Defining a breeding goal for sustainable farming of Atlantic salmon

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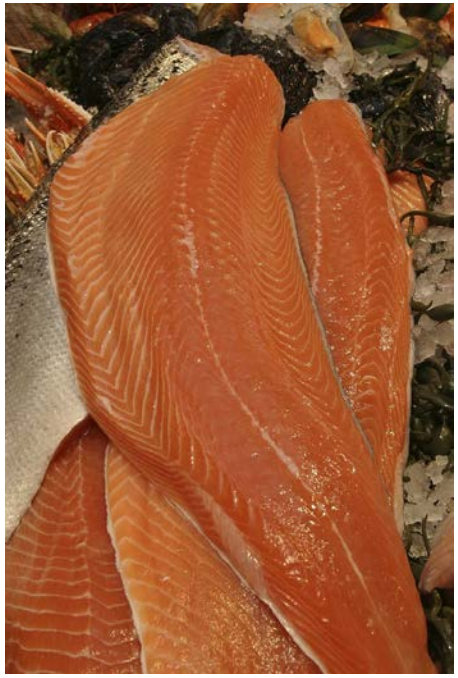
Outline

1) Overview of breeding programs for Atlantic salmon and how differ from livestock

2) Defining a breeding goal for sustainable farming of Atlantic salmon by including non-market / social values for a trait related to fish welfare

Salmon farming

- Salmon farming started late 60'ties
- Globally ca. 2 mill. ton Atlantic salmon
- Norway biggest producer (ca. 60%)



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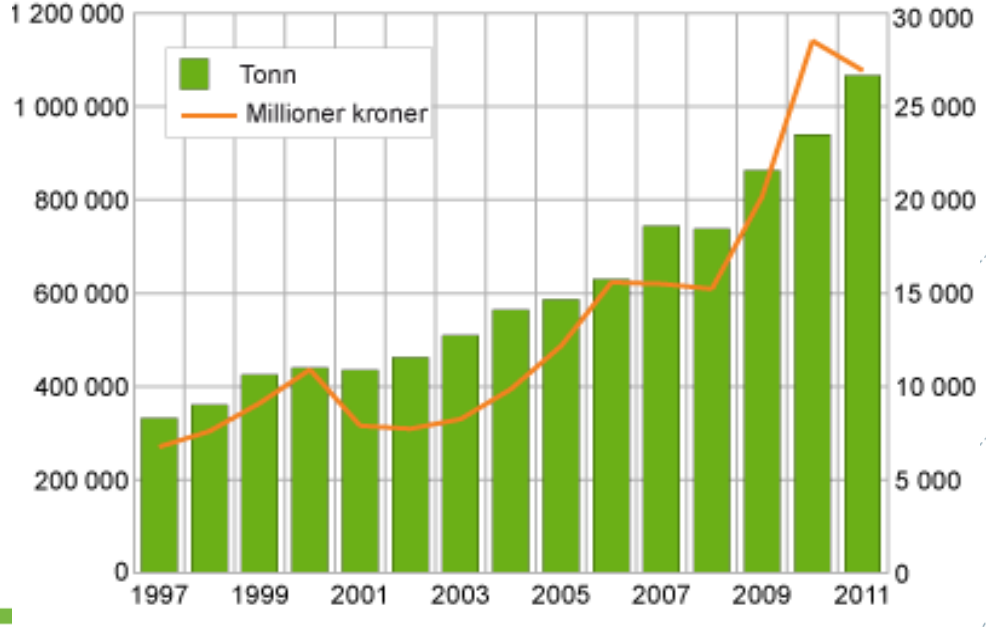
Production of salmon in Norway 1997-2011



Selective breeding of Atlantic Salmon in Norway

- Started in the 70'ties
- Wild caught salmon from 40 different river populations
- Generation interval = 3 - 4 yrs
- Current: 10th generation
- Relatively new domesticated compared to livestock

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Specific characteristics for salmon compared to livestock

- Very high fecundity (1200 eggs/kg)
- External (artificial) fertilization

  (stripping, mixing eggs and milk)

- Large full and half sib groups
- Flexible mating and breeding design
- Mostly nested design (1 ♂ : 2 ♀)
- Separate raring in family tanks until tagging (10-20g)

  (maternal vs. common rearing effect)
- Common tanks rearing using markers for parentage assignment

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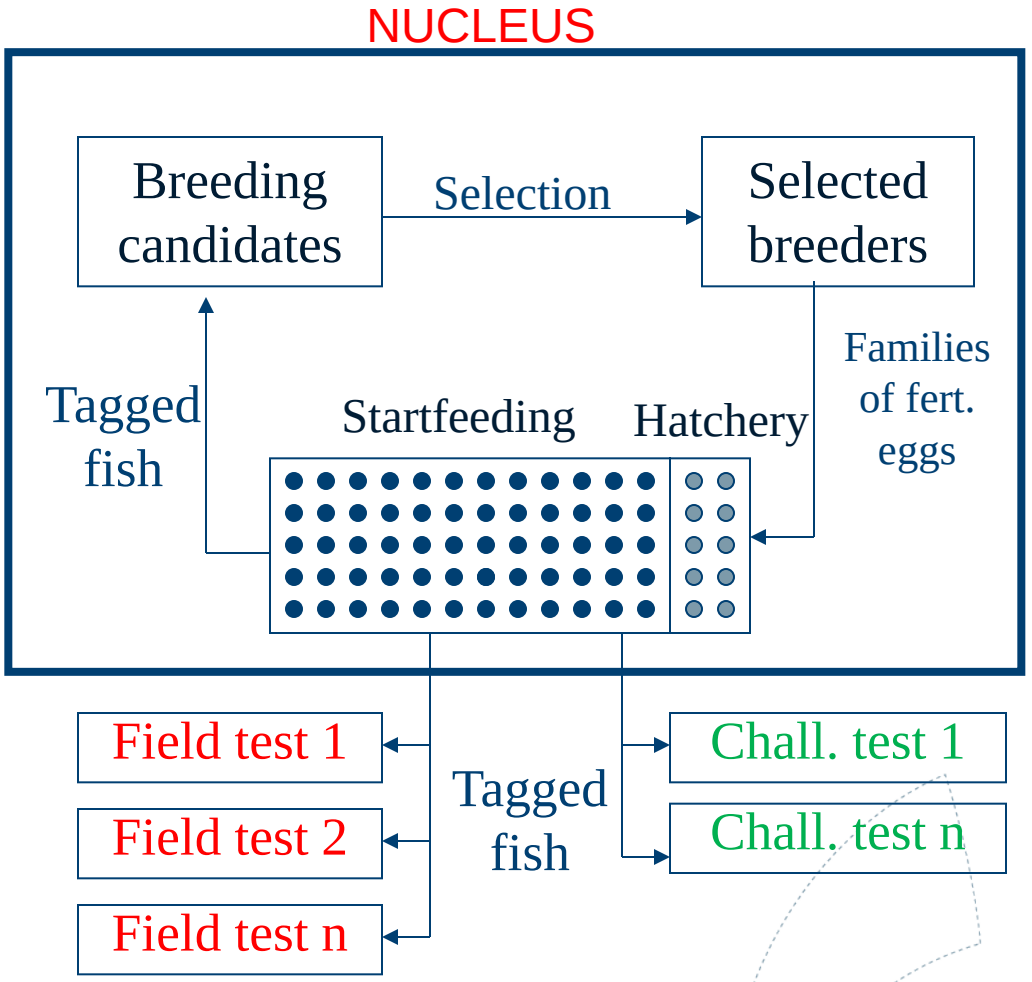
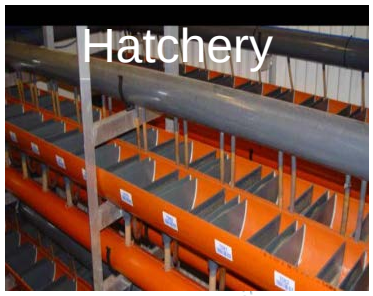
A typical structure of a salmon breeding program

Nucleus





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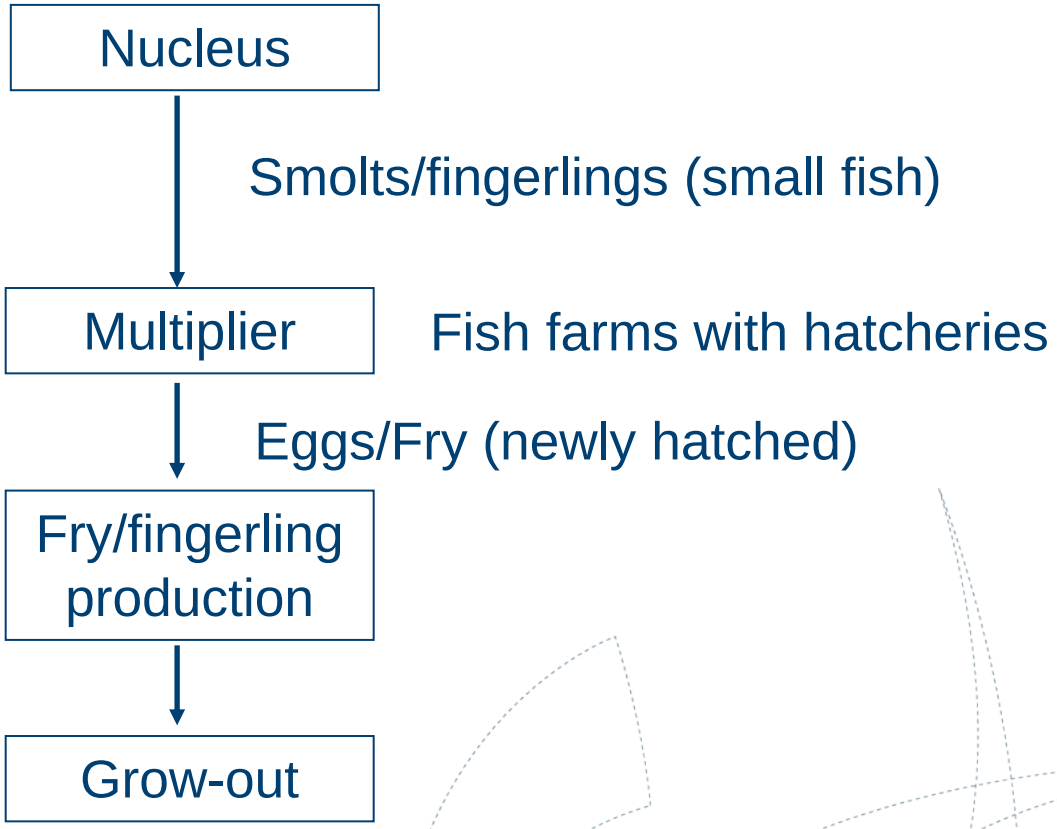
Breeding program - dissemination



10 – 12 international breeding companies world-wide

Breeding goal - Atlantic Salmon Norway

Atlantic salmon traits	Individual	Sib
Growth	x	x
Age at sex. maturity	x	x
Disease resistance		
- ISA		x
- IPN		x
- PD		x
- Lice		x
Carcass quality		
- Filet fat		x
- Filet colour		x

1. Individual selection

- Limited to traits that can be recorded on the live breeding candidates

2. **Sib (family) selection**

– Records on sibs of the candidates

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Defining a breeding goal for sustainable farming of Atlantic salmon

Introduction

- Growing public concern about sustainability issues (e.g. animal welfare)

- Need to consider these aspects in the breeding goal

- Thus in addition to **economic values** one need to consider non-market values like social and ethical aspects

$$H = EV_1 * g_1 + NV_1 * g_1$$

- By including non-market values in the breeding goal, trait related to sustainability can be given the appropriate social or strategic weight to obtain an acceptable response

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Introduction

Problems:

1) Add non-market **/** Increase weight on trait related to sustainability = decreased response in production traits = reduced farmer profit

- Need to balance genetic improvement in production vs. traits related to sustainability

2) Difficult to derive non-market values for traits because:

- Social or ethical aspects are public goods = value only partly traded in the market (people not buying fish may also care about fish welfare)

- New methods needed to find the non-market values of traits

Desired gain + survey about willingness to pay for improved fish welfare

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Aim

Show how to define a breeding goal for sustainable farming of Atlantic salmon by including non-market values obtained from a choice experiment among Norwegian house holds

Breeding plan for salmon

- Predicted selection response after 1 round of selection using the program Selaction
- 5% of sire selected
- 10% of dams selected
- 300 families produced

Traits

1) **Growth**
   -measured on the selection candidates and 14 sibs

2) **Resistance to Salmon lice**
   (a) consume skin and blood
   (b) parasites spread from farmed to stocks of wild salmon
   (c) chemicals used to combat the parasite

- Both economic value (cost of treatment) and non-market value (fish health and welfare)

- Measured on 14 sibs

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Genetic parameters

Heritabilities:

Growth = 0.30

Lice = 0.15

Correlations:

$r_g = 0$

$r_p = 0$

Economic values

Growth	**15 NOK / kg**	**1 NOK = 0.13 €**
Lice	**0.7 NOK / kg***	

* Based on treatment costs

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Derivation of Non-market value for salmon lice

- Based on households willingness to pay an ear marked tax to support breeding programs aiming at improving fish welfare
- Internet survey with a choice experiment
- 773 respondents representative for Norwegian population

Each respondent were asked to choose between:

2 breeding programs with improved fish welfare (A, B)
1 breeding program with focus on growth (Status Q, SQ)

- 4 welfare traits at two levels (bred for or not (Yes/NO))
  (only salmon lice considered in the current study)

<u>Cost of the breeding program:</u>

Increased tax per household per yr, 8 levels (100,.,1800 NOK)
- Costly to improve fish welfare because less response in growth
- Capture also WTP for non-consumers

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Example choice set with 3 breeding programs

If you were to choose between purchasing salmon from one of these two new breeding programs for farmed salmon and the presently used breeding program; which one would you choose? The additional cost would be in additional tax for your household to pay for more costly farmed salmon

	Breeding program		
	A	B	SQ
Less salmon with deformities	YES	NO	NO
Less salmon with injuries	YES	NO	NO
Increased resistance to salmon lice	NO	YES	NO
Increased resistance to diseases	NO	NO	NO
Extra tax NOK / household / year	800	500	0
I choose:	A	O	
	B	O	
	SQ	O	

6 different choices !

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Willingness to pay (WTP) and trade-off in growth

WTP in increased tax for improved salmon lice from the survey:

= **951 NOK (124 €) in tax per house hold /yr**

- 2.2 mill. households + 1.183,600,000 kg salmon produced in Norway /yr

WTP corresponds to 1.8 NOK per kg of salmon produced in Norway / yr

Tax can be used to improve salmon lice and compensate farmers for their reductions in profits due to lower response in growth

We can afford to loose 1.8 NOK /kg of salmon in response in growth to improve resistance towards salmon lice

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Derivation of NV for salmon lice

1) Calculated response for growth and salmon lice with **only EV's** in the breeding goal

2) How much can we increase the weight on salmon lice if accept loss in response in growth = 1.8 NOK per kg (= tax)
(Desired gain in growth = response with EV only – 1.8 NOK)

3) Restricted response in growth to desired gain

4) Obtain total weight on salmon lice

5) NV for salmon lice = total weight - EV

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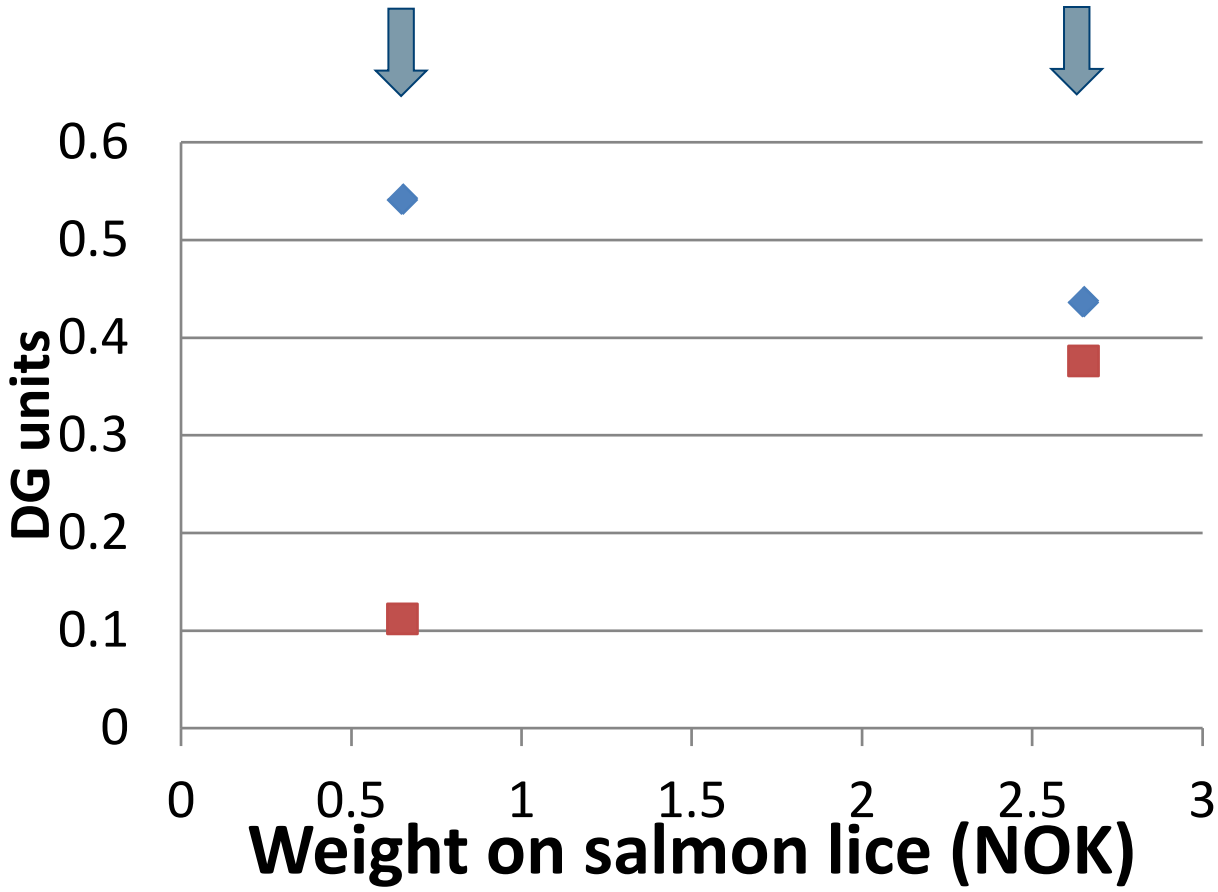
Results- response in growth and salmon lice & NV

Only EV in b.g.

Loss in growth = tax (1.8)



Growth

Lice

NV = 2.7 – 0.7 = 2 NOK

NV = TV - EV

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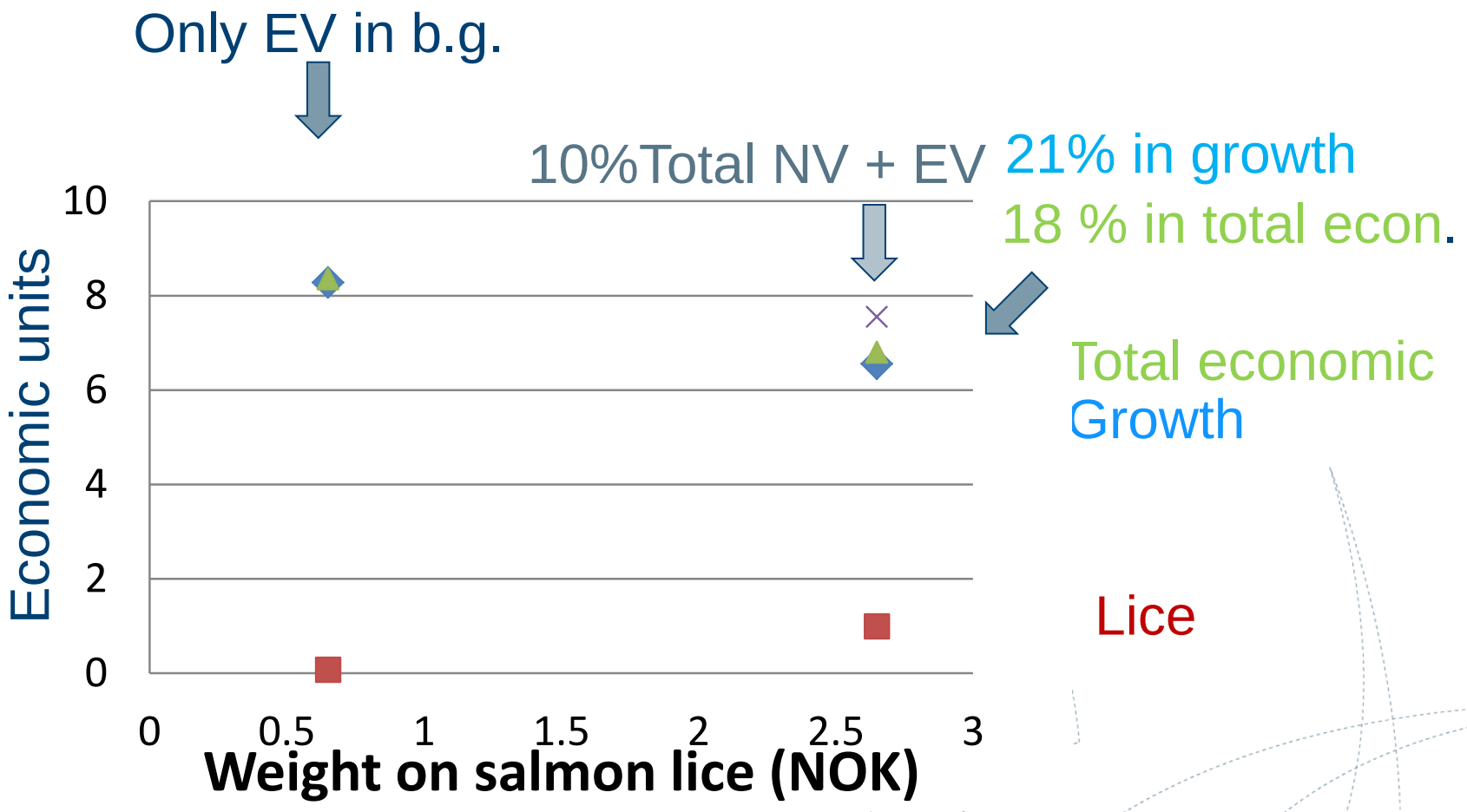
Results - Response in Economic units



Conclusion

- Demonstrated how one may define a breeding goal for sustainable farming of Atlantic salmon by including non-market values estimated using WTP from a choice experiment among Norwegian house-holds
- Consumer/citizens aspects needed to include sustainability
- However, results from hypothetical choice experiments may be biased

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