Buffer strip width and agricultural pesticide contamination in Danish streams: Implications for stream and riparian management

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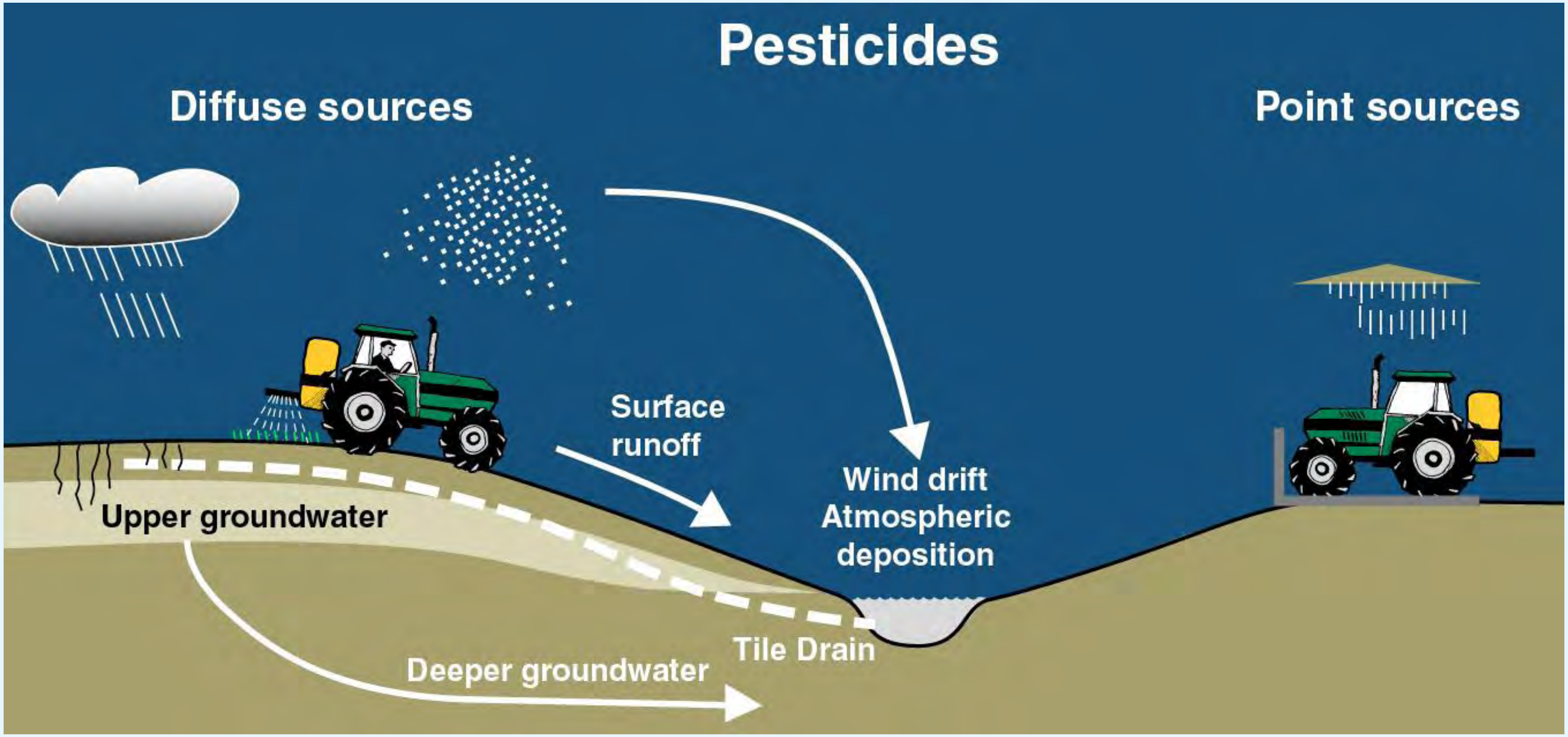
Outline

- **Transport routes for pesticides to streams**
- **Methodology**
- **Introduction to the SPEcies At Risk (SPEAR) concept**
- **Pesticide toxicity and buffer strip dimensions**
- **Prediction of in-stream pesticide toxicity using the Runoff-Potential (RP) model**
- **Conclusions**

I. Major transport routes for pesticides

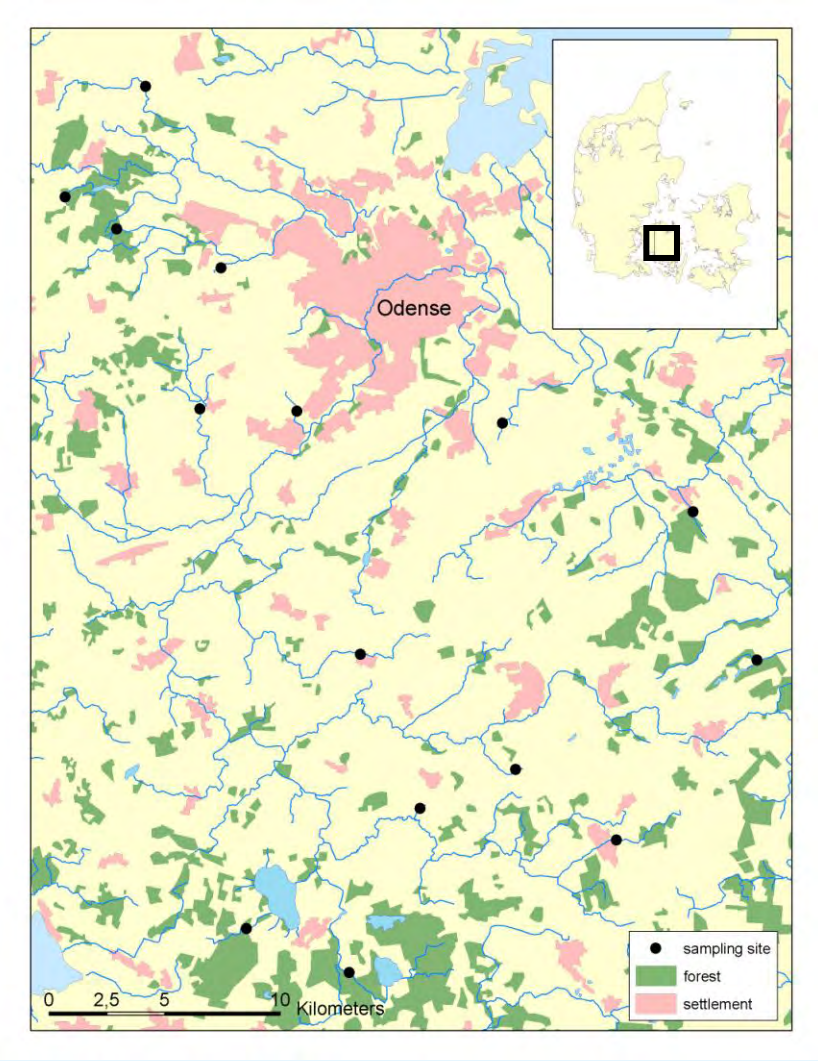


Frequency is similar while max. concentration is significantly higher in small streams

	Large streams		Small streams	
	Frequency (%)	Concentration Max (µg/l)	Frequency (%)	Concentration Max (µg/l)
Isoproturon	41	0.13	48	2.1
Diuron	37	0.073	29	0.36
Bentazon	25	0.028	37	1.2
Fenpropimorph	0	0	3	0.11
Dimethoat	2	0.034	4	0.12

Examples of frequency and maximum concentrations of pesticides in two stream types from the Danish Monitoring Program (NOVANA)

II. Methods



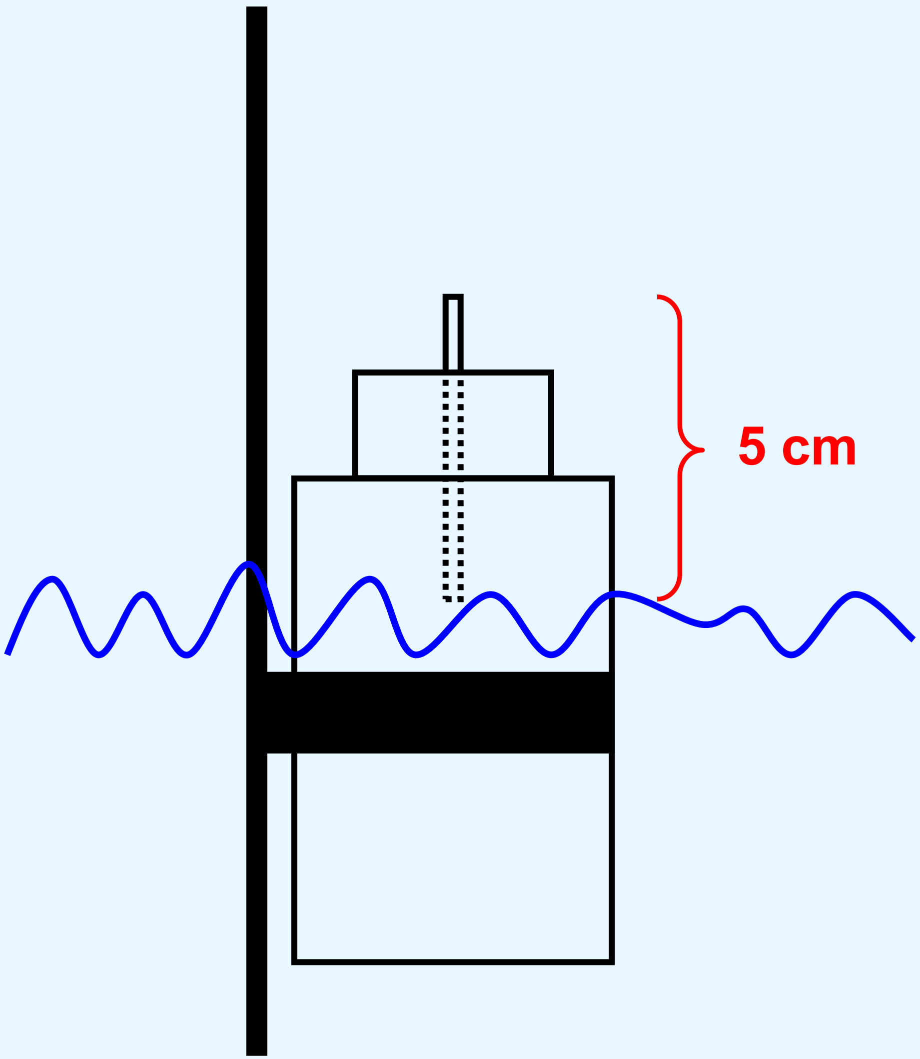
- **5 Sites in forested catchments**
- **9 Sites in catchments with intermediate to heavy agriculture**

Pesticide sampling

- **Event-triggered samplers (storm flow)**
- **Manual grab sampling of water (base flow)**
- **Sediment sampling (kayak corers)**

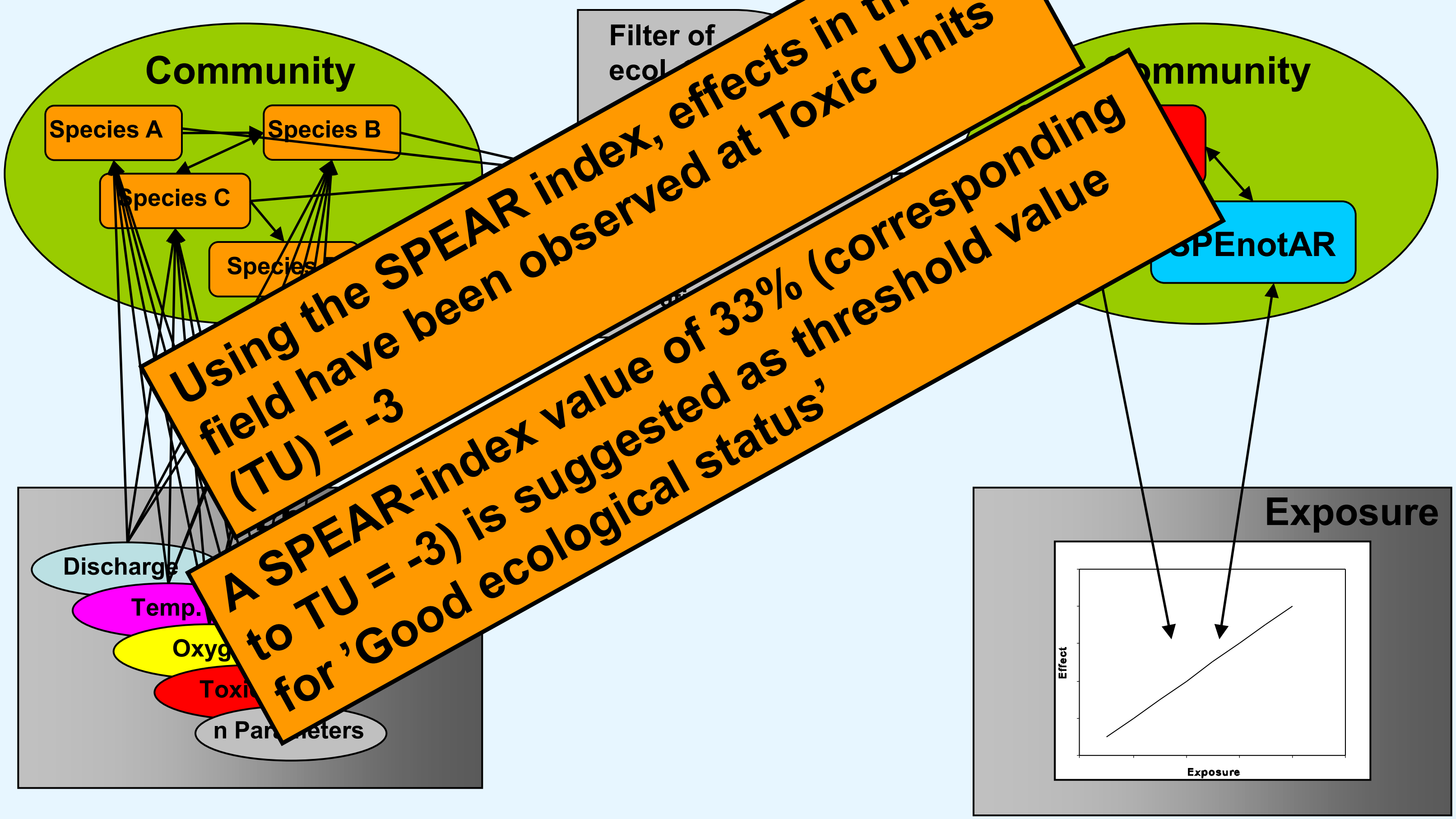
- **Samples were analysed for 19 herbicides, 6 fungicides and 6 insecticides.**

Pesticide sampling



Modified from Liess & von der Ohe, 2005

III. The SPEAR concept



Using the SPEAR index, effects in the field have been observed at Toxic Units (TU) = -3

A SPEAR-index value of 33% (corresponding to TU = -3) is suggested as threshold value for 'Good ecological status'

Modified after Liess et al., 2008

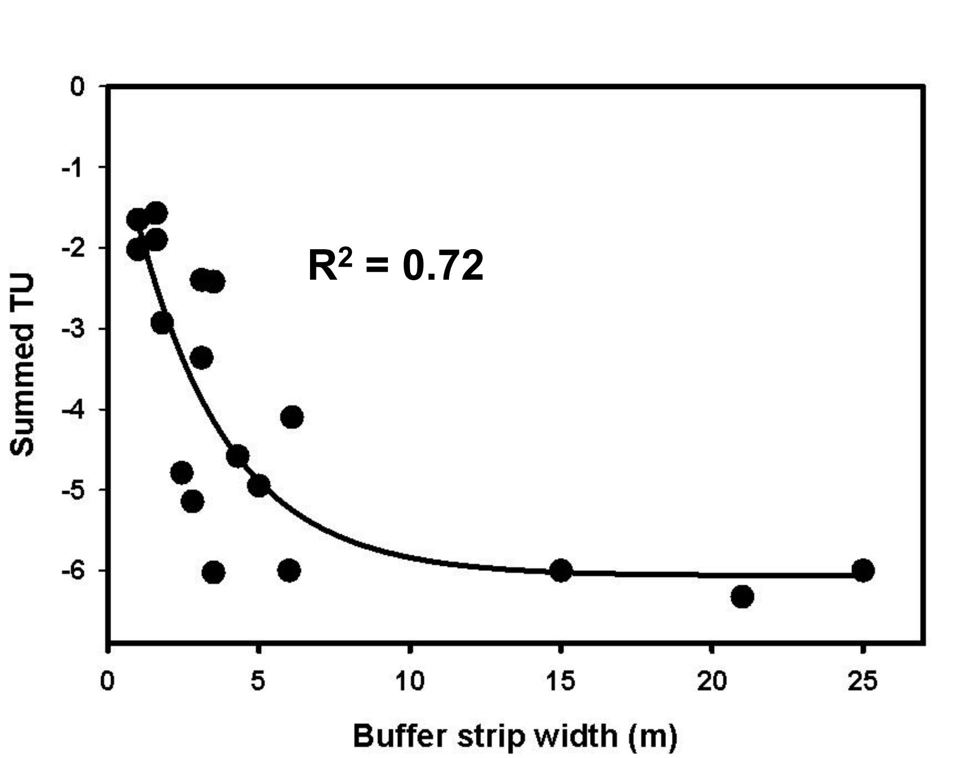
IV. Results

	Storm flow	Base flow	Sediment
Tot. conc. (µg L^{-1})	0.01 – 3.17	0.01 – 0.06	-
TU *(Daphnia magna)*	-6.63 to -1.57	-6.92 to -6.23	-

In total: 13 Herbicides
5 Fungicides
2 Insecticides

Buffer strips and pesticide toxicity

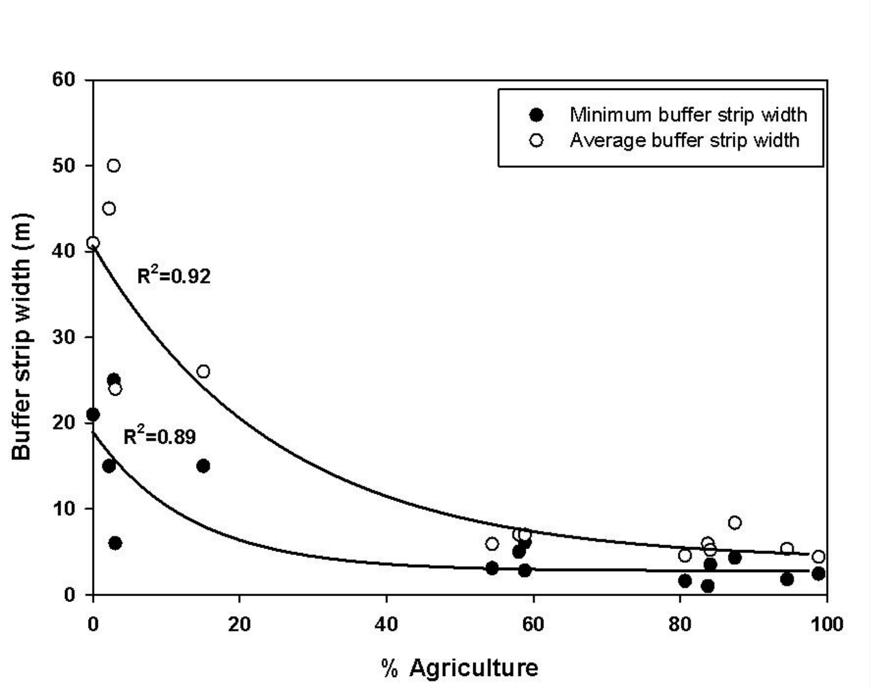
- **In-stream pesticide toxicity was primarily controlled by the width of buffer strips**
- **Buffer strips are known to retain significant proportions of pesticide runoff**
- **However, effects of buffer strips have never been linked to the toxicity of pesticides**
- **Tile drains???**



Rasmussen et al., 2011. (In press)

Buffer strips and agricultural intensity

- In addition, the width of buffer strips is clearly governed by agricultural intensity in the catchment
- This probably explains some of the strength in the correlation between buffer strip width and pesticide toxicity

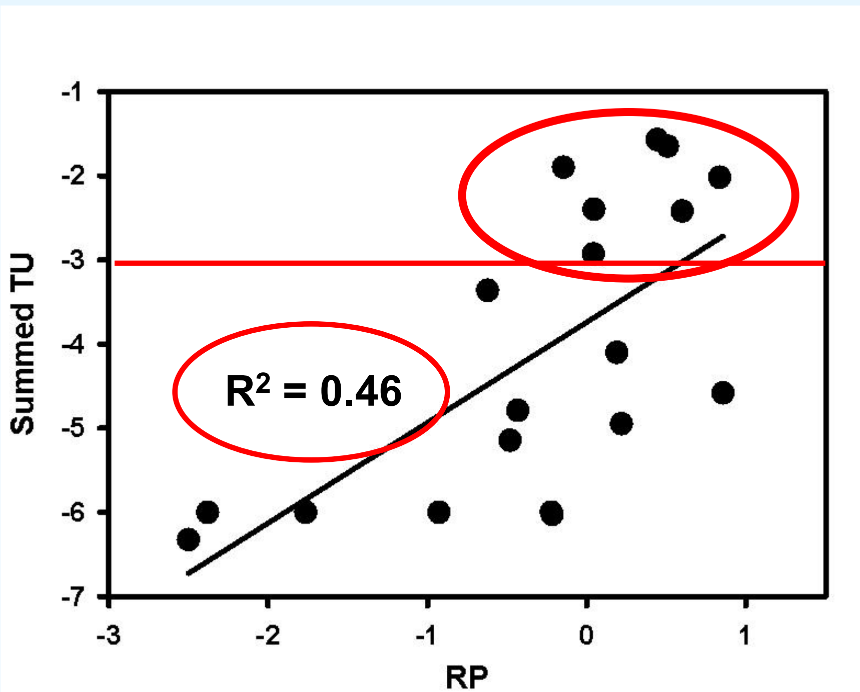


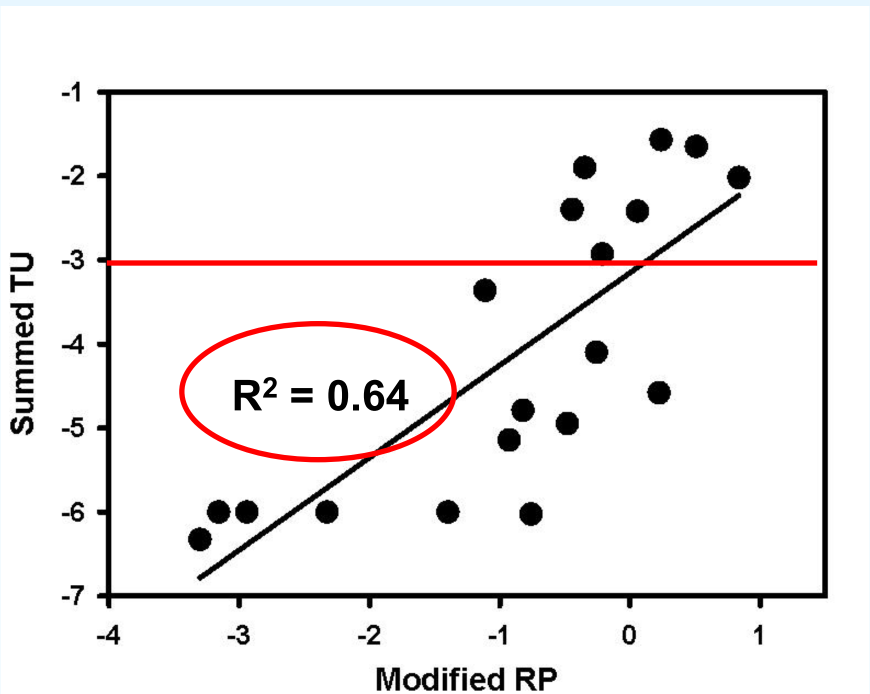
Rasmussen et al., 2011. (In press)

The Runoff Potential (RP) model

$$g_{LOAD} = \sum_{i=1}^{n} A_{ij} * D_{generic} * \left(1 - \frac{I_j}{100}\right) * \frac{1}{1 + \frac{K_{oc} * OC_i}{100}} * f(s_i) * \frac{f(P_i, T_i)}{P_i}$$

Buffer strips and predicted pesticide runoff

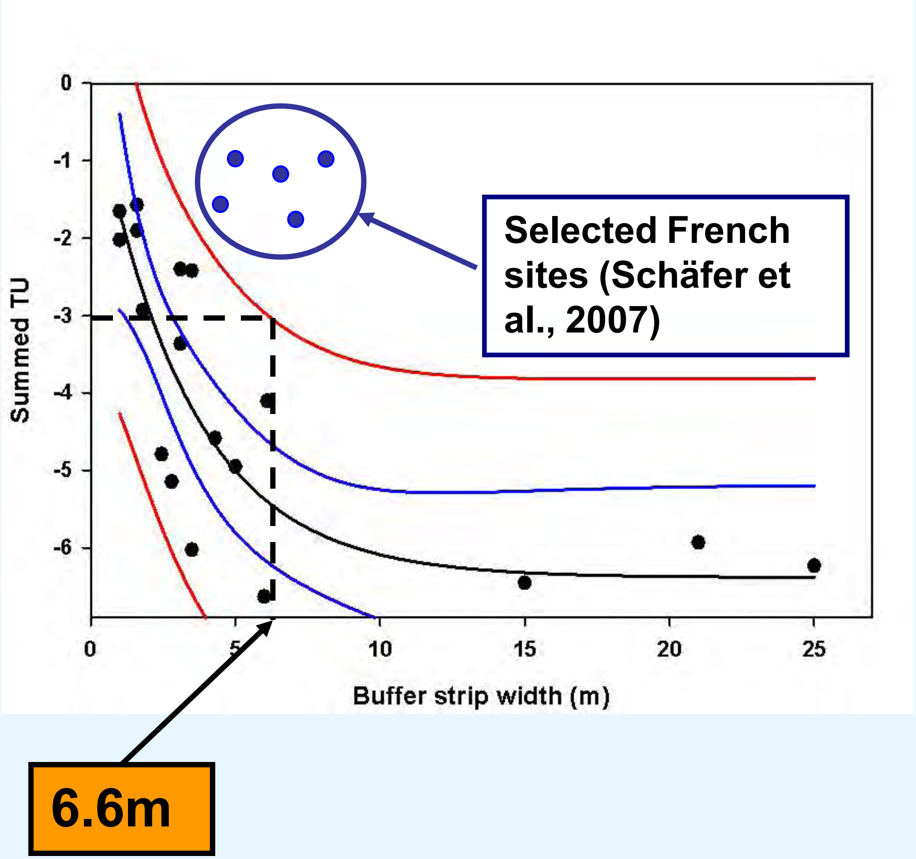




Rasmussen et al., 2011. (In press)

VI. Importance of buffer strips for obtaining good ecological quality

- **TU = -3 corresponds to 33% SPEARabundance = Good ecological status**
- **This emphasises the importance of vegetated buffer strips, but ideal dimensions should be estimated according to local site characteristics**



Conclusions

- **The prevalence and dimensions of buffer strips is indeed an effective mitigation tool for the protection of the upper branches of agricultural streams – however ideal dimensions should be assessed based on local site characteristics**
- **The suggested buffer strip width for sufficient protection of streams from pesticides is much below the dimensions that are presently required by Danish legislation (2 m for some higher-order stream sections)**

Conclusion

- **Despite the presence of buffer strips and relatively low pesticide application rates, the toxicity of found pesticide mixtures still exceed the threshold of expected community change**
- **Buffer strip characteristics improve predictive power of the RP model – and is tightly coupled to the occurrence and toxicity of agricultural pesticides in DK streams. We therefore find the improved RP model suitable for screening and identification of stream reaches at risk.**
- **Future research should focus on further improving the RP model using estimates for flow through tile drains**

Thank you for your attention!