Prosser 2010). The results are summarized in Table 6.37.

Table 6.37. *Percentage of active time spent by radio-tagged blue tits in orchards in the UK, presented as 90th percentile of the modelled PT distribution. The birds were caught inside the orchard or along the orchard edge; it is therefore recommended to use the values for the total sample of tracked birds (bold)*. *Data basis of .Finch et al. 2006 and Prosser 2010 are the same.*

| **Crop** | **Period** | **No. of birds** | **Mean** | **90 percentile** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| ***All birds:*** | | | | | |
| Orchard | Apr.-Sep. | 20 | 0.21 | 0.55 | Finch et al. 2006 |
|  |  | 20 |  | **0.53** | Prosser 2010 |
| ***Consumers only:*** | | | | | |
| Orchard | Apr.-Sep. | 16 | 0.27 | 0.58 | Finch et al. 2006 |
|  |  | 16 |  | 0.57 | Prosser 2010 |

**Body weight**

Body weight of both sexes is mostly 9.5-12.5 g (Snow and Perrins 1998). Mean body weight (11 g) must be used for risk assessment.

**Energy expenditure**

No species-specific data available, therefore calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

Blue tits are mostly foraging in the foliage of trees and bushes (Cramp and Perrins 1993). Ground-feeding occurs mainly in winter, when searching for beech mast etc. In an English study, the percentage of feeding observations on the ground was as follows: January-February 10-15%, March 4%, April 2%, May-August 0%, September-October 1%, November 5%, December 7 (Gibb 1954 cited in Cramp and Perrins 1993). Corresponding data from Sweden are 0% in September, 2% October, 1.5% November, 0.5% December, 1% January, 0% February, 0.5% March and 2% April (Ulfstrand 1962 cited in Cramp and Perrins 1993).

The diet of blue tits is reflecting seasonal changes with more seeds and fruits in winter and almost exclusively invertebrates in the breeding season (Cramp and Perrins 1993). In SW England, nuts and seeds from trees (beech, oak, chestnut, birch) were found in 13% of blue tit gizzards in September, 59% in October, 44% in November, 40% in December, 31% in January, 7% in February and 0% in March-August (Betts 1955 cited in Cramp and Perrins 1993). More detailed, quantitative data on diet composition are apparently not available, but invertebrates almost certainly make up the bulk of the diet throughout the year. The nestling diet consists of invertebrates (Cowie and Hinsley 1988). A study on composition of nestling diet indicates importance of Lepidoptera (61.7%, of which 57.6% larvae, 1.8% pupae and 2.3% adults), supplemented by spiders (18.5%), beetles (0.6%) and other items (10.1%, incl. Dermaptera, Dictyoptera, Diptera, Hemiptera, Hymenoptera, Neuroptera, Phthiraptera, Diplopoda, Oligochaeta, Gastropoda and vegetal material; Ceia et al. 2016).

### Starling *Sturnus vulgaris* (omnivore)



Starling (*Sturnus vulgaris*), Photo: M. Grimm

**Risk assessment**

Being a partial frugivore, the starling is relevant for the following scenarios:

* strawberries, BBCH 60-89
* fruit trees (cherry, plum), canopy directed applications during BBCH 60-89

A body weight of 75 g must be used in risk assessment (see section on body weight below).

The starling would also be relevant in grassland, which is its main foraging habitat, but here smaller species, such as yellow wagtail, represent the worst case.

Based on the information presented below, the following composition of diet may be assumed for these scenarios (Table 6.38).

**Table 6.38.** *Estimated diet composition to be used in risk assessment for starlings feeding on strawberries, cherries or plums.*

|  |  |
| --- | --- |
| **Strawberries, BBCH 60-89** | |
| **Food category** | **PD (fresh weight)** |
| Large seeds | 0.04 |
| Small seeds | 0.01 |
| Berries | 0.27 |
| Ground arthropods | 0.68 |
| **Orchard (plum, cherry), canopy directed applications during BBCH 60-89** | |
| **Food category** | **PD (fresh weight)** |
| Large seeds | 0.04 |
| Small seeds | 0.01 |
| Small fruit from orchards | 0.27 |
| Ground arthropods | 0.68 |

For those elements of the diet which are obtained from the ground, i.e. seeds and ground arthropods, interception in the crop or canopy shall be taken into account.

It is highly probable that not all of the food will be obtained within the treated area (PT < 1). However, specific data allowing a refinement of PT are not available.

**General information**

North European starling populations have suffered pronounced declines in recent decades but the species is still common and widespread across most of the Northern Zone (Table 6.39). Starlings depend on open areas, such as grassland, field crops or floodlands, for foraging, but also need suitable holes (natural or man-made) for nesting. Through more than a century, the starling benefited from the clearing of forests, establishment of human settlements and spread of agriculture in northern Europe. Its range and population size probably reached a maximum during the 1960s, after which most populations have declined (Rintala and Tiainen 2007, 2008). Agricultural intensification in general, and structural changes within farmland in particular, may well be the main reasons for the decline. At least in Finland, the major driver was probably the dramatic decline of dairy husbandry and the consequent decrease in availability of good starling habitat (Rintala and Tiainen 2007, 2008).

Table 6.39. *Population size and trends of starling (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 400,000-600,000 | 2000 | Decline; 20-49% | Decline; 20-29% |
| Estonia | 20,000-50,000 | 1998 | Decline; ≥ 50% | Decline; 20-29% |
| Finland | 30,000-60,000 | 1998-2002 | Decline; ≥ 50% | Decline; 30% |
| Latvia | 50,000-250,000 | 1990-2000 | Decline; ≥ 50% | Decline; < 20% |
| Lithuania | 250,000-300,000 | 1999-2001 | Stable | Stable |
| Norway | 200,000-500,000 | 1990-2003 | Decline; 20-49% | Decline; 20-29% |
| Sweden | 640,000 | 2008 | Decline; ≥ 50% | Decline; 12% |

The species is generally migratory within the Northern Zone, albeit with an increasing tendency for urban starlings to remain resident in southern Sweden, Denmark and southern and western Norway, especially in mild winters (Snow and Perrins 1998). Winter quarters are mainly in the Channel area.

Arrival in spring is in early March in the south, continuing throughout April in the north. Starlings are semi-colonial and breeding is synchronized, with almost all layings occurring in late April and early May in Denmark and southern Sweden and one week later in northern Finland (Cramp and Perrins 1994a). Usually single-brooded but two broods may occur, especially in the southern parts of the Northern Zone. Most young fledge between late May and mid-June. In late June and July, juveniles and some adults disperse, mainly in a south-westerly direction and often over several hundred kilometres, to gather at suitable feeding areas, e.g. in the Wadden Sea area. The breeding grounds may thus be vacated after midsummer, but in many areas within the Northern Zone large flocks may be found foraging on pastures until September. Autumn migration takes place mostly between mid-September and early November.

**Agricultural association**

Starlings are associated with open country, particularly grasslands. They breed in open forest, woodland edge, around farms, in villages and in urban areas, but always near grassland (including lawns, golf courses etc.).

Feeding is mainly on the ground in open areas of short grass, but salt marshes and intertidal zones are also used, particularly during migration. Among the different categories of grassland, rotational or permanent pastures and old leys are preferred (Tiainen et al. 1989, Whitehead et al. 1995, Petersen 1996b). However, sward height and density does not significantly affect foraging efficiency of starlings (Devereux et al. 2006). In late summer and autumn, stubble fields, newly-sown fields, orchards and thickets with berries are also used; e.g., in southern England up to 40% of the foraging birds were recorded in stubble fields and up to 10% in trees (Christensen et al. 1996).

**Body weight**

Body weight is somewhat variable, ♂ mostly 70-90, ♀ mostly 60-90 g (Snow and Perrins 1998). Mean body weight of the smaller sex (♀: 75 g) must be used for risk assessment.

**Energy expenditure**

According to English data, the daily energy expenditure is highest in spring (c. 290 kJ/day) and lowest in summer (c. 200 kJ/day) (Christensen et al. 1996). The intake of captive adult starlings was 210-265 kJ/day if kept on animal food. Alternatively, the energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet consists of animal as well as vegetable matter throughout the year, but the relative proportions vary with the annual cycle (and are parallelled by changes in the length of the intestine). Invertebrates dominate in spring and summer while vegetable matter comprises a high proportion of the diet during autumn and winter. The proportion of vegetable matter in the diet is less than 50% from April to June and 50-95% during the rest of the year (Christensen et al. 1996). In a Polish study of adult diet, 85% of all food items were animal during February-September (Gromadzki 1969), and in a similar Czech study, 69% of all food items were animal in March-November (Havlin and Folk 1965 cited in Christensen 1996 and Cramp and Perrins 1994a), see also Table 6.40. In both of these studies, almost no vegetable food items were taken between March and June.

Invertebrate food is collected from the soil surface or just below the soil surface by bill-probing. Insects such as Coleoptera, Diptera (e.g. *Tipula*) larvae, Hymenoptera and Lepidoptera larvae dominate but spiders and earthworms also occur in the diet. Nestling diet consists almost entirely of invertebrates (mainlyColeoptera, Diptera and Lepidoptera).

Vegetable food is mainly seeds, including cereal grain, but also fruits during summer and autumn. In a Polish study of 85 stomachs, cultivated fruits were found in up to 70% of stomachs (varying proportions in different months), cereal grain in up to 60%, wild seeds in up to 40% and wild fruits in up to 30% (Gromadzki 1969).

Havlin and Folk (1965) studied the composition of diet in adult starlings in Czechoslovakia during March-November by means of stomach analysis. The results are presented as percentage of food items (Table 6.40).

Table 6.40. *Diet composition of adult starlings in Czechoslovakia* (Havlin and Folk 1965 cited in Christensen 1996 and Cramp and Perrins 1994a)*.*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of food items** |
| **March-November** | Hymenoptera (mainly ants) | 30.5 |
| (n = 9,917) | Coleoptera | 27.0 |
|  | Wild fruit | 19.1 |
|  | Cultivated fruit | 7.3 |
|  | Diptera | 6.6 |
|  | Ceral grain | 3.4 |
|  | Spiders | 1.4 |
|  | Lepidoptera | 1.4 |
|  | Wild seeds | 0.7 |
|  | Others | 2.5 |

### Chaffinch *Fringilla coelebs* (omnivore)



Chaffinch (*Fringilla coelebs*), Photo: J. Gerlach

**Risk assessment**

The chaffinch is a relevant focal species for the following scenarios:

* orchards (all applications)
* bush berries, all season
* ornamentals/nursey, large plants (canopy and ground-directed applications)
* Christmas trees and decorative greenery: ground- and canopy-directed applications small and large plants (all season)
* forestry (broad-leaf), young/mature/clear-cut forests, all season
* forestry (conifer), young/mature/clear-cut forests, all season

A body weight of 21 g must be used in risk assessment (see section on body weight below).

The diet of chaffinches is varied and depends on the feeding habitat and the time of year. For the crops/cultures of relevance, the following composition of diet may be assumed (Table 6.41).

**Table 6.41.** *Estimated diet composition of chaffinches feeding in fruit trees, bush berries and ornamentals/nursery cultures (expert judgement based upon Table 6.44, Table 6.45 and Table 6.46).*

|  |  |
| --- | --- |
| **March-April** | |
| **Food category** | **PD (fresh weight)** |
| Small (weed) seeds | 0.90 |
| Ground arthropods | 0.10 |

|  |  |
| --- | --- |
| **May-July** | |
| **Food category** | **PD (fresh weight)** |
| Small (weed) seeds | 0.20 |
| Foliar arthropods | 0.40 |
| Ground arthropods | 0.40 |

|  |  |
| --- | --- |
| **August-September** | |
| **Food category** | **PD (fresh weight)** |
| Small (weed) seeds | 0.75 |
| Foliar arthropods | 0.10 |
| Ground arthropods | 0.15 |

For canopy-directed applications, interception by the canopy shall be taken into account for seeds and ground-dwelling arthropods.

Chaffinches are capable of dehusking, but small seeds are usually not dehusked (Buxton et al. 1998). Hence, including a dehusking factor in the calculations of exposure is probably not justified for the above scenarios.

PT in orchards, bush berries and ornamentals/ nursery may be refined using the information in Table 6.43.

**General information**

The chaffinch is one of the most numerous breeding bird species in northern Europe. It is widespread and abundant throughout the Northern Zone south of the July isothermal line of 12 °C (Snow and Perrins 1998). The breeding populations are apparently mainly stable (Table 6.42).

Table 6.42. *Population size and trends of chaffinch (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 1,500,000-2,000,000 | 2000 | Increase; 20-49% | Stable |
| Estonia | 1,500,000-2,500,000 | 1998 | Stable | Stable |
| Finland | 5,000,000-7,000,000 | 1998-2002 | Decline; 20-49% | Stable |
| Latvia | 2,600,000-3,200,000 | 1990-2000 | Stable | Stable |
| Lithuania | 2,500,000-3,500,000 | 1999-2001 | Stable | Stable |
| Norway | 1,000,000-1,500,000 | 1990-2002 | Stable | Stable |
| Sweden | 8,400,000 | 2008 | Stable | Decline; 9% |

Chaffinches are migratory across most of the Northern Zone, but some birds winter in the southern part, especially in years with a high production of beech mast. Most birds arrive at their breeding grounds during March-April and breeding takes place mainly in May-June. Remarkably for such a small bird, chaffinches are usually single-brooded and produce only 4-5 eggs per clutch. Autumn migration takes place mainly between mid-September and late October.

**Agricultural association**

Chaffinches are essentially forest and woodland birds but are commonly found at almost any site with trees, including orchards, rural gardens, and hedgerows and coverts in farmland. However, breeding populations in farmland are probably small compared with the primary populations in forest.

Chaffinches occur in farmland all year round, and especially during migration periods large flocks are often seen foraging on open fields. Low and open crops that do not impede the birds’ movements on the ground are probably preferred, but crop preferences are not strong (Petersen 1996b). Farmland may be a particularly important feeding habitat in years where the production of beechmast and other forest seeds is small.

In a study of orchards in the UK, 33 chaffinches were radio-tracked to estimate the active time spent in this habitat (Crocker et al. 1998, Finch and Payne 2006, Prosser 2010). The results are summarized in Table 6.43.

Table 6.43. *Percentage of active time spent by radio-tagged chaffinches in orchards in the UK, presented as 90th percentile of the modelled PT distribution. The birds were caught inside the orchard or along the orchard edge; it is therefore recommended to use the values for the total sample of tracked birds (bold)*.

| **Crop** | **Period** | **No. of birds** | **Mean** | **90 percentile** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| ***All birds:*** | | | | | |
| Orchard | Apr.-Sep. | 33 | 0.32 | 0.74 | Finch et al. 2006 |
|  |  | 28 |  | **0.77** | Prosser 2010 |
| ***Consumers only:*** | | | | | |
| Orchard | Apr.-Sep. | 29 | 0.36 | 0.76 | Finch et al. 2006 |
|  |  | 24 |  | 0.80 | Prosser 2010 |

**Body weight**

Mean body weight is for ♂ 21.9 and for ♀ 20.9 g (Buxton et al. 1998). A body weight of 21 g must be used for risk assessment.

**Energy expenditure**

The energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet of chaffinches is varied; it consists mainly of seeds and other plant material which are usually taken from the ground. During the breeding season, insects and other invertebrates make up the bulk of the diet and foraging in trees is more frequent. However, studies in the UK showed large portions of seeds during breeding (85%) and non-breeding (95%) seasons in adult birds, while nestlings were fed exclusively on invertebrates (Holland et al. 2006). The seeds taken range in weight from 0.1 mg (*Artemisia*) to 230 mg (beech) (Newton 1967). Cereal seeds comprised 44% of diet in the breeding season (Holland et al. 2006). Seeds are dehusked except for small and long seeds which are crushed (Buxton et al. 1998).

The diet of chaffinches has been investigated in all-year studies in Germany (Eber 1956) and England (Newton 1967). The results are shown in Table 6.44 to Table 6.46.

Table 6.44 *Seasonal variation in Chaffinch diet in England, analysed from gut contents (Newton 1967).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of volume** |
| **May to mid-July** | Seeds | 19 |
|  | Invertebrates | 81 |
| **mid-July to September** | Cereal grain | 56 |
|  | Weed seeds | 25 |
|  | Other seeds | 4 |
|  | Invertebrates | 15 |
| **October to April** | Cereal grain | 30 |
|  | Weed seeds | 65 |
|  | Invertebrates | 5 |

Table 6.45. *Seasonal variation in the ratio between plant and animal matter in Chaffinch diet in Germany, analysed from gut contents (Eber 1956).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of items** |
| **March-April** | Plant | 90 |
|  | Animal | 10 |
| **May-July** | Plant | 30 |
|  | Animal | 70 |
| **August-September** | Plant | 63 |
|  | Animal | 37 |
| **October-February** | Plant | 99 |
|  | Animal | 1 |

Table 6.46. *The composition of Chaffinch diet in Schleswig-Holstein, Germany, analysed from feeding observations (Christensen et al. 1996).*

| **Time of year** | **Food type** | **% of diet** |
| --- | --- | --- |
| **All year** | Cereal grain | 49 |
|  | Beech mast | 28 |
|  | Invertebrates | 9 |
|  | Asteraceae seeds | 5 |
|  | Brassicaceae seeds | 4 |
|  | Polygonaceae seeds | 4 |

The diet of chaffinch nestlings consists almost exclusively of invertebrates and includes foliage insects (e.g. aphids, Lepidoptera larvae), ground-dwelling invertebrates (e.g. Coleoptera and their larvae, Dermaptera, spiders, snails, earthworm cocoons) and even airborne insects (e.g. Lepidoptera*,* Diptera). The amount of vegetable matter is < 10% in all studies.

### Linnet *Carduelis cannabina* (granivore)

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Linnet (*Carduelis cannabina*), Photo: J. Gerlach

**Risk assessment**

The linnet is relevant for the following scenarios:

* winter rape, from flowering (BBCH 60) to post-harvest
* spring rape, from flowering (BBCH 60) to post-harvest
* beets, BBCH 10-49
* pulses, BBCH 10-39
* field grown vegetables, BBCH 10-89
* grass; newly sown, long grass with seed heads, and termination
* orchards, ground directed applications
* bush berries, ground directed application, all season
* ornamentals/nursey, all exposure scenarios

A body weight of 18 g must be used in risk assessment (see section on body weight below).

The diet may be assumed to consist entirely of small seeds (PD = 1).

For weed seeds exposed on or near the ground, interception by the crop canopy shall be taken into account as appropriate for the crop and growth stage in question.

There is no information about the relative amounts of rape seeds and weed seeds in the diet of linnets feeding in rape fields. Nor is there any information about the relative amounts of grass seeds and weed seeds in the diet of linnets feeding in grass fields (including grass for seed). In newly-sown grass fields, linnets will take the grass seeds but prefer weed seeds if available. Thus, the relative amounts of grass seeds and weed seeds in the diet will vary.

In risk assessment for seed treatments, it may be assumed that the birds feed entirely on grass seed (worst-case). An 18 g linnet needs 4.9 g (fresh weight) of small seeds to fulfil its average daily requirements.

Seeds are usually dehusked so a dehusking factor may be applied (cf. section 4.7). Case-specific evidence must be provided that dehusking actually plays a role under field conditions for this species.

For linnets feeding in oilseed rape or row crops, PT may be refined using the information in Table 6.48; the PT values for beet will probably also apply to pulses and field grown vegetables. There is no information allowing a refinement of PT for linnets feeding in grass fields.

There are no species-specific data allowing a refinement of PT for linnets feeding in orchards, bush berries or ornamentals/nursery cultures. In orchards, PT values are probably close to those found for chaffinch (Table 6.43), and similar values may well apply for bush berries and ornamentals/nursery.

**General information**

The linnet is widespread and abundant in the southern part of the Northern Zone (Denmark, Lithuania, southern Sweden). It is less numerous further north, reaching northwards until central Sweden and Finland and also occurring in a narrow belt along the coast of the Gulf of Bothnia (Snow and Perrins 1998). In Norway, linnets are mainly found in the agricultural landscape in the south-eastern part of the country (Gjershaug 1994 cited in Hage et al. 2011).

Like several other farmland birds, linnet populations have declined over large parts of western Europe during recent decades, incl. e.g. Sweden (Wretenberg et al. 2007), most probably as a result of agricultural intensification (Table 6.47). In Finland, where the species has increased, it has probably been favoured by set-asides, environmental fallows, organic farming and increasing densities of weeds (Hyvönen et al. 2003, Hyvönen and Huusela-Veistola 2008, Tiainen et al. 2008, 2012b).

Table 6.47. *Population size and trends of linnet (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 150,000-300,000 | 2000 | Increase; 20-49%\* | Decline; 20-29% |
| Estonia | 20,000-40,000 | 1998 | Decline; 20-49% | Stable |
| Finland | 20,000-30,000 | 1998-2002 | Decline; ≥ 50% | Increase; 100% |
| Latvia | 10,000-25,000 | 1990-2000 | Stable | Stable |
| Lithuania | 150,000-300,000 | 1999-2001 | Stable | Stable |
| Norway | 10,000-15,000 | 1990-2002 | Decline; 20-49% | Stable |
| Sweden | 110,000 | 2008 | Decline; 20-49% | Decline; 37% |

\* Probably a mistake. Published studies (Petersen and Nøhr 1991, Heldbjerg and Lerche-Jørgensen 2012) indicate strong decline until 1982 followed by a smaller increase.

Linnets are migratory throughout the Northern Zone, except that a few birds may winter in Denmark, especially in mild winters. The winter quarters are in Western Europe, the Mediterranean area and North Africa. The birds arrive at their breeding grounds during late March-April. Linnets breed from late April or early May to July or early August and usually produce two broods per year. Autumn migration takes place mainly during September-October.

**Agricultural association**

Linnets depend on shrubs and bushes for nest-sites and ready access to foodplants and ground foraging areas. Major habitats are scrub and heathland, farmland with hedges and low trees, orchards, uncultivated areas, young plantations, forest clear-cuts adjoining farmland, and suburban gardens. The species is widespread and locally abundant in farmland, where it is largely associated with rough vegetation at field borders, set-aside, rotational fallow and other uncultivated areas.

Within the arable land, several studies have indicated that linnets are to some extent associated with oilseed rape fields (Petersen 1996b, Crocker and Irving 1999, Mason and Macdonald 2000). Moorcroft et al. (2006) suggest that availability of oilseed rape is important to maintain populations of linnet in intensively managed agricultural systems. In spite of their association with oilseed rape during late spring and summer it seems that linnets only to a very limited extent use freshly-drilled rape fields for feeding, at least in spring (Petersen 1996a).

Crocker and Irving (1999) found linnets to be prevalent and abundant in sugar beet in summer and autumn. Beet fields seem to gain importance from late June onwards, probably as a result of the increasing amounts of available weed seeds (Esbjerg and Petersen 2002). In a Norwegian study, linnets were frequently recorded in field grown vegetables (Hage et al. 2011).

In a British study of radio-tagged birds, linnets using oil-seed rape for foraging (“consumers”) spent on average 44% of their active time within the rape fields (Finch et al. 2006). However, some birds spent almost all of their active time in rape fields. Linnets also used sugar beet and/or potato for foraging, but these crops were less intensively used (Table 6.48).

Table 6.48. *Percentage of active time spent by radio-tagged linnets in different crops in the UK, presented as 90th percentile of the modelled PT distribution. The birds were caught in general farmland (not in specific crops); therefore only values for the subsample of birds who actually used the crop in question (“consumers only”) are suitable for use in higher tier risk assessment (bold)*.

| **Crop** | **Period** | **No. of birds** | **Mean** | **90 percentile** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| ***Consumers only:*** | | | | | |
| Winter rape | April-July | 6 | 0.44 | 0.99 | Finch et al. Payne 2006 |
|  |  | 6 |  | **0.99** | Prosser 2010 |
| Beet  (+ potatoes) | April-Nov. | 11 | 0.25 | 0.59 | Finch et al. 2006 |
|  |  | 11 |  | **0.59** | Prosser 2010 |

**Body weight**

Body weight of ♂ mostly 17-22 g, of ♀ 15-21 g (Snow and Perrins 1998). Mean body weight of the smaller sex (♀: 18 g) must be used for risk assessment.

**Energy expenditure**

A captive linnet (16.9 g) had a BMR of 29.3 kJ/day (Christensen et al. 1996). The daily energy expenditure can be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

Linnets feed almost exclusively on small to medium-sized seeds and are particularly dependent on weeds of open country and waste ground. Over the full annual cycle, seeds from available Brassicaceae seem to be the most common food, but seeds of Caryophyllaceae (*Cerastium, Stellaria*), Polygonaceae (*Polygonum, Chenopodium*) and Asteraceae (e.g. thistles and *Taraxacum*) occur also frequently in the diet. The size of seeds taken ranges from 0.05 to 50 mg, but the main size range is 1-10 mg. Milky seeds are preferred to ripe seeds (Newton 1967). Seeds are dehusked (Buxton et al. 1998).

In an English study, the diet of linnets largely reflected weed abundance and included 25 of the 30 most common weeds in the area but no cereal grains (Newton 1967). By contrast, cereal grain was the most frequent food item in April and in autumn in a study from Schleswig-Holstein, northern Germany (Eber 1956).

Invertebrates, e.g. aphids and Lepidoptera larvae, appear incidentally (1%) in adult (breeding and non-breeding season) and nestling diet, while the seed fraction is composed exclusively of weed seeds (Holland et al. 2006). In an English study, insects occurred in only 2 out of 62 broods, with aphids making up 15% of the diet during the first nine days in one brood. In other studies, nestling diet consisted entirely of seeds. According to some early studies, insects may be predominant food of nestlings, but modern studies conclude that the proportion of invertebrates was rather overestimated in these early studies (Christensen et al. 1996).

* + 1. Siskin *Carduelis spinus* (granivore)

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Siskin (*Carduelis spinus*), Photo: M. Grimm

**Risk assessment**

The siskin is relevant for the following scenarios:

* Christmas trees and decorative greenery (all stages, canopy- and ground-directed applications)
* forestry (broad-leaf), young/mature forests, all seasons
* forestry (conifer), young/mature forests, all seasons

A body weight of 13.1 g must be used in risk assessment (see section on body weight below).

The diet consists mainly of seeds (PD = 1), especially of conifers (particularly spruce *Picea*), alder *Alnus*, birch *Betula*, and herbs. During the breedings season invertebrates are consumed, too.

For weed seeds exposed on or near the ground, interception by the crop canopy shall be taken into account for canopy-directed applications (fungicides, insecticides). Crop-specific interception values are not available for Christmas trees but due to the dense foliage they are to be expected in the range of highest values reported for broad-leaved trees, i.e. approx. 70% (EFSA 2009).

Conifer seeds are among the preferred seed types consumed by siskins but there is no information about the relative amounts of conifer seeds, seeds from deciduous trees (alder, birch) and weed seeds in the diet of siskins on a daily basis (i.e. true PD).

In risk assessment for granivorous birds in Christmas trees and decorative greenery plantations, it may be assumed that the birds feed entirely on conifer seeds (crop-directed application) or weed seeds (ground-directed application) as respective worst-case scenarios. In general, the RUD for seeds as recommended by EFSA (2009) is relevant for the risk assessment. A 13 g siskin needs 3.9 g (fresh weight) of small seeds to fulfil its average daily requirements.

The typical beak structure of Cardueline finches suggests that seeds are usually dehusked (Ziswiler 1965) so a dehusking factor may be applied (cf. section 4.7), based on quantitative data from appropriate studies. Case -specific evidence must be provided that dehusking actually plays a role under field conditions for this species.

There is no information allowing a refinement of PT for siskins feeding in Christmas trees and decorative greenery plantations.

**General information**

The siskin breeds in coniferous forests of the boreal and temperate zones from British Isles to the Far East. In the north, its European range just reaches 70 °N and it is fairly widespread in Scandinavia and the Baltics, where the core population is found in the spruce-dominated forests of Fennoscandinavia and the Baltics (Hagemeijer and Blair 1997). Despite large annual fluctuations due to seed availability from year to year, populations in the main breeding areas in northern Europe were largely stable 1970-1990. Stronghold populations fluctuated during 1990-2000 in Russia, and most other populations in Europe increased or were stable (BirdLife International 2004).

Densities may reach 10-80 breeding pairs/km² in Finland (Hagemeijer and Blair 1997), or in Estonia 11-40 in spruce-dominated forest, up to 24 in mature birch-spruce, 21 in boreal pine and 0-16 in various broad-leaved forests (Leibak et al. 1994).

**Table 6.49.** *Population size and trends of siskin (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 200-2,000 | 2000 | Increase; 20-49% | Increase |
| Estonia | 100,000-250,000 | 1998 | Stable | Fluctuating |
| Finland | 700,000-2,000,000 | 1998-2002 | Fluctuating | Increase; 35% |
| Latvia | 100,000-200,000 | 1990-2000 | Stable | Stable |
| Lithuania | 100,000-300,000 | 1999-2001 | Stable | Stable |
| Norway | 100,000-1,000,000 | 1990-2003 | Fluctuating | Stable |
| Sweden | 500,000-1,000,000 | 1999-2000 | Fluctuating | Increase; 10-19% |

Siskins are mostly migratory in northern breeding areas, but some southern populations may be resident. Most are nomadic during winter, but minority becomes resident at same site for several months. Numbers migrating vary greatly from year to year, and more distant movements are recorded when large numbers of birds are involved (eruption years). Availability of seed crops on favoured trees (alder *Alnus*, birch *Betula*) seems to be a major determinant of strength of movement away from breeding area. Many birds stay in or close to breeding areas in southern Scandinavia when plenty of natural food is available, or delay movement until mid-winter (or later) in southern Finland. Further east, fluctuating numbers remain to winter in Baltic states (Cramp 1992).

**Agricultural association**

Siskins breed in both lowland and mountain forest, coniferous or mixed, mainly in boreal and temperate zones, north to July isothermal line of 13 °C (Voous 1960). Mainly occupies spruce *Picea* but also fir *Abies*, pine *Pinus*, and larch *Larix* (Glutz von Blotzheim 1962), especially, where these are well-grown and well-spaced, and sometimes mixed with broad-leaved trees. Streamside locations are often preferred, especially outside breeding season where much foraging is apparent in alder and birch trees along watercourses. Has in recent years begun nesting more widely and frequently in fresh areas in England, apparently due to afforestation with conifers and the use of planted introduced conifers in parks and gardens (Cramp1992).

Siskins were frequently recorded year-round in conifer plantations of different age classes in countries belonging to the northern Zone (Edenius et al. 2011, Poulsen 2002, Gjerde and Sætersdal 1997, Hansson 1983) and in other parts of northern and central Europe, e.g. UK (Donald et al. 1998, Gillings et al. 2000, Harris 1983, Bibby et al. 1985, Calladine et al. 2013, 2015,), Ireland (Sweeney et al. 2010, Wilson et al. 2006) and Belgium (Baquette et al. 1994).

**Body weight**

Body weight of males (average 13.2 g, range 10.1 – 18.5 g) and females (average 12.9 g, range 10.0 – 18.0 g) is similar (Cramp 1992). A mean body weight of 13.1 g must be used for risk assessment.

**Energy expenditure**

The daily energy expenditure may be calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The siskin is very dependent on spruce *Picea* (or pine *Pinus*) on breeding grounds. Diet generally consists of seeds, especially of conifers (Coniferae, particularly spruce), alder *Alnus*, birch *Betula*, and herbs; some invertebrates in breeding season. Of herbs, favours Compositae, Polygonaceae, and Corylaceae, and tends to avoid (e.g.) Cruciferae, Rosaceae, and grasses (Gramineae). Feeds principally in trees, moving to tall herbs or ground when cones empty and seed has dropped; many invertebrates apparently taken from ground and at water's edge. In Finland, spruce seed has dropped by May and pine only later that month, so brief food shortage can result, and invertebrates and Compositae thus become important (Cramp 1992). In northern Europe, 1st brood possibly reared more on spruce seeds and 2nd more on pine seeds and insects such as aphids and caterpillars (Newton 1972). Invertebrates are essential in diet of nestlings in captivity (Röder 1991).

Moves restlessly through trees examining cones, acrobatically clinging to cones and twigs, often starting at crown and moving towards base; hangs and perches on stems and seed-heads of herbs with equal agility, spending less time on ground than in plants (Cramp 1992). In captivity, seed handling and consumption time ranged from 1.4 s (*Brassica*) to 10 s (hemp *Cannabis*); Compositae seeds of various species much preferred (Ziswiler 1965, which see for many details of bill morphology and dehusking behaviour).

### Yellowhammer *Emberiza citrinella* (omnivore)



Yellowhammer (*Emberiza citrinella*), Photo: M. Grimm

**Risk assessment**

The yellowhammer is relevant for the following scenario:

* winter cereals, freshly drilled (BBCH 0-9)

A body weight of 29 g must be used in risk assessment (see section on body weight below).

The yellowhammer would be relevant for other scenarios as well, but in these cases other omnivorous (skylark, ortolan bunting) or granivorous (linnet) species represent the worst-case.

The diet is composed of seeds (mainly cereal grain) and invertebrates and varies with the season. Cereal grain/ear may be picked directly from the growing straw. It is proposed that the diets specified below (Table 6.50) are used in higher tier risk assessment.

Table 6.50 *Estimated diet composition of yellowhammers feeding in cereals (expert judgement based mainly upon Table 6.56).*

|  |  |
| --- | --- |
| **Winter cereals, freshly drilled** | |
| **Food category** | **PD (fresh weight)** |
| Large seeds on ground | 0.70 |
| Small seeds | 0.05 |
| Ground arthropods | 0.25 |
| **Spring cereals, freshly drilled** | |
| **Food category** | **PD (fresh weight)** |
| Large seeds on ground | 0.59 |
| Small seeds | 0.06 |
| Ground arthropods | 0.35 |
| **Winter and spring cereals, BBCH 70-89** | |
| **Food category** | **PD (fresh weight)** |
| Cereal grain/ear on plant | 0.75 |
| Foliar arthropods | 0.13 |
| Ground arthropods | 0.12 |
| **Winter and spring cereals, pre-harvest desiccation** | |
| **Food category** | **PD (fresh weight)** |
| Cereal grain/ear on plant | 0.75 |
| Foliar arthropods | 0.06 |
| Ground arthropods | 0.19 |
| **Winter and spring cereals, post-harvest (stubble) treatments** | |
| **Food category** | **PD (fresh weight)** |
| Large seeds on ground | 0.75 |
| Ground arthropods | 0.25 |

In risk assessment for seed treatments, the following values may be used (Table 6.1).

Table 6.1. *Estimated amounts of treated seed consumed by a 29 g yellowhammer fulfilling its daily requirements by feeding on freshly drilled winter or spring cereals. PD for mixed diets as in Table 6.50.*

|  |  |  |
| --- | --- | --- |
|  | **PD (fresh weight)\*** | **Fresh weight (g)** |
| **Winter cereals** | 1.00 | 8.35 |
| 0.70 | 6.72 |
| **Spring cereals** | 1.00 | 8.35 |
| 0.59 | 6.05 |

\* PD = 1 may be used in acute risk assessment, PD < 1 in long-term risk assessment.

Seeds are usually dehusked so a dehusking factor may be applied (cf. section 4.7).

PT may be refined using the information in Table 6.53 and Table 6.54.

**General information**

The yellowhammer is a widespread and common or abundant species throughout the Northern Zone. It avoids dense forest, towns and mountain areas but otherwise occurs wherever trees or scrub (including farmland hedges) alternate with open areas. In recent decades, northern and western European populations have generally declined, incl. e.g. in Sweden (Wretenberg et al. 2007), while populations in central and eastern Europe have remained stable or may even have increased slightly (BirdLife International 2004).

Table 6.52 *Population size and trends of yellowhammer (breeding population) in the Nordic and Baltic countries. Sources: BirdLife International/European Bird Census Council (2000), BirdLife International (2004), Ottosson et al. (2012).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1970-1990) | **Trend**  (1990-2000) |
| Denmark | 400,000-600,000 | 2000 | Stable | Decline; 10-19% |
| Estonia | 100,000-200,000 | 1998 | Stable | Increase; 20-29% |
| Finland | 700,000-1,100,000 | 1998-2002 | Stable | Decline; 10% \* |
| Latvia | 80,000-160,000 | 1990-2000 | Decline; 20-49% | Stable |
| Lithuania | 600,000-750,000 | 1999-2001 | Stable | Stable |
| Norway | 150,000-500,000 | 1995-2002 | Stable | Decline; < 20% |
| Sweden | 900,000 | 2008 | Stable | Decline; 23% |

\* Farmland population has been more or less stable, with a moderate increase 2001-2011 (Tiainen et al. 2008, 2012b).

In the southern part of the Northern Zone, yellowhammers are mainly resident or dispersive, usually gathering in flocks at good feeding sites during winter. Northern populations are partial migrants, wintering up to 250-500 km SW of the breeding area (Snow and Perrins 1998). Most migrants arrive in March-April and the territories are defended from April until July. Breeding is from late April or May to July or (rarely) August. Yellowhammers usually produce two broods per year. The migrants leave September-November.

**Agricultural association**

Yellowhammers are found in arable landscapes during the breeding season as well as in winter when the species is strongly associated with this habitat (Stolt 1988). Entirely open landscapes are avoided and the preferred arable landscapes consist of habitat islands, forest edges, semi-natural pastures and hedgerows or bushes (Berg and Pärt 1994; Svensson et al. 1999; Bradbury et al. 2000, Vepsäläinen et al. 2010, Szymkowiak et al. 2014). Open fields are used for foraging (Stoate et al. 1998), but most of the foraging occurs in the vicinity of hedgerows and other kinds of cover.

The mean densities of yellowhammer in Swedish farmland are according to inventories between 0.12 and 0.15 territories/ha (Robertson and Berg 1992; Söderström 2001). Territories are often linear along, e.g., a hedgerow and the territory size is usually less than 1 ha (Söderström and Pärt 2000). Foraging bouts are often done outside the territory with a mean range of 116-184 m (maximum 238 m) (Petersen et al. 1995; Stoate et al. 1998). According to Lille (1996), the foraging range is usually restricted to a radius of 250 m around the nest with a mean foraging distance of 82 m. In a Danish study, differences in foraging range where found in the breeding season with longer foraging distances in May and July compared to June, and males generally moving longer distances than females (Petersen et al. 1995).

In the breeding season, different crop types are used for foraging (Petersen et al. 1995; Morris et al. 2001) but in general spring cereals are preferred and grassland is avoided. Crop preferences change during the season, probably due to changes in crop structure and food availability. Yellowhammers are adapted to ground-feeding, leading to a preference for early growth stages of cereals and for other crops that offer access to bare soil (Petersen et al. 1995). Cereals also become important as the grains ripen (Biber 1993, Stoate et al. 1998). Beet fields may be very important feeding sites in July (Petersen et al. 1995, Esbjerg and Petersen 2002). After harvest, cereal stubble is preferred.

Lille (1996) studied the feeding habitat of 20 pairs of yellowhammer feeding nestlings in farmland in northern Germany. He found that cereal fields were most frequently visited (42.5% of foraging trips), followed by set-aside (21.0%), hedgerows and other field border vegetation (15.7%), oilseed rape (12.7%) and wood (5.3%).

In a study in England, yellowhammers spent on average about 25% of their active time in arable crops (Crocker et al. 2002). However, some individuals spent almost all their active time in cropped habitats (Crocker et al. 2002). It is therefore reasonable to believe that some yellowhammers forage to a large extent in crops. Douglas et al. (2009) observed in the UK a significant shift of foraging habitats with season: In early summer (20 May-2 July; 233 flights, n=10 nests), field margins were used heavily (32.4 ± 7.0% of visits per nest), with little use of cereal crops (7.9 ± 3.9%), while in late summer (3 July-14 August; 506 flights, n=20 nests), use of field margins declined markedly (15.4 ± 3.4% of visits per nest) and use of cereal fields increased (55.8 ± 7.2%).

The proportion of time (PT) individual yellowhammers spent in different crops has been estimated by the Food and Environment Research Agency (formerly Central Science Laboratory) in the UK. The results are summarized in Table 6.53.

Table 6.53. *Percentage of active time spent by radio-tagged yellowhammers in different crops in the UK, presented as 90th percentile of the modelled PT distribution. The birds were caught in the general farmland (not in specific crops); it is therefore recommende to use values for the subsample of birds who actually used the crop in question (“consumers only”) (bold)*.

| **Crop** | **Period** | **No. of birds** | **Mean** | **90 percentile** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| ***All birds:*** | | | | | |
| Winter cereals | Winter  (Sep.-Mar.) | 44 | 0.02 | 0.05 | Finch et al. 2006 |
|  |  | 44 |  | 0.06 | Prosser 2010 |
|  | Summer  (Apr.-Aug.) | 28 | 0.21 | 0.77 | Finch et al. 2006 |
|  |  | 28 |  | 0.70 | Prosser 2010 |
| Winter rape | Winter  (Sep.-Mar.) | 44 | 0.01 | 0.00 | Finch et al. 2006 |
|  |  | 51 |  | 0.00 | Prosser 2010 |
|  | Summer  (Apr.-Aug.) | 28 | 0.11 | 0.60 | Finch et al. 2006 |
|  |  | 21 |  | 0.61 | Prosser 2010 |
| Beet  (+ potatoes) | Apr.-Nov. | 50 | 0.12 | 0.56 | Finch et al. 2006 |
|  |  | 50 |  | 0.55 | Prosser 2010 |
| ***Consumers only:*** | | | | | |
| Winter cereals | Winter  (Sep.-Mar.) | 10 | 0.02 | 0.14 | Finch et al. 2006 |
|  |  | 10 |  | **0.14** | Prosser 2010 |
|  | Summer  (Apr.-Aug.) | 17 | 0.34 | 0.87 | Finch et al. 2006 |
|  |  | 17 |  | **0.87** | Prosser 2010 |

In a Danish study, 31 and 23 radio-tagged yellowhammers were tracked on organic and conventional farms, respectively, during May-July (Petersen et al. 1995). The home ranges of birds on organic farms were dominated by grassland, winter cereals, spring cereals and various broad-leaved crops. On the conventional farms, the home ranges were dominated by winter cereals, maize, spring cereals and oil-seed rape. Results are presented as the proportion of records (fixes) in each crop type, which is supposed to be roughly equivalent to the proportion of time spent in each crop (Table 6.54). Comparison of usage and availability indicates crop preferences. Furthermore, the results illustrate how usage (PT) of a certain crop depends on availability.

Table 6.54. *The use of different crops by 54 radio-tagged yellowhammers on organic and conventional farms in Denmark. Records (fixes) from off-crop habitats have been excluded* *(Petersen et al. 1995).*

|  |  |  |  |
| --- | --- | --- | --- |
| **Crop** | **Availability**  **(proportion of**  **home range)** | **Usage**  **(proportion of crop fixes)**  (n=260) | |
| **Mean** | **95% confidence limits** |
| ***Conventional farms:*** | | | |
| Winter cereals | 0.30 | 0.21 | 0.10-0.32 |
| Maize | 0.30 | 0.31 | 0.19-0.43 |
| Spring cereals | 0.13 | 0.09 | 0.01-0.16 |
| Oil-seed rape | 0.13 | 0.24 | 0.13-0.35 |
| Grassland | 0.07 | 0.05 | 0.00-0.10 |
| Leafy crops | 0.05 | 0.07 | 0.00-0.13 |
| Others | 0.03 | 0.04 | – |
| ***Organic farms:*** | | | |
| Grassland | 0.37 | 0.15 | 0.07-0.22 |
| Winter cereals | 0.22 | 0.30 | 0.20-0.40 |
| Spring cereals | 0.20 | 0.22 | 0.13-0.31 |
| Leafy crops | 0.18 | 0.29 | 0.20-0.39 |
| Others | 0.03 | 0.04 | – |

**Body weight**

Mean body weight of both sexes is 27 g (24-31 g) (Buxton et al. 1998) or 25-36 g (Snow and Perrins 1998). The mean of these values (29 g) must be used for risk assessment.

**Energy expenditure**

No species-specific data available, therefore calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet of yellowhammers consists of seeds and invertebrates in variable proportions over the year. Seeds are usually dehusked (Buxton et al. 1998, Prosser 1999).

The species is foraging in a wide range of crop types such as maize, winter and spring cereals, rape, peas and sugar beet (Petersen et al. 1995; Stoate et al. 1998; Mason and Macdonald 2000; Morris et al. 2001). As cereal grains ripen, fields with these crops may provide food for both adults and young, although invertebrates are the major component of the nestling diet (Stoate et al. 1998).

The food of adult yellowhammers may consist of 80% invertebrates in May-June (Buxton et al. 1998), although faecal samples from five individuals collected in June in England revealed a diet of 100% cereals (Stoate et al. 1998). In the Moscow region of Russia, the proportion of invertebrates in diet was highest (70% by number) in June; the annual average diet compo­sition is shown in Table 6.55

The review of Holland et al. (2006) mentions 23% seeds (including large portion of cereal seeds) and 77% arthropods for adult and 35% seeds and 65% arthropods for nestling yellowhammers during the breeding season in Slovakia, Germany and UK.

Table 6.55. *All-year diet composition of adult yellowhammers in Moscow Region, Russia (Inozemtsev 1962 cited by Cramp and Perrins 1994b).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **% of food items** |
| **All year** | Coleoptera img. | 39.3 |
| (n=478) | Lepidoptera larvae | 1.0 |
|  | Tipulidae | 1.0 |
|  | *Seeds:* |  |
|  | Wheat | 12.3 |
|  | Oats | 8.8 |
|  | Pine | 8.7 |
|  | Spruce | 4.6 |
|  | Other seeds | 21.1 |

Prys-Jones (1977, cited in Buxton et al. 1998) studied the relative proportions of seeds and invertebrates in the diet of yellowhammers in the UK. The results are given in Table 6.56.

Table 6.56. *Yellowhammer adult diet in the UK (Prys-Jones 1977 cited by Buxton et al. 1998).*

| **Time of year** | **food type** | **% of diet** |
| --- | --- | --- |
| **March-June** | Seeds | 65 1) |
|  | Invertebrates | 35 1) |
| **July-October** | Seeds | 75 1) |
|  | Invertebrates | 25 1) |
| **November-February** | Seeds | 99 1) |
|  | Invertebrates | 1 1) |
|  |  |  |
| ***Seed composition*** 3) |  |  |
| **October-November** | Cereal | 93 2) |
|  | Grass | 7 2) |
| **December-February** | Cereal | 66 2) |
|  | Grass | 34 2) |
| **March-April** | Cereal | 91 2) |
|  | Grass | 9 2) |

1)  by volume

2)  by dry weight

3)  seeds of dicotyledons also found, especially in April, but negligible in terms of weight.

Some data on the diet of yellowhammer nestlings and the composition of invertebrates in the nestling diet are given in Table 6.57 and Table 6.58.

Stoate et al. (1998) studied yellowhammer during three years in a 292 ha mixed arable landscape in central England. The diet composition of nestlings was calculated from 144 faecal sacs from 56 broods (Table 6.57).

Table 6.57. *Yellowhammer nestling diet in the UK (Stoate et al. 1998).*

| **Time of year** | **food type** | **% of diet** |
| --- | --- | --- |
| **May-July** | Cereal seeds | 38 1 |
|  | Invertebrates | 62 1 |
|  |  |  |
| **Invertebrate composition** | Coleoptera3 4 | 40 2 |
|  | Diptera (adults) 3 | 17 2 |
|  | Lepidoptera larvae3 | 13 2 |
|  | Aranea3 4 | 10 2 |
|  | Hemiptera3 | 7 2 |
|  | Hymenoptera3 4 | 2 2 |

1 by volume

2 by number.

3 foliar arthropods

4 ground-dwelling arthropods.

Lille (1996) studied the diet of yellowhammer nestlings in farmland of northern Germany. The diet composition was calculated from identification of 4,764 food items brought to 12 broods (see below).

Table 6.58. *Yellowhammer nestling diet in North German farmland (Lille 1996).*

| **Time of year** | **Food type** | **% of diet** | |
| --- | --- | --- | --- |
|  |  | **by number** | **by fresh weight** |
| **June-July** | Cereal grain | 15.6 | 6.7 |
|  | Lepidoptera larvae1 | 12.0 | 46.2 |
|  | Lepidoptera img. 1 | 2.1 | 4.4 |
|  | Diptera larvae1 2 | 46.9 | 25.7 |
|  | Diptera img. 1 | 3.7 | 2.6 |
|  | Coleoptera1 2 | 6.2 | 7.1 |
|  | Arachnidae1 2 | 8.3 | 3.3 |
|  | Others | 5.3 | 4.0 |

1 foliar arthropods

2 ground-dwelling arthropods.

* + 1. Ortolan bunting *Emberiza hortulana* (omnivore)



Ortolan bunting (*Emberiza hortulana*), Photo: M. Schäf

**Risk assessment**

The ortolan bunting is relevant for the following scenarios:

* beets, spring/summer/autumn
* cereals, spring/summer/autumn
* orchards, spring/summer
* grass, spring/summer/autumn
* maize, spring/summer/autumn
* oilseed rape, spring/summer/autumn
* potatoes, spring/summer/autumn
* pulses, spring/summer/autumn

A body weight of 23.3 g must be used in risk assessment (see section on body weight below).

The diet is composed of invertebrates and seeds. It may vary with the season, but seeds are often consumed throughout spring and summer, cf. Table 6.63 and Table 6.64. It is proposed that the diets specified below (Table 6.59) are used in higher tier risk assessment, unless crop-specific data from Nordic countries are available.

**Table 6.59**. *Estimated general diet composition of ortolan buntings feeding in field crops and orchards (expert judgement based mainly upon Table 6.63 and information on foraging habitats and habits).*

|  |  |
| --- | --- |
| **Field crops (May to August)** | |
| **Food category** | **PD (fresh weight)** |
| Foliar arthropods | 0.50 |
| Weed seeds | 0.50 |
| **Field crops (September to October)** | |
| **Food category** | **PD (fresh weight)** |
| Weed seeds | 1.0 |
| **Orchards (May to August)** | |
| **Food category** | **PD (fresh weight)** |
| Foliar arthropods | 1.0 |

For seeds picked from the ground, an interception factor shall be applied as appropriate for the crop and growth stage in question.

In risk assessment for seed treatments the following values may be used (Table 6.60).

**Table 6.60.** *Estimated amounts of treated seed consumed by a 23.3 g ortolan bunting fulfilling its daily requirements by feeding on freshly drilled spring cereals. PD for mixed diets as in Table 6.59.*

|  |  |  |
| --- | --- | --- |
|  | **PD (fresh weight)\*** | **Fresh weight (g)** |
| **Spring cereals** | 1.00 | 8.35 |
| 0.59 | 5.84 |

\* PD = 1 may be used in acute risk assessment, PD < 1 in long-term risk assessment.

Cereal seeds are usually dehusked so a dehusking factor may be applied (cf. section 4.7), based on quantitative data from appropriate studies. Case-specific evidence must be provided that dehusking actually plays a role.

PT may be reduced to 0.88 in higher tier reproductive risk assessment based on the information in Table 7.61, unless crop-specific data from Nordic countries are available.

**General information**

The ortolan bunting is a rather widespread but declining species throughout the Northern Zone (except Denmark, where the species is already extinct, but nevertheless should be considered as focal species for reasons of harmonization within Nordic Zone). It is included in the Red Lists of four countries within the Northern Zone (Northern Zone 2020) and therefore, and due to it’s low body weight, needs to be addressed in the risk assessment. In the northern part of its range, it occurs mainly in cultivated land, preferring low-intensity, mixed farmland on light soils in dry climate, with sparsely vegetated spots and scattered or lines of trees or bushes, wires etc. In forested areas of Fennoscandia, it occupies forest margins, clearings and clear fells, even without access to arable land. In previous decades, northern and western European populations have generally declined while populations in southern Europe have remained stable or may even have increased considerably (Jiguet et al. 2016, Table 6.61).

**Table 6.61.** *Population size and trends of ortolan bunting (breeding population) in the Nordic and Baltic countries.* Sources: BirdLife International (2004), Jiguet et al. (2016).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Population size**  (breeding pairs) | **Year(s) of estimate** | **Trend**  (1990-2000) | **Trend**  (2004-2014) |
| Denmark | – |  |  |  |
| Estonia | 200-400 | 2014 | Decline; 20-29% | Decline; 80-95% |
| Finland | 7,000-19,000 | 2014 | Decline; 75% | Decline; 37-86%) |
| Latvia | 144-7,744 | 2004 | Decline; 0-19% | ? |
| Lithuania | 60-100 | 2012 | Decline; 0-19 | Decline; 88-92% |
| Norway | 20 | 2014 | Decline; 30-49% | Decline; 87-88% |
| Sweden | 2,600-5,000 | 2012 | Decline; >80% | Decline; 0-63% |

Ortolan buntings are migratory with wintering grounds in West Africa (Selstam et al. 2015). Most migrants arrive in May and leave again in August. In Sweden, 85% of clutches are completed between 20 May and 20 June, in the northern parts of breeding range one brood per year (Cramp and Perrins 1994b).

**Agricultural association**

In the northern parts of the European breeding range, the ortolan bunting favours small scale agricultural land and, as a speciality, it occurs frequently in burnt forest clear-cuts in Sweden and Norway. The agricultural association is less influenced by particular crops, but rather by not crop-specific habitat characteristics as not or sparsely vegetaged non-irrigated dry open soil (foraging) combined with structural elements like rocky outcrops, single trees or bushes, tree lines, wire posts and lines, roof ridges of isolated buildings (song posts, shelter and partly foraging, see e.g. Kosicki and Chylarecki 2012). These are essential prerequisites of suitable habitat, which are usually found in less intensively cultivated small scale agricultural areas. Occupied areas in Estland contained significantly more tall broadleaf trees, crop types, structural elements (trees, bushes, roads, overhead power lines and buildings) and spring wheat, but also had lower crop drilling densities than not-occupied areas. Amount of structural point elements, length of power lines, amount of tall broadleaf trees and number of different crops have a positive effect, whereas crop density and area of autumn-sown crops have a negative effect (Elts et al. 2015). Ortolan bunting territories in Sweden are strongly associated with arable fields under less intensive land use (fields containing unsown rows are essential), including unmanaged field borders or shrubby edges, set-asides and field islets, electric wires and barns (Berg 2008, Sondell et al. 2019). But Ortolan buntings inhabit also more intensively used areas as long as habitat requirements exist (e.g. unsown rows, discontinuities or wide crop spacing in-field and availability of song posts in- and/or off-crop). All Ortolan bunting territories within three study areas in Poland contained arable land (63% of total area within territory) and 60-100% (average 92.7% of territories) contained woods (25%; Goławski and Dombrowski 2002). The optimum of occurrence of Ortolan buntings is achieved in more heterogeneous landscapes (Szymkowiak et al. 2014).

The mean densities of ortolan buntings in Finnish farmland are on average 0.5 breeding pairs/10 ha, in more densely populated areas 0.9 bp/10 ha, but can be as high as 15 bp/10 ha locally (Glutz and Bauer 1997). Berg (2008) found 1.3 territories/km² of farmland in central Sweden. In agricultural areas of Poland, 0.7-3.3 bp/km², up to 1 bp/km² and up to 1,5 bp/km² were observed regionally (Tomiałojć 1990, Kuźniak 1994 cited by Glutz and Bauer 1997). Depending on location of the nesting area, foraging may take place outside the territory with a mean range of 1,074 m (maximum 2,700 m) for birds nesting on forest clear-cuts but foraging in farmland (Dale and Olsen 2002). Birds nesting in farmland usually forage up to 100 m around the nest, depending on season attractive food resources are exploited also 200 m distant from the nest (Conrads 1969). In a Swedish study area, average distances from different nests varied between 47-114 m (max. 250 m; Sondell et al. 2019). Particularly productive foraging areas are visited repeatedly by foraging individuals.

In the breeding season, different crop types are used for foraging as long as tracks, discontinuities or wide crop spacing provide access to bare or sparsely vegetated ground. In northern and central Europe foraging ortolan buntings were recorded on spring/autumn-sown cereals (rye, oat, wheat, barley, triticale), oilseed rape, stubble fields, cultivated grassland, set-aside, maize, potatoes, peas, sunflower, alfalfa, peet, mustard (Golawski and Dombrowski 2002, Berg 2008, Menz et al. 2009, Elts et al. 2015, Sondell et al. 2019). There is no specific crop preference detectable but crops offering suitable foraging areas on a general basis are more frequently used than others. Ortolan buntings forage mainly on the ground within short vegetation or on sparsely vegetated soil. Trees within territories are not just used as song posts but also for foraging (e.g. oak and fruit trees during insect calamities). Insects are collected from vegetation or in flight (Conrads 1969).

In Sweden, in radio-tagged birds only 18% of all foraging observed was outside of crop fields, i.e. in natural grass, at oat feeders and in tree canopies, while majority of foraging happened inside crop fields, i.e. spring-sown cereals (Sondell et al. 2019).

Radio-tagged ortolan buntings in Switzerland showed clear preference for maize fields (treated with herbicides) compared to cereal fields, meadows, luzerne fields or untreated maize fields as indicated by comparison of usage and availability of crop habitats, and probably due to the availability of sparsely vegetated open soil areas (Menz et al. 2009; Table 6.62).

**Table 6.62.** *Habitat availability and usage of different habitats within foraging area of 3-4 radio-tagged ortolan buntings on intensively cultivated area in western Switzerland (Menz 2008, Menz et al. 2009).*

|  |  |  |  |
| --- | --- | --- | --- |
| **Crop** | **Availability**  **(proportion of habitat within foraging area)** | **Foraging locations of 3 males**  (n=120 fixes) | |
| **Proportion of locations** | **95% Confidence limits** |
| Corn (herbicide use) | 0.249 | 0.883 | 0.762-1.004 |
| Corn (untreated) | 0.083 | 0.025 | -0.039-0.114 |
| Meadow, lucerne | 0.385 | 0.025 | -0.032-0.182 |
| Riparian vegetation | 0.083 | 0.000 | 0 |
| Cereals (rye, oat, ploughed) | 0.121 | 0.067 | -0.012-0.220 |
| Others (infrastructure, road works, river) | 0.218 | 0.000 | 0 |

**Body weight**

Mean body weight of males 22.7 g (16-30 g), of females 22.5 g (17-31 g) and of unsexed birds or both sexes combined 24.8 g (18.8-36 g) (Cramp and Perrins 1994b). The mean of these values (23.3 g) must be used for risk assessment.

**Energy expenditure**

No species-specific data available, therefore calculated allometrically using the equation for passerine birds in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The diet of ortolan buntings consists of invertebrates and seeds in variable proportions over the year, the latter mainly taken outside the breeding season (Cramp and Perrins 1994b). Oat seeds at least are dehusked (Glutz and Bauer 1997).

The species is foraging in a wide range of crop types such as spring/autumn-sown cereals (rye, oat, wheat, barley, triticale), oilseed rape, stubble fields, cultivated grassland, set-aside, maize, potatoes, peas, sunflower, alfalfa, peet, mustard (Golawski and Dombrowski 2002, Berg 2008, Menz et al. 2009, Elts et al. 2015, Sondell et al. 2019) and burnt forest clear-cuts, the latter particularly in Sweden and Norway (Starholm 2007, Lucas 2014, Percival 2014). Farmland is very important as foraging habitat, also for birds breeding in burnt forest clear-cuts (Dale and Olsen 2002), except parts of Sweden (Lucas 2014).

The food of adult ortolan buntings may consist exclusively of invertebrates during spring and summer, although seeds are also taken regularly in small numbers at least throughout spring and summer (Cramp and Perrins 1994b). In the Ukraine, the proportion of invertebrates in diet comprised 43.1% (by number based on 34 stomachs) May to August as shown in Table 6.63.

**Table 6.63.** S*ummer diet composition of adult ortolan buntings in Ukraine (Tarashchuk 1953 cited by Cramp and Perrins 1994b).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **Portion of food items** |
| **May-August** | **Invertebrates** | **43.1%** |
| (n=872) | Hymenoptera (mainly ants) | 17.2% |
|  | Coleoptera (mainly weevils, click beetles) | 9.8% |
|  | Orthoptera (mainly grasshoppers, crickets) | 6.7% |
|  | Lepidoptera (mainly caterpillars, pupae) | 5.1% |
|  | Diptera (mainly crane flies) | 1.7% |
|  | Hemiptera (mainly Coreidae) | 1.2% |
|  | Araneae | 0.4% |
|  | Others (millipedes, earwigs, snails) | 1.0% |
|  | **Seeds** | **56.9%** |
|  | Herbs | 48.3% |
|  | Wheat | 6.3% |
|  | Millet | 2.3% |

In the Volga-Kama region of east European Russia, of 16 stomachs during spring and summer 94% contained animal food (see Table 7.63) and 31% plant material (mostly seeds of grass and wheat). June stomachs contained no plant food, which was first apparent in July and increasing until autumn, when it was most important part of diet (Popov 1978 cited by Cramp and Perrins 1994b).

**Table 6.64.** Spring and s*ummer diet composition of adult ortolan buntings in Volga-Kama region, Russia (Popov 1978 cited by Cramp and Perrins 1994b).*

|  |  |  |
| --- | --- | --- |
| **Time of year** | **Food type** | **Frequency of occurrence (percentage of stomachs)** |
| **Spring-summer** | **Invertebrates** | **94%** |
| (n=16 stomachs) | Weevils | 81% |
|  | Orthoptera | 31% |
|  | Caterpillars | 31% |
|  | Hemiptera | 19% |
|  | Ants | 13% |
|  | Click beetles | 13% |
|  | Araneae | 13% |
|  | **Seeds (grass, weeds)** | **31%** |

The diet of ortolan bunting nestlings consists exclusively of animal matter, particularly caterpillars, also collected from trees (e.g. oaks) as part of the foraging habitat (Conrads 1969, Cramp and Perrins 1994b, Glutz and Bauer 1997)

In 190 food samples of nestling Ortolan buntings in Russia, 409 invertebrates were identifiable, while plant matieral was evident in just two cases (Maltschewskij cited by Conrads 1969, Table 6.57.). Further samples with similar constitution were compiled by Cramp and Perrins (1994b).

**Table 6.65.** *Ortolan bunting nestling diet in Russia (Maltschewskij cited by Conrads 1969).*

|  |  |  |  |
| --- | --- | --- | --- |
| **Time of year** | **Food type** | **Portion of food items** | |
| **June-July** | **Invertebrates** | **99.5%** | |
| (n=411) | Lepidoptera (Bordered white caterpillars, imagines) | 59.6% | |
|  | Coleoptera (June bugs, Garden chafer) | 18.0% | |
|  | Orthoptera | 11.2% | |
|  | Diptera | 7.8% | |
|  | Others | 1.7% | |
|  | Araneae | 1.2% | |
|  | **Plant material** | **0.5%** |

## Mammals

### Common shrew *Sorex araneus* (insectivore and worm/snail eating)

****

Common shrew (*Sorex araneus*), Photo: RIFCON GmbH

**Risk assessment**

The insectivorous common shrew is relevant for the following crop scenarios:

* winter rape, BBCH 80-89 and pre-harvest desiccation
* spring rape, BBCH 80-89 and pre-harvest desiccation
* grass (medium and long)
* Christmas trees and decorative greenery (all season)

A body weight of 8.1 g must be used in risk assessment (see section on body weight below).

The diet in rape fields and Christmas trees and decorative greenery plantations may be assumed to consist entirely of ground arthropods (PD = 1).

The diet in grassland also consists mainly of ground arthropods and may be taken from Table 6.66 for the month(s) in question. The proportion of earthworms in diet varies with the soil structure.

Home ranges of common shrews are small (usually ≈ 0.1 ha) and many individuals spend their entire life foraging in a single crop type. Thus, PT shall not be refined unless fully justified by case-specific data.

**General information**

The common shrew is a widespread and common species throughout the Northern Zone; apparent gaps in the distribution in Norway are assumed to be the result of patchy information (Mitchell-Jones et al. 1999). The species occurs in a wide range of habitats, including forests and arable land, but prefers moist and cool habitats with dense vegetation cover (Mitchell-Jones et al. 1999, Baagøe and Ujvári 2007). The most important requirement for finding the species in a habitat is that there is a ground cover to minimize visibility for predators. Breeding season is between May and September and usually two litters of young are born per year.

**Agricultural association**

The common shrew is widespread in arable landscapes (Tattersall et al. 2002; Huitu et al. 2004) but occurs in low numbers compared to, e.g., wood mouse (Jensen and Hansen 2003). As crops grow higher and ground cover increases common shrews are more likely to be found on arable land. However, this is probably animals nesting in surrounding habitats and making foraging trips to the fields (Tew et al. 1994). In a study in southern Sweden, single individuals of common shrew where caught in the fields while more regular captures where made on habitat islands situated in the fields (Loman 1991a). Thus, this shows that the species is present in the agricultural landscape and probably particularly in leys and hedges (L. Hansson pers. comm. to KemI, Schlinkert et al. 2016).

The home range of the common shrew varies depending on habitat and season and ranges between 0.037 and 0.23 ha (Gurney et al. 1998; Wang and Grimm 2007). In arable landscapes, common shrews can live their entire life within approximately one hectare (L. Hansson pers. comm. to KemI).

Common shrews are living in arable habitats and are present in these habitats all year round (Tew et al. 1994; Tattersall et al. 2002). In a Danish study covering summer and autumn, common shrews were regularly trapped in set-aside, permanent grassland and grass in rotation, occasionally in oilseed rape but never in wheat or pea fields (Jensen and Hansen 2003). The number of trapped shrews was generally very low except in some fields with grass in rotation (Jensen and Hansen 2003). Numbers declined from summer to autumn (Jensen and Hansen 2003). As crop cover extends, the species uses arable fields increasingly for foraging (Tew et al. 1994). In a study conducted by Tew et al. (1994), common shrews were caught between April and October away from hedgerows almost exclusively in autumn-sown cereal. It might be assumed that the common shrew spends more time in arable fields from June to harvest. Many individuals spend their entire life foraging in one crop type (L. Hansson pers. comm. to KemI), but no studies have been done on foraging behaviour of the common shrew in arable fields.

The common shrew is a small species with a high metabolic rate forcing it to have several foraging bouts per day (Saarikko and Hanski 1990, Merritt and Vessey 2000). During foraging sessions shrews might find all their prey in one arable field, although there are no studies on time budgets in arable crops.

**Body weight**

Shrews are fluctuating in body weight with a marked decrease in winter (Churchfield 1982).

Body weight is reported as follows:

* Summer weight 10.4 g (Aitchison 1987)
* Mean 8.1 (5-14) g (Gurney et al. 1998)

It is recommended that the body weight of 8.1 g (Gurney et al. 1998) is used for risk assessment.

**Energy expenditure**

For common shrew, energy expenditure regardless of season is 39 kJ/day (animal body weight 8.6 g) according to Gebczynski (1965). Alternatively, the energy expenditure can be calculated allometrically using the equation for mammals in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The common shrew is an opportunistic predator feeding on a wide range of common invertebrates, particularly earthworms, woodlice, spiders, slugs, snails and insect larvae. Only small amounts of vegetative food are consumed (Bjärvall and Ullström 1985, Ivanter et al. 2015). The common shrew finds its prey by encounter (Plesner-Jensen 1993) although some preferences for food items are shown (Churchfield 1982). The prey is found on the ground surface as well as under it, and studies have shown that individuals are able to find food at a depth of 120 mm (Churchfield 1980). The prey size varies from larger than 20 mm to smaller than 3 mm. 41% of the invertebrates taken have a body size less than or equal to 5 mm and very few are smaller than 3 mm (Churchfield 1982). The diet composition collected from 215 alimentary tracts of common shrews living in grassland is presented in Table 6.66.

Table 6.66. *Common shrew diet in grassland (n=215)* *(Pernetta 1976)1.*

| **Time of year** | **Food type** | **% of diet fresh weight** |
| --- | --- | --- |
| **April** | Opiliones and Spiders | 26 |
|  | Earthworms | 20 |
|  | Coleoptera larvae | 20 |
|  | Coleoptera adults | 15 |
| **May** | Opiliones and Spiders | 15 |
|  | Earthworms | 23 |
|  | Coleoptera larvae | 17 |
|  | Coleoptera adults | 40 |
|  | Chilopods | 2 |
|  | Isopoda | 3 |
| **June** | Opiliones and Spiders | 10 |
|  | Earthworms | 7 |
|  | Coleoptera larvae | 11 |
|  | Coleoptera adults | 57 |
|  | Isopoda | 4 |
| **July** | Opiliones and Spiders | 9 |
|  | Earthworms | 17 |
|  | Coleoptera larvae | 21 |
|  | Coleoptera adults | 30 |
|  | Slugs and Snails | 1 |
|  | Chilopods | 23 |
|  | Isopoda | 4 |
| **August** | Opiliones and Spiders | 13 |
|  | Earthworms | 36 |
|  | Coleoptera larvae | 3 |
|  | Coleoptera adults | 26 |
| **September** | Opiliones and Spiders | 14 |
|  | Earthworms | 20 |
|  | Coleoptera larvae | 8 |
|  | Coleoptera adults | 34 |
|  | Slugs and Snails | 2 |

1 For risk assessment purposes, all food items except earthworms may be assumed to belong to the category “ground-dwelling arthropods”.

In a study in England, Johnson et al. (1992) found that beetles were a major component of the diet with over 40% of the guts examined containing remains of adult beetles (n=199). Mollusc remains and aphids were each found in approximately 30% of the guts examined. The fourth major prey type was dipteran larvae or pupae (chiefly leatherjackets), which were found in 16-40% of guts. Earthworms were absent from the gut contents examined. This probably reflects the low numbers of worms present at the study site and possibly also the shrews’ difficulty in capturing worms in the heavy soils of the study site.

### Brown hare *Lepus europaeus* (herbivore)

****

Brown hare (*Lepus europaeus*), Photo: J. Gerlach

**Risk assessment**

The herbivorous brown hare is a relevant focal species in most field crops and grassland, and may also be relevant in orchards:

* winter cereals, BBCH 10-29
* spring cereals, BBCH 10-29
* maize, BBCH 10-≥ 40
* winter rape, BBCH 10-39
* spring rape, BBCH 10-39
* beets, BBCH 10-49
* pulses, BBCH 10-99
* field grown vegetables, BBCH 10-89
* strawberries, all stages except termination
* grass, short
* orchards, all applications
* bush berries, all stages

A body weight of 3800 g must be used in risk assessment (see section on body weight below).

Relevance in orchards and bush berries depends on whether field vole is considered relevant for the situation and Member State in question; in that case field vole will represent the worst-case.

The diet of brown hares consists almost entirely of green plant parts, with seeds and fruits being present in very small amounts only. The relative amounts of grasses (including cereals) and dicotyledons (leafy crops and weeds) in the diet vary with the crop and the season. In some studies, the diet of hares was found to include sizable amounts of cereal grain in late summer, but these data are not relevant for the scenarios where brown hare has been identified as a focal species.

For the relevant crop and grassland scenarios, the relative amounts of mono- and dicotyledons in the diet may in principle be estimated from Table 6.72 for the crop and time of year in question. Some food items will however not be available in a certain crop, e.g. cereals and dicotyledonous crops will not be available in the same field, and PD has to be adjusted to allow for this. In orchards (fruit trees), the diet consists entirely of grasses and weeds growing beneath the trees. In bush berries, hares will also eat the leaves of the bushes (especially *Ribes* sp.).

Taking the above considerations into account, the relative amounts of mono- and dicotyle­donous plants in the diet may be estimated as follows for use in risk assessment (Table 6.67).

Table 6.67. *Estimated diet composition of brown hares feeding in different crops. PD values were calculated from Table 6.72, omitting diet components assumed not be present in the crop in question and increasing the share of the other components proportionally. Spring: April-May; Summer: June-Sep.; Autumn: Oct.-Nov.*

| **Crop** | **Growth stage** | **Season** | **PD (fresh weight)** | | |
| --- | --- | --- | --- | --- | --- |
| Monocotyledons  (cereals, grasses) | Dicotyledons  (leafy crops,  non-grass weeds) | Bush berry plants (buds, leaves) |
| Winter cereals | BBCH 10-29 | Spring | 0.84 | 0.16 |  |
|  |  | Autumn | 0.95 | 0.05 |  |
| Spring cereals | BBCH 10-29 | Spring | 0.84 | 0.16 |  |
| Maize | BBCH 10-19 | Spring | 0.84 | 0.16 |  |
|  | BBCH 10-39 | Summer | 0.72 | 0.28 |  |
| Oilseed rape | BBCH 10-39 | Spring and autumn | 0.39 | 0.61 |  |
| Beets | BBCH 10-19 | Spring | 0.39 | 0.61 |  |
| Pulses | BBCH 10-39 |  |  |  |  |
| Vegetables | BBCH 10-49 |  |  |  |  |
| Beets | BBCH 10-49 | Summer | 0.26 | 0.74 |  |
| Pulses | BBCH 10-99 |  |  |  |  |
| Vegetables | BBCH 10-49 |  |  |  |  |
| Strawberries | Planting  Pre-flowering | Spring | 0.44 | 0.56 |  |
|  | Planting  Flowering and fruit develop.  Post-harvest | Summer | 0.30 | 0.70 |  |
| Grass, short;  Orchards |  | Spring and summer | 0.64 | 0.36 |  |
|  |  | Autumn\* | 0.93 | 0.07 |  |
| Bush berries |  | Spring | 0.54 | 0.30 | 0.16 |
|  |  | Summer | 0.45 | 0.28 | 0.27 |
|  |  | Autumn\* | 0.93 | 0.07 |  |

\* In orchards and bush berries, autumn treatments will always be post-harvest.

For applications in orchards and bush berries, interception by the canopy shall be taken into account as appropriate for the growth stage and type of application.

Brown hares have large home ranges (29-138 ha, cf. below), implying that it will usually be appropriate to refine PT. The values in Table 6.69 may be used for field crops (notice that only 90th percentiles are available) while PT values for grassland may be estimated from Table 6.68. There is no specific information allowing refinement of PT for orchards and bush berries.

**General information**

The brown hare is widespread and common, or fairly common, in open countryside throughout the southern and eastern part of the Northern Zone (Mitchell-Jones et al. 1999). It is absent from northern Finland, Sweden north of limes norrlandicus (Frylestam 1990), and Norway except for a small area in the south-easternmost part of the country. Occurrence in southern Sweden and Norway is due to introduction (Mitchell-Jones et al. 1999). North of its range the brown hare is replaced by the smaller mountain (or snow) hare *Lepus timidus*, which is the only indigenous lagomorph on the Scandinavian peninsula.

During recent decades, brown hare populations have declined strongly across large areas of western and central Europe, and in Denmark the species is now Red Listed as vulnerable. The main reason for the decline is probably agricultural intensification, including fertilizer and pesticide use, which causes a shortage of food during the summer half, thereby reducing the fecundity of females and survival of the young (Olesen and Asferg 2006).

The principal habitats of the brown hare are open agricultural landscapes with relatively small fields and different crops (Asferg and Madsen 2007). Reproduction starts early in the year, in February in the southern part of the Northern Zone, and ends in September (Frylestam 1980b, Asferg and Madsen 2007). In Denmark the brown hare may have up to four or even five litters during the breeding season, but due to food shortage the average number of litters per female is now only 2.3 (Olesen and Asferg 2006).

**Agricultural association**

The brown hare is found in all sorts of open agricultural landscape such as intensively farmed areas, areas with mixed farming and pastoral landscapes. Studies of the species have been conducted in a wide range of landscapes with different agricultural practices (Frylestam 1980a, Tapper and Barnes 1986, Pépin 1987, Smith et al. 2004).

Although there are marked variations in home range sizes, the general pattern seems to be large home ranges in areas of intensive agriculture and limited landscape diversity, and small home ranges in areas with a higher degree of natural habitats and thereby landscape diversity (Olesen and Asferg 2006). In intensively managed arable landscapes, home range sizes can be as large as 138 ha (Marboutin and Aebischer 1996), while much smaller home ranges are found in mixed farmland and in grass dominated landscapes, 29 ha and 34 ha, respectively (Broekhuizen and Maaskamp 1982, Smith et al. 2004). Average size of home ranges in Denmark was 44 ± 41 ha (Mayer et al. 2018).

Brown hare densities are, similar to home ranges, depending on landscape quality. In a quantitative study of brown hare numbers in relation to habitat type, Smith et al. (2005) found that abundance of hares showed a strong positive association with wheat, cereals, and beet. In the same study habitat diversity was also strongly positively associated with hare abundance, while monocultures showed a strong negative association (Smith et al. 2005). A study on radio-tracked hares in Denmark and Germany showed that active hares generally selected for short vegetation (1-25 cm) and avoided higher vegetation and bare ground while vegetation was more important for habitat selection in inactive (resting) hares, with fabaceae, fallows and maize being selected (Mayer et al. 2018). In Poland, hares that lived in monocultures were only found in areas which offered a variation of vegetation (Lewandowski and Nowakowski 1993). This might be because hares need a variety of vegetation types to ensure access to high quality food during the year, and thus, large crop fields have a negative impact on their feeding resource (Panek and Kamieniarz 1999).

Some mean hare densities (individuals/100 ha) in spring for different landscape types are: intensive arable land 29 (23-35) (Pépin 1987), for mixed farmland and pastoral land in Sweden 45 (38-55) and 14 (14-15), respectively (Frylestam 1979).

From a study in mixed farmland in England (50% winter wheat/barley and 50% grassland), the time (day and night) that brown hares spent in different crops are shown in Table 6.68.

Table 6.68. *Time spent (%) in different habitats* *(Tapper and Barnes 1986).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Crop** | **Jan** | **Feb** | **Mars** | **Apr** | **May** | **June** | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** |
| Wheat | 65 | 50 | 55 | 30 | 15 | 20 | 10 | 2.5 | - | - | 35 | 45 |
| Barley | - | - | - | - | 20 | 10 | 10 | 5 | 2.5 | - | - | - |
| Grass | 20 | 35 | 45 | 65 | 60 | 55 | 70 | 67.5 | 50 | 52.5 | 40 | 30 |
| Other | 15 | 15 | 0 | 5 | 5 | 15 | 10 | 25 | 47.5 | 47.5 | 25 | 25 |

According to Tapper and Barnes (1986), brown hares have two basic requirements: a feeding area and a resting area. Hares usually feed at night and rest at day, and depending on the habitat quality these areas can either coincide or differ (Tapper and Barnes 1986). In Table 6.68 the brown hare activity is not specified, making such a separation impossible. It has been shown from studies in France, England and Sweden that brown hares favour arable crops in spring, both in intensive arable land and mixed farmland (Frylestam 1980a; Pépin 1985; DEFRA 2002). From a dietary study, Chapuis (1990) showed that the predominant food of brown hare in spring (April and May) consists of wheat (Chapuis 1990). Similarly as in spring, winter cereals are again being favoured in autumn (Chapuis 1990; Frylestam 1992). From these studies it is reasonable to assume that brown hares in the study conducted by Tapper and Barnes (1986) use cereals for the majority of the foraging time when the shoots are young (i.e. April and May in areas where spring cereals dominate). Furthermore, in a more intensive agriculture landscape with a smaller proportion of grasslands the percent time that hares spend in different arable crops are probably higher as the grassland habitat covers a much smaller area or is largely absent. Thus, the numbers in Table 6.68 can be viewed as minimum estimates for the use of wheat and barley since cereal fields are likely to compensate for some of the functions of grasslands.

In a study performed by the UK Food and Environment Research Agency, brown hares were caught using walk-in traps set in gaps in hedges, and were fitted with collar-mounted radio tags. A vehicle was used for tracking which was carried out both day and night. The hares’ use of different crops was modelled by fitting a Beta distribution to the radio-tracking data. The results are reported by Prosser (2010); Table 6.69.

**Table 6.69.** *Percentage of active time spent by radio-tagged brown hares in different crops in the UK, presented as 90th percentile of the modelled PT distribution. The hares were caught in the general farmland (not in specific crops); it is therefore recommended to use the subsample of animals who actually used the crop in question (“consumers only”)* ***(bold)*** *(Prosser 2010)*.

| **Period** | **Crop** | **No. of animals** | **90th percentile** |
| --- | --- | --- | --- |
| ***All animals:*** |  |  |  |
| Spring  (March-May) | (winter) cereals | 19 | 0.87 |
| (winter) oil-seed rape |  | 1.00 |
| all crops |  | 1.00 |
| Summer  (June-August)\* | (winter) cereals | 20 | 0.62 |
| (winter) oil-seed rape |  | 0.56 |
| non-cereal crops |  | 0.75 |
| all crops |  | 0.94 |
| Autumn  (September-November) | (winter) cereals | 23 | 0.63 |
| (winter) oil-seed rape |  | 0.28 |
| non-cereal crops |  | 0.35 |
| all crops |  | 0.89 |
| Winter  (December-February) | (winter) cereals | 23 | 0.85 |
| (winter) oil-seed rape |  | 0.45 |
| all crops |  | 1.00 |
| ***Consumers only:*** |  |  |  |
| Spring  (March-May) | (winter) cereals | 14 | **0.93** |
| (winter) oil-seed rape | 7 | **1.00** |
| all crops | 19 | **1.00** |
| Summer  (June-August)\* | (winter) cereals | 10 | **0.89** |
| (winter) oil-seed rape | 4 | **0.88** |
| non-cereal crops | 10 | **0.95** |
| all crops | 18 | **0.99** |
| Autumn  (September-November) | (winter) cereals | 15 | **0.69** |
| (winter) oil-seed rape | 6 | **0.65** |
| non-cereal crops | 13 | **0.47** |
| all crops | 22 | **0.91** |
| Winter  (December-February) | (winter) cereals | 21 | **0.87** |
| (winter) oil-seed rape | 8 | **0.66** |
| all crops | 21 | **1.00** |

\* July was excluded from the calculations for oilseed rape because rape is normally harvested during this month in the UK.

**Body weight**

The body weight of 3.8 kg from the EFSA Guidance Document (EFSA 2009) is probably a realistic estimate (biased low) for the southern part of the Northern Zone and should be used for risk assessment.

**Energy expenditure**

No species-specific data available, therefore calculated allometrically using the equation for mammals in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The brown hare is feeding on a wide selection of arable crops (e.g. cereals), grasses and herbs. Cereal crops like winter wheat is a preferred food item but requirements are changing over the season and as cereals grow larger, more weedy grasses and herbs are included in the diet (Frylestam 1980a, Tapper and Barnes 1986, Chapuis 1990). It appears that the diet of hares closely reflects the vegetation available in the specific home range and the phenology of individual plant species (Olesen and Asferg 2006). Hares living in agricultural areas with intensive cereal production preferentially select green parts of cereals (up to 95%) during the early growth stages of these crops, but in summer when cereals ripen the use of wild dicotyledonous plant species increases in proportion to their appearance and abundance (Olesen and Asferg 2006). In pastoral landscapes, hares have a far more diverse diet of non-grass herbs (weeds) year round and, if present, they feed on root crops, wild grasses, clover and lucerne (Olesen and Asferg 2006). In arable landscapes during late summer, up to 20% of the stomach content may consist of cereal grain (Olesen and Asferg 2006).

From studies in Swedish farmland, brown hares show highest preferences for winter wheat and barley in April and May (Frylestam 1980a). Similarly, preferences are shown for spring cereals from May to July (Tapper and Barnes 1986). Below are listed some brown hare diets from different landscape types and times of year.

Frylestam (1986) studied the winter diet from a total of 120 stomachs of shot hares in three areas with different agricultural practises in southern Sweden (Table 6.70).

Table 6.70. *Brown hare diet in different agricultural landscape in southern Sweden* *(Frylestam 1986).*

| **Landscape type** | **Time of year** | **Food type** | **% of food items** |
| --- | --- | --- | --- |
| Intensive arable land | October-December | Wheat | 48.5 |
| (n=26) |  | Rape | 37.8 |
|  |  | Poaceae sp (Grasses) | 10.6 |
|  |  | Herbs and woody plants | 3.0 |
| Mixed farmland (n=39) | October-December | Poaceae sp (Grasses) | 62.9 |
|  |  | Wheat | 20.5 |
|  |  | Rape | 12.2 |
|  |  | Herbs and woody plants | 4.0 |
| Pastoral land (n=55) | October-December | Poaceae sp (Grasses) | 73.9 |
|  |  | Herbs and woody plants | 16.3 |
|  |  | Wheat | 7.6 |
|  |  | Rape | 1.0 |

Chapuis (1990) studied hare diets in an intensively managed arable landscape in France mainly comprised by winter wheat (40-50%), and maize (30%). The study area was 200 ha and data on hare diet was collected from faeces samples over two annual cycles (Table 6.71). Hansen (1990) studied the seasonal variation in dietary composition of brown hares in agricultural areas in Denmark (Table 6.72).

Table 6.71 *Brown hare diet in arable land* *(Chapuis 1990)1.*

| **Time of year** | **Food type** | **% of diet** |
| --- | --- | --- |
| **April** | Wheat | 90 |
|  | Other grasses | 7 |
|  | Other dicotolydons | 2.5 |
|  | Inflorescences of grasses | 1 |
| **May** | Wheat | 72 |
|  | Other grasses | 9 |
|  | Other dicotolydons | 2.5 |
|  | Inflorescences of grasses | 9 |
| **June** | Wheat | 34 |
|  | Other grasses | 18 |
|  | Inflorescences of grasses | 22.5 |
|  | Maize | 14 |
|  | Equisetum arvense2 | 15 |
|  | Other dicotolydons | 5 |
| **July** | Wheat | 10 |
|  | Other grasses | 11.5 |
|  | Inflorescences of grasses | 31 |
|  | Maize | 16.5 |
|  | Equisetum arvense2 | 9 |
|  | Other dicotolydons | 5 |
|  | Seeds of grasses | 4 |
| **August** | Wheat | 24 |
|  | Other grasses | 8 |
|  | Inflorescences of grasses | 27.5 |
|  | Equisetum arvense2 | 24 |
|  | Maize | 7.5 |
|  | Seeds of grasses | 10 |
|  | Other dicotolydons | 6 |
| **September** | Wheat | 71 |
|  | Other grasses | 10 |
|  | Other dicotolydons | 7 |
|  | Inflorescences of grasses | 5 |
|  | Seeds of grasses | 2.5 |
|  | Equisetum arvense2 | 1 |

1 All data on percentage of diet calculated approximately from figure 2 and 3 in Chapuis (1990).

2 Residues (RUD), energy content, assimilation efficiency etc. of *Equisetum* may be assumed to be the same as in grasses.

Table 6.72. *Brown hare diet, expressed as vol.% of stomach contents, in agricultural areas in Denmark (Hansen 1990).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Plant fraction, group or species** | **Winter**  **Dec.-Mar.**  **vol.%** | **Spring**  **Apr.-May**  **vol.%** | **Summer**  **Jun.-Sep.**  **vol.%** | **Autumn**  **Oct.-Nov.**  **vol.%** |
| Monocotyledon, cereals | 25-65 | 35-50 | 8-25 | 25-50 |
| Monocotyledon, wild and domestic grasses | 25-60 | 22-25 | 25-30 | 35-55 |
| Dicotyledon, wild herbs | 2-4 | 8-20 | 12-26 | 3-5 |
| Dicotyledon, crops | 0 | 0-15 | 18-45 | 2-3 |
| Seeds and fruit | 0-3 | 0 | 0-3 | 0-1 |

### Field vole *Microtus agrestis* (herbivore)



Field vole (*Microtus agrestis*), Photo: RIFCON GmbH

**Risk assessment**

The herbivorous field vole is relevant for the following crop scenarios:

* grass, medium and long (all season) > 10 cm
* orchards, canopy- and ground-directed treatments (all season)
* bush berries (all season)
* Forestry uses, ground directed applications
* Christmas trees and decorative greenery (all season)

A body weight of 30 g must be used in risk assessment (see section on body weight below).

Voles are only considered relevant in fruit trees (orchards), Christmas trees and decorative greenery plantations and bush berries where the ground cover (grass) is higher than 10 cm. In Denmark and Sweden, grass height is usually kept below 10 cm, hence field vole is *not* considered relevant in fruit trees and bush berries in these two countries. There is no specific information on grass height in Christmas trees and decorative greenery plantations within the Northern Zone, but assuming a height of above 10 cm, the small herbivore scenario should be addressed as a worst-case throughout the Northern Zone.

**Table 6.73.** *Estimated diet composition (PD values) of field voles feeding in grass-dominated habitats at different times of the year. PD values were calculated from Table 6.75 (see text).*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Food type** | **PD (fresh weight)** | | | |
| **Spring** | **Summer\*** | | **Autumn** |
| **March** | **June** | **August** | **October** |
| Grasses | 0.97 | 0.55 | 0.62 | 0.82 |
| Non-grass herbs | 0.03 | 0.43 | 0.32 | 0.17 |
| Small seeds |  |  | 0.05 | 0.01 |
| Ground arthropods |  | 0.02 | 0.01 |  |

\* Arithmetic mean between PD in June and August should be used as representative PD for summer

The composition of diet at different times of the year may be taken from Table 6.75 (which is preferred to Table 6.74 because the PD values are expressed in terms of weight). It is considered that the values in Table 6.75 are valid for all of the above-mentioned scenarios. In the calculation of PD, the percent content of “undetermined plant material” and “other” are left out and the shares of the other components increased proportionally to provide a sum of 100%; Table 6.73.

Home ranges of field voles may be very small (≈ 0.1 ha), so refinement of PT for field voles living in grass is probably not justified. In vegetation covered orchards, bush berries, Christmas trees and decorating green plantations and forest cuttings PT may be refined if justified by case-specific data.

**General information**

The field vole is widespread within the Northern Zone, where it occurs from southernmost Denmark and Lithuania to northernmost Norwegian mainland (Mitchell-Jones et al. 1999). Apparent gaps in the distribution in western and northern Norway and northern Finland are probably due to incomplete coverage in the European Atlas (Mitchell-Jones et al. 1999). The species is generally common within its range, except in marginal areas where it may be locally rare. Field voles may occur in woodland, provided there is a good grass cover, but are found mostly in open country where they prefer tall and dense grass vegetation and areas where the vegetation provides good cover, such as meadows, set-asides, river banks, vegetated margins of ditches and hedgerows (Mitchell-Jones et al. 1999, Hansen and Jensen 2007a). In Fennoscandian boreal forests, the field vole shows low densities in clear-cuts (Gorini et la. 2011).

In Denmark, breeding starts in March and ends in September; during this period four to five litters are born (Hansen and Jensen 2007a).

**Agricultural association**

The field vole can be found in farmland (Loman 1991a, Tattersall et al. 2002, Hansen and Jensen 2007a) where it mainly occurs in set-aside and permanent grassland while numbers in cereal fields are low (Jensen and Hansen 2003). For example, in a three years study of small mammals on arable land in England, Tew (1994) failed to capture any field voles away from the hedgerows around cereal fields. In another study in England, field voles were occasionally caught in the fields, but they were usually restricted to areas with dense ground cover, such as patches infested with blackgrass *Alopecurus myosuroides* (Johnson et al. 1992).

The species requires a vegetation cover for its presence and is therefore – apart from its occurrence in permanent grassland – found mainly in the surroundings of arable crops and not in the crop itself (Gurney et al. 1998, Hansen and Jensen 2007a). The most frequently used habitats in arable landscapes are field boundaries (e.g. ditches) (Huitu et al. 2004, Yletyinen and Norrdahl 2008), and particularly, field voles are found in two-year leys and set-asides (Hansson 1977, Rogers and Gorman 1995a, Tattersall et al. 2002). The species also occurs in orchards, provided the grass cover is higher than 10 cm.

The field vole is often found in leys and set-asides where there is a vegetation cover year round, and in such habitats voles can be both nesting and foraging (Hansson 1977, Jensen and Hansen 2003, Huitu et al. 2004). Thus, it is reasonable to believe that field voles can spend their whole life cycle in leys and set-asides, albeit in fairly low densities, compared to the densities in prime habitats such as meadows and other permanent grasslands.

In several studies, the captures of field voles in arable crops are few (e.g. Loman 1991a; Rogers and Gorman 1995a, Jensen and Hansen 2003) and the time spent in this habitat is probably low. The home range of field voles varies between 0.02 and 0.1 ha for females and 2-5 times that for males (Bjärvall and Ullström 1985, Yletyinen and Norrdahl 2008). For voles inhabiting field margins, distance between consecutive radio locations were longer in narrow strips and males moved farther than females, but there was significant seasonal variation in home range size, which was largest in autumn and smallest in winter; crop fields and all mowed habitat types were used less than small buffer zones, while crop fields were used proportionally more but little in summer (Yletyinen and Norrdahl 2008).

**Body weight**

The body weight of field voles is given for males and females separately:

* Males mean weight 39.7 (15-42) g, (Gurney et al. 1998).
* Females mean weight 30.9 (15-32) g, (Gurney et al. 1998).

A body weight of 30 g must be used for risk assessment.

**Energy expenditure**

Daily energy budget has been calculated for the field vole on a summer and a winter day to 51.7 kJ/animal/day (animal weight 23.8 g) and 44.5 kJ/animal/day (animal weight 20.4 g), respectively (Hansson and Grodzínski 1970). Alternatively, the energy expenditure can be calculated allometrically using the equation for mammals in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The field vole is a herbivore, mainly feeding on green leaves and stems of grasses. Almost no seeds or invertebrates are consumed (Hansson 1971). In a study in England where field voles were occasionally trapped in oilseed rape, a dietary analyses showed that the voles were eating mainly monocotyledons (82%) and only 3% oilseed rape (Rogers 1993). In a study in southern Sweden, animal food occurred with a maximum of 2% of total stomach content in any month (Hansson 1971). In the same study, the annual food habits of 527 field voles living in grassland was examined (Table 6.74). Also in alpine areas of Norway, amounts of monocotlydenuous and dicotyledonuous plants was similar (Saetnan et al. 2009).

Table 6.74. *Field vole diet in grassland of southern Sweden* *(Hansson 1971).*

| **Time of year** | **Food type** | **% of food items** |
| --- | --- | --- |
| **April** (n=26) | Grass (leaves and stems) | 71 |
|  | Herb (leaves and stems) | 2 |
|  | Graminoids (leaves and stems) | 9 |
|  | Vegetative storage organs\* | 17 |
| **May** (n=17) | Grass (leaves and stems) | 75 |
|  | Herb (leaves and stems) | 14 |
|  | Graminoids (leaves and stems) | 2 |
|  | Vegetative storage organs\* | 5 |
| **June** (n=29) | Grass (leaves and stems) | 52 |
|  | Herb (leaves and stems) | 37 |
|  | Graminoids (leaves and stems) | 2 |
|  | Vegetative storage organs\* | 10 |
| **July** (n=23) | Grass (leaves and stems) | 40 |
|  | Herb (leaves and stems) | 36 |
|  | Graminoids (leaves and stems) | 2 |
|  | Grass seeds | 19 |
| **August** (n=33) | Grass (leaves and stems) | 30 |
|  | Herb (leaves and stems) | 51 |
|  | Grass seeds | 12 |
| **September** (n=22) | Grass (leaves and stems) | 65 |
|  | Herb (leaves and stems) | 25 |
|  | Grass seeds | 8 |

\* Mainly underground storage organs, so residues will depend on the mode of action of the compound (systemic or non-systemic).

In a Dutch study, the diet composition was studied throughout the year at two sites (Faber and Ma 1986 cited in Gurney et al. 1998). The results from one of these sites are shown in Table 6.75. At the other site, the diet was dominated by wavy hair-grass *Deschampsia flexuosa* and also contained mosses (*Hypnum cupressiforme*) and blueberry *Vaccinium myrtillus*. Accordingly, this site was probably a grass-dominated heathland, making the results less relevant for risk assessment.

Table 6.75. *Stomach contents of field voles collected in grassland near Budel, the Netherlands* *(Faber and Ma 1986).*

| **Time of year** | **Food type** | **% fresh weight** |
| --- | --- | --- |
| **March** | Grasses | 96.1 |
|  | Dicotyledons | 2.5 |
|  | Undetermined plant material | 1.0 |
|  | Fungi | 0.3 |
| **June** | Grasses | 52.1 |
|  | Dicotyledons | 40.5 |
|  | Undetermined plant material | 3.0 |
|  | Animal material\* | 2.0 |
| **August** | Grasses | 57.4 |
|  | Dicotyledons | 29.0 |
|  | Undetermined plant material | 8.3 |
|  | Seeds | 4.9 |
|  | Animal material\* | 1.2 |
| **October** | Grasses | 79.0 |
|  | Dicotyledons | 17.0 |
|  | Undetermined plant material | 2.0 |
|  | Seeds | 0.7 |
|  | Other | 0.3 |
| **December** | Grasses | 96.0 |
|  | Dicotyledons | 0.3 |
|  | Undetermined plant material | 2.5 |
|  | Other | 0.7 |

\* Probably ground-dwelling arthropods.

### Wood mouse *Apodemus sylvaticus* (omnivore)



Wood mouse (*Apodemus sylvaticus*), Photo: M. Grimm

**Risk assessment**

The omnivorous wood mouse is a relevant focal species in all scenarios. Risk assessment for wood mice is assumed to cover also the striped field mouse *Apodemus agrarius*, which replaces the wood mouse in farmland in the Baltic States and Finland.

A body weight of 18 g must be used in risk assessment (see section on body weight below).

The diet composition (PD values) may in principle be deduced from Table 6.78 to Table 6.80 for the month(s) in question. The PD values in the tables shall however be adjusted to allow for differences in food availability between crops. Crop-specific PD adjustments and the resulting PD values are shown in Appendix and in the accompanying data sheet and calculator tool.

All insects and other arthropods listed in the tables may be assumed to be ground-dwelling. A few of the arthropods will be foliar but this is offset by the fact that burrowing arthropods, which probably have very low residues, also occur in the diet.

As wood mice obtain almost all of their food from the ground, interception in the crop canopy shall be taken into account as appropriate for the crop and application scenario in question, cf. section 4.5.

The wood mouse is also relevant for all field scenarios involving seed treatments. The values in Table 6.76 may be used in risk assessment; the PD values to be used in assessment of long-term risk are derived from the adjustments described in Appendix 4.

Table 6.76. *Estimated amounts of treated seed consumed by an 18 g wood mouse fulfilling its daily requirements by feeding in newly sown fields.*

|  | **PD (fresh weight)\*** | **Fresh weight (g)** | **Notes** |
| --- | --- | --- | --- |
| **Spring cereals\*\*** | 1.00 | 3.90 |  |
| 0.29 | 2.05 |  |
| **Winter cereals\*\*** | 1.00 | 3.90 |  |
| 0.55 / 0.60 | 2.45 / 2.41 | Values from Pelz/Green. Both values include an unknown amount of harvest spillage |
| **Maize\*\*** | 1.00 | 3.90 |  |
| 0.29 | 2.18 | Includes an unknown amount of cereal grain |
| **Spring rape\*\*\*** | 1.00 | 3.13 |  |
| 0.07 | 0.59 |  |
| **Winter rape\*\*\*** | 1.00 | 3.13 |  |
| 0.41 | 2.02 | Includes an unknown amount of weed seeds |
| **Beets\*\*\*** | 1.00 | 3.13 |  |
| 0.07 | 0.59 |  |
| **Pulses\*\*** | 1.00 | 3.90 |  |
| 0.29 | 2.18 | Includes an unknown amount of cereal grain |
| **Grass\*\*\*** | 1.00 | 3.13 |  |
| 0.42 | 2.25 | Based upon Rogers and Gorman (1995b) data |

\* PD = 1 may be used in acute risk assessment, PD < 1 in long-term risk assessment.

\*\* Large seeds. \*\*\* Small seeds.

Dehusking or cracking of seeds is part of the typical feeding behaviour of wood mice, so a dehusking factor may be applied, cf. section 4.7.

Home ranges of female wood mice are usually small (< 1 ha) and may well be within the area of a single field. For potatoes (all season), cereals in winter (October-February) and newly-drilled cereals in autumn, PT may be refined using the data in Table 6.77. In all other cases, PT shall not be refined unless fully justified by case-specific data.

**General information**

The wood mouse is common and widespread in Denmark, southern Sweden, southern Norway and south-western Lithuania (Mitchell-Jones et al. 1999). The species is found in a wide range of habitats, including both arable land and forest. There may be geographic variation in habitat, with western populations being associated mostly with diverse habitats and eastern populations with woodland edge habitats (Mitchell-Jones et al. 1999). In Denmark, wood mice are mainly found in open habitats, including arable land, and rarely occur in forest (Hansen and Jensen 2007b). In north-eastern Lithuania, Latvia, Estonia and southern Finland, the wood mouse is replaced in farmland and forests by the striped field mouse *A. agrarius*, which is of similar size (e.g. Šinkūnas and Balčiauskas 2006).

Wood mice are nocturnal and live in well developed burrow systems which can be as deep as 25 cm (Loman 1991a). Young are born from March-April to September-October with 2-4 litters during the breeding season (Hansen and Jensen 2007b).

**Agricultural association**

The wood mouse is widespread and common in the agricultural landscape and occurs in a number of farmland habitats (Jensen and Hansen 2003). Studies on the species have been conducted in set-asides as well as in arable crops such as wheat (autumn- and spring-sown), rye, winter barley, potatoes, sugar beet and oilseed rape (Green 1979, Pelz 1989, Loman 1991a, Rogers and Gorman 1995a, Fitzgibbon 1997, Todd et al. 2000, Jensen and Hansen 2003 and notifier study summarized in EFSA Journal 2004). Wood mice are found throughout the year in the fields (Green 1979, Loman 1991b, Rogers 1993) although densities decline following harvest due to predation and migration to hedges (Tew and Macdonald 1993, Tew et al. 1994).

Macdonald et al. (2000) compared the use of wheat, barley and rape fields by wood mice in England and found a tendency for numbers of mice to be lower in rape than in other crops. Jensen and Hansen (2003) on the other hand found that wood mice were trapped more commonly in rape than in other crops, particularly during autumn. In a study in NW France, Ouin et al. (2000) recorded low occurrence of wood mice in maize and carrot fields between May and July compared to fields with wheat and peas.

Wood mice are territorial and individuals have separate home ranges. There is a difference in home range size between breeding season and winter, as well as for males and females. The home range of males during the breeding season has been estimated at 1.22-1.87 ha and in winter at 0.34 ha (Green 1979, Tattersall et al. 2001). The corresponding estimates for females are 0.49-0.63 ha and in winter 0.46 ha (Green 1979, Tew et al. 1992). In an English study of radio-tracked mice in a winter wheat field, two males had large home ranges of 18.1 ha and 23.3 ha in June-July while a single female had a home-range of only 0.13 ha during the same period (Tew et al. 1992). According to Tew and Macdonald (1994), only females are defending territories, while males have larger undefended ranges overlapping as many female territories as possible (Tattersall et al. 2001). The home range size is also dependent on density. Higher densities lead to decreased home range sizes (Tew and Macdonald 1994). Population densities according to two studies on arable land are 1.14 individuals/ha (Pelz 1989) and 1.17 individuals/ha (Green 1979). Some spring/summer densities for different crop types are: winter wheat 2.30, spring sown cereals 1.02, and sugar beet 0.55 animals/ha (Green 1979). Densities in winter cereal fields in autumn are 5-10 animals/ha (Tew and Macdonald 1993, Hansen and Jensen 2007b).

There are populations of wood mouse that are present in agricultural landscapes and spend their entire life in this habitat. However, wood mice that lived in barley or wheat fields during the summer emigrated to the hedgerows after harvest (Tew et al. 1994) leading to large seasonal variations in population size in field centres (Macdonald et al. 2000). The home ranges for individual mice are likely to be inside the area of a single field and it is therefore reasonable to assume that these mice may spend their entire life cycle in a single field. This assumption is supported by other studies (Plesner-Jensen 1993; notifier study summarized in EFSA 2004).

Radio-tracking studies of wood mice caught in arable land have been conducted in the UK and are reported by Prosser (2010). The mice were equipped with collar-mounted radio tags and were tracked during “a day in the life” – or rather “a night in the life” since tracking was carried out from dusk to dawn to reflect the nocturnal habits of the species. In one project, data were allegedly collected from 20-30 individuals each during spring (March-May), summer (June-August), autumn (September-November) and winter (December-February). However, data are reported for the periods June-September and October-February and only for potatoes (summer) and cereals (winter) (Prosser 2010, Table 6.77.). In another study, wood mice were caught on or immediately adjacent to newly-drilled cereal fields in autumn. Tracking followed a protocol similar to that in the first study and the results are also shown in Table 6.77.

Table 6.77. *Percentage of active time spent by radio-tagged wood mice in different crops in the UK, presented as 90th percentile of the modelled PT distribution. Results are shown for the total sample of tracked mice (“all animals”) as well as for the subsample of animals who actually used the crop in question (“consumers only”)*. *Recommendations on which data set to use are given below the table and are also shown in bold* *(Prosser 2010).*

| **Period** | **Crop** | **No. of animals** | **90th percentile** |
| --- | --- | --- | --- |
| ***All animals:*** |  |  |  |
| Summer  (June-September)1 2 | Potatoes2 | 20 | 0.79 1 |
| Autumn  (September-November) 3 | Winter cereals,  newly-drilled3 | 21 | **0.37** |
| Winter  (October-February)2 | Winter cereals2 | 36 | 0.70 |
| ***Consumers only:*** |  |  |  |
| Summer  (June-September)1 2 | Potatoes2 | 17 | **0.82** 1 |
| Autumn  (September-November)3 | Winter cereals,  newly-drilled3 | 12 | 0.51 |
| Winter  (October-February)2 | Winter cereals2 | 10 | **0.81** |

1 Although data were only reported for June - September, it is assumed that that these values may be used for the whole growing season.

2 Animals were presumably trapped in general farmland; it is recommended to use data for “consumers only”.

3 Animals were trapped in or adjacent to newly-drilled cereal fields; it is recommended to use data for “all animals”.

**Body weight**

The body weight of wood mice shows an annual cycle with higher weights during breeding season compared to other times of year (Rogers and Gorman 1995a).

Body weight is reported as follows:

* Summer 25 g (May-August) (L. Hansson pers. comm. to KemI).
* Year round 18 (13-27) g (Gurney et al 1998).

The latter mean weight (18 g) must be used for risk assessment.

**Energy expenditure**

Daily energy budgets for wood mouse in summer, winter and annually have been calculated by Grodzínski (1985) from several scientific papers. The energy budget for wood mice on a summer and a winter day amount to 43.1 kJ/animal/day (weight 22 g) and 37.1 kJ/animal/day (weight 19 g), respectively (Grodzínski 1985). Alternatively, the energy expenditure can be calculated allometrically using the equation for mammals in accordance with the formula in Appendix G of the EFSA Guidance Document (EFSA 2009).

**Diet**

The wood mouse is an opportunistic feeder, taking mainly seeds and invertebrates. The diet depends on the main habitats which exist within the home range of the population, but also on the time of year as availability of food differ during the growth period. Plesner-Jensen (1993) found that seeds of wheat, barley and oil-seed rape were among the five most favoured food items to wood mice, with wheat ranking higher than the other crops. However, crop seeds are only available for a short time, and for most of the year wood mice rely on wild plant seeds (Green 1979, Pelz 1989). During winter, grazing of winter cereals by wood mice may locally cause considerable damage (Roebuck et al. 1944).

The principal diet of wood mouse throughout the year was reported by Hansson (1985) and Tew et al. (1992) to consist of 70% seeds/cereal grains, 15% animal matter and 5-10% vegetative plant tissue. The diet composition for different habitats and time of year for field-dwelling wood mice has been investigated in a number of different studies which are summarized below (Table 6.78; Table 6.79; Table 6.80).

In an English study, Barber et al. (2003) studied the amount of winter wheat seeds consumed by wood mice during a three week period following drilling in October. Two fields of 4.7 and 5.6 ha were examined and mice were caught in transects from the field boundary towards the centre of the field. A total of 90 wood mice were used to establish the proportion of stomach content that consisted of wheat seeds. The amount of wheat seeds, estimated as % of total stomach content (probably by volume), was:

* Less than 25% (90% of the individuals)
* Maximum 40% (10% of the individuals)

Pelz (1989) studied field-dwelling wood mice in a typical sugar beet growing area in the Rhineland, Germany. In the area, a three year crop rotation system with sugar beet, winter wheat and winter barley was employed. The analysis of food consumption was based on 465 wood mice that were caught between 1976-77 and 1980-86 (Table 6.78).

Table 6.78. *Wood mice diet in intensive arable land dominated by winter cereals and sugar beet (Pelz 1989).*

| **Time of year** | **Food type** | **Vol.% of diet** |
| --- | --- | --- |
| **March** (n=56) | Insect larvae1 | 25 |
|  | Earthworms | 23 |
|  | Vegetative plant tissue2 | 22 |
|  | Cereal grain | 23 |
|  | Sugar beet seeds | 7 |
| **April** (n=49) | Insect larvae1 | 45 |
|  | Earthworms | 26 |
|  | Vegetative plant tissue2 | 24 |
|  | Cereal grain | 5 |
| **May** (n=16) | Insect larvae1 | 10 |
|  | Earthworms | 40 |
|  | Vegetative plant tissue2 | 16 |
|  | Cereal grain | 30 |
|  | Dicotyledon seeds (herb) | 4 |
| **June** (n=15) | Insect larvae1 | 25 |
|  | Earthworms | 9 |
|  | Vegetative plant tissue2 | 9 |
|  | Cereal grain | 32 |
|  | Dicotyledon seeds (herb) | 25 |
| **July** (n=10) | Insect larvae1 | 28 |
|  | Vegetative plant tissue2 | 8 |
|  | Cereal grain | 48 |
|  | Dicotyledon seeds (herb) | 16 |
| **August** (n=41) | Insect larvae1 | 28 |
|  | Earthworms | 5 |
|  | Vegetative plant tissue2 | 10 |
|  | Cereal grain | 37 |
|  | Dicotyledon seeds (herb) | 20 |
| **September** (n=18) | Insect larvae1 | 25 |
|  | Earthworms | 13 |
|  | Vegetative plant tissue2 | 9 |
|  | Cereal grain | 33 |
|  | Dicotyledon seeds (herb) | 20 |
| **October** (n=48) | Insect larvae1 | 30 |
|  | Vegetative plant tissue2 | 25 |
|  | Cereal grain | 30 |
|  | Dicotyledon seeds (herb) | 15 |
| **November** (n=36) | Insect larvae1 | 9 |
|  | Earthworms | 3 |
|  | Vegetative plant tissue2 | 40 |
|  | Cereal grain | 40 |
|  | Dicotyledon seeds (herb) | 8 |

1 For risk assessment puposes, the insect larvae may be assumed to be picked from the ground.

2 Mono- or dicotyledonous, depending on the crop.

Green (1979) studied arable dwelling wood mice in English farmland. Among the crops grown in the study area were spring barley, spring and winter wheat and sugar beet. Wood mice living in winter wheat fields were caught for food analysis (Table 6.79).

Table 6.79. *Wood mouse diet in winter wheat fields in England (Green 1979).*

| **Time of year** | **Food type** | **Vol.% of diet** |
| --- | --- | --- |
| **September-December** (n=8) | Arthropods1 | 16 |
|  | Cereal grain | 60 |
|  | Dicotyledon seeds2 | 24 |
| **January-March** (n=30) | Arthropods1 | 16 |
|  | Earthworms | 16 |
|  | Cereal grain | 55 |
|  | Chickweed seed2 | 2 |
|  | Other dicotyledon seeds2 | 3 |
|  | Leaf tissue | 1 |
|  | Other plant tissue | 7 |
| **April-June** (n=15) | Arthropods1 | 12 |
|  | Cereal grain | 6 |
|  | Leaf tissue | 1 |
|  | Chickweed seed2 | 27 |
|  | Grass flowers/green seeds2 | 53 |

1 All arthropods may be assumed to be ground-dwelling.

2 Small seeds.

Rogers and Gorman (1995b) collected data on wood mice living on set-aside in Scotland. The set-aside included in the study was fallow from barley and regenerated naturally. The diet analysis was performed in 53 wood mice caught over an 18 month period (Table 6.80).

Table 6.80. *Wood mouse diet on set-aside* *(n=53) (Rogers and Gorman 1995b).*

| **Time of year** | **Food type** | **Vol.% of diet** |
| --- | --- | --- |
| **March-May** | Monocotyledons (Grasses) | 72 |
|  | Insects | 13 |
|  | Other animal material\* | 10 |
|  | Dicotyledons (Herbs) | 5 |
| **June-August** | Monocotyledons (Grasses) | 45 |
|  | Seeds | 42 |
|  | Other plant material | 5 |
|  | Dicotyledons (Herbs) | 3 |
|  | Other animal material\* | 2 |
|  | Insects | 1 |
| **September-November** | Monocotyledons (Grasses) | 50 |
|  | Seeds | 35 |
|  | Other plant material | 6 |
|  | Insects | 5 |
|  | Dicotyledons (Herbs) | 2 |
|  | Other animal material\* | 1 |

\* Probably mainly soil invertebrates (earthworms).

# Summary tables

The selection of relevant focal species for different combinations of crop and growth stage is summarized in this chapter.

The selection is based on the species specific information presented in chapter 6. Because of the different ecological traits of the focal species, only species considered relevant for a specific crop scenario are listed. Species that are not mentioned are assumed to be less frequent in the actual crop at that time of year, or the risk assessment for these species is covered by other, more sensitive species. Please notice, the focal species relevant for seed treatmen risk assessment are indicated in bold in the BBCH stage 0-9. All combinations of crop and granivorus focal species are seen in table 5.1.

The different scenarios within a certain crop are defined by their growth stage (BBCH, ref. Meier 2001). The calendar months mentioned in the tables refer to Danish conditions and are merely indicative. In cases where two time lines are presented, the upper line refers to spring-sown crops and the lower line to autumn-sown crops.

It should be noticed that although most of the focal species are widespread and common across the Northern Zone, not all of the species selected for a certain crop scenario may be relevant in all Member States within the Northern Zone.

Table 7.1. *Crop groupings according to EFSA (2009) and corresponding crop groupings in the current Northern Zone guidance document.*

| **EFSA (2009) Crop Group** | **Crops covered** | **NZ B&M GD Crop Group** | **Crops covered** |
| --- | --- | --- | --- |
| Bare soil | All arable crops (BBCH < 10) | **-** | **-** |
| Bush and cane fruit | Blackberry, dewberry, loganberry, raspberry, gooseberry, red and blackcurrant, etc. | **Bush berries** | red and black currant, raspberry, gooseberry and blackberry |
| Cereals | Wheat, barley, oats, rye, rice, millet, sorghum, triticale, etc. | **Cereals** | Wheat, barley, oats, rye, triticale |
| Cotton | Cotton | **-** | - |
| - | - | **Christmas trees and decorative greenery** | Christmas trees and decoratve greenery |
| - | - | **Forest uses** | Clear cuttings, young trees etc. |
| Fruiting vegetables | Tomatoes, peppers, chilli peppers, aubergines, cucumber, gherkins, courgettes, melons, squashes, watermelons, etc. | **-** | - |
| Grassland | Grass | **Grass** | grass for seed breeding, grass ley, mixed ley, pasture, turf |
| Hops | Hops | **-** | - |
| Leafy vegetables | Broccoli, cauliflower, Brussels sprouts, cabbage, Chinese cabbage, kale, cress, lambs lettuce, lettuce, escarole, spinach, chicory, chervil, chives, parsley, artichokes, cardoons, rhubarb, asparagus, etc. | **Vegetables (incl. Root and stem vegetables)** | carrots, onions, brassica vegetable crops, lettuce and leek |
| Legume forage | Alfalfa, clover, etc. | **-** | - |
| Maize | Maize, sweet corn | **Maize** | Maize |
| Oilseed rape | Oilseed rape, linseed, field (faba) beans, quinoa, poppy, mustard, sesame, etc. | **Oilseed rape** | Oilseed rape |
| Orchards | Grapefruit, lemon, lime, mandarins, oranges, pomelos, olives, almonds, chestnuts, hazelnuts, macademia, pecans, pine, pistachios, walnuts, apple, pear, quinces, apricots, cherries, peaches, nectarines, plums, avocado, date, kiwi, mango, pomegranate, fig, kumquat, litchi and passion fruit, etc. | **Fruit trees** | pome fruit (apple, pear), stone fruit (plum, cherry). |
| Ornamental /nursery | Flowers and plants for transplanting | **Ornamental/ nursery** | Ornamentals, plants of ‘*very different height and structure*’ |
| Potato | Potato, sweet potatoes | **Potato** | Potato |
| Pulses | Peas, lentils, French beans, soybeans, buckwheat, etc. | **Pulses** | peas and beans |
| Root and stem vegetables | Beetroot, carrot, celeriac, horseradish, Jerusalem artichoke, parsnips, parsley root, radishes, salsify, Swedes, turnips, celery, kohlrabi, fennel, etc. | **Beet (incl. Sugarbeet)** | sugarbeet, fodder beet, turnip |
| Sugarbeet | Sugarbeet |  |
| Strawberries | Strawberry, bilberry, cranberry, etc. | **Strawberries** | Strawberries |
| Sunflower | Sunflower | **-** | - |
| Vineyards | Grape | **-** | - |

**Beets** **(Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Beet crops include sugar beet, fodder beet and turnip; they are sown in spring and are subject to various pesticide treatments throughout the growing season.** | | | | | | | |
| **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-19** | **Closing of rows**  **BBCH 20-39** | **Final development towards harvesting**  **BBCH 40-49** |  |  |  |  |
| April | May-June | June | July-October |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - (treated seeds) 1)  - (weed seeds) 2) | - crop leaves  - weeds 3)  - ground-dwelling arthropods  - (weed seeds) 2) | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods 4) | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * **Skylark** * White wagtail * **Wood mouse** | * **Skylark** * White wagtail * Linnet * Ortolan bunting * **Brown hare** * **Wood mouse** | * Skylark * White wagtail * Linnet * Ortolan bunting * Brown hare * Wood mouse | * Skylark * White wagtail * Linnet * Ortolan bunting * Brown hare * Wood mouse |  |  |  |  |

1) Pelleted beet seeds may be eaten by mammals (mice) but are little attractive to birds (Prosser 1999) and are usually precision drilled at 2-3 cm depth.

2) Availability of weed seeds depends on the soil treatments.

3) The relative amounts of grasses and dicotyledonous weeds will vary.

4) The population of foliar arthropods in the field develops during this period.

**Bush berries**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Bush berries cultivated in the Northern Zone include red and black currant, raspberry, gooseberry and blackberry. Bush berries are subject to various pesticide treatments throughout the growing season (except during harvest).** | | | | | | | |
| **Pre-flowering**  **and flowering**  **BBCH ≤ 69** | **Development and ripening of fruits**  **BBCH 70-89** | **Post-harvest** |  |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - foliar arthropods  - ground-dwelling arthropods  - grass  - dicot. weeds  - weed seeds | - fruits  - foliar arthropods  - ground-dwelling arthropods  - grass  - dicot. weeds  - weed seeds | - foliar arthropods  - ground-dwelling arthropods  - grass  - dicot. weeds  - weed seeds |  |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Blue tit 1) * Chaffinch * Linnet * Brown hare * Field vole 2) * Wood mouse | * Whitethroat 1) * Blue tit 1) * Chaffinch * Linnet * Brown hare * Field vole 2) * Wood mouse | * Blue tit 1) * Chaffinch * Linnet * Brown hare * Field vole 2) * Wood mouse |  |  |  |  |  |

1) Canopy directed applications.

2) If ground vegetation (grass) height is ≥ 10 cm. This is assumed to be the case in Estonia, Finland, Latvia, Lithuania and Norway, but not in Denmark and Sweden.

**Cereals (Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-29** | **Stretching to flowering**  **BBCH 30-39** | **Stretching to flowering**  **BBCH 40-69** | **Develop­ment and ripening of grain**  **BBCH 70-89** | **Pre-harvest desiccation 1)** | **Post-harvest stubble treatments 2)** | **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-19** |
| April  **(spring cereals)** | (April-)May | June | June-July | July-August | August | August-Sep. |  |  |
|  | April-May  **(winter cereals)** 3) | May-June | May-June/July | July-Aug. | July-August | August-Sep. | Sep.-October | Sep.-October |
| **Food types** |  |  |  |  |  |  |  |  |
| - treated seeds  - ground-dwelling arthropods  - (weed seeds) 4) | - early growth stages of crop  - ground-dwelling arthropods  - (weed seeds) 4) | - ground-dwelling arthropods  - foliar arthrop.5)  - weeds  - crop itself is not attractive as food item | - ground-dwelling arthropods  - foliar arthrop.5)  - weeds  - crop itself is not attractive as food item | - ground-dwelling arthropods  - foliar arthropods  - weeds  - weed seeds  - cereal grain/ear | - ground-dwelling arthropods  - foliar arthropods  - weeds  - weed seeds  - cereal grain/ear | - ground-dwelling arthropods  - weeds 6)  - weed seeds  - waste grain | - treated seeds  - ground-dwelling arthropods  - (weed seeds) 4)  - (waste grain) 4) | - early growth stages of crop  - ground-dwelling arthropods  - (weed seeds) 4)  - (waste grain) 4) |
| **Selected species** |  |  |  |  |  |  |  |  |
| * **Bean goose** 9 * **Pink-foot. g.** 10) * **Skylark** * White wagtail * **Yellowhammer** * **Wood mouse** | * **Bean goose** 9 * **Pink-foot. g**. 10) * **Skylark** * White wagtail 7) * Ortolan bunting * **Brown hare** * **Wood mouse** | * Skylark * Ortolan b. * Wood mouse | * Skylark * Whinchat * Ortolan b. * Wood mouse | * Skylark * Whinchat * Ortolan b. * Wood mouse | * Skylark * Whinchat * Ortolan b. * Wood mouse | * Skylark * Ortolan b. * Wood mouse | * Bean goose 9 * **Woodpigeon** * **Skylark** * White wagtail 8) * **Yellowhammer** * **Wood mouse** | * **Bean goose** 9 * **Pink-foot. g.**10) * **Grey partridge** * **Brown hare** * Wood mouse |

1) At pre-harvest desiccation with herbicides, in most cases the crop and possible weeds in the field are completely wilted or may become unattractive as food within approx. one week. Hence, exposure via green plant parts and associated foliar arthropods is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds remain as food items in the field.

2) At post-harvest stubble treatments with herbicides, in most cases the weeds in the field are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds remain attractive as food items in the field.

3) The phenology of winter cereals differs between species. In general, rye and winter barley develop earlier than winter wheat.

4) Availability of weed seeds and waste grain depends on the soil treatments.

5) The population of foliar arthropods in the field develops during this period.

6) Grasses or dicotyledonous weeds, depending on the situation.

7) BBCH 10-14.

8) September.

9) Sweden, Finland and the Baltic

10) Denmark and Norway

**Christmas trees and decorative greenery**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Trees from nurseries (approx. 20 cm high) are planted mid-summer, maintenance particularly intensive for first 3-4 years (weed spraying), harvest begins by 5th year** | | | | | | | |
| **Herbicide treatments**  **(applied to ground)** | **Other treatments (applied to canopy)** |  |  |  |  |  |  |
| Jan.-Dec. | Jan.-Dec. |  |  |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - foliar-dwelling arthropods 1)  - weed seeds | - ground-dwelling arthropods  - foliar-dwelling arthropods 1)  - weed seeds  - tree seeds |  |  |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Robin * Chaffinch * Siskin 2) * Common shrew * Field vole | * Robin * Goldcrest 3) * Chaffinch * Siskin 2) * Common shrew * Field vole |  |  |  |  |  |  |

1) In the case of ground-directed application refers to arthropods on weeds.

2) Note that siskins may forage in tree canopies and on herbs in the undergrowth, i.e. the species needs to be considered for both ground- and canopy-directed applications.

3) Foliar arthropods in the tree canopy.

**Forestry uses (incl. power line clear cuttings and for reforestation)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | |
| **Broad-leaf forest (young)**  **approx. ≤ 30 years** | **Broad-leaf forest (mature)**  **approx. > 30 years** | **Broad-leaf forest (clear-cut)**  **approx. 0-3 years 1)** | **Conifer forest (young)**  **approx. ≤ 30 years** | **Conifer forest (mature)**  **approx. > 30 years** | **Conifer forest (clear-cut)**  **approx. 0-3 years 1)** |  |  |
| Jan.-Dec. | Jan.-Dec. | Jan.-Dec. | Jan.-Dec. | Jan.-Dec. | Jan.-Dec. |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - canopy-dwelling arthropods  - wood-dwelling arthropods  - grass and herbs  - weed seed  - tree seeds  - fruits | - ground-dwelling arthropods  - canopy-dwelling arthropods  - wood-dwelling arthropods  - grass and herbs  - weed seed  - tree seeds  - fruits | - ground-dwelling arthropods  - foliar-dwelling arthropods  - grass and herbs  - weed seed  - tree seeds  - fruits | - ground-dwelling arthropods  - canopy-dwelling arthropods  - wood-dwelling arthropods  - grass and herbs  - weed seed  - tree seeds  - fruits | - ground-dwelling arthropods  - canopy-dwelling arthropods  - wood-dwelling arthropods  - grass and herbs  - weed seed  - tree seeds  - fruits | - ground-dwelling arthropods  - foliar-dwelling arthropods  - grass and herbs  - weed seed  - tree seeds  - fruits |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Common redstart * Wren * Blue tit 2) * Common treecreeper 2) * Chaffinch * Siskin 2) * Wood pigeon * Bullfinch 2) 3) * Common shrew * Field vole * Brown hare * Wood mouse | * Common redstart * Wren * Willow warbler 2) * Common treecreeper 2) * Chaffinch * Siskin 2) * Hawfinch 2) * Stock dove * Bullfinch 2) 3) * Common shrew * Field vole * Brown hare * Wood mouse | * Common redstart * Wren * Chaffinch * Wood pigeon * Bullfinch 2) 3) * Common shrew * Field vole * Brown hare * Wood mouse | * Common redstart * Wren * Goldcrest 2) * Common treecreeper 2) * Chaffinch * Siskin 2) * Wood pigeon * Bullfinch 2) 3) * Common shrew * Field vole * Brown hare | * Common redstart * Wren * Goldcrest 2) * Common treecreeper 2) * Chaffinch * Siskin 2) * Wood pigeon * Bullfinch 2) 3) * Common shrew * Field vole * Brown hare * Wood mouse | * Common redstart * Wren * Chaffinch * Wood pigeon * Bullfinch 2) 3) * Common shrew * Field vole * Brown hare * Wood mouse |  |  |

1) Relevant for power line establishment and maintenance.

2) Only for application to tree canopy.

3) Wild berries or similar fruits, may also forage on weed seeds but this scenario is covered by granivorous species.

**Fruit trees (orchards)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Fruit trees in the Northern Zone include pome fruit (apple, pear) and stone fruit (plum, cherry). Fruit trees are treated with pesticides in spring and early summer, or post-harvest in autumn. Treatments with insecticides, fungicides and growth regulators are directed towards the canopy of the trees, while herbicides are applied to the ground beneath the trees. Generally, herbicide treatments take place in the tree rows, while the strips between the trees may be left untreated.**  **The relevant focal species for risk assessment depend on the kind of treatment (canopy or ground directed) rather than on the season.** | | | | | | | |
| **Herbicide treatments**  **(applied to ground)** | **Other treatments (applied to canopy)** |  |  |  |  |  |  |
| All season |  |  |  |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - grass  - dicot. weeds  - weed seeds  - ground-dwelling arthropods | - foliar arthropods  - fruit  - grass 1)  - dicot. weeds 1)  - weed seeds 1)  - ground-dwelling arthropods 1) |  |  |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Robin * Chaffinch * Linnet * Ortolan Bunting * Brown hare * Field vole 2) * Wood mouse | * Blue tit * Starling 3) * Chaffinch * Ortolan Bunting * Brown hare * Field vole 2) * Wood mouse |  |  |  |  |  |  |

1) Interception in the leaf canopy shall be taken into account.

2) If ground vegetation (grass) height is ≥ 10 cm. This is assumed to be the case in Estonia, Finland, Latvia, Lithuania and Norway, but not in Denmark and Sweden.

3) Only in stone fruit (cherry, plum) when fruits are present (BBCH 60-89).

**Grass (Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **This group includes grass for seed, grass ley, mixed ley, pasture and turf. Seed grass and leys are usually bi- or tri-annual (rotational grass), whereas pasture and turf are normally permanent (non-rotational grass).**  **Grass seeds are sown in spring or autumn, often as an undersown crop. Treatments vary depending on type of grassland. Pesticide use is most intensive in grass for seed where intensity of use is comparable to that in cereals. In leys and especially in permanent grassland (except golf courses), treatments are less frequent although herbicides, insecticides and fungicides may all be used.** | | | | | | | |
| **Sowing and**  **pre-emergence** | **Short grass**  **(≤ 10cm)** | **Medium and long grass, incl. with seed heads** | **Termination 1)** |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - grass seeds  - weed seeds  - ground-dwelling arthropods | - grass  - dicot. weeds  - weed seeds  - ground-dwelling arthropods  - (foliar arthropods)2) | - grass  - dicot. weeds  - grass and weed seeds  - ground-dwelling arthropods  - foliar arthropods | - grass  - dicot. weeds  - grass and weed seeds  - ground-dwelling arthropods  - foliar arthropods |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * **Skylark** * Yellow wagtail * **Linnet** * **Wood mouse** | * **Bean goose** 3) * **Pink-footed g.** 4) * **Skylark** * Yellow wagtail * Ortolan Bunting * **Brown hare** * **Wood mouse** | * Skylark * Yellow wagtail * Linnet * Common shrew * Field vole * Wood mouse | * Skylark * Yellow wagtail * Linnet * Wood mouse * Field vole |  |  |  |  |

1) At termination of leys or permanent grassland with herbicides (relevant for both short and medium/long grass) , in most cases the grass and possible weeds are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants and associated leaf-dwelling insects would be limited to the first week after treatment. Thereafter, only ground dwelling insects and seeds would remain attractive as food items in the field.

2) The population of foliar arthropods is set back when the grass is mown. Therefore, the shorter the grass and the more frequent the mowings, the smaller the population of foliar arthropods.

3) Sweden, Finland and the Baltic

4) Denmark and Norway

**Maize (Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Maize is sown in spring and is subject to various pesticide treatments until the crop is too high to allow driving in the field.** | | | | | | | |
| **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-29** | **Stretching**  **BBCH 30-39** | **Flowering, fruiting**  **BBCH ≥40** |  |  |  |  |
| April-May | May-June | June-July | August - September |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - (treated seeds) 1)  - (weed seeds) 2) | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods 4) | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods 4) |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * **Woodpigeon** * Skylark * White wagtail * **Wood mouse** | * **Skylark** * White wagtail * Ortolan Bunting * **Brown hare** * **Wood mouse** | * Skylark * Willow warbler5) * Ortolan Bunting * Brown hare * Wood mouse | * Skylark * Willow warbler5) * Brown hare * Wood mouse |  |  |  |  |

1) Maize seeds are usually precision drilled at 5 cm depth.

2) Availability of weed seeds depends on the soil treatments.

3) The relative amounts of grasses and dicotyledonous weeds will vary.

4) The population of foliar arthropods in the field develops during this period.

5) Not relevant for DK**Oilseed rape (Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oilseed rape is sown in spring or in early autumn and is subject to various pesticide treatments throughout the season.** | | | | | | | | | |
| **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-19** | **Stretching**  **BBCH 20-39** | **Development of side shoots and flower buds**  **BBCH 40-59** | **Flowering, development of fruits**  **BBCH 60-79** | **Ripening of seed**  **BBCH 80-89** | **Pre-harvest desiccation or laying in swaths 1)** | **Post-harvest stubble treatments 2)** | **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-19** |
| April  **(spring-sown )** | April-May | May | May-June | June-July | July-August | July-August | August-Sep. |  |  |
|  | March-April  **(autumn-sown)** | April | April-May | May-June | June-July | July | July-August | August | September |
| **Food types** |  |  |  |  |  |  |  |  |  |
| - treated seeds  - ground-dwell. arthropods  - (weed seeds) 3) | - ground-dwell. arthropods  - crop leaves  - (weed seeds) 3) | - ground-dwell. arthropods  - foliar arthropods 4)  - crop leaves  - weeds | - ground-dwell. arthropods  - foliar arthropods  - crop leaves  - weeds  - weed seeds | - ground-dwell. arthropods  - foliar arthropods  - crop leaves  - weeds  - weed seeds | - ground-dwell. arthropods  - foliar arthropods  - crop leaves  - weeds  - weed seeds  - rape seeds | - ground-dwell. arthropods  - foliar arthropods  - weeds  - weed seeds  - rape seeds | - ground-dwell. arthropods  - weeds 5)  - weed seeds  - rape seeds | - treated seeds  - ground-dwell. arthropods  - (weed seeds) 3)  - (waste grain) 3) | - ground-dwell. arthropods  - crop leaves  - (weed seeds) 3)  - (waste grain) 3) |
| **Selected species** |  |  |  |  |  |  |  |  |  |
| * **Skylark** * White wagt. * **Wood mouse** | * Woodpigeon * **Skylark** * White wagt. * **Brown hare** * **Wood mouse** | * Skylark * Ortolan b. * Brown hare * Wood mouse | * Skylark * Whitethroat * Ortolan b. * Wood mouse | * Whitethroat * Linnet * Ortolan b. * Wood mouse | * Whitethroat * Linnet * Ortolan b. * Com. shrew * Wood mouse | * Linnet * Ortolan b. * Com. shrew * Wood mouse | * Skylark * White wagt. * Linnet * Ortolan b. * Wood mouse | * **Skylark** * White wagt. * **Wood mouse** | * Woodpigeon * **Skylark** 6) * White wagt. * **Brown hare** * Wood mouse |

1) At pre-harvest desiccation with herbicides, in most cases the crop and possible weeds in the field are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants and associated foliar arthropods is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds remain attractive as food items in the field.

2) At post-harvest stubble treatments with herbicides, in most cases the weeds in the field are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds remain attractive as food items in the field.

3) Availability of weed seeds and waste grain depends on the soil treatments.

4) The population of foliar arthropods in the field develops during this period.

5) Grasses or dicotyledonous weeds, depending on the situation.

6) September - October.

**Ornamentals and nursery**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Ornamentals and nursery include plants of very different height and structure. They are subject to various pesticide treatments throughout their growth cycle. For larger plants, treatments with insecticides and fungicides are directed towards the canopy of the plants, while herbicides are applied to the ground beneath the plants.** | | | | | | | |
| **Pre-emergence** | **Small plants:**  **all treatments** | **Large plants:**  **herbicide treatments**  **(applied to ground)** | **Large plants:**  **insecticide and fungicide treatments (applied to canopy)** |  |  |  |  |
| All season |  |  |  |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - weeds 1)  - (weed seeds) 2) | - ground-dwelling arthropods  - (foliar arthro­pods)3)  - weeds 1) | - ground-dwelling arthropods  - weeds 1)  - weed seeds | - foliar arthropods  - ground-dwelling arthropods 4)  - weeds 1) 4)  - weed seeds 4) |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Robin * Linnet * Wood mouse | * Robin * Linnet * Wood mouse | * Robin * Chaffinch * Linnet * Wood mouse | * Blue tit * Chaffinch * Linnet * Wood mouse |  |  |  |  |

1) The relative amounts of grasses and dicotyledonous weeds will vary.

2) Availability of weed seeds depends on the soil treatments.

3) Depending on the culture and the situation.

4) Interception in the leaf canopy shall be taken into account.

**Potatoes**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Potato tubers are planted in spring, and the crop is subject to various pesticide treatments throughout the growing season.** | | | | | | | |
| **Planting and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-19** | **Development of side shoots, stretch­ing, closing of rows**  **BBCH 20-39** | **Development of inflorescences, flowering, develop­ment of tubers BBCH 40-89** | **Pre-harvest desiccation 1)**  **BBCH 90-99** |  |  |  |
| April | May | June | July-August | August-Sep. |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - (weed seeds) 2) | - ground-dwelling arthropods  - (weed seeds) 2)  - potato shoots are inedible and will not be eaten | - ground-dwelling arthropods  - foliar arthropods 3)  - weeds 4)  - weed seeds  - crop itself is not attractive as food item | - ground-dwelling arthropods  - foliar arthropods  - weeds 4)  - weed seeds  - crop itself is not attractive as food item | - ground-dwelling arthropods  - foliar arthropods  - weeds 4)  - weed seeds |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Skylark * White wagtail * Wood mouse | * Skylark * White wagtail * Ortolan bunting * Wood mouse | * Skylark * White wagtail * Ortolan bunting * Wood mouse | * Skylark * White wagtail * Ortolan bunting * Wood mouse | * Skylark * White wagtail * Ortolan bunting * Wood mouse |  |  |  |

1) At pre-harvest desiccation with herbicides, in most cases the crop and possible weeds in the field are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants and associated foliar arthropods is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds remain attractive as food items in the field.

2) Availability of weed seeds depends on the soil treatments.

3) The population of foliar arthropods in the field develops during this period.

4) The relative amounts of grasses and dicotyledonous weeds will vary.

**Pulses (Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **This group includes peas and beans, which are sown in spring and are subject to various pesticide treatments throughout the growing season.**  **The approximate time schedule refers to the cultivation of field peas for fodder.** | | | | | | | |
| **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Early growth stages of crop**  **BBCH 10-19** | **Development of side shoots (bean) and stretch­ing**  **BBCH 20-39** | **Development of flower buds**  **BBCH 40-59** | **Flowering and development**  **of pods**  **BBCH 60-79** | **Ripening of seeds, pre-harvest desiccation 1)**  **BBCH 80-99** |  |  |
| April | May | May-June | June | June-July | July-August |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - (treated seeds) 2)  - (weed seeds) 3) | - crop leaves  - ground-dwelling arthropods  - (weed seeds) 3) | - crop leaves  - weeds 4)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods 5) | - crop leaves  - weeds 4)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods | - crop leaves  - weeds 4)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods | - crop leaves  - crop (seeds)  - weeds 4)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * **Pink-footed g.** 6) * Skylark * White wagtail * **Wood mouse** | * Woodpigeon * **Skylark** * White wagtail * Linnet * Ortolan bunting * **Brown hare** * **Wood mouse** | * Skylark * White wagtail * Linnet * Ortolan bunting * Brown hare * Wood mouse | * Skylark * White wagtail * Ortolan bunting * Brown hare * Wood mouse | * Skylark * White wagtail * Ortolan bunting * Brown hare * Wood mouse | * Woodpigeon * Skylark * Ortolan bunting * Brown hare * Wood mouse |  |  |

1) At pre-harvest desiccation with herbicides, in most cases the crop and possible weeds in the field are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants and associated foliar arthropods is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds (including peas) remain attractive as food items in the field.

2) Peas are usually precision drilled at 6-8 cm depth, and thus are generally not accessible to birds (except geese and swans).

3) Availability of weed seeds depends on the soil treatments.

4) The relative amounts of grasses and dicotyledonous weeds will vary.

5) The population of foliar arthropods in the field develops during this period.

6) Denmark and Norway.

**Strawberries**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Strawberries are grown for several years in the same field. They are usually planted in spring (April to June), but planting may also occur during summer or autumn. Strawberry plants may be dipped in fungicides before planting, and the fields are subject to various pesticide treatments throughout the season (except during harvest).** | | | | | | | |
| **Planting**  **BBCH 10-19** | **Pre-flowering**  **BBCH 20-59** | **Flowering, development and ripening of fruits**  **BBCH 60-89** | **Post-harvest** | **Termination 1)** |  |  |  |
|  | Spring | Late spring, summer | Late summer,  autumn |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - crop leaves  - (weed seeds) 2)  - ground-dwelling arthropods | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods | - crop leaves  - fruits  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods | - crop leaves  - weeds 3)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * Skylark * White wagtail * Brown hare * Wood mouse | * Skylark * White wagtail * Brown hare * Wood mouse | * Skylark * White wagtail * Starling * Brown hare * Wood mouse | * Skylark * White wagtail 4) * Brown hare * Wood mouse | * Skylark * Wood mouse |  |  |  |

1) At termination of strawberry fields with herbicides, in most cases the crop and possible weeds in the field are completely wilted or at least have become unattractive as food within approximately one week. Hence, exposure via green parts of plants and associated foliar arthropods is limited to the first week after treatment. Thereafter, only ground dwelling arthropods and seeds remain attractive as food items in the field.

2) Availability of weed seeds depends on the soil treatments.

3) The relative amounts of grasses and dicotyledonous weeds will vary.

4)  Until late September.

**Vegetables (field grown; Species in bold need to be addressed for seed/seedling scenarios)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Major field grown vegetables within the Northern Zone include carrots, onions, brassica vegetable crops, lettuce and leek. Most brassica vegetable crops, lettuce and leek and some onions are not sown but are cultivated indoor before planting in the field. Phenology and time schedules vary between crops. Lettuce mature rapidly, in c. 8 weeks, and planting takes place continuously during the summer season. Pesticide treatments take place throughout the growing season.** | | | | | | | |
| **Sowing and**  **pre-emergence**  **BBCH 0-9** | **Leaf development**  **BBCH 10-19** | **Stretching, development of side shoots 1)**  **BBCH 20-39** | **Development of harvestable parts**  **BBCH ≥ 40** |  |  |  |  |
| **Food types** |  |  |  |  |  |  |  |
| - ground-dwelling arthropods  - (treated seeds) 2)  - (weed seeds) 3) | - crop leaves  - weeds 4)  - ground-dwelling arthropods  - (weed seeds) 3) | - crop leaves  - weeds 4)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods | - crop leaves  - weeds 4)  - weed seeds  - ground-dwelling arthropods  - foliar arthropods |  |  |  |  |
| **Selected species** |  |  |  |  |  |  |  |
| * **Skylark** * White wagtail * **Wood mouse** | * **Skylark** * White wagtail * Linnet * **Brown hare** * **Wood mouse** | * Skylark * White wagtail * Linnet * Brown hare * Wood mouse | * Skylark * White wagtail * Linnet * Brown hare * Wood mouse |  |  |  |  |

1) Only relevant for spinach, loosehead lettuce, kale, broccoli and brussel sprouts.

2) In crops that are sown (not planted), the seeds are generally too small to be attractive or are pelleted and precision drilled at some cm depth. In Sweden the risk assessment shall also cover potential spill of treated seeds.

3) Availability of weed seeds depends on the soil treatments.

4) The relative amounts of grasses and dicotyledonous weeds will vary.

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# Appendix 1

*Rules used for crop and growth stage-specific adjustment of general PD values in the skylark.*

The following rules were applied to modify the PD values, as specified by month in Table 6.17.. When the share (PD) of one or more food category was reduced (or increased) relative to the values in Table 6.17., the share of the other food categories was increased (or reduced) proportionally.

**Monocotyledonous leaves (grasses and cereals)**

**Dicotyledonous leaves (non-grass weeds, leafy crops)**

In the study of Green (1978) (Table 6.17.), monocotyledons were generally more common than dicotyledons in the diet. This is assumed to reflect availability in a cereal-dominated landscape.

General assumptions:

* No leaves or shoots are available in BBCH 0-9 (PD = 0).
* As long as the crop itself is attractive as skylark food, i.e. in BBCH 10-19 (10-29 in cereals), crop leaves are assumed to make up the entire green plant part of diet, except in potatoes and strawberries.
* At pre-harvest desiccation and stubble treatments, proportion of green plant parts in diet is reduced by 50%. This is because all green parts of plants are assumed to become inattractive as food items within one week after treatment.

Cereals and maize:

* In BBCH 10-29 (10-19 in maize) all green plants in diet are assumed to be monocotyledonous, i.e. PD for dicots is added to PD for monocots. After BBCH 29 (19) the monocot:dicot ratio in Table 6.17. is used.

Leafy crops (except potatoes and strawberries):

* In BBCH 10-19 all green plants in diet are assumed to be dicotyledonous, i.e. PD for monocots is added to PD for dicots. At later stages the monocot:dicot ratio in Table 6.17. is used, except that PD for monocots is reduced by 50%.

Potatoes:

* Potato shoots and leaves are inedible. The monocot:dicot ratio in Table 6.17. is used for all stages but the PD values are reduced by 50%.

Strawberries:

* Strawberry leaves are less attractive and are therefore not assumed to make up the entire green plant part of diet in early stages. The monocot:dicot ratio in Table 6.17. is used for all stages, except that PD for monocots is reduced by 50%.

**Cereal grain**

According to Table 6.17., cereal grain constitutes between 6 and 71 percent of diet dry weight. Again, this is assumed to reflect availability in a cereal-dominated landscape; in non-cereal crops, the share of cereal grain in the diet will be much lower.

Leafy crops and maize:

* The minimum PD recorded by Green (6%) is assumed to apply to all crops and months. The underlying rationale is that 6% represents the amount of grain which is “always” available in rotational fields due to harvest spillage, turning over of soil, etc.

Spring cereals:

* PD as in Table 6.17., except that the July level of 27% does not apply for growth stages (BBCH) ≤ 69 (when the grain is not developed); the June level of 6% is used instead.
* At BBCH 70-89 and pre-harvest desiccation, one third of the cereal grain is assumed to be exposed on the ground while the remainder is exposed on the plant and made available through lodging of straw or loosening of grain.

Winter cereals:

* PD as in leafy crops in April-July (until and including BBCH 69), thereafter (July-September) follows Table 6.17..
* At BBCH 70-89 and pre-harvest desiccation, one third of the cereal grain is assumed to be exposed on the ground while the remainder is exposed on the plant and made available through lodging of straw or loosening of grain.

**Small seeds**

All crops except oilseed rape:

* PD is assumed to follow Table 6.17.; the Green categories ”grass flowers and seeds” and ”dicotyledonous weed seeds” are merged to one class, small seeds.

Oilseed rape:

* As above, except that PD is assumed to be increased by a factor of 4 in July and a factor of 2 in August-September. This is because rape seeds are assumed to be attractive food for skylarks.

**Foliar arthropods**

**Ground-dwelling arthropods**

The Green category “invertebrates” must be split into foliar and ground-dwelling arthropods because the RUD values differ notably.

General:

* No foliar arthropods are assumed to occur in the diet at BBCH ≤ 19 (BBCH ≤ 29 for cereals).
* A foliar:ground-dwelling arthropod ratio of 1:3 in diet is assumed to apply during the main period of vegetative growth (usually BBCH 20-39).
* A ratio of 1:1 is assumed to apply at later growth stages (BBCH ≥ 40).
* A ratio of 1:3 is assumed to apply for pre-harvest desiccation treatments.
* No foliar arthropods are assumed to be present at stubble (post-harvest) treatments.

In some crops, e.g. most vegetables, BBCH stages 20-39 are not used because the growth pattern differs from the general pattern (no side shoots, no stretching). In these cases, the foliar:ground-dwelling arthropod ratio in skylark diet is assumed to be 1:1 as soon as leaf development is complete.

**Specific rules for grassland types**

The “grassland” category is a rather inhomogeneous mixture of grassland areas within and outside rotation, such as seed grass, leys, pasture and turf. Separate rules for adjustment of PT were defined for rotational and non-rotational grassland, mainly because of differences in availability of cereal grain. The rules are rather briefly presented here but should be easily understandable by comparison with the previous, more detailed accounts. Please also refer to the grassland table in section 6.

**Rotational grassland (seed grass and leys)**

Sowing and pre-emergence:

* Grassland within rotation is usually established by undersowing in cereal crops; therefore no specific scenario is defined for this stage.

Short grass:

* Monocotyledonous leaves: unchanged from Table 6.17. (short grass may be eaten).
* Dicotyledonous leaves: PD reduced by 50% (reduced availability).
* Cereal grain: PD fixed at 6% (“background” level).
* Small seeds: unchanged from Table 6.17..
* Arthropods: all ground-dwelling.

Medium and long grass:

* Monocotyledonous leaves: PD reduced by 50% (medium-long grass is not attractive skylark food).
* Dicotyledonous leaves: PD reduced by 50%.
* Cereal grain: fixed at 6%.
* Small seeds: unchanged from Table 6.17..
* Arthropods: foliar:ground-dwelling ratio set at 1:1.

Termination:

* Monocotyledonous leaves: PD reduced by 50% (the grass quickly becomes unattractive as food).
* Dicotyledonous leaves: PD reduced by 75% (combination of reduced availability and unattractiveness).
* Cereal grain: fixed at 6%.
* Small seeds: unchanged from Table 6.17..
* Arthropods: foliar:ground-dwelling ratio set at 1:3.

**Non-rotational grassland (pasture and turf)**

Sowing and pre-emergence (BBCH 0-9):

* Mono- and dicotyledonous leaves: none (PD = 0).
* Cereal grain: none.
* Small seeds: unchanged from Table 6.17..
* Arthropods: all ground-dwelling.

Short grass, medium and long grass, termination:

* As rotational grassland without cereal grain.

# Appendix 2

*Rules used for crop and growth stage specific adjustment of general PD values in the wood mouse.*

The following rules were applied to modify the PD values for wood mice, as specified by month in Table 6.78 (Pelz 1989) and by period in Table 6.79 (Green 1979) and Table 6.80 (Rogers and Gorman 1995b). The PD values in Table 6.78 are used for arable crops, including seed grass and other short-rotational grasslands, while those in Table 6.80 are used for permanent grasslands, fruit trees, bush berries, ornamentals and nursery cultures. The PD values in Table 6.79 represent an alternative to Table 6.78 for winter cereals (BBCH ≤ 69).

PD values are adjusted to reflect differences in availability between crops and growth stages, taking into account the crop composition (rotational scheme) in the study area. When the share (PD) of one or more food category is reduced (or increased) relative to the values in Table 6.78 to Table 6.80, the share of the other food categories is increased (or reduced) proportionally.

*Adjustment of Pelz (1989) data (Table 6.78):*

**Grasses and cereal shoots (monocotyledonous leaves/shoots)**

**Non-grass weeds, leafy crops (dicotyledonous leaves/shoots)**

These food categories were not separated in the Pelz study but were pooled in the category “vegetative plant tissue”. Because standard RUDs in mono- and dicotyledons differ notably, a separation is required. This separation is based upon the presumed availability of mono- and dicotyledons in the crop types in question.

General assumptions:

* No leaves or shoots are available in BBCH 0-9 (PD = 0).
* As long as the crop itself is very attractive food, i.e. in BBCH 10-19 (10-29 in cereals), crop leaves are assumed to make up the entire green plant part of diet, except in potatoes, strawberries and grasses.
* In later stages, a monocot:dicot ratio of 2:1 is assumed for cereals (including maize) and grass. A monocot:dicot ratio of 1:2 is assumed for other (leafy) crops.
* At pre-harvest desiccation, termination and stubble treatments, the proportion of green plant parts in diet is reduced by 50%. This is because all green parts of plants are assumed to become inattractive as food items within one week after treatment.

Potatoes:

* Potato shoots and leaves are inedible. The total share of vegetative plant tissue is reduced by 50% and a monocot:dicot ratio of 1:1 is assumed for all growth stages.

Strawberries:

* Strawberry leaves are not assumed to make up the entire green plant part of diet in any stage, so a monocot:dicot ratio of 1:2 is used for all stages.

Grass:

* A monocot:dicot ratio of 4:1 is assumed for short grass and a ratio of 2:1 is assumed for long grass and at termination.

**Cereal grain**

According to Table 6.78 cereal grain constitutes between 5 and 48 percent of diet volume. This is assumed to reflect availability in a cereal-dominated landscape; in non-cereal crops the share of cereal grain in diet will be much less.

Spring and winter cereals:

* In BBCH 0-9, PD for vegetative plant tissue (which is not available at that stage) is added to PD for cereal grain.
* The July PD level of 48% cereal grain is assumed not to apply for BBCH stages ≤ 69 (when the grain is not developed); the June level of 32% is used instead.
* At BBCH 70-89 and pre-harvest desiccation, two thirds of the cereal grain is assumed to be exposed on the ground while the remainder is exposed on the plant and made available through lodging of straw or loosening of grain.

Leafy crops and grass:

* The minimum PD recorded by Pelz (5%) is assumed to apply to all crops and months. The underlying rationale is that 5% represents the amount of grain which is “always” available in rotational fields due to harvest spillage, turning over of soil, etc.

Maize:

* In BBCH 0-9 (April), PD for vegetative plant tissue is added to PD for cereal grain; the sum (29%) is assumed to reflect the amount of old cereal grain *and* fresh maize seed in diet. This value is also used for BBCH 0-9 in May.
* In all other stages, maize seed is assumed not to occur in diet and a PD of 5% cereal grain is used (as in leafy crops).

**Other large seeds (peas and beans)**

Peas and beans are only available in fields with pulses. If more specific information is not available, residues in peas and beans are assumed to be similar to residues in cereal grain.

* In BBCH 0-9 (April and May), PD for large seeds/cereal grain is calculated as described above for maize and includes old cereal grain and newly sown peas (beans).
* BBCH 10-79: PD for large seeds is fixed at 5% as in other leafy crops, reflecting availability of old cereal grain.
* PD 80-99 (pre-harvest desiccation): PD is fixed at a level of 10% (cereal grain x 2), to include seeds in pods.

**Beet seeds**

Beet seeds are only available in beet fields as pelleted seeds. According to Pelz (Table 6.78), beet seeds constitute 7% of diet volume immediately after sowing.

A PD of 7% is assumed to apply to other small, freshly sown seeds as well (cf. below).

**Small seeds**

PD for small seeds generally follows Table 6.78 (dicotyledon seeds) with the following adjustments:

Spring rape:

* In BBCH 0-9 (April), when weed seeds do not occur in diet according to Pelz (1989), PD is set at 7% (as in sugar beet).
* PD is increased by 25% in BBCH 80-89 (ripening of fruit) and for stubble treatments (harvest spillage available).
* PD is increased by 50% at pre-harvest desiccation

Winter rape:

* In BBCH 0-9 (August), PD for dicotyledon seeds is increased by 25%.
* For treatments after BBCH 80, PD is adjusted as described for spring rape.

Field grown vegetables:

* In BBCH 0-9 (April), PD is set at 3.5% (half of the value in sugar beet and rape). This value is also added to PD for small seeds in May and June (BBCH 0-9 only). Vegetable seeds are usually pelleted and precision drilled or are too small to be really attractive.

Grass (medium and long):

* PD for small seeds is increased by 50% in June, July and August to include grass seeds.

**Insect larvae**

**Earthworms**

No changes from Table 6.78, except for proportional adjustments when PD for other food items is reduced or increased. All insect larvae in diet are assumed to belong to the category “ground-dwelling arthropods”.

*Adjustment of Rogers and Gorman (1995b) data (Table 6.80):*

All insects occurring in the diet are assumed to be ground-dwelling. The category “other animal material” (2-10% of diet) is assumed to consist of earthworms, which are a prominent element of wood mouse diet in arable land (cf. Table 6.78).

The category “other plant material” (0-6% of diet) is assumed to consist mainly of underground plant parts such as rhizomes and various storage organs. Residues in these are generally unknown but are probably lower than residues in leaves and shoots. The category was therefore merged with the “dicotyledon (herb)” category because standard RUDs for dicotyledons are lower than for grasses.

For the periods June-August and September-November, the PD values in Table 6.80 do not sum up to 100%. This is corrected by proportional adjustment and rounding.

**Permanent and semi-permanent grassland (long-lasting leys, pasture and turf)**

Sowing and pre-emergence (BBCH 0-9):

* Diet is specified for two periods where sowing usually takes place: spring (March-May) and autumn (August-October).
* No vegetative plant tissue in diet (PD = 0).
* Small seeds fixed at maximum level for “seeds” (PD = 42%).
* Insects and soil invertebrates (“other animal material”), spring: based on PD for March-May, adjusted to account for the absence of vegetative plant tissue.
* Insects and soil invertebrates, autumn: based on average PD for June-August and September-November, adjusted as above.

Short or long grass:

* All PD values as in Table 6.80, with “other plant material” being added to “dicotyledons (herbs)”.

Termination:

* PD values as described for short and long grass, except that PD for grasses and dicotyledons (including “other plant material”) are reduced by 50%.

**Fruit trees and bush berries**

All stages:

* All PD values as in Table 6.80, with “other plant material” being added to “dicotyledons (herbs)”.

**Ornamentals and nursery**

Vegetative plant tissue (grasses and herbs):

Ornamentals and nursery cultures are very variable; from small plants in nurseries to large plants grown under conditions reminiscent of those in orchards. Accordingly, the ground vegetation may vary from bare soil to grass cover. The following rules attempt to take this variation into account.

* Small plants: No grass cover, so the amount of grass in the diet is far below the PD values in Table 6.80. The total amount of vegetative plant material in diet is assumed to be equal to the sum of “dicotyledons (herbs)” and “other plant material”. A monocot:dicot ratio of 1:1 is assumed.
* Sowing and pre-emergence (BBCH 0-9): As in small plants, but with total amount of vegetative plant material reduced by 50%.
* Large plants: Some grass cover is asssumed. PD for monocotyledons is based upon the value in Table 6.80, reduced by 75%; “other plant material” is added to “dicotyledons (herbs)”.

Seeds:

All seeds are assumed to belong to the food category small seeds.

* Pre-emergence and small plants: PD as in Table 6.80, reduced by 75%.
* Large plants: PD is based upon Table 6.80, reduced by 50%.

Insects and other animal material (earthworms):

* All PD values are based upon Table 6.80.

# Appendix 3

*PD values (dry weight) for skylarks feeding in different crops.*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Spring cereals** | April | May | June | June | July | July | August | August | August | Sept. |
| BBCH | **0-9** | **10-29** | **30-39** | **40-69** | **40-69** | **70-89** | **70-89** | **Pre-harv.** | **Stubble** | **Stubble** |
|  |  |  |  |  |  |  |  | **desiccat.** | **treatm.** | **treatm.** |
| Grasses and cereal shoots |  | 0.38 | 0.17 | 0.17 | 0.13 | 0.10 | 0.01 | 0.01 | 0.01 | 0.01 |
| Non-grass herbs, leafy crops |  |  | 0.14 | 0.14 | 0.06 | 0.05 | 0.05 | 0.02 | 0.02 | 0.01 |
| Cereal grain/ear on plant |  |  |  |  |  | 0.18 | 0.37 | 0.39 |  |  |
| Large seeds/cereal grain on ground | 0.46 | 0.11 | 0.06 | 0.06 | 0.06 | 0.09 | 0.19 | 0.19 | 0.58 | 0.72 |
| Small seeds (weed seeds) | 0.33 | 0.23 | 0.23 | 0.23 | 0.09 | 0.07 | 0.14 | 0.14 | 0.14 | 0.13 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  | 0.10 | 0.20 | 0.33 | 0.25 | 0.12 | 0.06 |  |  |
| Ground-dwelling arthropods | 0.21 | 0.28 | 0.30 |  |  |  |  |  | 0.25 | 0.13 |
| Ground-dwelling arthropods with intercept. | |  |  | 0.20 | 0.33 | 0.26 | 0.12 | 0.19 |  |  |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Maize** | April | May | May | June | June | July |
| BBCH | **0-9** | **0-9** | **10-29** | **10-29** | **30-39** | **30-39** |
|  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  | 0.40 | 0.31 | 0.17 | 0.13 |
| Non-grass herbs, leafy crops |  |  |  |  | 0.14 | 0.06 |
| Cereal grain/ear on plant |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.57 | 0.42 | 0.24 | 0.23 | 0.23 | 0.09 |
| Large fruit (pome) |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  | 0.10 | 0.17 |
| Ground-dwelling arthropods | 0.37 | 0.52 | 0.30 | 0.40 | 0.30 | 0.49 |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  |
| Soil invertebrates |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Winter cereals** | Sept. | Sept. | April | May | May | June | May | June | July | July | August |
| BBCH | **0-9** | **10-19** | **10-29** | **10-29** | **30-39** | **30-39** | **40-59** | **40-69** | **60-69** | **70-89** | **70-89** |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  | 0.03 | 0.46 | 0.40 | 0.25 | 0.17 | 0.25 | 0.17 | 0.13 | 0.10 | 0.01 |
| Non-grass herbs, leafy crops |  |  |  |  | 0.15 | 0.14 | 0.15 | 0.14 | 0.06 | 0.05 | 0.05 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  | 0.18 | 0.37 |
| Large seeds/cereal grain on ground | 0.74 | 0.71 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.09 | 0.19 |
| Small seeds (weed seeds) | 0.13 | 0.13 | 0.29 | 0.24 | 0.24 | 0.23 | 0.24 | 0.23 | 0.09 | 0.07 | 0.14 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  | 0.08 | 0.10 | 0.15 | 0.20 | 0.33 | 0.25 | 0.12 |
| Ground-dwelling arthropods | 0.13 | 0.13 | 0.19 | 0.30 | 0.22 | 0.30 |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  | 0.15 | 0.20 | 0.33 | 0.26 | 0.12 |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Winter cereals** | July | August | August | Sept. |
| BBCH | **Pre-harv.** | **Pre-harv.** | **Stubble** | **Stubble** |
|  | **desiccat.** | **desiccat.** | **treatm.** | **treatm.** |
| Grasses and cereal shoots | 0.05 |  | 0.01 | 0.01 |
| Non-grass herbs, leafy crops | 0.03 | 0.03 | 0.02 | 0.01 |
| Cereal grain/ear on plant | 0.19 | 0.39 |  |  |
| Large seeds/cereal grain on ground | 0.10 | 0.19 | 0.58 | 0.72 |
| Small seeds (weed seeds) | 0.08 | 0.14 | 0.14 | 0.13 |
| Large fruit (pome) |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |
| Berries |  |  |  |  |
| Foliar arthropods | 0.14 | 0.06 |  |  |
| Ground-dwelling arthropods |  |  | 0.25 | 0.13 |
| Ground-dwelling arthropods with intercept. | 0.41 | 0.19 |  |  |
| Soil invertebrates |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Spring oilseed rape** | April | April | May | May | May | June | August | Sept. |
| BBCH | **0-9** | **10-19** | **10-19** | **20-39** | **40-59** | **40-59** | **Stubble** | **Stubble** |
|  |  |  |  |  |  |  | **treatm.** | **treatm.** |
| Grasses and cereal shoots |  |  |  | 0.15 | 0.15 | 0.09 | 0.01 | 0.01 |
| Non-grass herbs, leafy crops |  | 0.46 | 0.40 | 0.17 | 0.17 | 0.16 | 0.04 | 0.02 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.57 | 0.29 | 0.24 | 0.28 | 0.28 | 0.25 | 0.48 | 0.61 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  | 0.08 | 0.17 | 0.22 |  |  |
| Ground-dwelling arthropods | 0.37 | 0.19 | 0.30 | 0.26 |  |  | 0.41 | 0.30 |
| Ground-dwelling arthropods with intercept. | |  |  |  | 0.17 | 0.22 |  |  |
| Soil invertebrates |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Winter oil-seed rape** | August | Sept. | April | April | April | May | July | August |
| BBCH | **0-9** | **10-19** | **10-19** | **20-39** | **40-59** | **40-59** | **Stubble** | **Stubble** |
|  |  |  |  |  |  |  | **treatm.** | **treatm.** |
| Grasses and cereal shoots |  |  |  | 0.19 | 0.19 | 0.15 | 0.03 | 0.01 |
| Non-grass herbs, leafy crops |  | 0.10 | 0.46 | 0.16 | 0.16 | 0.17 | 0.03 | 0.04 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.51 | 0.42 | 0.29 | 0.36 | 0.36 | 0.28 | 0.31 | 0.48 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  | 0.06 | 0.11 | 0.17 |  |  |
| Ground-dwelling arthropods | 0.43 | 0.42 | 0.19 | 0.17 |  |  | 0.57 | 0.41 |
| Ground-dwelling arthropods with intercept. | |  |  |  | 0.12 | 0.17 |  |  |
| Soil invertebrates |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Beets** | April | May\* | June | June | July | August | Sept. |
| BBCH | **0-9** | **10-19** | **10-19** | **20-39** | **40-49** | **40-49** | **40-49** |
|  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  |  | 0.09 | 0.07 | 0.01 | 0.02 |
| Non-grass herbs, leafy crops |  | 0.63 | 0.31 | 0.16 | 0.07 | 0.11 | 0.07 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 |  | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.57 | 0.21 | 0.23 | 0.25 | 0.10 | 0.30 | 0.43 |
| Large fruit (pome) |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  | 0.11 | 0.35 | 0.26 | 0.21 |
| Ground-dwelling arthropods | 0.37 | 0.16 | 0.40 | 0.33 |  |  |  |
| Ground-dwelling arthropods with intercept. | |  |  |  | 0.35 | 0.26 | 0.21 |
| Soil invertebrates |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Values from Green (1980) sugar beet study

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Potatoes** | April | May | June | July | August | August | Sept. |
| BBCH | **0-9** | **10-19** | **20-39** | **40-89** | **45-89** | **90-99** | **90-99** |
|  |  |  |  |  |  | **(desiccat.)** | **(desiccat.)** |
| Grasses and cereal shoots |  | 0.16 | 0.10 | 0.07 | 0.01 | 0.01 | 0.01 |
| Non-grass herbs, leafy crops |  | 0.09 | 0.08 | 0.03 | 0.05 | 0.03 | 0.02 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.57 | 0.31 | 0.28 | 0.10 | 0.32 | 0.33 | 0.46 |
| Large fruit (pome) |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |
| Foliar arthropods |  |  | 0.12 | 0.37 | 0.28 | 0.14 | 0.11 |
| Ground-dwelling arthropods | 0.37 | 0.38 | 0.36 |  |  | 0.43\* | 0.34\* |
| Ground-dwelling arthropods with intercept. | |  |  | 0.37 | 0.28 |  |  |
| Soil invertebrates |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Low interception at this stage according to FOCUS (2000)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pulses** | April | May | May | June | May | June | June | July | August | July | August |
| BBCH | **0-9** | **0-9** | **10-19** | **10-19** | **20-39** | **20-39** | **40-79** | **40-79** | **60-79** | **80-99** | **80-99** |
|  |  |  |  |  |  |  |  |  |  | **(desiccat.)** | **(desiccat.)** |
| Grasses and cereal shoots |  |  |  |  | 0.15 | 0.09 | 0.09 | 0.07 | 0.01 | 0.04 | 0.01 |
| Non-grass herbs, leafy crops |  |  | 0.40 | 0.31 | 0.17 | 0.16 | 0.16 | 0.07 | 0.11 | 0.04 | 0.06 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.57 | 0.42 | 0.24 | 0.23 | 0.28 | 0.25 | 0.25 | 0.10 | 0.30 | 0.10 | 0.32 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  | 0.08 | 0.11 | 0.22 | 0.35 | 0.26 | 0.19 | 0.14 |
| Ground-dwelling arthropods | 0.37 | 0.52 | 0.30 | 0.40 | 0.26 | 0.33 |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  | 0.22 | 0.35 | 0.26 | 0.57 | 0.41 |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Field grown vegetables** | April | May | June | May | June | July | August | May | June | July | August | Sept. |
| BBCH | **0-9** | **0-9** | **0-9** | **10-19** | **10-19** | **10-19** | **10-19** | **20-39** | **20-39** | **20-39** | **20-39** | **20-39** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  |  |  |  |  |  | 0.15 | 0.09 | 0.07 | 0.01 | 0.02 |
| Non-grass herbs, leafy crops |  |  |  | 0.40 | 0.31 | 0.19 | 0.13 | 0.17 | 0.16 | 0.07 | 0.11 | 0.07 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.57 | 0.42 | 0.34 | 0.24 | 0.23 | 0.09 | 0.30 | 0.28 | 0.25 | 0.10 | 0.30 | 0.43 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  | 0.17 | 0.22 | 0.35 | 0.26 | 0.21 |
| Ground-dwelling arthropods | 0.37 | 0.52 | 0.60 | 0.30 | 0.40 | 0.66 | 0.51 | 0.17 | 0.22 | 0.35 | 0.26 | 0.21 |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  |  |  |  |  |  |  |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Field grown vegetables** | May | June | July | August | Sept. |
| BBCH | **40+** | **40+** | **40+** | **40+** | **40+** |
|  |  |  |  |  |  |
| Grasses and cereal shoots | 0.15 | 0.09 | 0.07 | 0.01 | 0.02 |
| Non-grass herbs, leafy crops | 0.17 | 0.16 | 0.07 | 0.11 | 0.07 |
| Cereal grain/ear on plant |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.28 | 0.25 | 0.10 | 0.30 | 0.43 |
| Large fruit (pome) |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |
| Berries |  |  |  |  |  |
| Foliar arthropods | 0.17 | 0.22 | 0.35 | 0.26 | 0.21 |
| Ground-dwelling arthropods |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.17 | 0.22 | 0.35 | 0.26 | 0.21 |
| Soil invertebrates |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Strawberries** | April | May | June | July | August | Sept. | April | May | June | June | July |
| Stage / BBCH | **Planting** | |  |  |  |  | **Pre-flowering (20-59)** | | | **Flowering and fruit** | |
|  |  |  |  |  |  |  |  |  |  | **development (60-89)** | |
| Grasses and cereal shoots | 0.19 | 0.15 | 0.09 | 0.07 | 0.01 | 0.02 | 0.20 | 0.15 | 0.09 | 0.09 | 0.07 |
| Non-grass herbs, leafy crops | 0.16 | 0.17 | 0.16 | 0.07 | 0.11 | 0.06 | 0.16 | 0.17 | 0.16 | 0.16 | 0.07 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.36 | 0.28 | 0.25 | 0.10 | 0.30 | 0.43 | 0.36 | 0.28 | 0.25 | 0.25 | 0.10 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  | 0.11 | 0.17 | 0.22 | 0.22 | 0.35 |
| Ground-dwelling arthropods | 0.23 | 0.34 | 0.44 | 0.70 | 0.52 | 0.43 |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  | 0.11 | 0.17 | 0.22 | 0.22 | 0.35 |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Strawberries** | July | August | Sept. | April | May | June | July | August | Sept. |
| Stage / BBCH | **Post-harvest treatm.** | | | **Termination** | |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.07 | 0.01 | 0.02 | 0.12 | 0.09 | 0.05 | 0.04 | 0.01 | 0.01 |
| Non-grass herbs, leafy crops | 0.07 | 0.11 | 0.07 | 0.10 | 0.10 | 0.09 | 0.04 | 0.06 | 0.03 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.10 | 0.30 | 0.43 | 0.44 | 0.34 | 0.29 | 0.10 | 0.32 | 0.45 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |
| Foliar arthropods | 0.35 | 0.26 | 0.21 | 0.07 | 0.10 | 0.13 | 0.19 | 0.14 | 0.11 |
| Ground-dwelling arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.35 | 0.26 | 0.21 | 0.21 | 0.31 | 0.38 | 0.57 | 0.41 | 0.34 |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Rotational grass (seed grass, leys)** | April | May | June | July | August | Sept. | April | May | June | July | August | Sept. |
| Stage | **Short grass** | |  |  |  |  | **Medium and long grass** | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.35 | 0.28 | 0.18 | 0.13 | 0.02 | 0.03 | 0.21 | 0.16 | 0.10 | 0.07 | 0.01 | 0.02 |
| Non-grass herbs, leafy crops | 0.07 | 0.08 | 0.08 | 0.03 | 0.06 | 0.03 | 0.09 | 0.09 | 0.08 | 0.03 | 0.06 | 0.03 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.32 | 0.26 | 0.25 | 0.10 | 0.32 | 0.44 | 0.39 | 0.31 | 0.28 | 0.10 | 0.32 | 0.45 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  | 0.12 | 0.19 | 0.24 | 0.37 | 0.27 | 0.22 |
| Ground-dwelling arthropods | 0.20 | 0.32 | 0.43 | 0.68 | 0.54 | 0.44 |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  | 0.13 | 0.19 | 0.24 | 0.37 | 0.28 | 0.22 |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Rotational grass (seed grass, leys)** | April | May | June | July | August | Sept. |
| Stage | **Termination** | | |  |  |  |
|  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.22 | 0.17 | 0.11 | 0.07 | 0.01 | 0.02 |
| Non-grass herbs, leafy crops | 0.05 | 0.05 | 0.04 | 0.02 | 0.03 | 0.02 |
| Cereal grain/ear on plant |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.41 | 0.32 | 0.29 | 0.10 | 0.33 | 0.45 |
| Large fruit (pome) |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |
| Foliar arthropods | 0.06 | 0.10 | 0.12 | 0.19 | 0.14 | 0.11 |
| Ground-dwelling arthropods |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.20 | 0.30 | 0.38 | 0.56 | 0.43 | 0.34 |
| Soil invertebrates |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Non-rotational grass (turf, pasture)** | April | May | August | Sept. | April | May | June | July | August | Sept. |
| Stage | **Sowing and pre-emergence** | | | | **Short grass** | |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  |  |  | 0.37 | 0.29 | 0.20 | 0.14 | 0.02 | 0.04 |
| Non-grass herbs, leafy crops |  |  |  |  | 0.08 | 0.09 | 0.08 | 0.04 | 0.06 | 0.04 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground |  |  |  |  |  |  |  |  |  |  |
| Small seeds (weed seeds) | 0.61 | 0.45 | 0.37 | 0.50 | 0.34 | 0.28 | 0.26 | 0.10 | 0.34 | 0.46 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.39 | 0.55 | 0.63 | 0.50 | 0.21 | 0.34 | 0.46 | 0.72 | 0.58 | 0.46 |
| Ground-dwelling arthropods with intercept. | |  |  |  |  |  |  |  |  |  |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Non-rotational grass (turf, pasture)** | April | May | June | July | August | Sept. | April | May | June | July | August | Sept. |
| Stage | **Medium and long grass** | | |  |  |  | **Termination** | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.23 | 0.17 | 0.11 | 0.07 | 0.02 | 0.02 | 0.24 | 0.18 | 0.11 | 0.08 | 0.01 | 0.02 |
| Non-grass herbs, leafy crops | 0.09 | 0.10 | 0.09 | 0.04 | 0.06 | 0.04 | 0.05 | 0.05 | 0.05 | 0.02 | 0.03 | 0.02 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground |  |  |  |  |  |  |  |  |  |  |  |  |
| Small seeds (weed seeds) | 0.42 | 0.33 | 0.29 | 0.11 | 0.34 | 0.47 | 0.43 | 0.35 | 0.31 | 0.11 | 0.35 | 0.48 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods | 0.13 | 0.20 | 0.25 | 0.39 | 0.29 | 0.23 | 0.07 | 0.10 | 0.13 | 0.20 | 0.15 | 0.12 |
| Ground-dwelling arthropods |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.13 | 0.20 | 0.26 | 0.39 | 0.29 | 0.24 | 0.21 | 0.32 | 0.40 | 0.59 | 0.46 | 0.36 |
| Soil invertebrates |  |  |  |  |  |  |  |  |  |  |  |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

# Appendix 4

*PD values (fresh weight) for wood mice feeding in different crops.*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Spring cereals** | April | May | June | June | July | July | August | August | August | Sept. |
| BBCH | **0-9** | **10-29** | **30-39** | **40-69** | **40-69** | **70-89** | **70-89** | **Pre-harv.** | **Stubble** | **Stubble** |
|  |  |  |  |  |  |  |  | **desiccat.** | **treatm.** | **treatm.** |
| Grasses and cereal shoots |  | 0.16 | 0.06 | 0.06 | 0.07 | 0.05 | 0.07 | 0.04 | 0.04 | 0.03 |
| Non-grass herbs, leafy crops |  |  | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 |
| Cereal grain/ear on plant |  |  |  |  |  | 0.16 | 0.12 | 0.13 |  |  |
| Large seeds/cereal grain on ground | 0.29 | 0.30 | 0.32 | 0.32 | 0.32 | 0.32 | 0.25 | 0.26 | 0.39 | 0.34 |
| Small seeds (weed seeds) |  | 0.04 | 0.25 | 0.25 | 0.21 | 0.16 | 0.20 | 0.21 | 0.21 | 0.21 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.45 | 0.10 | 0.25 |  |  |  |  |  | 0.29 | 0.26 |
| Ground-dwelling arthropods with intercept. |  |  |  | 0.25 | 0.37 | 0.28 | 0.28 | 0.29 |  |  |
| Soil invertebrates | 0.26 | 0.40 | 0.09 | 0.09 |  |  | 0.05 | 0.05 | 0.05 | 0.14 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Winter cereals** | Sept. | Oct. | Sept. | Oct. | Nov. | March | April | May | May | June |
| BBCH | **0-9** | **0-9** | **10-19** | **10-19** | **10-19** | **10-19** | **10-29** | **10-29** | **30-39** | **30-39** |
|  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  | 0.09 | 0.25 | 0.40 | 0.23 | 0.24 | 0.16 | 0.11 | 0.06 |
| Non-grass herbs, leafy crops |  |  |  |  |  |  |  |  | 0.05 | 0.03 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.42 | 0.55 | 0.33 | 0.30 | 0.40 | 0.25 | 0.05 | 0.30 | 0.30 | 0.32 |
| Small seeds (weed seeds) | 0.20 | 0.15 | 0.20 | 0.15 | 0.08 |  |  | 0.04 | 0.04 | 0.25 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.25 | 0.30 | 0.25 | 0.30 | 0.09 | 0.27 | 0.45 | 0.10 | 0.10 | 0.25 |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  |  |  |  |  |
| Soil invertebrates | 0.13 |  | 0.13 |  | 0.03 | 0.25 | 0.26 | 0.40 | 0.40 | 0.09 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Winter cereals** | May | June | July | July | August | July | August | August | Sept. |
| BBCH | **40-59** | **40-69** | **60-69** | **70-89** | **70-89** | **Pre-harv.** | **Pre-harv.** | **Stubble** | **Stubble** |
|  |  |  |  |  |  | **desiccat.** | **desiccat.** | **treatm.** | **treatm.** |
| Grasses and cereal shoots | 0.11 | 0.06 | 0.07 | 0.05 | 0.07 | 0.03 | 0.04 | 0.04 | 0.03 |
| Non-grass herbs, leafy crops | 0.05 | 0.03 | 0.03 | 0.03 | 0.03 | 0.01 | 0.02 | 0.02 | 0.02 |
| Cereal grain/ear on plant |  |  |  | 0.16 | 0.12 | 0.17 | 0.13 |  |  |
| Large seeds/cereal grain on ground | 0.30 | 0.32 | 0.32 | 0.32 | 0.25 | 0.33 | 0.26 | 0.39 | 0.34 |
| Small seeds (weed seeds) | 0.04 | 0.25 | 0.21 | 0.16 | 0.20 | 0.17 | 0.21 | 0.21 | 0.21 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  |  |  |  |  | 0.29 | 0.26 |
| Ground-dwelling arthropods with intercept. | 0.10 | 0.25 | 0.37 | 0.28 | 0.28 | 0.29 | 0.29 |  |  |
| Soil invertebrates | 0.40 | 0.09 |  |  | 0.05 |  | 0.05 | 0.05 | 0.14 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| --- | --- | --- | --- | --- | --- |
| **Winter cereals** | Sept. | Sept. | Jan.- | April- | April- |
| Green (1979) alternative | -Dec. | -Dec. | Feb. | June | June |
| BBCH | **0-9** | **10-19** | **10-19** | **14-39** | **40-69** |
|  |  |  |  |  |  |
| Grasses and cereal shoots |  |  | 0.08 | 0.01 | 0.01 |
| Non-grass herbs, leafy crops |  |  |  |  |  |
| Cereal grain/ear on plant |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.60 | 0.60 | 0.55 | 0.06 | 0.06 |
| Small seeds (weed seeds) | 0.24 | 0.24 | 0.05 | 0.80 | 0.80 |
| Large fruit (pome) |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |
| Berries |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |
| Ground-dwelling arthropods | 0.16 | 0.16 | 0.16 | 0.12 |  |
| Ground-dwelling arthropods with intercept. |  |  |  |  | 0.12 |
| Soil invertebrates |  |  | 0.16 | 0.01 | 0.01 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Maize** | April | May | May | June | June | July |
| BBCH | **0-9** | **0-9** | **10-29** | **10-29** | **30-39** | **30-39** |
|  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  | 0.22 | 0.12 | 0.08 | 0.10 |
| Non-grass herbs, leafy crops |  |  |  |  | 0.04 | 0.05 |
| Cereal grain/ear on plant |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.29\* | 0.29\* | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) |  | 0.05 | 0.05 | 0.35 | 0.35 | 0.29 |
| Large fruit (pome) |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.45 | 0.13 | 0.14 | 0.35 | 0.35 | 0.51 |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  |
| Soil invertebrates | 0.26 | 0.53 | 0.54 | 0.13 | 0.13 |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Cereal grain + maize seeds

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Spring oilseed rape** | April | April | May | May | May | June | July | July | August | July | August | August | Sept. |
| BBCH | **0-9** | **10-19** | **10-19** | **20-39** | **40-59** | **40-79** | **60-79** | **80-89** | **80-89** | **Pre-harv.** | **Pre-harv.** | **Stubble** | **Stubble** |
|  |  |  |  |  |  |  |  |  |  | **desiccat.** | **desiccat.** | **treatm.** | **treatm.** |
| Grasses and cereal shoots |  |  |  | 0.07 | 0.07 | 0.04 | 0.05 | 0.05 | 0.05 | 0.02 | 0.02 | 0.02 | 0.02 |
| Non-grass herbs, leafy crops |  | 0.24 | 0.22 | 0.15 | 0.15 | 0.08 | 0.10 | 0.09 | 0.09 | 0.05 | 0.05 | 0.05 | 0.04 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.07\* |  | 0.05 | 0.05 | 0.05 | 0.35 | 0.29 | 0.34 | 0.35 | 0.41 | 0.42 | 0.38 | 0.35 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.56 | 0.45 | 0.14 | 0.14 |  |  |  |  |  |  |  | 0.42 | 0.35 |
| Ground-dwelling arthropods with intercept. |  |  |  |  | 0.14 | 0.35 | 0.51 | 0.47 | 0.39 | 0.47 | 0.39 |  |  |
| Soil invertebrates | 0.32 | 0.26 | 0.54 | 0.54 | 0.54 | 0.13 |  |  | 0.07 |  | 0.07 | 0.08 | 0.19 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Rape seeds

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Winter oilseed rape** | August | Sept. | Oct. | March | April | Oct. | Nov. | March | April |
| BBCH | **0-9** | **10-19** | **10-19** | **10-19** | **10-19** | **20-39** | **20-39** | **20-39** | **20-39** |
|  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  |  |  |  | 0.11 | 0.21 | 0.09 | 0.08 |
| Non-grass herbs, leafy crops |  | 0.13 | 0.34 | 0.27 | 0.24 | 0.23 | 0.42 | 0.18 | 0.16 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.41 | 0.28 | 0.20 | 0.09 |  | 0.20 | 0.13 | 0.09 |  |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.46 | 0.36 | 0.41 | 0.31 | 0.45 | 0.41 | 0.14 | 0.31 | 0.45 |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  |  |  |  |
| Soil invertebrates | 0.08 | 0.18 |  | 0.28 | 0.26 |  | 0.05 | 0.28 | 0.26 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Winter oilseed rape** | April | May | June | June | July | July | July | August |
| BBCH | **40-59** | **40-79** | **70-79** | **80-89** | **80-89** | **Pre-harv.** | **Stubble** | **Stubble** |
|  |  |  |  |  |  | **desiccat.** | **treatm.** | **treatm.** |
| Grasses and cereal shoots | 0.08 | 0.07 | 0.04 | 0.04 | 0.05 | 0.02 | 0.02 | 0.02 |
| Non-grass herbs, leafy crops | 0.16 | 0.15 | 0.08 | 0.08 | 0.09 | 0.05 | 0.05 | 0.05 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) |  | 0.05 | 0.35 | 0.40 | 0.34 | 0.41 | 0.37 | 0.38 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  |  |  |  | 0.51 | 0.42 |
| Ground-dwelling arthropods with intercept. | 0.45 | 0.14 | 0.35 | 0.32 | 0.47 | 0.47 |  |  |
| Soil invertebrates | 0.26 | 0.54 | 0.13 | 0.11 |  |  |  | 0.08 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Beets** | April | May | June | June | July | August | Sept. | Oct. |
| BBCH | **0-9** | **10-19** | **10-19** | **20-39** | **40-49** | **40-49** | **40-49** | **40-49** |
|  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  |  | 0.04 | 0.05 | 0.05 | 0.04 | 0.11 |
| Non-grass herbs, leafy crops |  | 0.22 | 0.12 | 0.08 | 0.10 | 0.10 | 0.09 | 0.23 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.07\* | 0.05 | 0.35 | 0.35 | 0.29 | 0.30 | 0.28 | 0.20 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.56 | 0.14 | 0.35 | 0.35 |  |  |  |  |
| Ground-dwelling arthropods with intercept. |  |  |  |  | 0.51 | 0.42 | 0.36 | 0.41 |
| Soil invertebrates | 0.32 | 0.54 | 0.13 | 0.13 |  | 0.08 | 0.18 |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Beet seeds

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Potatoes** | April | May | June | July | August | August | Sept. |
| BBCH | **0-9** | **10-19** | **20-39** | **40-89** | **45-89** | **90-99** | **90-99** |
|  |  |  |  |  |  | **(desiccat.)** | **(desiccat.)** |
| Grasses and cereal shoots |  | 0.06 | 0.03 | 0.04 | 0.04 | 0.02 | 0.02 |
| Non-grass herbs, leafy crops |  | 0.06 | 0.03 | 0.04 | 0.04 | 0.02 | 0.02 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) |  | 0.06 | 0.37 | 0.32 | 0.33 | 0.34 | 0.32 |
| Large fruit (pome) |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.60 | 0.16 | 0.38 |  |  | 0.48\* | 0.39\* |
| Ground-dwelling arthropods with intercept. |  |  |  | 0.55 | 0.46 |  |  |
| Soil invertebrates | 0.35 | 0.61 | 0.14 |  | 0.08 | 0.09 | 0.20 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Low interception at this stage according to FOCUS (2000)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pulses** | April | May | May | June | May | June | June | July | August | July | August |
| BBCH | **0-9** | **0-9** | **10-19** | **10-19** | **20-39** | **20-39** | **40-79** | **40-79** | **60-79** | **80-99** | **80-99** |
|  |  |  |  |  |  |  |  |  |  | **(desiccat.)** | **(desiccat.)** |
| Grasses and cereal shoots |  |  |  |  | 0.07 | 0.04 | 0.04 | 0.05 | 0.05 | 0.02 | 0.03 |
| Non-grass herbs, leafy crops |  |  | 0.22 | 0.12 | 0.15 | 0.08 | 0.08 | 0.10 | 0.10 | 0.05 | 0.05 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.29\* | 0.29\* | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.10 | 0.10 |
| Small seeds (weed seeds) |  | 0.05 | 0.05 | 0.35 | 0.05 | 0.35 | 0.35 | 0.29 | 0.30 | 0.30 | 0.31 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.45 | 0.13 | 0.14 | 0.35 | 0.14 | 0.35 |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  | 0.35 | 0.51 | 0.42 | 0.53 | 0.43 |
| Soil invertebrates | 0.26 | 0.53 | 0.54 | 0.13 | 0.54 | 0.13 | 0.13 |  | 0.08 |  | 0.08 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

\* Cereal grain + peas (or beans)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Field grown vegetables** | April | May | June | May | June | July | August | May | June | July | August | Sept. |
| BBCH | **0-9** | **0-9** | **0-9** | **10-19** | **10-19** | **10-19** | **10-19** | **20-39** | **20-39** | **20-39** | **20-39** | **20-39** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  |  |  |  |  |  | 0.07 | 0.04 | 0.05 | 0.05 | 0.04 |
| Non-grass herbs, leafy crops |  |  |  | 0.22 | 0.12 | 0.15 | 0.15 | 0.15 | 0.08 | 0.10 | 0.10 | 0.09 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.03 | 0.08 | 0.28 | 0.05 | 0.35 | 0.29 | 0.30 | 0.05 | 0.35 | 0.29 | 0.30 | 0.28 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.58 | 0.17 | 0.49 | 0.14 | 0.35 | 0.51 | 0.42 | 0.14 | 0.35 | 0.51 | 0.42 | 0.36 |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  |  |  |  |  |  |  |
| Soil invertebrates | 0.34 | 0.70 | 0.18 | 0.54 | 0.13 |  | 0.08 | 0.54 | 0.13 |  | 0.08 | 0.18 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| **Field grown vegetables** | May | June | July | August | Sept. | Oct. |
| BBCH | **40-49** | **40-49** | **40-49** | **40-49** | **40-49** | **40-49** |
|  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.07 | 0.04 | 0.05 | 0.05 | 0.04 | 0.11 |
| Non-grass herbs, leafy crops | 0.15 | 0.08 | 0.10 | 0.10 | 0.09 | 0.23 |
| Cereal grain/ear on plant |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.05 | 0.35 | 0.29 | 0.30 | 0.28 | 0.20 |
| Large fruit (pome) |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.14 | 0.35 | 0.51 | 0.42 | 0.36 | 0.41 |
| Soil invertebrates | 0.54 | 0.13 |  | 0.08 | 0.18 |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| **Strawberries** | April | May | June | July | August | Sept. | Oct. | April | May | June | June | July |
| Stage / BBCH | **Planting** | |  |  |  |  |  | **Pre-flowering (20-59)** | | | **Flowering and fruit** | |
|  |  |  |  |  |  |  |  |  |  |  | **development (60-89)** | |
| Grasses and cereal shoots | 0.08 | 0.07 | 0.04 | 0.05 | 0.05 | 0.04 | 0.11 | 0.08 | 0.07 | 0.04 | 0.04 | 0.05 |
| Non-grass herbs, leafy crops | 0.16 | 0.15 | 0.08 | 0.10 | 0.10 | 0.09 | 0.23 | 0.16 | 0.15 | 0.08 | 0.08 | 0.10 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) |  | 0.05 | 0.35 | 0.29 | 0.30 | 0.28 | 0.20 |  | 0.05 | 0.35 | 0.35 | 0.29 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.45 | 0.14 | 0.35 | 0.51 | 0.42 | 0.36 | 0.41 |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  |  | 0.45 | 0.14 | 0.35 | 0.35 | 0.51 |
| Soil invertebrates | 0.26 | 0.54 | 0.13 |  | 0.08 | 0.18 |  | 0.26 | 0.54 | 0.13 | 0.13 |  |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| **Strawberries** | July | August | Sept. | Oct. | March | April | May | June | July | August | Sept. | Oct. | Nov. |
| Stage / BBCH | **Post-harvest** | | |  | **Termination** | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.05 | 0.05 | 0.04 | 0.11 | 0.05 | 0.05 | 0.04 | 0.02 | 0.03 | 0.03 | 0.02 | 0.07 | 0.16 |
| Non-grass herbs, leafy crops | 0.10 | 0.10 | 0.09 | 0.23 | 0.11 | 0.09 | 0.08 | 0.05 | 0.05 | 0.05 | 0.05 | 0.14 | 0.32 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.29 | 0.30 | 0.28 | 0.20 | 0.10 |  | 0.06 | 0.37 | 0.32 | 0.33 | 0.30 | 0.25 | 0.19 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.51 | 0.42 | 0.36 | 0.41 | 0.36 | 0.51 | 0.16 | 0.37 | 0.55 | 0.46 | 0.38 | 0.49 | 0.21 |
| Soil invertebrates |  | 0.08 | 0.18 |  | 0.33 | 0.30 | 0.61 | 0.14 |  | 0.08 | 0.20 |  | 0.07 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| **Rotational grass (seed grass, leys)** | March | April | May | June | July | August | Sept. | Oct. | Nov. |
| Stage | **Short grass** | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.22 | 0.19 | 0.17 | 0.10 | 0.12 | 0.12 | 0.10 | 0.27 | 0.50 |
| Non-grass herbs, leafy crops | 0.05 | 0.05 | 0.04 | 0.02 | 0.03 | 0.03 | 0.03 | 0.07 | 0.13 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.09 |  | 0.06 | 0.35 | 0.29 | 0.30 | 0.28 | 0.20 | 0.13 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.31 | 0.45 | 0.14 | 0.35 | 0.51 | 0.42 | 0.36 | 0.41 | 0.14 |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  |  |  |  |
| Soil invertebrates | 0.28 | 0.26 | 0.54 | 0.13 |  | 0.08 | 0.18 |  | 0.05 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Rotational grass (seed grass, leys)** | March | April | May | June | July | August | Sept. | Oct. | Nov. |
| Stage | **Medium and long grass** | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.18 | 0.16 | 0.15 | 0.07 | 0.09 | 0.09 | 0.09 | 0.23 | 0.42 |
| Non-grass herbs, leafy crops | 0.09 | 0.08 | 0.07 | 0.04 | 0.04 | 0.04 | 0.04 | 0.11 | 0.21 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.09 |  | 0.05 | 0.44 | 0.38 | 0.39 | 0.28 | 0.20 | 0.13 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.31 | 0.45 | 0.14 | 0.29 | 0.44 | 0.36 | 0.36 | 0.41 | 0.14 |
| Soil invertebrates | 0.28 | 0.26 | 0.54 | 0.11 |  | 0.07 | 0.18 |  | 0.05 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

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| **Rotational grass (seed grass, leys)** | March | April | May | June | July | August | Sept. | Oct. | Nov. |
| Stage | **Termination** | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.11 | 0.09 | 0.08 | 0.05 | 0.05 | 0.05 | 0.05 | 0.14 | 0.32 |
| Non-grass herbs, leafy crops | 0.05 | 0.05 | 0.04 | 0.02 | 0.03 | 0.03 | 0.02 | 0.07 | 0.16 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Small seeds (weed seeds) | 0.10 |  | 0.06 | 0.37 | 0.32 | 0.33 | 0.30 | 0.25 | 0.19 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. | 0.36 | 0.51 | 0.16 | 0.37 | 0.55 | 0.46 | 0.38 | 0.49 | 0.21 |
| Soil invertebrates | 0.33 | 0.30 | 0.61 | 0.14 |  | 0.08 | 0.20 |  | 0.07 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Non-rotational grass (turf, pasture)** | March | Aug. | March | June | Sept. | March | June | Sept. | March | June | Sept. |
|  | -May | -Oct. | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. |
| Stage | **Sowing and** | | **Short grass** | |  | **Medium and long grass** | | | **Termination** | | |
|  | **pre-emergence** | | |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots |  |  | 0.72 | 0.46 | 0.51 | 0.72 | 0.46 | 0.51 | 0.59 | 0.31 | 0.36 |
| Non-grass herbs, leafy crops |  |  | 0.05 | 0.08 | 0.08 | 0.05 | 0.08 | 0.08 | 0.04 | 0.06 | 0.06 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground |  |  |  |  |  |  |  |  |  |  |  |
| Small seeds (weed seeds) | 0.42 | 0.42 |  | 0.43 | 0.35 |  | 0.43 | 0.35 |  | 0.59 | 0.50 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.33 | 0.39 | 0.13 | 0.01 | 0.05 |  |  |  |  |  |  |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  | 0.13 | 0.01 | 0.05 | 0.21 | 0.01 | 0.07 |
| Soil invertebrates | 0.25 | 0.19 | 0.10 | 0.02 | 0.01 | 0.10 | 0.02 | 0.01 | 0.16 | 0.03 | 0.01 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Fruit trees (orchards)** | March | June | Sept. | March | June | Sept. |
|  | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. |
| Application / Stage | **Canopy directed (all stages)** | | | **Ground directed (all stages)** | | |
|  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.72 | 0.46 | 0.51 | 0.72 | 0.46 | 0.51 |
| Non-grass herbs, leafy crops | 0.05 | 0.08 | 0.08 | 0.05 | 0.08 | 0.08 |
| Cereal grain/ear on plant |  |  |  |  |  |  |
| Large seeds/cereal grain on ground |  |  |  |  |  |  |
| Small seeds (weed seeds) |  | 0.43 | 0.35 |  | 0.43 | 0.35 |
| Large fruit (pome) |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  | 0.13 | 0.01 | 0.05 |
| Ground-dwelling arthropods with intercept. | 0.13 | 0.01 | 0.05 |  |  |  |
| Soil invertebrates | 0.10 | 0.02 | 0.01 | 0.10 | 0.02 | 0.01 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bush berries** | March | June | Sept. | March | June | Sept. |
|  | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. |
| Application / Stage | **Canopy directed (all stages)** | | | **Ground directed (all stages)** | | |
|  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.72 | 0.46 | 0.51 | 0.72 | 0.46 | 0.51 |
| Non-grass herbs, leafy crops | 0.05 | 0.08 | 0.08 | 0.05 | 0.08 | 0.08 |
| Cereal grain/ear on plant |  |  |  |  |  |  |
| Large seeds/cereal grain on ground |  |  |  |  |  |  |
| Small seeds (weed seeds) |  | 0.43 | 0.35 |  | 0.43 | 0.35 |
| Large fruit (pome) |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |
| Ground-dwelling arthropods |  |  |  | 0.13 | 0.01 | 0.05 |
| Ground-dwelling arthropods with intercept. | 0.13 | 0.01 | 0.05 |  |  |  |
| Soil invertebrates | 0.10 | 0.02 | 0.01 | 0.10 | 0.02 | 0.01 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ornamentals and nursery** | March | June | Sept. | March | June | Sept. | March | June | Sept. | March | June | Sept. |
|  | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. | -May | -Aug. | -Nov. |
| Stage / Application | **Pre-emergence** | |  | **Small plants** | |  | **Large plants, canopy directed** | | | **Large plants, ground directed** | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Grasses and cereal shoots | 0.05 | 0.11 | 0.11 | 0.09 | 0.19 | 0.18 | 0.39 | 0.32 | 0.35 | 0.39 | 0.32 | 0.35 |
| Non-grass herbs, leafy crops | 0.05 | 0.11 | 0.11 | 0.09 | 0.18 | 0.18 | 0.11 | 0.13 | 0.11 | 0.11 | 0.13 | 0.11 |
| Cereal grain/ear on plant |  |  |  |  |  |  |  |  |  |  |  |  |
| Large seeds/cereal grain on ground |  |  |  |  |  |  |  |  |  |  |  |  |
| Small seeds (weed seeds) |  | 0.60 | 0.47 |  | 0.49 | 0.38 |  | 0.48 | 0.40 |  | 0.48 | 0.40 |
| Large fruit (pome) |  |  |  |  |  |  |  |  |  |  |  |  |
| Small fruit (plum, cherry) |  |  |  |  |  |  |  |  |  |  |  |  |
| Berries |  |  |  |  |  |  |  |  |  |  |  |  |
| Foliar arthropods |  |  |  |  |  |  |  |  |  |  |  |  |
| Ground-dwelling arthropods | 0.51 | 0.06 | 0.26 | 0.46 | 0.05 | 0.22 |  |  |  | 0.28 | 0.02 | 0.12 |
| Ground-dwelling arthropods with intercept. |  |  |  |  |  |  | 0.28 | 0.02 | 0.12 |  |  |  |
| Soil invertebrates | 0.39 | 0.12 | 0.05 | 0.36 | 0.09 | 0.04 | 0.22 | 0.05 | 0.02 | 0.22 | 0.05 | 0.02 |
| Sum | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

# Appendix 5

A single published data sourse giving useful Thousand grain weights (TGW) is Heimbach (2018), and the respective data (crop seed type, mean and 90th percentile TGW) is summarized below. The author used seed batches of important arable crops used in Germany for seed treatment for the European market.

For the FAA (section 5.3, page 31) the mean shall be used for long-term and the 90th percentile for acute risk assessments. If the crop of concern ist not listed here, please check for further details the original data in Heimbach (2018).

Besides these published data, seed breeding companies, chambers of agriculture or agricultural cooperative societies for farmer supply may provide additional, or more NZ variety specific data, and the intention is to provide TGW values per crop of most NZ relevant data in the near future.

**Thousand grain weight to be used for risk assement of seed treatment via the Excel spread sheet (Mean values are used for long-term and 90th percentile is used for acute)**

| **Crop** | **Scientific name** | **N** | **Mean 1 in g** | **90th percentile 2 in g** |
| --- | --- | --- | --- | --- |
| ***Peas & beans:*** | | | | |
| Forage peas | *Pisum sativim* | 91 | 246 | 290 |
| Vining peas | *Pisum sativim* | 45 | 173 | 204 |
| Field beans | *Vicia faba* | 69 | 561 | 655 |
| ***Cereals:*** |  |  |  |  |
| Barley | *Hordeum vulgare* | 1935 | 56 | 64 |
| Wheat | *Triticum aestivum* | 2005 | 49 | 56 |
| Durum wheat | *Triticum durum* | 123 | 54 | 63 |
| Rye | *Secale cereale* | 431 | 40 | 45 |
| Triticale | *Triticosecale rimpaui* | 408 | 53 | 62 |
| Oat | *Avena sativa* | 185 | 44 | 50 |
| ***Maize* 3** | | | | |
| Maize | *Zea mays* | 1858 | 290 | 340 |
| ***Beet*** | | | | |
| Sugarbeet | *Beta v. vulgaris altissima* | 3164 | 10.7 | 12.1 |
| Sugarbeet pelleted | *Beta v. vulgaris altissima* | 3629 | 30.2 | 33.3 |
| Fodder beet | *Beta v. vulgaris crassa.* | 191 | 11.6 | 16.1 |
| Fodder beet pelleted | *Beta v. vulgaris subsp.* | 113 | 28.1 | 29.4 |
| Winter turnip rape | *Brassica rapa* | 24 | 4.5 | 4.9 |
| Turnip | *Brassica rapa* | 43 | 2.3 | 2.6 |
| ***OSR*** | | | | |
| Winter oilseed rape | *Brassica napus* | 1428 | 5.6 | 7.1 |
| ***Grass*** | | | | |
| Perennial ryegrass | *Lolium perenne* | 187 | 2.7 | 3.6 |
| Italian ryegrass | *Lolium multiflorum* | 265 | 3.7 | 4.9 |
| Meadow fescue | *Schedonorus pratensis* | 28 | 2.3 | 3.1 |
| Meadowgrass | *Poa pratensis* | 15 | 0.32 | n.a. |

1 For crops with different data (e.g. winter/summer wheat) the max mean was taken from Heimbach (2018)

2 For crops with different data (e.g. winter/summer wheat) the max 90th percentile was taken from Heimbach (2018)

3 Please note that maize seed weights are often reported as kg/unit (i.e. ), rather than in TGWs

1. Expressed as a factor for multiple applications (MAF). [↑](#footnote-ref-2)
2. The underlying rationale is that 6% represents the amount of grain which is “always” available in rotational fields due to harvest spillage and remains, turning over of soil, etc. [↑](#footnote-ref-3)
3. Residue studies including excessive rain/irrigation within the half life/DT50 of the substance will not be considered representative. [↑](#footnote-ref-4)
4. It should be noted that this assumption will almost never be met, implying that the true level of protection may only be reliably estimated by probabilistic methods. [↑](#footnote-ref-5)
5. Calculated using standard values for energy and moisture content and assimilation efficiency for cereal grain, cf. Appendix G (Tables 3 and 4) to the EFSA Guidance Document (EFSA 2009). [↑](#footnote-ref-6)
6. Calculated using standard values for energy and moisture content and assimilation efficiency for cereal grain, cf. Appendix G (Tables 3 and 4) of EFSA (2009). [↑](#footnote-ref-7)
7. Calculated using standard values for energy and moisture content and assimilation efficiency for cereal grain. [↑](#footnote-ref-8)