Northern aquaculture; modern vaccine- and gene technology giving health and welfare to the fish and well-being to the farmer

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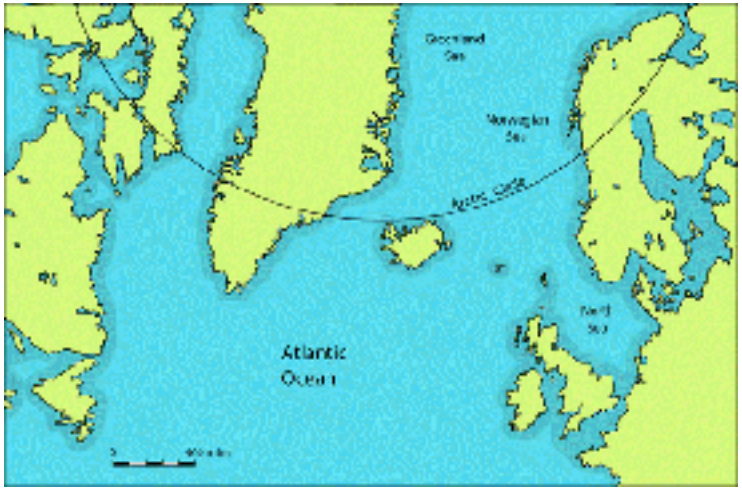
Northern salmonid mariculture



Country	Tons (2014) harvest weight
Norway	1 341 000
Faroe Islands	70 893
Scotland	169 210
Canada	120 000
EU-27	628 230 (2007)

Norway aquaculture in comparison

Annual meat production	**1000 tons**
Salmonid aquaculture, Norway	1341
Finfish aquaculture EU-27 (2007)*	628
Sheeps +goats, EU-28 *	808
Beef, Germany*	1128
Pork, Denmark*	1587

2014 Norwegian Directorate of Fisheries ; Eurostat *

Producer prices in comparison

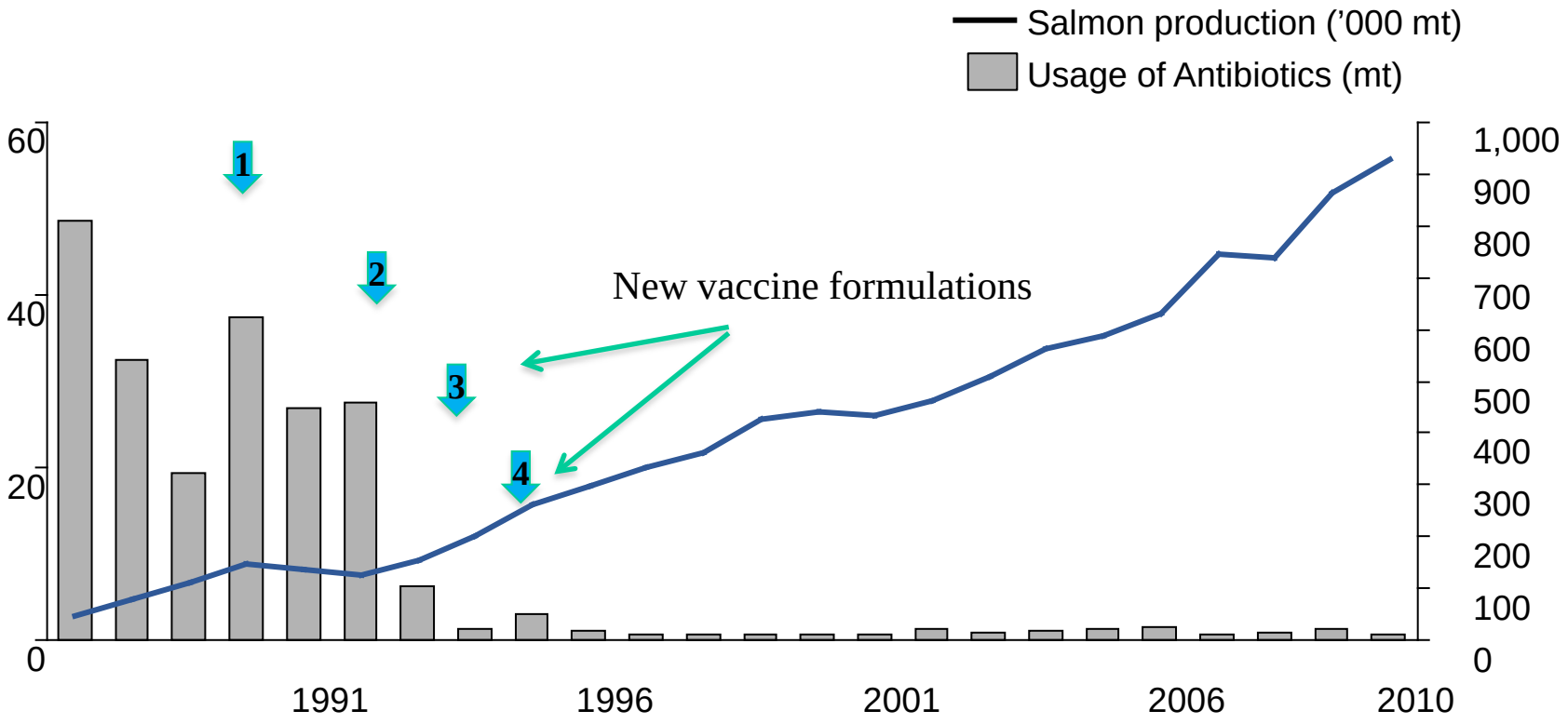
Meat type	**2015 so far**
Atlantic salmon	4,0-4,8 Euro/kg
Beef, Germany (young bulls)	3,7-4,0 Euro/kg
Pork, Germany	1,3-1,5 Euro/kg

Comparative sales of antibacterial drugs in Norway 2014

	Kg active substance	Proportion
Aquaculture	ca. 1590	1%
Terrestrial animals	ca 5300	14%
Humans	ca. 44 200	85%

Source: Norm/Norm-Vet 2014 report and Prof K. Grave, pers. comm.

Vaccination stopped antibiotic use



The ”breakthrough of fish vaccination” 1991-1993

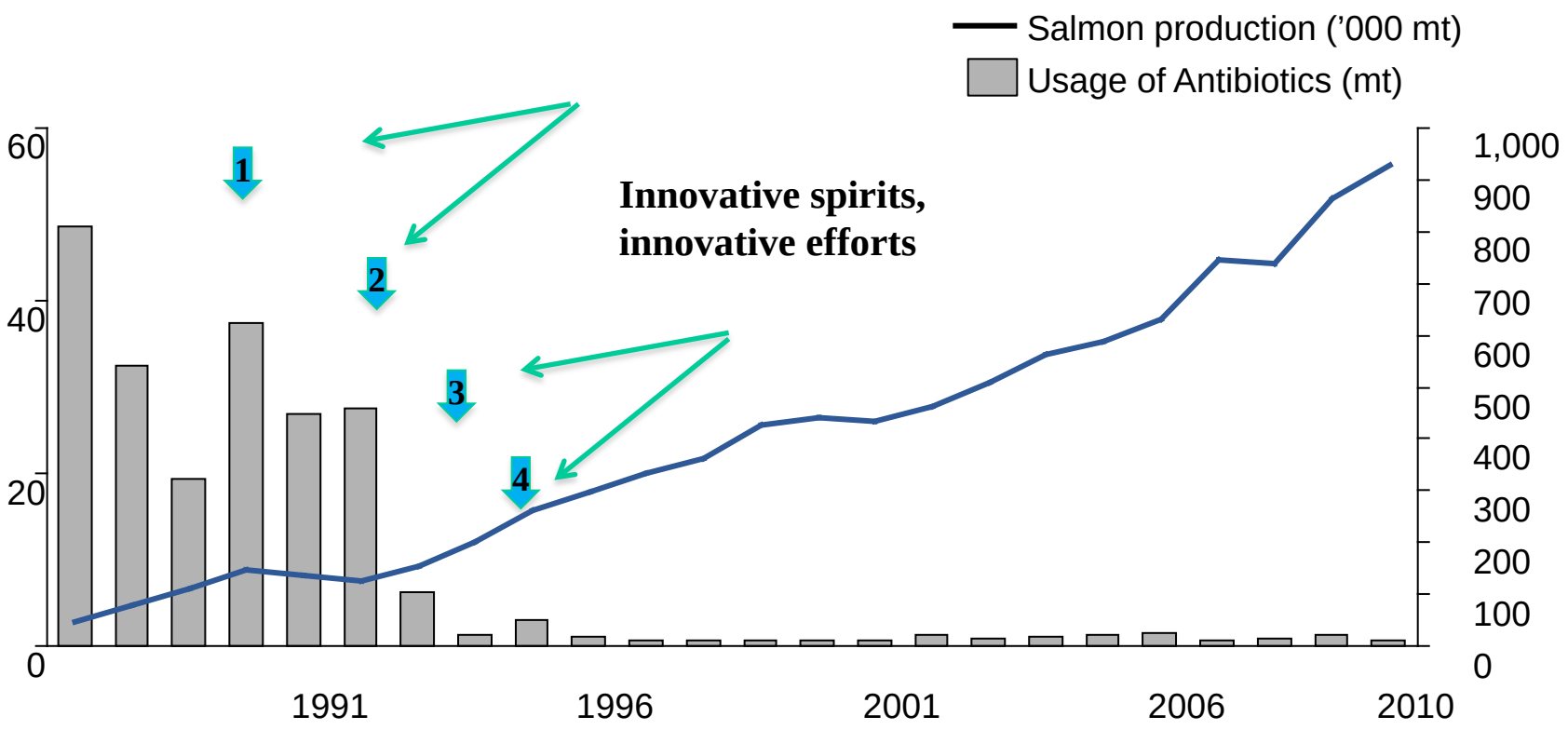
- Multivalent, oil adjuvanted vaccine technology
  - highly effective against bacterial diseases, even against furunculosis
  - long-lasting immunity (through harvest)

Year	# smolts	# doses	coverage
1991	40 mill	17,5 mill	43%
1992	60 mill	30,5 mill	51%
1993	60 mill	53,5 mill	90%

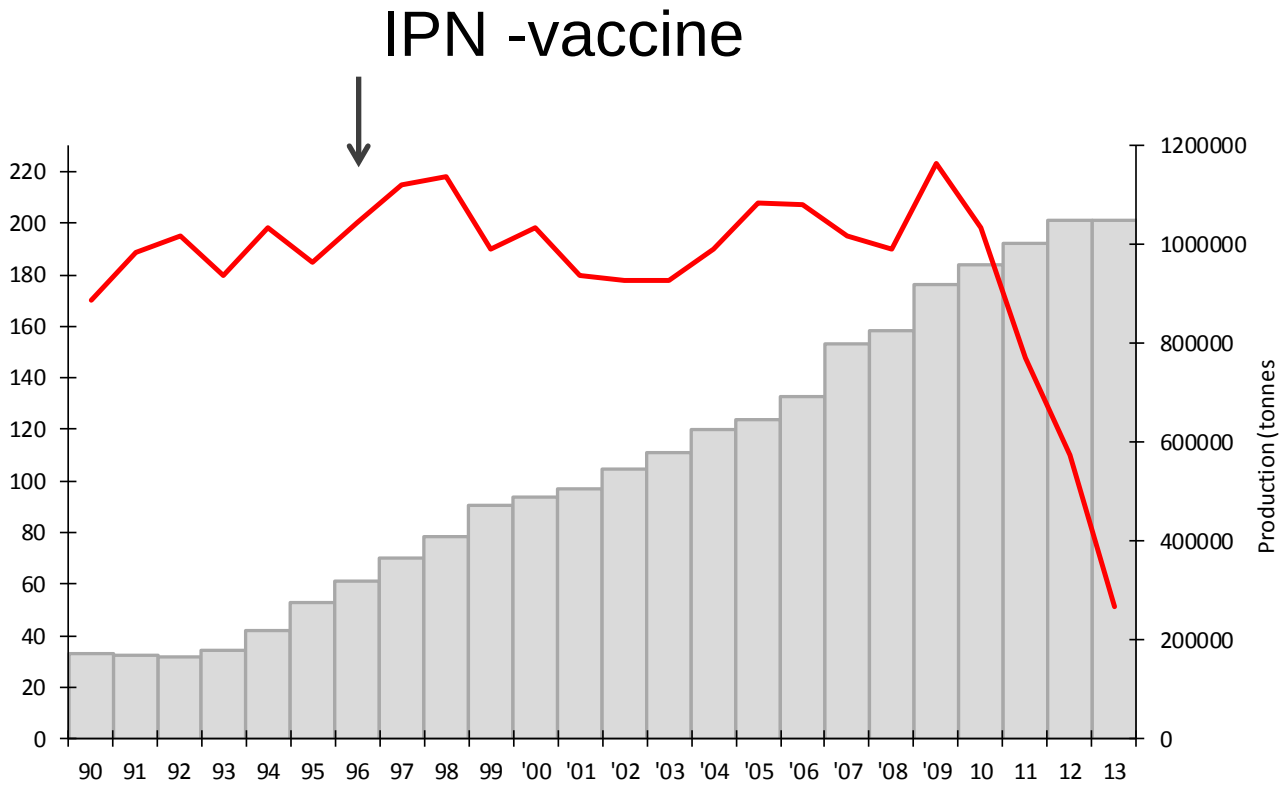
It did not happen by itself

- 3% R&D levy on sales accepted for 3 years by the veterinary pharmaceutical industry (voluntarily…….?)
- Large-scale field trial with vaccines under development (prototypes) accepted by the Norwegian Medicines Agency
- Scientifically convincing results obtained
- Propaganda campaign ”stop furunculosis” was financed by the Salmon Farmer´s marketing co-operative

We could have given up, but didn't



Viral diseases – a different story



Source: AquaGen AS; based on data from National Veterinary Institute / FHL

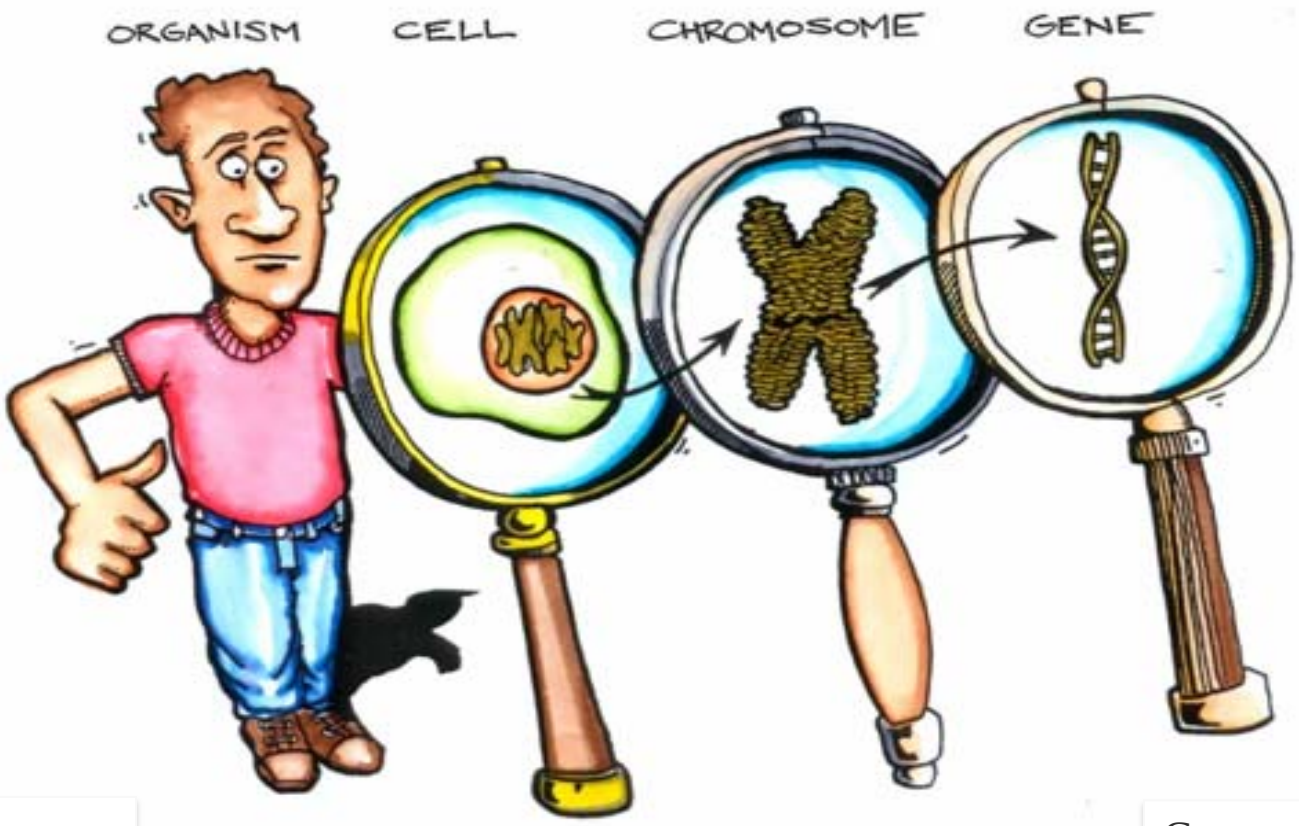
Breeding for disease resistance

A high priority in current Atlantic salmon breeding programs

- selection for resistance to bacterial infections since 1995 (5 generations)
- up to 60% of the basis for selection in AquaGen production stocks of certain years *
- Selection for resistance to IPN virus included since 2002

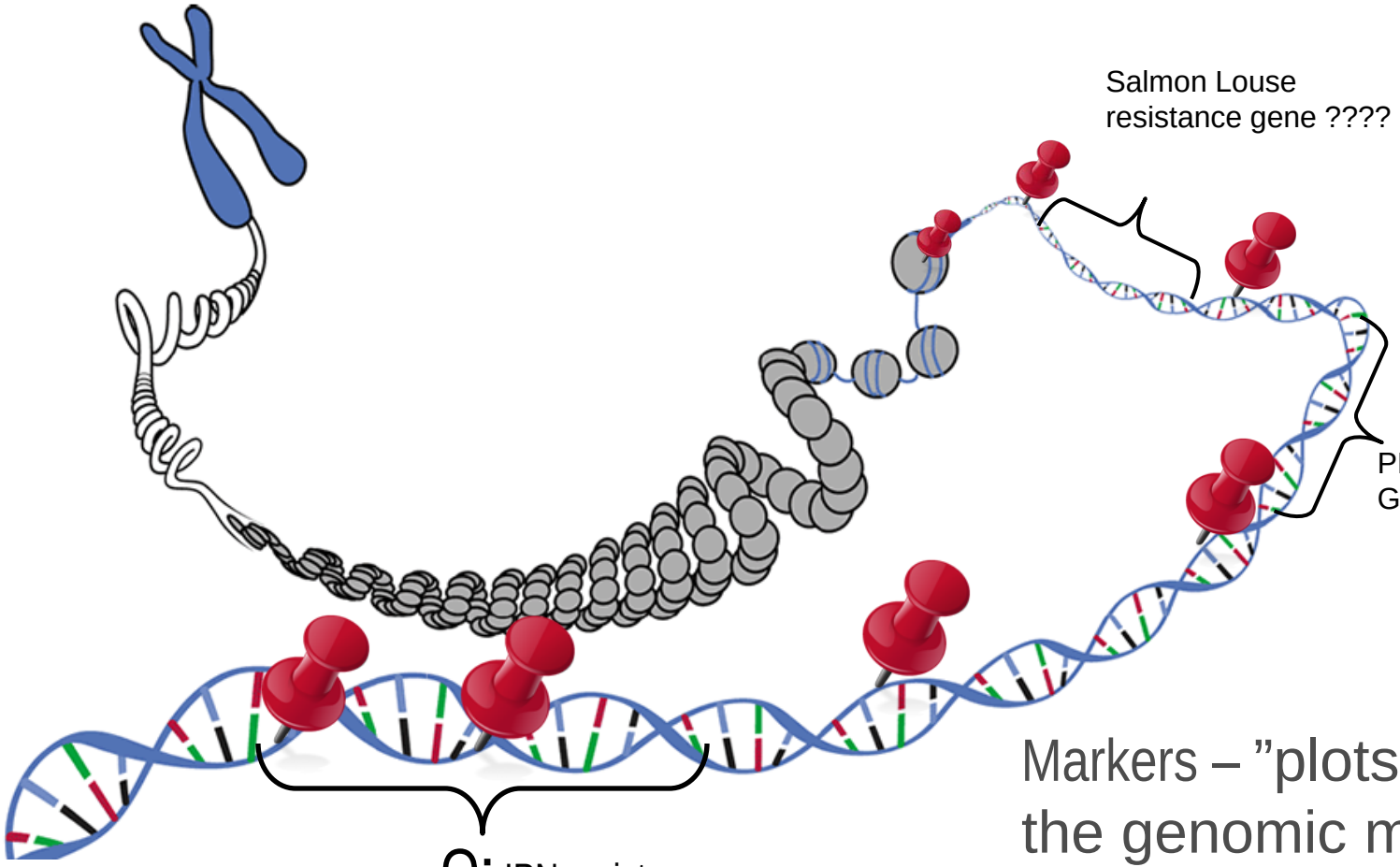
* A. Storset, pers. comm.

From fenotype- to genotype–based selection

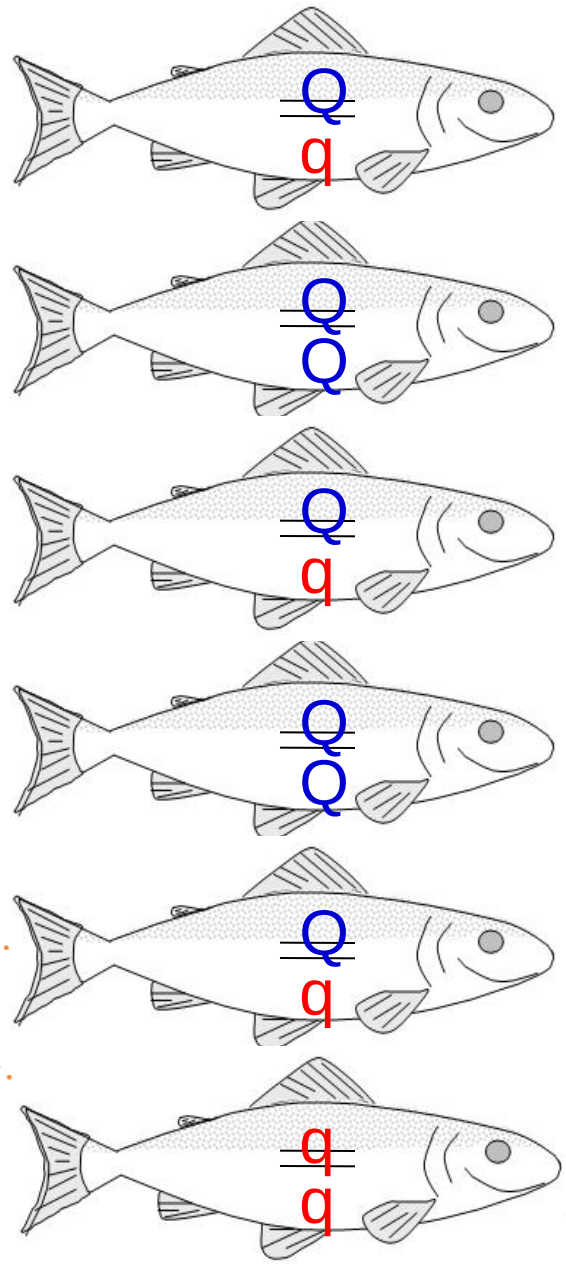


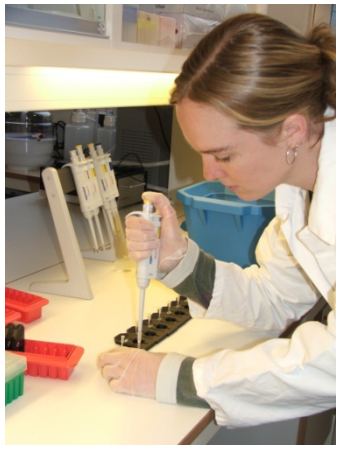
Fenotype → Genotype

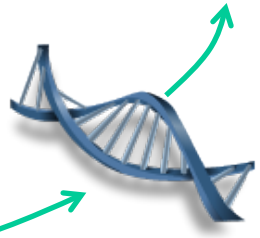
Genomic markers

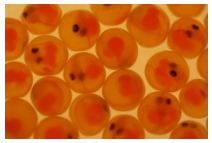


Markers – ”plots” on the genomic map



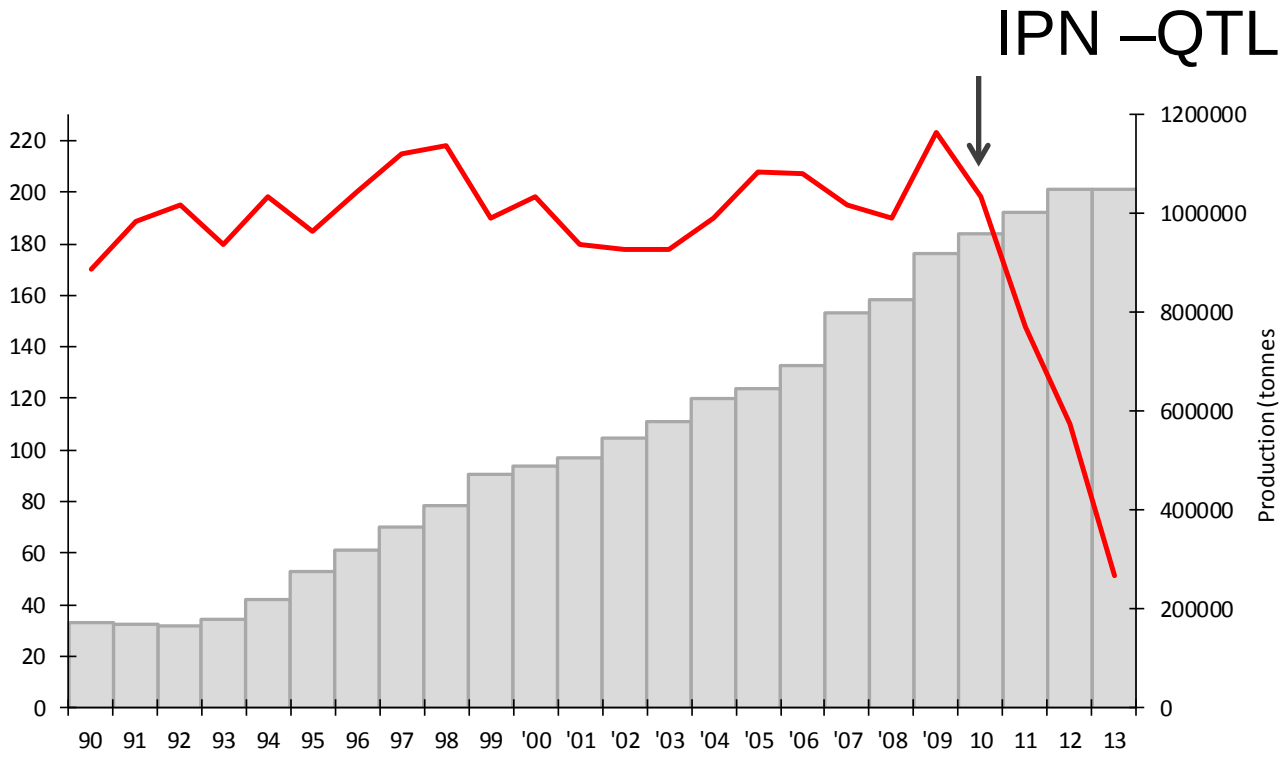






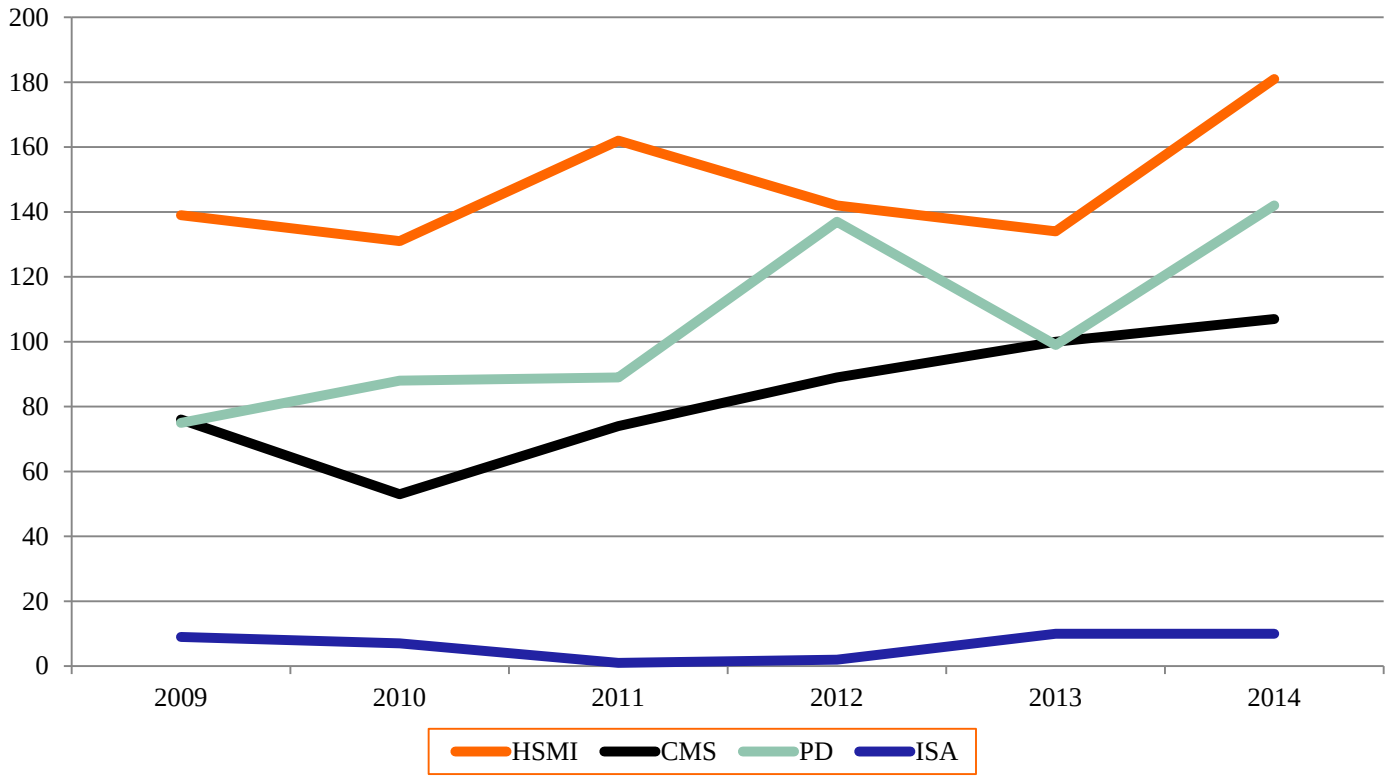
”Super-resistant” offspring

Selection based on genomic marker resolved the problem



Source: AquaGen AS; based on data from National Veterinary Institute / FHL

Other viral infections remain a challenge



(Naked) DNA virus vaccines

- A mobile genetic element (plasmid) makes target cells produce a specific protein (antigen)
- A plasmid is not a complete organism (bacterium or virus), conventional vaccines are
- Cannot live or replicate on itw own (outside the target cell)
- Protein (antigen) production stops when the host cell dies

DNA (plasmid) veterinary vaccines

- West Nile virus vaccine for horses (Fort Dodge, USA)
- Licensed in 2005

- **Infectious Hematopoietic Necrosis virus vaccine for salmon (Novartis Animal Health, now Elanco Canada)**
- **Licensed in 2005**

- Canine Oral Melanoma gene therapy vaccine (Merial, USA)
- Licensed in 2010

Vaccines against novirhabdovirus diseases in salmonids (Egtvedt disease, IHN)

- Scientific documentation showing high and long-lasting vaccine protection
- Extensive research in Aarhus (DK) and Seattle (USA)
- A DNA vaccine for salmon was launched in B, Canada in 2005
- Intramuscular injection
- ≈ 100 million fish vaccinated to date
- No reported adverse effect
- No reported clinical outbreaks in vaccinated fish

Genetic fingerprinting for identification of escapees

AquaGen

Konseptbevis-
genetisk sporing av «rømt» laks med SNP-basert slektskapstesting

Kjøglum S., Lien S., Kent M.; Grove H.; Lie Ø.

Gene profile of both parents ≈ 100% correct parentage

+ database of distribution of eggs through the farming chain

= verification or falsificaiton of putative escapees

45 mill ”Green track” salmon eggs delivered in 2014-15

Total amount used in Norway:
360-380 mill eyed eggs

Conclusions

1) If you want people to eat more (aquaculture) fish, look for innovative solutions! Focus on blocking hurdles tend to kill rather than to support.

2) Without mass vaccination, aquaculture is neither profitable nor sustainable in the long run!

3) Modern gene technology does not equal genetic modification! And can support all kinds of aquaculture operations (ECO as well as conventional).

Acknowledgements

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