# Current status and development of methods for detecting field-level effects of pesticides in aquatic systems

## Welcome address

Jenny Kreuger

Director, Centre for Chemical Pesticides, SLU

*CKB Expert workshop*
*SLU, Uppsala, 2014-11-19*

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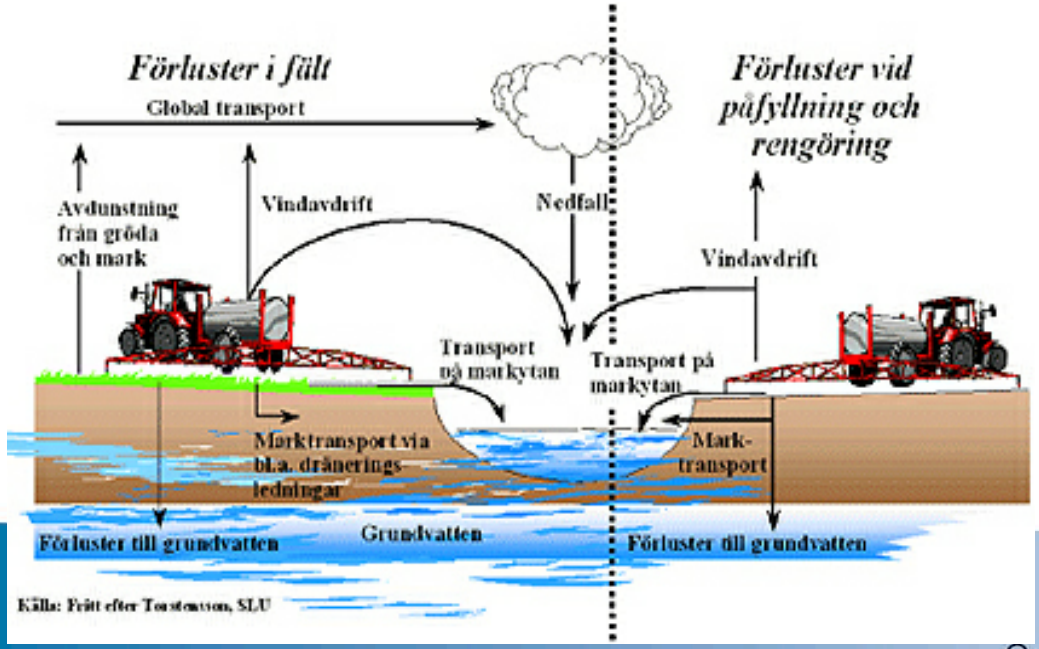
# Centre for Chemical Pesticides (CKB)

- CKB is a partnership forum within the area of chemical pesticides for researchers at SLU and interested parties outside the university
- Started in 2006
- A reference group with 10 representatives from both public authorities and different stakeholders - guiding the direction of our work

# CKB – current focus

- Environmental impact of pesticides used within agriculture, with special focus on the aquatic environment

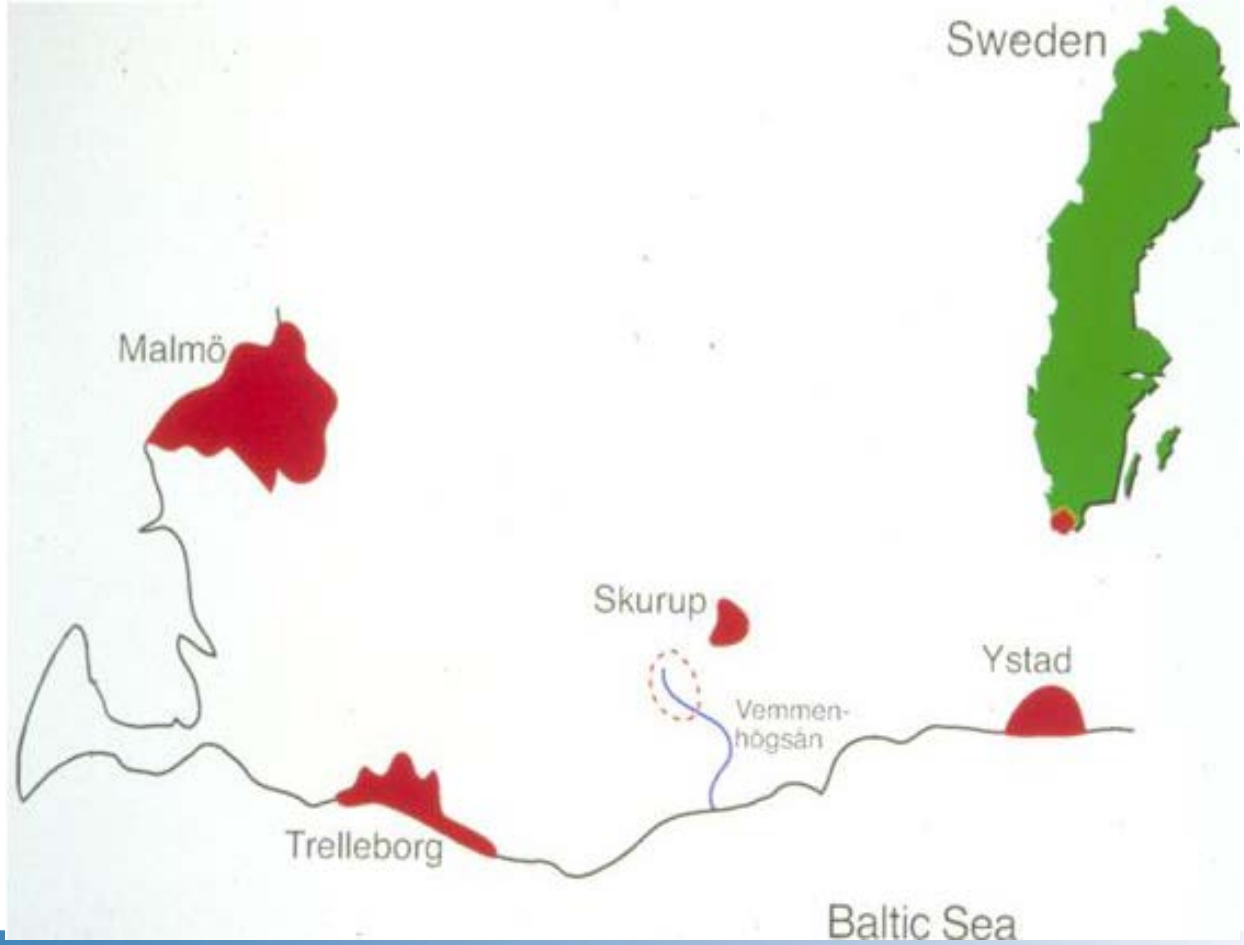


# CKB Areas of operation 2012-2016

- Analytical method development *(Ove Jonsson)*
- Environmental fate *(Mats Larsbo)*
- Environmental effects *(Willem Goedkoop)*
- Environmental monitoring *(Bodil Lindström)*
- Risk assessment tools *(Nick Jarvis, Julien Moeys)*
- Information and education *(Mikaela Gönczi)*

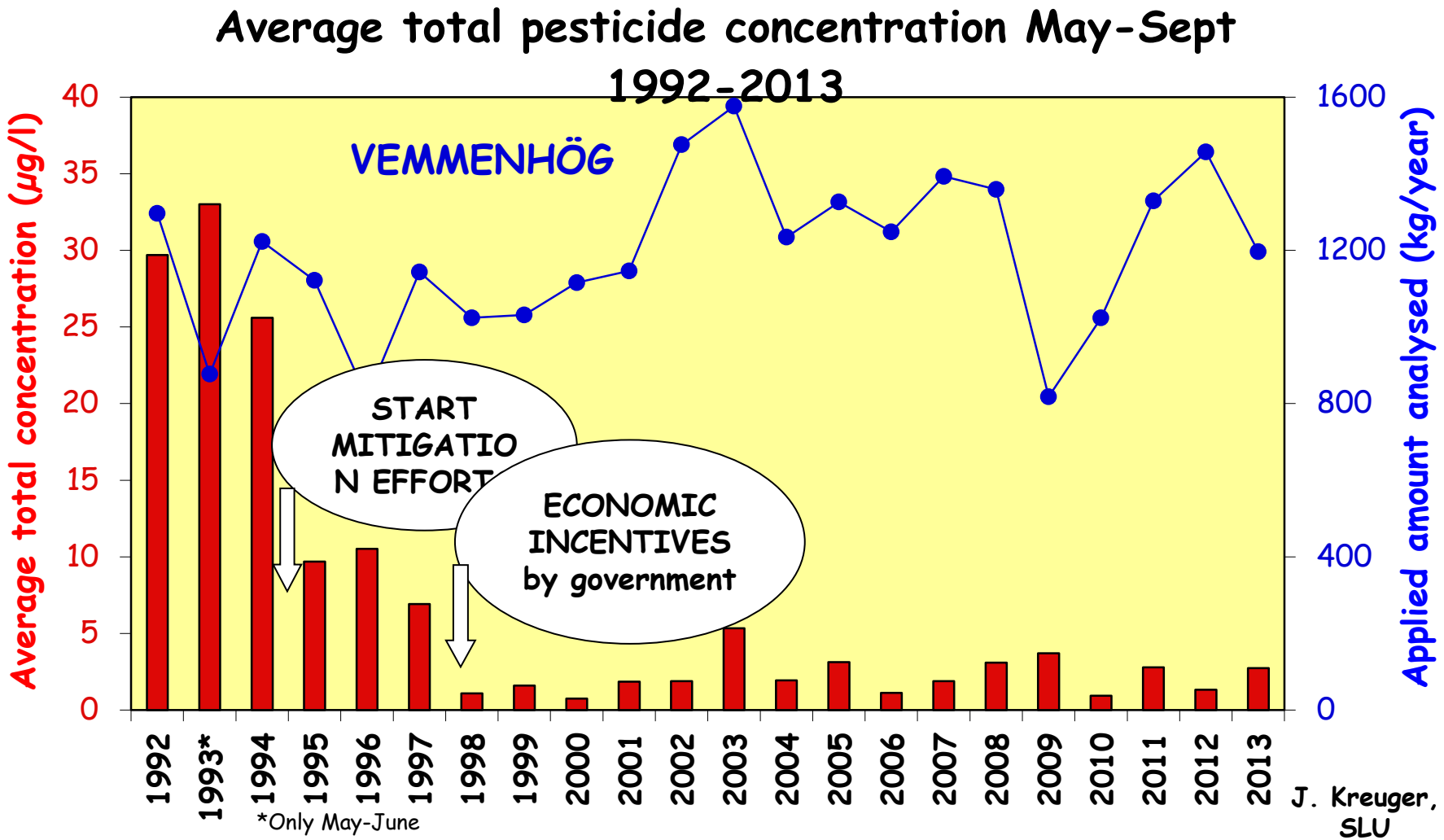
# Swedish monitoring experiences
# The Vemmenhög catchment

- Monitoring of pesticides in stream water from an agricultural catchment in southern Sweden
- Started in 1990, now 25 years of data



# Results long-term monitoring

## A 90% reduction in pesticide concentrations



# Current Swedish pesticide monitoring program in agricultural areas – from 2002


- **Surface water:**
- Västergötland (O18)
- Östergötland (E21)
- Halland (N34)
- Skåne (M42)

***Streams*** *draining small catchments (8-16 km²)*

- Skivarpsån
- Vegeå

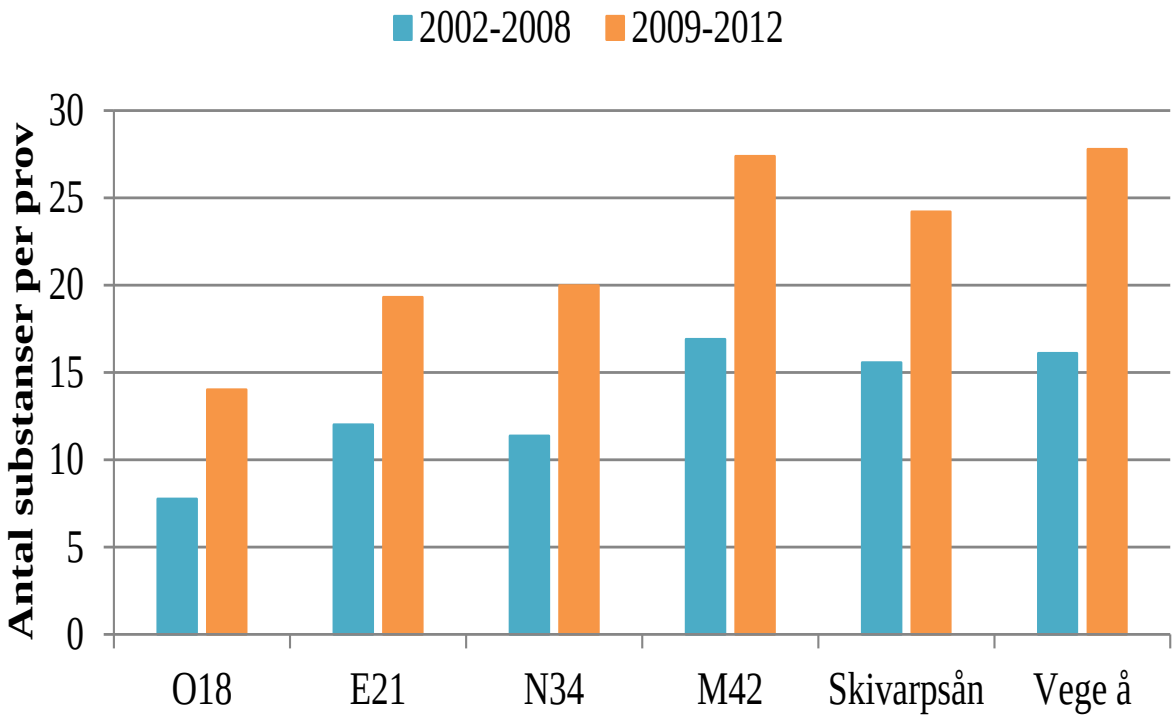
***Rivers*** *(100-500 km²)*

Objective: Feed-back on the national risk-reduction program and the regulatory process, as well as the basis for information to farming community

# Analytical program development

- New pesticides enter the market, old ones disappear
- The analytical program needs to be flexible
- Selection criteria:
  - Most heavily used (corresponds to ca. 90% of sold amounts in Sweden) and sprayed on large acreages
  - Superseded though still frequently detected
  - Included in Water Framework Directive (WFD)
  - Aquatic toxicity
  - List updated each year in co-operation with regulatory authorities and feedback from farmer interviews

# Number of pesticides detected



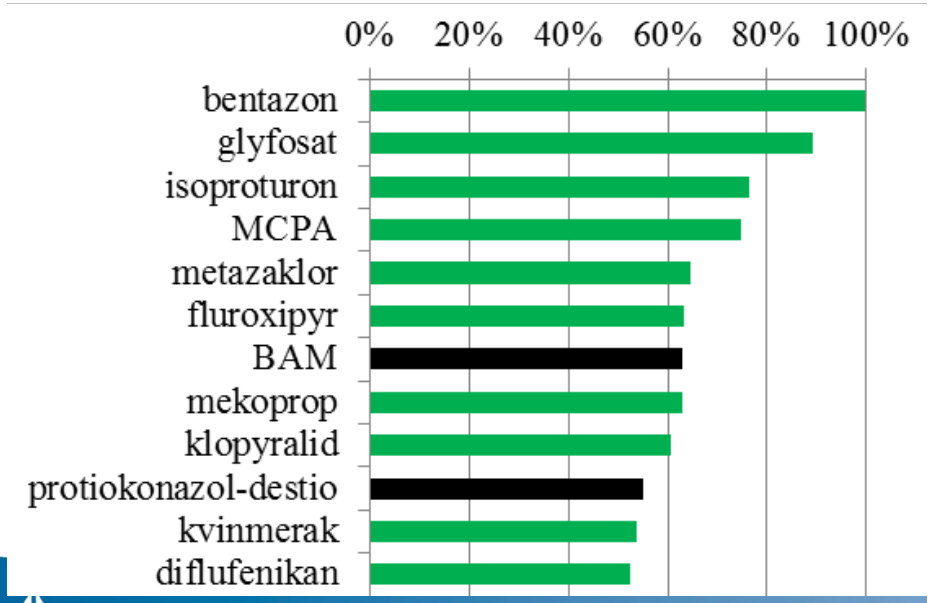

Average number of pesticides detected per sample, divided between two periods

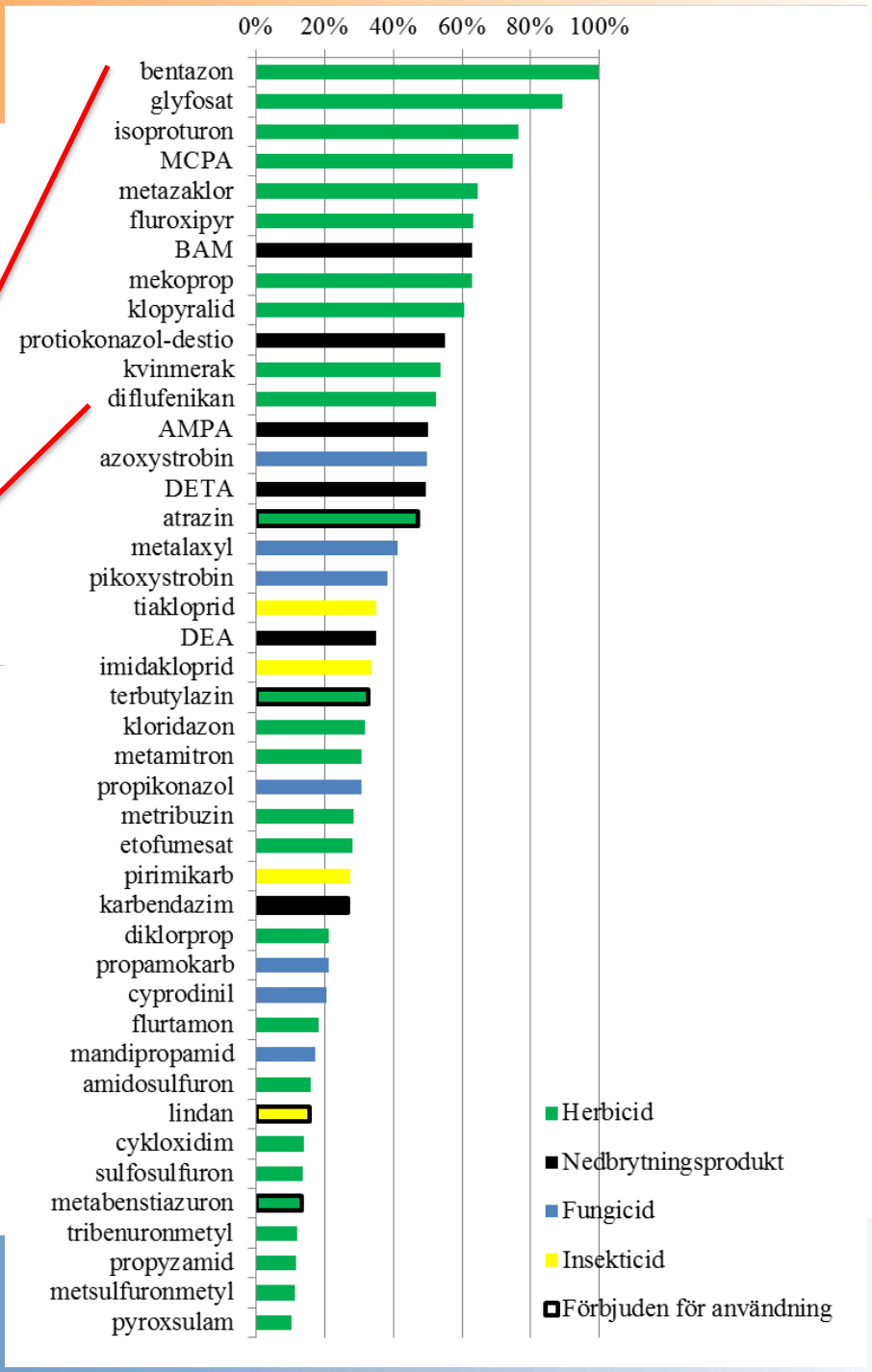
From 2009

- A generally lower limit of detection (LOD)
- More pesticides included in the program (e.g. some potato fungicides)

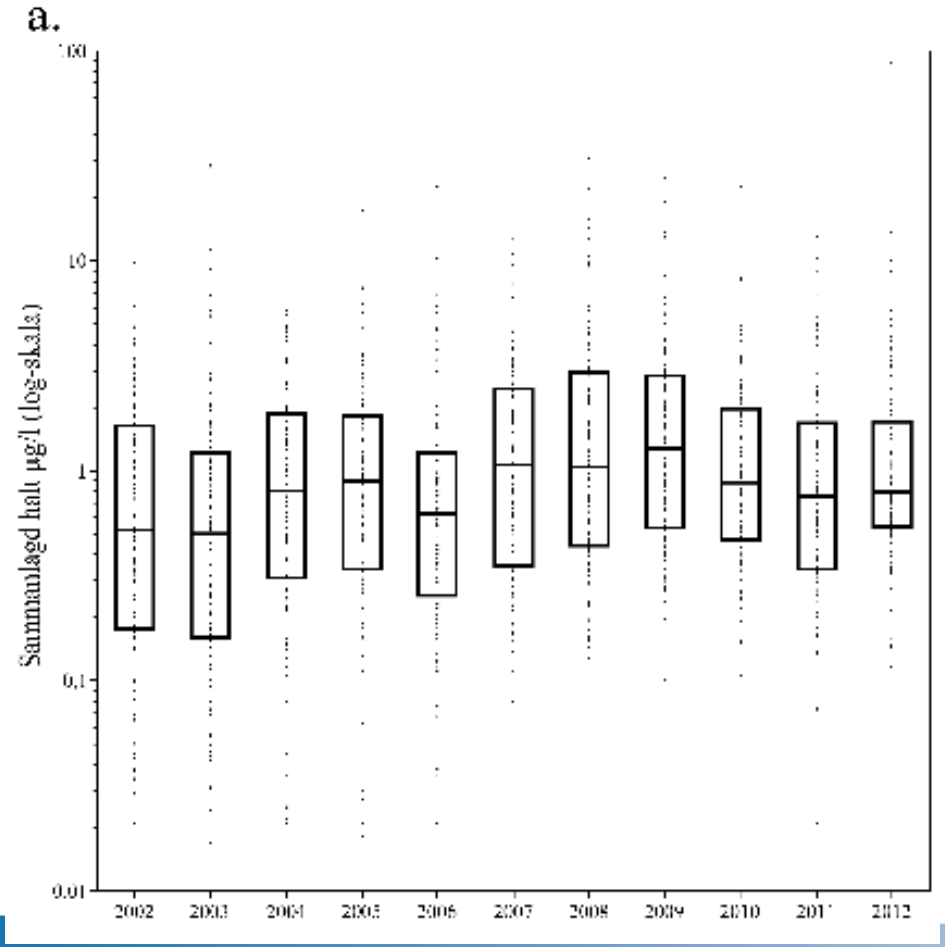
# Surface water

- Herbicides dominating
- Some legacy pesticides still detected



# ∑pesticide concentrations in surface waters 2002-2012




Annual median concentration - no trend during the past 11 years

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RISK

Exposure

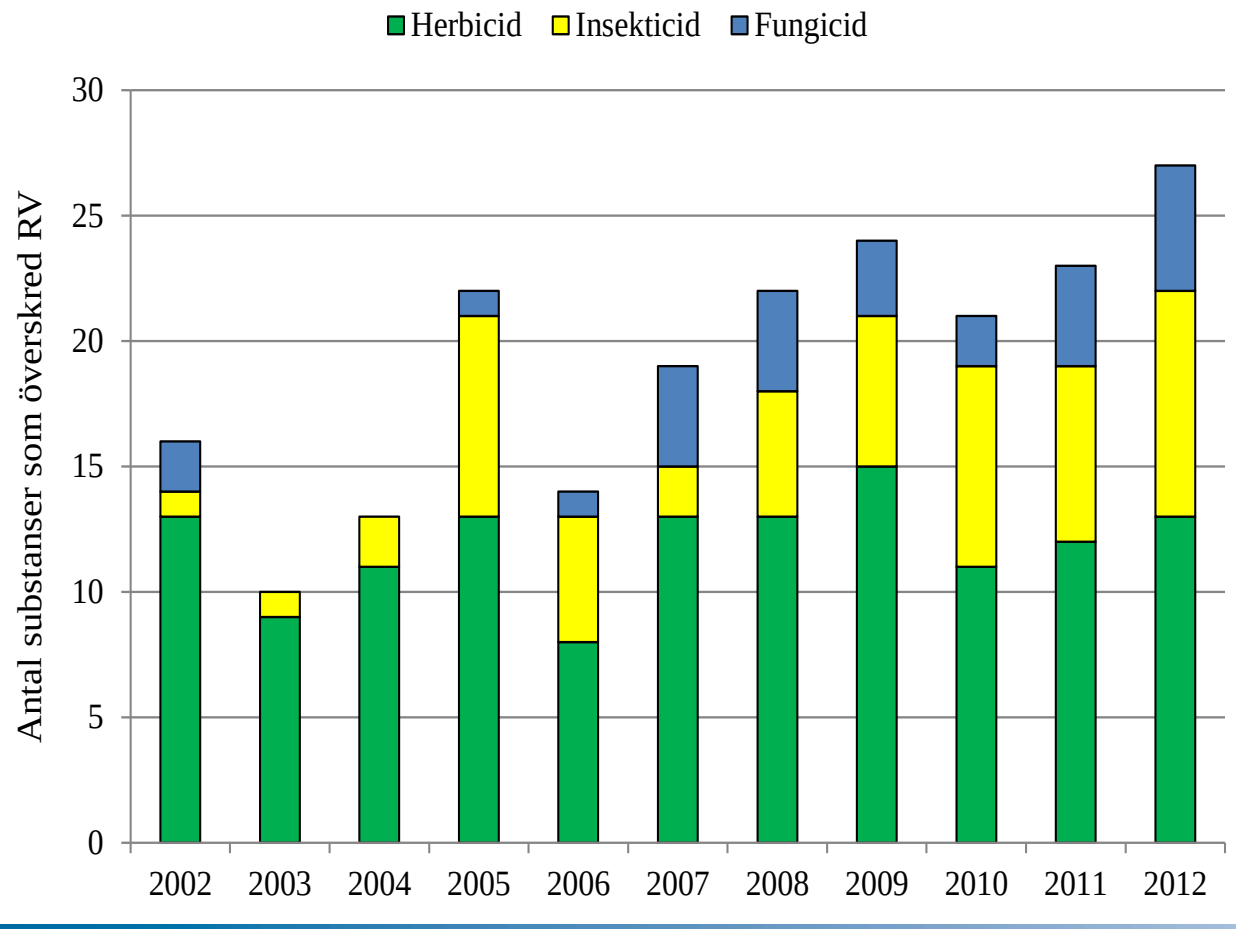
Toxicity

# Swedish National Environmental Quality Objectives (EQO) for surface waters (examples)

www.kemi.se

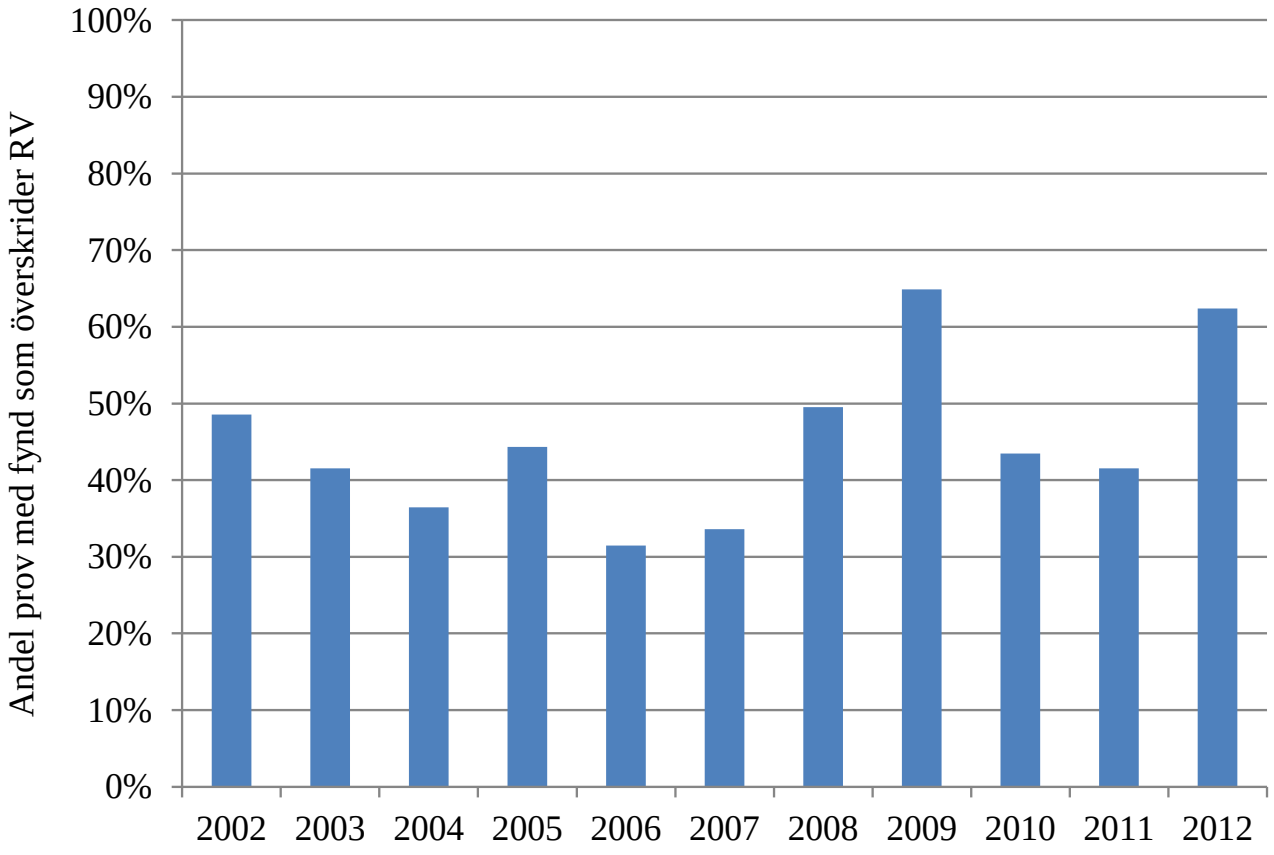
| Pesticide | EQO (µg/l) | Pesticide | EQO (µg/l) |
|---|---|---|---|
| fluroxypyr | 100 | aclonifen | 0.12 |
| glyphosate | 100 | tribenuron-methyl | 0.1 |
| clopyralid | 50 | pirimicarb | 0.09 |
| bentazone | 30 | metribuzin | 0.08 |
| mecoprop | 20 | sulfosulfuron | 0.05 |
| metamitron | 10 | triflusulfuron-methyl | 0.03 |
| MCPA | 1 | metsulfuron-methyl | 0.02 |
| fluazinam | 0.4 | terbuthylazine | 0.02 |
| isoproturon | 0.3 | rimsulfuron | 0.01 |
| fenpropimorph | 0.2 | diflufenican | 0.005 |
| metazachlor | 0.2 | esfenvalerat | 0.0001 |

# Findings above EQS or national Environmental Quality Objectives (EQO)




Number of pesticides detected ≥ EQS or EQO per year

# Findings above EQS or national Environmental Quality Objectives (EQO)




Number of surface water samples with one or more pesticides exceeding EQS or EQO

# Conclusions

- Results demonstrate a 90% decline in pesticide concentrations in surface waters when implementing best management practices and applying pesticides according to regulation – however, during later years no decline in either absolute concentrations or in relation to toxicity levels
- How do we know if current pesticide concentrations are good enough or not when it comes to protecting species and the biological status in the aquatic environment – in the field?
- This workshop will show us the way forward!

# Questions?

Acknowledgement:

- The national pesticide monitoring programme is funded by the Swedish Environmental Protection Agency
- Information about pesticide research and monitoring at SLU www.slu.se/ckb (Centre for Chemical Pesticides)
- Publications downloadable from: http://www.slu.se/ckb/miljoovervakning/publikationer
- Data downloadable from: http://jordbruksvatten.slu.se

jenny.kreuger@slu.se

# Pesticide monitoring – many different reasons

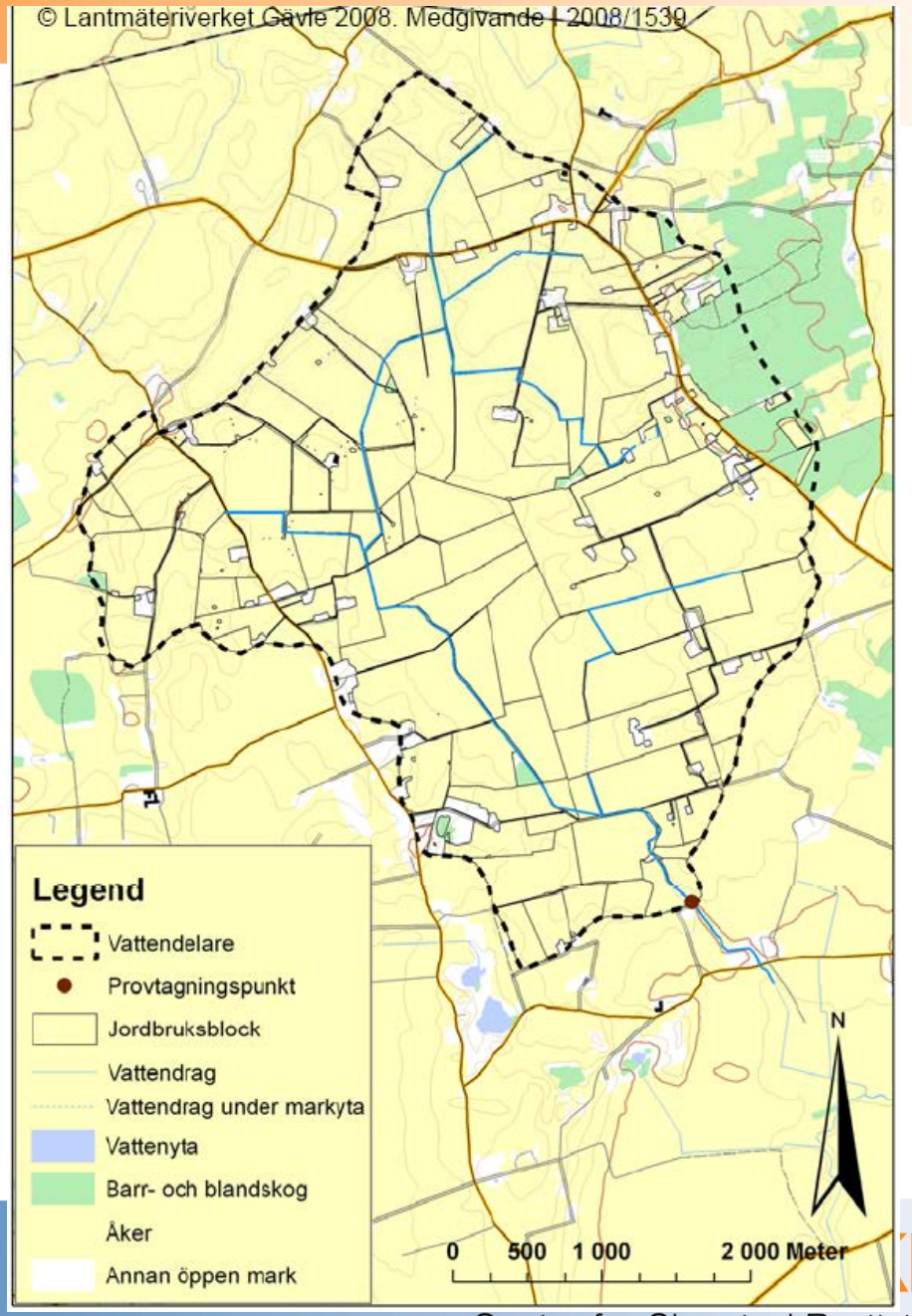
- To investigate pesticide fate in the actual field situation
  - Go beyond the the well-controlled conditions common for most environmental fate studies
- Investigate the development over time
  - Follow-up on regulatory decisions (eg drinking water directive, WFD)
  - Follow-up on the registration process and policy changes
- Develop scientific understanding
  - Calibration/validation of exposure models (regional/catchment scale)

# Stream water sampling in catchments

- Automatic water sampling
- Time paced weekly composite samples (1 sub-sample each 90 min during the week) during main growing season
- During later years also bi-weekly composite samples during winter season in 2 catchments
- Continuous water flow measurements

# Catchment inventory

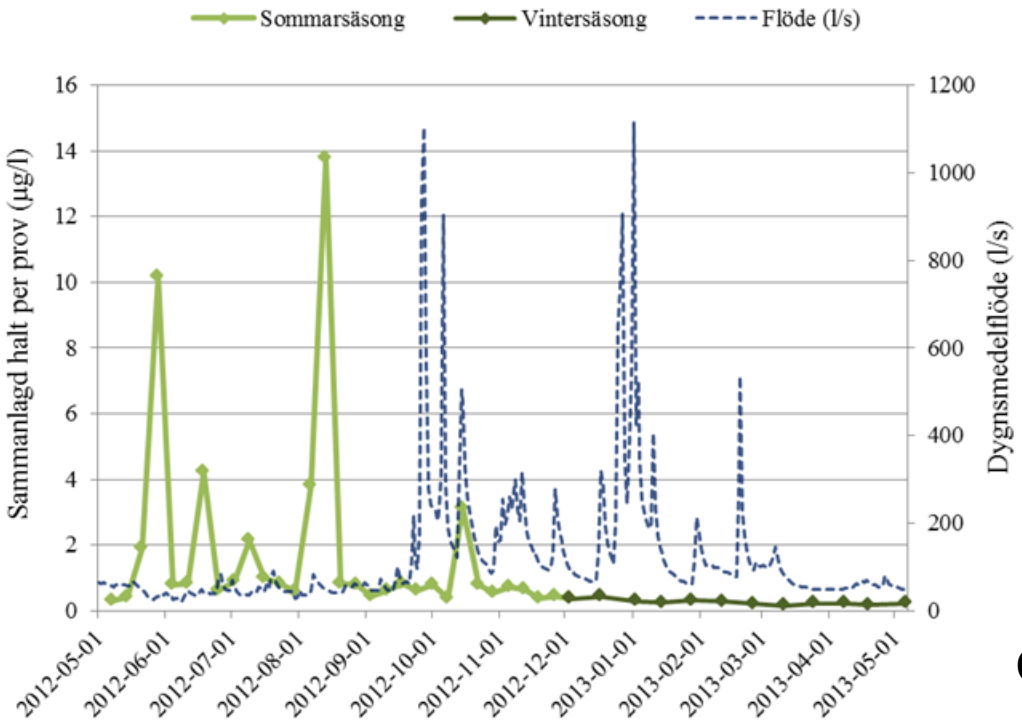
- Yearly interviews with farmers in the catchments on the use of pesticides (& crops and nutrients) – which pesticides, when, where and how much
- Gives good background for interpretation and method development, as well as model validation



# Analytical methods

- On-line LC-MS/MS for a broad range of pesticides
  - Method description *Jansson & Kreuger, 2010, J. AOAC Intern., vol 93, 1732-1747*
- GC-MS for the most non-polar compounds
- Currently including ca 130 different pesticides in the monitoring program, incl. some degradation products
- LOD/LOQ levels are at the ng/l-level for most pesticides

# Summed weekly (summer) and bi-weekly (winter) average concentrations over a growing season (2012/2013)



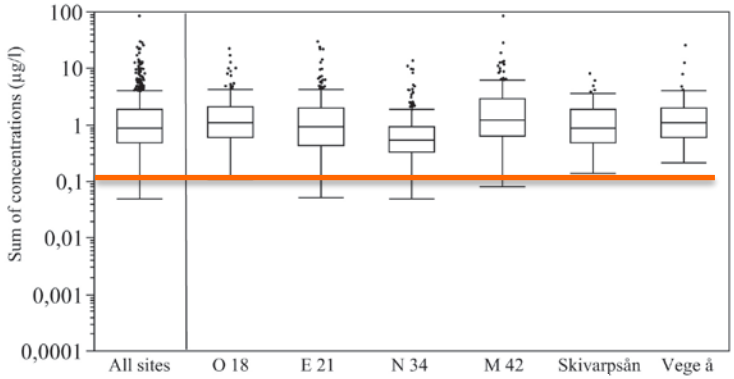

= pesticide concentration (µg/l)

= waterflow (l/s)

Catchment Halland (N 34)

# Concentration levels in streams

HERBICIDES

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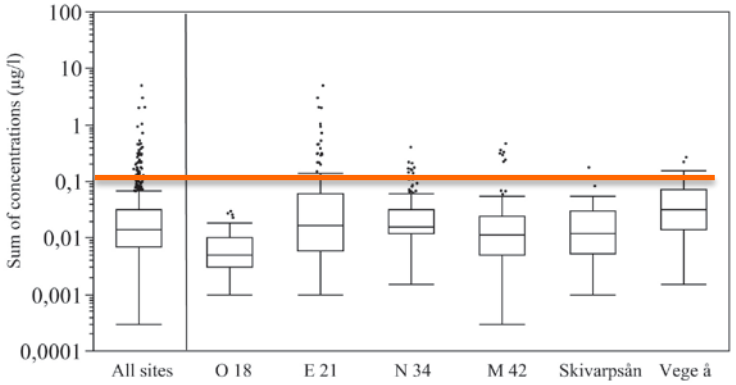


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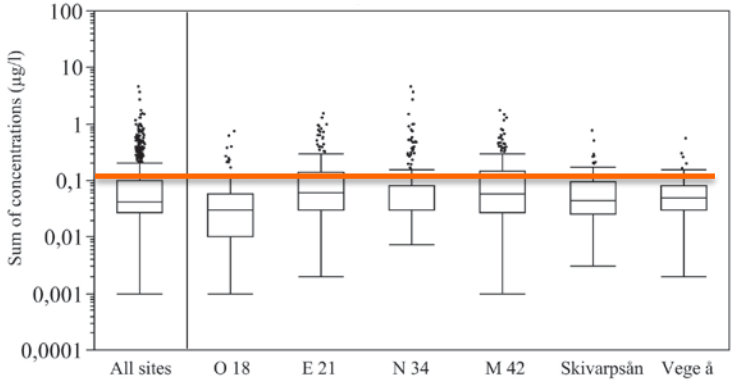


- Roughly a 100-fold difference in concentration levels between the three types of pesticides – reflecting a difference in application rates
- Concentration levels in rivers (based on grab samples) does not differ substantially from the smaller streams

Data from 2002-2012

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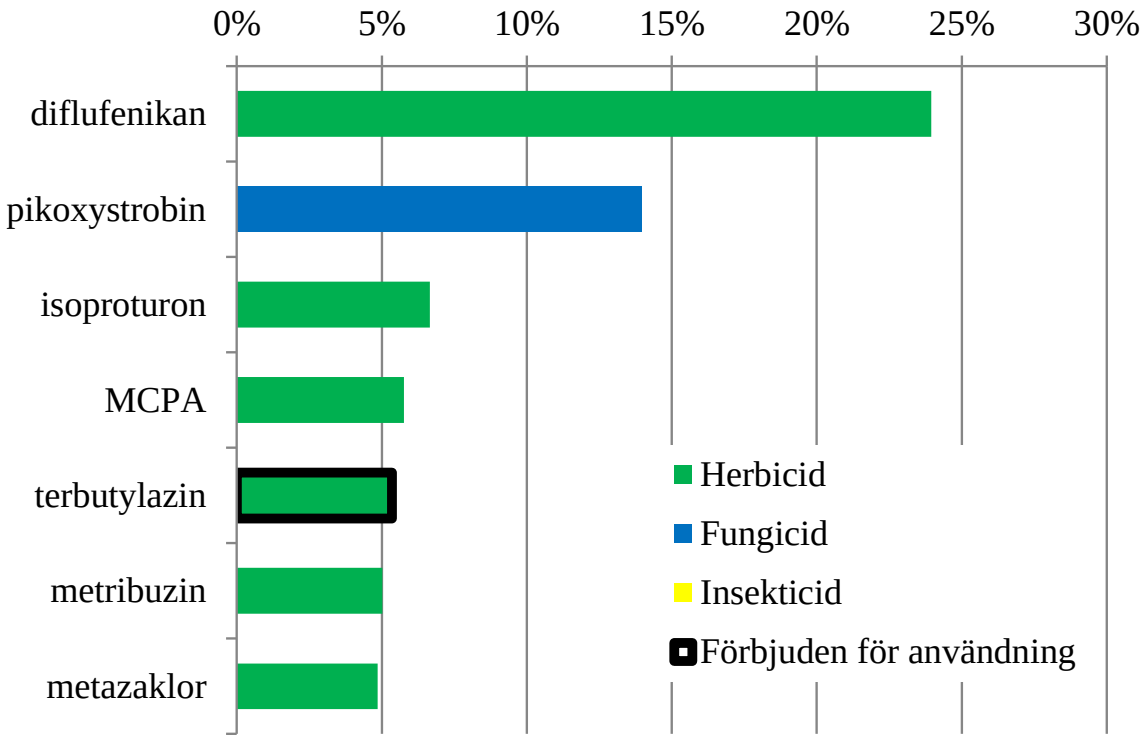
# Pesticides exceeding WQO 2002-2012




Detection frequency of pesticides exceeding the national WQO for surface water samples (>5%), 2002-2012

# CKB's mission statement

- Develop knowledge that allows the effects of chemical pesticides in the environment to be described and predicted in a reliable way - *and*
- This knowledge shall lead to countermeasures so that the impact on the environment lies within acceptable limits

# Pesticides in water from

- Diffuse sources
  - Processes influenced by soil and weather conditions, the intrinsic properties of the pesticide, management practices *(EU regulation 1107/2009)*
- Semi-point and point sources
  - Unregulated applications, e.g. on surfaces with no active soil such as farmyards, or practices, e.g. effluents from greenhouses
  - Spillage during application, filling and cleaning spraying equipment, waste disposal, accidents *(EU directive 2009/128)*