

EUFRAM

Concerted action to develop a European Framework for probabilistic risk assessment of the environmental impacts of pesticides¹

Work Package 8

PRELIMINARY PAPER ON CASE STUDIES FOR PROBABILISTIC RISKS ASSESSMENTS²

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2 EXECUTIVE SUMMARY

The objective of this Work Package is to 'survey candidate case studies known or available to members and enrich them by further processing to evaluate the harmonised framework produced by work under objectives 3-7 and provide reference material to act as benchmark examples for dissemination and informing end-users'. Initially, a database of case studies undertaken by or known to EUFRAM partners was compiled to inform the debate over which examples to take forward.

At the first project meeting, it was agreed that case studies will be produced on two levels to inform different parts of the EUFRAM process. First, existing comparisons between deterministic and probabilistic calculations at the first tier of the risk assessment will be collated and enriched where necessary. These comparisons are required to inform the debate in WP3 about where probabilistic approaches should be used in the risk assessment scheme. Secondly, a minimum of two more complex (risk refinement) cases studies will be produced. These may be tiered assessments going through different levels of refinement and will be used to test and demonstrate procedures and recommendations developed within the project. This paper sets out those examples of each kind of case study which may be taken forward for enrichment. A forward plan of action for the enrichment and documentation of case studies is set out which includes two case study meetings to be held in autumn 2003 and spring 2004.

3 INTRODUCTION

Case studies are required in EUFRAM to i) test procedures and recommendations developed within the project; and, ii) provide benchmark examples for dissemination to the scientific and regulatory community. Work package 8 is designed to produce worked examples that are suitable for adoption as peer-reviewed benchmarks from regulatory practice and for use in training for end-users in government and industry.

The aims of WP8 are: i) to survey existing probabilistic studies for their suitability for use in EUFRAM; ii) to select those studies to be used as benchmark examples in EUFRAM; iii) to look into the need for refinement of existing studies; iv) to provide reference material to be used to evaluate procedures developed/recommended by other work packages (in particular WP3 to WP7); and, v) to support and facilitate the example case studies.

4 STUDY REQUIREMENTS FOR CONSIDERATION IN WP8

There has been a breadth of risk assessments based on probabilistic approaches in the last few years. Some of these studies could be used to support the EUFRAM case studies providing they meet a number of criteria which are listed further below. The work programme stipulates that at least two case studies will be developed within EUFRAM, one assessing risks of agricultural pesticides to aquatic organisms and one to terrestrial organisms. One or more case studies will be subdivided into two versions to reflect the diversity of situations with regard to the availability of data to support the risk assessment. The first version will reflect instances where the risk

assessment can be based on a reasonable amount of data (e.g. as in the case of the re-evaluation of existing compounds) whereas the second version will be based on a limited set of data to mimic situations often encountered when undertaking risk assessments for new compounds.

Existing studies that could form the basis for the EUFRAM case studies should meet the following criteria:

1. The data supporting the PRA should be available and no use limitations (e.g. confidentiality issues, undue limitations on publication) should be attached to them;
2. The study should be relevant to the pesticide registration framework in the European Union;
3. Probabilistic aspects should be considered or could be readily developed on both the exposure and effects sides;
4. The case studies should reflect situations where large amounts of supporting data are available, but also those situations more typical of the context of pesticide registration where limited data are available - this could be done either in separate case studies or within a single case study (by removal of data);
5. The case studies should be comprehensive, but remain achievable within the context of the preparation of a regulatory dossier;
6. Where possible, field monitoring data should be available at various levels to provide 'validation' or groundtruthing of the probabilistic assessment;
7. There should be possibilities to support any necessary work from sources external to EUFRAM.

5 REVIEW OF PREVIOUS WORK WHICH COULD SUPPORT EUFRAM CASE STUDIES

Appendix 1 presents information on existing case studies that could form the basis of the EUFRAM case studies. The list of studies was compiled by i) asking members of the WP8 working group to provide information on the studies that they have been involved with or that they know of; ii) reviewing information presented in the EUPRA report; and iii) screening results from literature searches. It should be noted that the list is more or less restricted to those studies that have been undertaken by WP8 members and those which may support EUFRAM case studies. *The intention was not to draw a comprehensive literature review of studies dealing with probabilistic risk assessments for pesticides within an environmental context.*

It is clear from the list that probabilistic approaches which have been undertaken in the past to assess the risk of a pesticide impacting on organisms are diverse and contrast with regard at least to the following aspects:

- Consideration of the uncertainty on the exposure, effects or both sides;
- Use of different probability approaches;
- Use of different methods for uncertainty analysis;
- Use of different ways to express the data;
- Effects: use of different endpoints;
- Effects: use of single or numerous types of organisms;
- Effects: consideration of indirect effects;
- Effects: use of data from microcosms/mesocosms/laboratory streams;

- Exposure: use of a model to simulate pesticide exposure as opposed to the use of monitoring data;
- Exposure: use of a scenario based approach where a small number of scenarios representative of the compound usage are defined;
- Exposure: spatially based approach making use of GIS technologies;

6 PROPOSITIONS OF CASE STUDIES

Case studies will be produced on two levels to inform different parts of the EUFRAM process. First, existing comparisons between deterministic and probabilistic calculations at the first tier of the risk assessment will be collated and enriched where necessary. These comparisons are required to inform the debate in WP3 about where probabilistic approaches should be used in the risk assessment scheme. Secondly, a minimum of two more complex (risk refinement) cases studies will be produced. These may be tiered assessments going through different levels of refinement and will be used to test and demonstrate procedures and recommendations developed within the project.

Good risk assessment relies upon a robust and appropriate problem formulation as set out in USEPA (1998). Each of the case studies will be initiated by a full problem formulation step.

6.1 Comparison between deterministic and probabilistic calculations at the first tier of the risk assessment

Work Package 3 is considering the role and outputs of probabilistic risk assessments. A specific question is whether probabilistic assessments should be used only as a refinement step (following an adverse outcome at a lower tier) or should be applied across the whole risk assessment process. Comparisons between deterministic and probabilistic calculations at the first tier will be collected to inform debate on this issue, including the feasibility of implementing PRA at lower tiers, potential incompatibilities in approach or between tiers, and the robustness of DRA calculations.

The database of existing case studies contains several examples which can be used (see below). Further direct comparisons are expected to arise from the detailed case studies where these adopt a tiered approach to the risk assessment (see Section 6.2). In each example, the risk assessment model(s) applied at the first tier should be retained, though additional information (e.g. distributions on parameter values) may have been included in generating the probabilistic version of the risk assessment. Means to capture and incorporate expert knowledge may be particularly important at lower tiers where data availability may be more limiting. A secondary objective should thus be to demonstrate relevant approaches identified in Work package 4 (methods of uncertainty analysis).

Table 1: Case studies comparing DRA and PRA at the first tier of the risk assessment

No.	Description	Contact
1	PECgw values for atrazine derived for the FOCUS Okehampton scenario using PEARL – comparison between deterministic (FOCUS) calculation and probabilistic (Monte Carlo-based) calculation	Colin Brown, Cranfield Uni
25	Avian risk assessment for blue tits exposed to chlorpyrifos in orchards – comparison of deterministic assessment with a series of Monte Carlo models in which progressively more parameters were replaced with distributions	Andy Hart, CSL
27	Avian risk assessment for geese exposed to a hypothetical pesticide applied to cereals – comparison of deterministic assessment with a series of Monte Carlo models in which progressively more parameters were replaced with distributions	Andy Hart, CSL
33	Spatial analysis of cotton landscape to derive probabilistic distribution of PECsw values arising from drift of a pyrethroid	Mick Hamer, Syngenta
-	PECsw values arising from drift of a hypothetical pesticide to a ditch – comparison of deterministic assessment with Monte Carlo simulations replacing parameters with distributions	Colin Brown, Cranfield Uni

6.2 Case studies demonstrating risk refinement

Detailed case studies are needed to evaluate the assessment framework developed within EUFRAM and subsequently to provide reference material to act as benchmark examples. Risk refinement case studies will be worked examples of the application of probabilistic methods to assessing the environmental impact of pesticides, starting from specification of the type and use of pesticide, modelling the exposure routes and scenarios and the dose-response for relevant non-target aquatic organisms, and ending with estimates of impact suitable for use in regulatory decision-making. The work will be designed to produce worked examples that are suitable for adoption as peer-reviewed benchmarks for regulatory practice and for use in training for end-users in government and industry.

The work programme stipulates that a minimum of two case studies will be developed (one terrestrial and one aquatic). However, a total of nine potential case studies were identified at the first project meeting. These are listed giving brief details of the scope in the table below. All nine potential case studies will be taken forward into the first case study meeting for discussion. The case studies cover a variety of levels of complexity. At least some examples should include evaluation against field data for higher level effects to allow simple ‘validation’ and to inform discussions under Work Package 9 (practical approaches for validation). It is expected that case studies will apply a range of methods relevant to PRA, but it was agreed at the first project meeting that detailed evaluation of methods cannot be undertaken within Work Package 8.

Table 2: Overview of case studies demonstrating risk refinement

No. and short name	Description	Co-ordinator	Contributors
1. Carbaryl - aquatic	Currently a hierarchical analysis of effects of carbaryl on aquatic invertebrates based on intrinsic toxicity and ecological requirements of different species. Exposure component would need to be added.	Dieter Schaefer	Bayer, Fraunhofer
2. Atrazine - aquatic	Tiered exposure and effects assessment from Jeff Giddings for the US. European exposure component would need to be added.	Mick Hamer	Syngenta, Cranfield, Guelph
3. Chlorpyrifos - avian	Exposure and effects for chlorpyrifos / blue tits for CEFIC-LRI. Fully developed, but no potential to modify for EUFRAM	Joanna Jaworska	Mainly undertaken by Cadmus
4. Avian population level assessment	Compare direct exposure (blue tit – combine CSL & RIVM data) with indirect exposure via a secondary poisoning model (water→fish→fish-eating bird or mammal or soil→worm→worm-eating bird of mammal); population information for great crested grebe/otter or blackbird/badger from WEBFRAM organisations?	Robert Luttkik	RIVM, CSL
5. WEBRAM - aquatic	Effects of chlorpyrifos on aquatic invertebrates. Modular case study under development. Exposure based on post-processing for FOCUS models. Effects assessment will include SSD's (incl. indigenous/non-indigenous), ecotoxicity of pulsed exposures and population level assessment. Case study will include comparison against mesocosm data and field effects monitoring.	Colin Brown	Cranfield, Alterra, UFZ, other members of WEBFRAM 2, INIA
6. WEBFRAM – avian/ mammalian	Acute risk for birds and mammals exposed to sprays in cereals, leafy crops and orchards. Chemical(s) to be decided.	Andy Hart	CSL, other members of WEBFRAM 3
7. WEBFRAM -NTA	Case study contracted for WEBFRAM – no details at present.	Kevin Brown	CSL, Ecotox, other members of WEBRAM 4
8. Insecticide	Example of a regulatory assessment for the aquatic environment	Hector Galicia	Springborn
9. Med. assessment	Exposure and effects assessment for an insecticide based on Mediterranean scenarios. Considers both aquatic and terrestrial compartments. Includes Monte Carlo modelling for exposure via runoff and erosion and assessment of effects based on SSD.	Jose Tarazona/Vicky Pablos	INIA

7 RELATED WORK

Two groups are preparing case studies which may have relevance to WP8. The first is a series of projects funded by the UK DEFRA to model effects of pesticides on non-target pesticides. The cluster of projects is known as WEBFRAM and the contact is Helen Thompson (h.thompson@csl.gov.uk). Case studies are contracted to be delivered over the next 12 to 36 months for aquatic organisms, terrestrial vertebrates (short and long-term effects), and above- and below-ground terrestrial invertebrates. The projects will not only consider probabilistic approaches, but there will be significant benefit in close collaboration. Three projects are identified in Section 6.2 as developing case studies which can be fed into EUFRAM.

Secondly, the FOCUS work group on landscape and mitigation factors in ecological risk assessment for pesticides will be working with a number of example scenarios in preparing a report in early 2004. The emphasis will be on showing how to incorporate landscape-level information into risk assessments, but this may be within a probabilistic framework. The contact is Colin Brown (c.brown@cranfield.ac.uk).

8 REFINEMENT OF CASE STUDIES

It is expected that most of the case studies will need enriching by further processing, for example to include aspects not previously considered or to demonstrate specific methods and/or tools being considered for the framework in Work Packages 3-7 and 10. Work Package 8 strongly relies on collaboration with these other working groups as the case studies will be used to demonstrate approaches developed or recommended therein. A forward plan for developing the case studies will be produced as a stepwise process commencing from the delivery of preliminary papers on the other WP's at the end of June 2003. Two separate case study meetings will be convened to facilitate consistent development of each study and to allow detailed discussion of issues arising.

Table 3: Forward plan for development of the case studies

Development point	Date
Collation of information from other WP's including activities to be built into the case studies, required outputs and any constraints on developing the case studies	15 July 2003
Preparation of preliminary paper for each case study including: (1) problem formulation and conceptual model; (2) summary of any existing DRA; (3) summary of any existing PRA; (4) collate data to be used in further development of the case study; (5) plan of forward actions. Preliminary papers to be sent to Mark Clook for distribution to WP3 partners	31 August
Case study meeting 1, Silsoe, UK	14-15 October 2003
Data pooling and enrichment of case studies by further processing to facilitate common interpretation of facts regarding the approaches under consideration and produce draft report sections describing the results and preliminary conclusions.	October 2003 – March 2004
Case study meeting 2, Silsoe, UK	9-11 March 2004
Integration and finalisation of report sections on the selected case studies. Submission of peer-reviewed papers as appropriate.	30 April 2004

A task for WP3 is to determine what 'decision-takers', 'policy-makers', 'stakeholder representatives' and 'scientific advisers' want as output from PRA. It was agreed at project meeting 1 that in order to try and progress this issue it would be best to present relevant people with case studies. Prior to the first case study meeting, WP8 will provide WP3 Partners with partially completed case studies as well as relevant information on problem formulation so that they can elicit feedback from relevant people. Responses will be considered and incorporated into subsequent case studies by WP8 and will be discussed at the second case study meeting.

9 ACKNOWLEDGEMENTS

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10 REFERENCES

USEPA (1998). Guidelines for ecological risk assessment. Washington DC: US Environmental Protection Agency.

References to case studies within the database are provided in full in Appendix A.

11 APPENDIX A: DATABASE OF EXISTING CASE STUDIES

- Sheet 1: Generalities + information on exposure and effects assessments (studies #1 to #19)
- Sheet 2: Generalities + information on exposure and effects assessments (studies #20 to #34)
- Sheet 3: Generalities + information on exposure and effects assessments (studies #35 to #51)
- Sheet 4: Funding, availability and suitability to support a case study within EUFRAM (studies #1 to #19)
- Sheet 5: Funding, availability and suitability to support a case study within EUFRAM (studies #20 to #34)
- Sheet 6: Funding, availability and suitability to support a case study within EUFRAM (studies #35 to #51)

	Generalities						Exposure assessment				Effects assessment			
Data provided by:	ID #	Brief title	Probabilistic component (exposure/effects/both)	Description of probabilistic approach	Compartment considered (terrestrial/aquatic)	Compound(s) considered	Route(s) of exposure considered	Exposure assessment (Modelling? Experimental data?)	Probabilistic approach(es) for exposure	Organism(s) considered	Assessment of effects (lab tests, microcosms, literature data)	Probabilistic approach(es) for effects	Endpoint(s) considered and number of datapoints	
Igor Dubus	#1	Comparison of Monte Carlo and scenario-based approaches for assessing the risk of atrazine leaching to groundwater resources	Exposure only (exposure compared to a limit concentration of 0.1 microg/l in groundwater)	Comparison of Monte Carlo modelling (PEARL model, one FOCUS scenario) and scenario-based modelling (MACRO modelling for multiple scenarios)	Terrestrial (leaching to groundwater)	Atrazine	standard application to an agricultural field + leaching through soil	Modelling only	Monte Carlo + scenario-based modelling	n/a	n/a	n/a	n/a	
Igor Dubus	#2	First-step assessment of the uncertainty associated with MACRO modelling	Exposure only	Monte Carlo modelling with the MACRO model for a large number of input parameters	Terrestrial (leaching to groundwater)	2 theoretical pesticides	standard application to an agricultural field + leaching through soil	Modelling only	Monte Carlo (for 4 leaching scenarios)	n/a	n/a	n/a	n/a	
Pamela Byrne	#3	PRA for a fungicide using SSDs - Aquatic Ecosystem	Effects	Species Sensitivity Distributions for all aquatic groups	Aquatic (Surface Water)	Fungicide	Standard application to an agricultural field + spray drift	n/a	n/a	Fish - 5 species; Inverts - 19 species;	Acute lab tests; mesocosm study; sediment toxicity (spiked water & spiked sediment)	SSDs	Fish LC50s - 5; Inverts EC50 - 19; EAC - mesocosm	
Pamela Byrne	#4	Assessing the probability of the 0.1g/l groundwater threshold level being breached following application of a seed dressing in a major region of use	Exposure only (assessment against 0.1g/l level)	Scenario based probabilistic framework, integrating distribution of representative soil classes and the presence of aquifers with regard to regional land areas accounted for by target crop.	Terrestrial (leaching to groundwater)	Seed dressing	standard application to an agricultural field + leaching through soil	n/a	n/a	n/a	n/a	n/a	n/a	
Igor Dubus	#5	DEFRA research project PN0932: Addressing interspecific variation in sensitivity and the potential to reduce this in ecotoxicological risk assessments	Effects only	Species sensitivity distributions			n/a	n/a	n/a					
Igor Dubus	#6	DEFRA research project PN0933: UK case study on probabilistic risk assessment for aquatic organisms	Exposure and effects	Monte Carlo for exposure, SSD for effects	Aquatic (Surface Water)	Chlorpyrifos	Spray drift	Rautmann et al. data + monitoring data	Percentiles from Rautmann et al.	Fish and invertebrates	literature data	SSD	LC/EC50 110 in total	
Igor Dubus	#7	DEFRA research project PN0933: UK case study on probabilistic risk assessment for aquatic organisms	Exposure and effects	Monte Carlo for exposure and for effects	Aquatic (Surface Water)	Atrazine	Spray drift + drainflow	Rautmann et al. data + MACRO modelling	Monte Carlo for drainflow	Amphibians	literature data	Monte Carlo for a population model		
Robert Luttk	#8	A probabilistic model for deriving soil quality criteria based on secondary poisoning of top predators. I. Model description and uncertainty analysis	Exposure and effects (toxicity)	Monte Carlo modelling with a large number of input parameters (assimilation efficiency of food, metabolic rate, caloric content of food, species sensitivity, bioaccumulation factors)	Terrestrial compartment (soil to food for avian and mammalian raptors)	DDT and Cadmium	Concentrations in soil - transfer through the food chain and intake by top predators	Modelling with experimental data, like BCFs and BAFs	Monte Carlo	sparrow hawk, kestrel, barn owl, little owl, badger, and weasel	Literature data	Yes, a.o. 5th percentile	NOEC data on lethality, growth and reproduction	
Robert Luttk	#9	A probabilistic model for deriving soil quality criteria based on secondary poisoning of top predators. II. Calculations for dichlorodiphenyltrichloroethane (DDT) and cadmium.	See #8	See #8	See #8	See #8	See #8	See #8	See #8	See #8	See #8	See #8	See #8	
Robert Luttk	#10	Modelling the influence of temporal and spatial factors on the assessment of impacts of pesticides on skylarks	Exposure and effects (toxicity)	Agent-Based Model with probabilities that certain pesticides will be used and certain conditions will occur	Agricultural compartment ((landuse, farmer behaviour and skylarks	several pesticides (eg dicamba, MCPA, clopyralid, etc)	Food	Modelling only	events are all probabilistic	skylark	Literature data	n/a	lethality LC50 or LD50	
Dieter Schaefer	#11	Higher-tiered aquatic risk assessment for Deltamethrin	Exposure and effects	Risk curves (joint probability curves, combination of exposure and effect distributions) to quantify the risk to aquatic organisms	Aquatic	Deltamethrin	spray drift (only relevant entry route)	Ganzelmeier drift data	Monte Carlo	aquatic invertebrates	lab studies (incl. literature data), microcosm	SSD	acute EC50 in lab studies (28 species), LOEC in microcosm (28 species)	
Dieter Schaefer	#12	Higher-tiered aquatic risk assessment for Endosulfan in cotton	Exposure and effects	Geographical analysis of aquatic exposure (in combination with PRZM run-off modelling), deterministic risk assessment based on most sensitive species	Aquatic	Endosulfan	spray drift, run-off	Ganzelmeier drift data, run-off modelling	scenario-based modelling for run-off	fish, aquatic invertebrates	lab studies (incl. literature data)	SSD	acute L(E)C50 in lab studies (19 fish species, 13 invertebrate species)	
Dieter Schaefer	#13	Spatially distributed modelling for drainage risk assessment of sulfonylurea herbicides in the UK	Exposure (and effects)	MACRO drainflow modelling for multiple scenarios, calculation of ditch concentrations and semi-probabilistic risk evaluation	Aquatic	several sulfonylurea herbicides	drainflow	Modelling only	scenario-based modelling	aquatic plants	lab studies (with and without recovery)	n/a	chronic EC50	
Dieter Schaefer	#14	Risk to terrestrial non-target plants from Isoxaflutole spray drift exposure	Exposure and effects	Risk curves (joint probability curves, combination of exposure and effect distributions) to quantify the risk to neighboring crops and plants	Terrestrial	Isoxaflutole	Spray Drift	Experimental (SDTF)	Monte Carlo	Terrestrial Non Target Plants & Crops	lab studies	SSD using Bayesian Hierarchical Approach	EC25/EC50	
Dieter Schaefer	#15	Risk to terrestrial non-target plants from Isoxaflutole runoff exposure	Exposure and effects	Risk curves (joint probability curves, combination of exposure and effect distributions) to quantify the risk to neighboring crops and plants	Terrestrial	Isoxaflutole	Runoff	Modelling	Multiple scenario	Terrestrial Non Target Plants & Crops	lab studies	SSD using Bayesian Hierarchical Approach	EC25/EC50	
Dieter Schaefer	#16	Risk to terrestrial non-target crops from isoxaflutole through irrigation water	Exposure and effects	Risk curves (joint probability curves, combination of exposure and effect distributions) to quantify the risk to neighboring crops and plants	Terrestrial	Isoxaflutole	Irrigation	Modelling and monitoring	Monte Carlo / Distributions Integration	Terrestrial Non Target Crops	lab studies	SSD using Bayesian Hierarchical Approach	EC25	
Hector Galicia	#17	Ecological risk assessment decision-support system (ERADSS)	Exposure and effects	Log-normal distribution with respect to concentration. Probability of exceeding a EEC % was calculated	Sediment-Water	1,1,1-trichloroethane	diffuse-source	Modelling and Experimental data	Cumulative frequency distribution	aquatic/sediment	Lab tests	n/a	Acute and chronic toxicity; 6	
Hector Galicia	#18	PRA of a model incorporating actual exposure data for Chlorpyrifos to estimate population-based exposures	Exposure	Monte Carlo of the Aggregate Exposure Model	Integrated exposure to adults and children relevant to FQPA (August 1996)	Chlorpyrifos	inhalation, absorption dermal, and ingestion	Experimental	Monte Carlo of a proposed model	mammals	Lab tests	n/a	n/a	
Matthias Liess	#19	Modelling the sum of adverse effects of agriculture; linking with invertebrates	Both	GIS based modelling of exposure compared with governmental field monitoring	aquatic	n/a	surface runoff	Experimental data + modelling	Probabilistic and scenario based modelling	aquatic invertebrates	field monitoring	using rts (relative taxa sensitivity), similar to ssd	abundance	

		Generalities				Exposure assessment				Effects assessment			
Matthias Liess	#20	Linking exposure of insecticides with effects on aquatic invertebrates in one stream	Both	Event controlled sampling of pesticides. Linking exposure to invertebrates in the stream and in a bypass experimental stream. Study duration one year, recovery investigated (and present)	aquatic	Approx. 10 insecticides	application to an agricultural field + surface runoff	Experimental data	no	aquatic invertebrates	field monitoring + microcosm	results can be investigated using ssd and rts (relative taxa sensitivity)	survival, emergence several data point throughout the year
Matthias Liess	#21	Linking exposure of insecticides with effects on aquatic invertebrates in around 20 streams	Both	Event controlled sampling of pesticides. Linking exposure to invertebrates in the streams. Study duration one to three years, recovery investigated (and present)	aquatic	Approx. 20 pesticides	surface runoff	Experimental data	no	aquatic invertebrates	field monitoring	using rts (relative taxa sensitivity), similar to ssd	abundance
Matthias Liess	#22	Modelling of pesticide contamination in agricultural stream - surface water runoff	Exposure only	Event controlled sampling of pesticides is compared with GIS based modelling of exposure	aquatic	Approx. 20 pesticides	surface runoff	Experimental data + modelling	Probabilistic and scenario based modelling	n/a	n/a	n/a	n/a
Kevin Brown	#23	Field and lab evaluation of terrestrial effects	Effects	Comparison of population level effects in large scale field study for range of species and range of rates with results of lab rate response tests with non-target arthropods	terrestrial	pyrethroid insecticide	standard application to an agricultural field	Experimental data	Not yet applied but could be.	terrestrial epigeal fauna at the species level	lab effects for selected species and field effects for 20 or 30 species	not yet applied	n/a
Andy Hart	#24	ECOFRAM Terrestrial Report, Appendix C10	Both	Comparison of deterministic assessment with a series of Monte Carlo models in which progressively more parameters were replaced with distributions.	Terrestrial (blue tits in orchards)	Chlorpyrifos	Dietary	Modelling and measured residues on insects	Monte Carlo	Blue tit	lab tests	Monte Carlo treatment of between species variation in LD50 and slope of probit	Acute lethality. Model run with LD50s from 1, 2 and 17 species. Model output is distributions for % mortality
Andy Hart	#25	CSL blue tits in orchards example	Both	Comparison of deterministic assessment with a series of Monte Carlo models in which progressively more parameters were replaced with distributions. Improved methods and more detailed description than Ecofram example.	Terrestrial (blue tits in orchards)	Chlorpyrifos	Dietary	Modelling and measured residues on insects	Monte Carlo	Blue tit	lab tests	Monte Carlo treatment of between species variation in LD50 and slope of probit	Acute lethality. Model run with LD50s from 1, 2 and 17 species. Model output is distributions for % mortality
Andy Hart	#26	Cadmus blue tits in orchards example	Both	Comparison of 1D and 2D Monte Carlo, interval analysis and P-bounds models. Restricted to exposure but included drinking water as well as dietary route.	Terrestrial (blue tits in orchards)	Chlorpyrifos	Dietary and drinking water	Modelling and measured residues on insects	1D and 2D Monte Carlo, interval analysis and P-bounds	Blue tit	n/a	n/a	n/a
Andy Hart	#27	UK geese on cereals example	Both, but only exposure was probabilistic	Comparison of deterministic assessment with a series of Monte Carlo models in which progressively more parameters were replaced with distributions. Based on deterministic worked example in Appendix of EU guidance doc on risk assessment for birds and mammals. Aim was to produce a probabilistic assessment closer to current EU regulatory approach (e.g. using TER as output).	Terrestrial (geese in cereals)	Hypothetical	Dietary	Modelling with fictional data	Monte Carlo, including 1D and 2D	Geese	fictional lab data	Deterministic - distribution of TERs obtained by combining distribution for exposure with fixed LD50.	Acute lethality. Model output is distribution of TERs, or percentiles of TER distribution with confidence limits (2D MC)
Andy Hart	#28	WEBFRAM 3 acute avian/mammalian risk scenarios	Both	UNDER DEVELOPMENT. First of several scenarios to be developed and web-enabled for UK PSD. First prototype should be operational but not web-enabled by first EUFRAM case study meeting.	Terrestrial (acute risks for birds and mammals exposed to sprays in cereals, leafy crops and orchards)	to be decided (TBD)	Dietary	TBD	TBD	Birds and mammals (indicator species, to be confirmed)	LD50s	TBD	Acute lethality. Output to include both TER and % mortality outputs, presented together.
Andy Hart	#29	CSL secondary poisoning model	Both	UNDER DEVELOPMENT. Detailed simulation model of secondary poisoning of barn owls feeding on rodents contaminated with rodenticide. Intended as a research study (to explore sources of uncertainty) rather than a tool for regulatory assessment. Programmed in Visual Basic.	Terrestrial	Bromadiolone	Dietary	modelling	multi-dimensional Monte Carlo	Barn owl	acute and repeated dose LD50s, plus various special studies	Monte Carlo treatment of between species variation in LD50 and slope of probit, and also uncertainty	Acute and short-term lethality, output is %mortality
Andy Hart	#30	Pellston aquatic fate case study	Aquatic fate only	Workshop group study. 1) considered feasibility and approaches for applying probabilistic methods to PRZM/EXAMS, 2) demonstration of Bayesian updating in a simplified fate model.	Aquatic fate only	DETAILS NOT AVAILABLE UNTIL CHAPTER REVIEWED BY PELLSTON PARTICIPANTS.							
Andy Hart	#31	Pellston aquatic effects case study	Both	Workshop group study. Explored various probabilistic approaches for small and large aquatic toxicity datasets	Aquatic effects only	DETAILS NOT AVAILABLE UNTIL CHAPTER REVIEWED BY PELLSTON PARTICIPANTS.							
Andy Hart	#32	Pellston terrestrial case study	Both	Workshop group study. Explored various probabilistic approaches for acute avian risk model with small and large datasets	Terrestrial	DETAILS NOT AVAILABLE UNTIL CHAPTER REVIEWED BY PELLSTON PARTICIPANTS.							
Mick Hamer	#33	Probabilistic aquatic risk assessment for atrazine	Both	SSDs developed for different organism groups, also mesocosm and field endpoints. PRZM/EXAMS used to generate exposure concs also field monitoring used to give distribution of exposures (Solomon et al 1996) - update of the analysis used Monte-Carlo to vary input parameters. (Giddings)	Aquatic	Atrazine	Drift and run-off	Modelling and monitoring	Scenario based modelling, monitoring to produce frequency distribution. In update Monte Carlo used to vary inputs into model.	Invertebrates, fish, plants algae	lab, mesocosms, streams, field	SSD	"Acute" 45 plant 52 animals. Chronic 14 plant 17 animals. 20 field/meso etc
Mick Hamer	#34	Probabilistic aquatic risk assessment of cotton pyrethroids	Both	SSDs developed for different organism groups, compared to mesocosm/field endpoints. Spatial analysis of cotton landscape used to give landscape level exposure characterisation. 10th percentile effect concentrations were compared to exposure distribution to generate RQ distribution.	Aquatic	Cypermethrin as a representative cotton pyrethroid	Drift and run-off	Modelling	Scenario based modelling to give frequency distribution	Invertebrates, fish	lab, mesocosms, field	SSD	for cypermethrin 58 acute values

		Generalities				Exposure assessment				Effects assessment			
Igor Dubus (from EUPRA)	#35	US-EPA approach to PRA for aquatic organisms	Both	Four-tier approach. First two tiers have been demonstrated. Second tier based on joint probability distributions combining results from a 2D-MC for a single exposure scenario and EC50 distributions for representative species	Aquatic	Test compound	run-off and erosion	Modelling (PRZM-EXAMS)	2D-MC analysis for one single scenario (+ use of different scenarios as refinement)	Freshwater and estuarine fish + invertebrates	Dose-response curve from the literature	Fitting of a log-probit to acute ecotox data. Slope and intercept of the dose response curve randomly sampled	LC50 - use of 5th, 50th and 95th-percentile sensitive species
Igor Dubus (from EUPRA)	#36	US-EPA approach to PRA for terrestrial organisms	Both	Probit model combining exposure from dietary and drinking water routes and effects based on intra- and inter-species variations	Terrestrial	Test compound	dietary and drinking routes	Allometric relationships, literature values, field data		5 species of birds	LC50 derived from fitting of log-logistic distribution to 13 experimental values		Inter- and intra-species differences. 3 LD50s for each focal species (5th, 50th and 95th-percentile)
Igor Dubus (from EUPRA)	#37	Comparison of four methods to assess exposure probabilistically in a terrestrial environment	Exposure only	Use of interval analysis, 1D-MC, 2D-MC and probability bounds to propagate uncertainty through exposure estimates for blue tits in apple orchards	Terrestrial	chloryrifos	dietary and drinking routes	Straightforward equation	interval analysis, 1D-MC, 2D-MC and probability bounds	N/A	N/A	N/A	N/A
Igor Dubus (from EUPRA)	#38	Scenario-based approach to assess risk in ditches resulting from drainflow losses	Exposure only	Scenario-based exposure modelling. Comparison with selected ecotox endpoints for Lemna (recovery values in particular)	Aquatic	name undisclosed	drainflow and dilution into a receiving ditch	Modelling + a field study for validation	scenario-based approach	Lemna gibba only	lab tests	N/A (deterministic endpoints)	EC50 + recovery
Igor Dubus (from EUPRA)	#39	Probabilistic exposure for atrazine in ponds	Exposure only	Monte Carlo approach applied to model inputs (highest ECOFRAM tier) for farms ponds in the US.	Aquatic (pond)	atrazine	runoff and erosion	Modelling + monitoring data	1D-MC for multiple scenarios	N/A	N/A	N/A	N/A
Igor Dubus (from EUPRA)	#40	ECOFRAM approach for aquatic ecological risk assessment for atrazine	Both	ECOFRAM approach based on 4 tiers of increasing refinement	Aquatic	atrazine	runoff and erosion	Modelling + experimental depending on the tier considered	scenario-based to MC depending on the tier considered	dependent on the tier considered	dependent on the tier considered	dependent on the tier considered	dependent on the tier considered
Igor Dubus (from EUPRA)	#41	Comparison of drift estimated using BBA tables and effects	Both	Comparison of drift estimated using BBA tables and effects	Terrestrial	multiple compounds	Drift	BBA tables	implemented in the BBA tables	non-target plants	literature data	?	NOEC, EC10, EC20, EC30 and EC50
K Solomon	#42	Ecological risk assessment of atrazine in North American surface waters	Effects and exposures	SSDs and Measured CDs (MeCDs)	Aquatic (Surface Water)	Atrazine	All	na	Distributions	All aquatic	Acute lab tests; microcosm and mesocosm study	SSDs	LC50 and EC50 cosm NOECs
K Solomon	#43	Chlorpyrifos: Ecological risk assessment in North American aquatic environments	Effects and exposures	SSDs and MeCDs	Aquatic (Surface Water)	Chlorpyrifos	Mainly corn uses	Both	Distributions	All aquatic	Acute lab tests; microcosm and mesocosm study	SSDs	LC50 and EC50 cosm NOECs
K Solomon	#44	An ecological risk assessment of diazinon from agricultural use in the Sacramento-San Joaquin River basins, California	Effects and exposures	SSDs and MeCDs	Aquatic (Surface Water)	Diazinon	All	Measured	Distributions	All aquatic	Acute lab tests; microcosm and mesocosm study	SSDs	LC50 and EC50 cosm NOECs
K Solomon	#45	Probabilistic risk assessment of cotton pyrethroids: 1. Distributional analyses of laboratory aquatic toxicity	Effects and exposures	SSDs and modelled CDs (MoCDs)	Aquatic (Surface Water)	Pyrethroids	All	Modelled	Distributions	All aquatic	Acute lab tests; microcosm and mesocosm study	SSDs	LC50 and EC50 cosm NOECs
K Solomon	#46	Aquatic ecological risks posed by tributyltin in United States surface waters: Pre-1989 to 1996 data	Effects and exposures	SSDs and MeCDs	Aquatic (Salt Water and FW)	Tributyl tin	All	Measured	Distributions	All aquatic	Acute lab tests	SSDs	LC50s and estimated Chronic data
K Solomon	#47	A probabilistic ecological risk assessment of tributyltin in surface waters of the Chesapeake Bay watershed.	Effects and exposures	SSDs and MeCDs	Aquatic (SW)	Tributyl tin	All	Measured	Distributions	All aquatic	Acute lab tests	SSDs	LC50s
K Solomon	#48	Aquatic Ecological Risk Assessment of Atrazine - A Tiered Probabilistic Approach	Effects and exposures	SSDs, MoCDs and MeCDs	Aquatic	Atrazine	All	Measured and modeled	Distributions	All aquatic	Acute lab tests; microcosm and mesocosm study	SSDs	LC50s
K Solomon	#49	Chlorpyrifos: ecotoxicological risk assessment for birds and mammals in corn agroecosystems	Effects and exposures	SSDs, MoCDs and MeCDs	Terrestrial	Chlorpyrifos	Granular and food	Measured and modeled	Distributions	Birds	Acute lab tests	SSDs	LC50s and LC5s (estimated)
K Solomon	#50	Ecological risk assessment for aquatic organisms from over-water uses of glyphosate	Effects and exposures	SSDs, MoCDs and MeCDs	Aquatic	Glyphosate	Weed control in wetlands and forestry	Measured and modeled	Distributions	All aquatic	Acute lab tests	SSDs	LC50s
Vicky Pablos	#51	Environmental risk assessment of an insecticide under Mediterranean conditions using a probabilistic approach	Both	Monte Carlo for run-off and soil erosion estimations and SSD	Aquatic and Terrestrial	Insecticide	Standard application to an agricultural field (considering other routes, as run-off and soil erosion)	Modelling and experimental data	Monte Carlo	na	Laboratory and literature data	SSD	Acute and chronic toxicity

Funding, availability and suitability to support a case study within EUFRAM								
ID #	Sector generating the case study (academia / government / industry)	Funding source	Availability	Contact name	Contact email	Contact affiliation	Reference(s)	Suitability for supporting a case study within EUFRAM (1=least suitable; 5=most suitable). Very subjective, but your view would be useful
#1	Academia	DEFRA (UK)	Publicly available (URL given in reference)	Igor Dubus	i.dubus@cranfield.ac.uk	Cranfield University, UK	Dubus IG, Brown CD, Beulke S and Turner NL (2002). Uncertainty and probabilistic approaches to pesticide fate modelling. Cranfield Centre for EcoChemistry research report for DEFRA PL0548, 138p. The case study is presented in Chapter 5 of the report which can be downloaded at http://www.pfmodels.org/downloads.html	3
#2	Academia	DEFRA (UK)	Publicly available (see references)	Igor Dubus	i.dubus@cranfield.ac.uk	Cranfield University, UK	1) Dubus IG, Brown CD and Beulke S (1998). Sensitivity analyses for leaching models used for pesticide registration in Europe. SSLRC research report for DEFRA PL0532, 407p. 2) Dubus IG and Brown CD (2002). Sensitivity and first-step uncertainty analyses for the preferential flow model MACRO. Journal of Environmental Quality, 31:227-240.	1
#3	Industry	Product development in support of Annex I Inclusion	Monograph currently with Working Group Legislation with one outstanding issue	Pamela Byrne	Pamela.Byrne@agriculture.gov.ie	Pesticide Control Service, Dept. of Agriculture & Food.	Full title not available currently as monograph is currently being peer reviewed by EU	3
#4	Industry	Product development in support of Annex I Inclusion	Monograph currently with Working Group Legislation with one outstanding issue	Pamela Byrne	Pamela.Byrne@agriculture.gov.ie	Pesticide Control Service, Dept. of Agriculture & Food.	Full title not available currently as monograph is currently being peer reviewed by EU	3
#5	Academia	DEFRA (UK)	Publicly available	Lorraine Maltby	l.maltby@sheffield.ac.uk	University of Sheffield		
#6	Academia	DEFRA (UK)	Publicly available	Mark Crane	craneconsultants@aol.com	Crane Consultants		
#7	Academia	DEFRA (UK)	Publicly available	Mark Crane	craneconsultants@aol.com	Crane Consultants		
#8	Academia/government	Ministry of Environment (VROM)	Publicly available (see references)	Robert Luttkik	Robert.Luttkik@RIVM.NL	RIVM, Bilthoven, the Netherlands	T. P. Traas, R. H. Jongbloed, and R. Luttkik (1996) A probabilistic model for deriving soil quality criteria based on secondary poisoning of top predators. I. Model description and uncertainty analysis for dichlorodiphenyltrichloroethane (DDT) and cadmium. Ecotoxicology and Environmental Safety 34, 264-278.	4
#9	Academia/government	Ministry of Environment (VROM)	Publicly available (see references)	Robert Luttkik	Robert.Luttkik@RIVM.NL	RIVM, Bilthoven, the Netherlands	R. H. Jongbloed, T. P. Traas, and R. Luttkik (1996) A probabilistic model for deriving soil quality criteria based on secondary poisoning of top predators. II. Calculations for dichlorodiphenyltrichloroethane (DDT) and cadmium. Ecotoxicology and Environmental Safety 34, 279-306.	4
#10	Academia	Danish government a.o. EPA	Will be published in the near future in ETC	Christopher John Topping	cjt@dmu.dk	Department of Landscape Ecology, National Environmental Research Institute, Denmark	Topping, C.J. and P. Odderskaer (2003?) Modeling the influence of temporal and spatial factors on the assessment of impacts of pesticides on skylark	2 The model as such perhaps not so useful, but a lot of data on skylarks which can be extremely helpful for creating a testcase
#11	Industry	Bayer CropScience	Results published (see reference)	Dieter Schäfer	dieter.schaefer@bayercropscience.com	BayerCropScience, Germany	Feyerabend, M. et al. (2002): Higher-tiered Aquatic Risk Assessment for the Pyrethroid Insecticide Deltamethrin. Poster at the IUPAC 2002 Conference, Basel.	4
#12	Industry	Bayer CropScience	unpublished	Dieter Schäfer	dieter.schaefer@bayercropscience.com	BayerCropScience, Germany		2
#13	Industry	Bayer CropScience	unpublished	Dieter Schäfer	dieter.schaefer@bayercropscience.com	BayerCropScience, Germany		3
#14	Industry	Bayer CropScience	Results published (see reference)	Tharacad Ramanarayanan & Michael Dobbs	Tharacad.Ramanarayanan@BayerCropScience.com & Michael.Dobbs@BayerCropScience.com	Bayer CropScience, USA	Ramanarayanan, T.S. et al. (2002): ASAE paper	4
#15	Industry	Bayer CropScience	Results published (see reference)	Tharacad Ramanarayanan & Michael Dobbs	Tharacad.Ramanarayanan@BayerCropScience.com & Michael.Dobbs@BayerCropScience.com	Bayer CropScience, USA	Ramanarayanan, T.S. et al. (2002): ASAE paper	2
#16	Industry	Bayer CropScience	Results published (see reference)	Tharacad Ramanarayanan & Michael Dobbs	Tharacad.Ramanarayanan@BayerCropScience.com & Michael.Dobbs@BayerCropScience.com	Bayer CropScience, USA	Ramanarayanan, T.S. et al. (2002): SETAC Poster	4
#17	Government	Industry most	Some data available (cf. references)	Kevin Reinert	Kevin_H_Reinert@RohmHaas.com	Rohm & Hass but data were from Environment Canada	Reinert K. et al (Eds.) , 1998. Ecological Risk Assessment Decision-Support System: A Conceptual Design, p. 75. SETAC	3
#18	Private Industry primarily	Dow for most	Some data available (cf. references)	Part of the data I guess Keith Solomon would be best. The rest or all Dow.	In the group	In the group	1) Giesy J.P., Solomon K.R., Coats J.R., Dixon K.R., Giddings J.M., Kenaga E.E. (1998) Ecological risk assessment of chlorpyrifos in North American aquatic environments. Rev. Environ. Contam. Toxicol. 160:1-129. 2) Barrow, C. Shurdut, B., and Eisenbrandt, D., 1999. Chapter 14 in "International Pesticide Product Registration Requirements, ACS Symposium Series 724; Garner, W. et al (Eds.), American Chemical Society, Washington.	3
#19	Academia /Government	UBA, D	publication submitted	Matthias Liess	Matthias.Liess@onlinehome.de	UFZ, D	publication submitted	5

Funding, availability and suitability to support a case study within EUFRAM

#20	Academia	DFG (D)	Publicly available (see references)	Matthias Liess	Matthias.Liess@onlinehome.de	UFZ, D	Liess, M., and R. Schulz. 1999. Linking insecticide contamination and population response in an agricultural stream. Environmental Toxicology and Chemistry 18:1948-1955.	3
#21	Academia	DFG (D), UBA, D	Publicly available (see references), more to come soon	Matthias Liess	Matthias.Liess@onlinehome.de	UFZ, D	Liess, M., R. Schulz, N. Berenzen, J. Nanko-Drees, and J. Wogram. 2001. Pesticide contamination and macroinvertebrate communities in running waters in agricultural areas. UBA Texte 65:227.+ publication in prep.	5
#22	Academia	DFG (D), UBA, D	publication submitted	Matthias Liess	Matthias.Liess@onlinehome.de	UFZ, D	publication submitted	5
#23	Industry	Industry	Industry owned but possibly available if molecule not named	Kevin Brown	kbrown@ecotox.co.uk	Ecotox Limited	Not published	2
#24	Government	DEFRA (UK)	Public	Andy Hart	a.hart@csf.gov.uk	CSL, UK	Anon. 1999. Risks to birds from the use of chlorpyrifos on apples: an example using ECOFRAM approaches. 27pp. Appendix C10 in: US EPA. Ecological Committee on FIFRA Risk Assessment Methods (ECOFRAM): ECOFRAM Terrestrial Draft Report. Available on the internet at http://www.epa.gov/oppefed1/ecorisk/index.htm .	2
#25	Government	DEFRA (UK)	Public	Andy Hart	a.hart@csf.gov.uk	CSL, UK	Hart, A. Probabilistic assessment of pesticide risks to birds. Submitted to: Environmental Fate and Effects of Pesticides, J.R. Coats and H. Yamamoto, eds., ACS Books, Washington, DC (in press).	4
#26	Consultants	?	Public	Dwayne Moore	dmoore@cadmusgroup.com	Cadmus Group, Canada	Moore DRJ, Pawlisz A, Hart A, Warren-Hicks WA, Ferson S. 2001. Probabilistic techniques to determine risk to blue tits exposed to chlorpyrifos in apple orchards. In: Hart, A. Probabilistic risk assessment for pesticides in Europe: implementation and research needs. Report of the European workshop on Probabilistic Risk Assessment for the Environmental Impacts of Plant Protection Products (EUPRA). Central Science Laboratory, Sand Hutton, UK, p. 65.	3
#27	Government	DEFRA (UK)	Public	Andy Hart	a.hart@csf.gov.uk	CSL, UK	Hart, A. 2001a. Comparison of a deterministic approach to ecotoxicological risk assessment with a probabilistic approach. Paper submitted to the Environmental Panel of the UK Advisory Committee on Pesticides (ref. SC 10992, 23 May 2001). Hart, A. 2001b. Comparison of deterministic and probabilistic approaches for acute risks to birds. In: Hart, A. Probabilistic risk assessment for pesticides in Europe: implementation and research needs. Report of the European workshop on Probabilistic Risk Assessment for the Environmental Impacts of Plant Protection Products (EUPRA). Central Science Laboratory, Sand Hutton, UK, p. 93.	4
#28	Government	DEFRA (UK)	Not yet available - will be public	Andy Hart	a.hart@csf.gov.uk	CSL, UK	Not yet available	5
#29	Government	HSE (UK)	Not yet available - will be public	Andy Hart	a.hart@csf.gov.uk	CSL, UK	Not yet available	1
#30								1
#31								3?
#32								4
#33	Academia	industry	public				Solomon et al (1996) ET & C vol 15 pages 31 - 76. Updated with more exposure, approx 2000	4?
#34	industry	industry	public	Mick Hamer	mick.hamer@syngenta.com	Syngenta	ET & C vol 20 pages 652 - 692 (5 papers)	4?

Funding, availability and suitability to support a case study within EUFRAM

#35	Regulatory	Regulatory	public	Ingrid Sunzenauer	sunzenauer.ingrid@epamail.epa.gov	USEPA	EUPRA report (page 61)	3
#36	Regulatory	Regulatory	public	Ingrid Sunzenauer	sunzenauer.ingrid@epamail.epa.gov	USEPA	EUPRA report (pages 62 and 63)	3
#37	Academia	?	?	Dwayne Moore	dmoore@cadmusgroup.com	Cadmus Group, Canada	EUPRA report (page 65)	4
#38	Academia	Industry	available	Colin Brown	c.brown@cranfield.ac.uk	Cranfield University, UK	EUPRA report (page 77)	3
#39	Academia	Industry	?	Jeff Giddings	kgiddings@compuserve.com	Cadmus Group	EUPRA report (page 82)	4
#40	Academia	Industry	?	Jeff Giddings	kgiddings@compuserve.com	Cadmus Group	EUPRA report (page 83)	4
#41	Academia	Government	?	Tarazona	tarazona@inia.es	INIA	EUPRA report (page 87)	2
#42	Industry/academia	Industry	Published		ksolomon@uoguelph.ca	University of Guelph	Solomon KR, Baker DB, Richards P, Dixon KR, Klaine SJ, La Point TW, Kendall RJ, Giddings JM, Giesy JP, Hall LWJ, Weisskopf C, Williams M. 1996. Ecological risk assessment of atrazine in North American surface waters. <i>Environmental Toxicology and Chemistry</i> 15:31-76.	4
#43	Industry/academia	Industry	Published				Giesy JP, Solomon KR, Coates JR, Dixon KR, Giddings JM, Kenaga EE. 1999. Chlorpyrifos: Ecological risk assessment in North American aquatic environments. <i>Reviews of Environmental Contamination and Toxicology</i> 160:1-129.	4
#44	Industry/academia	Industry	Published				Giddings JM, Hall LWJ, Solomon KR. 2000. An ecological risk assessment of diazinon from agricultural use in the Sacramento-San Joaquin River basins, California. <i>Risk Analysis</i> 20:545-572.	4
#45	Industry/academia	Industry	Published		ksolomon@uoguelph.ca	University of Guelph	Solomon KR, Giddings JM, Maund SJ. 2001. Probabilistic risk assessment of cotton pyrethroids: I. Distributional analyses of laboratory aquatic toxicity. <i>Environmental Toxicology and Chemistry</i> 20:652-659. Giddings JM, Solomon KR, Maund SJ. 2001. Probabilistic risk assessment of cotton pyrethroids: II. Aquatic mesocosm and field studies. <i>Environmental Toxicology and Chemistry</i> 20:660-668. Hendley P, Holmes C, Kay S, Maund SJ, Travis KZ, Zhang M. 2001. Probabilistic risk assessment of cotton pyrethroids: III. A spatial analysis of the Mississippi cotton landscape. <i>Environmental Toxicology and Chemistry</i> 20:669-678. Travis KZ, Hendley P. 2001. Probabilistic aquatic risk assessment of pyrethroids: IV. Landscape-level exposure characterization. <i>Environmental Toxicology and Chemistry</i> 20:679-686. Maund SJ, Travis KZ, Hendley P, Giddings JM, Solomon KR. 2001. Probabilistic risk assessment of cotton pyrethroids: V. Combining landscape-level exposures and ecotoxicological effects data to characterize risks. <i>Environmental Toxicology and Chemistry</i> 20:687-696.	4
#46	Industry/academia	Industry	Published				Cardwell RD, Brancato MS, Toll J, DeForest D, Tear L. 1999. Aquatic ecological risks posed by tributyltin in United States surface waters: Pre-1989 to 1996 data. <i>Environmental Toxicology and Chemistry</i> 18:567-577.	4
#47	Industry/academia	Industry	Published				Hall LWJ, Scott MC, Killen WD, Unger MA. 2000. A probabilistic ecological risk assessment of tributyltin in surface waters of the Chesapeake Bay watershed. <i>Human and Ecological Risk Assessment</i> 6:141-179.	4
#48	Industry/academia	Industry	Report submitted to USEPA. Should be available from Syngenta		alan.hosmer@syngenta.com		Giddings JM, Anderson TA, Hall LWJ, Kendall RJ, Richards RP, Solomon KR, Williams WM. 2000. Aquatic Ecological Risk Assessment of Atrazine - A Tiered Probabilistic Approach: A Report of An Expert Panel. Novartis Crop Protection, Inc. Greensboro, NC, USA, Report No. 709-00. June 2000.	4
#49	Industry/academia	Industry	Published		ksolomon@uoguelph.ca	University of Guelph	Solomon KR, Giesy JP, Kendall RJ, Best LB, Coats JR, Dixon KR, Hooper MJ, Kenaga EE, McMurry ST. 2001. Chlorpyrifos: ecotoxicological risk assessment for birds and mammals in corn agroecosystems. <i>Human and Ecological Risk Assessment</i> 7:497-632.	4
#50	Academia		Published		ksolomon@uoguelph.ca	University of Guelph	Solomon KR, Thompson DG. 2003. Ecological risk assessment for aquatic organisms from over-water uses of glyphosate. <i>Journal of Toxicology and Environmental Health B</i> 6:211-246.	4
#51	Government	INIA (Spain)	Confidential information	Tarazona & Pablos	tarazona@inia.es; pablos@inia.es	Laboratory for Ecotoxicology. INIA	-	3