

Lead in game in Sweden



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Background

- Studies from e.g. Germany, Spain, USA, Norway and Efsa have shown elevated levels of lead in game.
- Studies indicate that consumption of game is positively correlated with increased lead levels in blood.
- New toxicological evaluations of lead (Efsa, 2010; JECFA, 2011, NTP 2012), leading to withdrawal of TWI, and concluding no “safe level” for lead.
- Efsa conclude that exposure of lead to pregnant women (fetuses) and children in Europe is close to, or over, the health based reference point, 0,5 μg Pb/kg b.w. /day.

Lead in game – a Swedish problem?

Results from European studies, lead in game meat (mg/kg)

	Animal	Ammunition	No of samples	Median mg/kg	Mean mg/kg	Std deviation mg/kg	No of samples exceeding ML 0.1 mg/kg %	Maximum mg/kg
EFSA ^a	game	-	2521	0,02	3,15	-	-	867
BfR ^b	boar	bullet	-	0,02	4,7	-	-	684 (1998) 288 (2007)
NVI ^c	minced moose meat	bullet	52	0,3	5,6	20	31	110
IREC ^d	bird	shot	128	-	2,55	0,75	55	-

^a EFSA, 2010a. EFSA panel on contaminants in the food chain (CONTAM); Scientific opinion on lead in food. EFSA J. 8(4), 1570.

^b Bundesinstitut für Risikobewertung, "Bleibelastung von Wildbret durch Verwendu", Stellungnahme Nr. 040/2011

^c Norwegian Veterinary Institute, Lindboe. M., et al. Lead concentration in meat from lead-killed moose and predicted human exposure using Monte Carlo simulation. Food Additives and Contaminants (2012) 1-6, iFirst

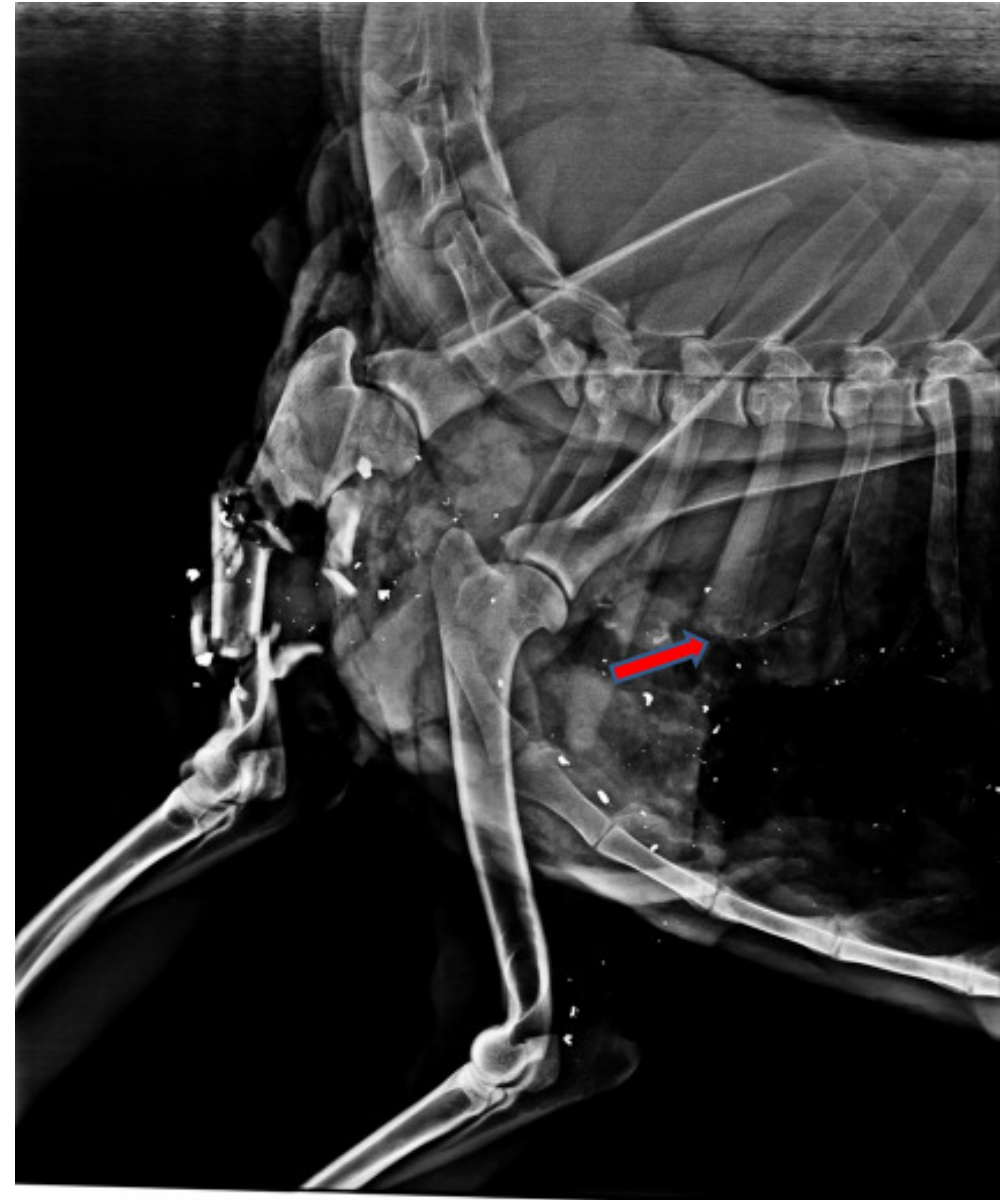
^d Mateo.R, et al. 2010. Bioaccessibility of Pb from ammunition in game meat is affected by cooking treatment. PLoS One 6, e15892.

Lead in game – The Problem



Roe deer shot
with a lead
bullet

Photo: The National
Veterinary Institute, 2012



Lead in game – why is this a matter of concern in Sweden and for NFA?

- 300 000 licensed hunters in Sweden.
- Approximately 600 000-900 000 persons (7-10 % of the Swedish population) as potential high consumers of game (i.e. non commercial).
- Annual “production” of game meat in Sweden correspond to approximately 12 % of the production of beef.
- EFSA's opinion on lead 2010, “no safe level”

Three questions to answer

1) Elevated levels of lead in Swedish moose meat?

➡ Sampling, X-ray and analysis

(Swedish Association for Hunting and Wildlife Management *and*
The Swedish National Veterinary Institute)

2) Risk for human health?

➡ Exposure- and risk assessment

(National Food Agency)

3) Manage the risk?

➡ Risk management options

- * Dialogue with companies?
- * Legislation?
- * Control?
- * Consumer advice?

(National Food Agency)

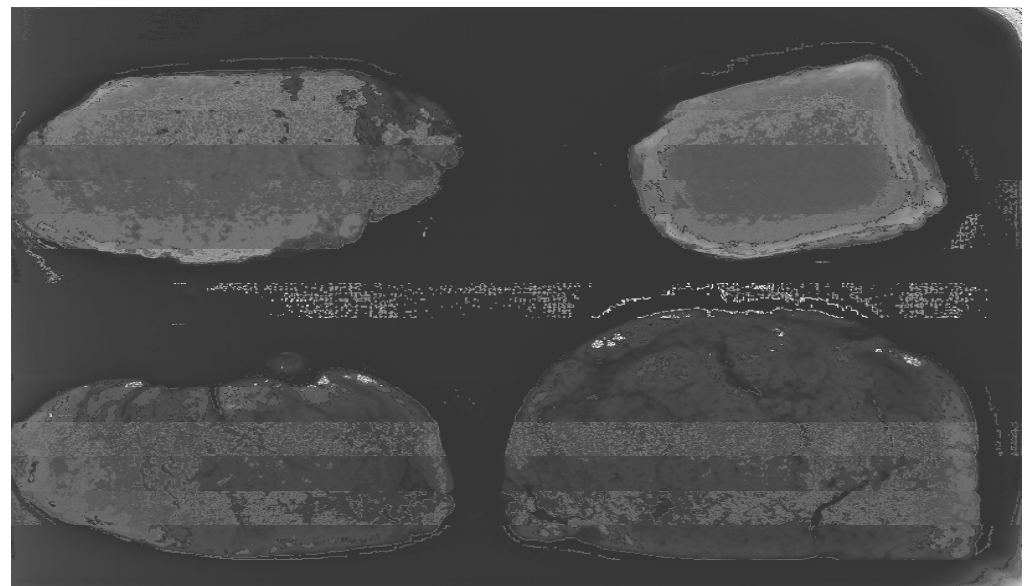
Sampling and X-ray of minced moose meat

Done in collaboration with the National Veterinary Institute (SVA) and Swedish Association for Hunting and Wildlife Management (SJF)



- SJF collect 48 minced moose meat from private freezers from north to south in Sweden.
 - 6 samples are bought in groceries
- Total of 54 samples of minced moose meat.

- SVA perform X-ray of the samples
- Detect fragments of metal in 19 samples out of 54 (35 %)



Analysis of lead in moose meat – preparation and analytical methods (NFA)



Method for preparation *(Lindboe, M., et al. 2012)*

Lead fragments probably not evenly distributed in the meat packages

=> All the meat (i.e. 200-600 g) in each package was therefore extracted

=> 15 % HNO₃ used to dissolve the lead fragments

=> Stand for 20 hrs., with occasional stirring

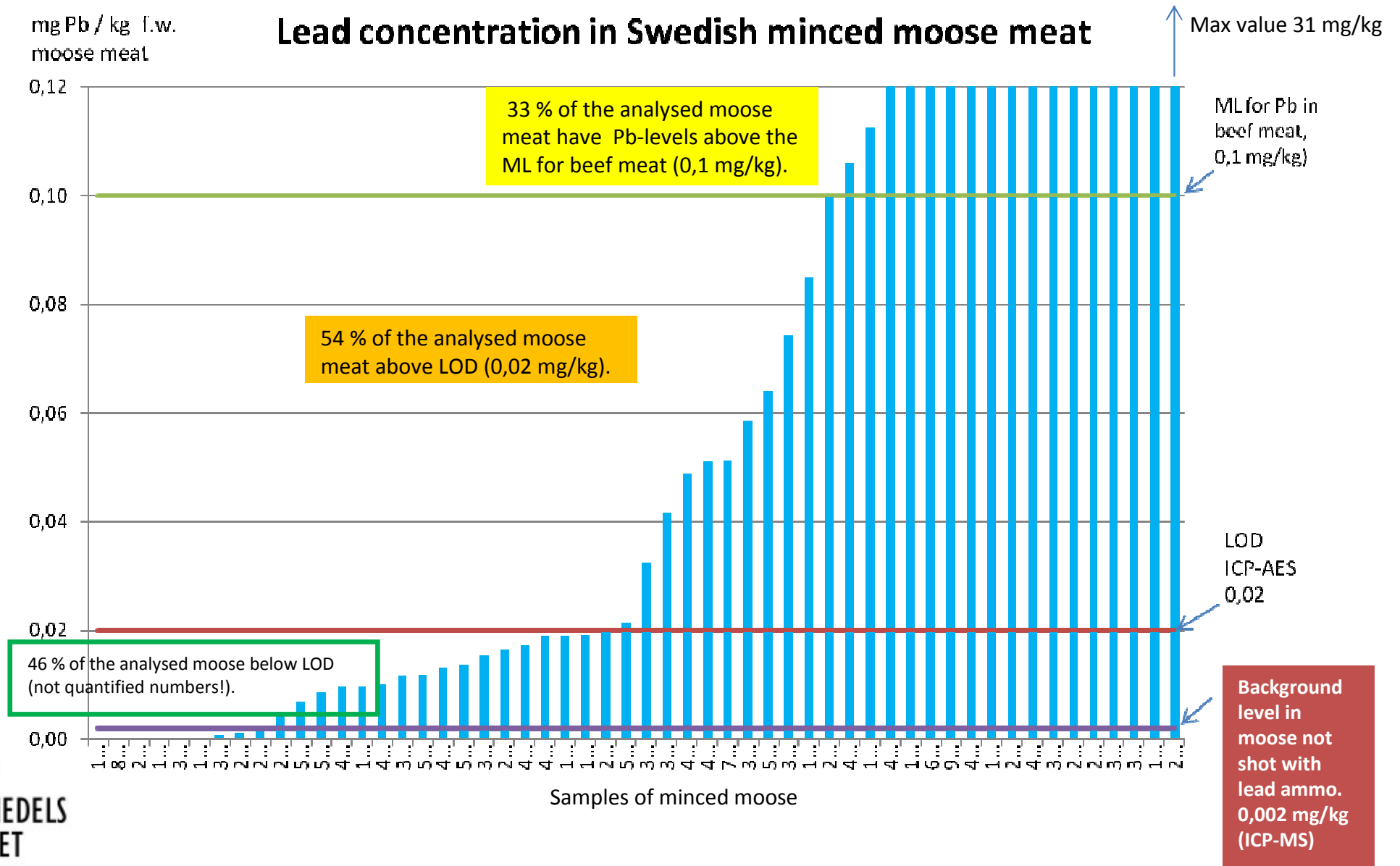
=> Sample from the extraction solution taken for analysis



Two methods were used:

- Direct use of the extract, ICP-AES, Spektro Ciros CCD (Uppsala university)
- Accredited method at NFA with micro wave digestion and analysis with ICP-MS, Agilent 7700x

Analytical results – lead in minced moose



Environmental contamination (background levels) of lead in game meat from Sweden

Results from game meat analysed for Pb in 2011. The meat is collected from areas of the animal **not** in vicinity of the area where the shot hit the animal.

Species (whole meat)	Number of samples	Median (mg Pb/kg f.w.)	Max (mg Pb/kg f.w.)
Moose	71	<0.02	0.143
Boar	19	<0.02	<0.02
Roe deer	16	<0.02	<0.02

Probably not a problem in Sweden, since the Pb-level in 105 analyses out of 106 are below the LOQ of 0.02 mg/kg f.w.

1) Elevated levels of lead in Swedish minced moose meat due to lead ammunition?

Minced moose meet:

54 % with lead levels above 0.02 mg/kg f.w.

Whole meet from moose, boar and roe deer (background levels):

0,009 % with lead levels above 0.02 mg/kg f.w.

YES

Next step:

Exposure- and risk assessment of lead from minced moose meat

Efsa risk assessment 2010 – lead

- Documented adverse health effects from lead are neurotoxicological, renal and cardiovascular.
- No safe level could be established, but a reference point (RP) was established (BMDL_{0.1}) to a blood lead level at 12 µg/L, which corresponds to a dietary intake of 0,5 µg Pb/kg b.w./day (effects on IQ).
- Moreover, Efsa concludes that in infants, children and pregnant women, there is potential concern at current levels of exposure to lead for effects on neurodevelopment.
- **A margin of exposure (MOE) of 10 or greater should be sufficient to ensure that there is no appreciable risk of a clinically significant effect on IQ.**
- A work should continue to reduce exposure to lead, from both dietary and non-dietary sources.

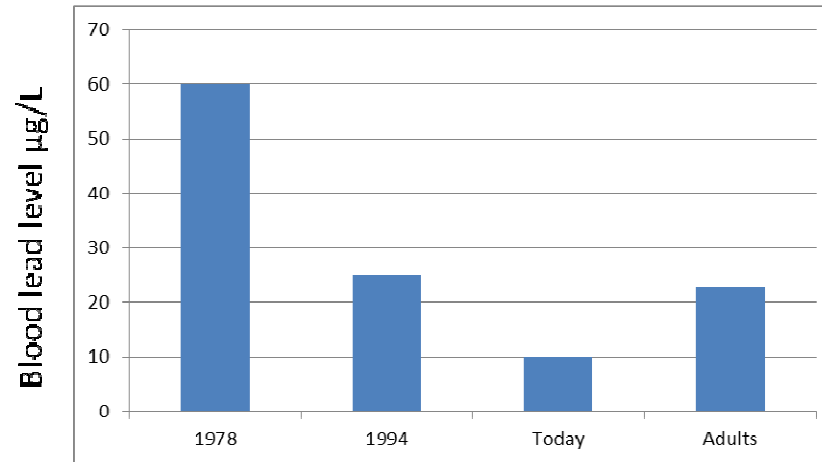
Other new toxicological evaluations of lead and its adverse health effects.

• **JECFA** Evaluation of certain food additives and contaminants (2011). Seventy-third report of the Joint FAO/WHO Expert Committee on Food Additives. WHO Technical Report Series 960

• **National Toxicology Program (NTP)**, U.S. Department of Health and Human Services, Monograph on health effects of low-level lead, June 2012,

Lead exposure in Sweden

Blood lead levels in Swedish school children
Strömberg et al, 2008



- Most of the exposure of lead via *food* comes from cereals, drinks and vegetables.
- Other sources are shellfish, game liver and mushrooms.
- *Mean intake of lead from all food sources in adults:*

7-11 µg per person and day (Becker et al. 2011,

Food Market

Basket 2012).

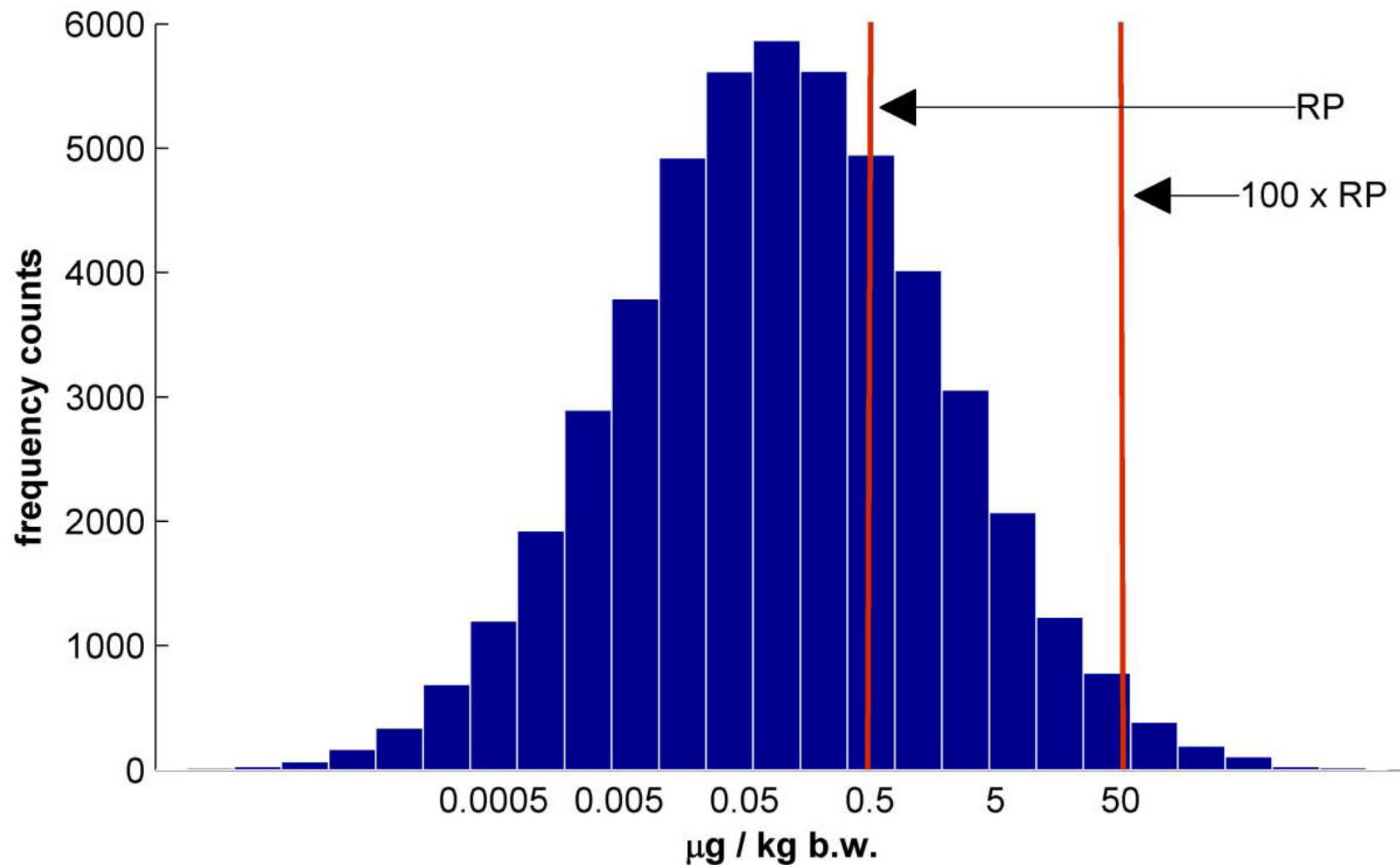
Worst case modeling of the moose results - risk characterization

- Based on NFA food consumption survey for 4-year old children, the minced beef consumption was "replaced" with minced moose meat.
- The mean concentration, 0,9 mg Pb /kg f.w., was used in the modeling
- It was assumed that all metallic lead was dissolved
- Both normal and high consumers were used in the modeling

But, the modeling is not only a worst case scenario, since it ONLY consider lead exposure from minced moose meat!

The risk for a “high consumer” child to be exposed to elevated lead levels from minced moose meat during 1 month

Above RP at 9 days out of 30 days when minced moose meat is consumed



Are there uncertainties?

- Bio accessibility

- Calcium status

- Bio availability

Of course!

- Receptions

- Portion size

- Consumption

- Iron status

- Analytical uncertainty

- Fasting vs. full stomach

- Blood lead levels

Dissolved lead and uptake of lead fragments in the stomach/intestine

Dissolved metallic lead in the stomach and intestine

- The accessibility is dependent on the acidity of the food (recipes) what, and how much you eat and the size of the lead particles.
- According to Mateo *et al*, 2011, the amount of dissolved lead is 6.75 %, 4.51 % and 0.7 % in meat, cooked in vinegar, wine or uncooked, respectively.

Uptake of dissolved lead from the stomach and the intestine

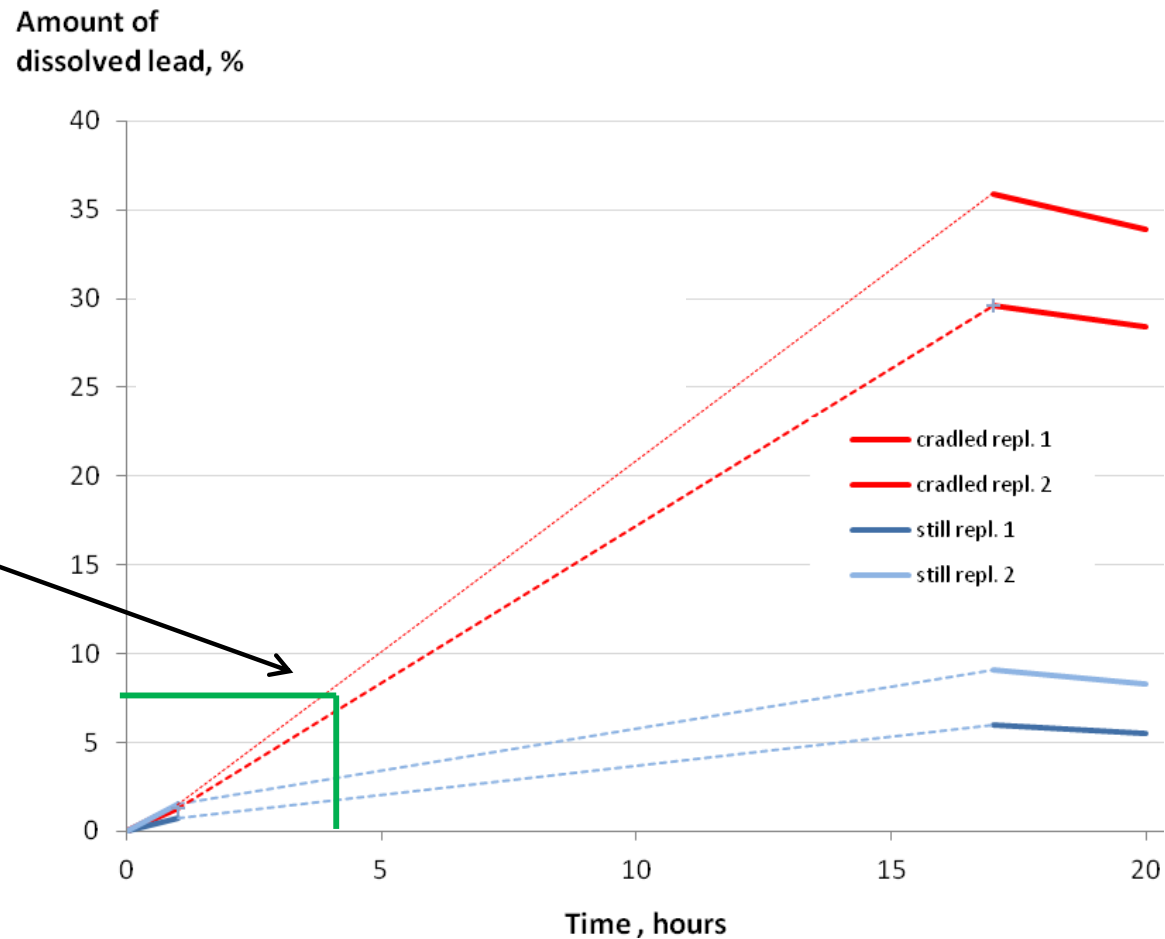
- Efsa reports that the uptake of dissolved lead in the stomach and intestine is 10-15 % in adults and 50 % in children.
- Efsa used an uptake of 50 % in the calculation of RP 0,5 µg Pb/kg b.w./day

Preliminary NFA results

- solubility of lead in 0,1 M HCl

The amount of dissolved lead in percent as a function of time

- 0,1 M HCl is the approx. conc. in the stomach
- the duration of food in the stomach is approx. 4 hrs.



4 hrs. in the
0,1 HCl result
in 7,5 % ??
dissolved Pb

Risk management question

How much of the lead exposure is acceptable to come from lead in game meat?

“A margin of exposure (MOE) of 10 or greater should be sufficient to ensure that there is no appreciable risk of a clinically significant effect on IQ.” (Efsa-opinion 2010)

Solubility and uptake – considerations for the risk management based on the present results

Percent of RP (0.5 µg Pb/kg b.w./day), with different levels of solubility of the metallic lead, 1 %, 5 % and 10 %.

Red.....

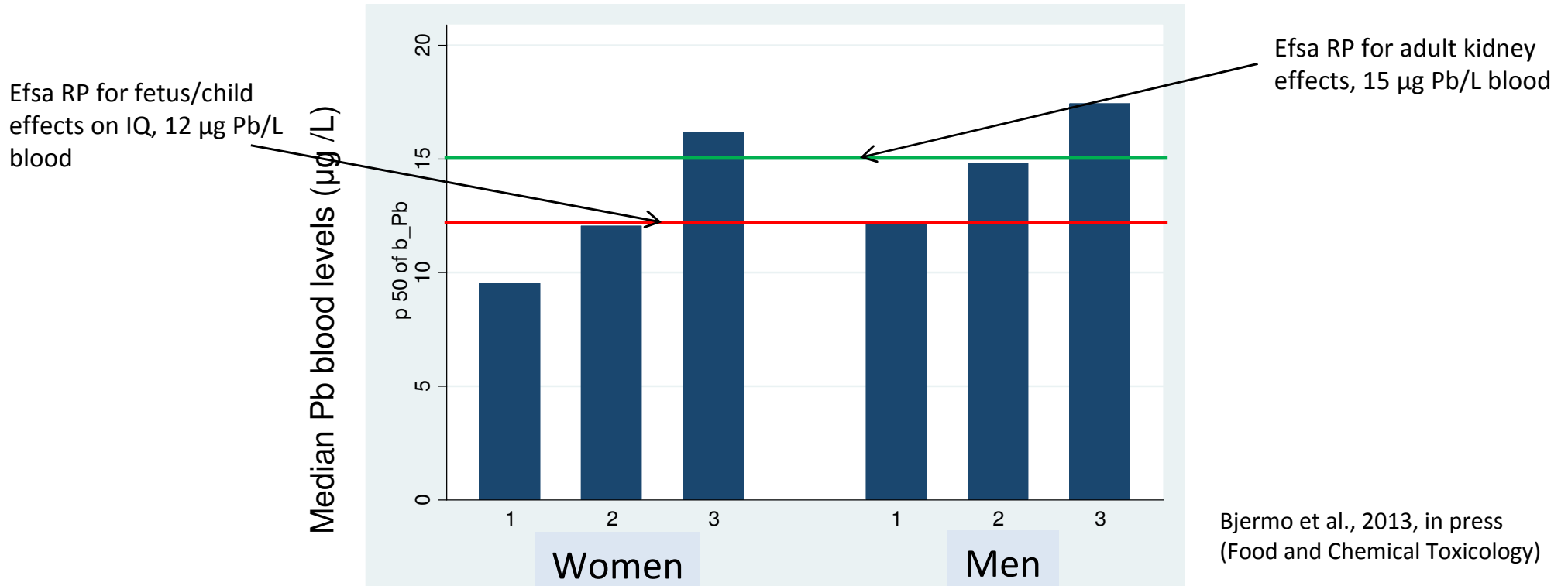
Lead in minced moose meat (µg Pb/kg)	Lead per portion (µg Pb/65 g)	Percent of RP when 1 % Pb is dissolved for uptake	Percent of RP when 5 % Pb is dissolved for uptake	Percent of RP when 10 % Pb is dissolved for uptake
99,8	6,5	0,7	3,6	7,2
106,0	6,9	0,8	3,8	7,7
112,3	7,3	0,8	4,1	8,1
135,1	8,8	1,0	4,9	10
169,8	11,0	1,2	6,1	12
176,2	11,5	1,3	6,4	13
298,5	19,4	2,2	11	22
398,2	25,9	2,9	14	29
697,8	45,4	5,0	25	50
816,8	53,1	5,9	29	59
884,5	57,5	6,4	32	64
904,6	58,8	6,5	33	65
1450,0	94,3	11 % above Efsa MOE level	52	105
2540,0	165,1	18	92	183
2540,0	165,1	18	92	183
3402,4	221,2	25	123	246
3402,6	221,2	25	123	246
30000,0	1950,0	217	1083	2167

Does game meat significantly contribute to blood lead levels?

- Significant increase of blood lead levels have been shown in persons consuming game meat compared to non-consumers of game meat (*Iqbal et al. 2009, Tsuij 2008*).
- Pigs fed game meat containing lead fragments show significant increased blood lead levels (*Hunt et al. 2009*).
- Preliminary NFA results:
game consumption and blood lead levels are positively correlated

Preliminary NFA results

- median Pb blood levels vs. game consumption



Game consumption	Women		Men	
	Number (n)	Percent (%)	Number (n)	Percent (%)
Never (1)	34	24	24	19
< 1 time/month (2)	80	57	72	58
> 1 time/month (3)	26	19	28	23
Total	140		124	
P (Anova)	0.0008 (0.0041)		0.0217 (0.0676)	

()= adjusted for age and education

Risk assessment – Conclusions

- “High consumers” of game meat, e.g. hunters and their families, are at risk for elevated exposure to lead due to game consumption
- In these consumer groups, the exposure to lead from game meat can contribute to exceeding of the health based reference points for lead

Where are we in the process?

Analysis finalized

Are there elevated levels of lead in Swedish minced moose?

YES

Risk assessment finalized

Could this exposure cause health effects?

YES, especially for fetuses and small children

Next step

Risk management

How should NFA manage this risk?

- * Dietary advice?
- * Dialogue with game slaughter houses?
- * Legislation?
- * Control?

Rationale for risk management

- There are approximately 600 000 - 900 000 potential consumers of game in Sweden.
- NFA has documented a source of lead exposure via game meat in Sweden
- Based on the lead level distribution in the 54 moose meat packages, the risk of consuming a package with elevated lead levels was high, approx. 9 out of 30 occasions would result in moose meat with elevated lead levels.
- Even if the accessibility of lead is set to 1 %, the study shows that approximately 10 % of the collected samples has lead levels above the MOE of 1/10 of RP
- NFA finds it unacceptable that the food commodity "game meat" by it self contribute with as much as 10-28 % of the RP.
- Very specific and known source of the "contaminant"
- Possible to permanently risk reduce (e.g. improved cutting routines or choose lead free ammunition)

Risk management decision

”NFA decide that this route of lead exposure should be communicated and that consumer advices should be formulated to limit the lead exposure via game meat”

Risk management – by NFA

Dietary advice

1. For pregnant women, women who plan children in the near future and children < 7 years –
Avoid consumption of meat from areas close to the wound channel, from game shot with lead ammunition.
2. For hunters, their families and other high consumers
Limit consumption to once a week, of meat from areas close to the wound channel, from game shot with lead ammunition.



Risk management
– by the *Swedish
Association for
Hunting and
Wildlife
Management*

Advice to hunters

1. Improved cleaning practices
when game is prepared for
butchering

Remove at least 5 cm
unaffected meat around the wound
channel”

2. Consider choice of ammunition

3. Be aware of shot placement



Subsequent risk management activities

- Follow-up studies 1(2)

NFA will, in cooperation with, the National Veterinary Institute and Swedish Association for Hunting and Wildlife Management follow up the results from present studies

Prospective blood lead level study directed to high consumers of game meat (e.g. hunters families)

Status – ongoing, results in late 2013 – 2014

Study bio accessibility of metallic lead

Status – ongoing, preliminary results presented at this meeting, results 2013

Follow-up studies 2(2)

Lead from rifle ammunition in other game species than moose

Status: Ongoing, results 2014

Lead from shot gun ammunition in game

Status: Ongoing, results 2014

”Cutting study” of game meat

Status – Ongoing (but very difficult to perform), results 2014

Thank
you for
your
attention!



