

“Tracking salmon by using rare earth elements”

Magny S. Thomassen



The main object of this project is to develop a method that, both **easy** and **cheep**, can distinguish farmed from wild salmon, and at the same time track the salmon back to the farm.

As Ce Dy Er Eu Gd Ho
La Lu Nd Pr Sc Sm Sr
Tb Tm U Y Yb

Rare Earth Elements														Y 39			
La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71			
Lanthanides																	
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	An	Lr														

Easy?

- Scales are easy to collect so sampling can be done by unskilled personnel
- They are removed non-lethally and hence allow for multiple sampling during a fish's life
- Scales require minimal preparation before analysis



Project plan

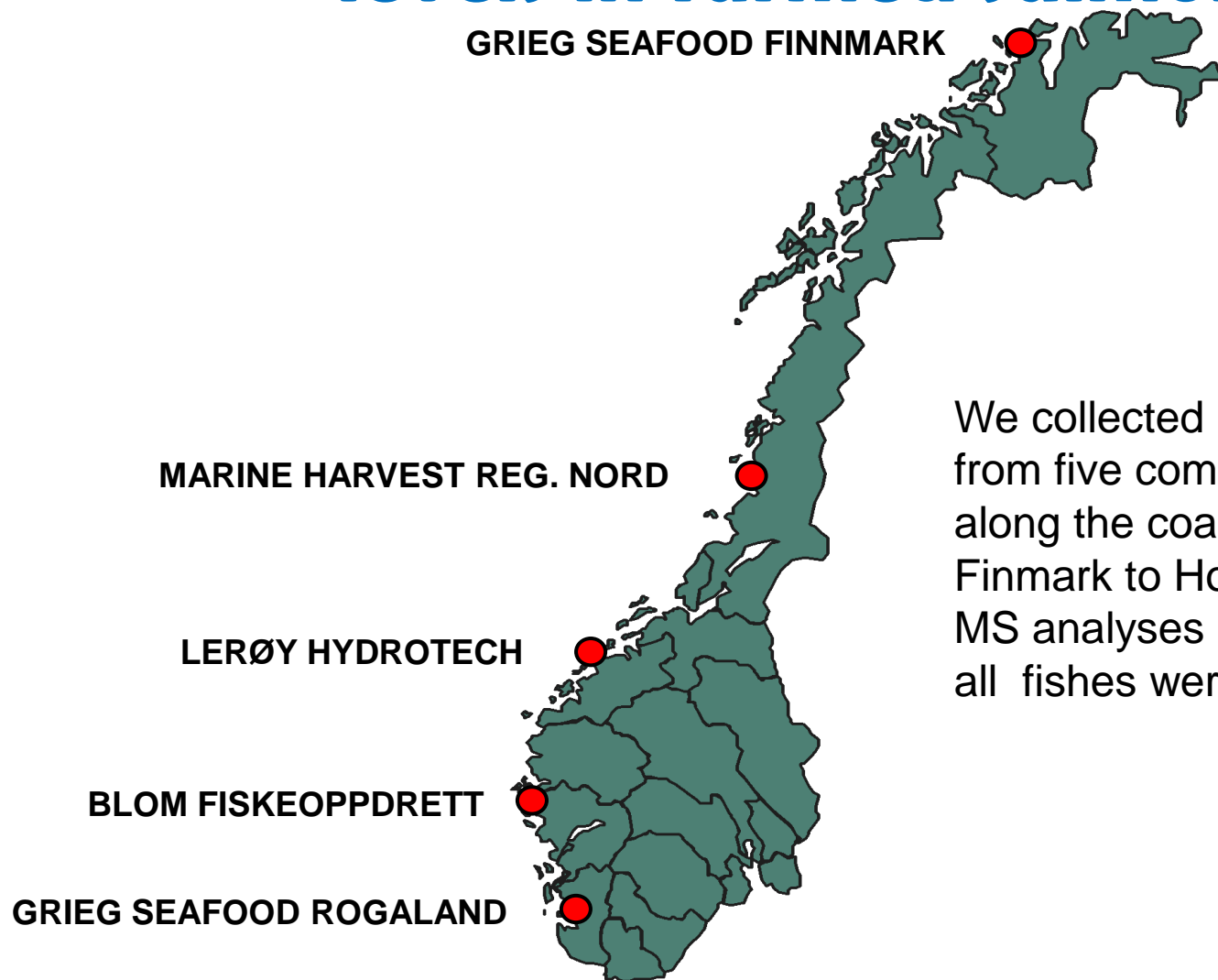


WP1: To get an insight into the background levels of rare earth elements in salmon smolt collected from different farms up along the coast.

WP2: Testing of several elements in feed for 1+ smolt in seawater.

WP3: Testing the rare earth elements on 0-smolt, different doses, combinations and colder water

In WP1 we studied the background levels in farmed salmon

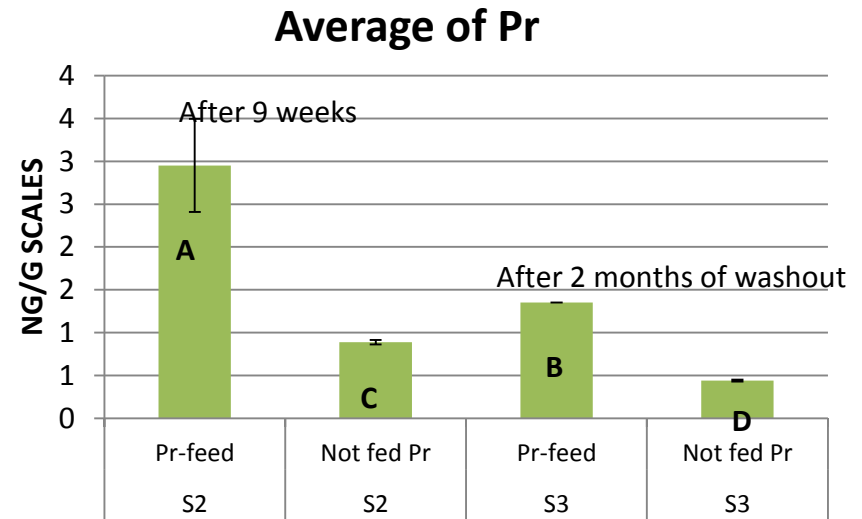
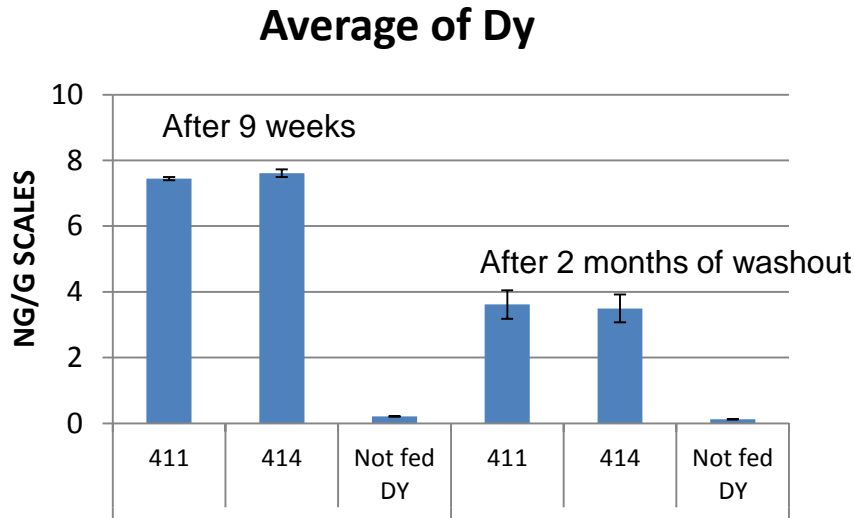


We collected 10-20 0+ smolt from five commercial farms along the coast, from Finnmark to Hordaland. ICP-MS analyses of scales from all fishes were performed

Mean background values (ng/g)

[illegible]

In the first feeding study we used 5 different elements in 1+salmon, and the results were positive: Scales were labelled by all five elements tested



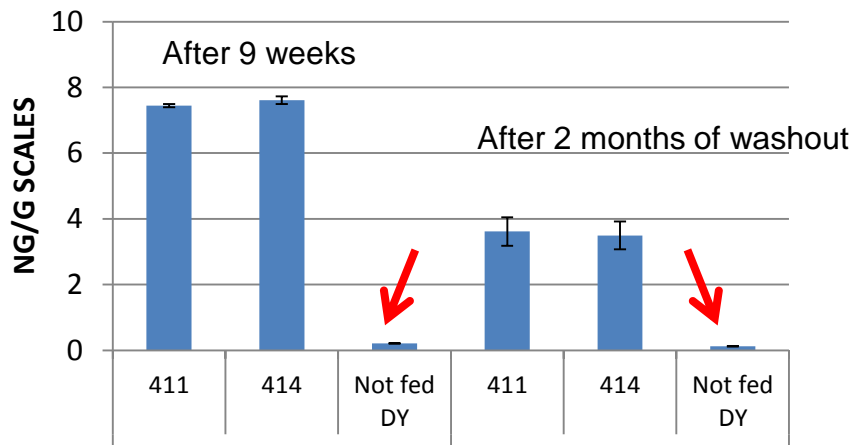
All were significantly higher than the background level also after 2 months on a commercial diet, but we see best effect when the background levels are low

Very interesting, the background levels seem also to fall to a similar degree!

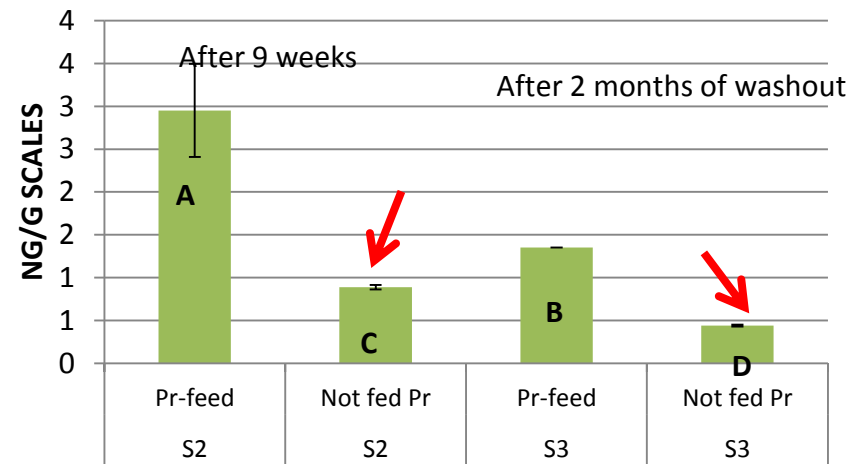
This may tell us something about when the background levels were incorporated, and may be a fingerprint from the different smolt producers!

Very interesting, the background levels seem also to fall to a similar degree!

Average of Dy

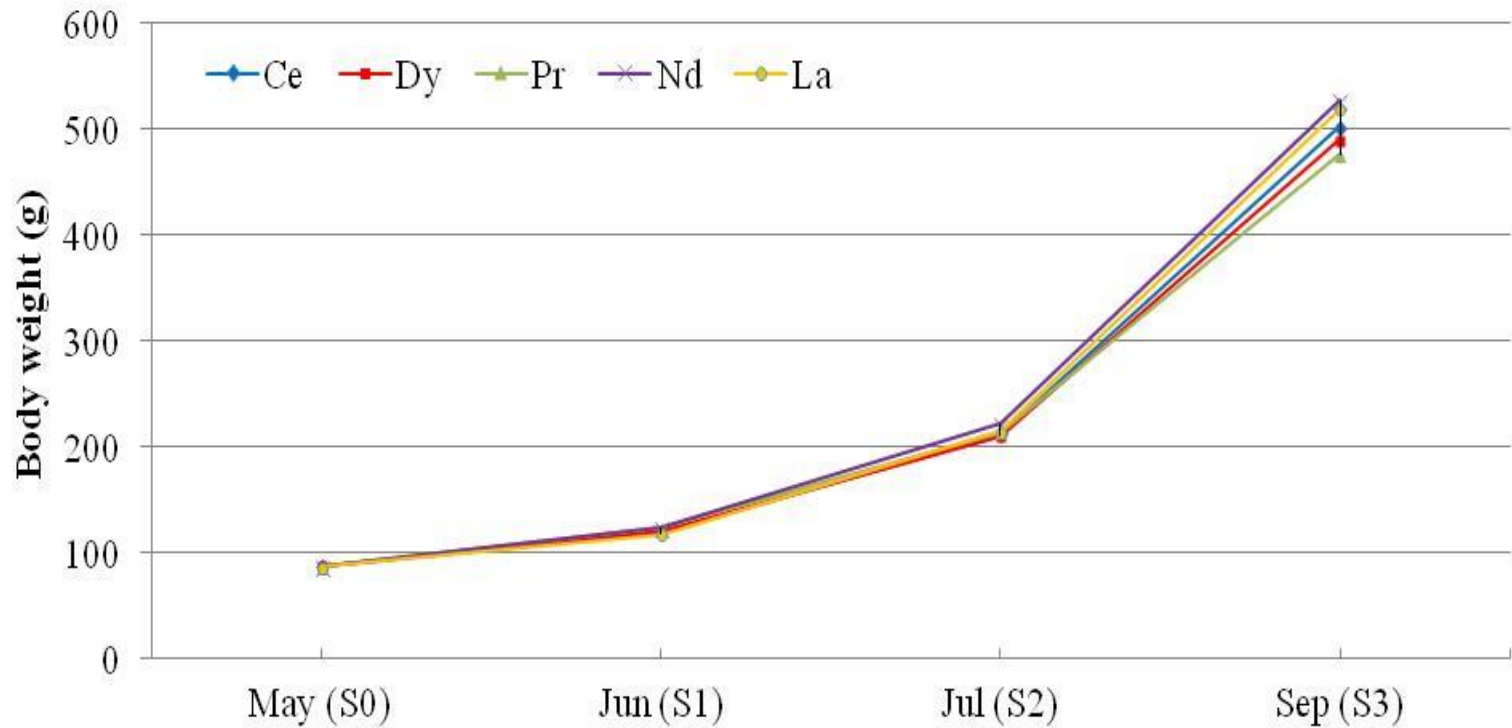


Average of Pr



This may tell us something about when the background levels were incorporated, and may be a fingerprint from the different smolt producers! I will come back to this.

No growth differences and no mortality



WP3: Study on 0-smolt

Feed used

Feed 1: 125 mg Dy/kg

Feed 2: 250 mg Dy/kg

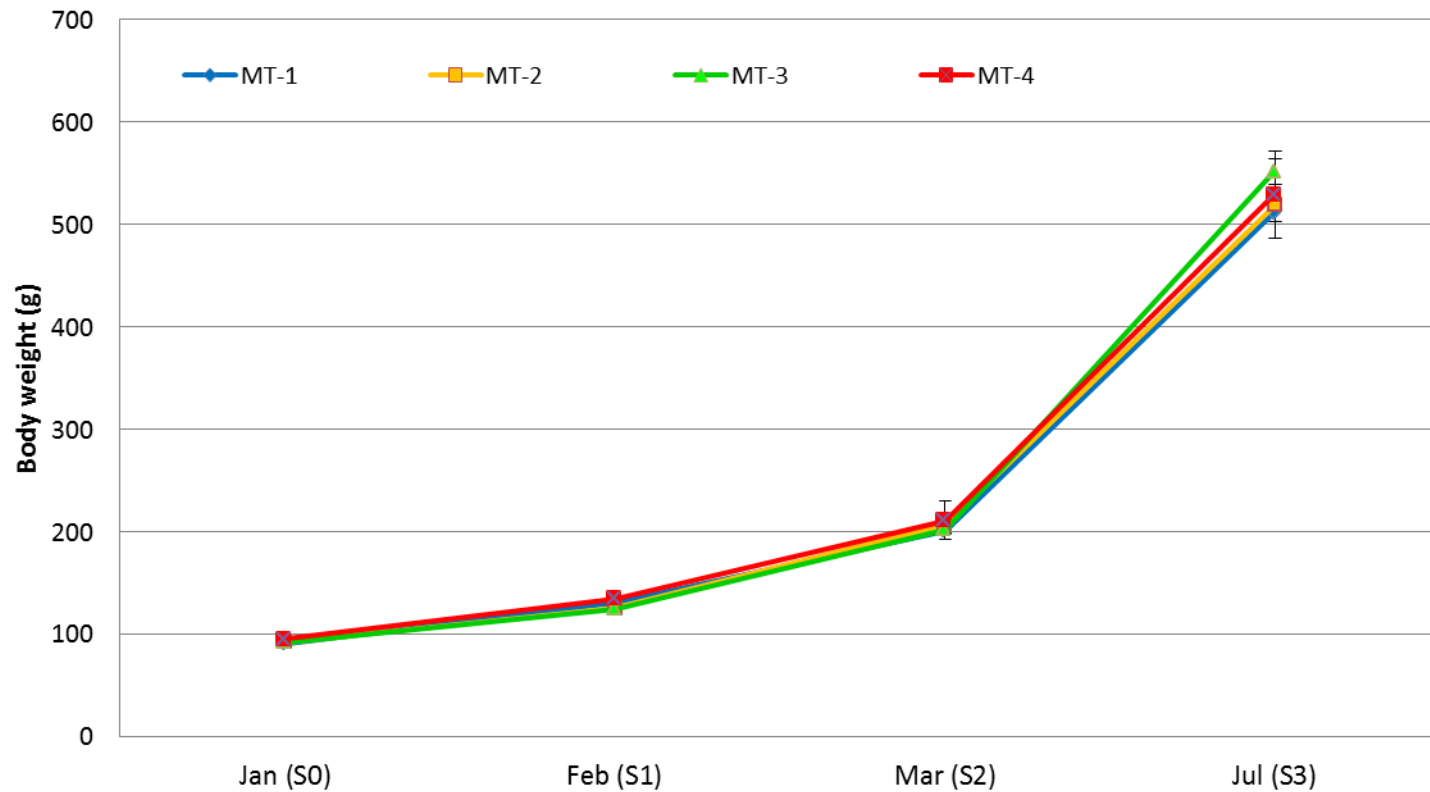
Feed 3: 125 mg Pr/kg

Feed 4: 125 mg Pr + 125 mg Dy /kg

These feeds were fed to two tanks pr. feed, 50 fish in each.

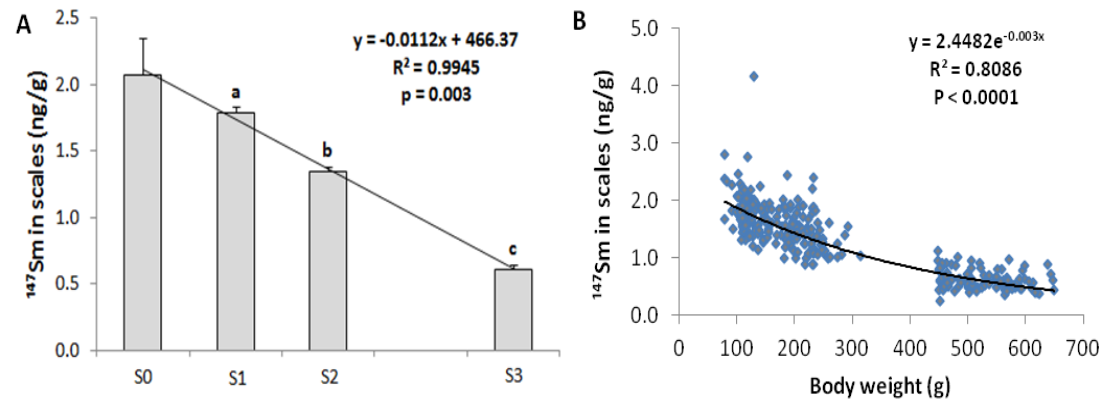
Temperature between 6,6 and 8,6 C.

As for the 1+ smolt, we found no growth differences and no mortality

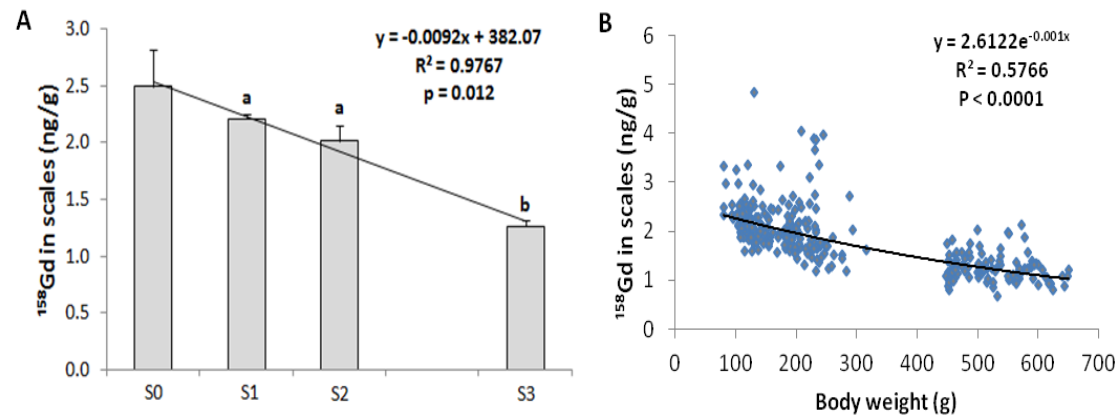


The background levels of most (14) of the elements decreased with time in seawater

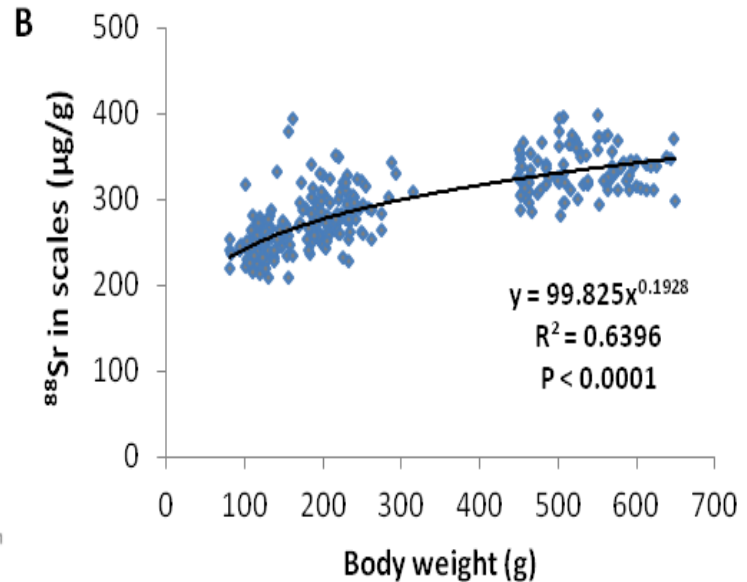
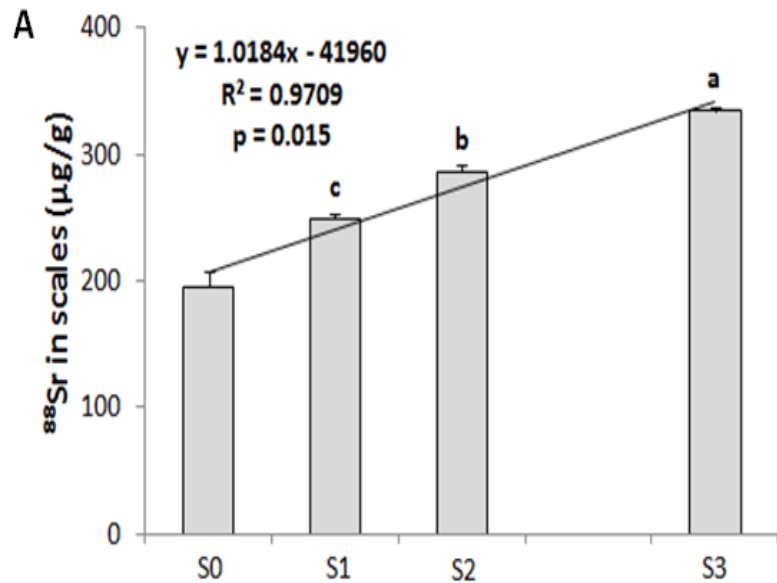
Sm



Gd



But the background levels of three (Sr, U and Sc) of the elements **increased** with time in seawater



This suggest that the latter three elements are being more incorporated in the scales in seawater than in freshwater.

Strontium has been reported to be 200-400 times more concentrated in salt water than in freshwater.

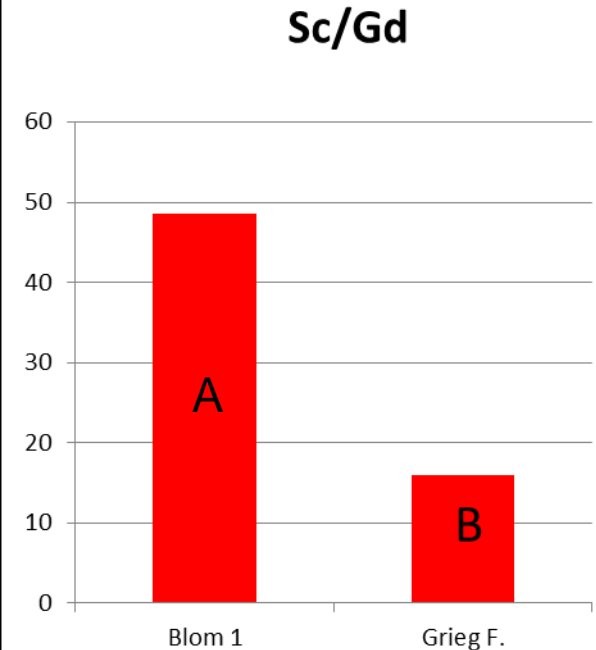
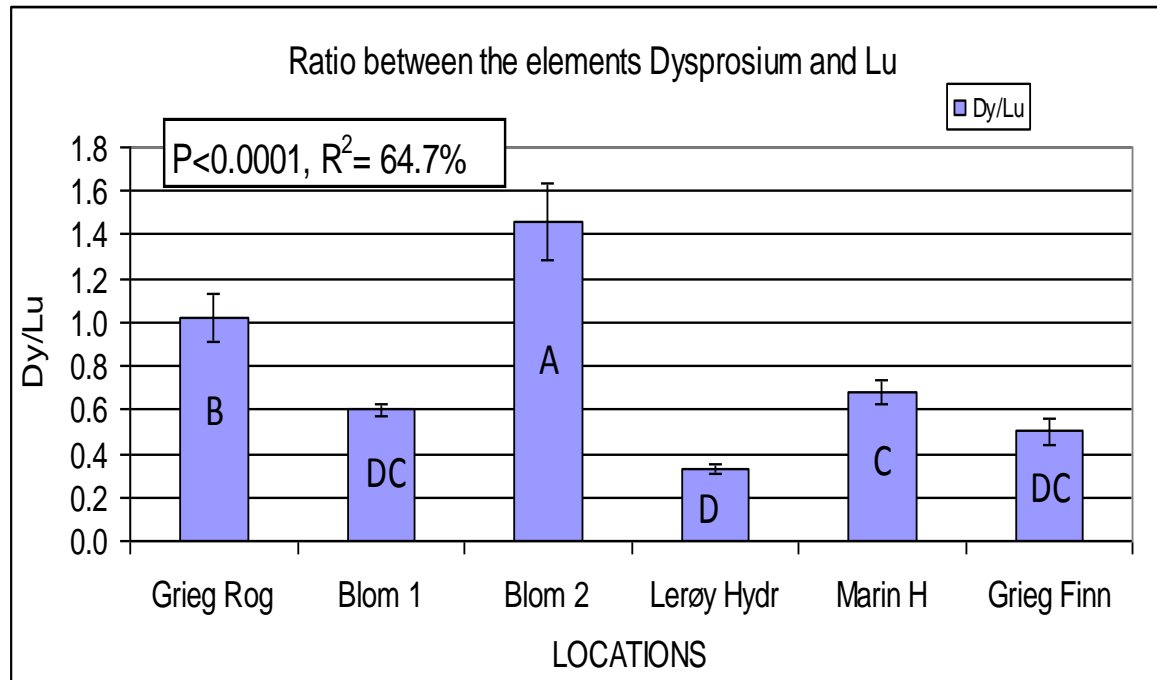
The opposite would apply for the other 14 elements which may be more abundant in freshwater.

These findings are very interesting as they indicate that farmed salmon may get a «double» chemical fingerprint in the scales during its lifecycle and that this signature might be used as a natural tag for the identification of reared fish from specific farm sites!

As an example, the results from the studies from the different farms along the coast showed interesting differences!

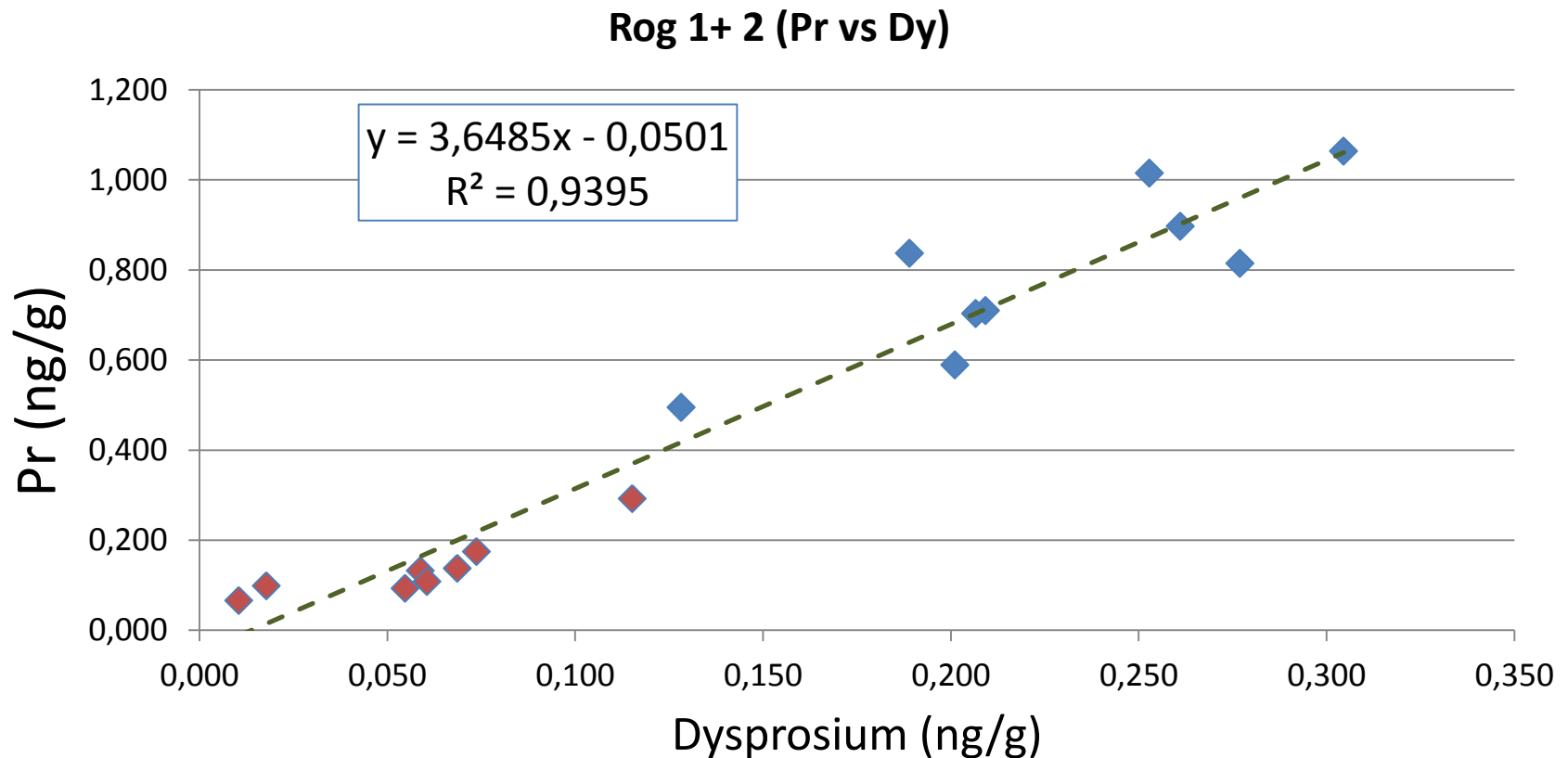
We saw that by looking on ratios between the elements that we got a "fingerprint" of each location!

Since we get data for 19 elements at the same time, we can study more than **300 ratios!**

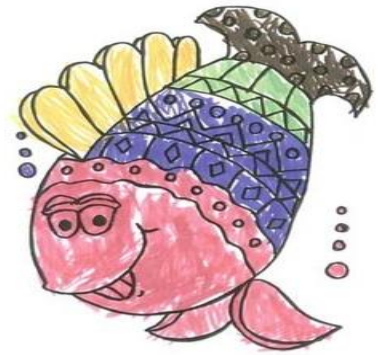


But we had one important question: Will this "fingerprint" stay constant over time??

To test this we were lucky to get some scales from the same fish group after more than one year in sea, and our results gave us the answer: **Yes!**



Conclusions this far

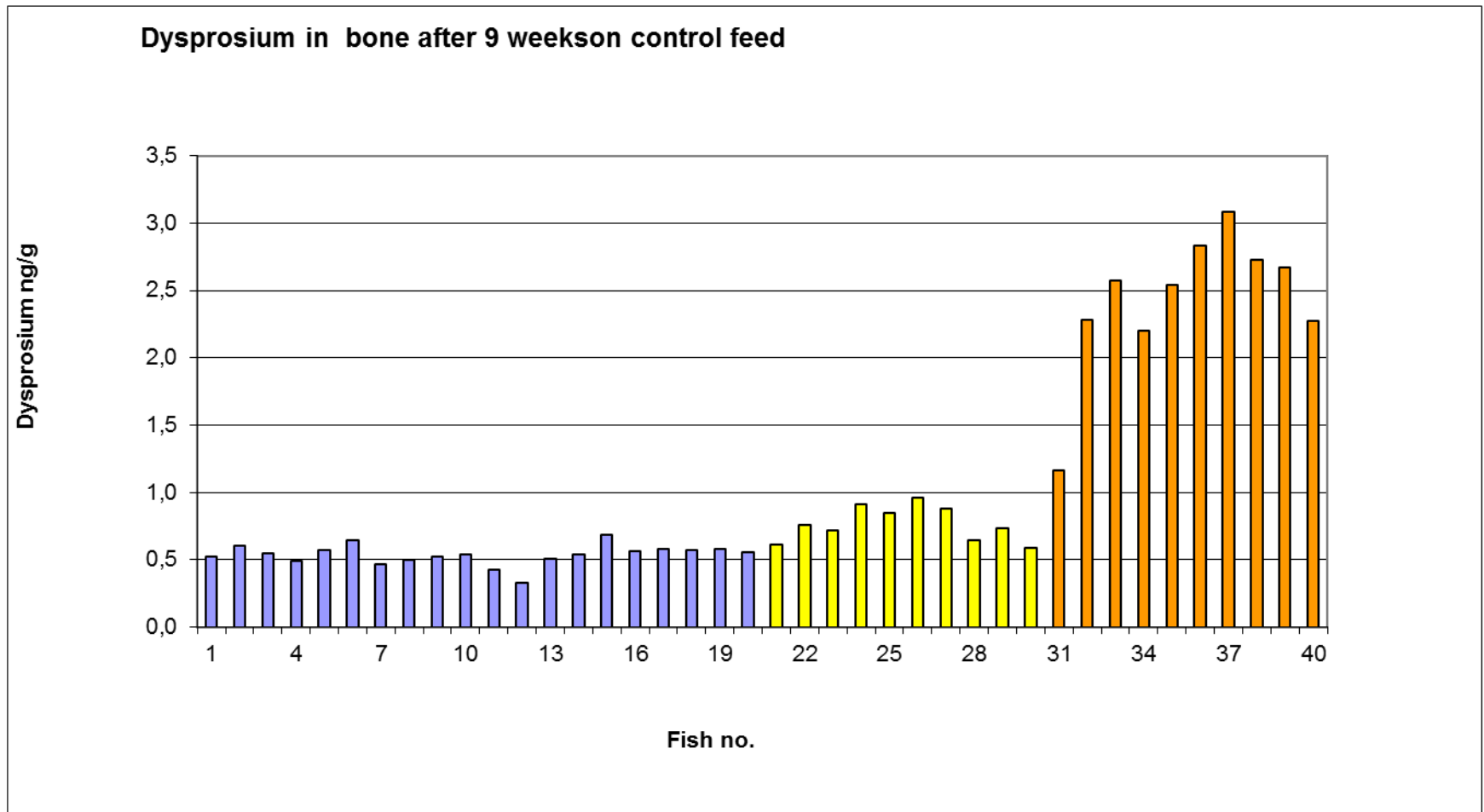


- By adding small amounts (100-200 mg/kg) of Rare Earth Elements to the feed, salmon smolts can be marked, and the mark will survive for months!
- And even better: Perhaps just analysing the background (fingerprints) of these elements can be enough !!
- I also have to thank my very dedicated and clever Master student Marta Perez who did most of the work on the 1+ smolt!

Thank you!



The label is found also in bone



Is this cheap?

- How much feed needed: 120 g/fish
- How much of an element: 200 mg x 0,12 kg = 24 mg

3500 kr/kg

$3,5 \text{ kr/g} \times 0,024 = 0,08 \text{ kr/fish}$

