*InSEAS: In*itiative for the *S*tudy of the *E*nvironment and its *A*quatic *S*ystems

Defining “optimal” conditions for rearing salmon in closed containment RAS.

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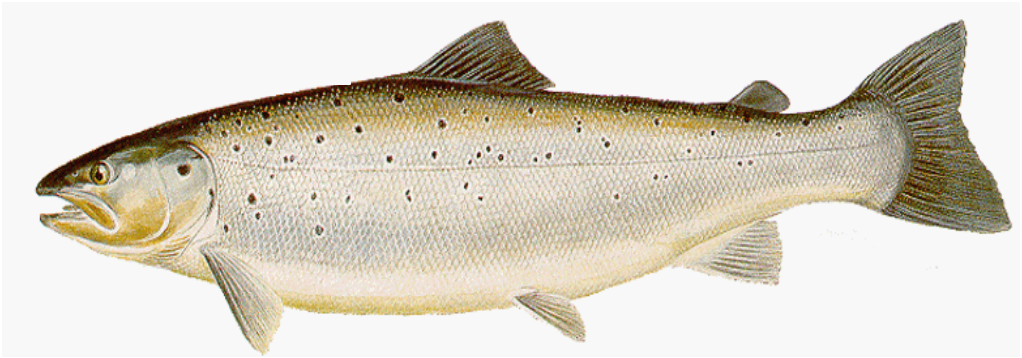
Closed Containment Aquaculture

Food →



Food →

The Goal:

Grow salmon in RAS from smolt to adult as quickly as possible, with as little food as possible, while maintaining the highest possible product quality.

Factors Affecting Growth

SPECIES/STRAIN

ENVIRONMENT

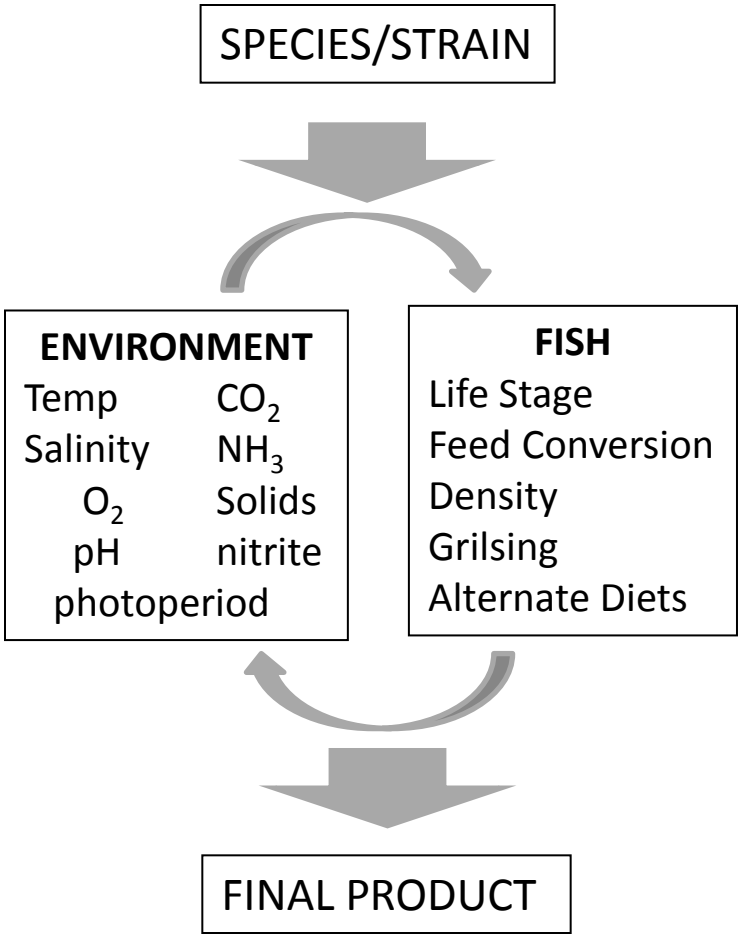
Temp
Salinity
O_2
pH
photoperiod
CO_2
NH_3
Solids
nitrite

FISH

Life Stage
Feed Conversion
Density
Grilsing
Alternate Diets

FINAL PRODUCT

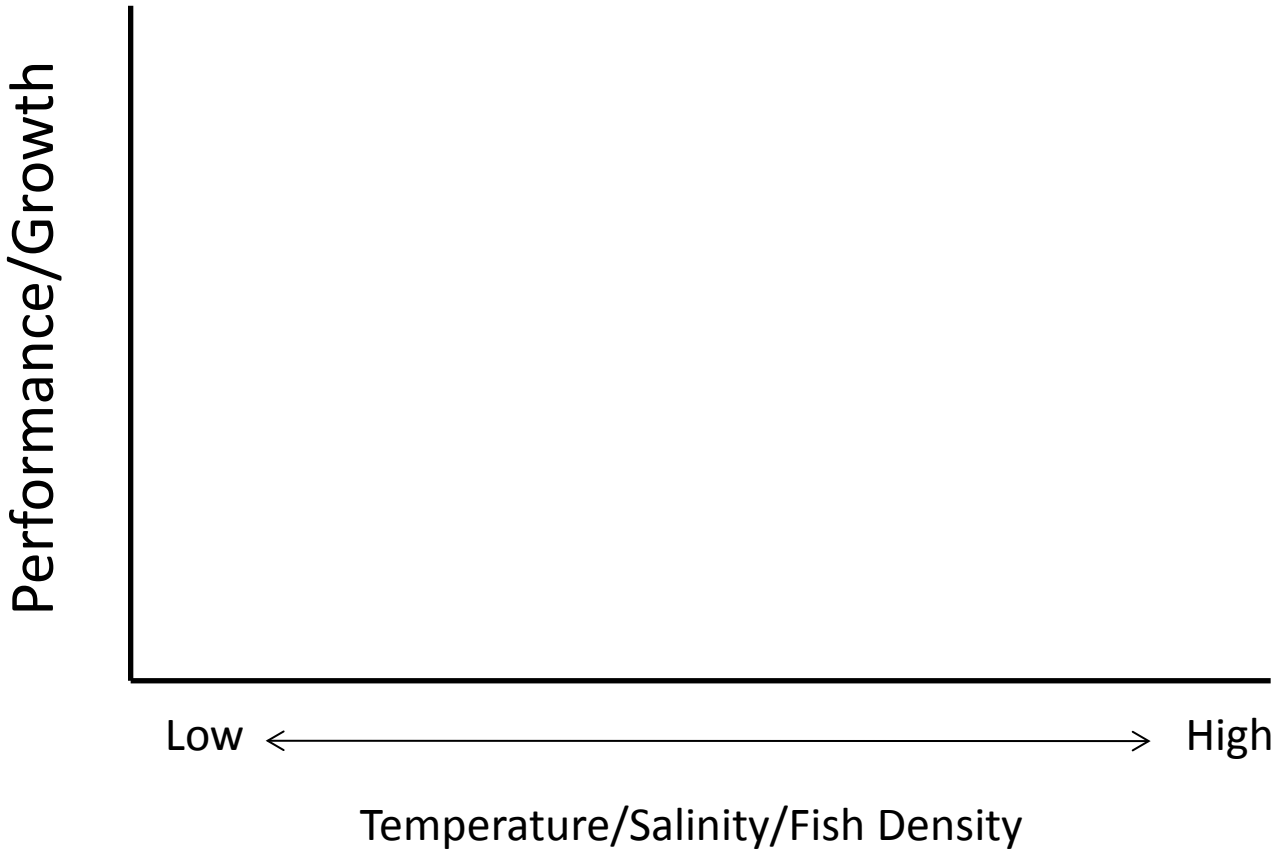
Factors Affecting Growth



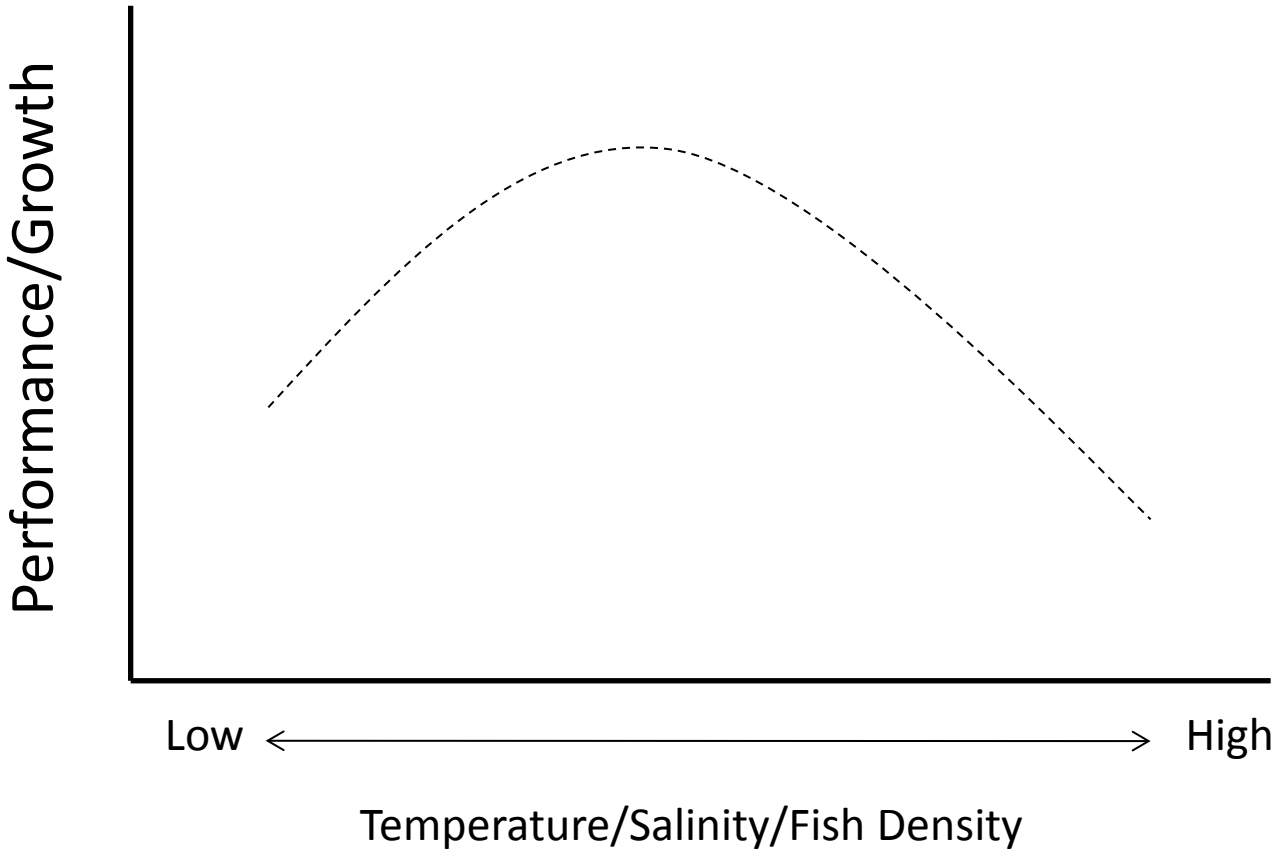
By using RAS to grow salmon, we have the opportunity to rear fish under conditions that maximize growth, welfare, and product quality.

Optimal Conditions

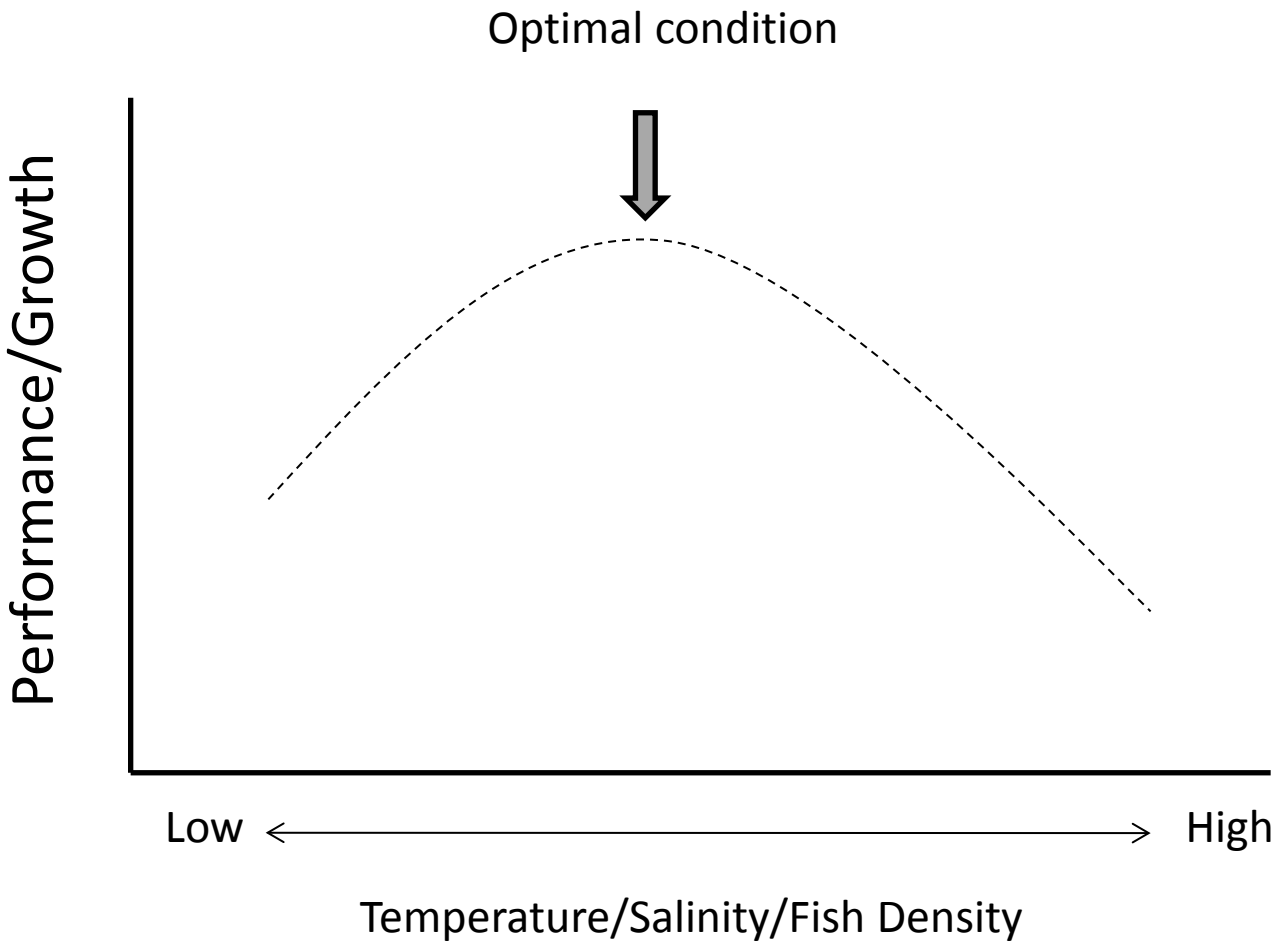
Optimal Growth



Optimal Growth

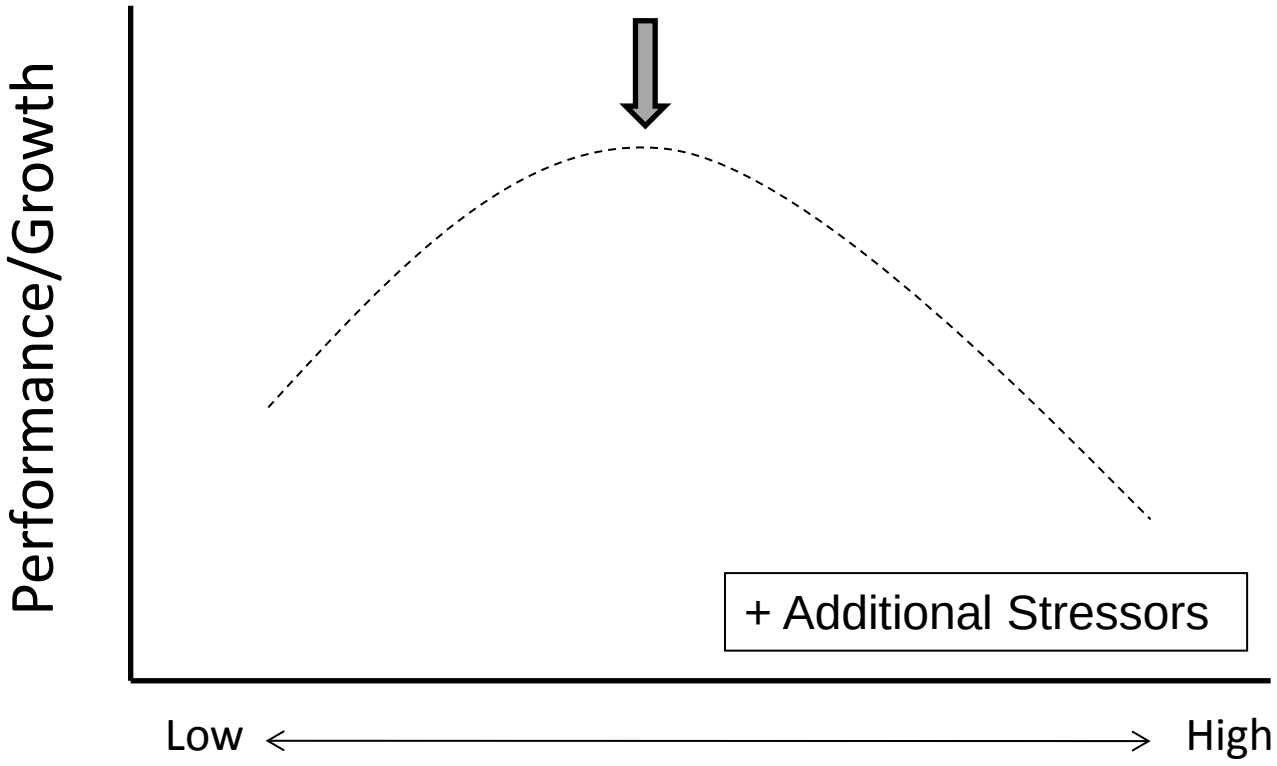


Optimal Growth



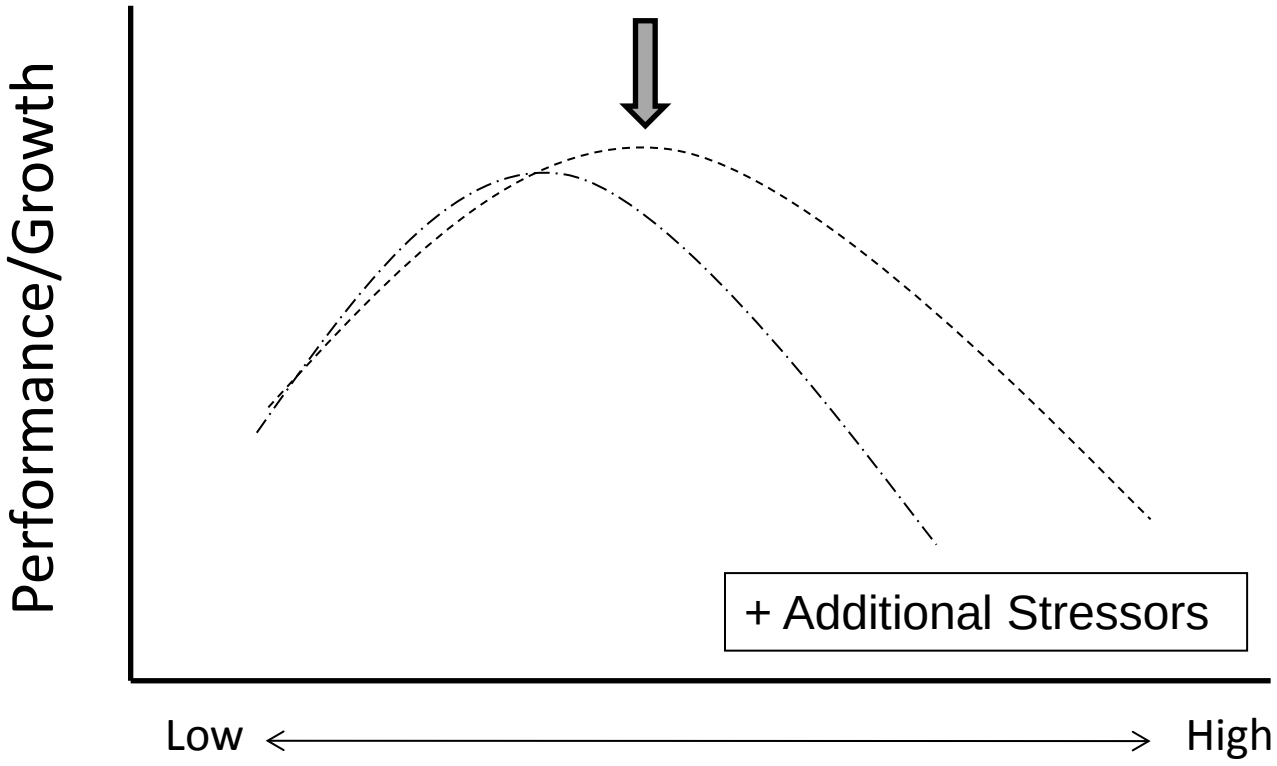
Optimal growth under specific conditions

Optimal Growth



Stress can be cumulative and exposure to multiple stressors could shift performance/growth curves.

Optimal Growth



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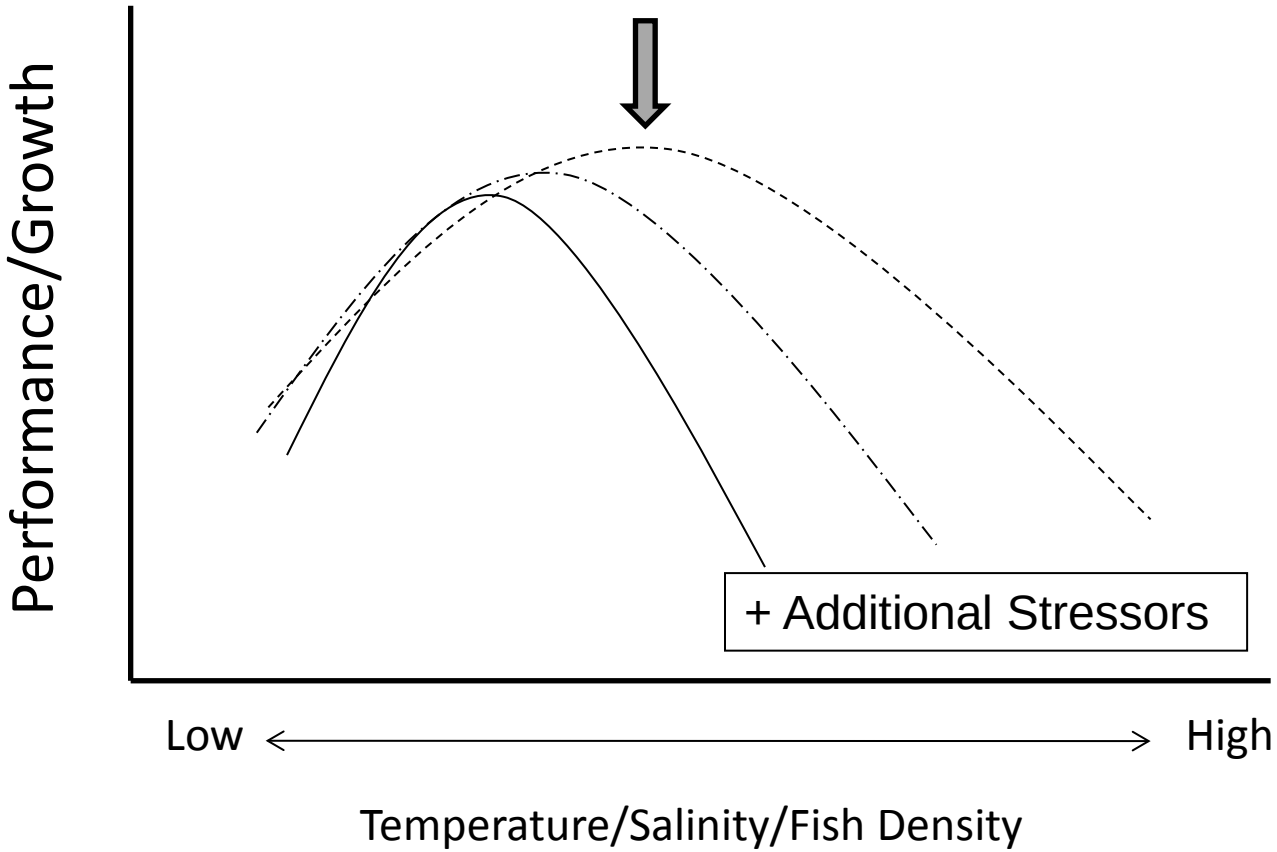
Optimal Growth



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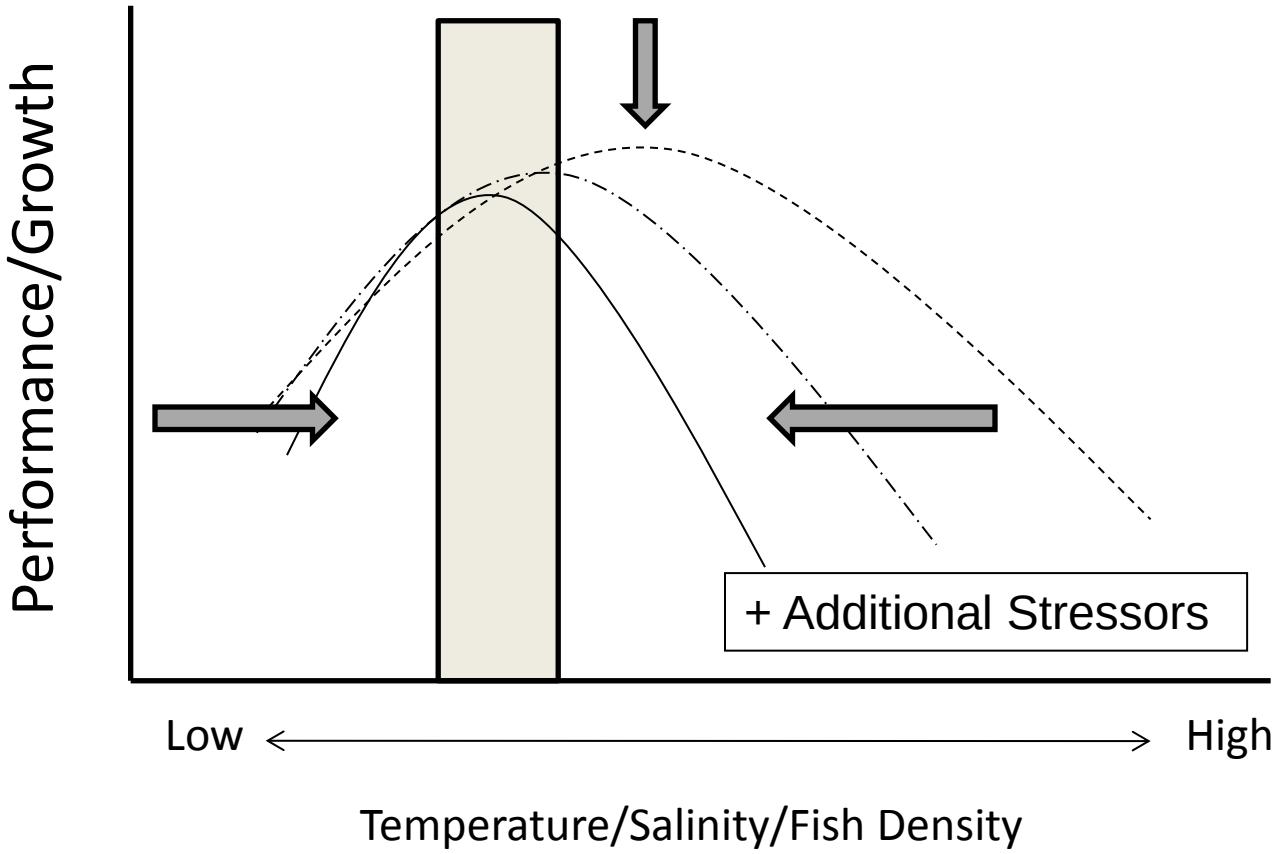
Optimal Growth



Stress can be cumulative and exposure to multiple stressors could shift performance/growth curves.

Goals of *InSEAS*

Profitability in RAS is dependent upon optimizing conditions for growth of salmon at high density.

It is generally unknown how environmental factors affect the growth of salmon in closed containment RAS.

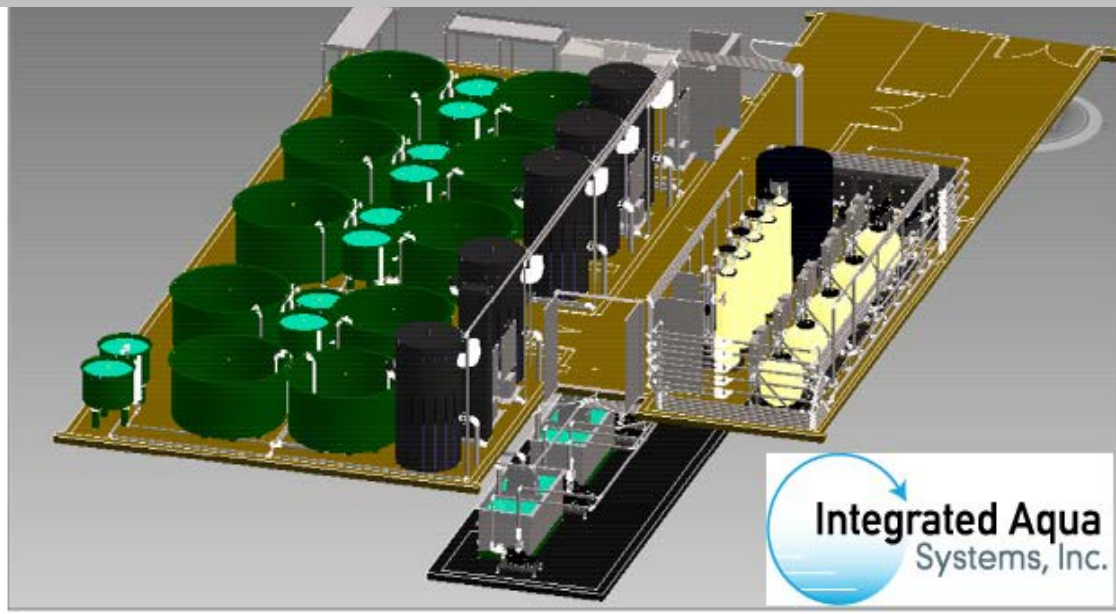
The Goals

Construct a RAS research facility capable of growing salmon at high density under different environmental conditions.

Determine the “optimal” conditions for rearing salmon in RAS.

Update on the *InSEAS* Facility

- 33,000 sq. ft. aquatics research laboratory.
- 7 RASs for high-density RAS with 4 replicate tanks.
- 6 RASs for low-density RAS



- all RAS are capable of precise control and remote monitoring of water salinity, T, CO_2, ammonia, O_2 and pH.
- 10 environmentally controlled chambers rooms (3 x 5m).
- 5 analytical labs for physiological, biochemical & behavioural analysis.

The *InSEAS* Facility

High-density RAS

7 RAS each with
2 x 8 ft diameter (5m^3) &
2 x 42” diameter (0.7m^3)
tanks

The *InSEAS* Facility

High-density RAS

7 RAS each with
2 x 8 ft diameter (5m^3) &
2 x 42” diameter (0.7m^3) tanks

Each 5m^3 tank fitted with an Arvotek automatic feeder.

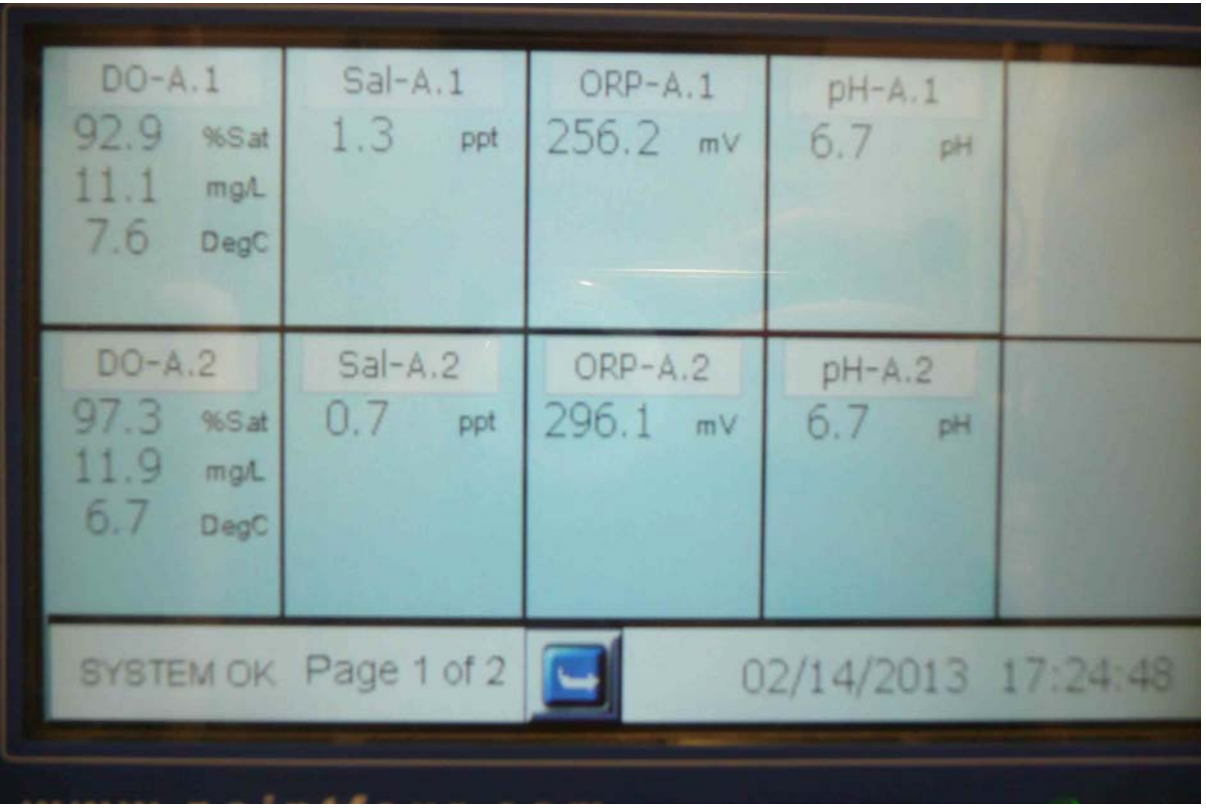
The *InSEAS* Facility

Each RAS is equipped with:

- Large scale biological filters (foam bead)
- Denitrification & several mechanical filters
- Foam fractionators
- *uv* & ozone treatment
- O_2 injection systems
- Temperature regulation (8°C to 25°C)

Maintain fish at stocking densities up to 120 kg/m^3

The *InSEAS* Facility



Control & Monitor:
salinity,
temperature,
ammonia
CO_2, O_2 and pH.
Photoperiod

Monitored 24/7 by dedicated facility staff

The *InSEAS* Facility

Fully Functional RAS

Coho Salmon
(Target Marine Hatcheries)
Atlantic Salmon

Testing Phase

Do fish grow at the same rate in all 7 RAS when held under the same conditions?

Monitoring Growth

Handling fish affects growth.

Monitoring Growth

Handling fish affects growth.

Collaborating with the AKVA group to test their latest Vicass HD biomass estimator.

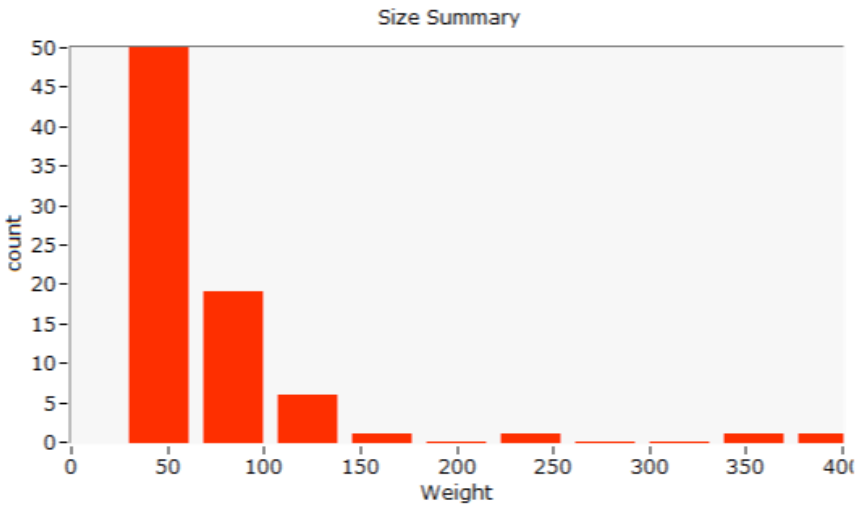
Allows for minimally invasive measurements of population biomass in aquaculture.

Monitoring Growth

VICASS HD BIOMASS REPORT AKVA group

General Information			
Sample Date:	30/08/2013 15:26:26	Cage Population:	2000
Site:	UBC	Species:	Coho
Cage ID:	A2b		
Comments:			
Associated Files:	C:\Users\Josh\Desktop\Fish Data Files\1308301526		

Statistical Information			
Average Weight	72 g	Confidence	81.42 %
Weight STD	61 g	Average Condition Factor (K)	1.22
C.V.	84.26 %	Minimum Live Weight	26 g
Sample Size	79	Maximum Live Weight	412 g
Rejected	2.53 %		



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InSEAS Research

Determine the "optimal" conditions for rearing Atlantic and coho salmon in RAS.

The possible combinations of parameters (salinity, temperature, ammonia, CO_2, O_2 and pH) that *InSEAS* can investigate in isolation or in combination with a range of biotic variables (strain/species, life stage, density, diet) are enormous.

Two-tiered multi-factorial approach to determine the "optimal" rearing conditions for salmon:

1) Regression Approach

2) Subsequent rigorous replication

InSEAS Research

Current Research Priorities

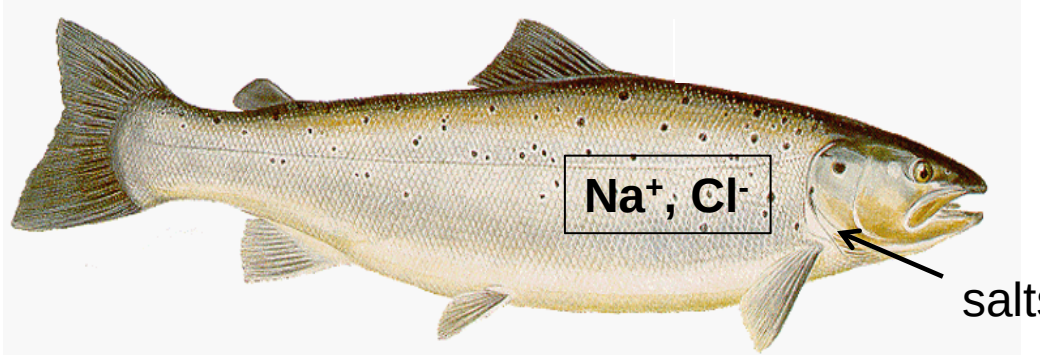
1: Determine the optimal **salinity** and **temperature** for growth, performance and welfare of Altantic and coho salmon from smolt to adult

2: Determine the optimal combination of salinity and temperature for growth, performance and welfare of Altantic and coho salmon, from smolt to adult.

Interacting factors: Density and photoperiod
Emphasis on: Grilsing, FCR

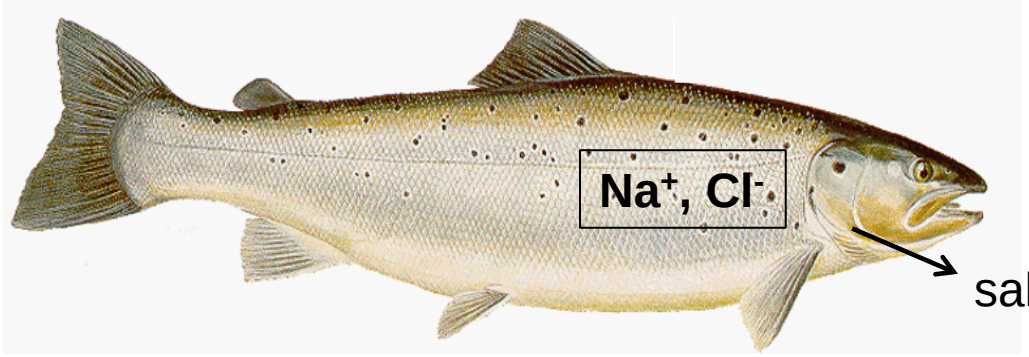
Salinity Effects on Fish

Salmon in fresh water:



Na+, Cl-

Salmon in sea water:

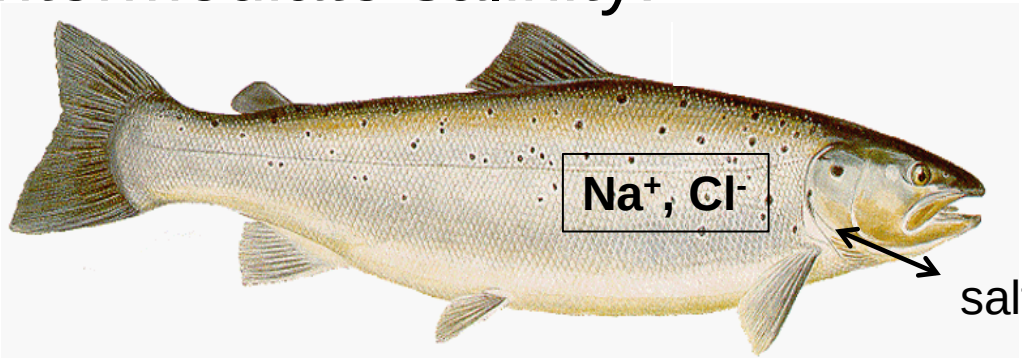


Na+, Cl-

Maintaining salt balance can account for 10-50% of resting metabolic rate

Salinity Effects on Fish

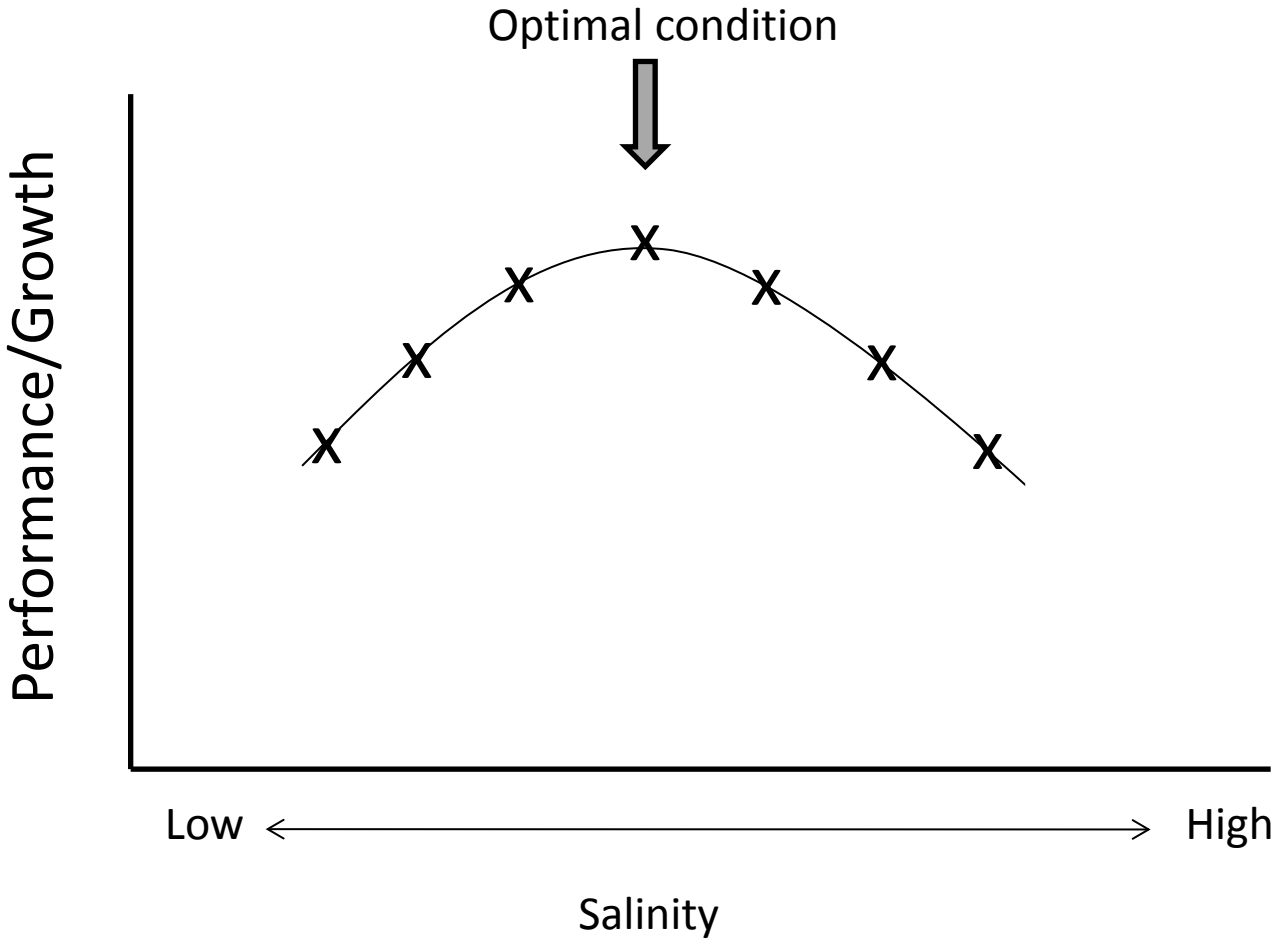
Salmon intermediate salinity:



Na+, Cl-

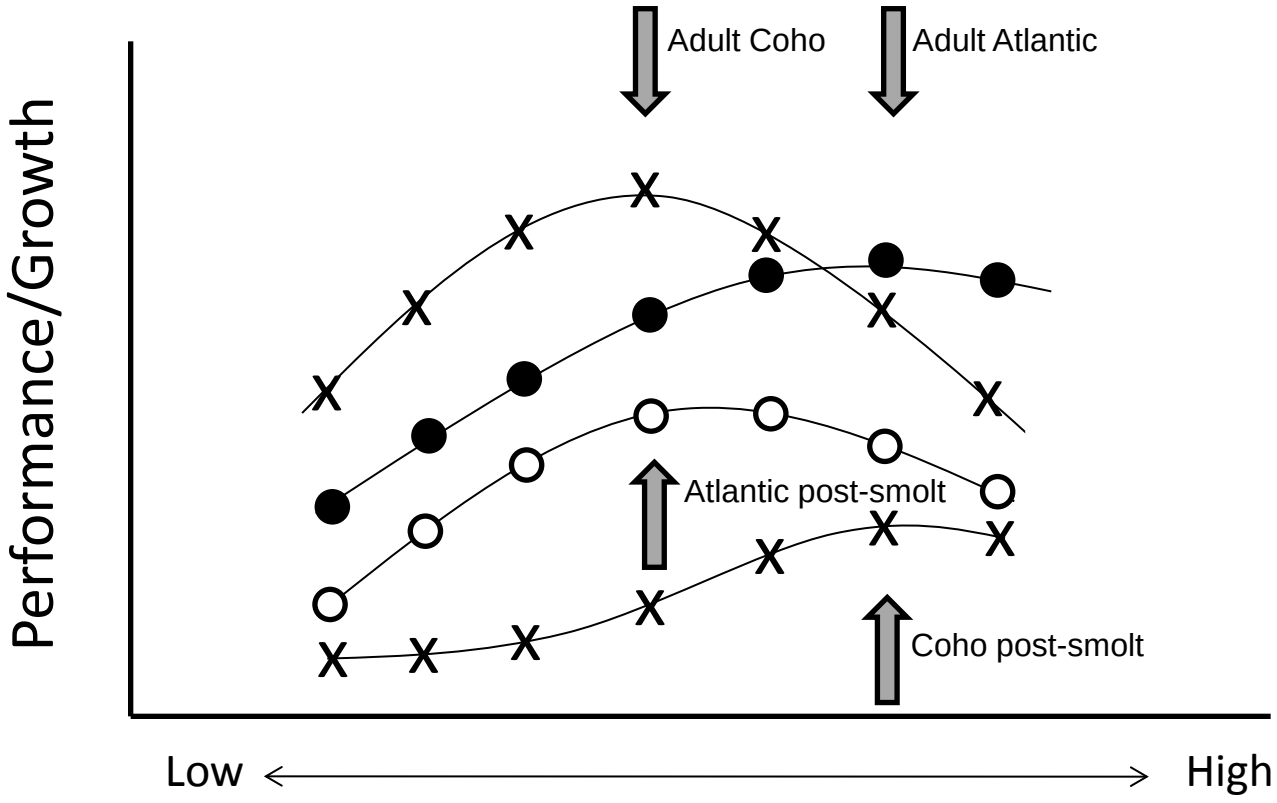
Very low % of resting metabolic rate?

InSEAS Regression Approach



Determine the optimal salinity for growth, performance and welfare of Altantic and coho salmon from smolt to adult.

InSEAS Regression Approach



In a single experiment, we could determine the optimal value for a given parameter in two species across multiple life stages.

InSEAS Replication

Regression approach would be used to identify 2 or 3 salinities or temperatures that could be further investigated in duplicate or triplicate.

From this *InSEAS* can precisely quantify the benefit of the "optimal" condition relative to a control condition (for example FW vs SW) which can be incorporated into economic feasibility models.

InSEAS Research Outcomes

InSEAS can precisely control environmental conditions over a broad range to rigorously identify “optimal” conditions for closed-containment production.

The overall goal of *InSEAS* will be:

i) Define water quality parameters (salinity, T, NH_3, CO_2, O_2, pH,) and other conditions (density, alternate diets) that result in “optimal” growth performance and welfare of salmon at all life stages of development from larvae, fry, smolt to adult on a species/strain of choice.

ii) Timely and efficient transfer of scientific information that can be used in economic forecasting of the costs and benefits of using “optimal” or “sub-optimal” conditions in production.

Acknowledgements

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