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

Defining optimal salinity for growth of Coho and Atlantic salmon in RAS

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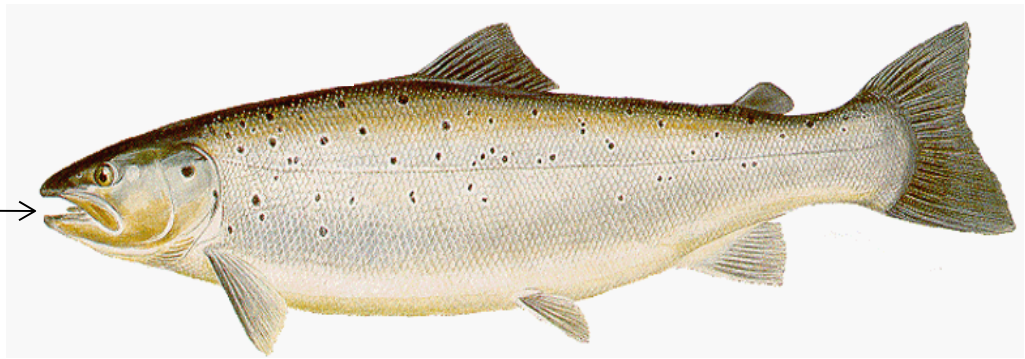
Closed Containment Aquaculture

Food →



Food →

The Goal

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

Factors Affecting Growth

SPECIES/STRAIN

ENVIRONMENT

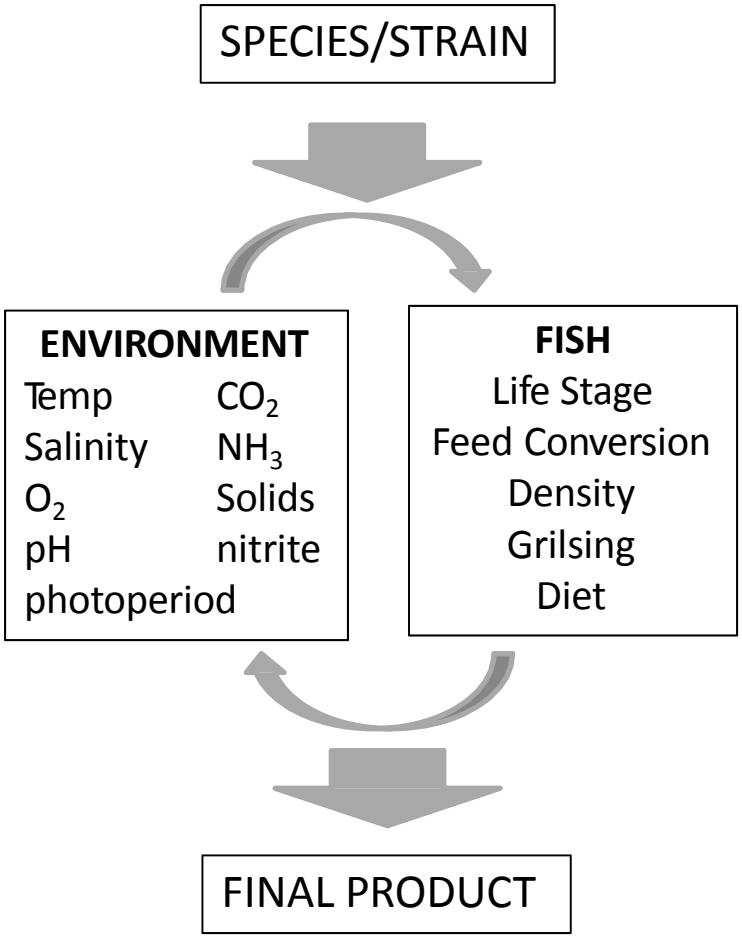
Temp	CO_2
Salinity	NH_3
O_2	Solids
pH	nitrite
photoperiod	

FISH

Life Stage
Feed Conversion
Density
Grilsing
Diet

FINAL PRODUCT

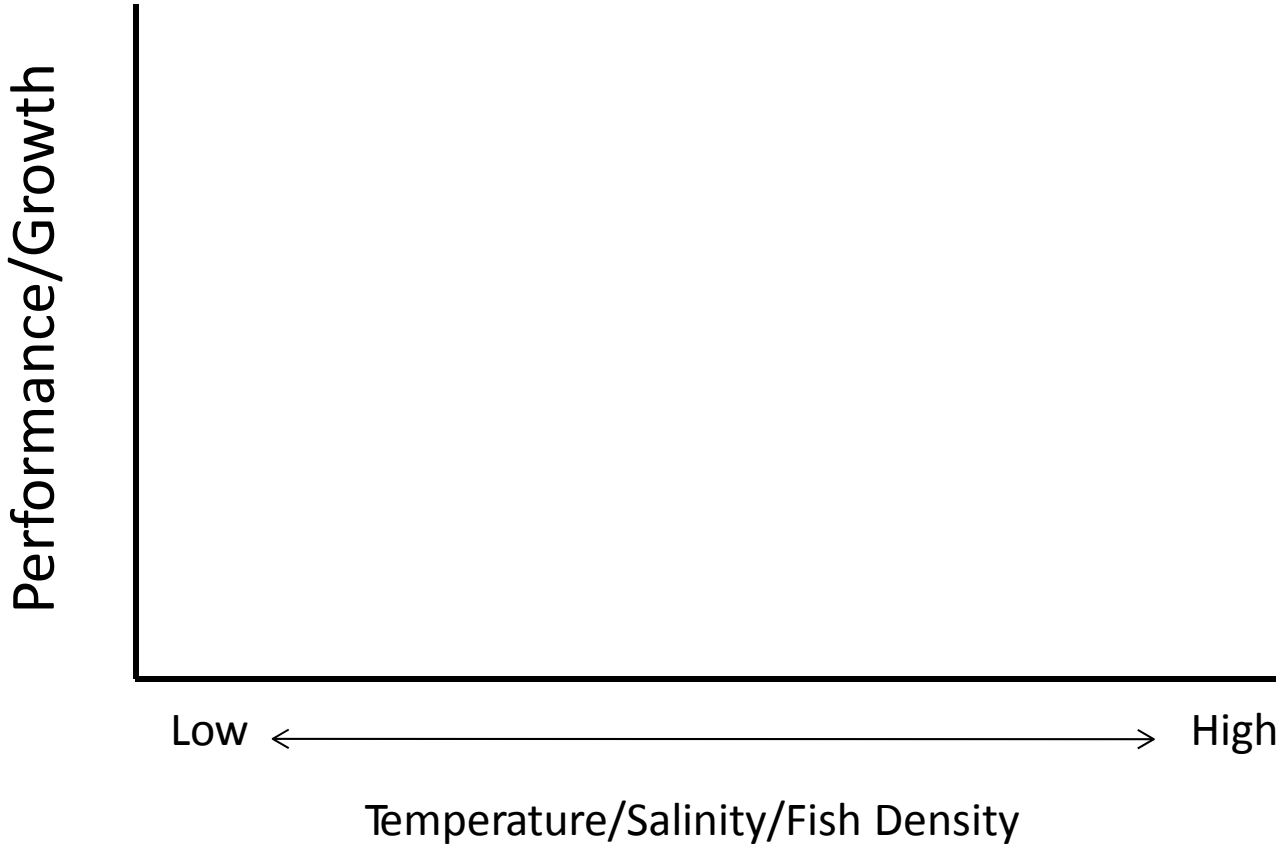
Factors Affecting Growth



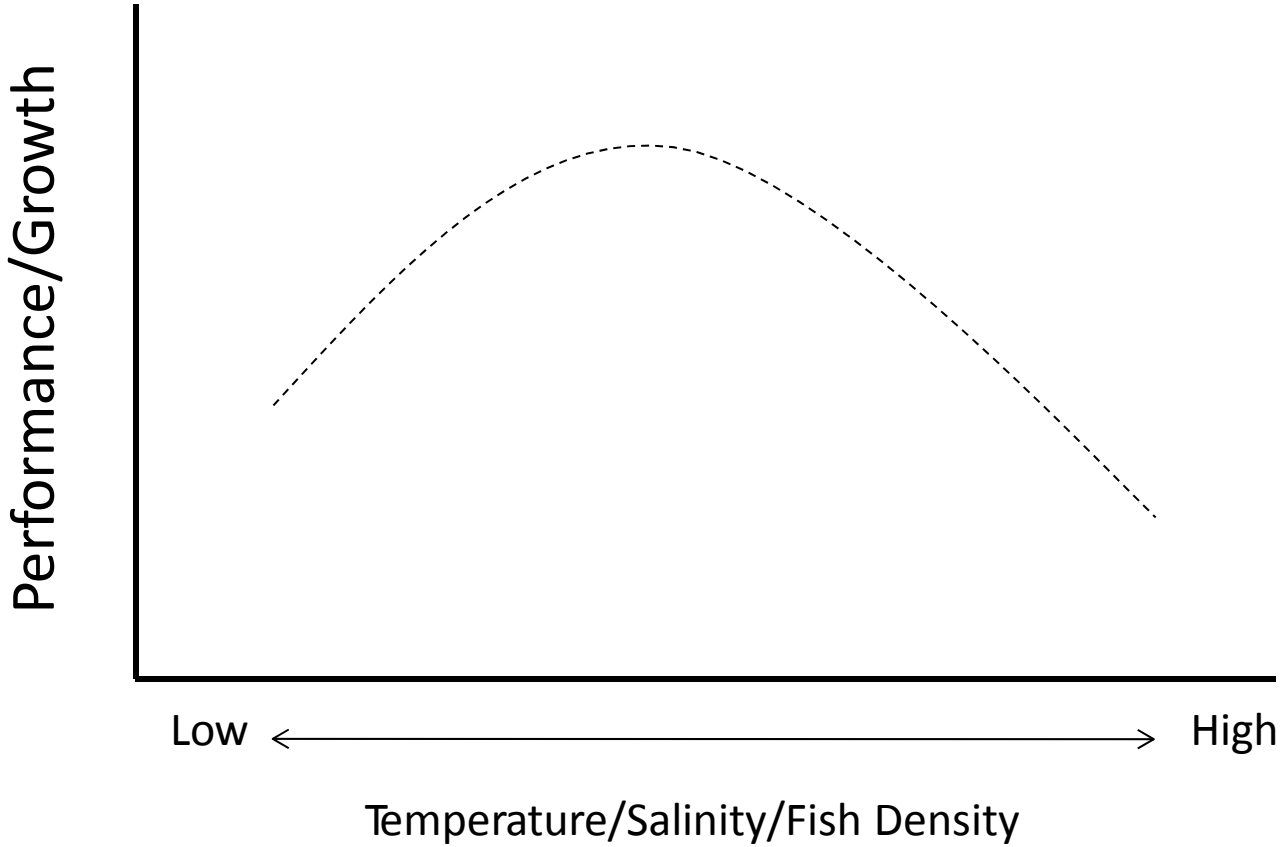
By using RAS to grow salmon, we have the opportunity to rear fish under conditions that maximize growth, welfare, and product quality.

Optimal Conditions

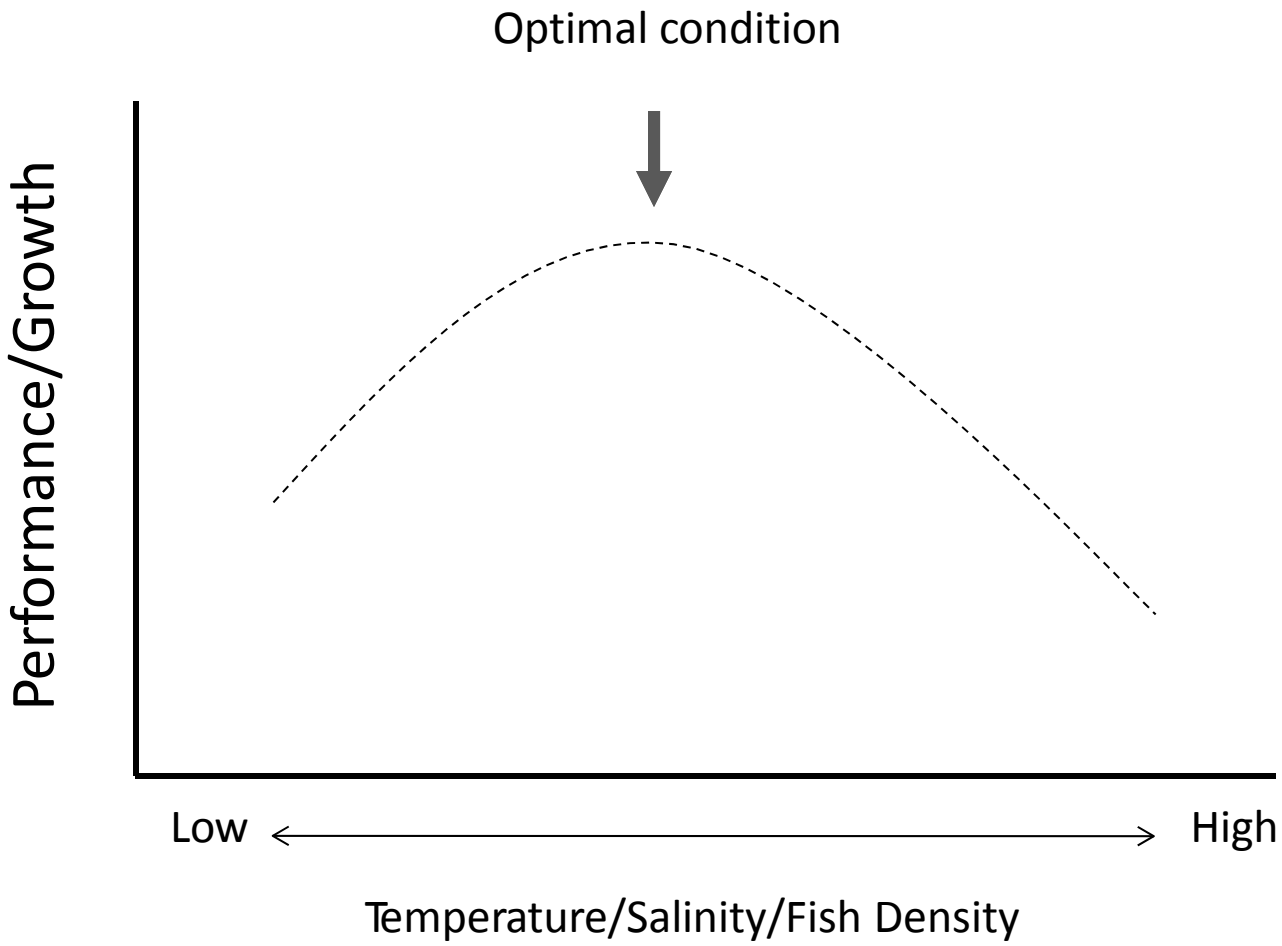
Optimal Growth



Optimal Growth

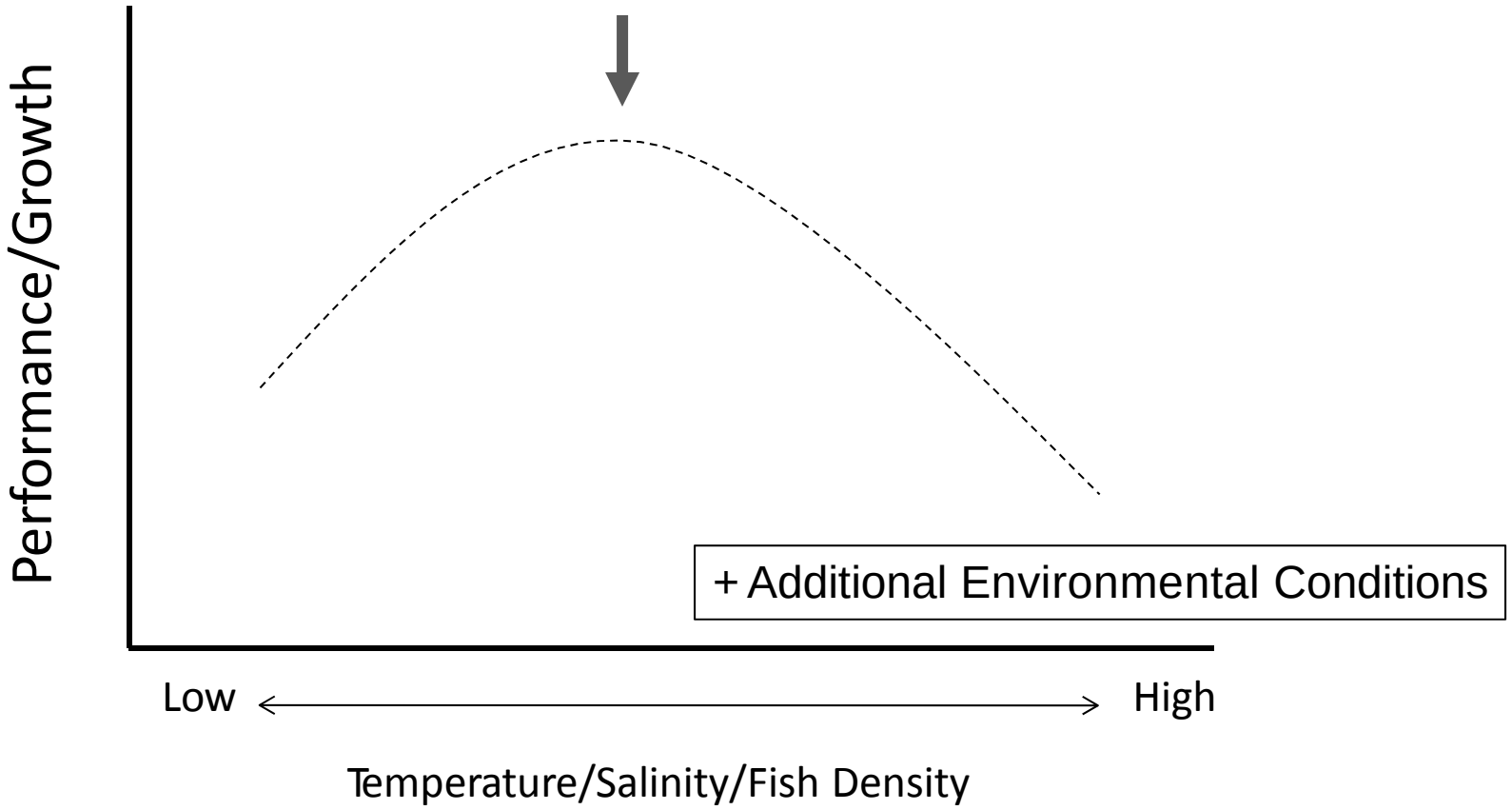


Optimal Growth



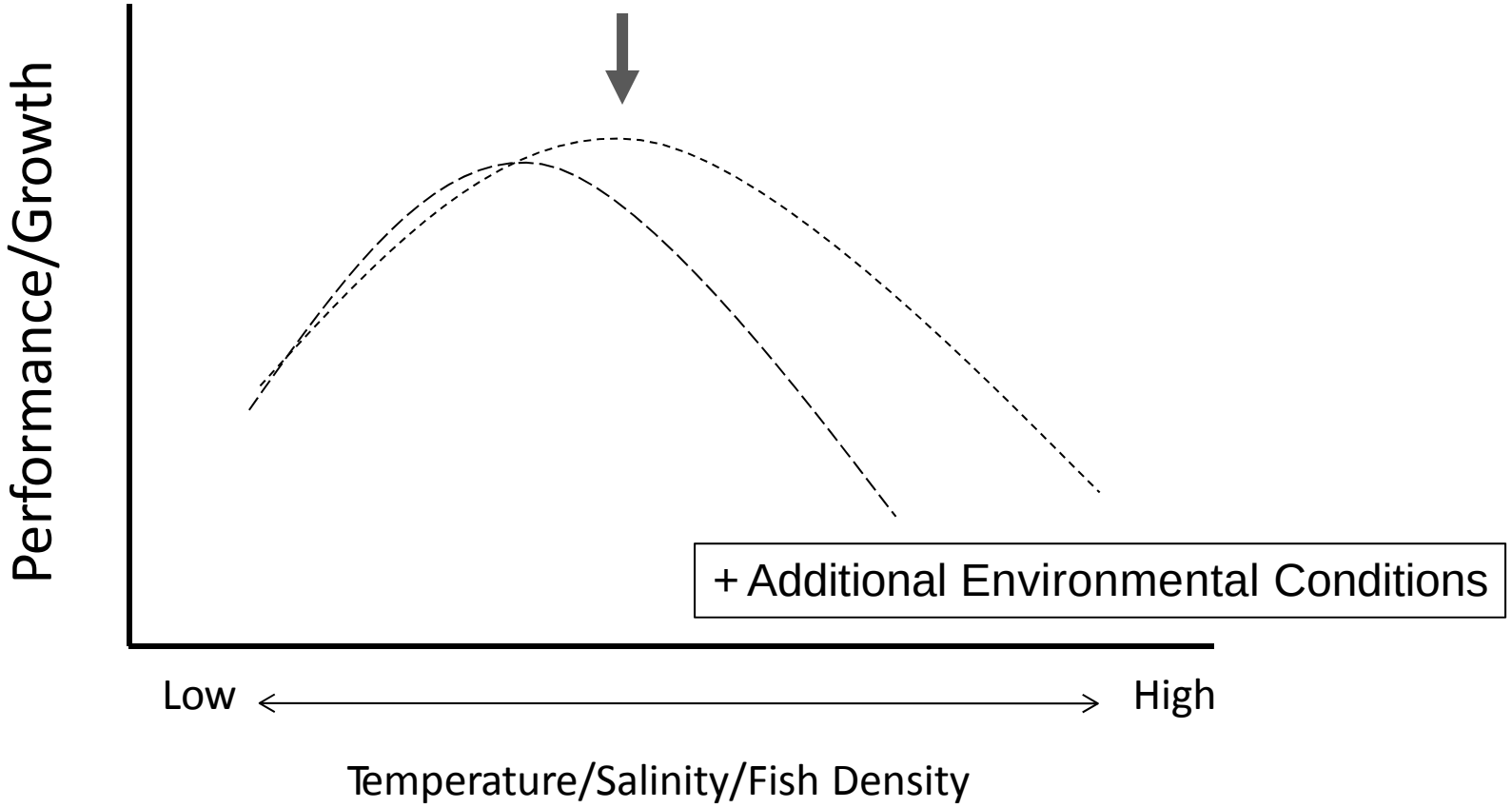
Optimal growth under specific conditions

Optimal Growth



Environmental conditions can interact and shift the optimal conditions for growth.

Optimal Growth



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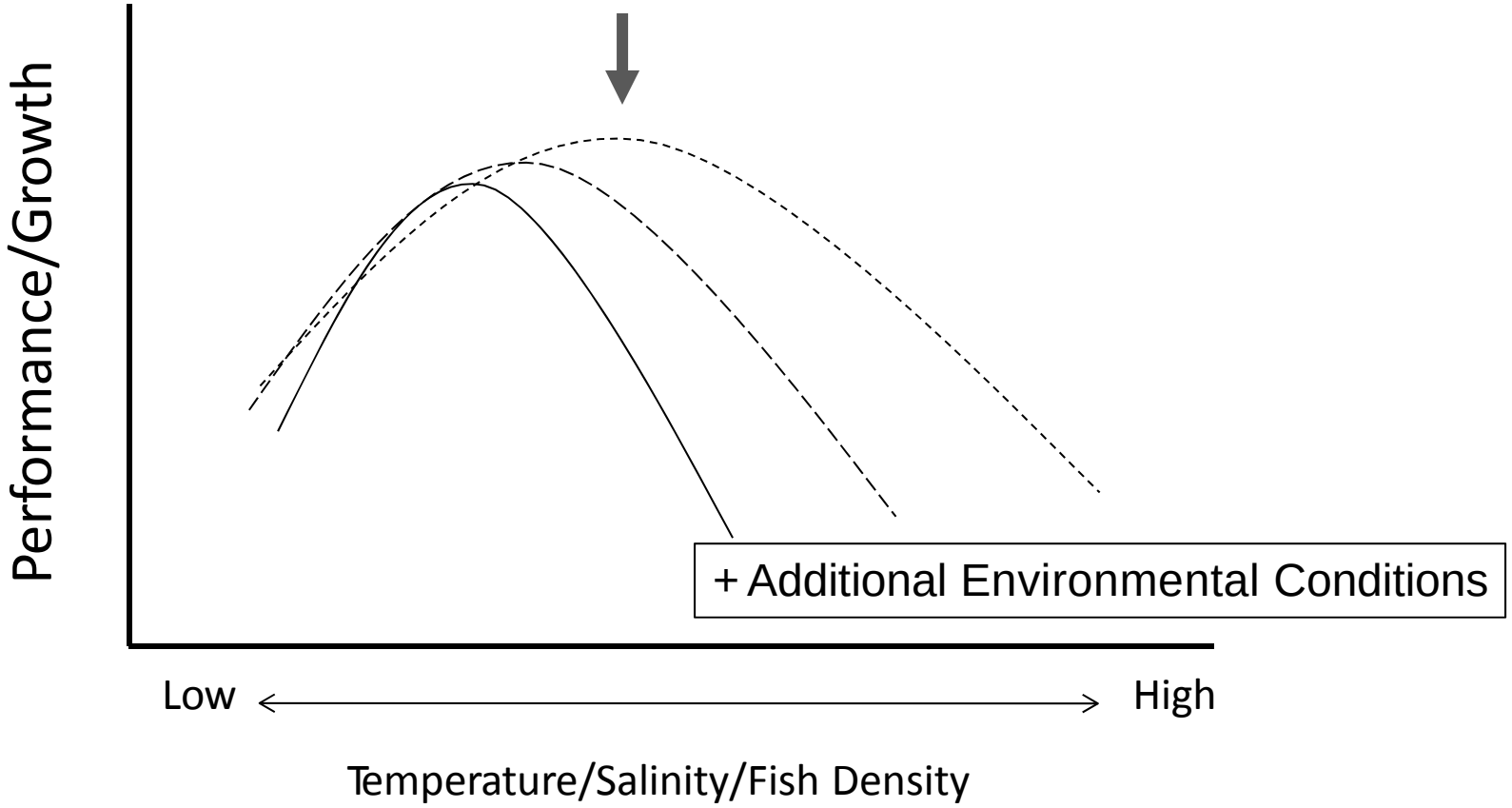
Optimal Growth



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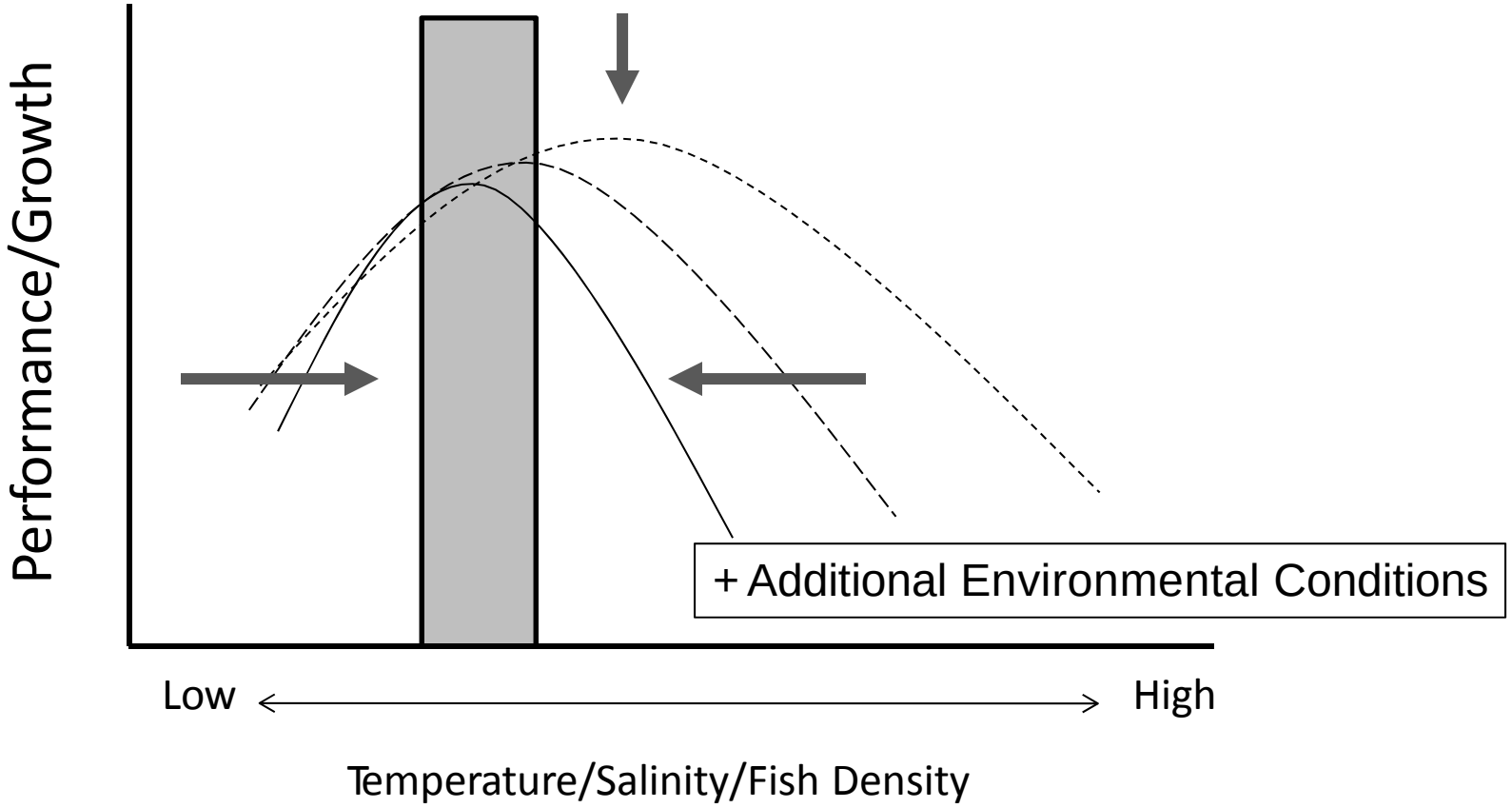
Optimal Growth



Environmental conditions can interact and shift the optimal conditions for growth.

InSEAS Research

Determine the optimal conditions for rearing salmon in RAS.

- The possible combinations of parameters that may affect growth are enormous.

- Multi-tiered approach to determine the optimal rearing conditions for salmon:
  1. Regression approach
  2. Subsequent replication
  3. Multi-factorial studies

InSEAS Research

Three-Year Funding from Natural Sciences & Engineering Research Council of Canada (NSERC)

Research Priority: Determine the optimal ***environmental conditions*** for growth, performance, physiological robustness, welfare and product quality of Atlantic and coho salmon from smolt to adult.

Year 1 Salinity

Year 2 Temperature

Year 3 Photoperiod & Salinity

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Year 1 Salinity

Year 2 Temperature

Year 3 Photoperiod & Salinity

} **Environmental conditions examined in future years are flexible**

Effects of Salinity on Fish

Salmon in fresh water

Na+, Cl-

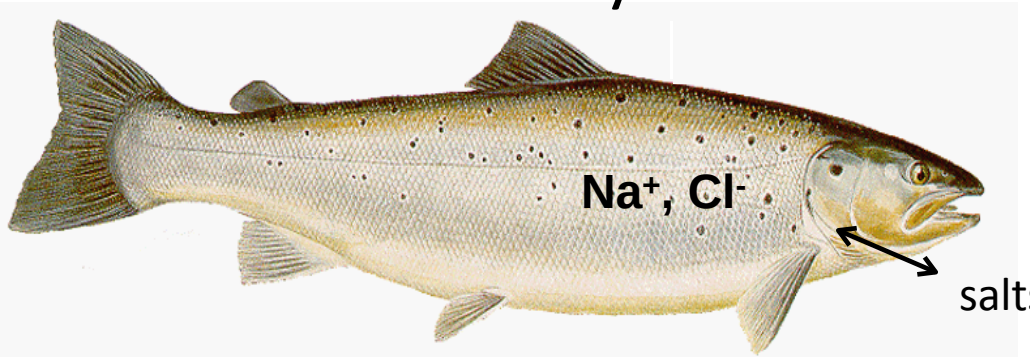
Salmon in sea water

Na+, Cl-

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

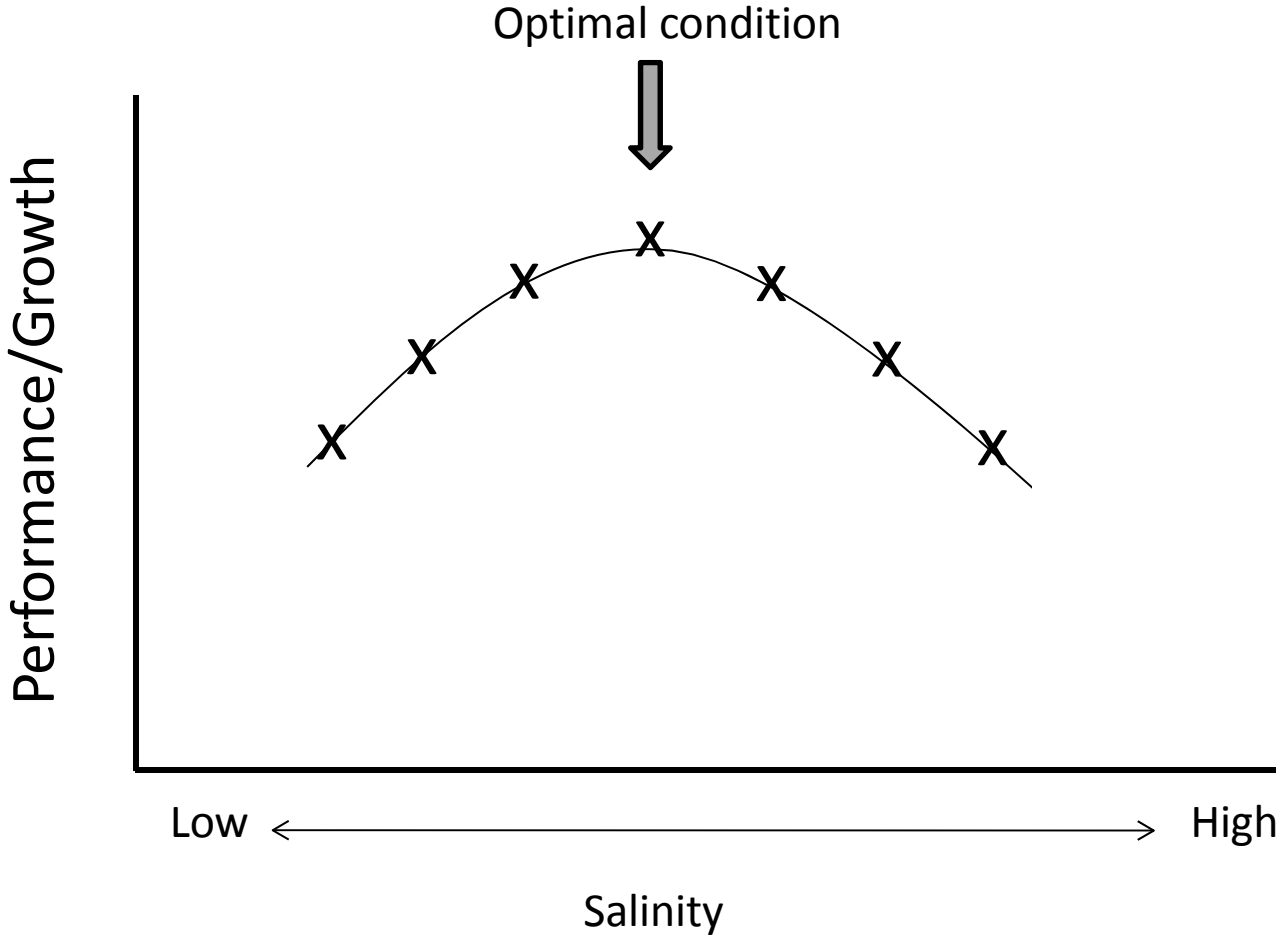
Effects of Salinity on Fish

Salmon at intermediate salinity



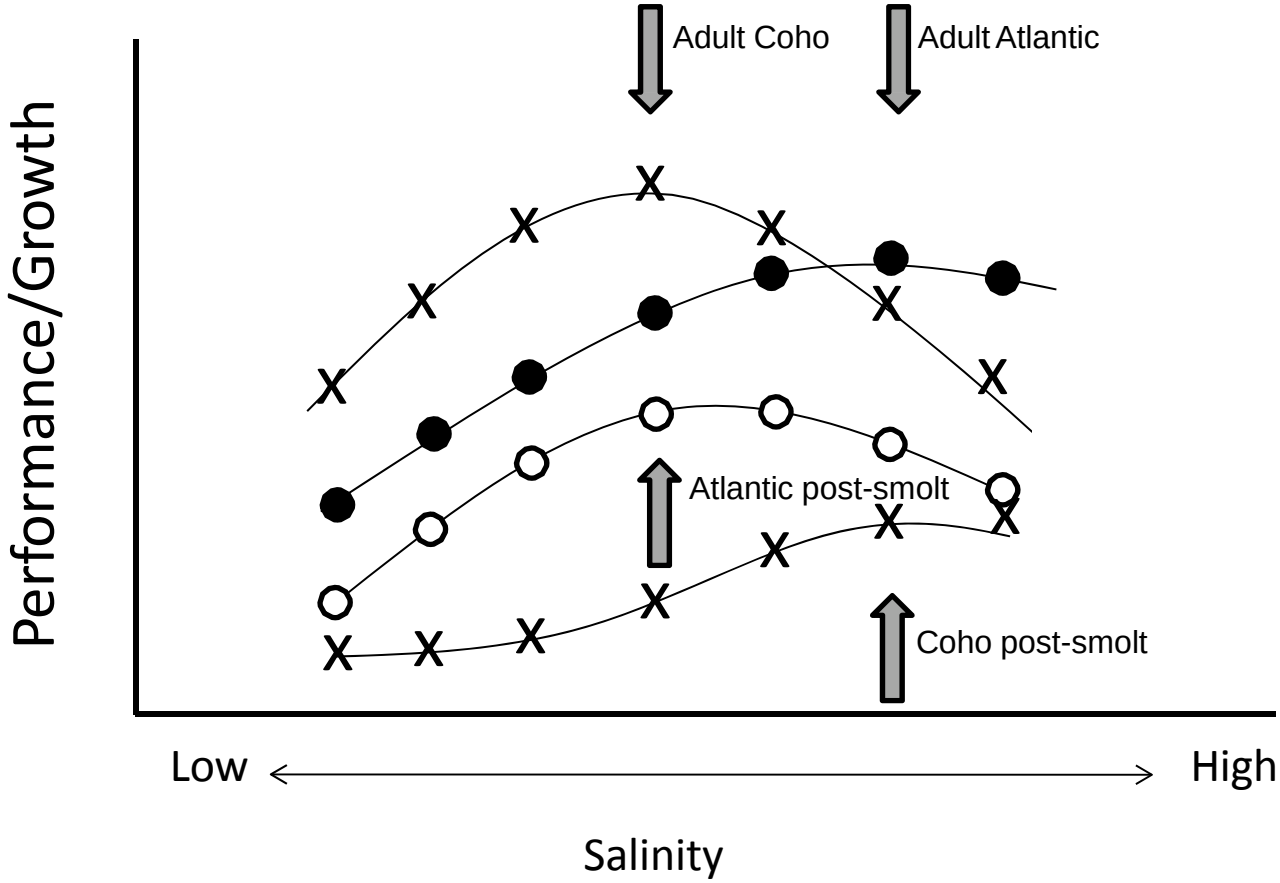
Hypothesis: Growth will be enhanced at an intermediate salinity.

InSEAS Regression Approach



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

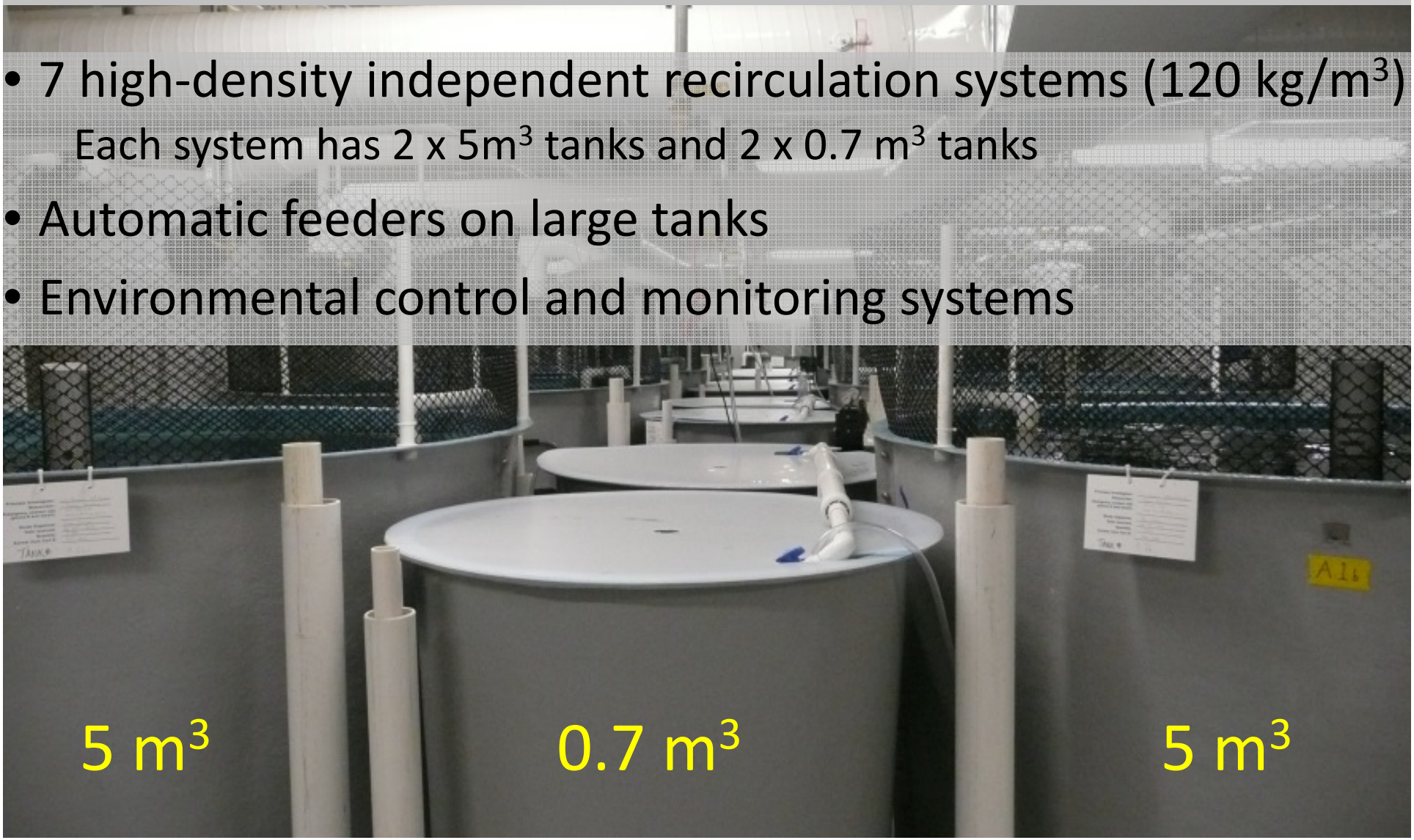
InSEAS Regression Approach



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

InSEAS RAS Research Facility

- 7 high-density independent recirculation systems (120 kg/m^3)
  Each system has 2 x 5m^3 tanks and 2 x 0.7 m^3 tanks
- Automatic feeders on large tanks
- Environmental control and monitoring systems

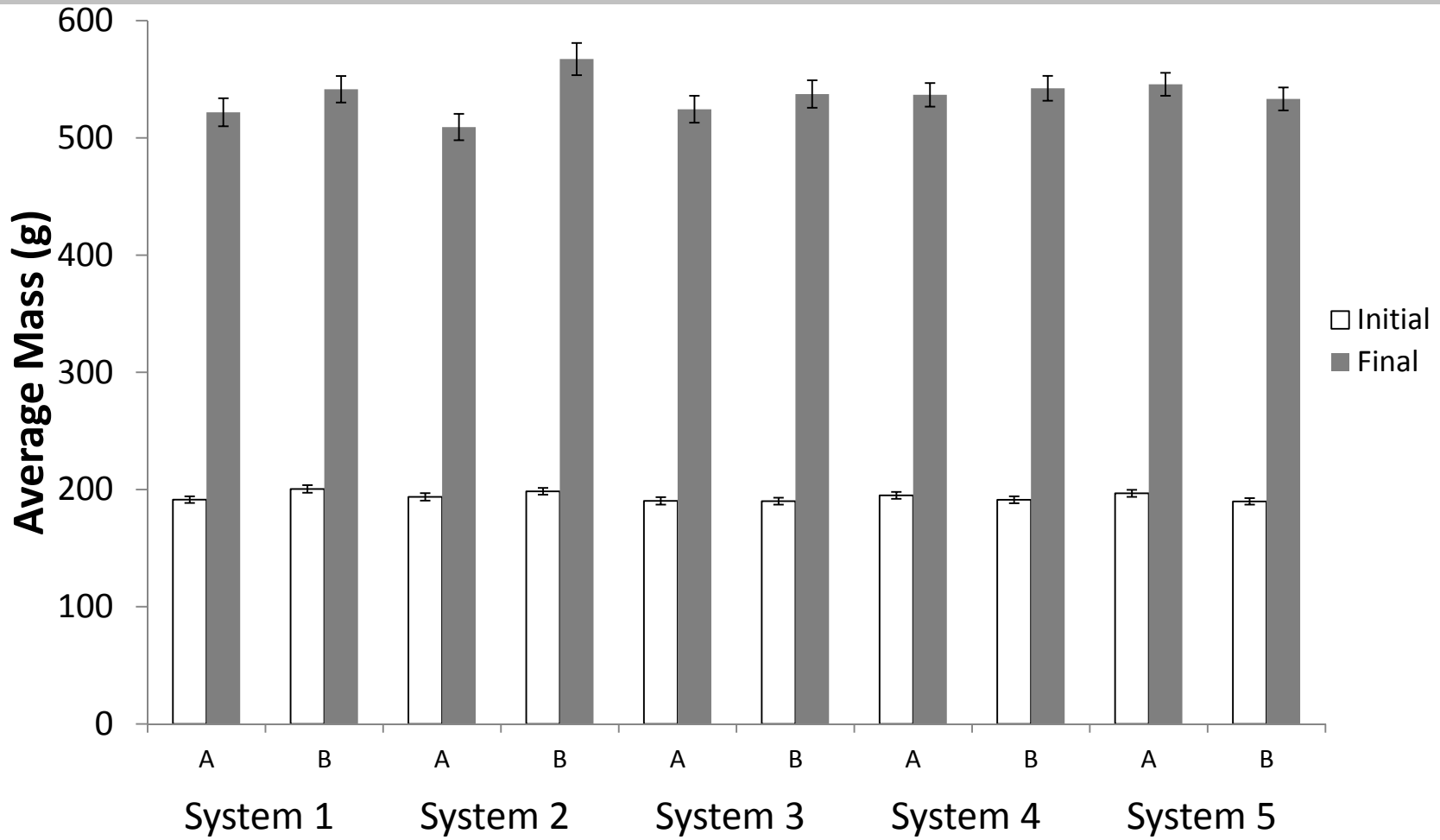


Is fish growth affected by system?

Initial Testing of RAS

- Do fish grow at the same rate in each RAS when held under the same conditions?
- Completed a growth trial with coho salmon in 2014

Is fish growth affected by system?



Growth rate was similar in each system at 2.1 to 2.5 g/day

Defining Optimal Salinity

Rear coho & Atlantic salmon for 12-15 months at 5 salinities ranging from freshwater to seawater at 13°C
(0, 5, 10, 20, and 30ppt)

Stocking density maintained at 40 kg/m^3

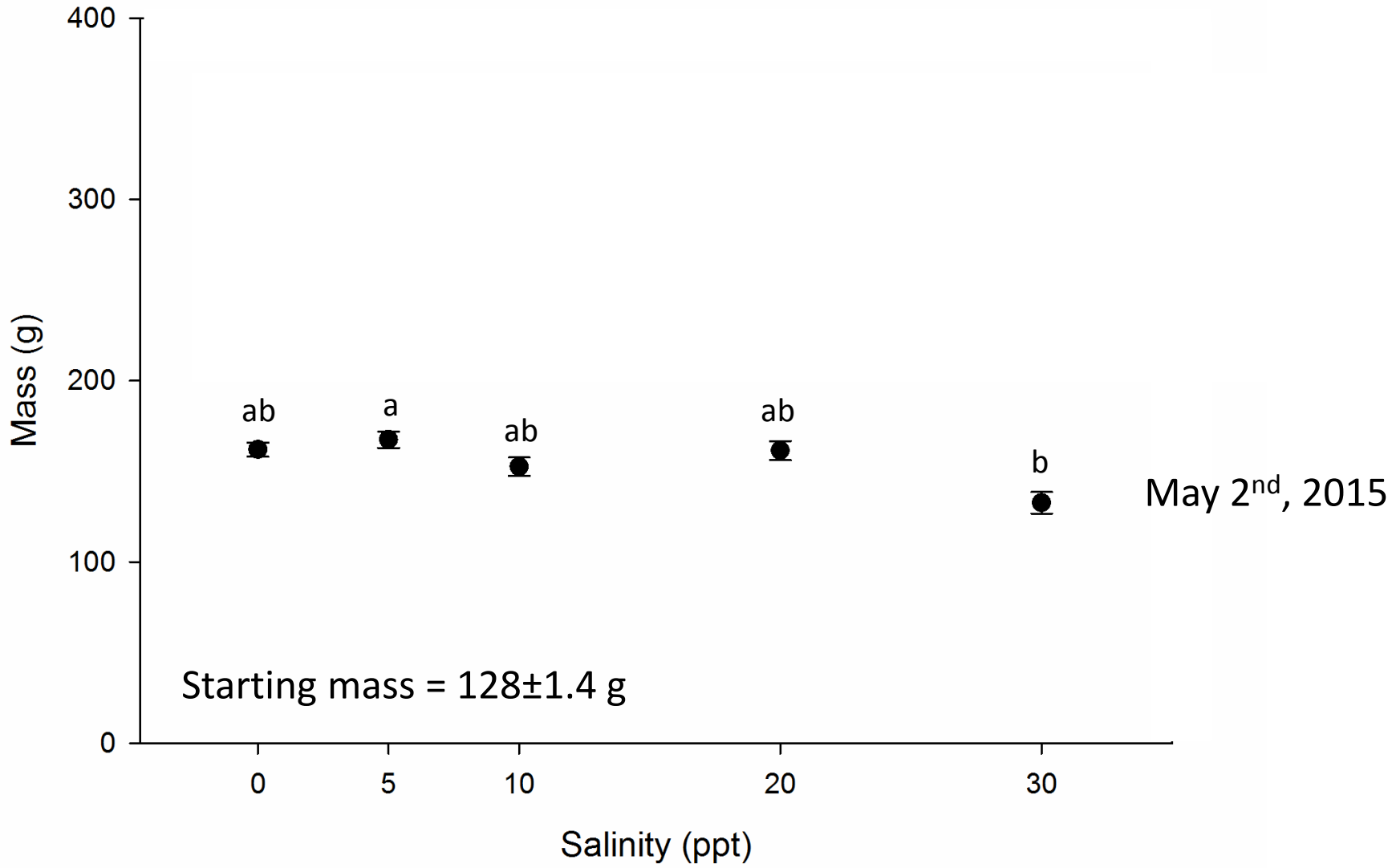
Coho salmon growth trials started in May 2015

Atlantic salmon growth trials started in July 2015

Both large & small tanks

Monitor growth, feed conversion, maturation & physiological robustness

Coho Salmon
Growth in 5 m^3 tanks



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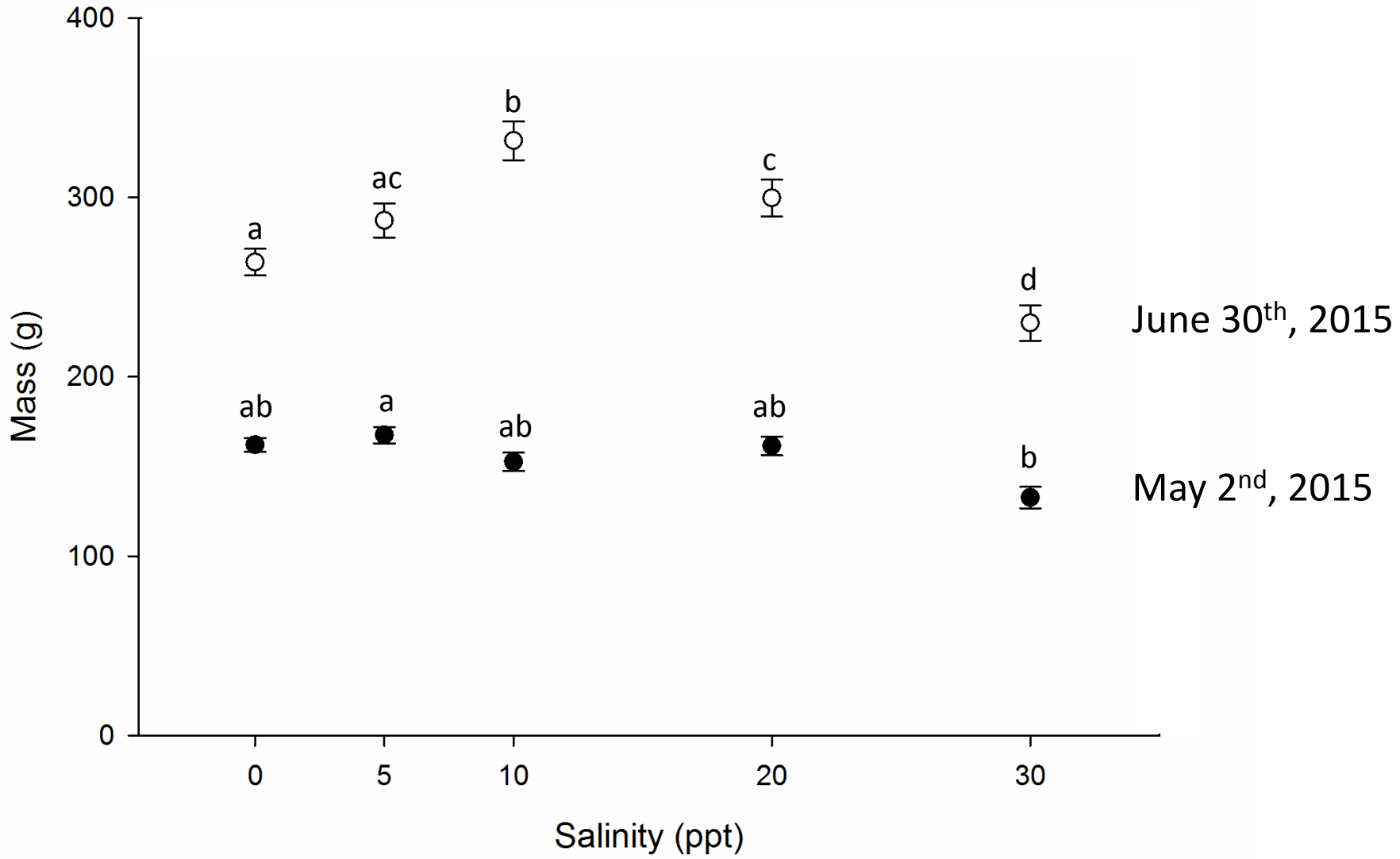

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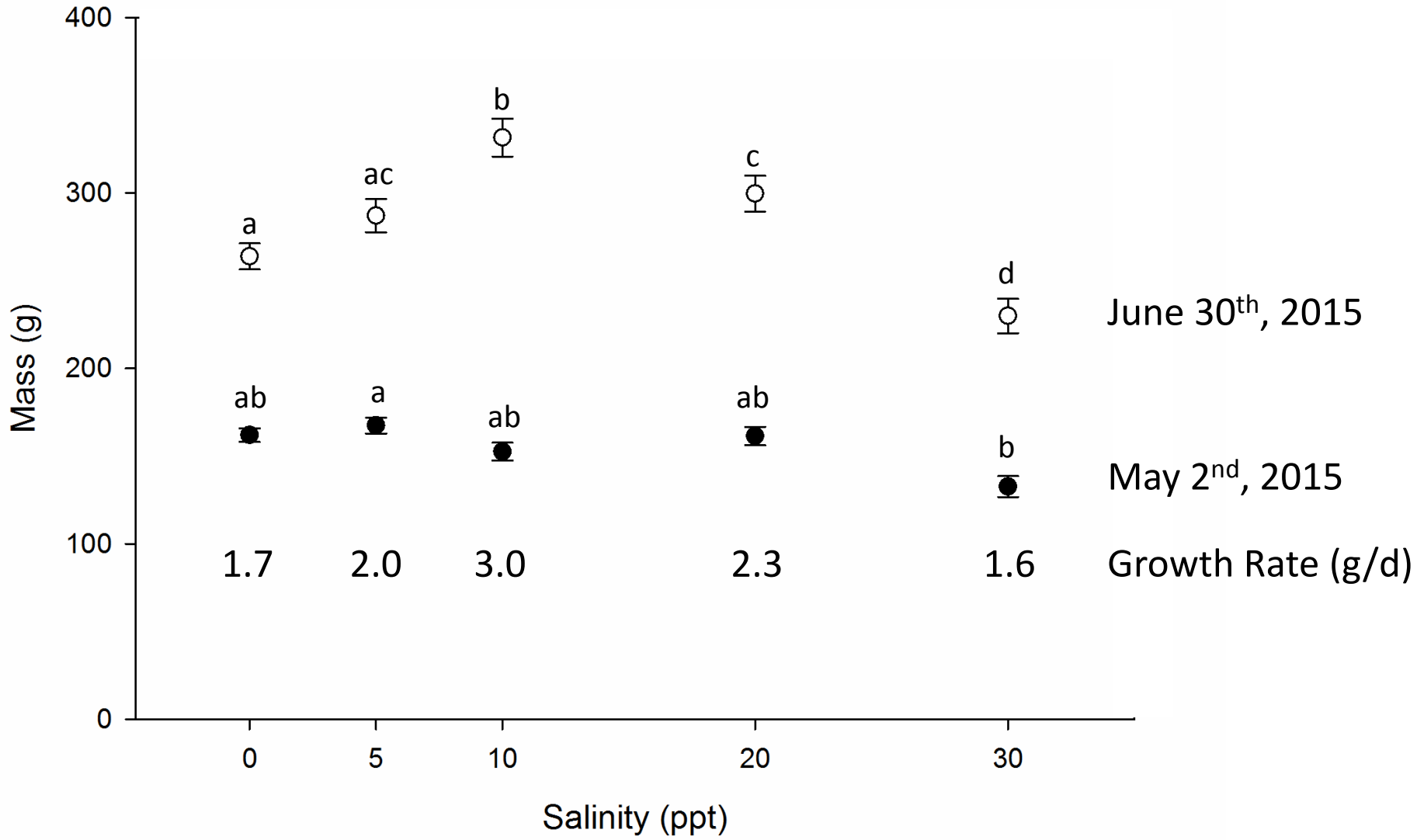

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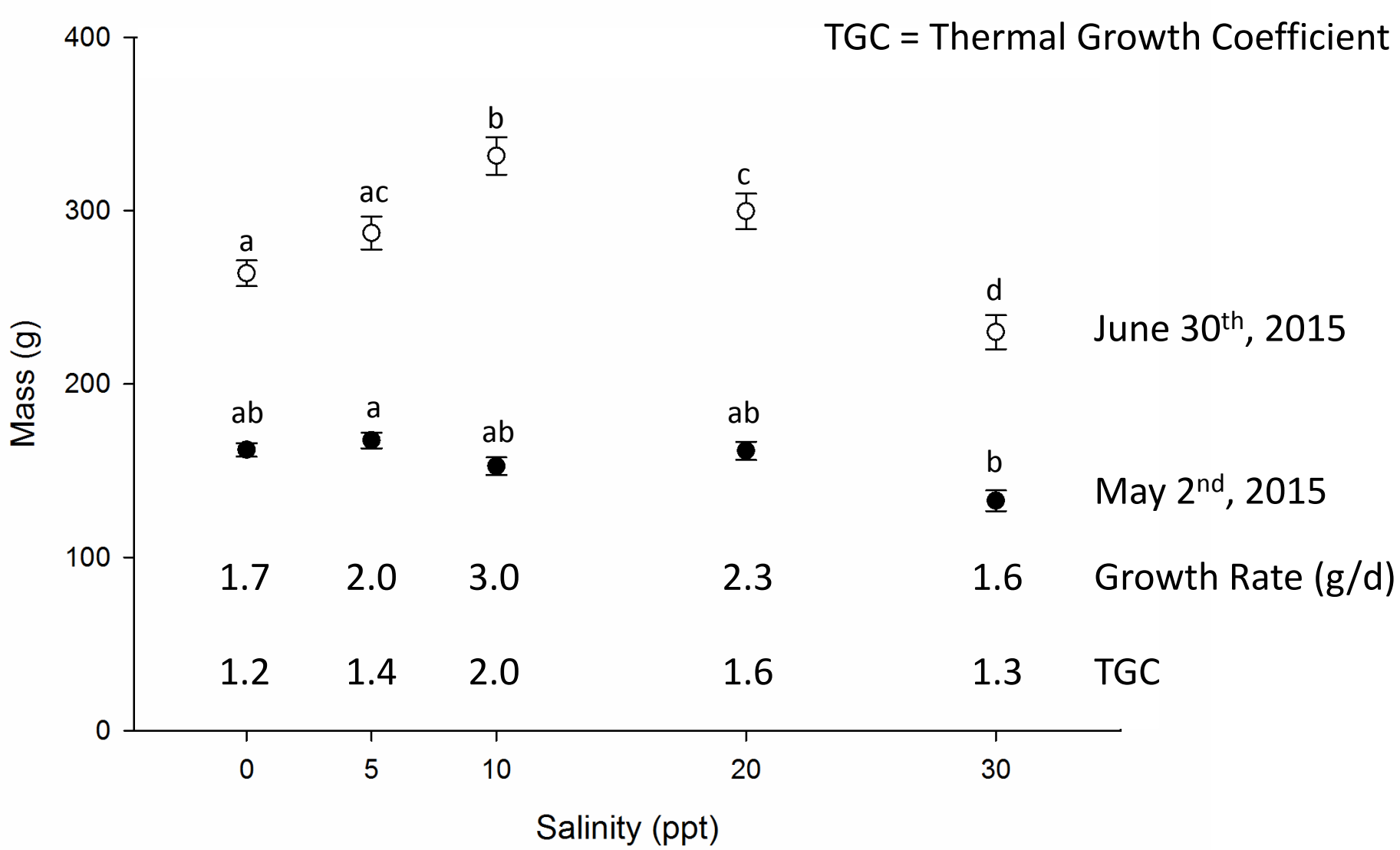

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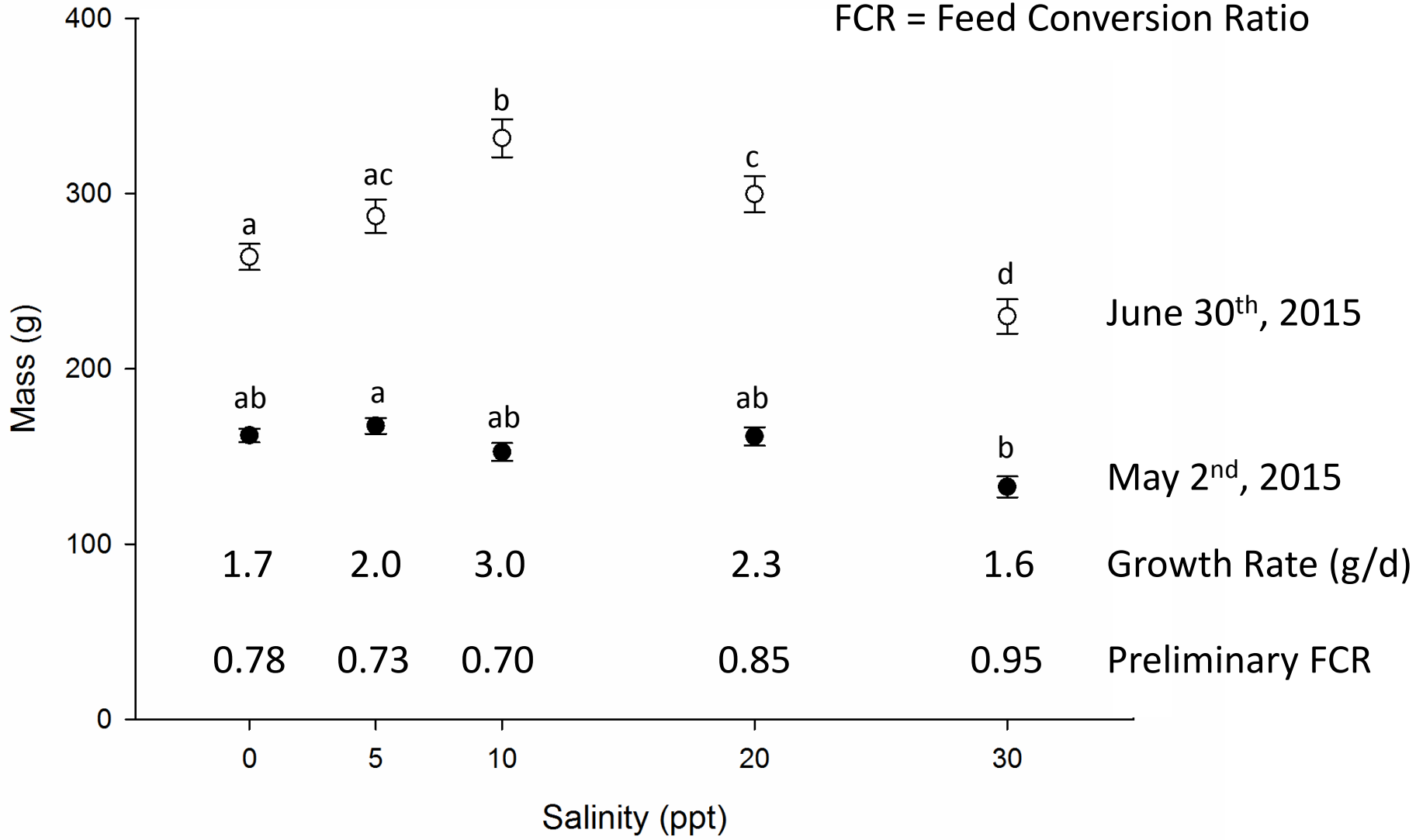

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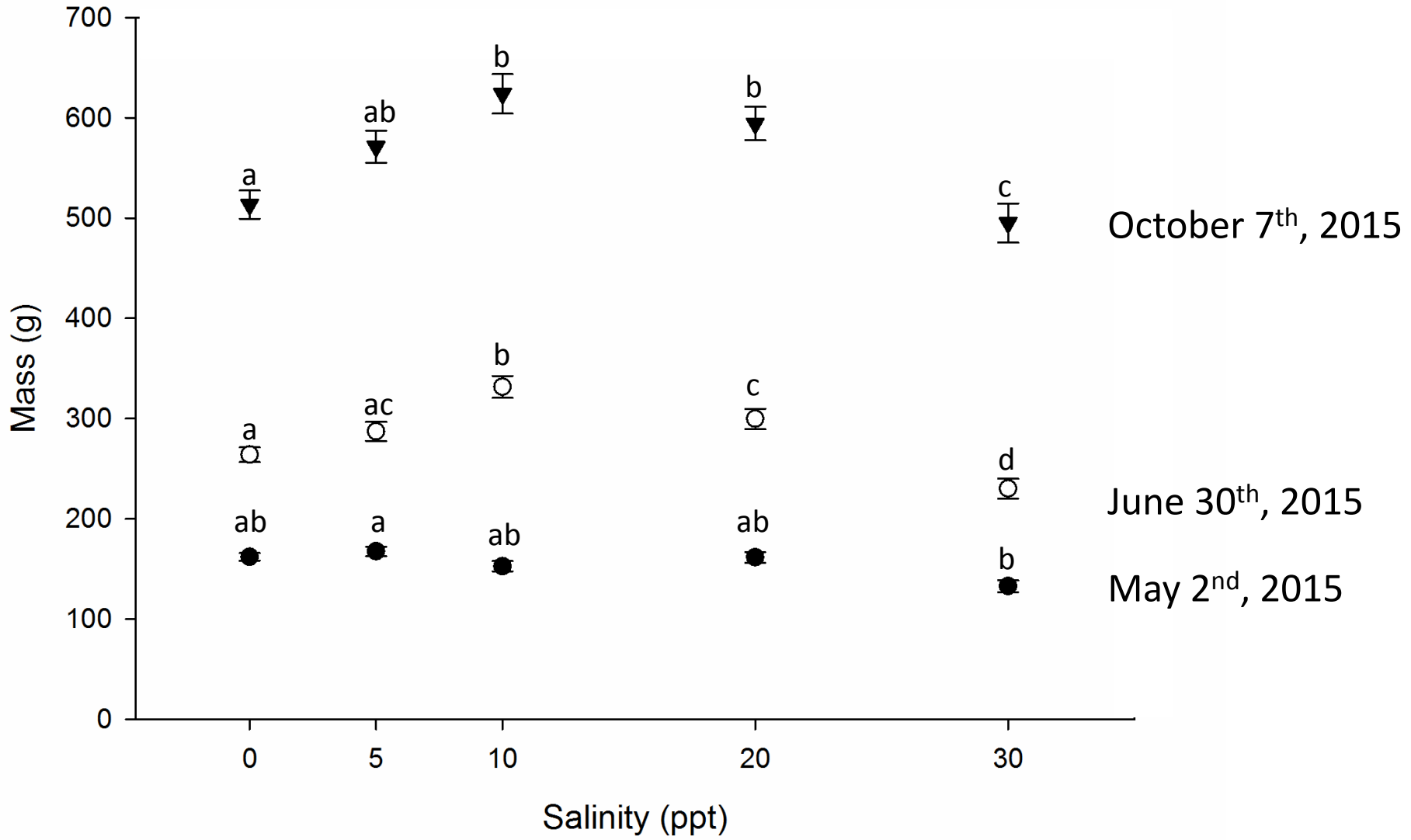
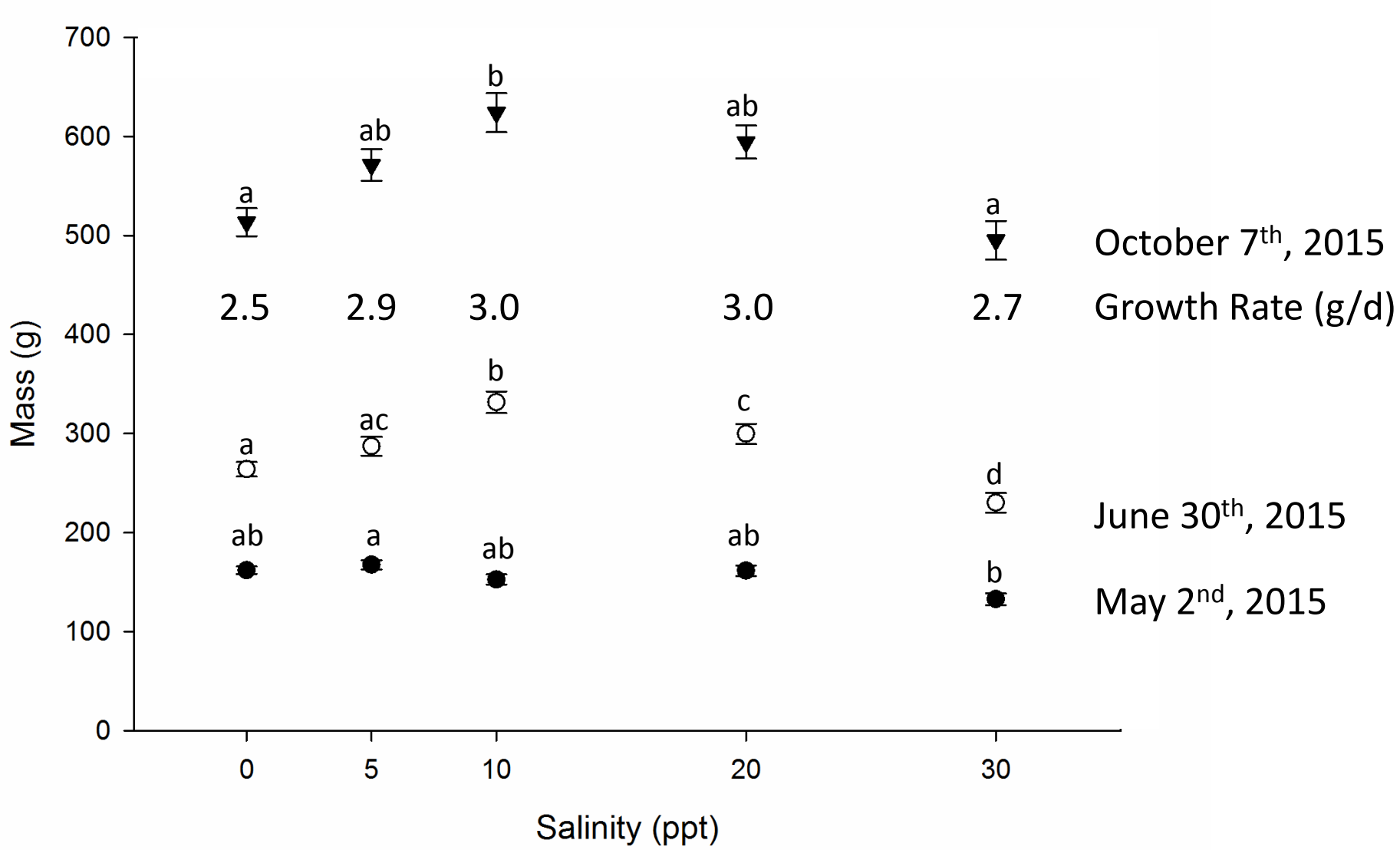
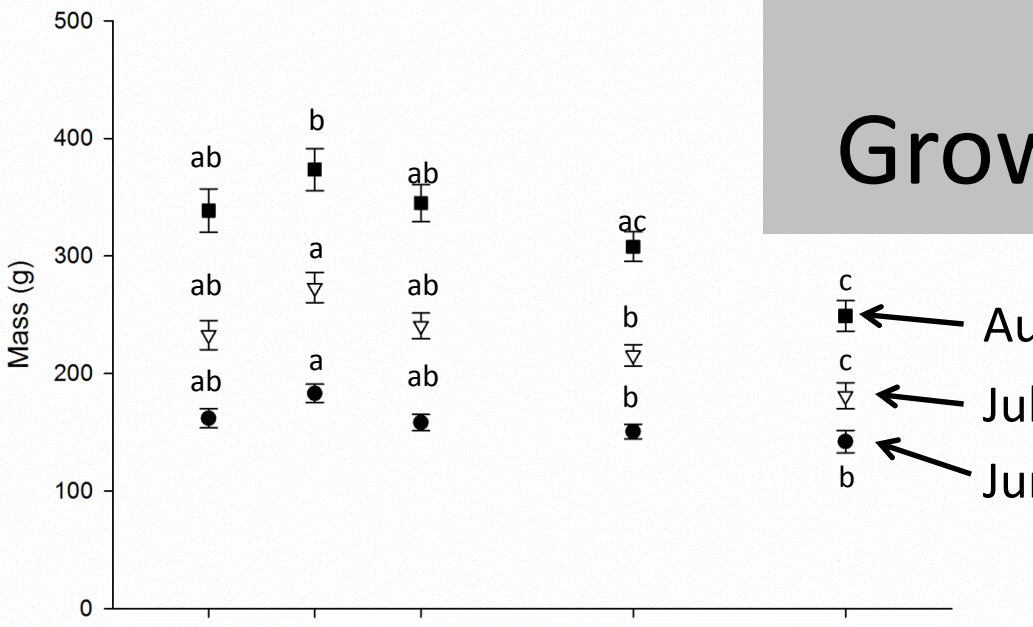
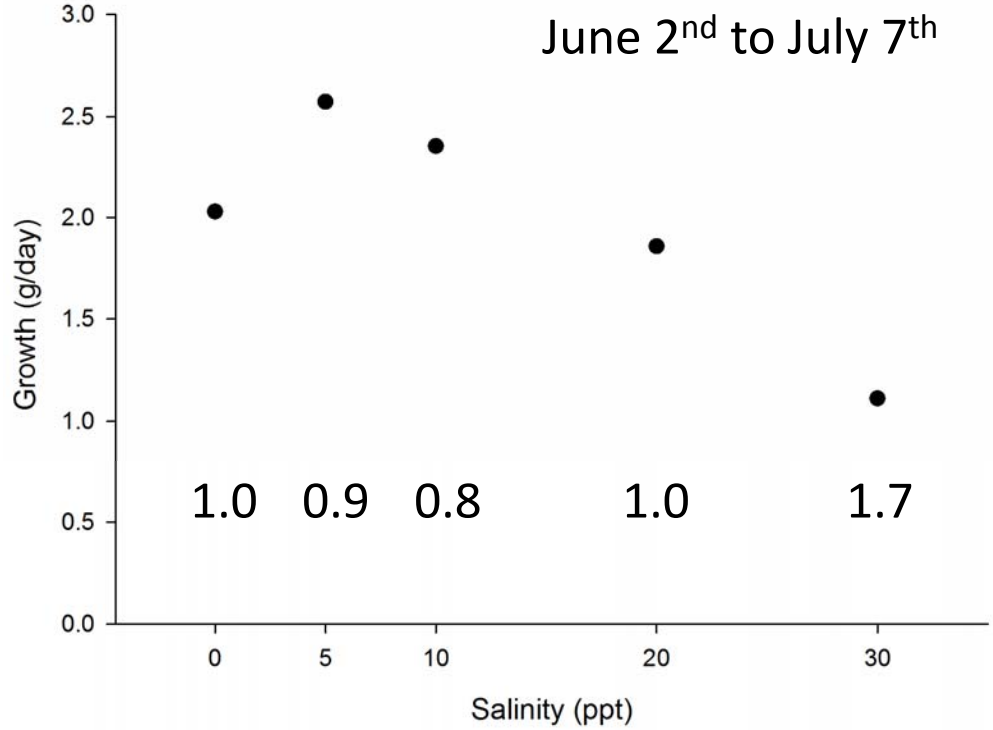


Coho Salmon
Growth in 5 m^3 tanks



Coho Salmon
Growth in 0.7 m^3 tanks





Coho reared in small tanks at intermediate salinities appear to grow faster with lower feed conversion ratios than at higher salinities.

Summary
Coho Salmon in RAS

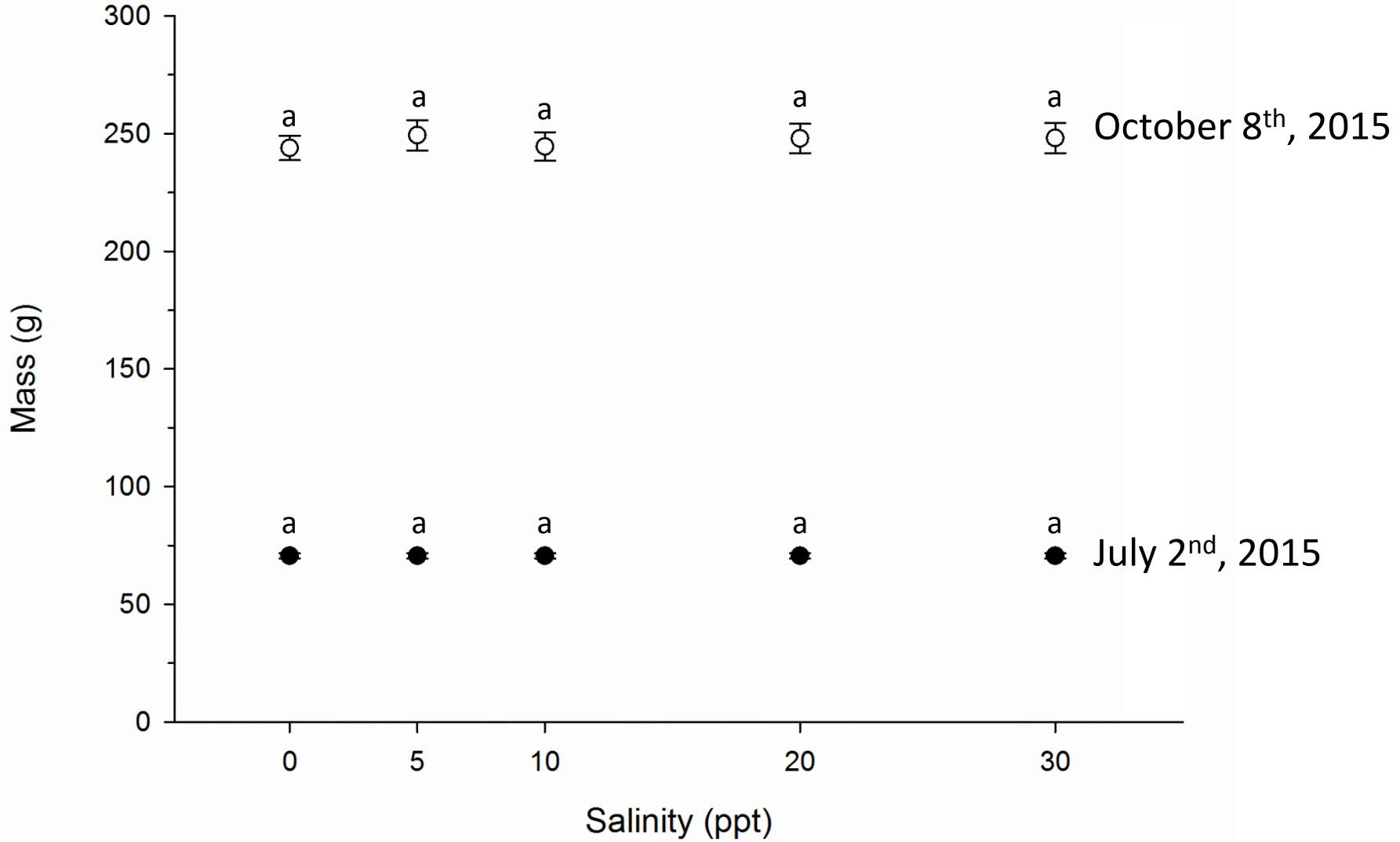
At small sizes, growth is enhanced at 10 ppt compared with 0, 20, & 30 ppt

At 5 and 10 ppt salinity, feed conversion ratios are lowest

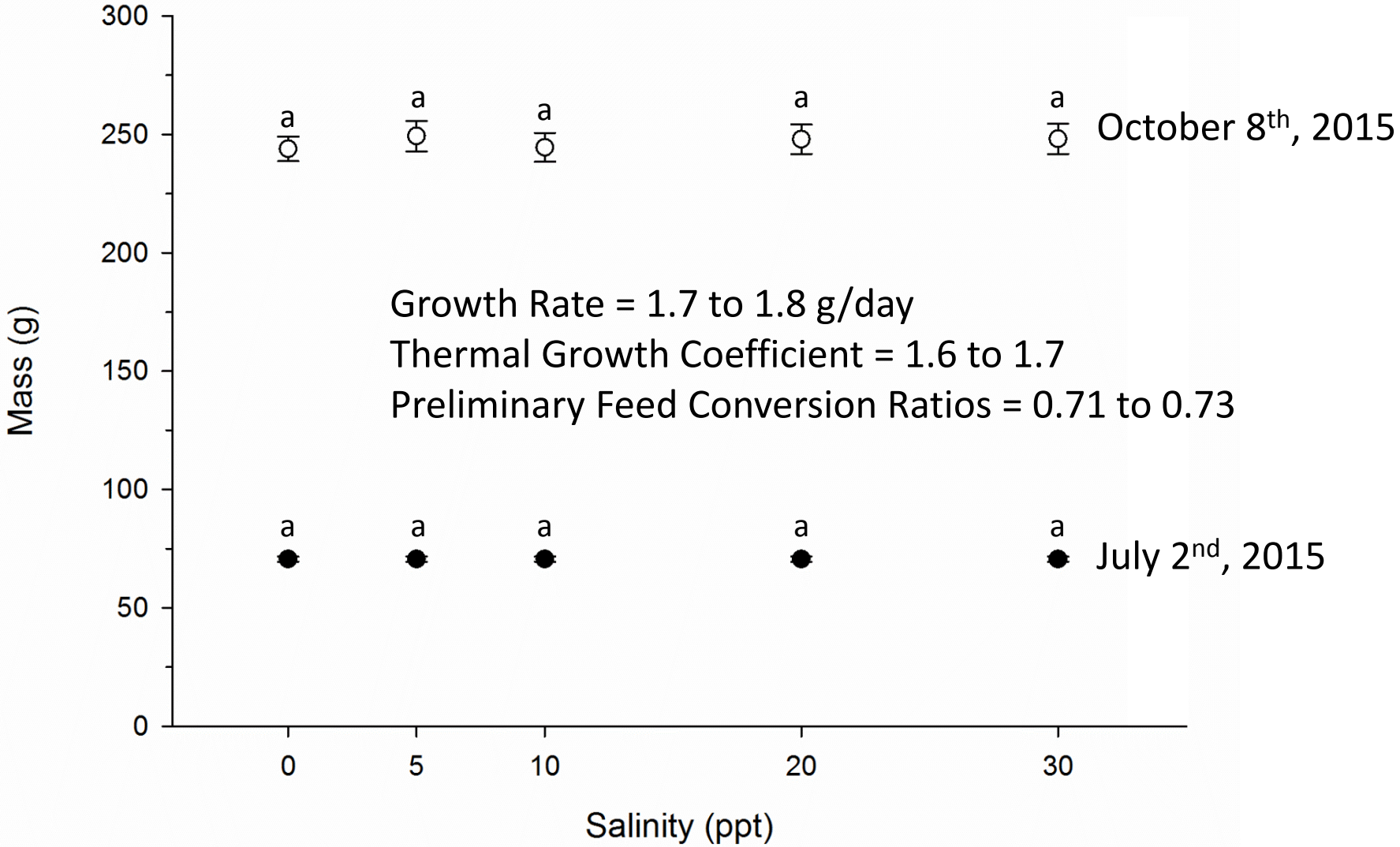
Both large & small tank experiments suggest that coho salmon grow better at intermediate salinities

Coho reared at intermediate salinities show better colouration and tank behaviour (data not shown) suggesting they are experiencing less stress

Atlantic Salmon
Growth in 5 m^3 tanks



Atlantic Salmon
Growth in 5 m^3 tanks



Conclusions
Coho & Atlantic Salmon

Coho Salmon

- Intermediate salinities appear to improve growth compared with freshwater and seawater
- Data on optimal salinity derived from small and large tank experiments appear consistent

Atlantic Salmon

- Between 75 and 250 g, salinity has no effect on growth or feed conversion ratios.

Future Directions
Coho & Atlantic Salmon

Growth trials will continue for 10 – 12 months

- Will assess growth rate, FCR & morphometrics every 2 to 3 months
- Pit tagged fish for evaluation of individual growth rates
- Assess stress tolerance and physiological status every 2 to 3 months
- Monitor for early maturation in Atlantic salmon
- Assess fillet quality

Thank you

<u>Research</u>

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<u>Collaborators</u>

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