Oppsummering og anvendelse i næringen

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Fish Health

Monitoring of mortality and growth between tagged and control fish is being undertaken for all three marking techniques

Monitoring of production parameters

	Spawning	Fertilsation	Hatch success	First feeding	Vaccination	Smoltifaction	Sea Transfer	Production Size
Vaccination Mortality Growth					No difference	No difference	No difference	
Egg immersion Mortality Growth		No difference	No difference	No difference	No difference			
Maternal Transfer Mortality Growth	No difference	No difference	No difference	No difference	No difference			

Application

Labelling via Maternal Transfer: Applied 3 to 6 weeks prior to spawning

A) Marker solutions held by hatchery facilities

B) Markers solution may be injected during sorting stage

C) Recommend injections to be administered at least 3 weeks prior to spawning

D) Current number of possible codes (N = 63)

Application

Labelling via Egg Immersion: Applied during egg swelling stage post fertilisation

A) Marker solutions held by hatchery facilities

B) Eggs bathed in markers solutions for 2 hours immediately post fertilisation before eggs are placed into hatchery rearing trays

C) Current possible number of codes (N = 7)

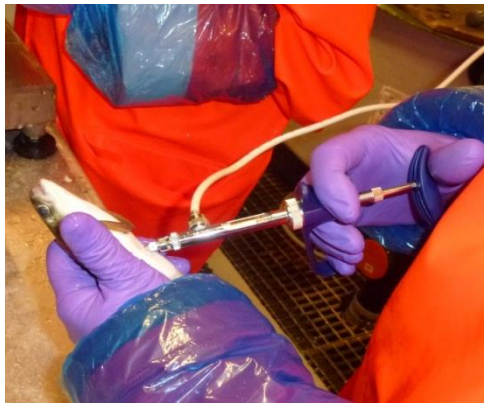
Application

Labelling Vaccines: Applied during vaccination either by mixing with a vaccine or second injection

A) Markers can be added during the vaccine production stage prior to distribution

B) Marker solutions can be produced by independent groups and distributed to individual farms.

C) Number of possible codes (N = 63)

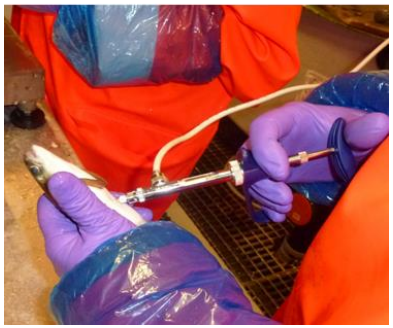


Application

Double Marking: First mark applied at the egg stage (Maternal transfer or egg immersion) second marker applied at vaccination

A) Enables a greater number of code combinations

B) Number of possible codes (N = 1020)



Application

Possible future application to industry

One code for each company applied at the egg producer stage

(83 codes required, currently 63 available)

Each company then has the opportunity to separate into 83 new groups by vaccine marking

(83 codes required, currently 63 available)

Company Trade off between:

Cost of marking vs. possibility of tracing own escapes

Cost projections

Scenario 1: A mark for all farm locations (N = 1000)

(Possible, We can make 1020 codes using 4 Ba and 2 Sr markers, but Sr markers are currently restrained by cost, and require further optimisation of techniques)

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(Currently achievable)

Cost projections

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Scenario 2: A mark for all company's and counties (N = 164)

(Currently achievable)

Scenario 3: A mark for all company's in Norway (N = 83)

(Currently achievable)

Cost projections

Scenario 1: A mark for all farm locations (N = 1000)

(Possible, We can make 1020 codes using 4 Ba and 2 Sr markers, but Sr markers are currently restrained by cost, and require further optimisation of techniques)

Scenario 2: A mark for all company's and counties (N = 164)

(Currently achievable)

Scenario 3: A mark for all company's in Norway (N = 83)

(Currently achievable)

Scenario 4: Marking 300 million fish with 1 marker (N =1)

(Currently achievable)

Cost projections Scenario 1

In total we can produce **1020 unique markers** using the 4 Ba and 2 Sr markers combined with marking by maternal transfer and vaccination

The average cost for **markers 1 to 255** would be **0.0929 NOK per fish** using Ba

The cost per code from **markers 256 to 1020** due to requirement to use ^{86}Sr or ^{87}Sr requires further optimisation as the current cost is approximately:

3 NOK per fish for codes 256 to 765

4.5 NOK per fish for codes 766 to 1020

Note: the cost per fish could be greatly reduced by optimising code allocation.

(i.e. Larger production sites would receive cheaper marker codes)

Cost projections Scenario 2

A mark for all company's and counties (N = 164)

Company and county data sourced from Kontali Analyse AS

Method: Combination marking with vaccination, maternal transfer or both with Ba codes

Vaccination: Marks the region of the otolith developing at the parr/pre-smolt stage

Maternal Transfer: Marks the core of the otolith developing at the eyed egg stage

Cost for 300 million fish spread evenly across all company by county combinations

Cost per fish = 0.062 NOK

Total cost to mark 300 million fish = 18,600,000 NOK

Cost projections Scenario 3

A mark for all company's in Norway (N = 83)

Company data sourced from Kontali Analyse AS

Method: Combination marking with vaccination, maternal transfer or both with Ba codes

Vaccination: Marks the region of the otolith developing at the parr/pre-smolt stage

Maternal Transfer: Marks the core of the otolith developing at the eyed egg stage

Cost for 300 million fish spread evenly over 83 companies:

Cost per fish = 0.035 NOK

Total cost to mark 300 million fish = 10,446,000 NOK

Cost projections Scenario 4

Marking 300 million farmed Atlantic salmon with 1 Ba code

Vaccination (50 g fish)	Cost Per individual	Total
^{137}Ba @ 0.001 µg. g^{-1} fish weight (15 g for 300 million parr)	0.0013 NOK per parr	390,000 NOK

Cost projections Scenario 4

Marking 300 million farmed Atlantic salmon with 1 Ba code

Vaccination (50 g fish)	Cost Per individual	Total
^{137}Ba @ 0.001 µg. g^{-1} fish weight (15 g for 300 million parr)	0.0013 NOK per parr	390,000 NOK

Egg immersion (2000 eggs L^{-1})	**Cost Per individual**	**Total**
^{137}Ba @ 100 µg. L^{-1} (150,000 L for 300 million eggs)	**0.0013 NOK per egg**	**390,000 NOK**

Cost projections Scenario 4

Marking 300 million farmed Atlantic salmon with 1 Ba code

Vaccination (50 g fish)	Cost Per individual	Total
^{137}Ba @ 0.001 µg. g^{-1} fish weight (15 g for 300 million parr)	0.0013 NOK per parr	390,000 NOK

Egg immersion (2000 eggs L^{-1})	Cost Per individual	Total
^{137}Ba @ 100 µg. L^{-1} (150,000 L for 300 million eggs)	0.0013 NOK per egg	390,000 NOK

Maternal Transfer (5000 eggs per 10 kg brood fish)	**Cost Per individual**	**Total**
^{137}Ba @ 0.02 µg. g^{-1} brood fish weight (60000 brood fish for 300 million eggs)	**0.0011 NOK per egg**	**330,000 NOK**

Analysis costs Scenario 1

Monitoring program sampling 10000 fish per year

Analysis of 10000 samples per year	Days required	Equipment cost per Day	Labour Cost (6000 NOK per day)	Totals
Sample preparation (50 per day)	200		200 Days	1,200,000
Laser ablation (50 per day)	200	14,400	200 Days	4,080,000
Data analysis (50 per day)	200		200 Days	1,200,000
			Total Estimated Cost	**6,480,000**

Sample analysis costs based on standard processing costs

Analysis costs Scenario 2

Rapid response to an escape event (N =50)

Analysis of 50 samples	Days required	Equipment cost Per Day	Labour cost (6000 Nok per day)	Totals
Sample preparation	2		2 Days	12000
Laser ablation	1	14,400	1 Day	20400
Data analysis and report	2		2 Days	12000
			Total Estimated Cost	**44,400**

Sample analysis and report can be completed in 1 week from the day otoliths are delivered to the laboratory

Conclusion

1 Guarantee 100% accurate mark detection

2 Marks are permanent
(Tags remain unchanged in the otolith permanently)

3 Marking is low cost
(Currently have 255 financially viable codes, with a further 765 codes possible)

4 No health or welfare issues for marked fish
(Monitoring of growth and mortality of complete production cycle)

5) Each method can be applied during the production cycle with minimal cost