InSEAS Research

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

Research to determine "optimal" conditions for fish rearing.

Colin J. Brauner and Jeffrey G. Richards
Department of Zoology,
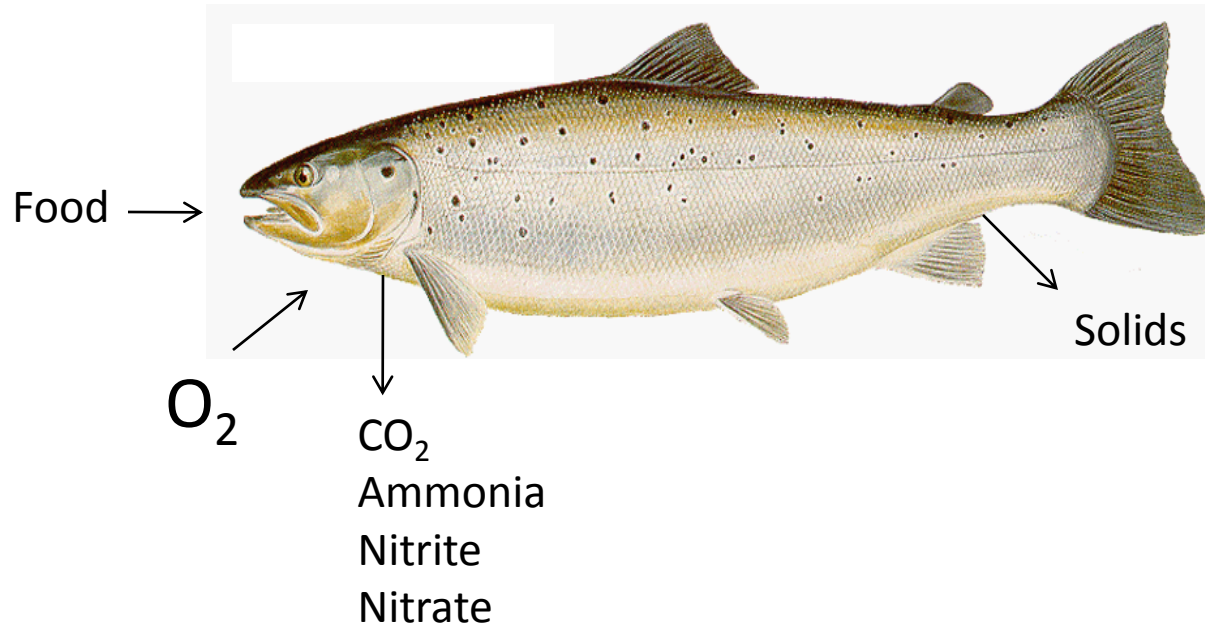University of British Columbia

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Profitability in RAS is dependent upon optimizing conditions for growth at high density.
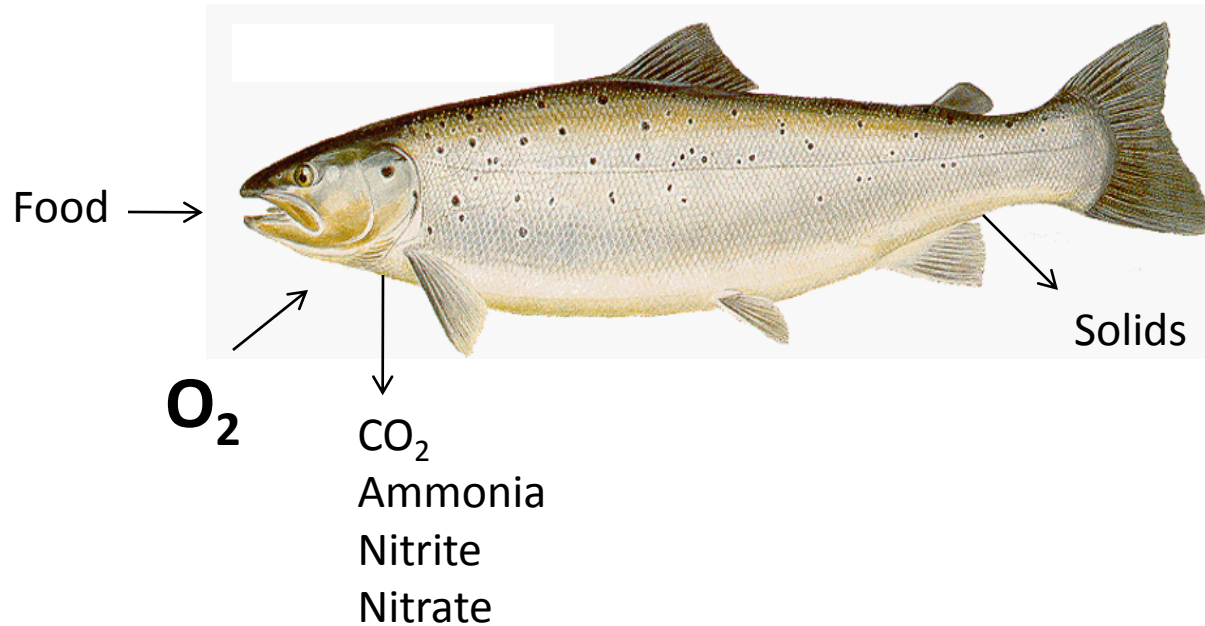
Conditions that result in "adequate" growth in some species are well described but few studies are systematically designed to derive evidence-based "optimal" values promoting fish welfare and product quality and economy.

The goal of InSEAS is to determine "optimal" conditions for fish rearing and provide timely and efficient transfer of science based information to Industry.
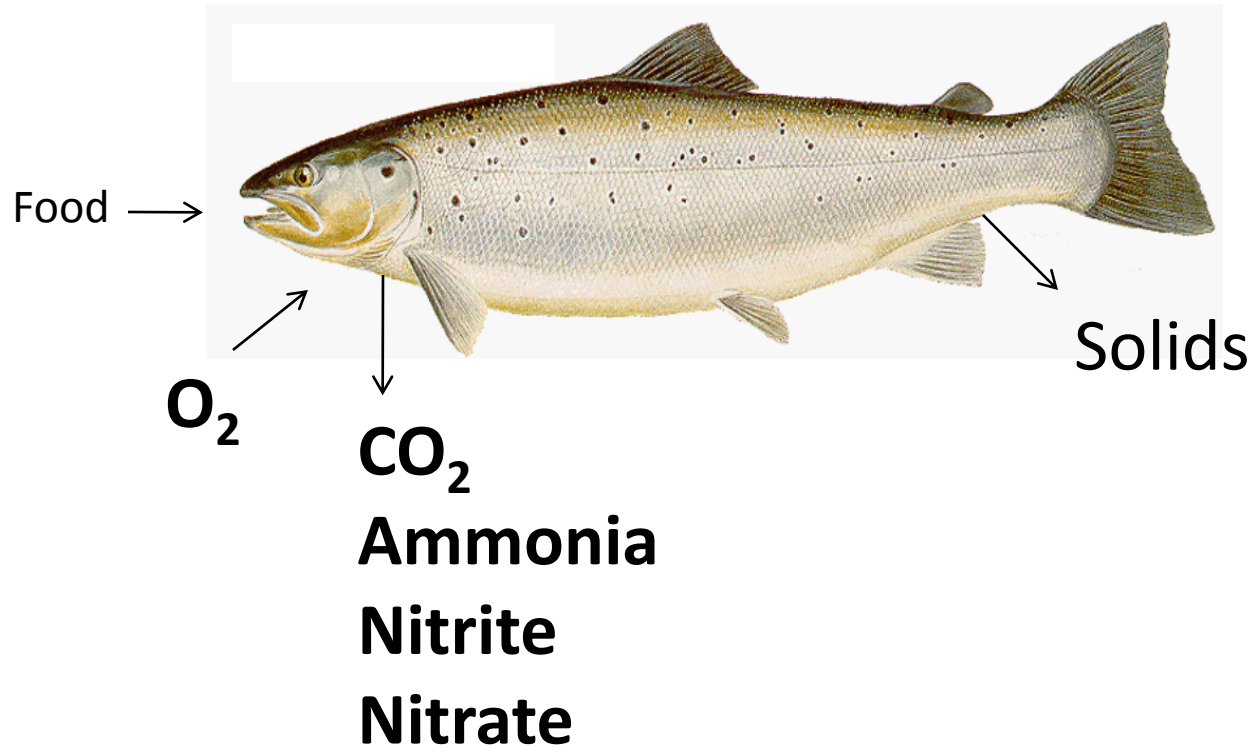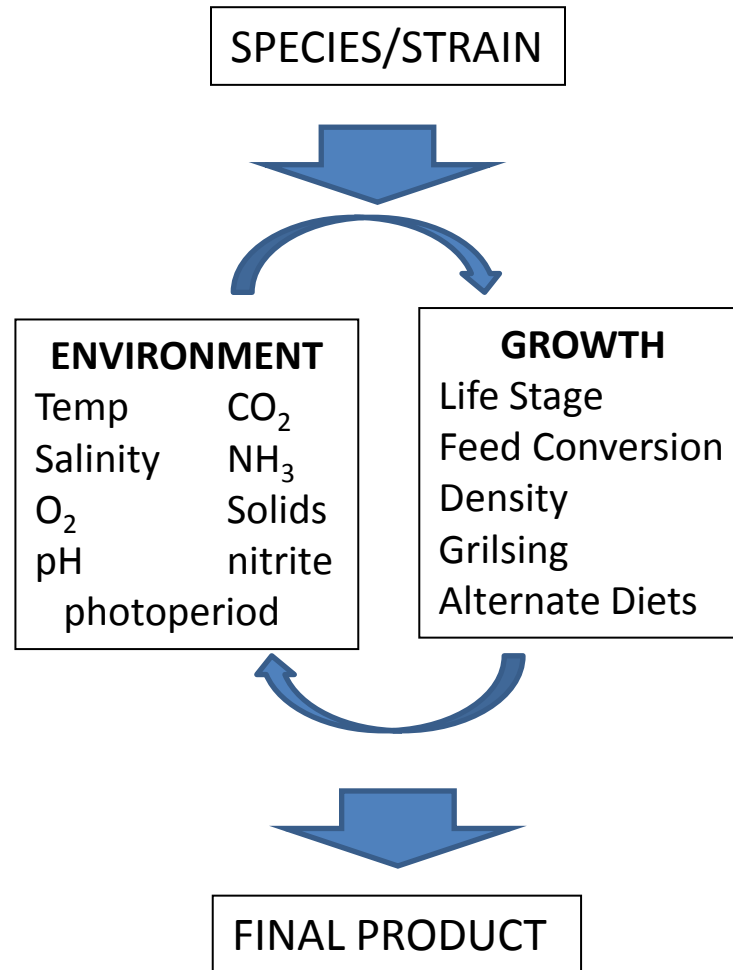
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Food →

O$_2$

CO$_2$
Ammonia
Nitrite
Nitrate

Solids

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Food →

O₂

CO₂
Ammonia
Nitrite
Nitrate

Solids

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Food →

O₂

CO₂
Ammonia
Nitrite
Nitrate

Solids

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SPECIES/STRAIN

ENVIRONMENT

Temp	CO_2
Salinity	NH_3
O_2	Solids
pH	nitrite
photoperiod	

GROWTH

Life Stage
Feed Conversion
Density
Grilsing
Alternate Diets

FINAL PRODUCT

Biological Factors: Conclusions

There are currently large knowledge gaps in water quality "thresholds" in candidate species.

Even less is known regarding how water quality parameters interact.

This information can be provided through small scale research based systems to provide information required for optimal production.

Optimal growth under specific conditions

Optimal condition

Performance/Growth

Low ←————————————————→ High

Temperature/Salinity/Fish Density
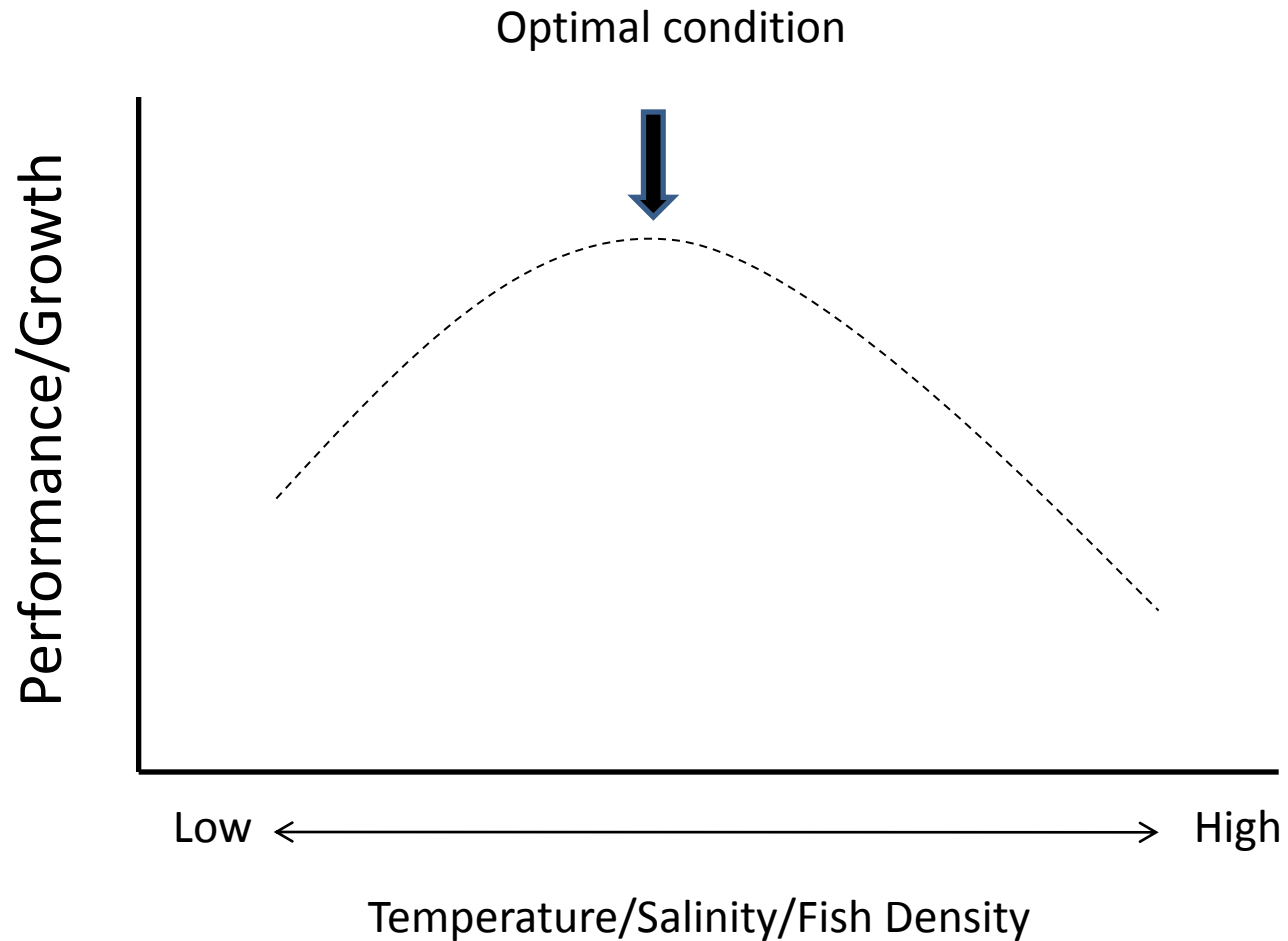
Optimal growth under specific conditions
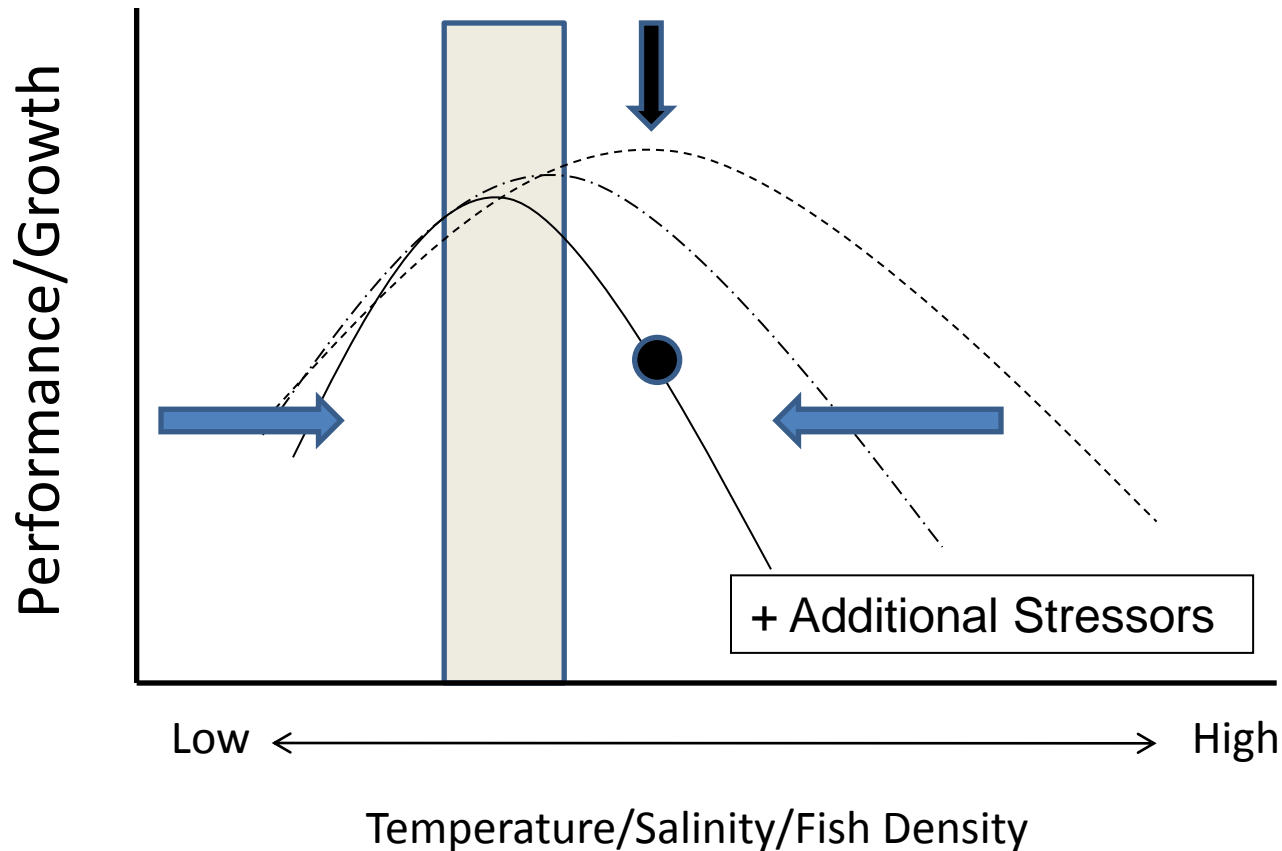
Because stress is cumulative, as stressors are added, optimal conditions for growth and product quality may shift.
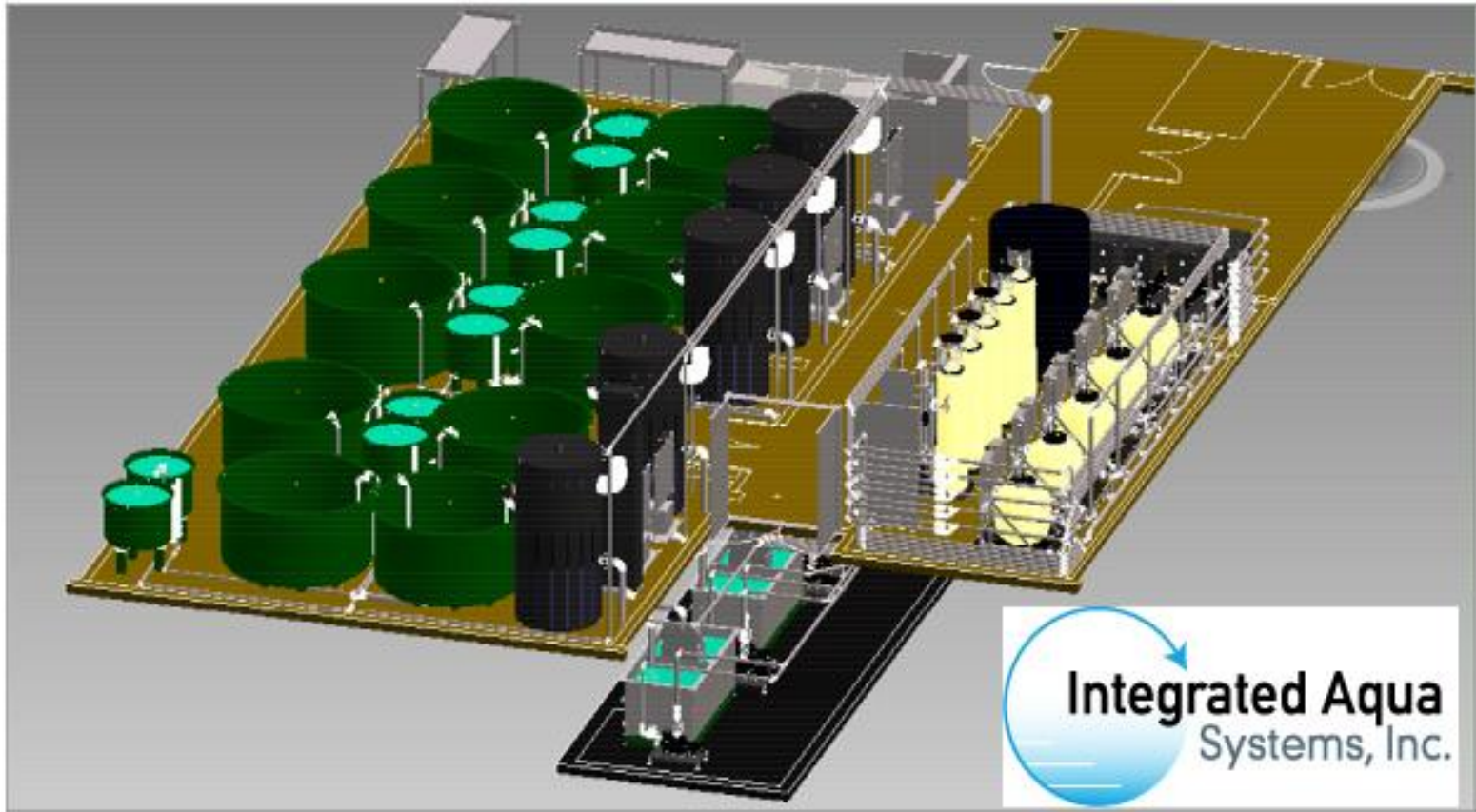
InSEAS Research: The Facility

- 33,000 sq. ft. state-of-the-art aquatics research laboratory.

- 7 RASs for high-density fish rearing, each with 4 replicate tanks.

- 6 RASs for low-density fish rearing, each with 10 replicate tanks and experimental wet tables.

- all RASs 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 laboratories equipped with state-of-the-art facilities for physiological, biochemical, and behavioural analysis.

InSEAS Research: The People

Two full-time dedicated aquatic technicians available 24/7 for aquatic life support.
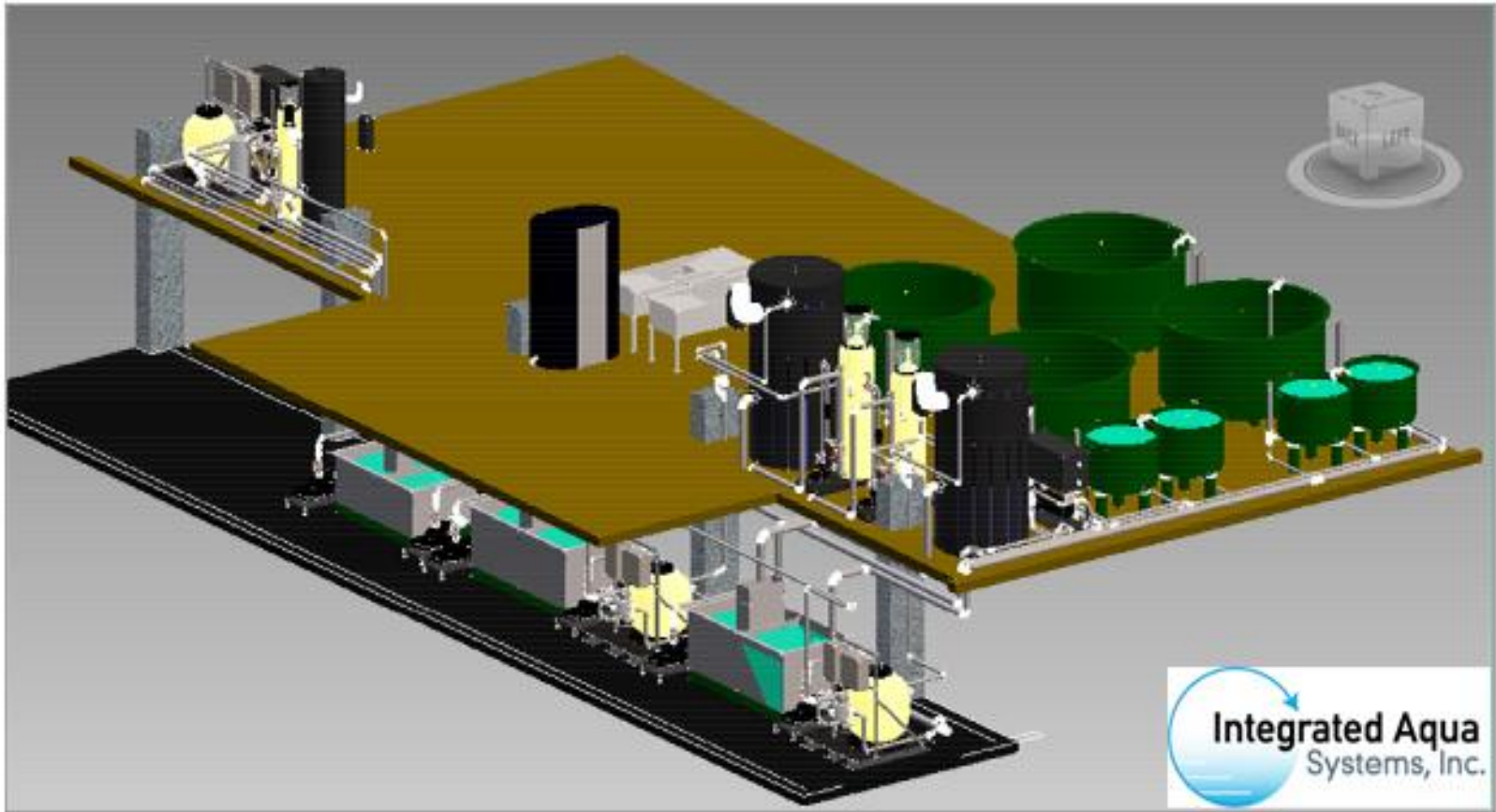
A team of 17 internationally recognized PI's in fish physiology and fish biology.

InSEAS Research: The Facility

5 RASs for high-density fish rearing, each comprised of 2-8 ft diameter (5m^3) and 2-42" diameter (0.7m^3) tanks with precise control and remote monitoring of water salinity, temperature, ammonia, CO_2, O_2 and pH.

InSEAS Research: The Facility

2 RASs for high-density fish rearing, each comprised of 2-8 ft diameter (5m^3) and 2-42" diameter (0.7m^3) tanks with precise control and remote monitoring of water salinity, temperature, ammonia, CO_2, O_2 and pH.

InSEAS Experimental Approach

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.

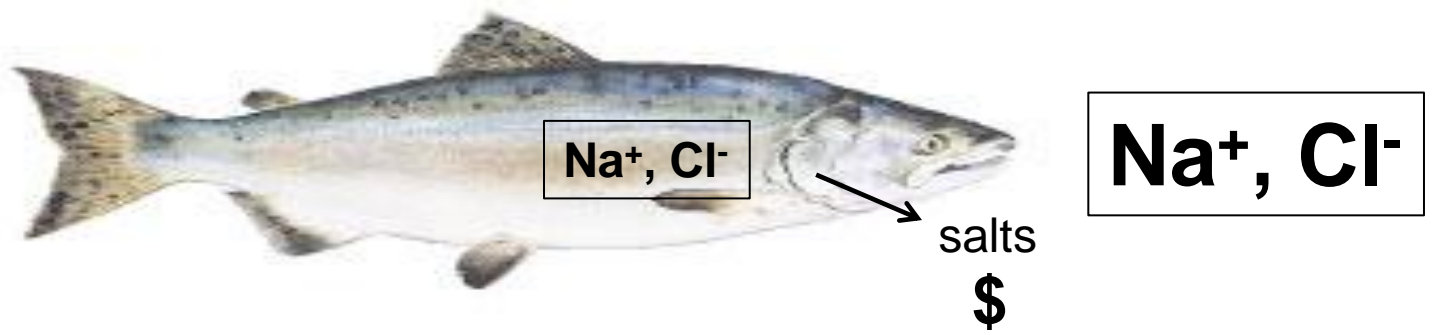Two-tiered multi-factorial approach to determine the "optimal" rearing conditions for salmon:

1) Regression Approach

2) Subsequent rigorous replication:
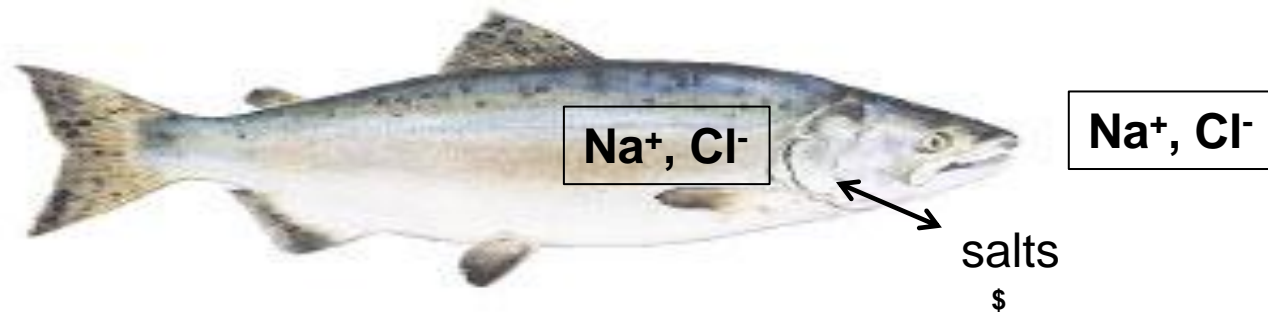
Salinity Effects in Fish

Salmon in fresh water:

Na⁺, Cl⁻

salts

$
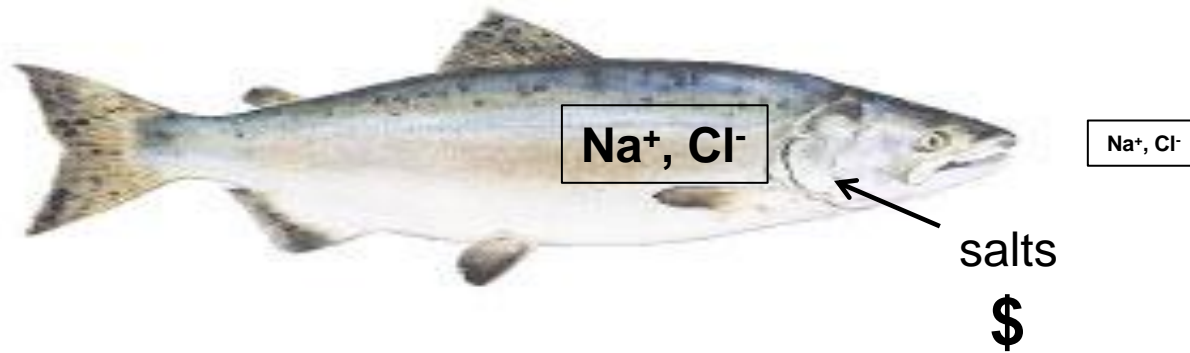
Salmon in sea water:

Na⁺, Cl⁻

salts

$

$ 10-50% of resting metabolic rate

Salinity Effects in Fish

Salmon intermediate salinity:

Na⁺, Cl⁻

Na⁺, Cl⁻

salts
$

$ 0% of resting metabolic rate?

InSEAS Regression Approach
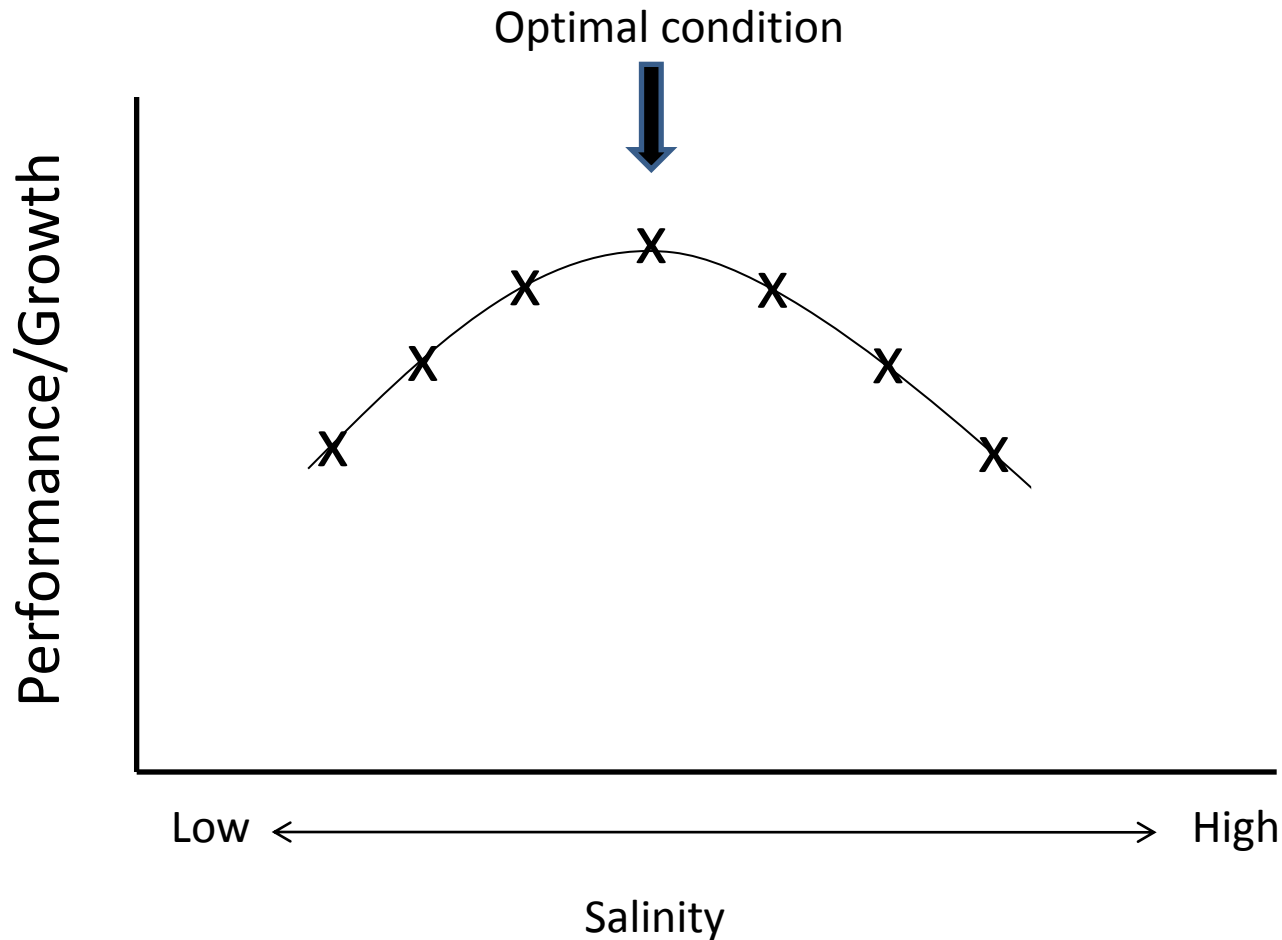
Optimal condition

Performance/Growth

Low ← → High

Salinity

Determine the optimal salinity for growth performance and welfare of Altantic and coho salmon, at multiple life stages of development (from smolt to adult).

InSEAS Regression Approach
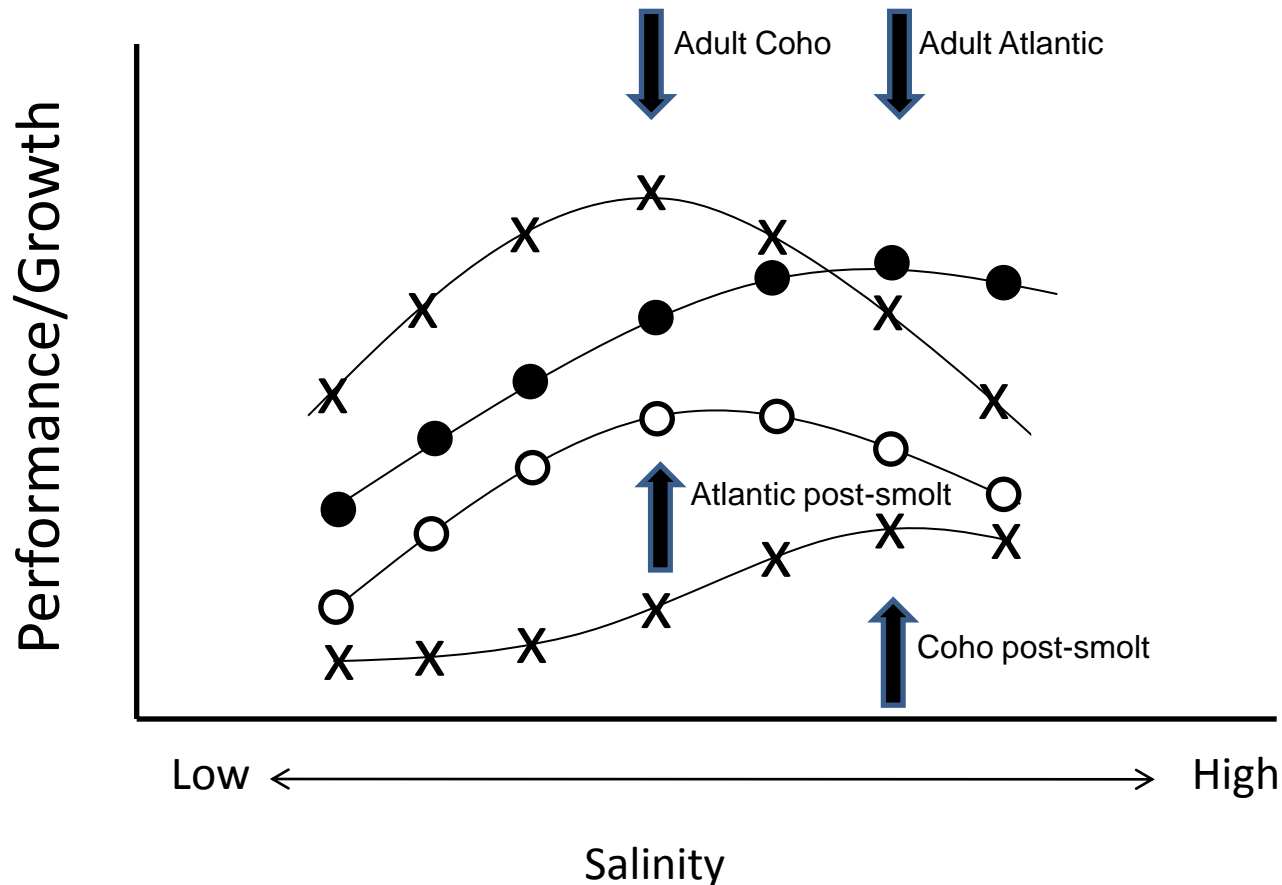
Outcome of a single experimental trial using a regression approach in 7 RASs (each with 4 replicate tanks) to identify the optimal value for a given parameter on for example, 2 species at 2 life stages simultaneously in a single experimental trial.

InSEAS Subsequent Replication

Regression approach would be used to identify 2 or 3 salinities 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

Current Research Priorities

1: Determine the **optimal salinity** for growth performance and welfare of Altantic and coho salmon, at multiple life stages of development (from smolt to adult).

2: Determine the optimal combination of salinity and T for growth performance and welfare of Altantic and coho salmon, at all life stages of development (from smolt to adult).

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

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