Semi-closed containment systems in Atlantic salmon production

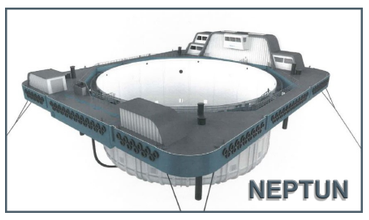
NTNU
Norwegian University of Science and Technology

STUDENT: SIMEN A. HAALAND SUPERVISOR: BJØRN EGIL ASBJØRNSLETT CO-SUPERVISOR: ASTRID BURAN HOLAN (AQUAOPTIMA)

INTRODUCTION

Aquaculture industry in Norway is facing some enormous challenges. Sealice, escapes and diseases are some of the major issues related to production of Atlantic salmon. While struggling with this problems there is a clear vision of growth and increase of aquaculture production. How can the industry fulfill the vision and goal of growth [1], and at the same time take control of the major problems?

Semi-closed containment system floating in sea arise as an alternative or possibly a supplement to the traditional production of Atlantic salmon in open net pens. New production strategies and systems are under development because of the demanding production conditions seen in traditional production. Prolonged production of smolts, both in S-CCS in sea and on land in recirculating aquaculture systems (RAS), are being proposed [2].



Retrieved from Aquafarm Equipment.

Semi-closed containment systems (S-CCS) are primarily being developed to be able to produce bigger smolts than applied today, and to reduce the total time salmon are exposed in open net cages [3]. Reducing the time in open net cages reduces the exposure for sealice and possible diseases. This could also affect the effectiveness of the open net production sites and improve the salmon production cycle. What differentiates S-CCS from a traditional open net pen system is the physical barrier that separates the rearing environment from the external environment.

The main focus will be to see how the introduction of S-CCS can influence the salmon production chain with respect to reducing the time salmon is exposed in sea, mortality, investment cost, more effective use of open net production sites and sites and area used in production. Is it only in the period from 100 gram to 1 kg it could be beneficial to operate with S-CCS or can it be other parts of the production chain that can benefit from S-CCS? Could this increase the effectiveness of sites and possibly increase production in volume? This are questions this master thesis will try to highlight, discuss and answer. Different strategies for applying S-CCS and landbased farming in todays production regime will be proposed and evaluated based on key criteria.

OBJECTIVE

The overall goal is to highlight the possibilities and challenges related to S-CCS. Possibilities being the opportunity of increased and more efficient production of Atlantic salmon. Focus related to the challenges will be on safe water supply to the rearing environment, water quality and water treatment, increasing production cost and how to fit S-CCS into todays production regime.

Introduce semi-closed containment system and Atlantic salmon production. How can S-CCS fit into todays production regime. The literature review will form basis for strategies and criteria to be evaluated.

Propose the different production strategies using S-CCS and landbased production. Do a comparative analysis of these strategies using two different methods, Rank Order Centroid and Analytic Hierarchy Process.

The three proposed strategies are evaluated on the five criteria;

Time in sea(1), *Mortality(2)*, *Cost(3)*, *Efficiency(4)*, *Sites and area(5)*.

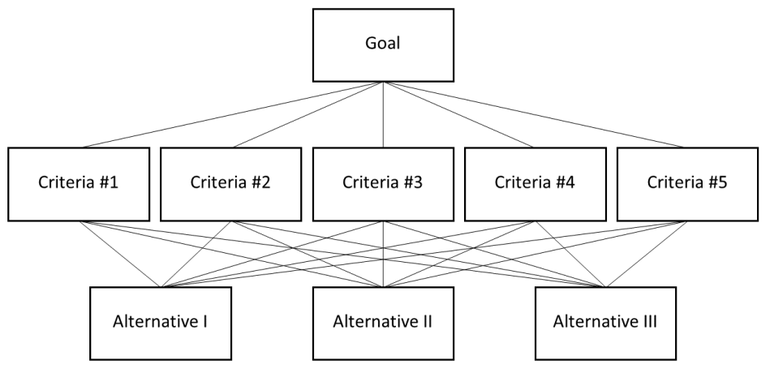
REFERENCES

[1] Olafsen, T. *et al.*, (2012). Verdiskaping basert på produktive hav i 2050. Report DNKNVS and NTVA.
[2] Iversen, A. *et al.*, (2013). Oppdrettsteknologi og konkurranseposisjon. Report Nofima.
[3] Mathisen, F., (2016). Production of post-smolt in RAS. *Smoltproduksjon* conference at Sunndalsøra October 2016.
[4] Saaty, T. Vargas, L.G., (2012). Models, Methods, Concepts Applications of the Analytic Hierarchy Process. Springer US, Boston, MA.

METHOD

The methods applied to evaluate the strategies are Rank Order Centroid (ROC) and Analytic Hierarchy Process (AHP). ROC can be described as a Simple Multi Attribute Rating Technique Exploiting Ranks (SMARTER), while AHP often is referred to as a Multiple-criteria decision-making (MCDM) method. The basic of the AHP is to construct a matrix expressing these relative values of attributes and then normalize the matrix [4]. In this case there are five criteria and three alternatives to be evaluated upon the criteria. The first stage is to create the matrix where criteria is compared against each other. Every comparison matrix is controlled to be consistent so the comparisons are not totally random.

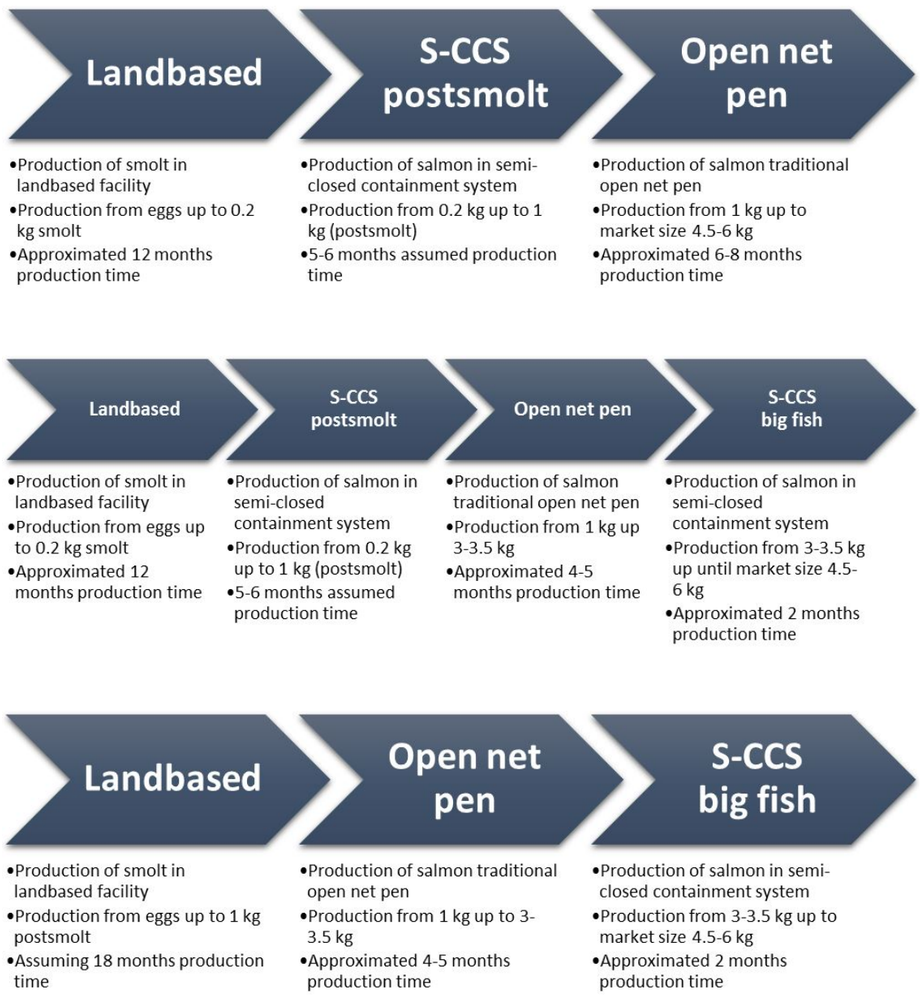
The figures below show how a hierarchy structure might look like and how the alternatives are related to all the criteria. It is also possible to insert sub-criteria, making the analyse more complex. Below the hierarchy structure is the comparison matrix for the criteria.



	Criteria #1	Criteria #2	Criteria #3	Criteria #4	Criteria #5
Criteria #1	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}
Criteria #2	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}
Criteria #3	C_{31}	C_{32}	C_{33}	C_{34}	C_{35}
Criteria #4	C_{41}	C_{42}	C_{43}	C_{44}	C_{45}
Criteria #5	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}

PROPOSED PRODUCTION STRATEGIES

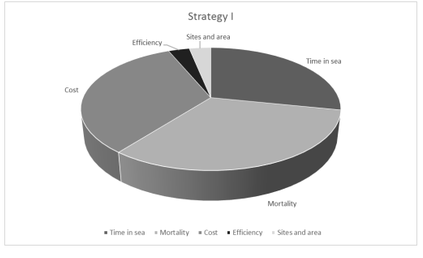
Based on the literature review and the criteria determined, three production strategies including S-CCS were proposed:



RESULTS

Diagrams presented below show the composition of the result for the best solution when applying the two methods. The table display the final result after applying ROC and AHP upon the criteria and alternatives.

(a) ROC best solution



(b) AHP best solution

Alternative	ROC	AHP
Strategy I	0,700	0,375
Strategy II	0,702	0,315
Strategy III	0,675	0,310