Excessive lead burden among Golden Eagles and the search for the source of lead

Cooperation:

- Swiss Ornithological Institute Sempach
- Cantonal Fish and Game Departments of GR, BE, LU, GL, SG
- Institut of Pharmacology Veterinary and Toxicology, University of Zurich
- Department of Forensic Pharmacology & Toxicology, University of Zurich
- Foundation Pro Bartgeier
- Parco Nazionale dello Stelvio

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Stiftung Pro Bartgeier

Amt für Jagd und Fischerei Graubünden
Ufficio per la caccia e la pesca dei Grigioni
Uffizi da chatscha e pestga dal Grischun

Universität Zürich

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Questions and hypothesis

- Are GE and BV impacted by lead ?
- Which organs are impacted by lead ?
- What are the sources of lead for GE and BV ?

→ hypothesis: **if ammunition is the source of lead, scavengers should be significantly more affected than non-scavengers**

section of bodies / analysis

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Amount of acute poisoning

(with symptoms of poisoning and/or very high lead concentration in blood or liver/kidney)

Golden Eagles:	Bearded Vultures:	Eagle Owl:
3 (6) out of 41	(3 out of 6)	0 out of 20
≥ 7.3%	**50.0%**	**0.0%**

9.5.2011 Scuol Clinica Alpina

10.11.2009 Bisistal, Ikarus

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results

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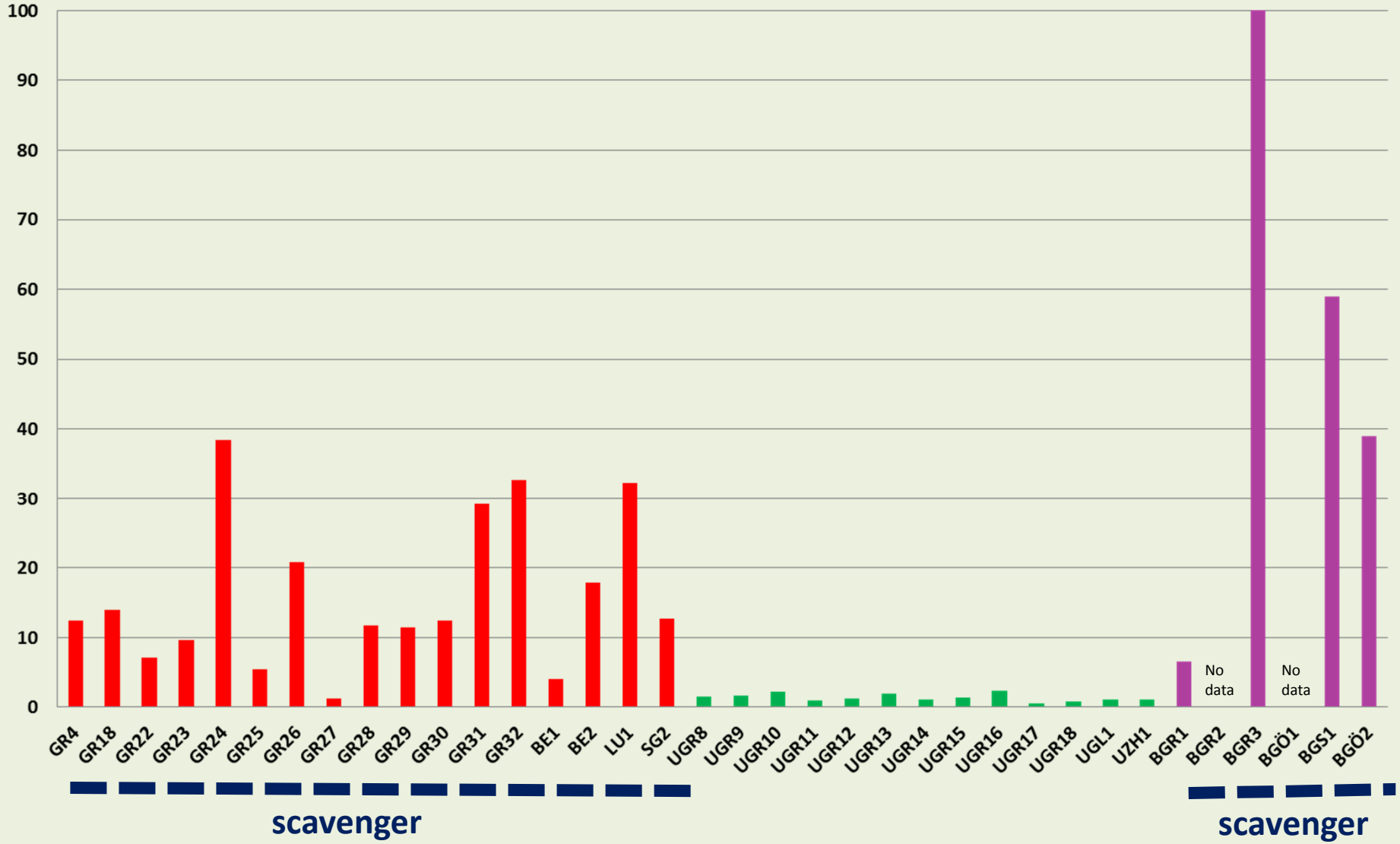
lead in bones golden eagles eagle owl bearded vulture µg/g



Golden eagles – lead concentration in feathers (n = 18)

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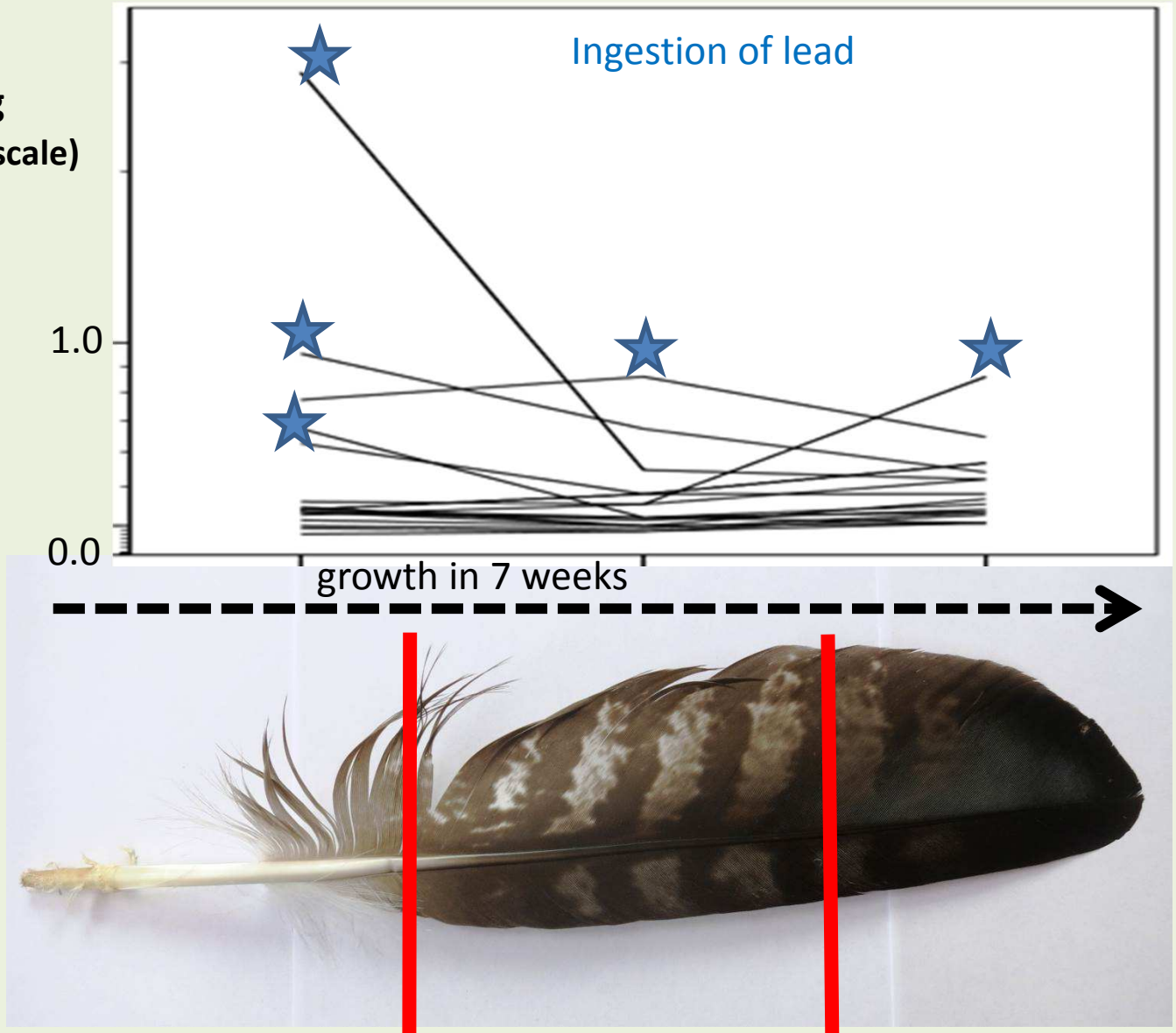

Lead concentration in segments of the shaft of individual flight feathers (n = 18). Each flight feather is from a different individual golden eagle.
Note the logarithmic y axis

lead-isotopes analysis: first results

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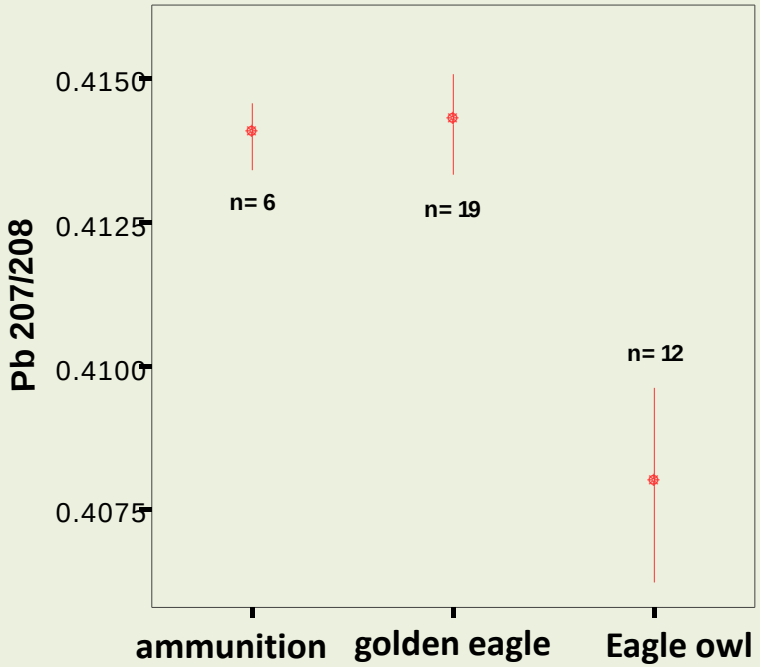
isotope ratio $^{207}Pb/^{208}Pb$

Caliber of ammunition Grisons: 10,3(!) x 60 mm

Golden eagle and eagle owl: bones



Ammunition: 5 samples of commonly used projectiles (bullets and shot) and 2 shot which were found incapsulated in the bones.

The isotope ratio $^{207}Pb/^{208}Pb$ differs significantly between ammunition and eagle owl and between golden eagle and eagle owl. No difference was found between ammunition and golden eagle.

First conclusions

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possible lead sources

gamekeeping

shot and deposited small game

offals

The evidences point to ammunition as the source of lead in the bodies of golden eagels. But alternative lead sources can't be totally excluded (bio-accumulation, soil).

Additional samples were analysed:

- prey of golden eagles (ibex carcasses, marmots)
- prey of eagle owl (small mammels, birds)
- soil

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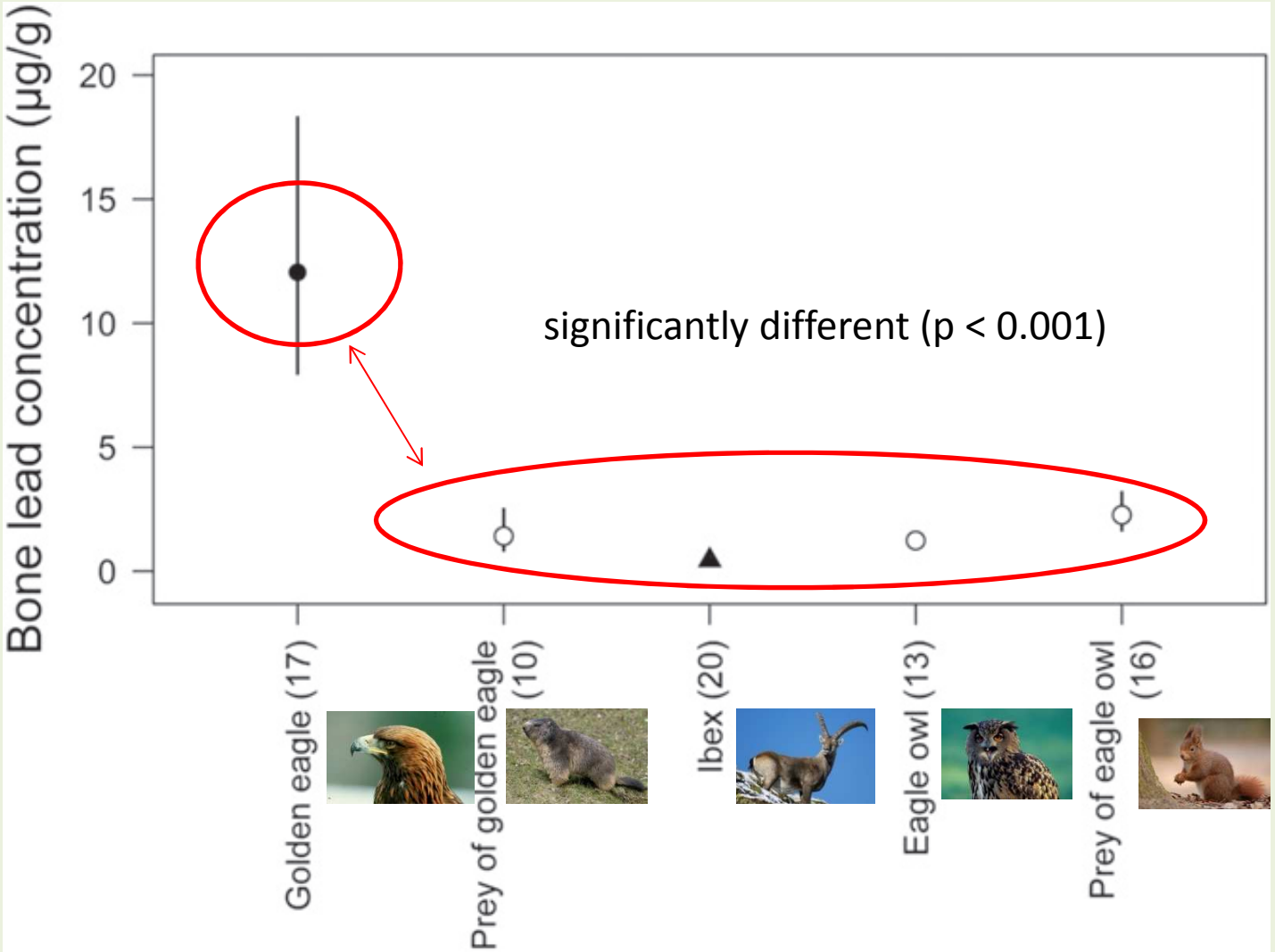
analysis of the prey of golden eagels: lead concentrations in bones



Mean bone lead concentration of golden eagles and eagle owls compared with their prey. Lines are 95% confidence intervals (if not shown they are smaller than the symbol). Means not sharing the same symbol are significantly different from each other at the p < 0.001 level. Numbers in parentheses are sample sizes.

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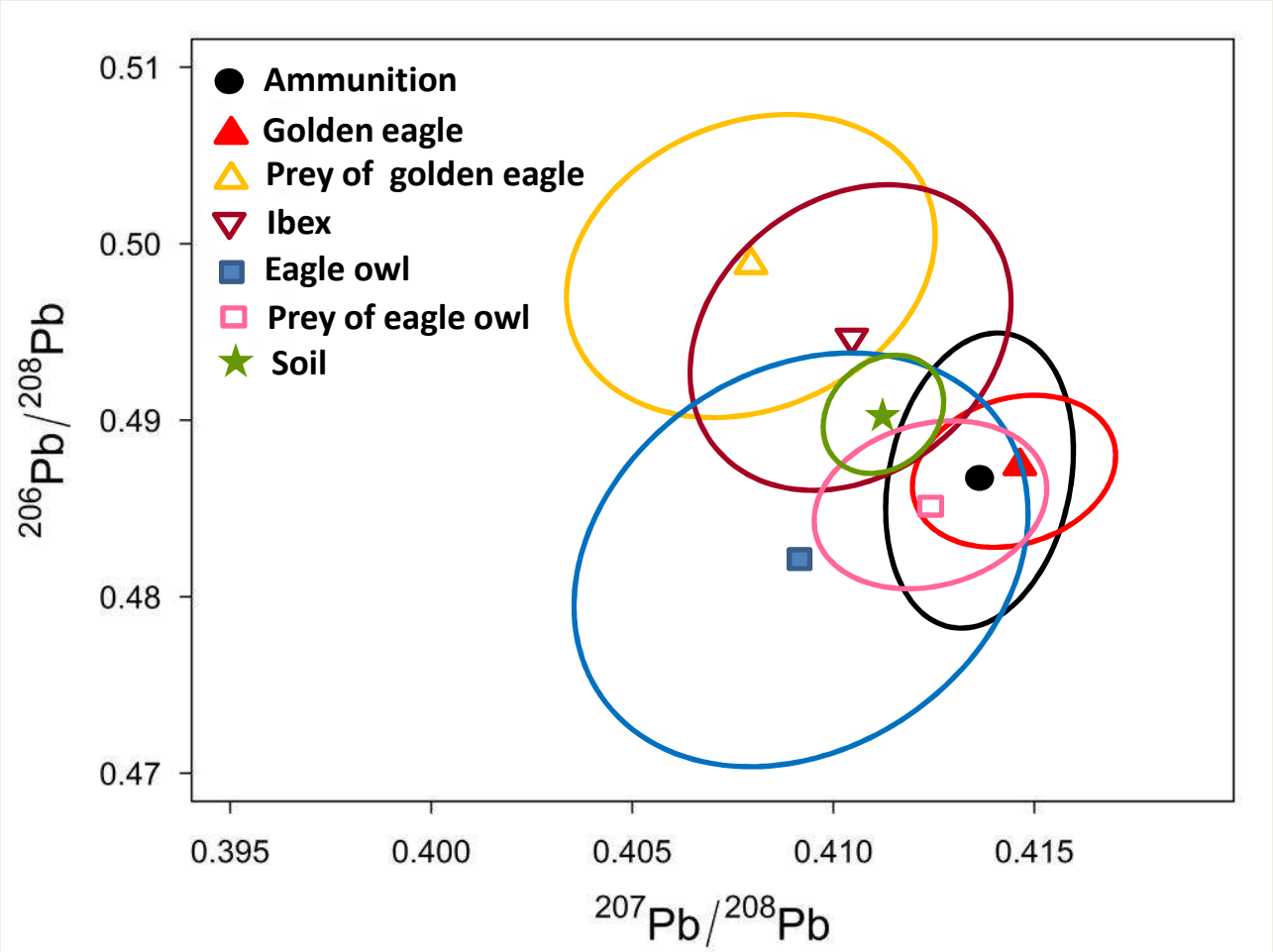
Lead isotopes ratio of Pb^{207}/Pb^{208} and Pb^{206}/Pb^{208}



Mean ratio of 207Pb/208Pb and 206Pb/208Pb found in bones of golden eagles, eagle owls, their prey and in Alpine ibex, as well as in ammunition and soil. Ellipses are 95% confidence intervals. A sample is significantly different from another sample if the mean is not included within the 95% confidence ellipse of the other sample.

Are offals - left in the field by hunters - sources of lead?

Offal of a deer, deposited by a hunter during the hunting season 2013

Shot-channel of a lead bullet in a soap block.

The bullet was 34% lighter after the shot (Einstein 25.2.14)

> 60% of the offals contained lead fragments (n = 146; Bassi and Ferloni 2012; Sondrio).

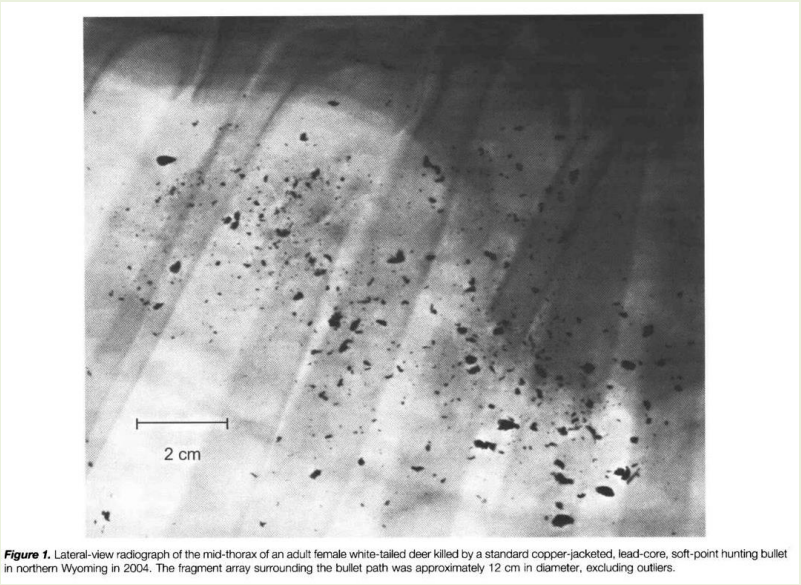


Figure 1. Lateral-view radiograph of the mid-thorax of an adult female white-tailed deer killed by a standard copper-jacketed, lead-core, soft-point hunting bullet in northern Wyoming in 2004. The fragment array surrounding the bullet path was approximately 12 cm in diameter, excluding outliers.

Lateral-view radiograph of the mid-thorax of an adult female white-tailed deer killed by a standard copper-jacketed lead-core soft-point hunting bullet in northern wyoming in 2004. The fragment arrays surrounding the bullet path was approximately 12 cm in diameter excluding outliers. (Hunt et la. 2006).

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ibex - hunting september 2014, Engadin

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Golden eagles consuming offals of ibex

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Open questions:

- **What impact have the high lead concentrations on the vitality of golden eagles?**
- **Are feathers of bearded vultures appropriate for isotope studies?**

24.2.15 Sempach

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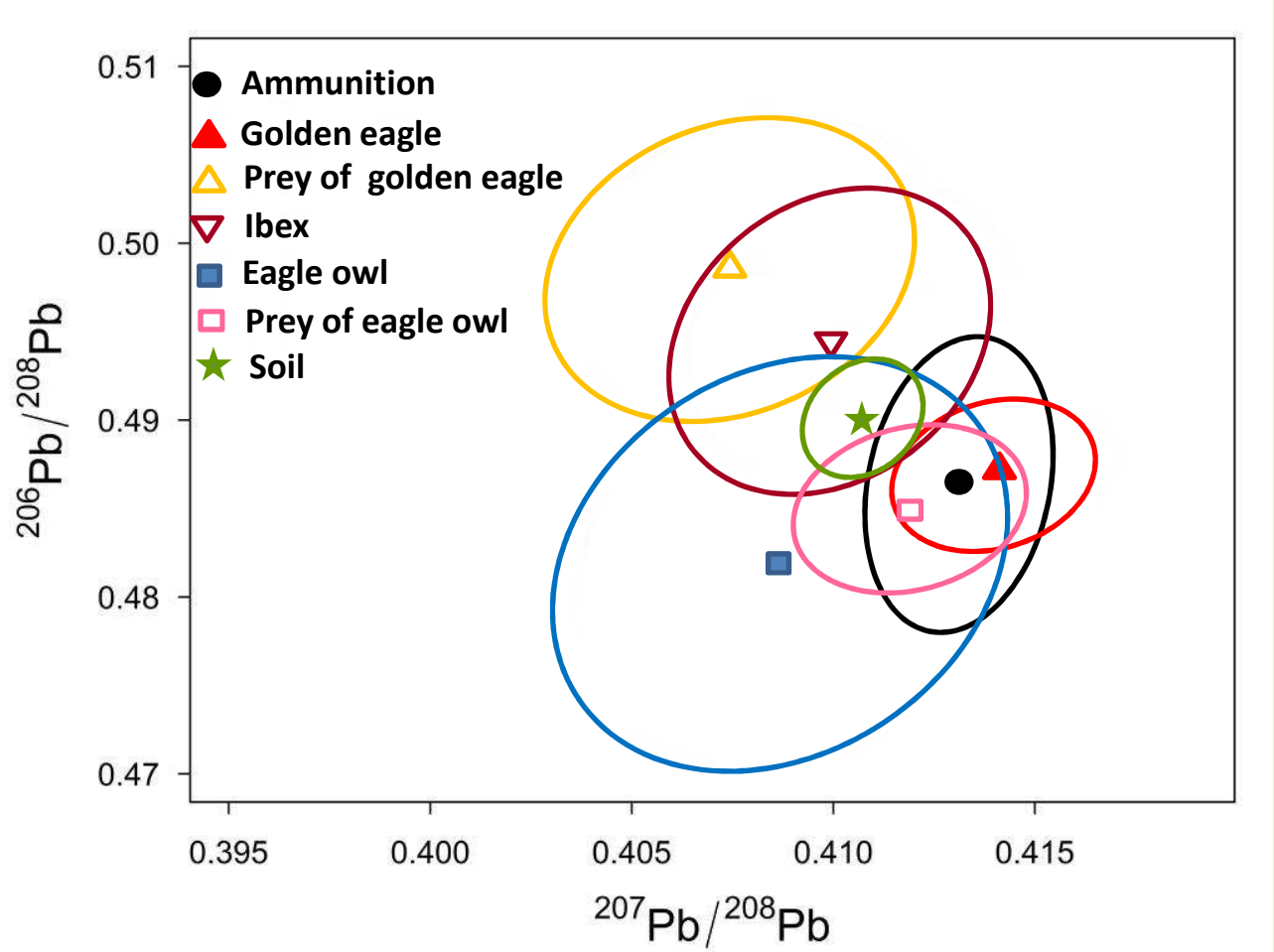
Lead signatures and feathers Pb207/Pb208 and Pb206/Pb208
(golden eagles n = 15, feathers n = 80)



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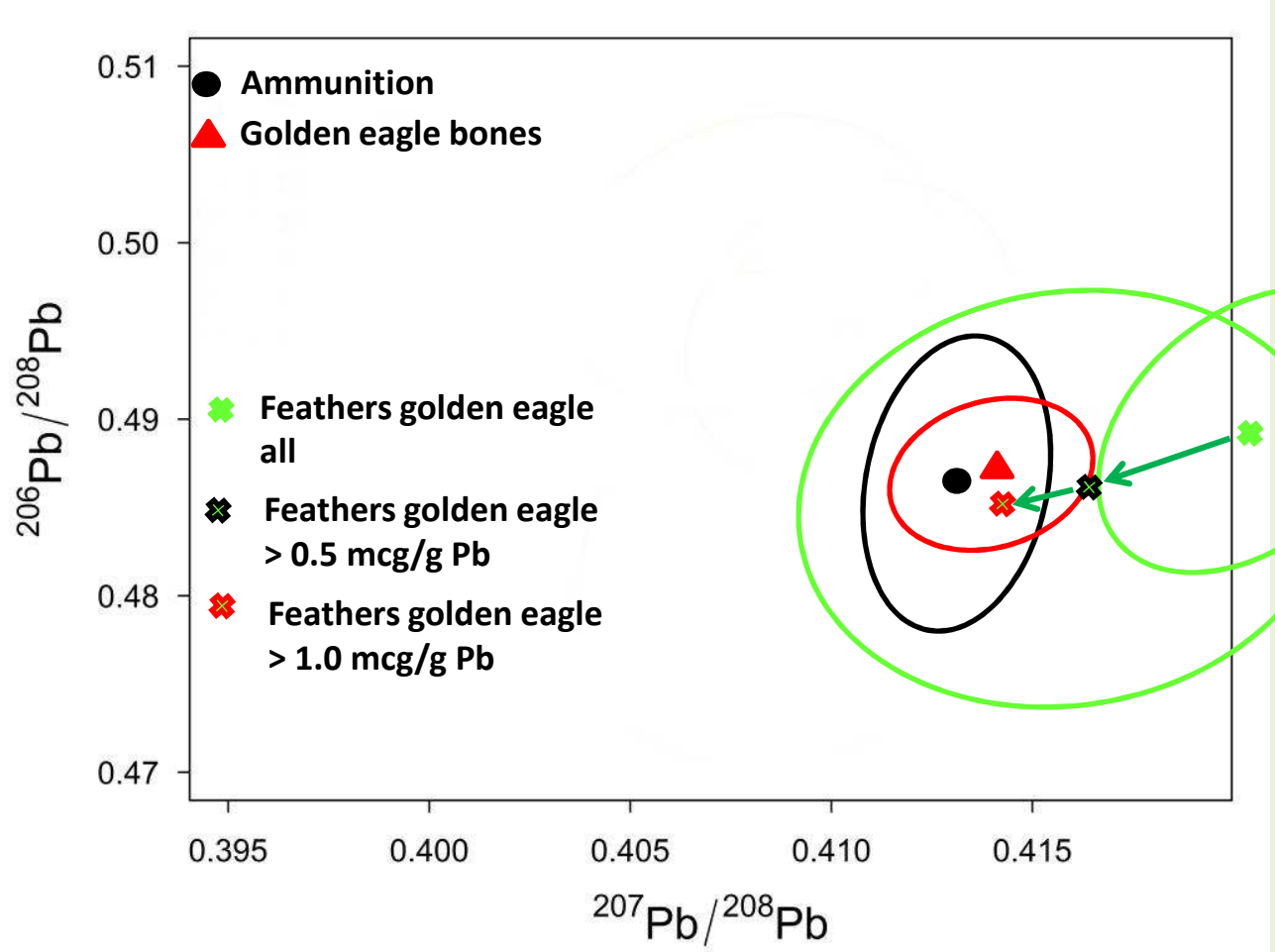
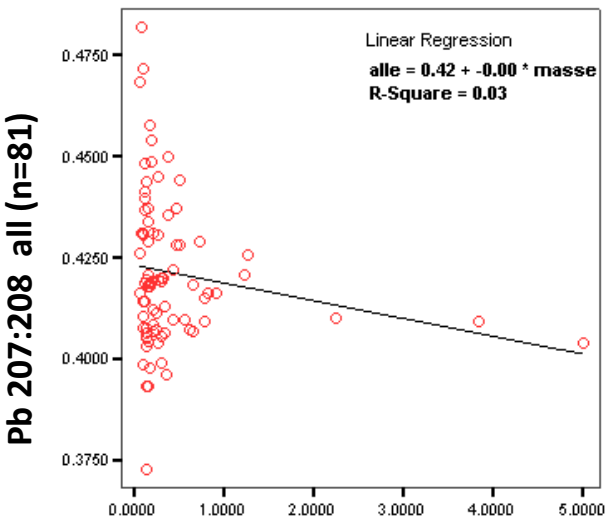
Lead signatures and feathers Pb207/Pb208 and Pb206/Pb208
(golden eagles n = 18, feathers n = 80)

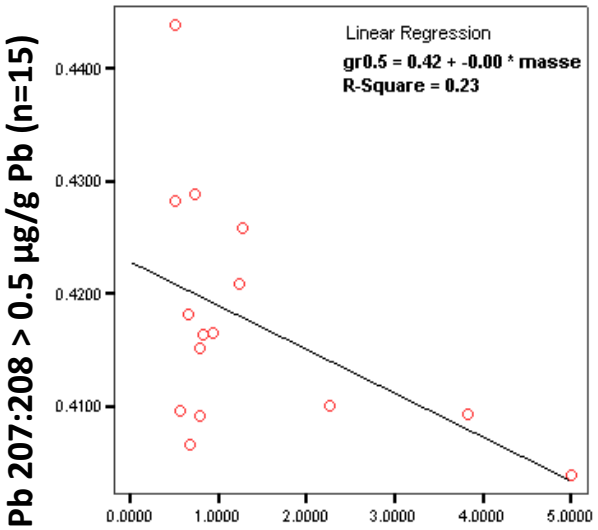


All feathers



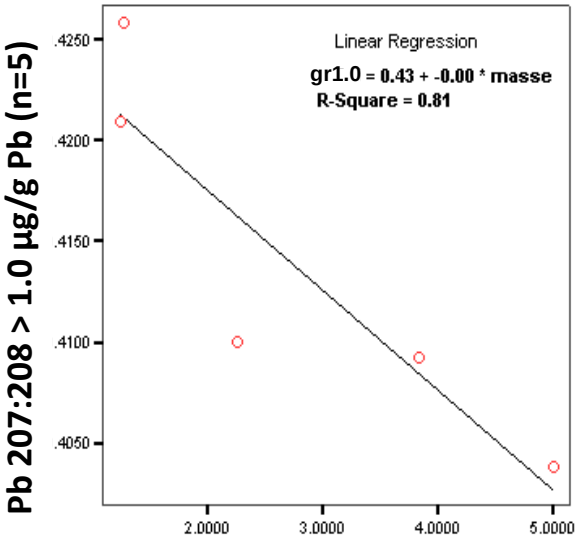
mean feathers µg/g Pb

Only feathers with slightly elevated lead conc.



mean feathers µg/g Pb

Only feathers with elevated lead conc.



mean feathers µg/g Pb

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.001	1	.001	2.329	.131 [a]
	Residual	.028	79	.000		
	Total	.028	80			

a. Predictors: (Constant), masse

b. Dependent Variable: alle

not significant: p > 0.05

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.000	1	.000	3.989	.067[a]
	Residual	.001	13	.000		
	Total	.002	14			

a. Predictors: (Constant), masse

b. D ndent Variable: gr0.5

not significant: p > 0.05

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.000	1	.000	12.793	.037[a]
	Residual	.000	3	.000		
	Total	.000	4			

a. Predictors: (Constant), masse

b. Dependent Variable:

significant: p < 0.05

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Conclusion

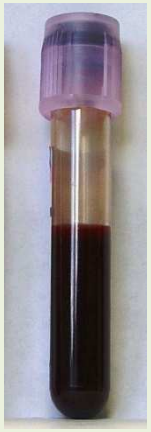
- All evidences point to **ammunition as a source of lead** in golden eagles' tissues

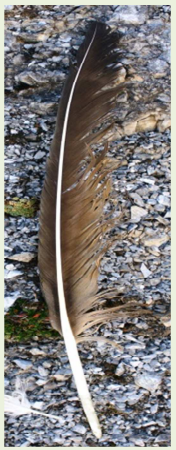
- Some findings indicate an even higher lead burden in **bearded vultures**

- **Feather analysis** on lead isotopes ratio are less purposeful than the analysis of bones

→ For statistical evidence, a sufficient sample size is crucial
(**lead concentrations** and **isotope ratios)**

A multilateral approach is required to clarify the origin of the lead
in BV tissues (blood, bones, liver, feathers)



Consequences?

In all **Swiss Cantons**:

- Hunting on waterfowl: lead shot ammunition is banned since 2014
- Bullet ammunition:
  - in three Cantons (SG, GR and SZ):
    Gamekeepers changed to lead-free ammunition.
  - 30’000 hunters are still hunting with lead ammunition

Thank You !

http://iopscience.iop.org/1748-9326/10/3/034003/article

http://link.springer.com/article/10.1007/s10336-015-1220-7