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PHOTO: Assessing photoperiod regimes for post-smolt production

CtrlAQUA

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Background: Atlantic salmon growout trials

Major Challenge: Grilsing

Up to 80% of male salmon mature early

Maturation

- Decreased growth and feed conversion
- Reduced fillet yield
- Reduced product quality
- Increased susceptibility to opportunistic infections

Historical Background

Long history of maturation affecting Atlantic salmon production:

- Major source of economic loss for farmers
  - Johnston et a., 2006; McClure et al., 2007
- $11M – 24M in annual lost revenue ($250M industry)
  - McClure et al., 2007
- In-cage grilsing estimated at 20-30% (1998-2002)
  - Peterson et al., 2003


Courtesy of the BC Salmon Farmers Association

Maturation in Atlantic salmon

Sexual maturation in *Salmo salar* A highly flexible process, influenced by:

- Photoperiod
- Water temperature
- Feed intake
- Nutrition
- Lipid reserves
- Growth rate
- Stock genetics
- Etc.

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A Review of Factors Influencing Maturation of Atlantic Salmon, *Salmo salar*, with Focus on Water Recirculation Aquaculture System Environments

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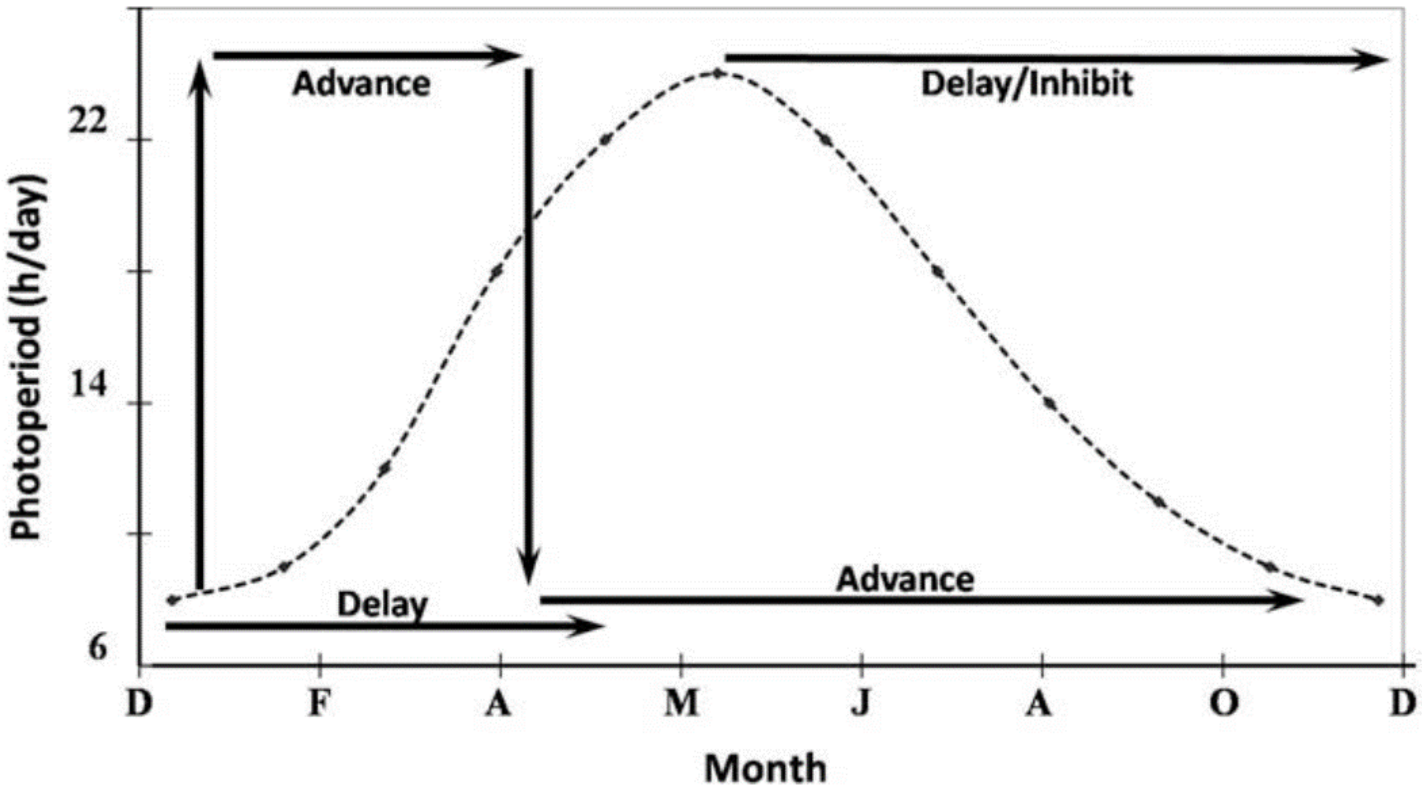
Photoperiod

- An essential determinant for initiating sexual maturation in teleosts Taranger et al., 2010
- Evolutionary strategy to ensure juveniles hatch during advantageous environmental conditions

  Bromage et al., 2001
- Direction of daylength change more important than specific hours of daylight
  Bromage and Duston, 1986

- "Decision" to mature is made during late autumn (declining photoperiod) but not fixed before early spring



Taranger et al., 2010

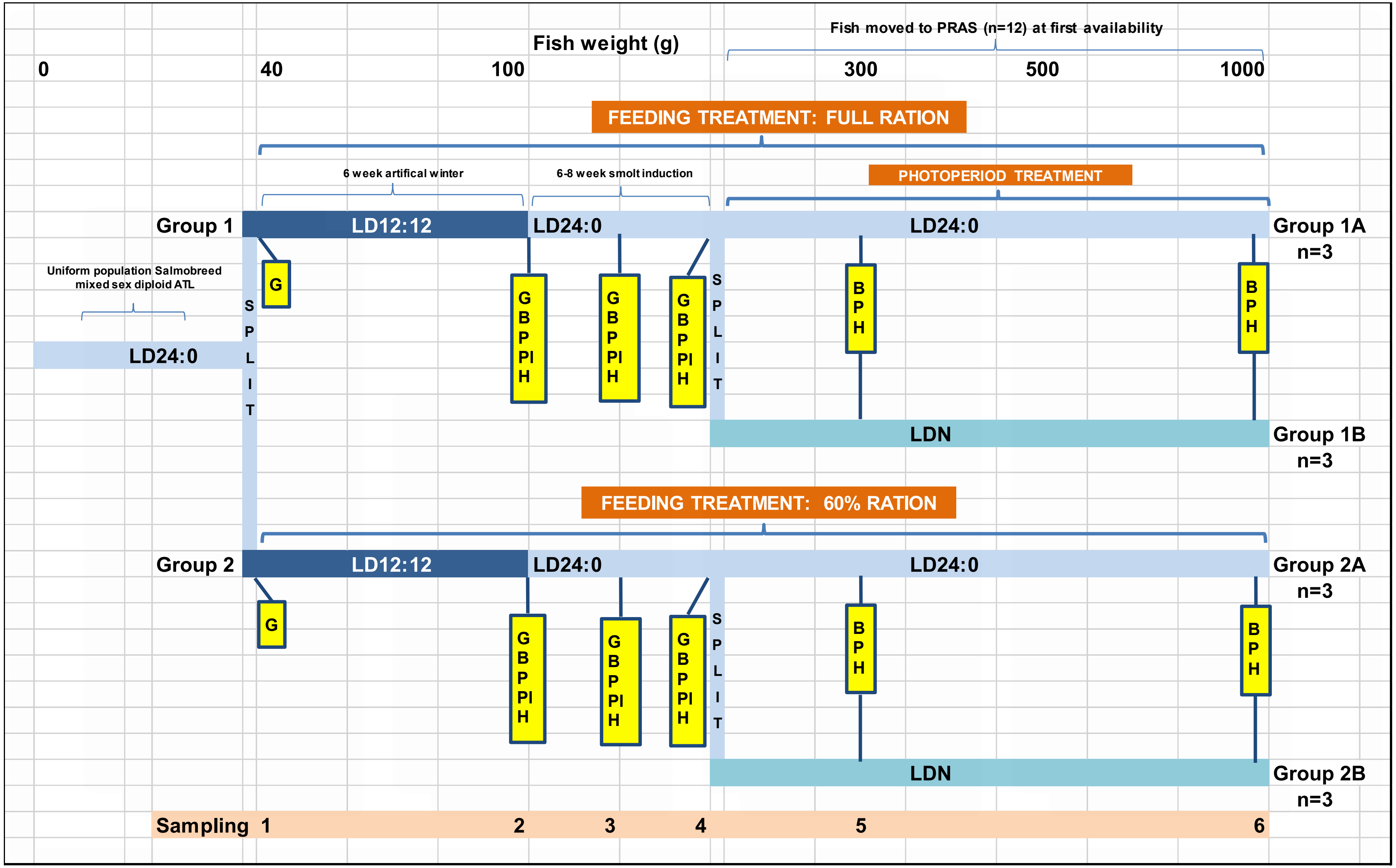
PHOTO II

Objective: To examine the effects of different photoperiod regimes on the quality and robustness of Atlantic salmon post-smolts raised to 1,000g, and to market size, in freshwater RAS

- There is significant industry interest in raising larger smolts (up to 1kg) in land-based freshwater RAS
- This new variation on smolt production is largely untested, and optimum environmental conditions need to be established to ensure salmon quality prior to sea cage transfer
- Photoperiod regimes need assessment for their influence on growth performance, maturation, smoltification, and immunocompetence.

PHOTO II: photoperiod & feeding rate

Study design overview:



2x2 factorial study design incorporating:

(i) **photoperiod** (constant, i.e. LD24:0 vs. natural, i.e. LDN) and

(ii) **feeding regime** (full ration vs. 60% ration)

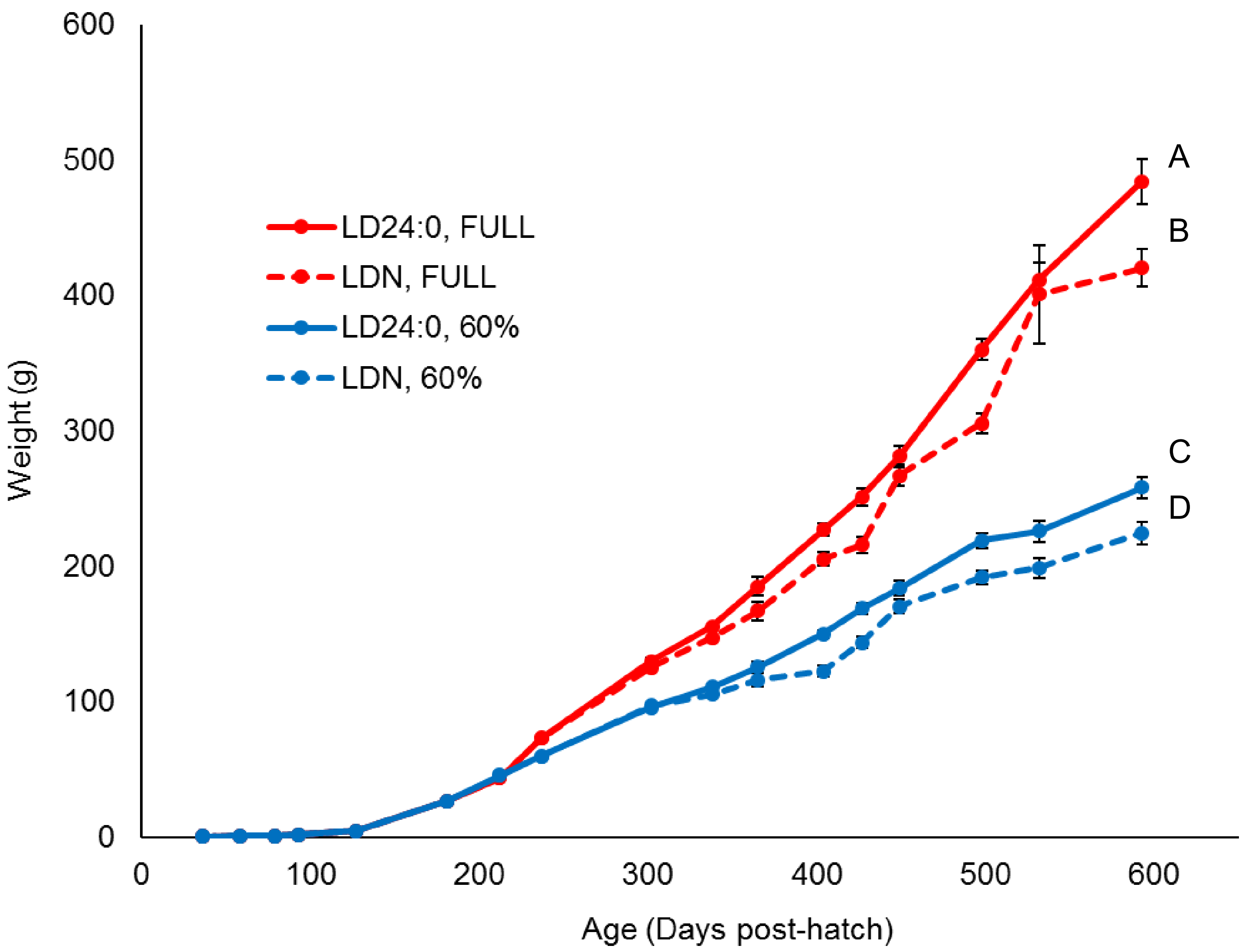
from smolt to 1,000g in freshwater aquaculture systems

Initial plan was to transfer fish to 5 m^3 PRAS tanks at first availability; however:

- Construction delays prevented transfer throughout study period
- Salmon remained in 0.5 m^3 tanks until ~500g

PHOTO II: photoperiod & feeding rate

Growth performance in 0.5 m^3 tanks prior to transfer:



ANOVA	
Treatment	p-value
Photoperiod	0.0002
Diet	<0.0001
Photoperiod x Diet	0.3239

Initial phase in 0.5 m^3 tanks demonstrated significant effects of both photoperiod and dietary restriction.

No maturation observed at this point

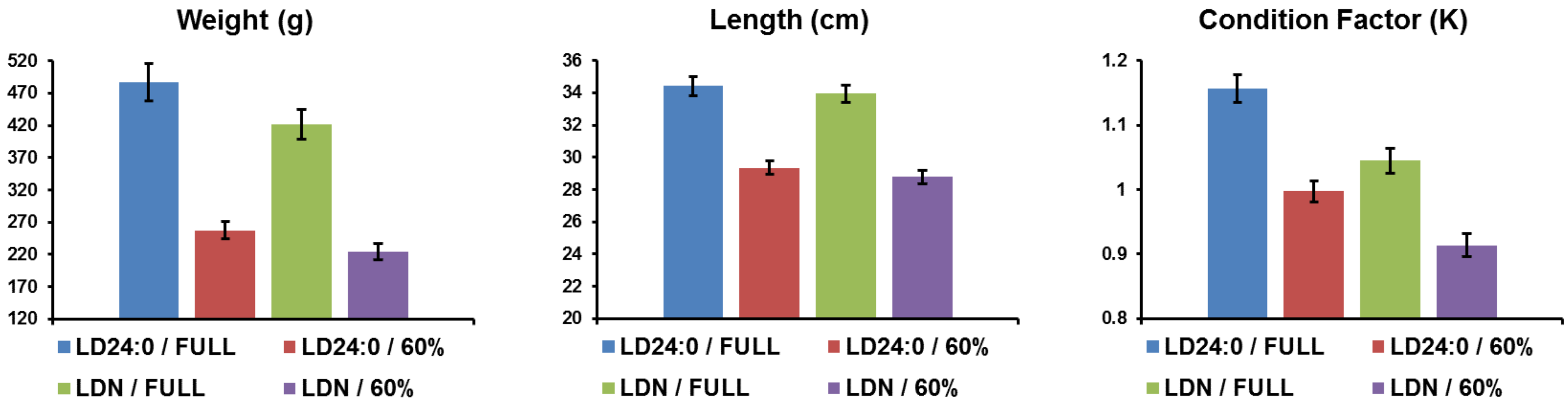
Reduced diet in general resulted in poor condition factor

Salmon fin clipped according to treatment and transferred to a single 10 m^3 PRAS tank for growth to 1,000 g

PHOTO II: photoperiod & feeding rate

500g sampling event (September 25, 2017):

RESULTS



Performance

- Best growth performance in the full ration treatment groups
- Best condition factor in LD24:0 / full ration group
- Poor condition factor in 60% ration groups

*****No observable signs of maturation in any treatment group*****

PHOTO II: photoperiod & feeding rate

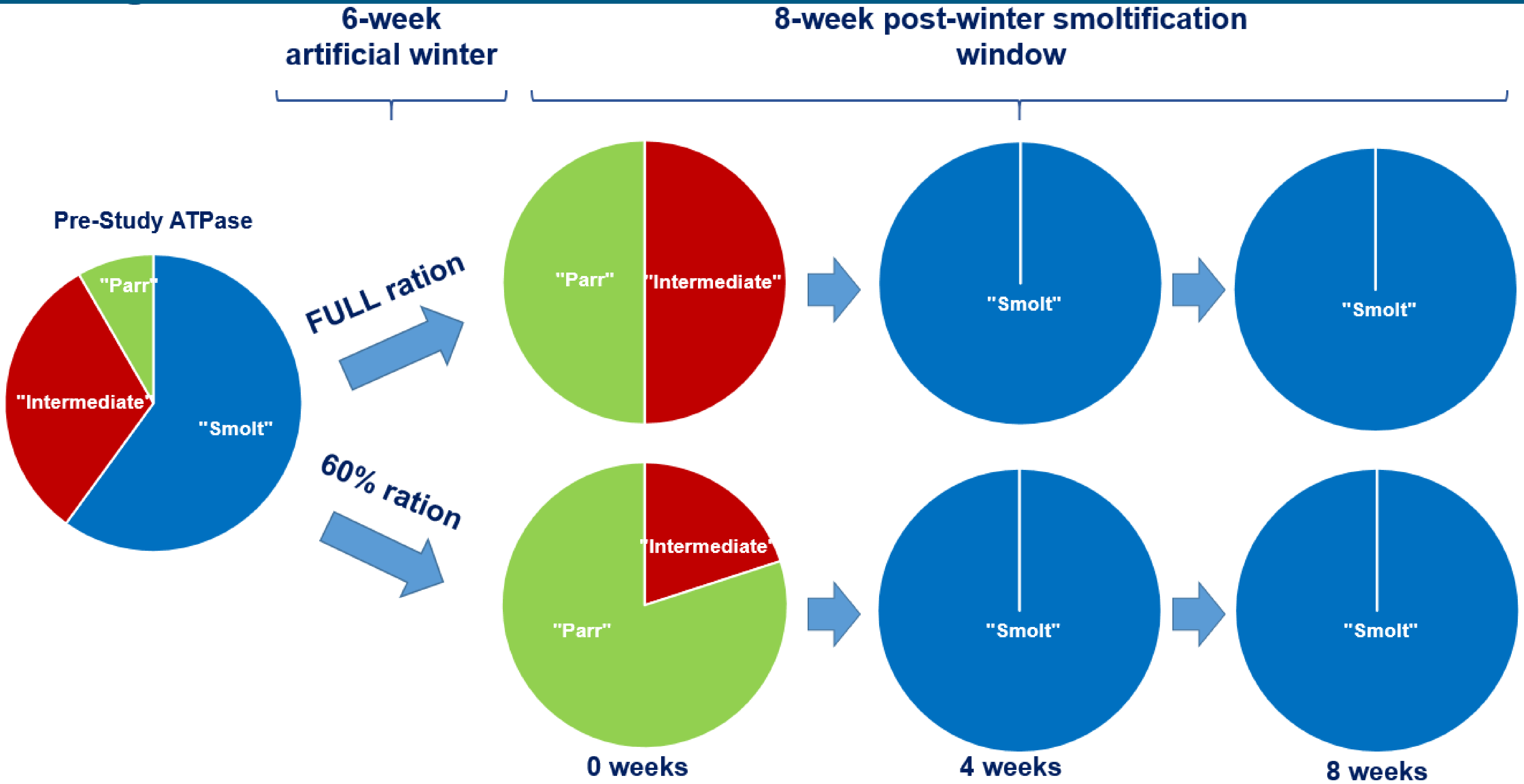


PHOTO II: photoperiod & feeding rate

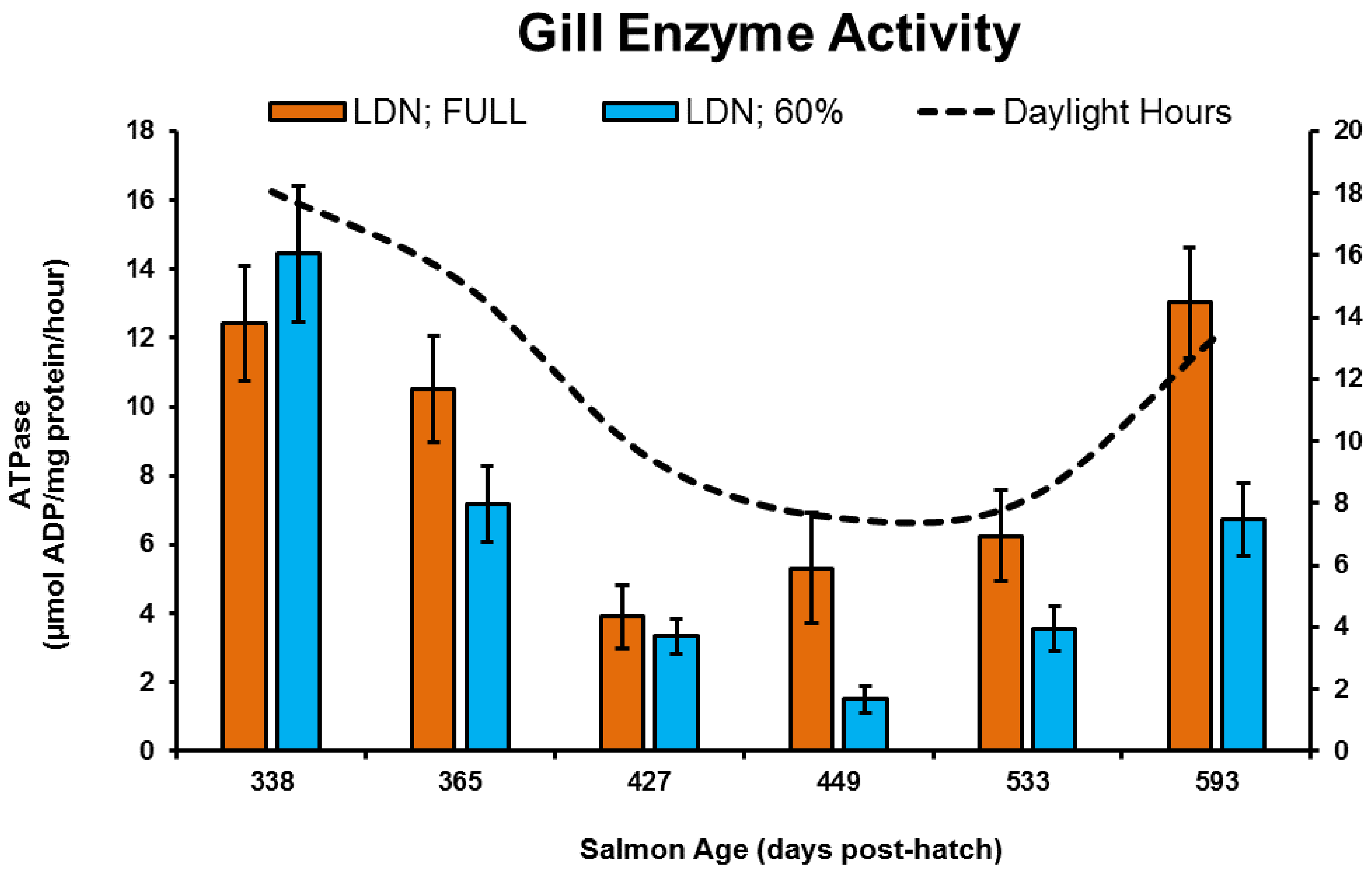


PHOTO II: photoperiod & feeding rate

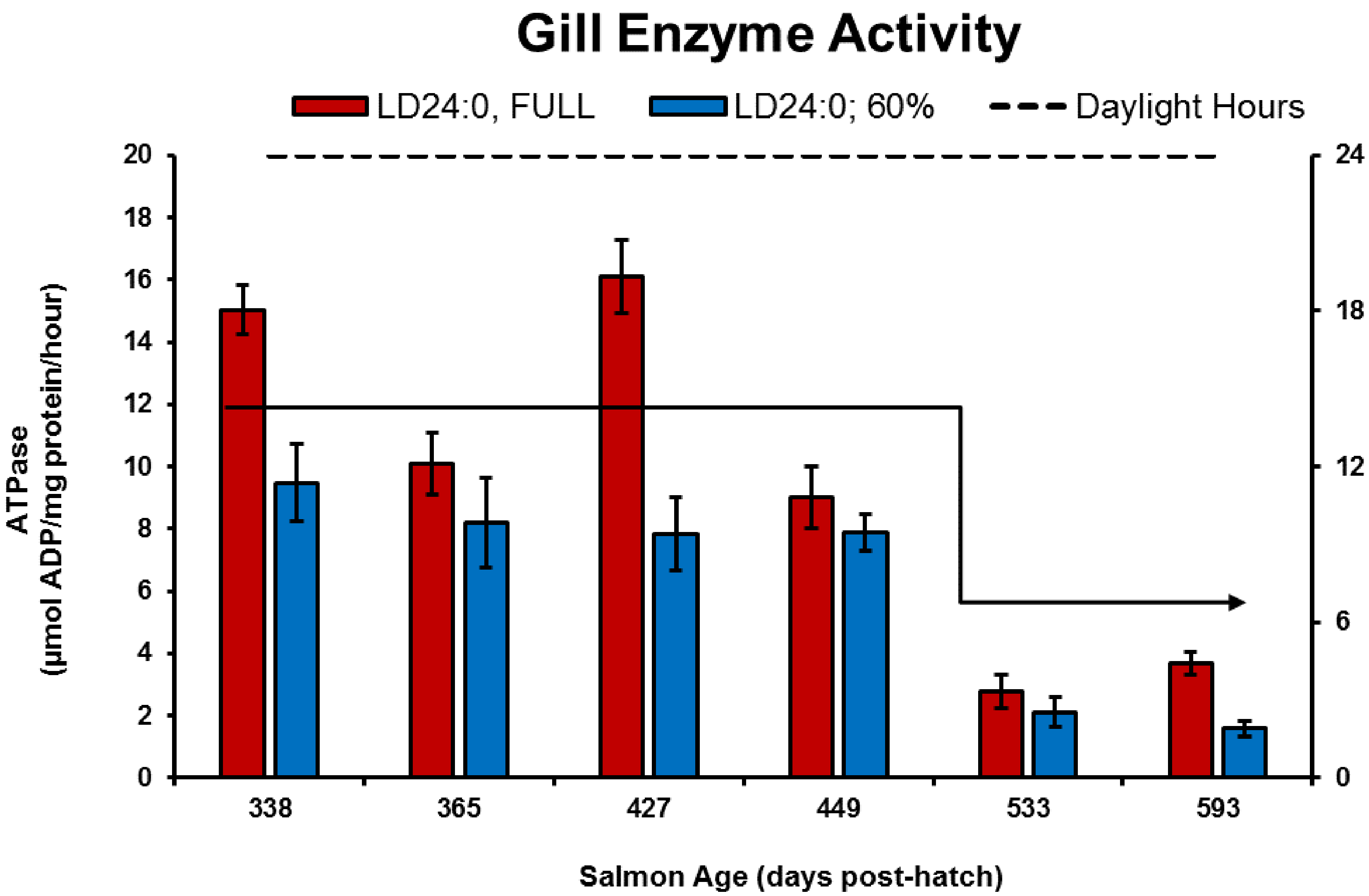
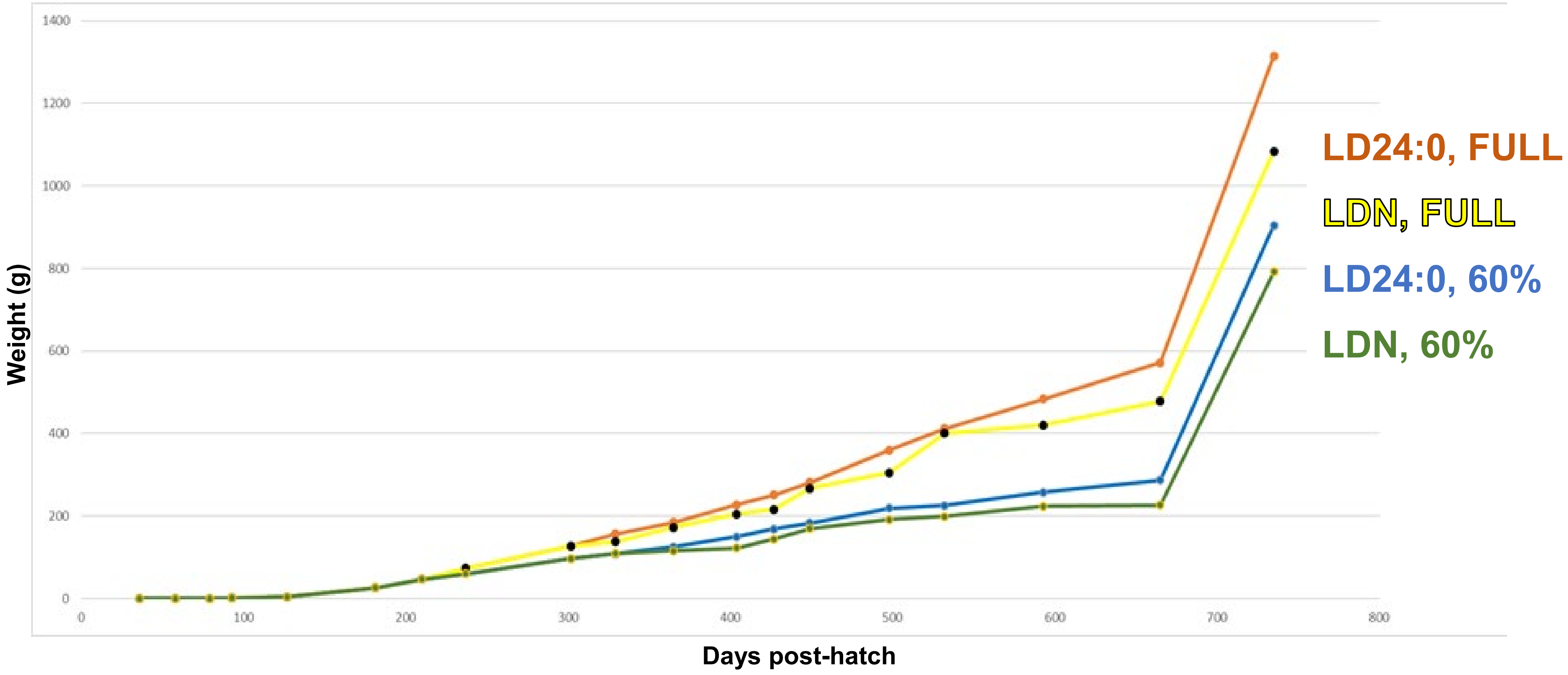


PHOTO II – 1,000g



Photoperiod	Ration	Mean weight (g)	Mean Male GSI	Mean Female GSI	% Males GSI >1%	% Female GSI > 1%
LD24:0	Full	1315	2.75	0.40	47	0
LD24:0	60%	904	2.11	0.26	40	0
LDN	Full	1084	2.62	0.68	70	15
LDN	60%	792	0.09	0.21	0	0

Performance up to ~1,000 g mean weight:

Compensatory growth observed in all groups post-transfer to 10 m^3 PRAS tank (all groups fed 100% post-transfer).

Significant male maturation in all groups except LDN, 60%

PHOTO III: S_0 winter & ploidy

Study overview:

- 2x2 factorial study with all-female Atlantic salmon:
  - S_0 and no-S_0 winter
  - Diploid and triploid
- Initial treatments conducted in flow-through 0.5 m^3 tanks
- Fish PIT tagged and combined (post-S_0) into a three 10 m^3 tank PRAS, to be raised to 1,000g
- Additional tank includes diploid fish under LD12:12 photoperiod

- Most recent data collection:

	LENGTH	WEIGHT	GSI
Diploid / S0	296.5 ± 0.870	1038.5 ± 15.15	0.1776 ± 0.040
Diploid / no S0	303.4 ± 10.04	1115.2 ± 83.57	0.2403 ± 0.030
Triploid / S0	300.4 ± 6.98	1041.7 ± 64.24	0.0315 ± 0.001
Triploid / no S0	317.0 ± 4.45	1203.0 ± 53.43	0.0297 ± 0.001
Diploid LD12:12 / S0	288.5 ± 4.53	967.0 ± 34.12	0.1435 ± 0.030
Diploid LD12:12 / no S0	296.1 ± 5.94	1072.2 ± 46.76	0.1319 ± 0.010

- Tagged fish will be grown to 6-7 kg harvest size in a semi-commercial scale RAS in 2019

Next Steps:

- Additional tissues analyses for immunocompetence and maturation (PHOTO II)
- PHOTO III fish to be harvested late 2019
- 3 manuscripts submitted for peer-review in 2019
- PHOTO IV?