Your Fish, Our Solutions for “Faster Growth - Better Health”

GIS Gas Infusion Systems Inc.

“Faster Growth – Better Health”

- **Industry Challenges**
- Cleaner fish: improve growth & health (new vaccines-response)
- Salmon: reduce time in saltwater, bigger smolt
- Salmon: improve vaccine efficacy/duration
- RAS: improve economic picture, faster growth, reduce gas management costs

- **GIS Solutions**
- Faster growth by > 150%
  - Salmon & Cleaner fish hatcheries
- Improve survivability > 50%
  - Salmon & Cleaner fish hatcheries
- Enhance vaccine response 100% more immunoglobulins
  - Salmon & Cleaner fish
- 94-97% efficacy for O2 infusion
- 50% reduction Opex for CO2 removal

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Assessing the Effects of GIS Technology to Produce High DO Freshwater Saturation On Atlantic Salmon (*Salmo Salar*) Growth, and Overall Health Within A Simulated Commercial Hatchery Setting

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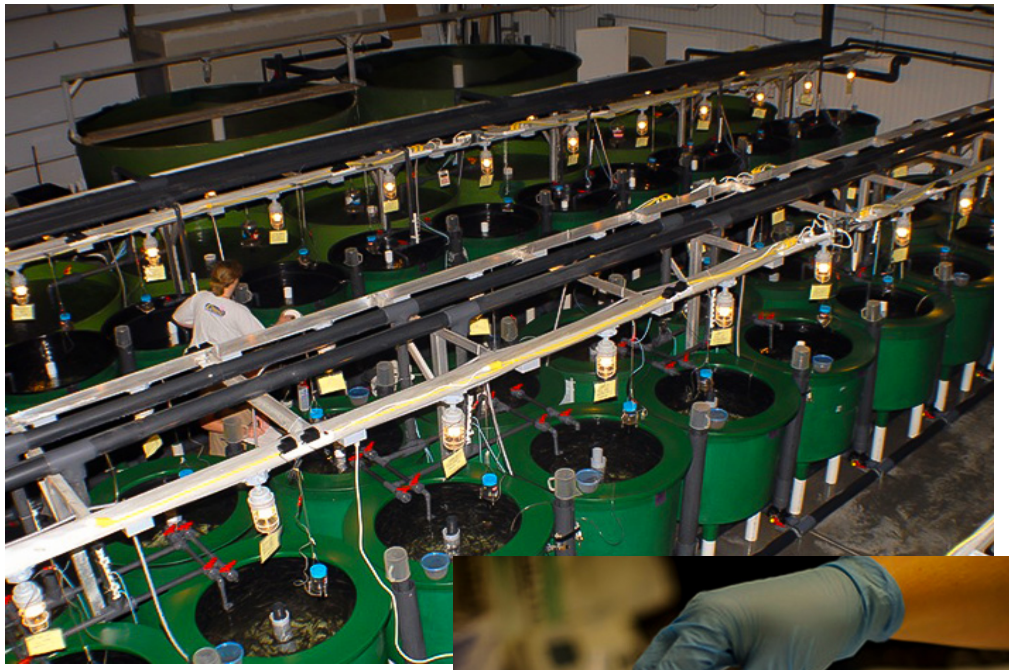
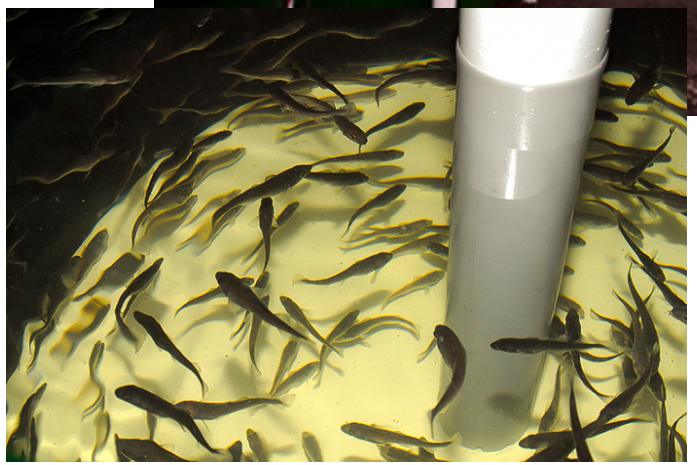
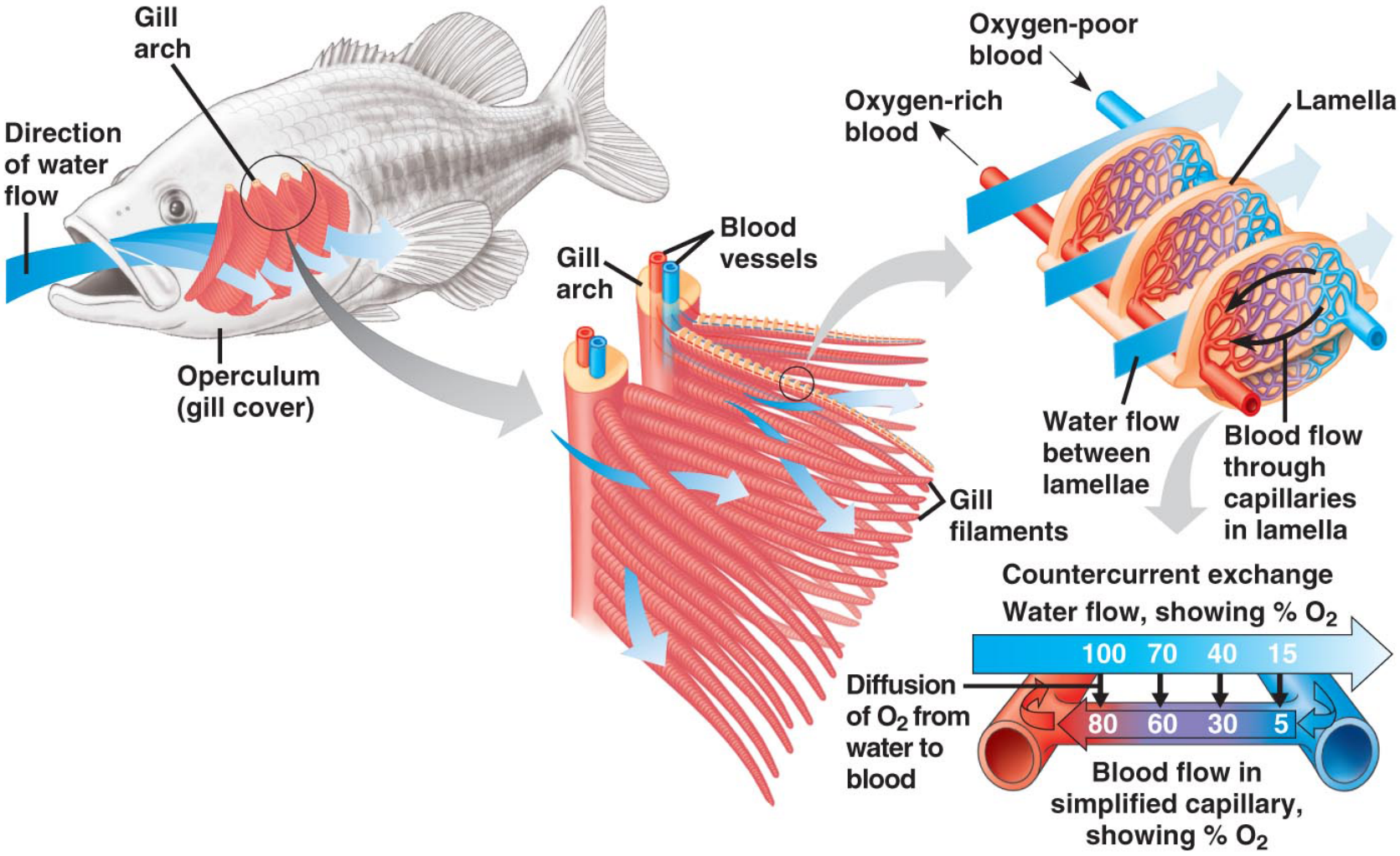
Research @ Huntsman Marine Science Center





Introduction - Respiration



Lachina @ Pearson Education, Inc.

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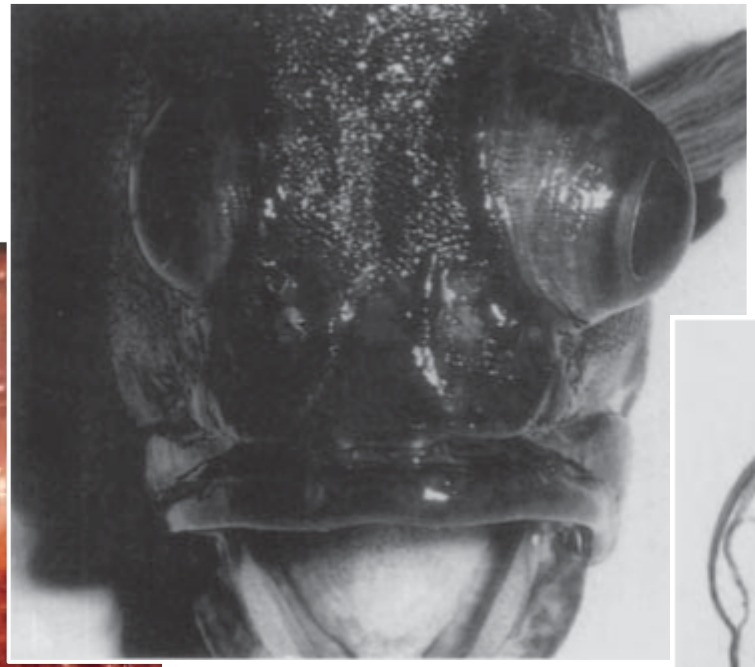
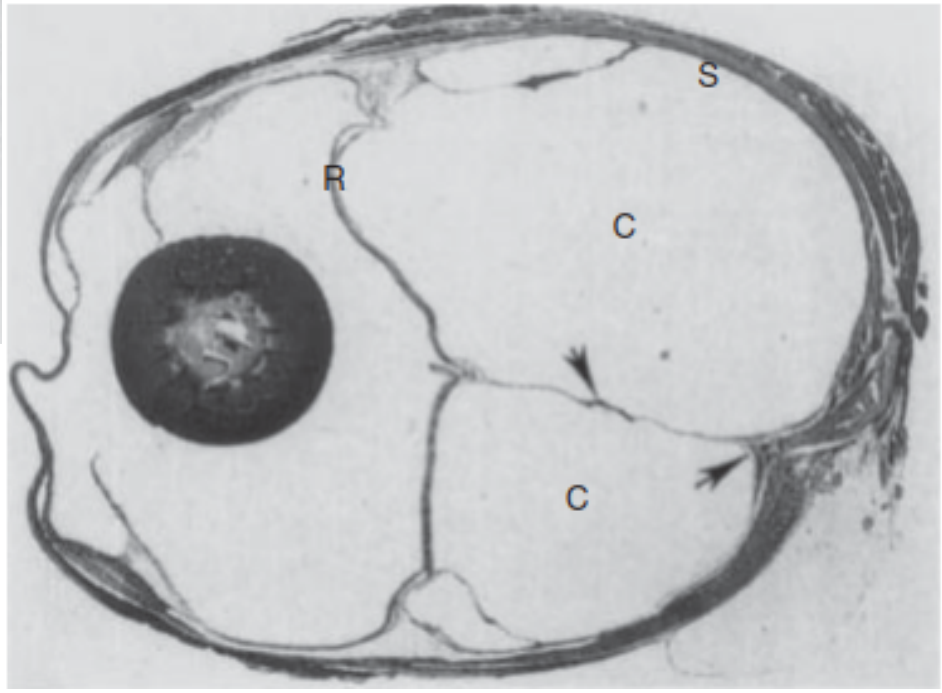
Introduction – Gas Bubble Disease

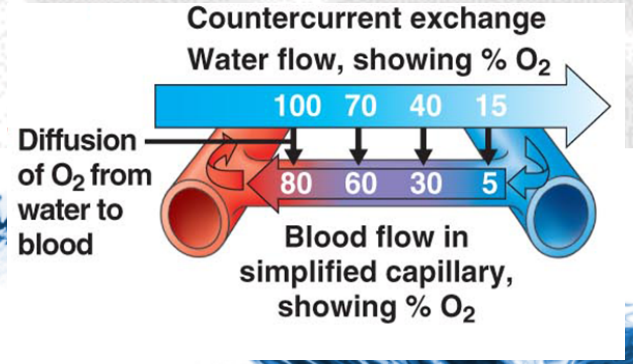




Roberts, Ronald J. *Fish pathology*. John Wiley & Sons, 2012.

Introduction – Gas Infusion Systems

- Mass Gas Transfer: Extracting N2 from Water and infusing O2 via polymer coated microporous fiber material
- Constant total gas pressure
- Soluble Stable O2



Introduction – Study Objectives

Stage I: Evaluation at Fresh Water for **"Faster Growth-Better Health"**

- Fish Health and Survival
- Growth
- Hematocrit

Stage II: Evaluation Fresh to Seawater to Ascertain the Response to **"Faster Growth-Better Health"**

- Survival Post Smolting
- Fish Health

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Methods – Hatchery Simulation and Sampling

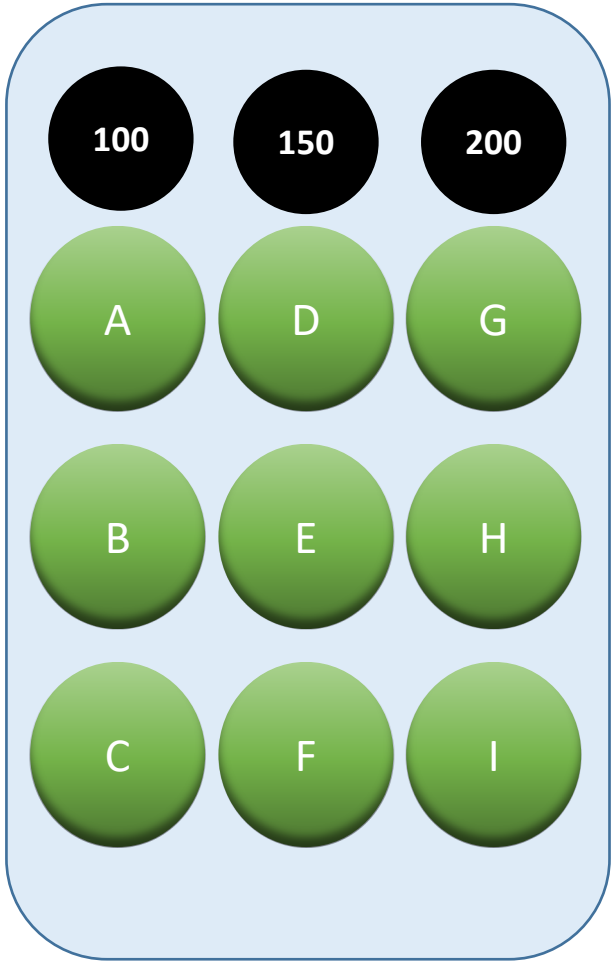
Generic early rearing production plan for Atlantic salmon in freshwater in a commercial hatchery

Start size (g)	Tank size (m^3)	# Fish	Start density (kg/m^3)	Split density (kg/m^3)	End size (g)
0.2	15	150,000	2	40	4
4	15	67,500	20	40	10
10	15	30,375	20	30	16
16	15	13,669	15	30	37
37	15	6,151	15	40	108

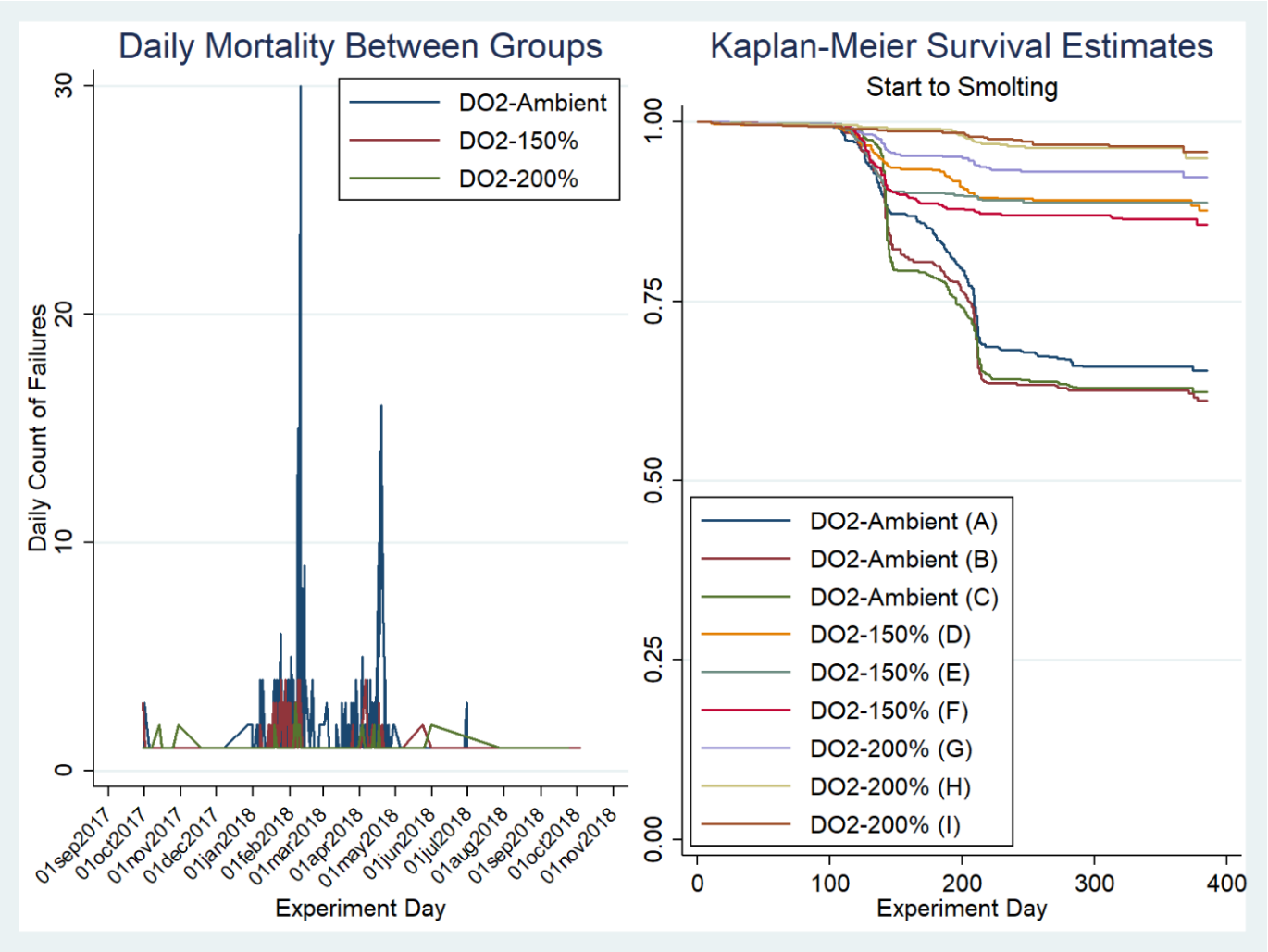
Start size (g)	Tank size (m^3)	# Fish	Start density (kg/m^3)	Split density (kg/m^3)	End size (g)
1.5	0.3	1500	8	40	9
9	0.3	675	20	30	15
15	0.75	508	10	30	49
49	0.75	228	15	40	146
146	0.75	103	20	40	324

1. Mortality and Survival
2. Monthly bulk weight
3. Weight and length of pooled sample (n=10 tank) at cutbacks
4. Hematocrits and General Necropsy at cutbacks

Methods -Experimental Design



Results: Mortality in GIS Groups are Significantly lower than in Ambient



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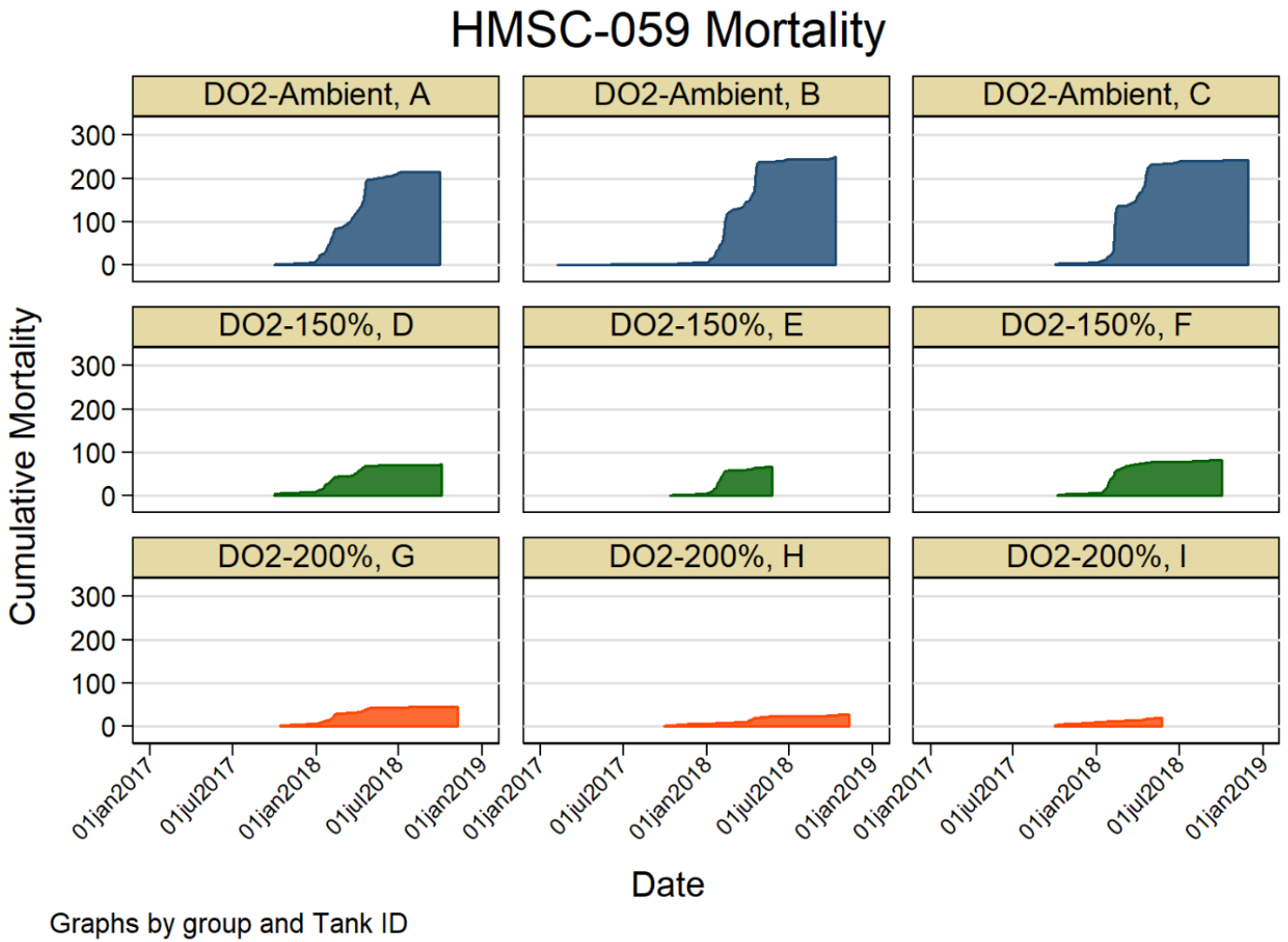
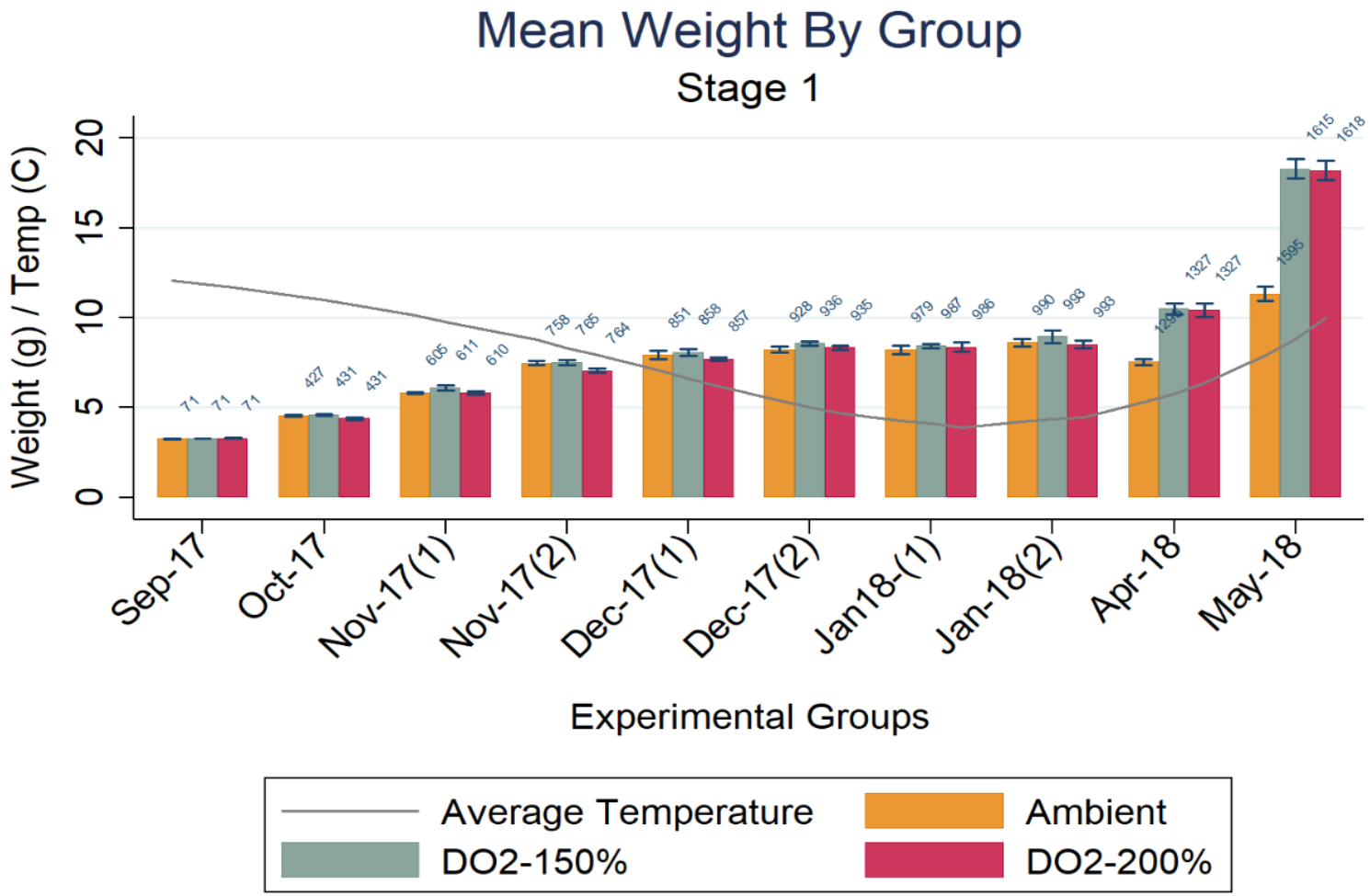
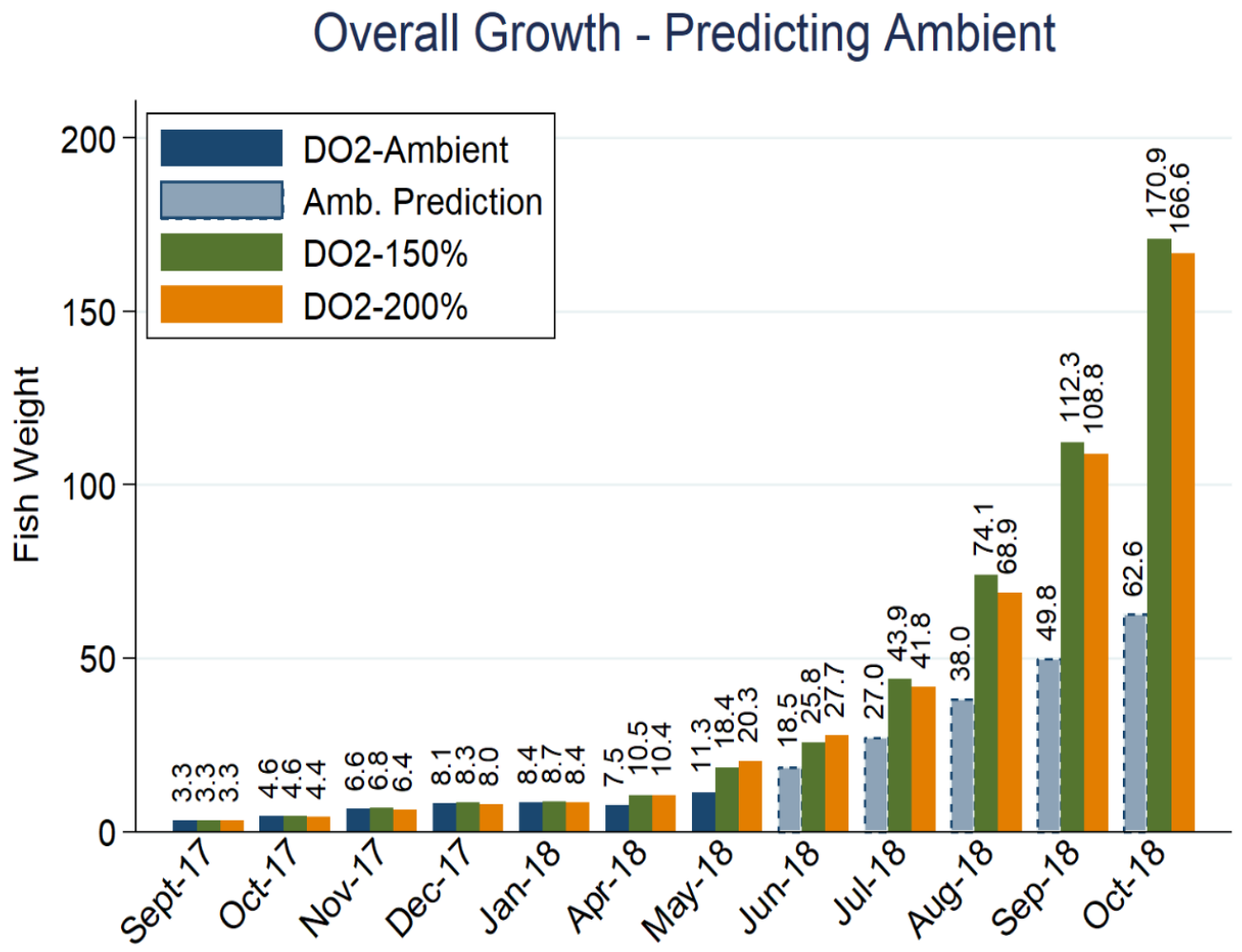


Results – Average Weight Increased in Higher Oxygen Saturation Groups

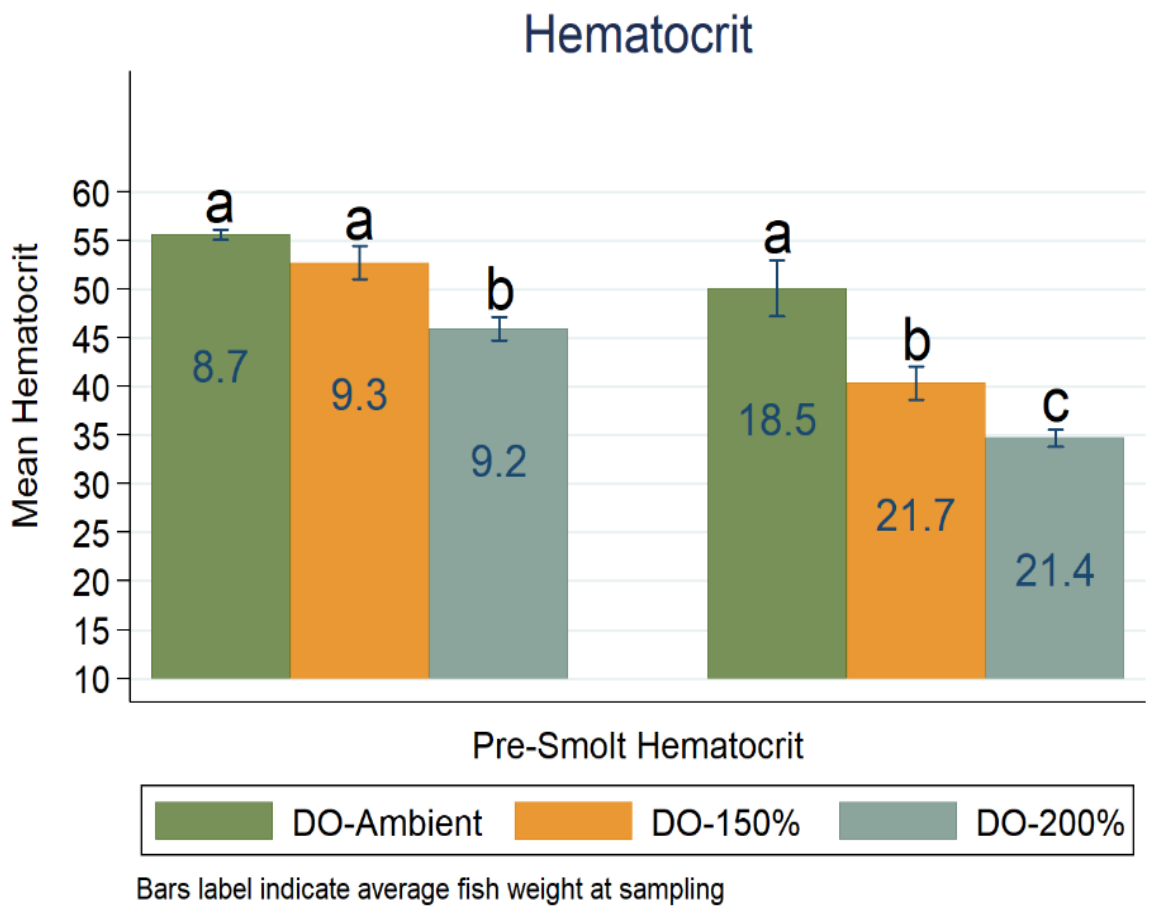


Mean values with error bars. Bars labels represent mean degree days at time of sample

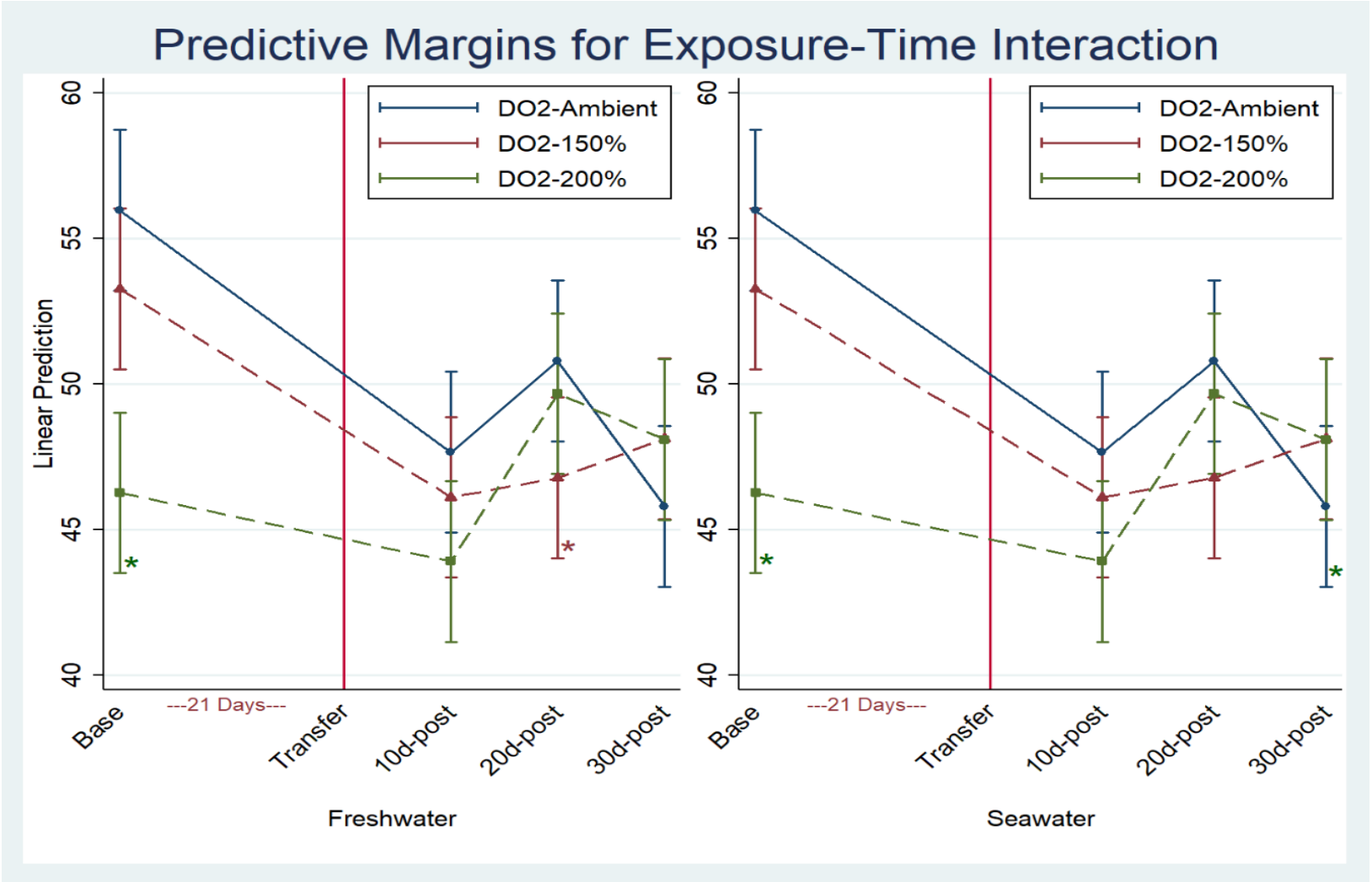
Results – Average Weight Increased in Higher Oxygen Saturation Groups



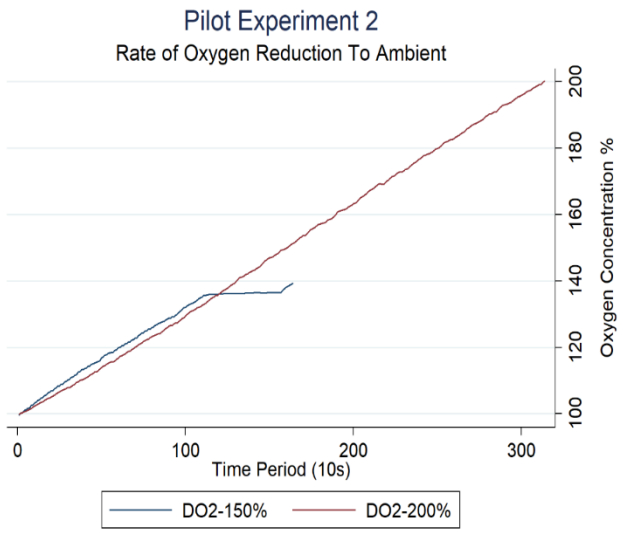
Results- Higher Oxygen Saturation Induced Lower Hematocrit

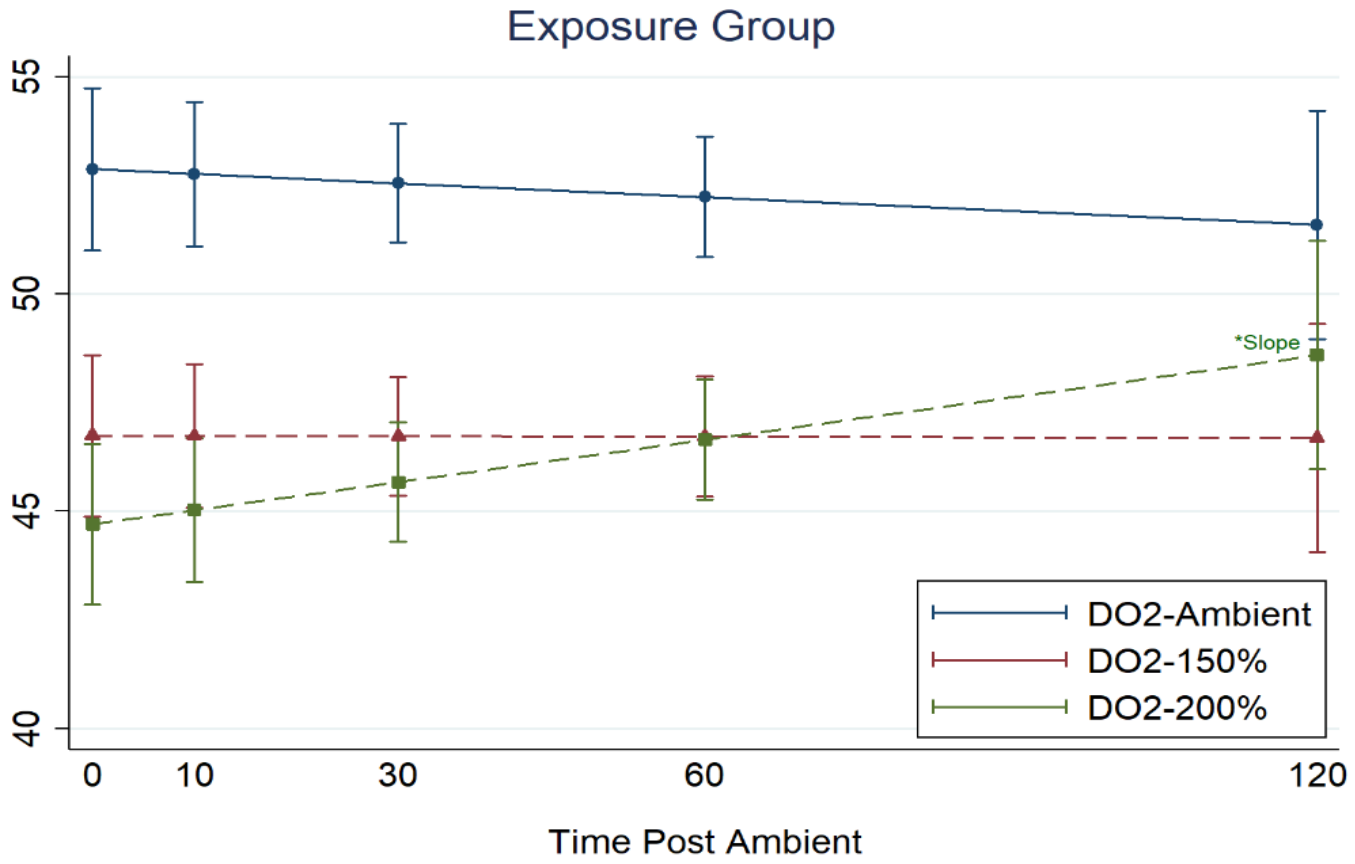


Results- Hematocrit Recovery In Fresh and Saltwater (10d, 20d & 30d)

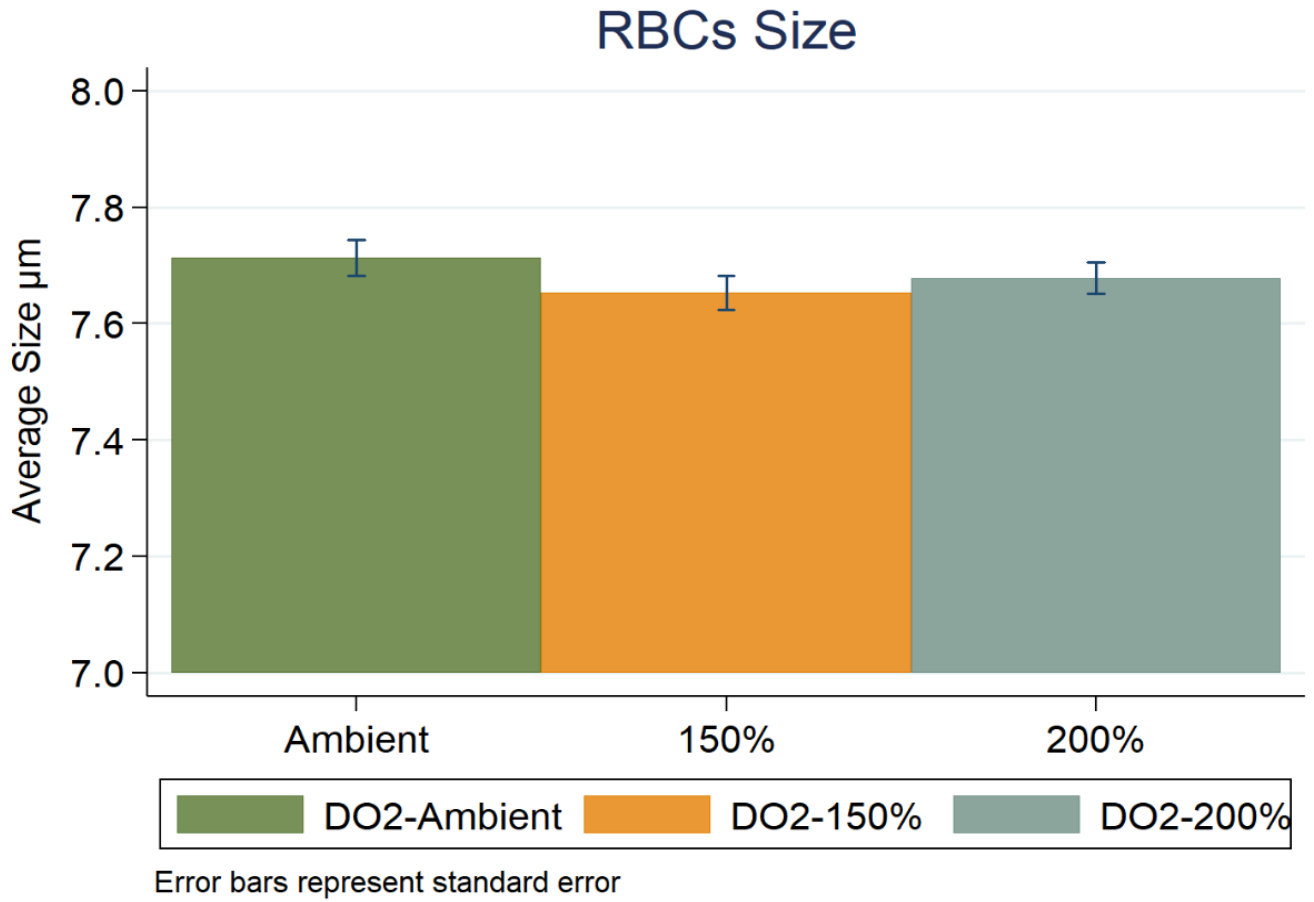


Results- Acute Hematocrit Recovery in Freshwater (10min to 120min)



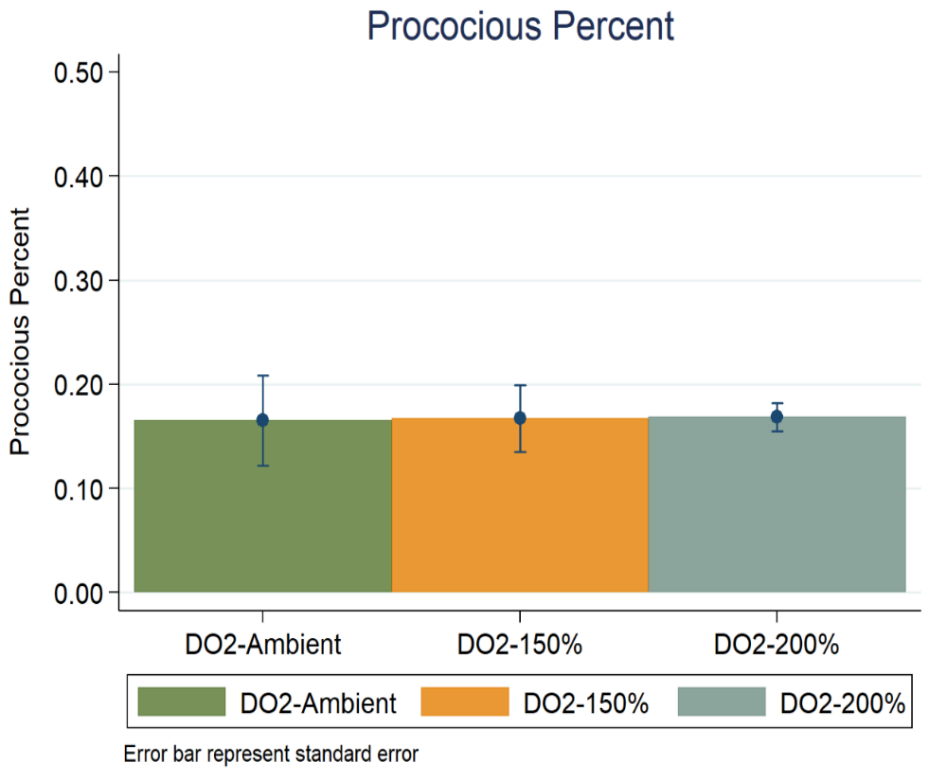


Results- No Significant Change in RBCs Size Baseline (Coulter Counter)

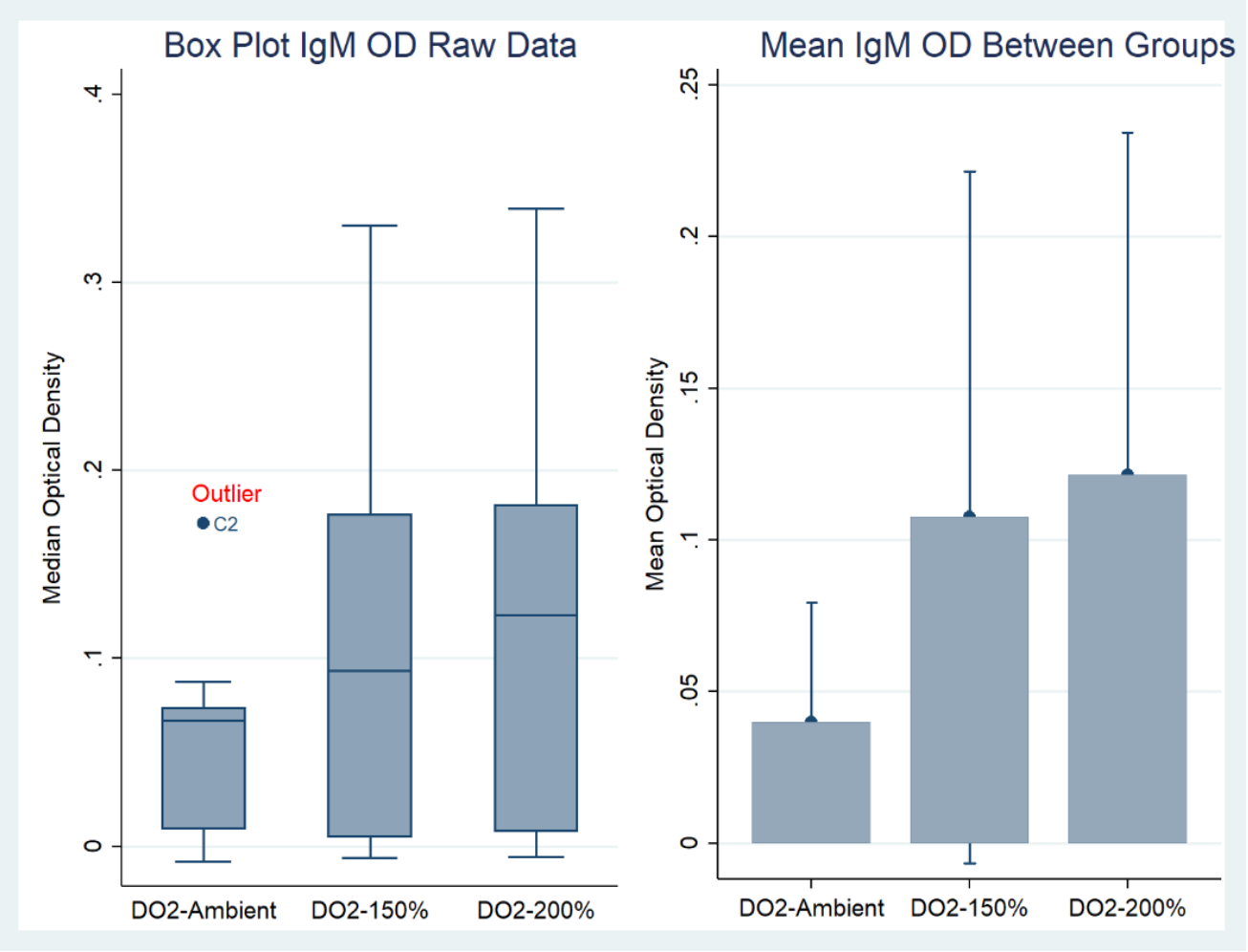


Necropsy at Cutbacks

- There was no notable difference between groups.
- There was no difference in the number of Precocious fish between groups no effect



Immunoglobulin Response to Forte V II® in High Oxygen Saturation (Pilot)



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Smolting Plans

Days to Smolt	DO2-Ambient			DO2-150%			DO2-200%		
	A	B	C	D	E	F	G	H	I
0	Smolt	Ambient	Ambient	Smolt	150%	150%	Smolt	175%	175%
1									
2								150%	
3									
4					125%			125%	150%
5									
6					Ambient			Ambient	
7									
8						125%			125%
9									
10		Smolt			Smolt			Smolt	
11									
12						Ambient			Ambient
13									
14									
15									
16			Smolt			Smolt			Smolt

Survival Post Smolting

- Mortality over 60 days following transfer to seawater was quite limited across all tanks, DO2 treatments and smolting plan.

- Mortalities included:
  - 2/100 fish from tank B (DO2-Ambient),
  - 1/100 fish from tank C (DO2-Ambient),
  - 1/100 fish from tank G (DO2-200%; direct smolting) and
  - 2/100 fish from tank H (DO2-200%; Gradual 5-day smolting).

  (a total of 3 fish/600 from the 2 high oxygenated groups)

“Faster Growth – Better Health”

- Conclusions
  - **Improved survival** within 150% and **200%** oxygen saturation **(>50%)**
  - **Significantly improved growth** within **150%** and 200% oxygen saturation **(168%)**
  - **No requirement for phased in re-acclimation**
  - Regulation of RBCs concentration in blood (**Hematocrit Plasticity**)
  - **No effect on early maturation** from increased oxygen environments

- Near Term Ongoing Studies
  - 1400 tissue & 800 blood samples being analyzed at Mount Allison University
  - Designer feed formulation to further enhance “Faster Growth-Better Health”
  - Disease challenge in freshwater and in saltwater post-smolting.

Your Fish, Our Solutions For
"Faster Growth – Better Health"

GIS Gas Infusion Systems Inc.

- Cleaner fish hatcheries/grow-out facilities
  - Faster growth and improved survivability
- Salmon hatcheries
  - Bigger smolt in a stress free environment (minimize time at sea)
- RAS grow-out facilities
  - Shorten cycle and reduce Opex costs
- Live haul transport (well boats & trucking) and treatments
  - Improve flesh quality, reduce treatment stresses, constant pH
- Pre & Post vaccination programs
  - Improve response/efficacy and increase protection duration

Acknowledgements

Huntsman Marine Science Center

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- Huntsman Staff

Sponsor

- Gas Infusion Systems

"Faster Growth-Better Health"

GIS Gas Infusion Systems Inc.

www.gasinfusionsystems

- New Brunswick Innovation Foundation

NBIF New Brunswick Innovation Foundation