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Focal Species of Birds in European Crops for Higher Tier Pesticide Risk Assessment

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ABSTRACT

Focal species have been defined by the European Food Safety Authority (EFSA) as real species that represent others in a crop resulting from their potential higher level of exposure to pesticides. As such they are the most appropriate species for refining estimates of exposure further, through, for example, radio tracking and dietary studies. Plant protection product manufacturers collectively commissioned many studies in Europe, according to the EFSA guidelines, to identify focal species in different crops that may be used in risk assessments for spray applications of pesticides. Using frequency of occurrence in crops and risk-based criteria for exposure, all studies have been reviewed to identify if possible at least 1 focal species per feeding guild, per crop in the new registration zones for southern and central Europe. Some focal species repeatedly appeared across a wide range of arable or tree crops but not both, demonstrating broad adaptation to these 2 different crop structures. Many have widespread distributions, for example, 15 of the focal species have a distribution covering all agricultural regions of Europe (northern, central, and southern zones). Three species, corn bunting, serin, and tree sparrow, are restricted to the central and southern zones, whereas another 4 species, Sardinian and fan-tailed warbler, and crested and short-toed lark, are essentially restricted to the southern zone. The authors consider the focal species identified as suitable for risk assessment in Europe at the zonal level and for further refinement of exposure through studies, such as radio tracking or diet analysis, if necessary. *Integr Environ Assess Manag* 2014;10:247–259. © 2013 SETAC

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INTRODUCTION

Assessing the risk to birds from the effects of pesticides, using a quotient of estimated daily dietary dose and toxicity, was first described by Kenaga (1973). The European Plant Protection Organisation (EPPO) (1994) adopted this and described how it may be used for standard risk assessment in Europe. To describe the exposure of birds to pesticides in milligrams active substance per kilogram body weight per day, the diet guild, food ingestion rate, and body weight of the animal has to be known in addition to a residue per unit dose. As a consequence, many species-specific exposure scenarios theoretically exist, and, for reasons of protection levels and regulatory simplicity, the representatives of different feeding guilds with the highest potential exposure are selected for particular crops. This approach was developed further by the SANCO/4145/2000 Guidance Document (European Commission 2002), and was recently revised again by European Food Safety Authority (EFSA) in their document on "Risk Assessment for Birds and Mammals" (EFSA 2009). EFSA (2009) recognises that this approach may be overprotective but desirable to screen pesticides, allowing pragmatic registration of products with the lowest risk. Consequently, substances fail the initial risk assessment because the EFSA guidance document (EFSA 2009) identifies so-called "representative species" for a size, diet guild, and agricultural situation in the absence of real data. They provide conservative assumptions for the ecological parameters, diet composition (proportion of diet, PD), time budget (proportion of time feeding in treated area, PT) and food ingestion rate. Focal species, as defined by EFSA (2009), are real species that occur regularly in a particular crop and are protective (i.e., representative and cover the risk) of other species that could be exposed there. The importance of establishing real focal species in risk assessment is to introduce greater realism, but not at the expense of adequate protection. Focal species may be used in risk assessment directly with conservative assumptions, and may be used as candidates for further risk refinement through radio-tracking studies to measure the proportion of time they forage in treated crops (PT) and measurement of their diet in representative landscapes (PD) or as candidates for field effect studies.

This paper represents a review of all crop-specific studies from 11 Plant Protection Product (PPP) manufacturers conducted with the same methodology to identify focal species in different crops. The methods used to determine focal species in major crops in Europe are based on the required standards recently defined by EFSA (2009). Focal species studies carried out by Member State governments (MS) have been considered alongside the PPP manufacturer studies in the discussion to identify similarities and differences with the intent to achieve consistency in focal species selection across the EU. The underlying field data for this analysis has come from proprietary, confidential studies carried out by PPP manufacturers. These studies were specifically designed to identify bird species

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using specific crops mainly during spring and summer, the period of most frequent PPP use in Europe. These seasons also coincide with the breeding season, a period when the birds are resident and relevant for reproduction risk assessment. Special attention is given to the robustness of criteria for the selection of focal species and their distribution in Europe. The purpose of this paper is to provide a list of "focal species" by crop type, based on the PPP manufacturer database of in-crop targeted studies for use by regulators and PPP manufacturers in risk assessment or for further research (e.g., studies on PD and PT) to refine estimates of exposure in higher-tier risk assessments and selecting candidates for field effects studies. With large amounts of information supporting the analysis of focal species in all crops described, a supplemental data file is available online to support the conclusions and for further analysis if required.

MATERIALS AND METHODS

This review is based on 72 previously unpublished field studies of plant protection companies who register their products within Europe (BASF, Bayer Crop Science, Cheminova, DOW, GOWAN, Makhteshim, Irvita, Isagro, Monsanto, Sharda, and Syngenta). The studies have been conducted in 16 EFSA crop groupings (bare soils, bulbs and onion-like crops, cereals, cotton, fruiting vegetables, leafy vegetables, legume forage, maize, oilseed rape, orchards, potatoes, pulses, root and stem vegetables, strawberries, sugar beet and vineyards) in 8 different countries spread across the central and southern work-sharing zones of Europe (Figure 1). Generally, within each study the crop was surveyed up to 3 times during different growth stages, mainly in spring and summer when most plant protection products are used and birds are breeding. The total period during which the surveys of each study took place ranged from a minimum of 2 weeks to up to 4 months, depending on crop development.

Studies were conducted strictly in line with the recommendations of the current guidance document for the risk assessment of birds (EFSA 2009, Appendix M), using the "transect method." For each study, a number of fields (mean, 22; range, 5–59) were selected in 1 or several countries in a work sharing zone to represent typical fields and distribution for the crop in question. The study fields were generally visited during different crop growth stages, to make 1 to 3 surveys per study to represent the majority of crop protection chemical usage timings. Growth stages are described according to the Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie (BBCH) (Enz and Dachler 1997). The exact location of each field was recorded, together with size, crop growth stage, date, habitat surroundings, and weather. All bird species within the field were recorded in each study field by walking slowly along a defined longitudinal transect across the field. Only birds within the crop were recorded, because these are most likely to be exposed to pesticide applications compared with species that rather use noncrop habitats. However, species that breed in the field surroundings but forage within the field are also covered. Individual birds were registered visually or acoustically in the crop, 50 m either side of the central transect line for field crops and 25 m either side for taller orchard crops (or to the edge of the field, whichever was narrower). More details on survey methods can be found in Appendix M of EFSA (2009).

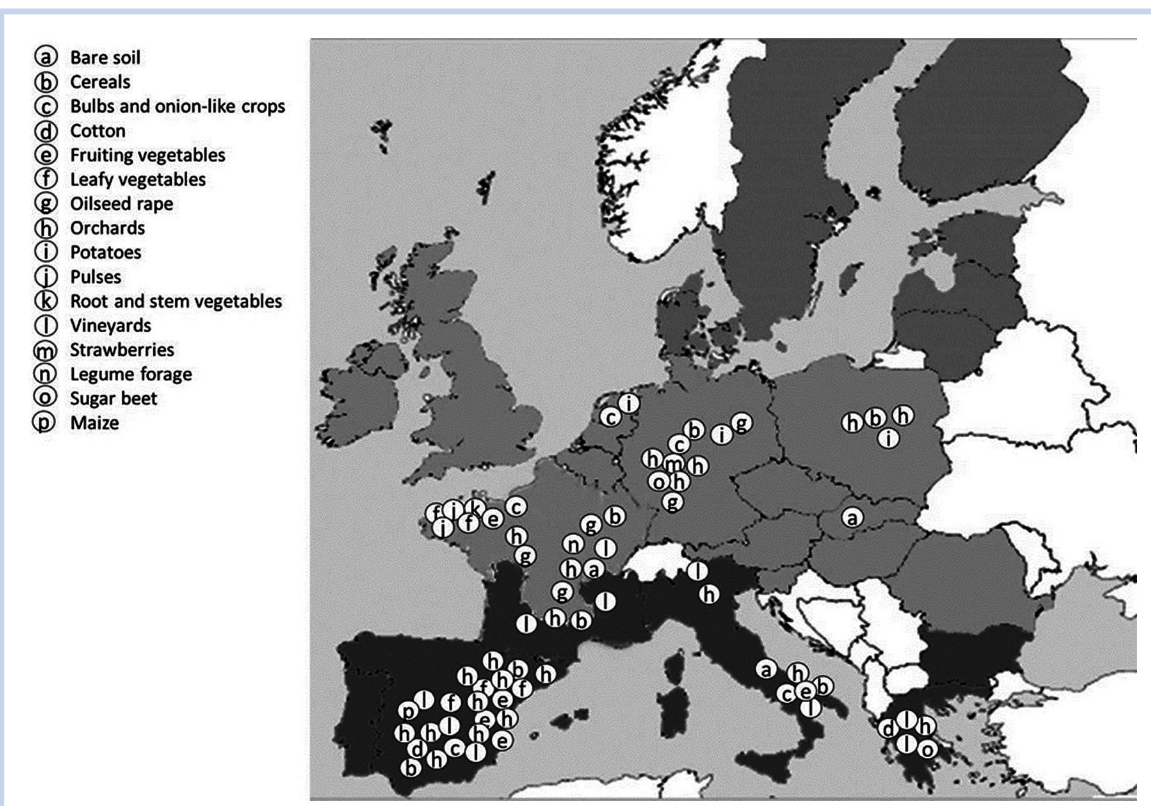

Figure 1. For pesticide registration, Europe divided into the 3 work-sharing zones north (mid grey), central (light grey), and south (dark grey) and the location of focal species study sites. Some sites comprise several crop categories, and only the dominant crop is shown. Northern and southern regions of France are allocated to central and southern work-sharing zones according to SANCO 7525/VI/95–rev. 8 (European Commission 2008).

The recorded data in the original studies were used to calculate the frequency of occurrence (FO), dominance, and abundance. According to the guidance document (EFSA 2009), the FO or prevalence is considered to be most relevant parameter to determine "focal species."

Bird Distributions

Focal species for different crops (or "crop groups" according to EFSA 2009) were determined from all available studies.

The distribution of focal species candidates (FO > 20%) represented in these studies were compared within and between countries in Europe for inconsistency. Studies were allocated to either the central or southern zone according to published work sharing zones by the European Commission (2009), the only exception being France, described as the southern zone. Avifauna distributions and climate for northern France have more in common with the central zone. Therefore, studies conducted in the northern regions of France, Bretagne, Champagne-Ardenne, Pays de la Loire, and Bourgogne have been included in the central zone, whereas studies in regions Midi-Pyrenees and Languedoc-Roussillon remain in the southern zone. Mean FO values were calculated across countries within zones to determine a "zonal FO." If the study location was outside of the breeding range for a species, the FO for that species and study was omitted from the calculation of the zonal mean. This was done to prevent underrecording of the mean FO for a species, where the crop was within its range. If the study was within the range for the species, but the species was absent in the crop, it was given a zero value in the mean calculation. European bird distributions were taken from Cramp (1998) and Hagemeijer and Blair (1997). This can be illustrated with the fan-tailed warbler (*Cisticola juncidis*) and the short-toed lark (*Calandrella brachydactyla*), both species with restricted distributions in southern Europe. All studies in the southern zone were within the range of the fan-tailed warbler, and absence from studies resulted in a zero entry in the mean. The short-toed lark has a restricted distribution, and the single study in France was outside the range for this species and was therefore excluded from the calculation of mean FO for the southern zone. Most studies include up to 3 surveys during different crop growth stages and allow for determination of crop growth stage–specific focal species candidates. This paper concentrates on the selection of crop-specific focal species in the spring and summer, during the breeding period. However, if clear growth stage effects on focal species within the breeding season were observed, these have been identified. Thus, no reference to BBCH stage means that the focal species identified can be recommended as a focal species throughout the breeding season in the specified crop type.

Focal Species Selection Criteria

By definition, focal species are required to be protective of other species that might be exposed to pesticide applications in the field (EFSA 2009). Therefore, one must consider exposure-dependent parameters to ensure that the level of protection and uncertainty are taken into account. This has been done in a consistent way by taking account of FO, diet guild, and body weight (according to Dunning 2008). Other parameters influencing the exposure, such as PT (proportion of time spent foraging in the treated area, a surrogate for treated food in diet) can only be investigated and used once these "protective" focal species have been identified, and thus this parameter cannot be included here.

The FO can be expressed in 2 ways, in relation to the total number of fields (FO_{field}) or the total number of surveys (FO_{survey}). If a species is observed in 16 of 20 different fields (census sites), the frequency of occurrence per field (FO_{field}) is 80%. If more than a single census is done on each field, FO_{survey} can provide information about temporal changes. For example, if 20 fields are visited 3 times during the course of the study and a species is observed on 16 of 60 surveys (3×20), the FO_{survey} is 27%. If the FO_{field} is high and the FO_{survey} is low, the species are likely to be transient, for example, on migration or only attracted to a specific growth stage, which identifies a specific time window for potential exposure. The migratory status of birds observed in the field can then be further confirmed by looking at the breeding distribution of the species. All FO values quoted refer to FO_{field} unless specified.

Frequency of occurrence (FO) in a crop may reflect the distribution of the bird in the wider landscape or the attractiveness of the crop for the species. FO values greater than 20% have been used as a filter to identify potential "focal species" (i.e., candidates) occurring frequently in the crop. The threshold of 20% is based on observation efficiencies of approximately 97% resulting from 3 repeated counts over the same transect route (Haila and Kuusela 1982; Erit 2004) and the likelihood of false negatives of only 10%. The defined threshold FO of 20% guarantees that a focal species that occurs only in one fifth of all fields is identified in 90% of all cases. The selection of a higher threshold would increase the probability that a real focal species is not detected, or by lowering the threshold inflating the list of focal species beyond its usefulness as a risk-based filter. Analysis of the cereals data in Tables 1 and 2 shows how the number of candidates decline with increasing FO but are fairly stable between 6 and 9 species, with an FO of 20%. Setting the frequency of occurrence relatively low at 20% retains enough species from different feeding guilds and with low body weight to be taken forward as candidates.

Diet guild influences exposure through the differences in residues on food types and the food ingestion rate, through the calorific value and assimilation efficiency of that food (Crocker et al. 2002). As a consequence, all species were categorized into 4 dietary guilds: insectivorous, granivorous, herbivorous, and omnivorous, as recommended by EFSA (2009). The allocation of a given species to a particular dietary guild is not exclusive; some species can be assigned to more than 1 guild depending on season or local circumstances. Consequently, the most likely dominant food source during the survey period was taken as the primary determinant for the allocation of species to individual guilds (Wilson et al. 1996, 1999; Christensen et al. 1996; and Holland et al. 2006). In the case of omnivores, evidence was found for a significant proportion of both seeds and insects in the adult diet during the spring and summer. Aerial feeders (swallows, martins, and swifts) feature in many crops during the surveys. These species feed on flying insects "over the crop" and across more widespread areas than many other species. Residues on flying insects are lower than for insects on foliage and the ground (Schabacker 2006), and probably for this reason EFSA have not defined residues for this group. Consequently, aerial feeding birds have been excluded from analyses on the assumption that foliar and ground foraging insectivores will be protective of them.

Body weight influences exposure by allometric daily energetic requirements and thus food ingestion rate. Allometric equations have been published based on doubly labeled water measurements in animals in the field during the breeding season

Table 1. FO values for focal species candidates in cereals, where the mean FO is ≥ 20% in at least one zone categorized by feeding guild and ranked by body weight (bw) [a]

Country[b]			**DE**	**PL**	**FR**		**FR**	**IT**	**ES**	**ES**	
Work-sharing Zone[c]			**Central**	**Central**	**(South)**		**South**	**South**	**South**	**South**	
BBCH[d]			**10–83**	**10–83**	**10–77**		**14–65**	**10–69**	**30–85**	**15–99**	
Number of fields			**25**	**24**	**21**	**Mean FO Central ($n = 3$)**	**15**	**20**	**21**	**15**	**Mean FO South ($n = 4$)**
Species	**Guild**	**b.w.**									
Yellow wagtail	Insectivorous	17.6	20.0	66.7	85.7	57.5	6.7	25.0	71.4	0.0	25.8
Motacilla flava											
Meadow pipit	Insectivorous	18.4	0.0	4.2	0.0	1.4	40.0	35.0	42.9	40.0	39.5
Anthus pratensis											
Little bustard	Insectivorous	940.0					0.0		4.8	60.0	21.6
Tetrax tetrax											
Short-toed lark	Omnivorous	21.8						60.0	4.8	0.0	21.6
Calandrella brachydactyla											
Skylark	Omnivorous	37.2	96.0	95.8	81.0	90.9	73.3	95.0	14.3	0.0	45.7
Alauda arvensis											
Crested lark	Omnivorous	39.0	0.0	0.0	0.0	0.0	0.0	100.0	33.3	40.0	43.3
Galerida cristata											
Corn bunting	Omnivorous	46.0	0.0	37.5	38.1	25.2	20.0	95.0	85.7	80.0	70.2
Miliaria calandra											
Calandra lark	Omnivorous	61.6					0.0	10.0	52.4	40.0	25.6
Melanocorypha calandra											
Quail	Omnivorous	90.0	0.0	12.5	52.4	21.6	33.3	40.0	28.6	40.0	35.5
Coturnix coturnix											

[a]Some species have a restricted breeding distribution in Europe and if a study was conducted outside the regular breeding range of a species, the accompanying fields in the table were left empty, whereas a '0.0' indicates the species generally occurs in the study region but was not recorded.
[b]DE = Germany; PL = Poland; FR = France; IT = Italy; ES = Spain.
[c]Work-sharing zone according to EUROPEAN COMMISSION (2009). France represents a borderline case with Central (northern parts) and Southern (southern parts) elements (EUROPEAN COMMISSION 2008). Northern France is treated as Central Zone here: "(South)"
[d]The BBCH-scale is a system for a uniform coding of phenologically similar growth stages of mono- and dicotyledonous plant species. The abbreviation BBCH derives from Biologische Bundesanstalt, Bundessortenamt and CHemical industry (Enz and Dachler 1997).

(Nagy et al. 1999). A halving of the body weight (on average) increases energetic requirements by a factor of 1.3 (Crocker et al. 2002).

No data allow correlation of FO in focal species studies with PT. However, a doubling of the FO during the breeding season may represent increased attractiveness of the crop for nesting or foraging of the given species and in terms of potential exposure may be considered equivalent to an increase in food ingestion rate/body weight) from 1 to 1.3, which may arise through halving the body weight.

These parameter values have been taken into consideration in a consistent way to identify focal species, using the following filtering process for each guild within a crop and zone.

Filter 1—Select all species within a guild with a mean FO greater than 20% (focal species candidates)
Filter 2—Of focal species candidates, select all those with lowest body weight (exclude candidates with body weight > 2× the candidate with the lowest body weight)
Filter 3—Of filter 2 candidates, select those with highest FO (exclude candidates with an FO < 0.5× the candidate with the highest FO)
Filter 4—Of filter 3 candidates, select the candidate with the lowest body weight

These are intended to be pragmatic but conservative filters. Subsequent studies to refine exposure of these focal species (PT) may lead to a conclusion that they are not protective of other focal species candidates. Published studies measuring estimates of the proportion of time spent in treated fields, as analyzed by Finch and Payne (2006), indicate that this is only occasionally going to influence the exposure to the extent that it might change the selection of the focal species. In some circumstances, alternative focal species have been identified. This has been considered necessary because of restricted species distributions and the location of study sites, especially if only a single study exists within a zone. Marginal differences between focal species candidates may be seen after applying the body weight and FO criteria. In such circumstances, behaviors that may affect exposure such as residential status (i.e., migrant on passage or resident), nest location, home range, and feeding strata have been taken into account. Under these circumstances, more than a single focal species has been identified, and any alternative species identified also may be considered protective in the risk assessment of the relevant feeding guild.

In circumstances in which no focal species qualified for a diet guild, this guild was described as redundant in the risk assessment, on the assumption that the crop in a certain growth stage is not highly attractive for any species of this diet guild. This may also be a response to limited food availability. Consequently, the exposure for species of this guild is then low, and focal species in other guilds will be protective.

The north to south regulatory zones are not always fine enough in scale for defining focal species suitable for country (MS) level, especially because species distributions may vary from east to west. Defining zonal focal species within these constraints is challenging for species with more restricted distributions in Europe. Fortunately, many focal species are ubiquitous. However, in some cases, after the examination of studies at country (MS) level, another candidate focal species may be a better fit. In such cases, these species are described as "alternative" focal species. The implications of not being able to apply these criteria fully and consistently were small, because the "focal species" defined for the zone are considered protective of all other species in that crop.

RESULTS

All 72 focal species studies were conducted in accordance with EFSA (2009). Full analyses for cereals are presented as an example of how focal species have been determined for all crops together with relevant discussion where necessary to support focal species choice. Results for all other crops are summarized, and full details of results for all crop types are included in a Supplementary Data file online.

Focal Species Selection in Cereals

Seven methodologically identical line-transect studies were conducted in cereal fields in Europe to determine focal bird species. Most of the study sites were in winter cereals, mainly wheat and barley, but the results are considered representative for winter and spring cereals because the crop structure is similar. Studies using line transect counts were conducted in the central zone (Germany, Poland, and France) comprising 70 fields and in the southern zone (France, Italy, and Spain) comprising 71 fields (Table 1). Table 1 presents the focal species candidates where the mean frequency of occurrence equaled or exceeded 20% in at least 1 zone. Two of 4 dietary foraging guilds relevant for pesticide risk assessment were represented, with insectivorous ($n = 3$) and omnivorous ($n = 6$) species.

Only single herbivorous (wood pigeon, *Columba palumbus*) and granivorous (linnet, *Carduelis cannabina*) species were recorded with FO of 20% or greater, and only in single studies. Diversity of insectivorous and omnivorous species was much greater. Yellow wagtail showed a high FO in most studies in both the central and southern zones. Omnivorous birds were well represented in the central and southern zones, with larks, especially skylark, showing consistently high FO values, with the exception of Spain. In Spain the corn bunting achieved a higher frequency of occurrence than skylark. Generally these species also show the lowest body weight among the high-ranking species within this guild.

A total of 9 species were recorded in cereals with a mean zonal FO greater than 20% (Table 2). The mean FO for granivorous and herbivorous birds did not exceed the 20% threshold for any species in any registration zone. Among insectivorous birds, the yellow wagtail was the only species in the central zone with a mean FO greater than 20%, so it represents the focal species. In the southern zone, the meadow pipit displays a higher FO than yellow wagtail and little bustard.

Table 2. Example of how the criteria were applied to determine focal species in cereals

Candidates guild & zone	Filter 1 mean FO > 20%	Filter 2 lowest bw	Filter 3 highest FO	Filter 4 lowest bw	Alternative if relevant
Insectivore Central zone	Yellow wagtail	Yellow wagtail	Yellow wagtail	Yellow wagtail	
Omnivore Central zone	Skylark Corn bunting Quail	Skylark Corn bunting	Skylark Corn bunting	Skylark	
Insectivore Southern zone	Yellow wagtail Meadow pipit Little bustard	Yellow wagtail Meadow pipit	Yellow wagtail Meadow pipit	Yellow wagtail	BBCH > 58 for fan-tailed warbler (FO = 19.4%, bw = 6.5g)
Omnivore Southern zone	Skylark Crested lark Short-toed lark Calandra lark Corn bunting Quail	Skylark Crested lark Short-toed lark	Skylark Crested lark	Skylark	
Alternative if relevant Omnivore Spain & Portugual	Crested lark Calandra lark Corn bunting Quail	Crested lark Calandra lark Corn bunting	Calandra lark Corn bunting	Corn bunting	

The body weights for meadow pipit and yellow wagtail are similar (difference < 2 ×), and the FO values are similar (difference <2 ×); thus, the yellow wagtail with the lowest body weight is selected as the focal species. Furthermore, the meadow pipit does not nest in the southern zone. The fan-tailed warbler may be considered an alternative focal species of insectivore in the southern zone because of its very small size (<0.5× the yellow wagtail), despite a mean FO less than 20% (19.4%). However, this species was only present in cereals during late growth stages (BBCH > 56). Among omnivorous birds the skylark showed the highest FO value in the central zone and represented the smallest species and was selected.

Six omnivorous candidates were found in the southern zone, including 4 lark species. The short-toed lark has the lowest body weight, but the difference compared with the skylark and crested lark was less than 2×. The FO values for both skylark and crested lark were similar but more than 2× that of the short-toed lark. Thus the skylark was selected as focal species with the lowest body weight. However, the short-toed lark and skylark were not candidate focal species (mean FO <20%) in Spain. Taking the 2 studies for Spain in isolation (Table 2) the calandra lark, crested lark, and the corn bunting were all candidates with highest FO and low body weights. The crested lark has the lowest body weight, but the difference between all 3 species was less than 2×. The FO for the corn bunting (83%) was more than 2× that of the crested lark (37%) and less than 2× for the calandra lark (46%). The corn bunting, with a lower body weight than the calandra lark, qualified as an alternative focal species for the omnivorous guild in Spain (and Portugal). Short-toed lark, a summer visitor, was only represented in cereals with an FO greater than 20% in Italy at late BBCH stages, which coincided with the breeding season. The mean skylark FO is more than 2× that of the short-toed lark, so the short-toed lark in Italy has not been described as an alternative species to the skylark.

The focal species criteria have been applied to all other crop types. Crop types have been combined into arable crops (annual planting with tillage) in Table 3 and tree crops (permanent and woody of taller structure) in Table 4. The *italicized* species in Tables 3 and 4 represent alternative focal species included because of a negligible separation in exposure-based criteria, and either may be protective of other species. Alternative focal species are also included for "distribution" reasons where a focal species is absent and replaced by another, such as with skylark and corn bunting in cereals. Following Tables 3 and 4, additional texts are provided to describe the application of the criteria where necessary.

Focal Species Selection in Arable Crops

Bare soil. No granivores or herbivores qualified as focal species in the southern and central zones (or insectivores in the central zone) after 1 and 2 studies comprising transects in 32 and 62 fields, respectively. The crested lark (bw 39 g; FO = 9%) may be considered an alternative focal species in the southern zone despite the FO less than 20%, because it is significantly smaller than a carrion crow. Crested lark is also more widespread than skylark during the breeding season further south, as observed in other crop types. For a similar reason, the yellow wagtail (bw 18 g; FO 18%) is included in the central zone.

Bulb and onion-like crops. No granivores or herbivores qualified as focal species in the southern and central zones after 2 and 3 studies comprising transects in 38 and 60 fields, respectively. Marginal separation was seen between wagtails as focal species in the central zone. The white wagtail (*Motacilla alba*) (bw 21 g; FO = 25%) meets the focal species criteria. However, the yellow wagtail (bw 18 g; FO = 17%), unlike the white wagtail, nests in field crops. Consequently, yellow and white wagtails are recommended focal species in and outside the breeding season, respectively. Marginal separation was seen between the short-toed lark (bw 22 g; FO = 47%) and the crested lark (bw 39 g; FO = 90%) in the southern zone. However, the crested lark is a resident, unlike the short-toed lark, a summer visitor.

Cereals. No granivores or herbivores qualified as focal species in the southern and central zones after 4 and 3 studies comprising transects in 71 and 70 fields, respectively. The fan-tailed warbler (bw 9.4 g; FO = 19%) may be considered an alternative focal species to yellow wagtail (bw 18 g; FO = 26%) in the southern zone cereals at greater than BBCH 56. Corn bunting (bw 46 g; FO = 83%) may be considered an alternative focal species to the skylark (bw 37 g; FO = 12%) in Spain.

Cotton. Cotton is only grown in the southern zone, and no focal species of herbivores were identified after 2 studies comprising transects in 51 fields. Focal species identified are consistent with Foudoulakis et al. (2012). Focal species candidates were crested lark (bw 39 g, FO = 73%), house sparrow (*Passer domesticus*) (bw 27 g, FO = 49%), and short-toed lark (bw 22 g, FO = 20%). The house sparrow marginally best fits the focal species criteria, but its occurrence is dependent on proximity to buildings for nesting. The crested lark is larger, nests in the field, and shows a high FO at all growth stages and may be considered an alternative species.

Fruiting vegetables. Field-grown fruiting vegetables are largely grown in the southern zone. Fruiting vegetables were represented by tomatoes and melons from 4 studies comprising transects in 94 fields. House sparrow, short-toed lark, crested lark, and corn bunting were focal candidates of small omnivores. House sparrow (bw 27 g, FO = 67%) marginally meets the criteria better than crested lark (bw 39g, FO 99%) and short-toed lark (bw 22 g, FO = 40%). Both lark species nest in field crops, unlike the house sparrow. The crested and short-toed lark may be considered alternative species.

Leafy vegetables. Leafy vegetables are represented by brassicas and lettuce in both the southern and central zones, with 3 and 2 studies comprising transects in 95 fields and 43 fields, respectively. No focal species of herbivores were present in the southern zone or granivores in the central zone. Marginal separation of wagtails were seen as focal species in both zones. Many of these counts were conducted outside the breeding season, and when this was taken into account through FO_{survey} values the yellow and white wagtails could be defined best as focal species during and outside the breeding season, respectively, in both zones. Five small passerines were candidate omnivorous focal species in the southern zone. Of these, house sparrow (27 g, FO = 50%) and crested lark (39g, FO = 100%) best fitted the focal species criteria. Crested lark may be considered marginally the focal species, with an FO 2× that of the house sparrow and nesting in fields, unlike the house sparrow, which nests in buildings. House sparrow may be considered an alternative species.

Table 3. Focal species for risk assessment in Arable Crops in Europe (EFSA Crop Categories 2009) and alternatives (species names in italics) where species provide similar protection levels or relate to differences in distributions and BBCH stage[a]

Crop type	Guild	Southern zone focal species	Central zone focal species
Bare soil	Herbivore	None identified	None identified
Bare soil	Granivore	None identified	None identified
Bare soil	Insectivore	Yellow wagtail	*Yellow wagtail*
Bare soil	Omnivore	Carrion crow *Crested lark*	Skylark
Bulb & onion-like	Herbivore	None identified	None identified
Bulb & onion-like	Granivore	None identified	None identified
Bulb & onion-like	Insectivore	Yellow wagtail	White wagtail *Yellow wagtail*
Bulb & onion-like	Omnivore	Short-toed lark *Crested lark*	Skylark
Cereals	Herbivore	None identified	None identified
Cereals	Granivore	None identified	None identified
Cereals	Insectivore	Yellow wagtail *Fan-tailed warbler*	Yellow wagtail
Cereals	Omnivore	Skylark *Corn bunting*	Skylark
Cotton	Herbivore	None identified	NA
Cotton	Granivore	Linnet	NA
Cotton	Insectivore	Yellow wagtail	NA
Cotton	Omnivore	House sparrow *Crested lark*	NA
Fruiting vegetables	Herbivore	None identified	No data collected
Fruiting vegetables	Granivore	Serin	No data collected
Fruiting vegetables	Insectivore	Yellow wagtail	No data collected
Fruiting vegetables	Omnivore	House sparrow *Crested lark* *Short-toed lark*	No data collected
Leafy vegetables	Herbivore	None identified	Woodpigeon
Leafy vegetables	Granivore	Serin	None identified
Leafy vegetables	Insectivore	Yellow wagtail *White wagtail*	Yellow wagtail *White wagtail*
Leafy vegetables	Omnivore	Crested lark *House sparrow*	Skylark
Legume forage	Herbivore	No data collected	None identified
Legume forage	Granivore	No data collected	Linnet
Legume forage	Insectivore	No data collected	Lapwing
Legume forage	Omnivore	No data collected	Skylark
Maize	Herbivore	None identified	No data collected
Maize	Granivore	Woodpigeon	No data collected

(*Continued*)

Table 3. (*Continued*)

Crop type	Guild	Southern zone focal species	Central zone focal species
Maize	Insectivore	Starling	No data collected
Maize	Omnivore	House sparrow	*Skylark*
		Crested lark	
Oilseed rape	Herbivore	None identified - limited growth stages	None identified *Woodpigeon*
Oilseed rape	Granivore	None identified - limited growth stages	None identified *Linnet*
Oilseed rape	Insectivore	Yellow wagtail	Yellow wagtail
Oilseed rape	Omnivore	None identified - limited growth stages	Skylark
Potatoes	Herbivore	No data collected	None identified
Potatoes	Granivore	No data collected	None identified
Potatoes	Insectivore	No data collected	Yellow wagtail
Potatoes	Omnivore	No data collected	Skylark
Pulses	Herbivore	No data collected	Woodpigeon
Pulses	Granivore	No data collected	None identified
Pulses	Insectivore	No data collected	Dunnock *Yellow wagtail*
Pulses	Omnivore	No data collected	Skylark
Root & stem vegetables	Herbivore	No data collected	None identified
Root & stem vegetables	Granivore	No data collected	None identified
Root & stem vegetables	Insectivore	No data collected	Yellow wagtail
Root & stem vegetables	Omnivore	No data collected	Skylark
Strawberries	Herbivore	No data collected	Woodpigeon
Strawberries	Granivore	No data collected	Linnet
Strawberries	Insectivore	No data collected	Yellow wagtail
Strawberries	Omnivore	No data collected	Skylark
Sugar beet	Herbivore	None identified	None identified
Sugar beet	Granivore	None identified	None identified *Linnet*
Sugar beet	Insectivore	Yellow wagtail	Yellow wagtail
Sugar beet	Omnivore	None identified	Skylark

None identified = No species within guild qualified as a focal species.
No data collected = No study conducted yet.
NA = Not applicable as the crop is not grown commercially in zone.
[a]The appropriate use of alternative species are described in text for each crop type.

Legume forage. A single study in alfalfa comprising transects from 21 fields was conducted in the central zone during the winter.

Maize. Only a single study in the southern zone using the transect methodology was available comprising transects from 20 fields. This study provided 2 focal species candidates, the house sparrow (bw 27 g, FO = 50%) and crested lark (bw 39g, FO = 95%). House sparrow, while meeting the focal species criteria marginally better, does not nest in fields as the crested lark does. These data are supported by 2 additional studies conducted using a “point count” methodology described in

Table 4. Focal species in tree crops (EFSA Crop Categories 2009) and alternatives (species names in italics) where species provide similar protection levels or relate to differences in distributions of BBCH stage[a]

Crop type	Guild	Southern zone focal species	Central zone focal species
Pome fruit	Herbivore	Woodpigeon	Woodpigeon
Pome fruit	Granivore	Serin	Serin
Pome fruit	Insectivore	Blackbird (ground)	Blackbird (ground) Great tit (canopy)
Pome fruit	Omnivore	Chaffinch *Greenfinch*	Chaffinch
Stone fruit	Herbivore	Woodpigeon	NA
Stone fruit	Granivore	Serin	NA
Stone fruit	Insectivore	Blackbird (ground)	NA
Stone fruit	Omnivore	Tree sparrow	NA
Citrus	Herbivore	None identified	NA
Citrus	Granivore	Serin	NA
Citrus	Insectivore	Blackbird (ground) Sardinian warbler (canopy)	NA
Citrus	Omnivore	Greenfinch	NA
Olives	Herbivore	None identified	NA
Olives	Granivore	Serin	NA
Olives	Insectivore	Great tit (canopy)	NA
Olives	Omnivore	Chaffinch	NA
Vineyards	Herbivore	None identified	None identified
Vineyards	Granivore	Serin	Linnet
Vineyards	Insectivore	Blackbird (ground)	Blackbird (ground)
		Great tit (canopy)	Great tit (canopy)
Vineyards	Omnivore	Crested lark *House sparrow*	Woodlark

[a]The appropriate use of alternative species are described in text for each crop type.
None identified = No species within guild qualified as a focal species.
NA = Not applicable as the crop is not grown commercially in zone.

EFSA (2009) as appropriate for fields with little or no crop cover, which is the case in maize up to BBCH 16. Using the same criteria, the southern zone point counts confirm house sparrow and crested lark as candidates but in addition identify wood pigeon (in this case defined as a granivore through observation) and starling (*Sturnus vulgaris*) (insectivore). Point counts in a single central zone study identified only the skylark as the focal species (omnivore).

Oilseed rape. Oilseed rape is largely grown in the central zone. Studies reflect this, with 4 studies in the central zone comprising transects from 102 fields and a single study in the southern zone comprising transects in 20 fields. No focal species candidates for herbivores and granivores were found in the central zone, although the linnet came close to meeting the criteria (bw 15 g, FO = 18%). Yellow wagtail (bw 18 g, FO = 59%) is a focal species for the insectivorous guild in both southern and central zones. The only other candidate, the meadow pipit (bw 18 g, FO = 39%) does not nest in the southern zone. No focal species candidates for omnivores were found in the southern zone, but this may be explained by the narrow growth stage range monitored (BBCH 61–65) which was reflected in one of the central zone studies (BBCH 57–65) also. Crocker and Irvine (1999) reported wood pigeons and cardueline finches in oilseed rape in the United Kingdom (central zone) as focal species candidates. Wood pigeon may be considered a focal species of herbivore during the autumn through to spring (early growth stages) and linnet as a granivore during the summer (late growth stages).

Potatoes. Three studies were conducted in potato in the central zone comprising transects in 76 fields. Yellow wagtail (bw 18 g, FO = 74%) and skylark (bw 37 g, FO = 66%) were the only candidates.

Pulses. Two studies were conducted in pulses in the central zone comprising transects from 42 fields. Only single candidates were found for focal species of herbivore (wood pigeon), insectivore (dunnock, *Prunella modularis*) and omnivore (skylark). The absence of yellow wagtail is surprising (Mason and McDonald, 2000) with the high FO in similar arable crops in these studies. Yellow wagtails also avoid trees and hedgerows (Arisz 2007), unlike dunnocks, and this is likely to explain underrepresentation in the small fields studied in northwest France. Consequently, the yellow wagtail may be considered an alternative focal species.

Root and stem vegetables. A single study was conducted in the central zone comprising transects in 22 fields. Yellow wagtail and skylark were the only relevant focal species candidates.

Strawberries. A single study was conducted in the central zone comprising transects from 20 fields. Focal species were wood pigeon, linnet, yellow wagtail, and skylark.

Sugar beet. Single studies were conducted in the southern and central zones represented by transects in 20 fields in both zones. Yellow wagtail and skylark were the only small focal species candidates in the central zone and yellow wagtail in the southern. Linnet, reported by Crocker and Irving (1999), qualified as a focal species candidates of granivore in sugar beet during the summer and autumn, representing late growth stages, and may be considered focal species.

Focal Species in Tree Crops (Orchards and Vineyards)

Tree crops have been treated separately from arable crops because of their permanent structure and general lack of cultivation. Orchards have been further divided into pome fruit, stone fruit, citrus, and olives for much the same reasons, together with tree density, tree height, leaf and ground cover.

Pome fruit (apples and pears). Five studies were conducted in the central zone comprising transects in 151 orchards and 4 studies in the southern zone comprising 79 orchards. Focal species in pome fruit were similar in both southern and central zones, with the exception of the great tit (*Parus major*) (bw 19 g, FO = 11%). However, marginal separation was seen of focal species candidates for omnivores in southern orchards with chaffinch, *Fringilla coelebs* (bw 21 g, FO = 35), house sparrow (bw 27 g, FO = 37%), and greenfinch, *Carduelis chloris*, (bw 28 g, FO 61%). Greenfinch may be considered an alternative focal species to chaffinch.

Stone fruit (peaches and nectarines). Stone fruits are largely a southern zone crop, and 5 studies have been conducted comprising transects in 90 orchards. Focal species were similar to those in pome fruit, with wood pigeon, serin, *Serinus serinus*, and blackbird, *Turdus merula*. No focal species candidates were found for insectivore other than blackbird (FO = 73%). The Sardinian warbler (*Sylvia melanocephala*), (bw 11 g, FO = 12%), a canopy species, did not meet the criteria. Five candidates of small omnivore were tree sparrow (*Passer montanus*) (bw 22 g, FO = 40%), house sparrow (bw 27 g, FO = 40%), greenfinch (bw 28 g, FO = 50%), cirl bunting, *Emberiza cirlus*, (bw 23 g, FO = 23%), and crested lark (bw 39g, FO = 25%). Tree sparrow met the criteria best.

Citrus (orange, lemon, and lime). Citrus is a southern zone crop, and data comprised 4 studies with transects in 82 orchards. No candidates were found for herbivores. Five candidates were found for insectivores, Sardinian warbler, blackcap, *Sylvia atricapilla*, robin, *Erithacus rubecula*, great tit, and blackbird. The Sardinian warbler (bw 11 g, FO = 72%) best met the focal species criteria for a canopy foraging species, and blackbird (bw 113 g, FO = 96%) may be considered an optional ground-foraging insectivore. Of omnivores, 3 small candidates were found: greenfinch (bw 28 g, FO = 60%), house sparrow (bw 27g, FO = 44%), and crested lark (bw 39 g, FO = 22%). Greenfinch best met the focal species criteria, nesting in the trees, unlike the house sparrow (Cramp 1998).

Olives. Olives are another southern zone crop, and data comprised 2 studies with transects in 43 orchards. No focal species candidates were found for herbivores, and 3, 5 and 7 candidates of granivore, insectivore, and omnivore, respectively. Several species such as robin (bw 18 g, FO = 83%) and blackcap (bw 16 g, FO = 69%) were present in the autumn only as winter visitors or on migration. For insectivores, the great tit (bw 19 g, FO = 74%) and for omnivores the chaffinch (bw 21 g, FO = 69%) were best fit for resident species.

Vineyards. Ten studies are available, 8 in the southern zone comprising transects in 132 vineyards and 2 in the central zone comprising transects in 52 vineyards. No focal species candidates were found for herbivores. The differential exposure of birds following ground and vine (foliar) targeted sprays and the approach taken in EFSA (2009) provides justification to consider both ground and canopy foraging focal species, where candidates exist. Despite high diversity of insectivores in the southern zone, only the blackbird (ground foraging) qualified. In the central zone, both great tit (foliar) and blackbird (ground) qualified as focal species. Diversity of omnivores was also high, with 5 candidates in the southern zone, tree sparrow (bw 22 g, FO = 26%) and house sparrow (bw 27 g, FO = 28%), greenfinch (bw 28 g, FO = 22%), black-headed bunting, *Emberiza melanocephala*, (Greece only) (bw 30 g, FO = 25%) and crested lark (bw 39 g, FO = 54%). The crested lark and house sparrow meet the criteria best but marginal separation was seen. The crested lark may nest in vineyards, unlike the house sparrow, which prefers buildings, so the crested lark may be considered the focal species and the house sparrow an alternative. In the central zone, 2 omnivorous candidates were found, the woodlark (bw 26.9g, FO 67.5%) and cirl bunting (bw 23.1g, FO = 21%). The woodlark best fitted the criteria as a focal species. Diversity in vineyard structure (height and ground cover) may have influenced the focal species diversity (e.g., Schaub et al. 2010).

DISCUSSION

Criteria and thresholds used to identify focal species are closely aligned to the parameters that drive exposure estimates in risk assessment and as such focal species for each crop and zone should be protective of others in risk assessment. The inclusion of alternative species where there is additional uncertainty regarding the size of the database for a single crop type, distributions, crop stage, timing of pesticide use, and marginal separation between competing species gives further confidence in this protection. These points are discussed further in the following sections.

The selection of focal species is complicated by geographical distributions that may have an influence on the correct choice; therefore consideration of focal species by the zonal approach makes some sense. However, factors driving bird distributions are complex and independent of political boundaries or the recently implemented work-sharing zones for harmonization of the registration process in the EU (European Commission 2009). The zonal approach has been established for regulatory purposes but has limitations regarding bird distributions.

Despite the large number of studies, some crop types were represented by few studies (small database), increasing the uncertainty about focal species. This potential source of uncertainty and the representativeness of focal species may be reduced by looking at the distribution of focal species candidates across Europe in the European Bird Atlas (Hagemeijer and Blair 1997) and Birds of the Western Palearctic (Cramp 1998). Many focal species candidates have widespread distributions, 15 species have a distribution covering all agricultural regions of Europe (northern, central, and southern zones). Three species, corn bunting, serin, and tree sparrow, are restricted to the central and southern zones, whereas another 4 species, Sardinian and fan-tailed warbler and crested and short-toed lark, are essentially restricted to the southern zone.

In general, most foliar applications of pesticide occur in the spring and summer before harvest, which aligns with the peak breeding seasons for most birds. Some vegetable crops, especially in the southern zone, are grown throughout the year and often outside of the breeding season. To take account of this, we have identified a resident species, the white wagtail, as a 2nd focal species, where the initial focal species was a summer visitor, the yellow wagtail. This was possible through the analysis of focal species candidates during different survey periods and from published breeding status in Cramp (1998).

All studies summarized in this paper relate to spray applications to crops, including bare soil and early post emergence. No seed treatment uses were included, because these may influence the focal species. This may be addressed in future studies. For systemic pesticides, which are used as seed treatments and can be expected in young shoots of plants, focal species of herbivores at early growth stages may be used.

Crop structure, obviously different between arable and plantation (vines and top fruit) crops, is one of the most influential factors determining the focal species and therefore a source of uncertainty between crop types and growth stages. Of the 23 focal species identified across all crops, 10 are specific to arable, 8 specific to plantations, and 5 share both (crested lark, linnet, serin, house sparrow, and wood pigeon). Wagtails (insectivores) and larks (omnivores) dominated these guilds in arable crops, represented in 17 of 21 (81%) and 20 of 20 (100%) of all arable crops studied, respectively. The 2 species of wagtail, yellow and white, show different behaviors, with yellow wagtails visiting Europe in summer to breed in open field crops whereas white wagtails are resident in southern and central Europe and generally nest in structures close to buildings. Nesting within crop fields was taken as evidence of potentially higher exposure and hence a reason for recommending yellow wagtail during the breeding season and white wagtail outside the breeding season, where both species were identified as focal species candidates. Larks were represented by 3 species, skylark, crested lark, and short- toed lark, in arable crops. All nest in open field crops; the crested lark is resident, the skylark largely resident in the south and west of its European range and a summer visitor to the northern and eastern distribution of its range. The short-toed lark is a summer visitor to southern Europe only. In addition, the crested lark and woodlark are represented as focal species in vineyards, if the crop structure is relatively open and tree height low for the plantation category.

Within the crop groupings defined under EFSA (2009), specific crops have their characteristic crop structure and growth stage changes (BBCH) that also may impact on usage by different bird species. However, this does not appear to have greatly influenced those focal species identified during the breeding season, with high consistency within arable crops for skylark (100% arable crop types in the central zone), crested lark (66% in the southern zone), and yellow wagtail (81% in the southern and 75% in the central zones). In plantations, serin (100% in plantation crop types in the southern zone), blackbird (80% in the southern zone), and great tit (60% and 100% in the southern and central zones, respectively) are predominant as reoccurring focal species.

As a result of changing crop structure, the attractiveness of crops for farmland birds might change over the season (e.g., Kragten et al. 2008; Kragten 2011). Any influential effects of BBCH growth stage have been identified and discussed, for example, fan-tailed warbler in cereals. In some crops, the effects of BBCH stage have not been tested, such as maize, in which no studies were done beyond BBCH growth stage 16. This was influenced by the fact that most crop protection chemicals are applied early in maize to ensure good crop establishment.

Boundary type may influence focal species. Tall hedgerows and trees deter some ground nesting species such as skylarks and yellow wagtails (Donald 2004; Arisz 2007) and provide essential nest cover for others such as dunnock and blackbird (Cramp 1998). Blackbirds and dunnocks like to forage beneath the crop when nest sites are available in the form of hedgerows. This may explain the results for pulses and oilseed rape, where the dunnock represented the focal species in pulses in northwest France and dunnock and blackbird focal species candidates in oilseed rape in the UK (Crocker and Irving 1999). Where oilseed rape was grown in more open landscapes (France and Germany), the yellow wagtail replaced the dunnock.

The influence of boundary type and adaptation of species to the crop, and how these might influence exposure through PT estimates, are largely managed through the way transects counts were made. By determining focal species from transects running through the middle of the crop, and not from the field boundary, the influence of the boundary is minimized. EFSA (2009) included this guidance on transect methodology on the assumption that species detected from the middle of the crop are more representative of those species likely to have the highest exposure to pesticides. However, it is possible that by using this method some species are underestimated. Species that breed in field boundaries might forage in the field close to their nesting site (Goodwin et al. 2013).

Assigning dietary guilds to focal species candidates is difficult because diet may change with seasonal availability and need. Diets described as relevant during the breeding season were used (Wilson et al. 1996, 1999; Christensen et al. 1996; Cramp 1998; and Holland et al. 2006). Of the 23 focal species identified only a single herbivore (wood pigeon) was counted; 2 granivores (linnet and serin), 11 insectivores, and 9 omnivores. This confirms that there are few species of obligate herbivorous and granivorous birds on farmland. The allocation of herbivorous guild to a wood pigeon was done in most crops, whereas it was described as a granivore in early growth stages of maize. For this reason and other sources of uncertainty, it is worth looking at published sources of focal species in crops. No birds were defined as frugivores, although fruit and berries can make up a significant part of an omnivores diet, typically outside of the breeding season in orchards. Dietary guild is used by EFSA (2009) because diet is influential in setting exposure levels through calorific values, assimilation rates, and residues influencing guild body weights and exposure. The consideration of a range of guilds reduces the risk of missing a "protective" species. In this evaluation, only a single herbivore qualified as a focal species, the wood pigeon, and in some crops no herbivore guild. Most obligate and facultative herbivores are large, for example, geese and wood pigeon, respectively. The FO values of less than 20% have been used in this paper to indicate that birds are not as well adapted to feeding on crops. In the case of herbivores, their energy expenditure is relatively low because of size. For these reasons, where herbivores do not qualify as focal species, focal species from other guilds are considered to be protective for all birds visiting crops to feed.

Small granivores such as linnet are less represented in these studies than has been reported by Crocker and Irving (1999) for the United Kingdom, where linnet was recorded with an FO > 20% in oilseed rape, sugar beet, and set-aside but not cereals. Low FO for small granivores, other than close to harvest for small seeded crops such as oilseed rape, may reflect low weed seed availability on the soil. These same data from Crocker and Irving (1999) confirm wood pigeon as a focal species in OSR, but not cereals or sugar beet. Geese, when foraging in flocks, are known to cause significant damage and may represent herbivores locally in countries with wintering populations and close to coastlines (Jepsen 1991) so can be expected to be underrepresented by Crocker and Irving (1999) and in PPP manufacturers studies described here.

Relatively few publications are available providing focal species in Europe for risk assessment. Crocker et al. (1998, 1999) in the United Kingdom (central zone) have published focal species candidates for oilseed rape, sugar beet, cereals, and pome fruit orchards. Focal species candidates in these studies have much in common with central zone species defined in this publication, with some regional differences resulting from the westerly distribution of the British Isles and boundary features. This is most conspicuous in the insectivorous guild, where dunnock and blackbird feature in place of yellow wagtail in arable crops. In orchards central zone focal species, wood pigeon, great tit, blackbird, and chaffinch were also focal species candidates in the United Kingdom. The only differences were the presence of blue tit and robin as focal species candidates in the United Kingdom but not the rest of central zone studies and the absence of the serin in the United Kingdom, which is outside its range.

Whereas central zone focal species are distributed throughout the northern zone, central zone focal species may be good candidate focal species in the northern zone. On this basis, the following species could be expected to be focal species candidates in arable crops (wood pigeon, linnet, yellow wagtail, white wagtail and skylark) and in orchards (wood pigeon, linnet, blackbird and great tit). Focal species guidance is in preparation by northern zone MS, and focal species will be based on a mixture of publications and reports, including Hage et al. (2011), Danish Environmental Protection Agency (2010), Petersen et al. (1995). Focal species must be selected from modern studies, using appropriate census methodologies and risk criteria to ensure they are protective of other species.

CONCLUSIONS

Using the criteria defined above, focal species identified from industry studies had much in common with the EFSA published representative species listed in their table of tier 1 generic focal species. Notable exceptions included the absence from the list developed here of herbivorous and granivorous guilds from some crop types and the absence of some of the smallest representative species. Some focal species repeatedly appeared across a wide range of arable or tree crops, but not both, demonstrating broad adaptation to these 2 different crop structures. Many focal species have widespread distributions, and 15 species have a distribution covering all agricultural regions of Europe (northern, central, and southern zones). Three species, corn bunting, serin, and tree sparrow, are restricted to the central and southern zones, whereas another 4 species, Sardinian and fan-tailed warbler, crested and short-toed lark, are essentially restricted to the southern zone.

The authors consider focal species identified in this publication as suitable for risk assessment in Europe at the zonal level and for further refinement studies, such as radio tracking, in Europe if necessary.

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SUPPLEMENTAL DATA

Supplemental data provided support for the analysis of focal species in all crops identified.

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