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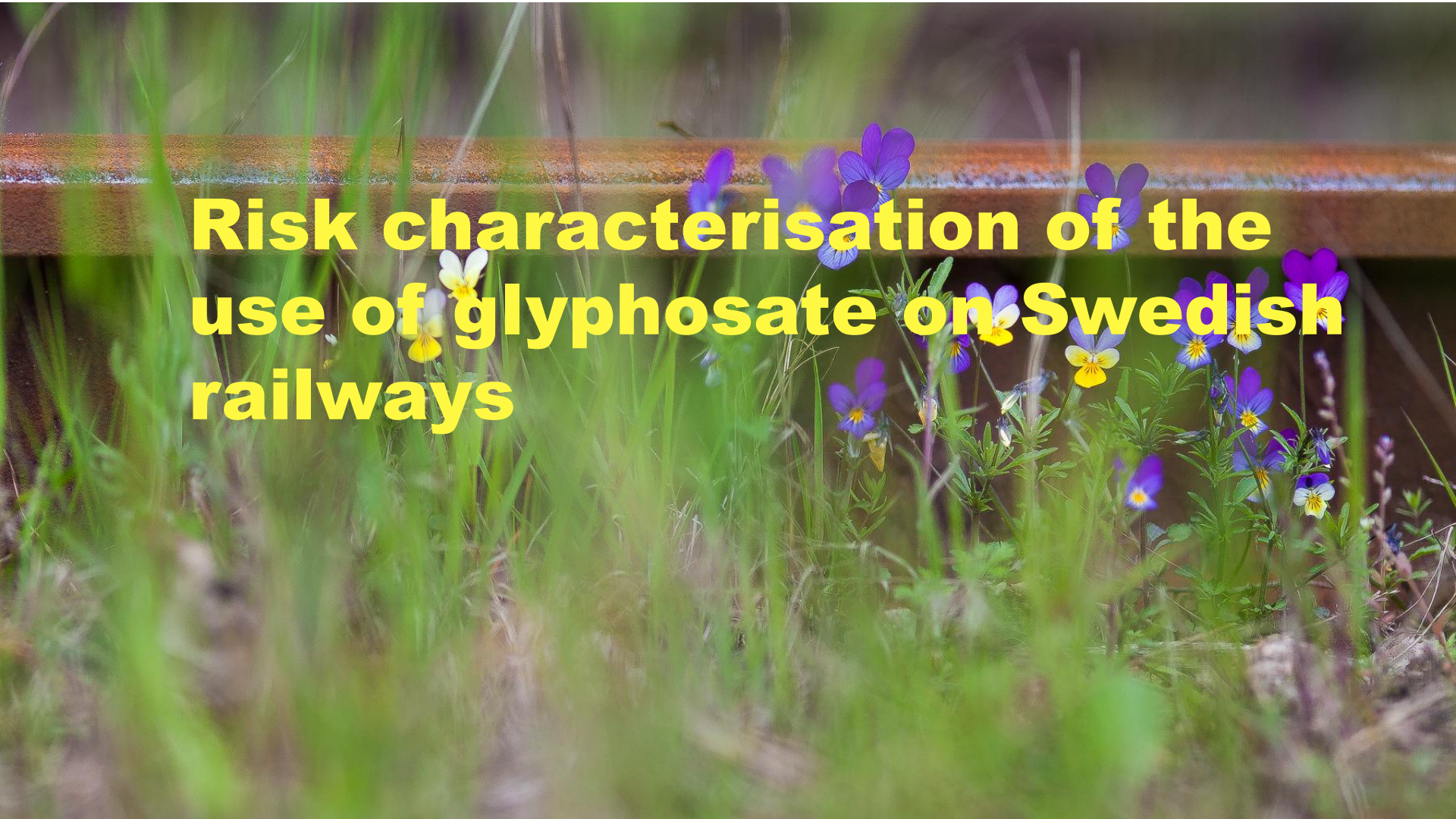
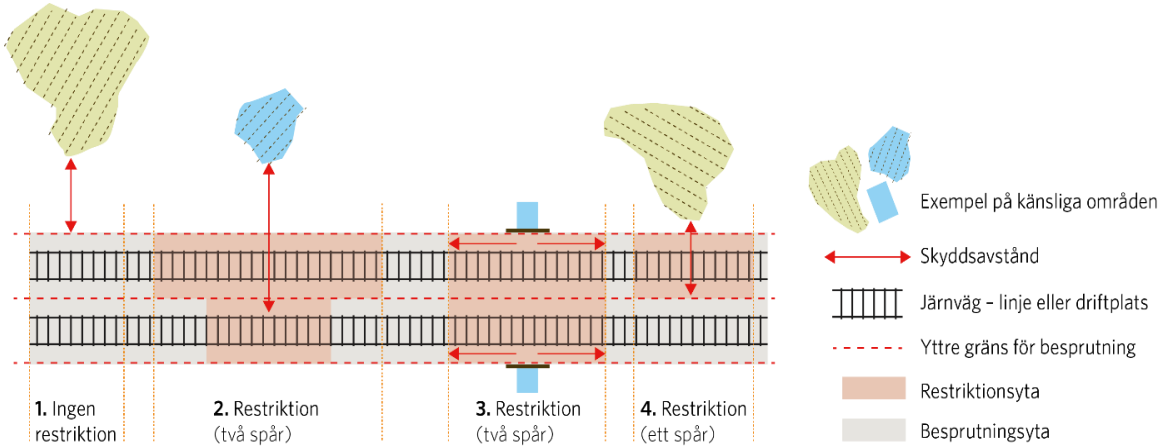


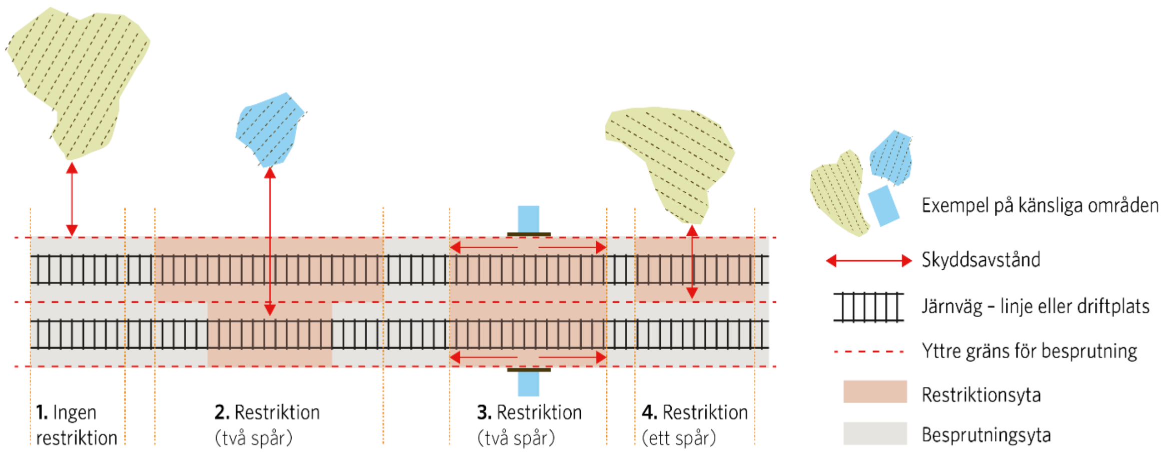
Risk characterisation of the use of glyphosate on Swedish railways

Background



- Trafikverket carried out a revision of no-spray zones 2014-2015
- Old approach: based on ”wish-list” from municipalities – large differences betwen regions
- New standardized approach: generated based on GIS-data and minimum safe distances to sensitive environments

Background



- Some minimum safe distances are regulated in law (e.g. min distance to surface water = 6 m)
- Safe distances and sensitive environments not selected based on assessment of the actual risk posed by herbicides to said environments
- In other cases: disagreement among people as to what constitutes a sensitive environment
- To support the work: carried out a simple risk characterization of spatial configurations and safe distances from railways

Basics of risk characterization

- Step 1: Estimate Predicted Environmental Concentration (PEC)
- Step 2: Estimate Predicted No-Effect Concentration (PNEC)
- Step 3: Calculate risk characterization ratio (RCR = PEC/PNEC)

- An RCR ≥1 indicates unacceptable risk
- An RCR <<1 indicates low risk
- Conservative estimates of spread, exposure and sensitivity should be used

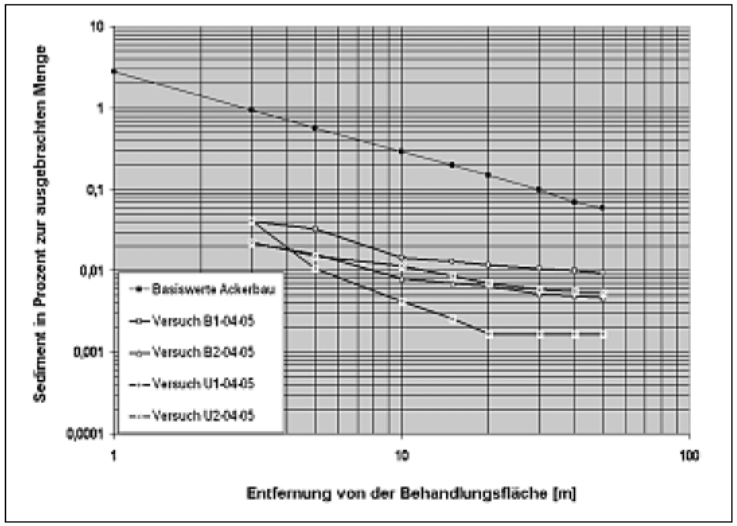
Spread and exposure scenarios

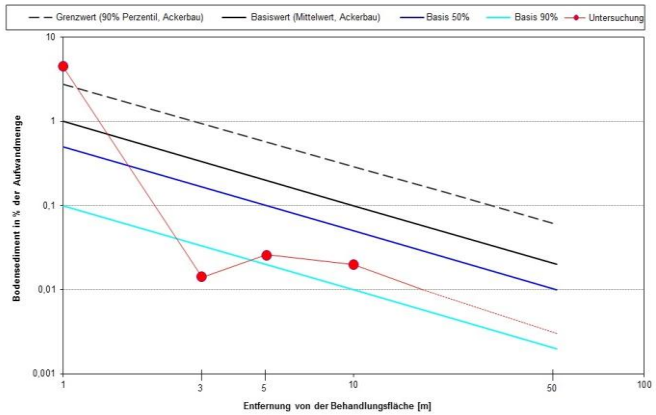
- Wind drift:
  - effects on surrounding vegetation
  - effects on surrounding surface waters (aquatic organisms)
  - human exposure (direct or indirect)
- Potential for drinking water contamination also considered (through wind drift or leaching)

Not considered:

- Spread through surface runoff
- Risks to other terrestrial organisms
- Risks to organisms in the track itself
- Risks to applicators

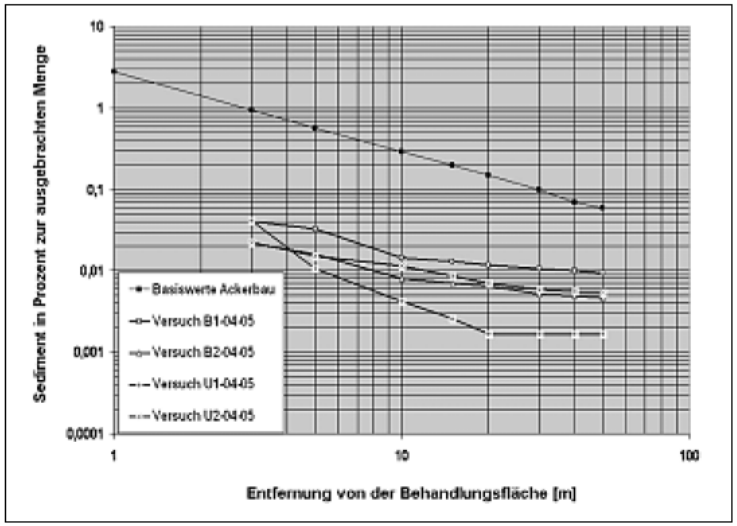
Spread through wind drift





- Data was available from measurement of wind drift carried out in Germany (Wygoda et al. 2006 *Nachrichtenbl. Deut. Pflanzenshutzd*. 58: 323-326)
- Drift about 0.04% of applied dose at 3 m distance from sprayed area
- Drift data closer than 3 m was not available but likely to be much higher

Spread through wind drift



- Drift values calculated for 0, 3, 6 and 12 m distance to spray zone
- Drift assumed to be 1, 2 or 4 times that of what was observed by Wygoda et al.
- Calculations performed for a dose of 1800 g/ha

PECs from wind drift

- Calculation of concentration in surface water (µg/l):
  - calculation for surface waters of 0.1, 0.5 and 1 m depth
  - uniform distribution of glyphosate in water assumed
  - no adsorption to sediments
- Calculation of concentration in soil (mg/kg):
  - assumption of uniform distribution in top cm of soil
  - calculated for different bulk densities (sand, clay, organic soil)

Human exposure scenarios

- Direct exposure – person standing next to track when sprayed
  - assumption that person hit by amount normally spread over 1 m^2
  - skin adsorption 10% (actually lower)
  - calculated for child with 15 kg body weight
- Indirect exposure through consumption of surface water or soil
  - calculated for 5 l of 0.1 m deep surface water or 1 kg of topsoil – again for child of 15 kg
- 100% uptake from soil or water was assumed
- Combined exposure scenario also calculated (all of the above)

PNEC-value for plants

- No-effect levels against plants not usually determined during registration of herbicides
- Litterature review of papers studying wind drift damage of glyphosate (13 studies, on 24 different plant species was included)
- Lowest dose at which an effect was observed in any study was
  8 g glyphosate/ha
  (hormetic response)
- I used 4 g/ha as PNEC-value for plants

PNEC-value for surface waters

- Guideline values for herbicides in surface water determined by the Swedish Chemicals Agency in 2007
- Guideline value = the highest concentration from which no negative effects can be expected
- For glyphosate the guideline value is set to 100 µg/l
  - this value was used as PNEC
- The risk of exceeding the EU limit for drinking water of 0.1 µg/l was also considered in both wind drift and leaching scenarios

PNEC-value for human exposure

- Actually a Derived No-Effect Level (DNEL)
- Use of Acute Reference Dose (ARfD) as DNEL not possible because no ARfD was allocated
- Acceptable operator exposure level (AOEL = 0.2 mg/kg bw per day) was used for direct exposure
- Acceptable Daily Intake value (ADI = 0.3 mg/kg bw per day) was used for indirect consumption scenarios
- In the current EFSA conclusion values are proposed as:
  ARfD = 0.5 mg/kg bw
  AOEL = 0.1 mg/kg bw per day
  ADI = 0.5 mg/kg bw per day

Results for plants

	Distance	RCR
1 x wind drift	0 m	450
	3 m	0.18
	6 m	0.14
	12 m	0.05
2 x wind drift	0 m	450
	3 m	0.37
	6 m	0.27
	12 m	0.09
4 x wind drift	0 m	450
	3 m	0.74
	6 m	0.54
	12 m	0.18

- RCRs < 1 in all cases other than in the case of direct spraying
- RCRs close to 1 – indicates that result could be sensitive to assumptions
- Reasonable to assume that effects can occur at distances closer than 3 m from sprayed area

Results for surface waters

	Distance	RCR 0.1 m	RCR 0.5 m	RCR 1 m
1 x wind drift	0 m	18	3.6	1.8
	3 m	0.007	0.002	7E-04
	6 m	0.005	0.001	5E-04
	12 m	0.002	4E-04	2E-04
2 x wind drift	0 m	18	3.6	1.8
	3 m	0.015	0.003	0.002
	6 m	0.011	0.002	0.001
	12 m	0.004	7E-04	4E-04
4 x wind drift	0 m	18	3.6	1.8
	3 m	0.03	0.006	0.003
	6 m	0.022	0.004	0.002
	12 m	0.007	0.001	7E-04

- RCRs below 1 in all cases other than the direct spraying
- The fact that RCRs <<1 indicates that the risk of damage to surface waters > 3 m from sprayed area is very low
- If wind drift < 5% the RCR is <1 for all scenarios

Results for human exposure

		RCRs for different scenarios			
	Distance	wind drift	drinking water	eating soil	combined
1 x wind drift	0 m	30	0.6	8	45
	3 m	0.012	0.0003	0.0033	0.018
	6 m	0.009	0.0002	0.0024	0.014
	12 m	0.003	6E-05	0.0008	0.005
2 x wind drift	0 m	30	0.6	8	45
	3 m	0.025	0.0005	0.0066	0.037
	6 m	0.018	0.0004	0.0048	0.027
	12 m	0.006	0.0001	0.0016	0.009
4 x wind drift	0 m	30	0.6	8	45
	3 m	0.049	0.001	0.0131	0.074
	6 m	0.036	0.0007	0.0096	0.054
	12 m	0.012	0.0002	0.0032	0.018

- RCRs well below 1 in all scenarios except for direct spraying
- The fact that RCRs are so low despite very conservative estimates indicates that this conclusion is very robust

Concentration in surface water

		Concentration (µg/l)		
	Distance	0.1 m	0.5 m	1 m
1 x wind drift	0 m	1800	360	180
	3 m	0.74	0.15	0.07
	6 m	0.54	0.11	0.05
	12 m	0.18	0.04	0.02
2 x wind drift	0 m	1800	360	180
	3 m	1.48	0.3	0.15
	6 m	1.08	0.22	0.11
	12 m	0.36	0.07	0.04
4 x wind drift	0 m	1800	360	180
	3 m	2.95	0.6	0.3
	6 m	2.16	0.43	0.22
	12 m	0.72	0.14	0.07

- Concentrations mostly exceed the EU limit for drinking water of 0.1 µg/l
- Limit not exceeded for >1 m deep water at 12 m distance
- Unlikely to use shallow surface water as source for drinking water

Risk for groundwater contamination

- Results available from environmental monitoring program conducted 2007-2010
- Limit exceeded in some cases directly below or close to the railway (Glyphosate or AMPA detected in concentrations >0.1 µg/l in 16 of 289 samples)
- Risk of contamination likely to be highest for private wells close to the track
- Risk of contamination probably lower today due to more targeted application technique, which reduces applied amounts

Overall conclusions

- Use of glyphosate on Swedish railways very unlikely to affect peoples health
- The risk for affecting surface waters is also very low
- The risk for non-target plants is acceptable > 3 m from sprayed area – but likely that effects can occur at distances < 1 m
- Certain risk for contamination of groundwater or drinking water at levels > 0.1 µg/l

Room for improvement

- PEC-calculation can be improved by better data on wind drift
- Exposure scenarios can be improved by more realistic assumptions
- PNEC-estimates can be improved by more thorough litterature review + better methodology
- Scenarios could be developed for other doses and other herbicides – as well as for other organisms

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Thank you for your attention!

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