

Sampling design – from a statistical point of view

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How we sample organisms (or sediment) has a large effect on

- estimates of **levels** and **spatial differences in levels**

- estimates of **time trends**

1. What do we consider **one station**?

- how many days do we allow sampling time to stretch over?

- how large area can we consider to be a single station?

 - 1a. Small-scale (some km)

 - 1b. Large-scale (hundreds of km)

2. How does **pooling of samples** affect the analysis and conclusions?

This study:

- Cod
- Legacy contaminants (metals, PCBs, etc.)

1a. Small-scale variation

Data from the VIC project



Inner Oslo fjord
(Asker-Håøya)

		Slemm.	Svestad	Håøya
1997	15.-18. jan	X	X	X
	22. jan	X		
	3. feb	X		
1998	15.-17. jan	X	X	X
	21. jan	X		
	2. feb	X		
1999	14. jan	X		
	18.-21. jan	X	X	X
	28. jan	X		



One location, one sampling



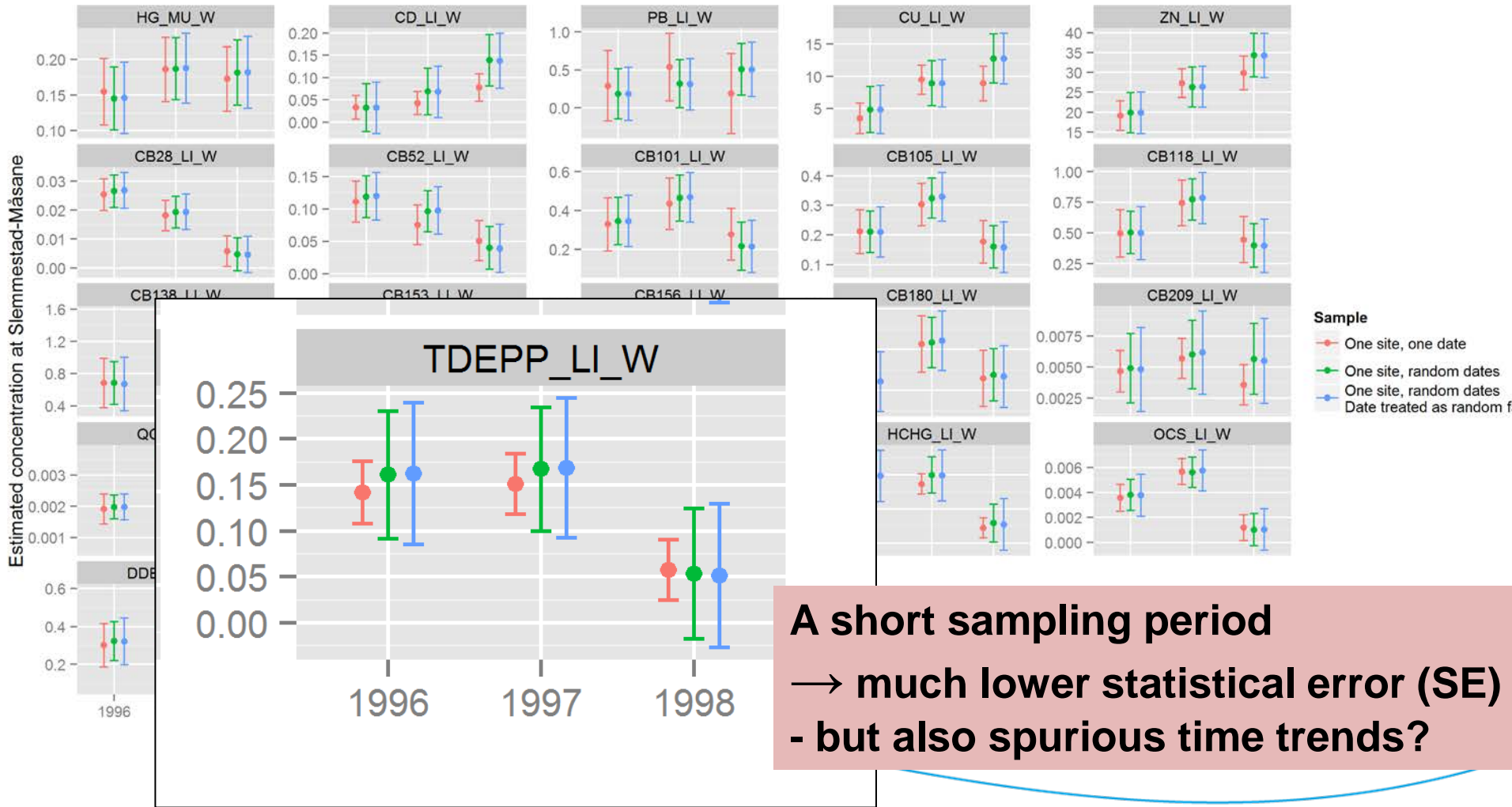
Extension in space (3 locations)



Extension in time (ca. 2 weeks)

Sampling extended in time

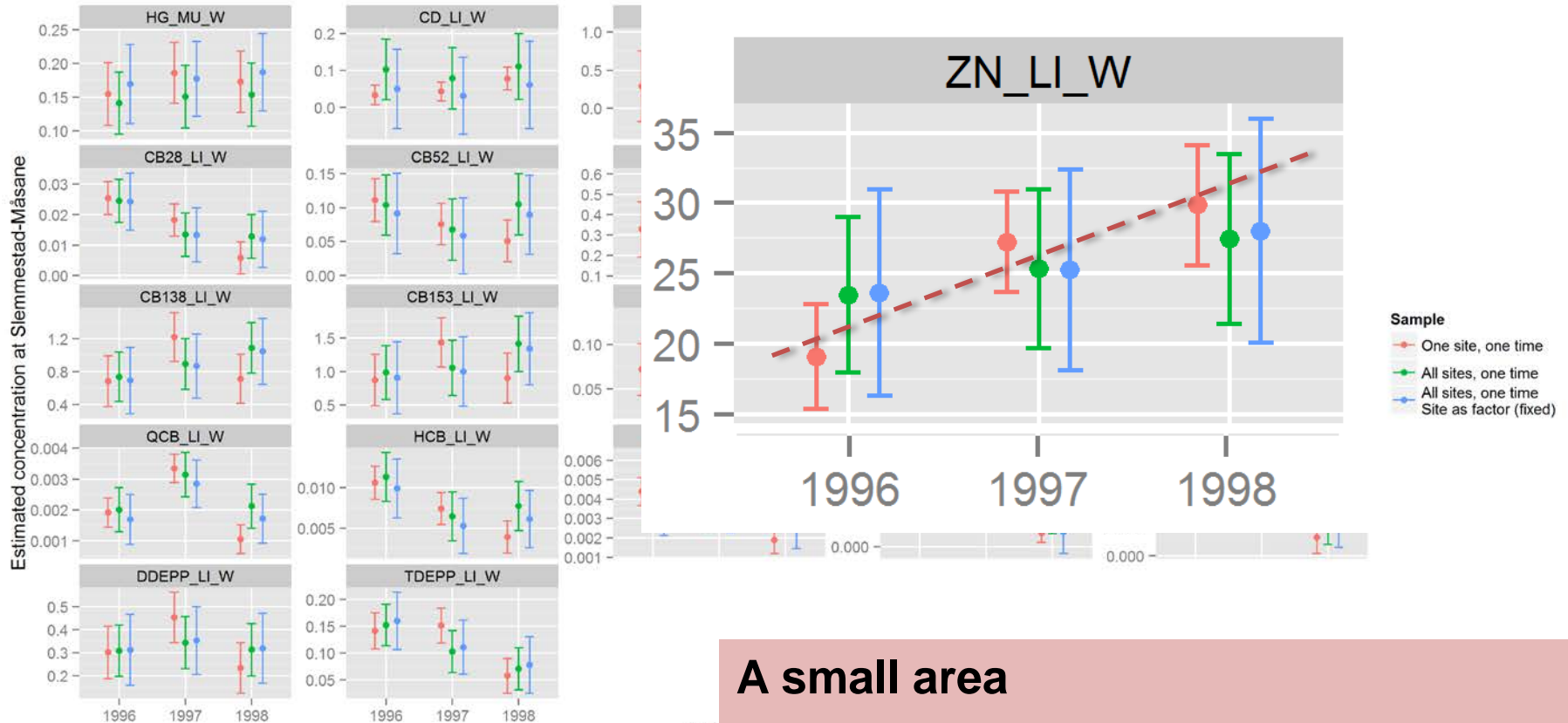
1 locality, 1 day (●)
 1 locality, 3 days during 2 weeks (●, ●)
 (● and ● : date as fixed or random factor)



Sampling extended in space

1 locality, 1 occasion (●)
 3 localities, 1 occasion (●, ●)
 (● and ● : location fixed / random factor)

Extension of sampling in space

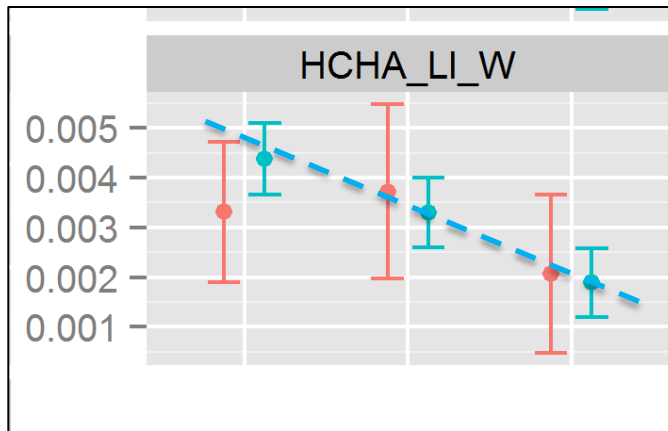


A small area

→ much lower statistical error (SE)
 - but quite clearly spurious time trends

Sampling extended in both **space and time**

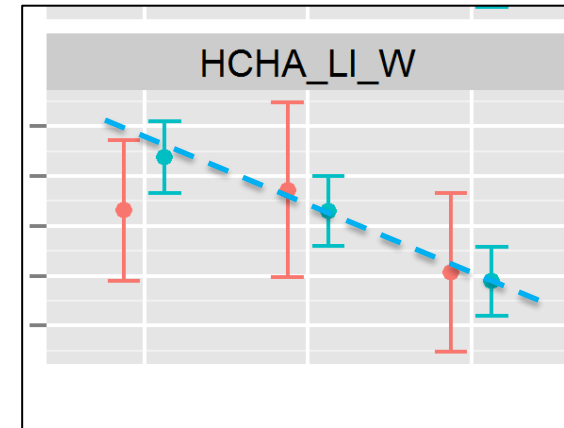
All data (●)
compared with
One location, one occasion (●)



Same conclusion: lower statistical error (SE) but spurious time trends

Conclusions for small-scale studies

- sampling over a small area and a short time
- **Unrealistically low statistical uncertainty**
- **Spurious trends**
- Fish in a single sample are clearly not independent of each other

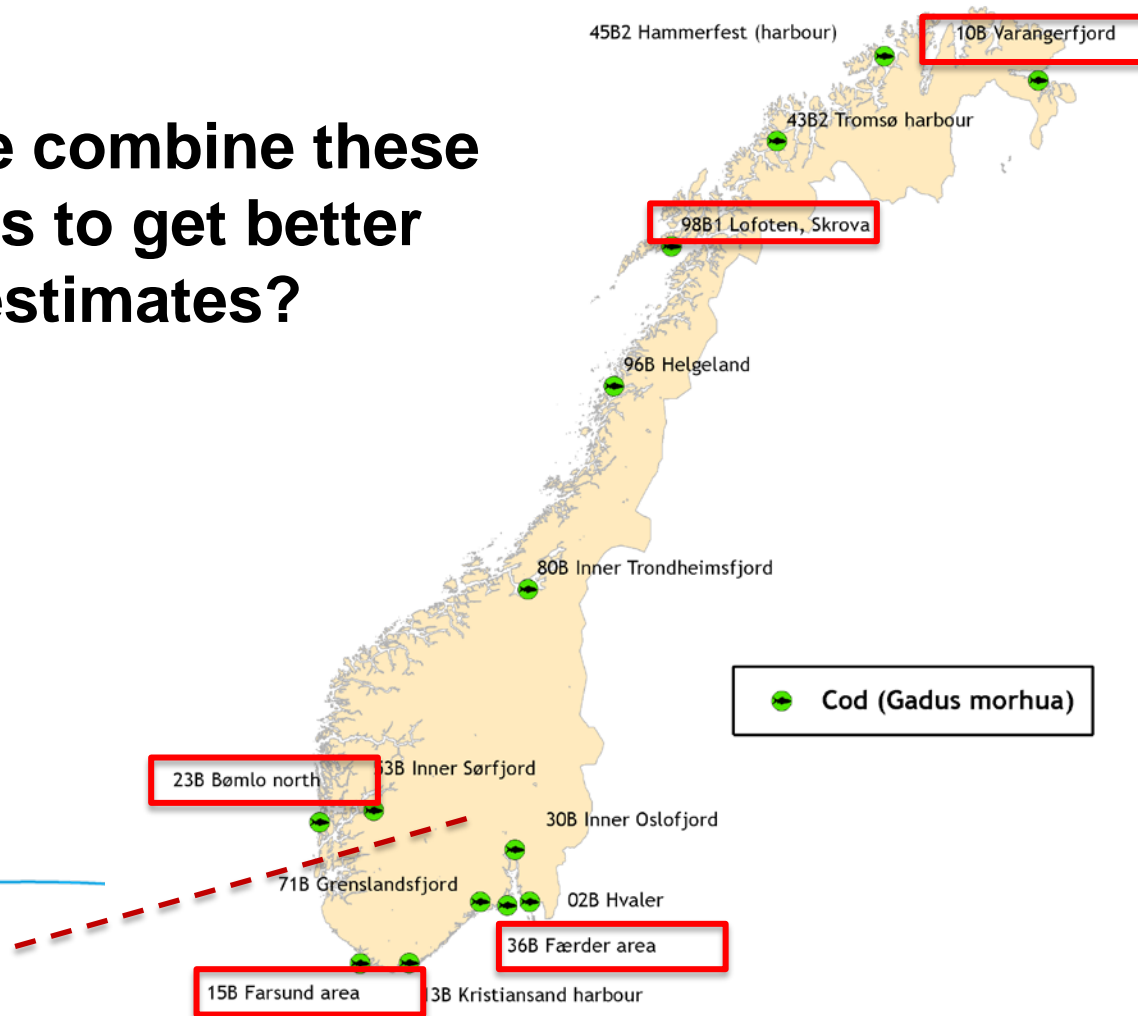


		Slemm.	Svestad	Håøya
1997	15.-18. jan	X	X	X
	22. jan	X		
	3. feb	X		
1998	15.-17. jan	X	X	X
	21. jan	X		
	2. feb	X		
1999	14. jan	X		
	18.-21. jan	X	X	X
	28. jan	X		

1b. Large-scale variation

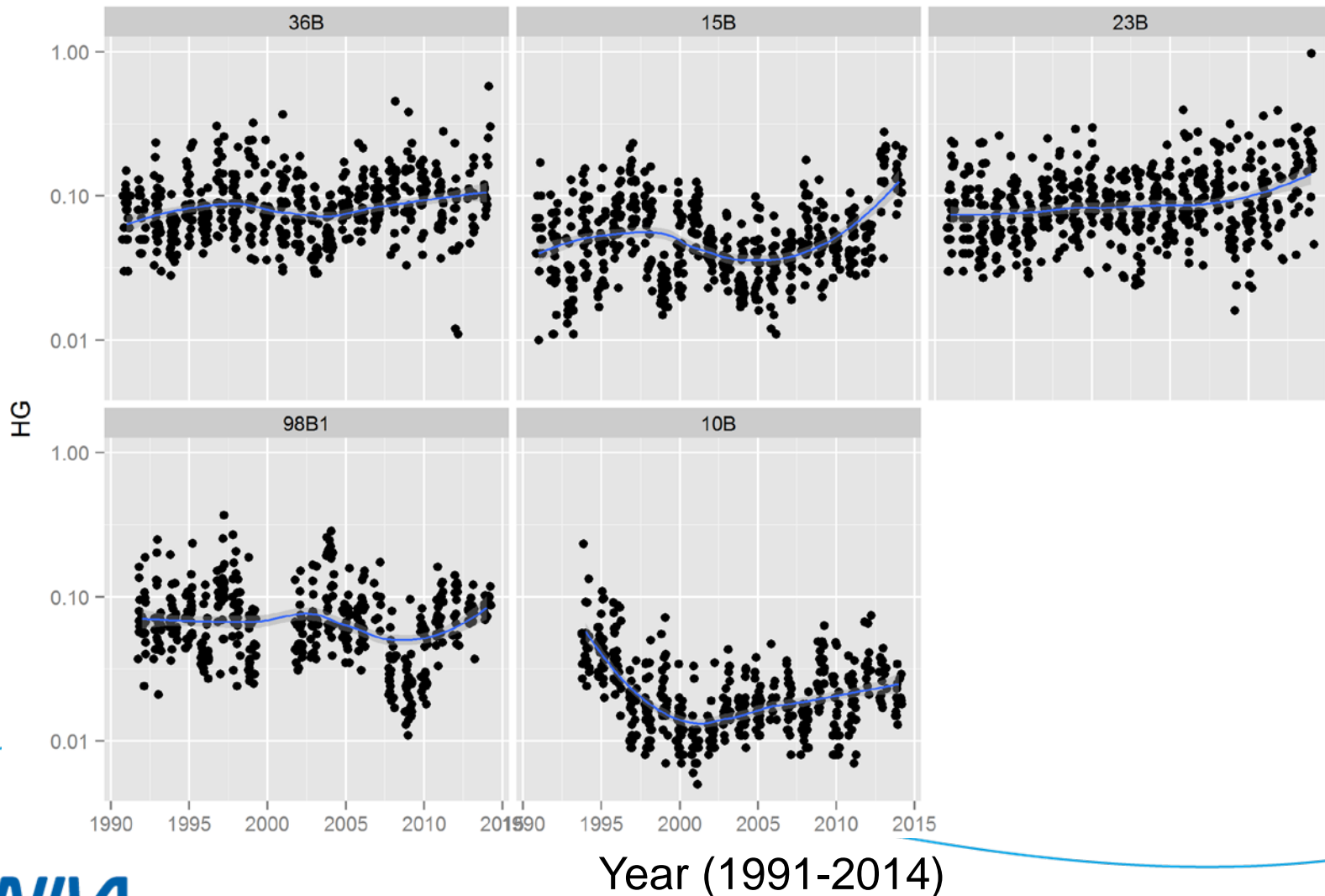
Picked stations not close to point sources

Can we combine these stations to get better trend estimates?



1b. Large-scale variation

Example: mercury

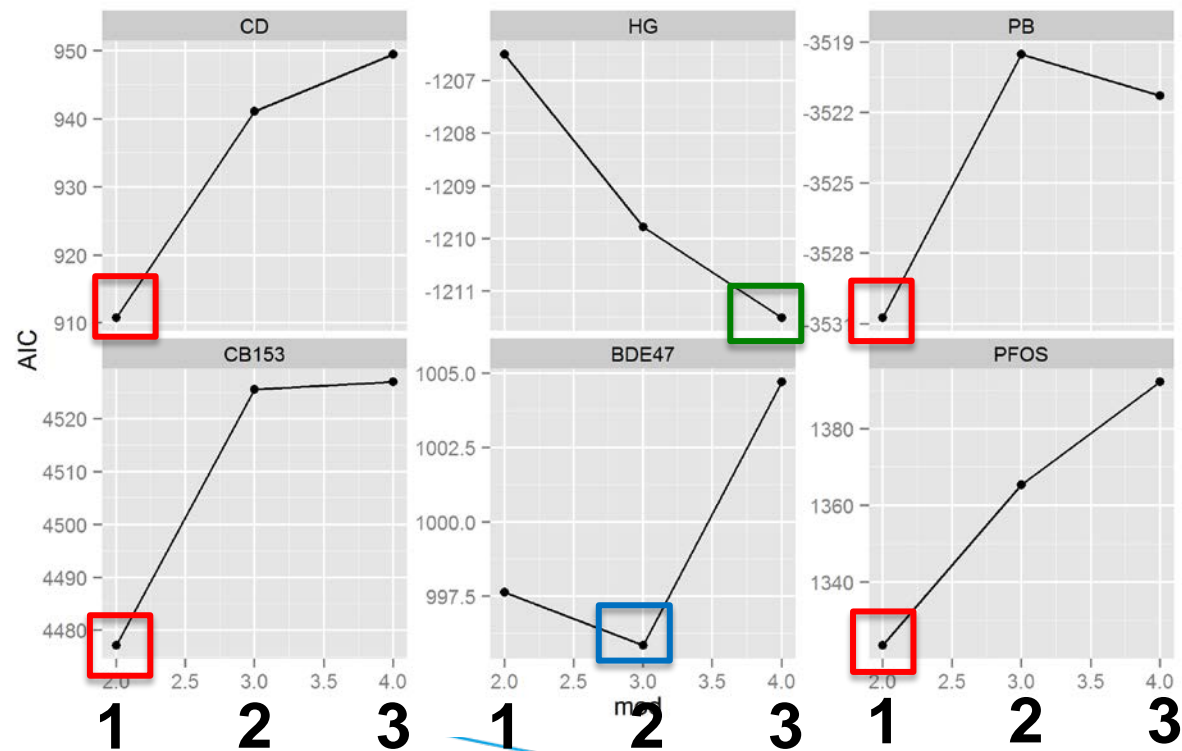


1b. Large-scale variation

Compared three models:

- ➔ (1) Specific time trend for each station
- ➔ (2) Specific time trend for southern vs. northern areas
- ➔ (3) Common time trend

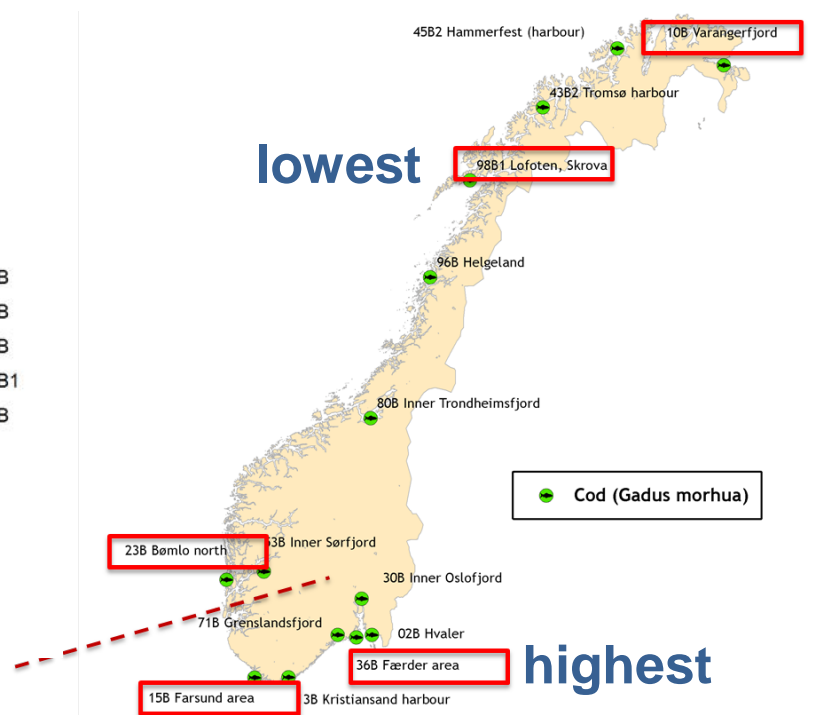
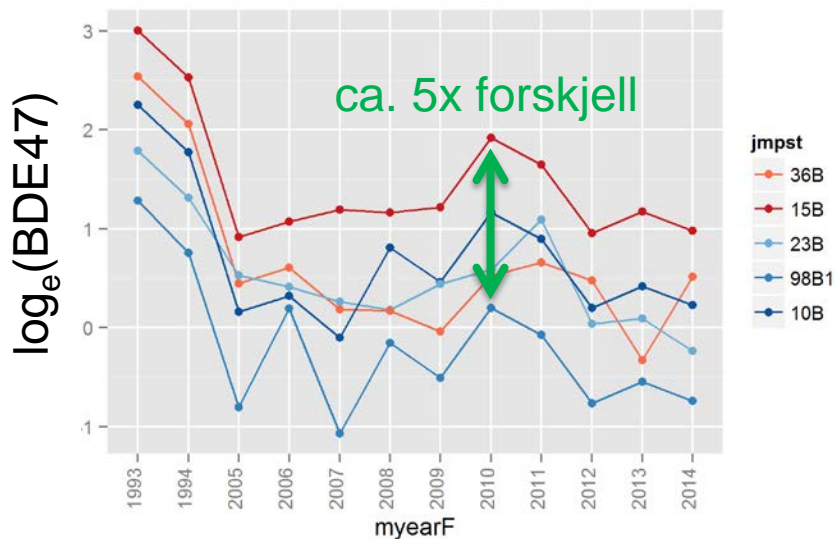
AIC
lower values
= more
parsimonious
model



1b. Large-scale: conclusions

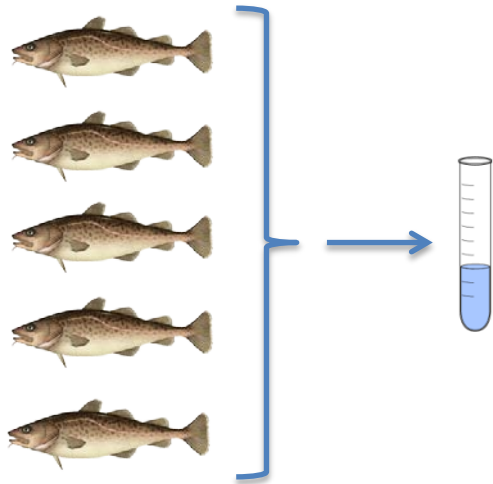
- Even "uncontaminated" locations have very often very different trends
- In addition, concentration levels differ a lot among stations

- Example: BDE-47



Dag Ø. Hjermann 5. november2015

2. Pooled samples



Example: 25 fish per station

(1) 25 analyses

(2) 5 analyses (each pooled from 5 fish)

→ **Loses a bit statistical power**

"Loses" 15-30 % of significant time trends

→ **A bit higher rate of Type 1 errors**

Method (2) shows a trend in 1-2% of the cases where method (1) does not show a trend

→ **Mean level becomes biased upwards**

Estimated concentration ca. 10-20 % too high
But: can be adjusted if the number of fish per sample is (approximately) equal

Conclusions

- On a small scale (for instance, within a fjord), it is advantageous if sampling is done over some time (~2-3 weeks) and space (some km)
 - Fish in a sample tends to have similar age and history
 - At least when using active gear (i.e. trawling)
- On a large scale, stations should not be combined
- Pooled samples are OK (significantly more "bang for the buck") but pooled samples should contain equally many fish
- Same conclusions for emerging contaminants?