

**Physiological Changes
Associated with Live Haul:
Maintaining Healthy Fish**



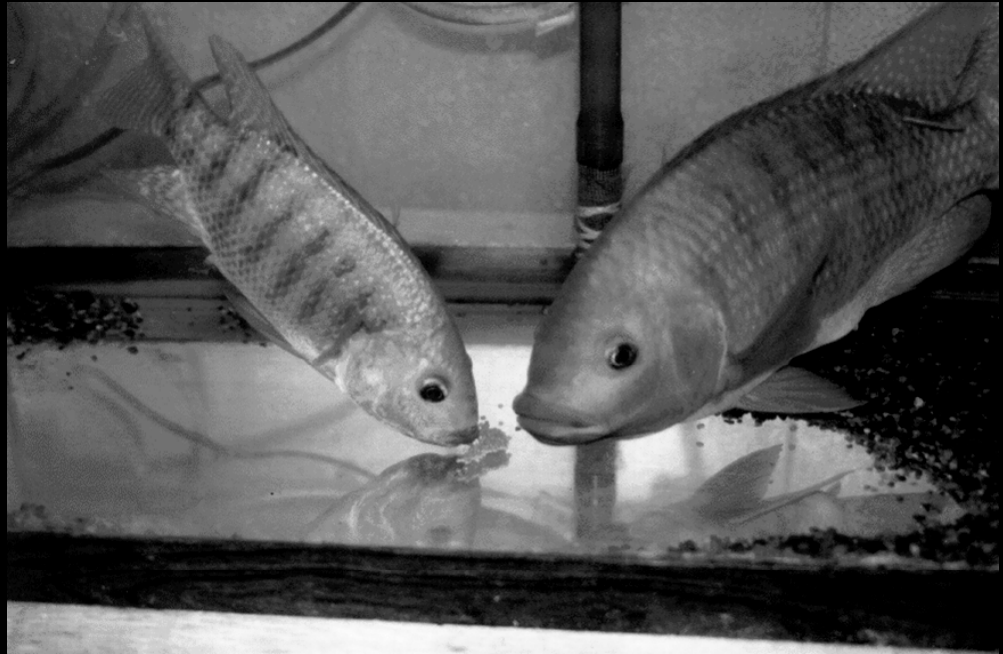


Keep Fish Alive & Healthy After Haul

Personnel

- **NOAA – Colt, Rust, Johnson**
- **OSU – Schreck, Feist & Chitwood**
 - ❑ **Momoda, Ph.D. student**
- **U. ID – Fornshell**
- **Clemson – Tomasso**
- **Cooperators – Fish Breeders of ID,
Troutlodge, The Fisheries**

Tilapia



Rainbow Trout



Introduction

- **Tilapia production in Idaho generates lots \$ annually**
- **Transport from grower to retailer requires 25-30 hr**
- **Mortality ranges from 5 to 20%**



Objectives

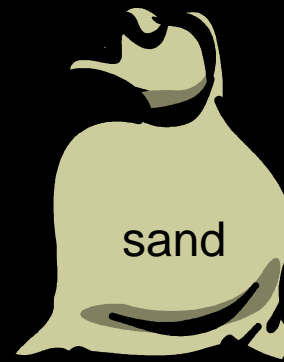
1. Utilize fluorescein to assess physical injury incurred by tilapia during transport
2. Compare different hauling media and recovery conditions on survival during and after transport of tilapia. Examine water quality
3. Determine effects of a pre-transport salt-dip on survival after transportation of tilapia
4. Assess physical injury and pathology of tilapia during loading, hauling and retail holding

Fluorescein Dye to Detect Bodily Injury

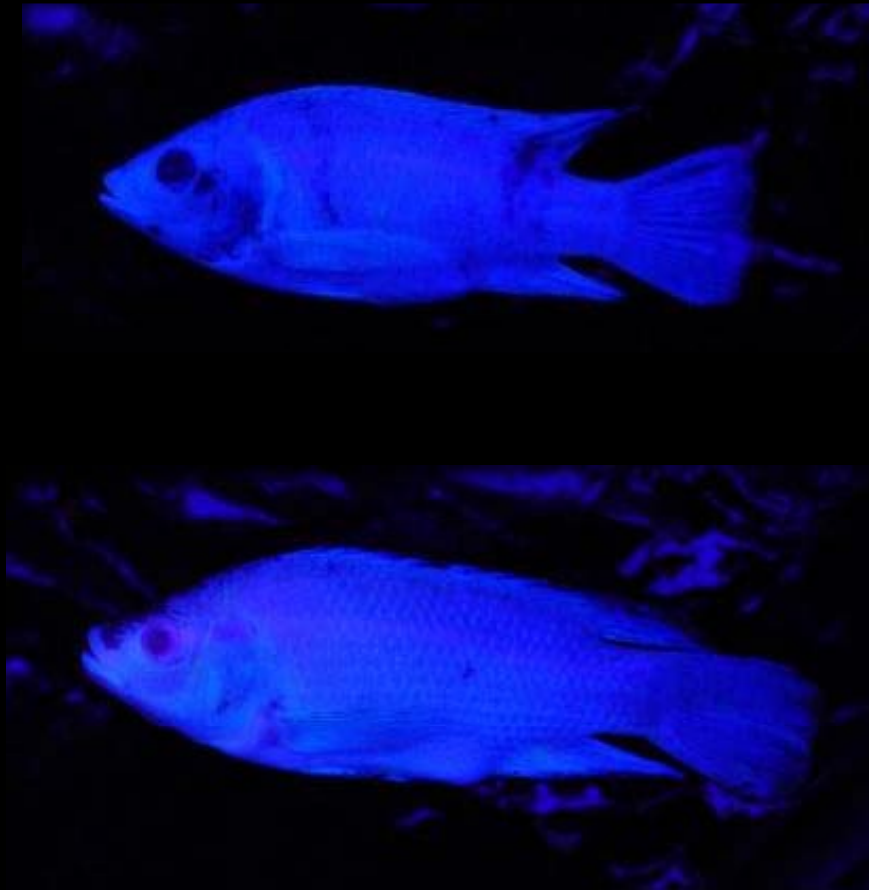


Bodily Injury of Net Stressed Tilapia

Net Stress:
2 h crowd + 30 s handling w/ 5 kg sand

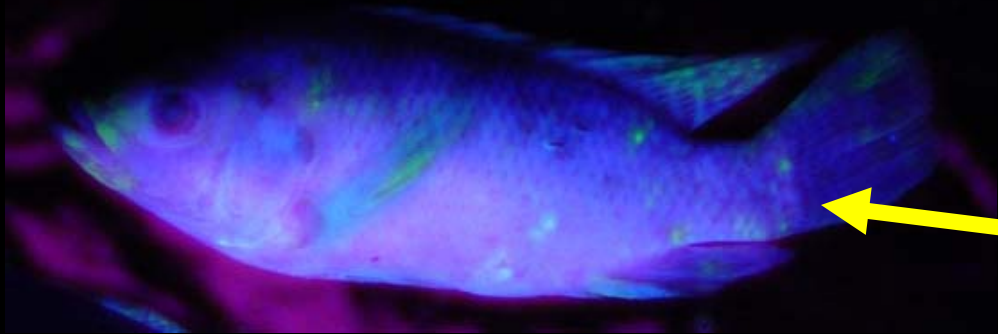


Controls: Non-Net Stressed Tilapia



Fish sampled from different tank than those subjected to net stress.

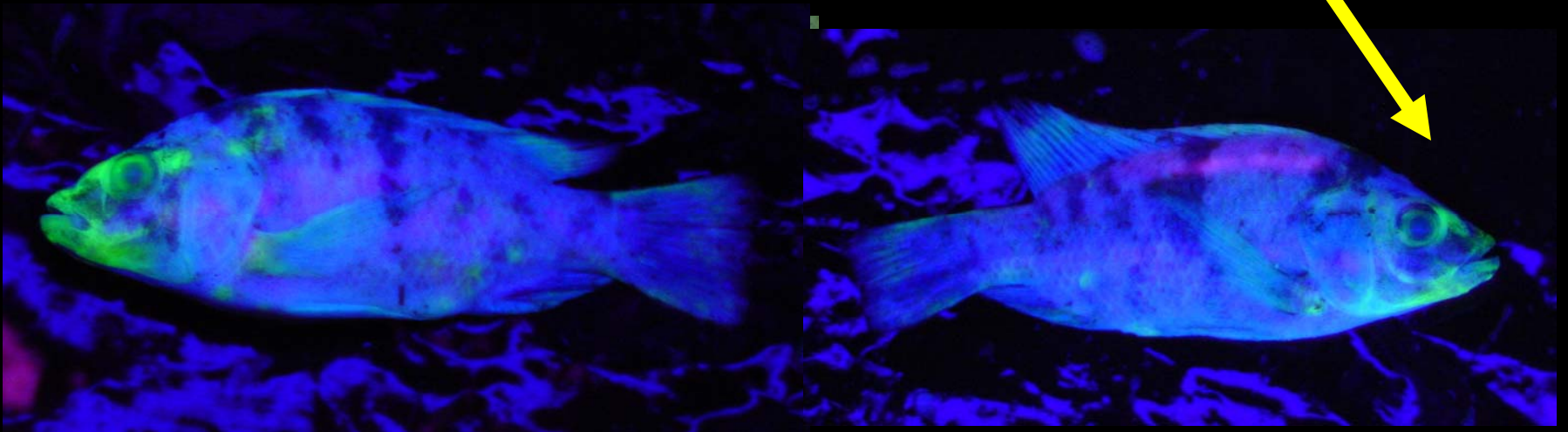
Net Stressed: Fish 1



Puncture wounds

Net abrasion

Net Stressed: Fish 2

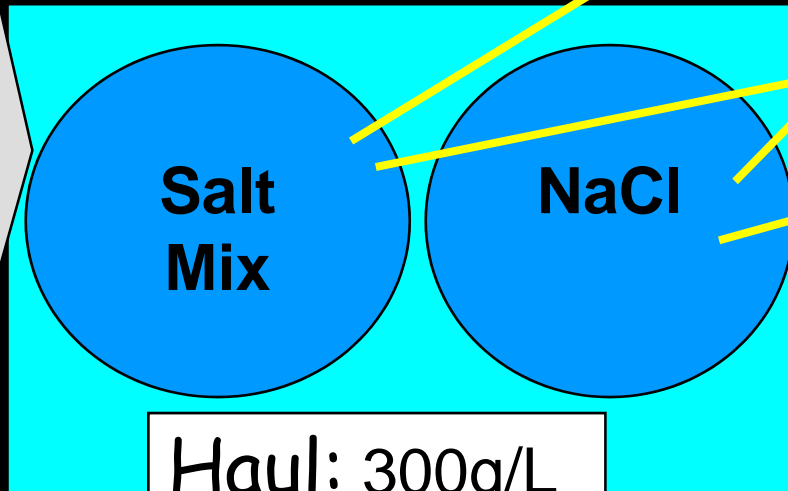
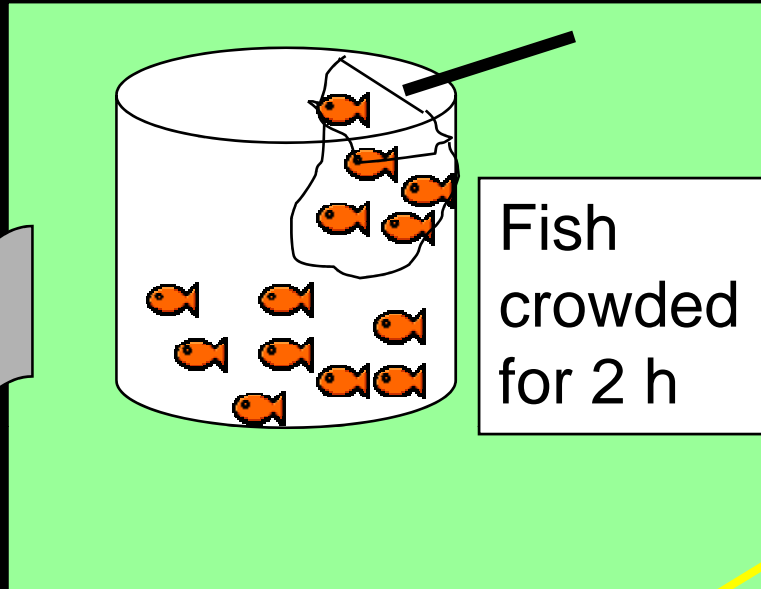


Simulated Lab Experiments

Objective: To assess both different hauling and recovery conditions on survival.

- Water chemistry (temperature, DO, pH and CO₂)
- Bodily injury

Experimental Design



Unconditioned
 H_2O

Conditioned
 H_2O

RECOVERY

Rearing

Arrival

Pond Crowding

Distribution

Timeline

Loading

Unloading

Transport

Holding

0 h

24 h

70-92 h

acclimation
Control

2 hr Crowd
2 h Crowd

1 min net

300 g/L, salt, Hi DO, 24 h
(2.5 lb/gal)

Haul: NaCl
(3g/L)

Haul: 'Salt Mix'

dewater

hold

Recovery: Cond. H₂O
Recovery: Uncond. H₂O

Ion	Concentration (mg/L)
Sodium	3,473
Chloride	4,893
Potassium	189
Calcium	133
Magnesium	56
BiCarbonate	200

Mortalities

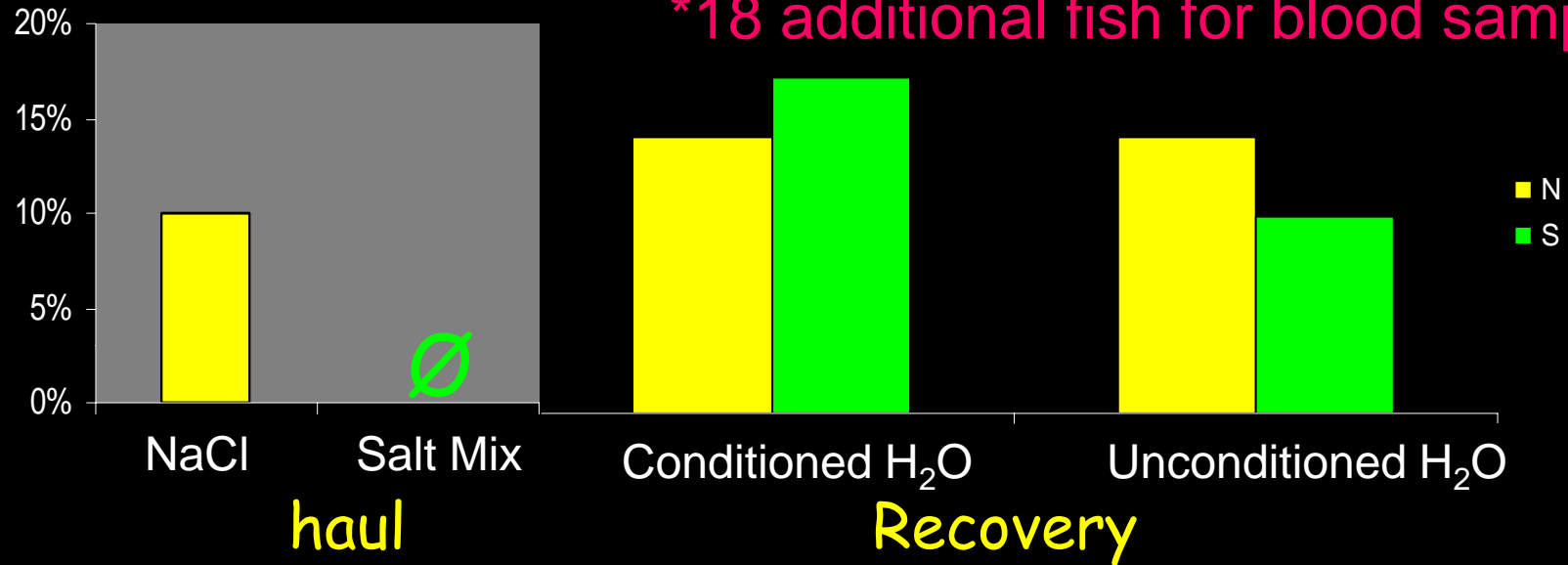
Total:

Jan 07= 6/38 (16%)

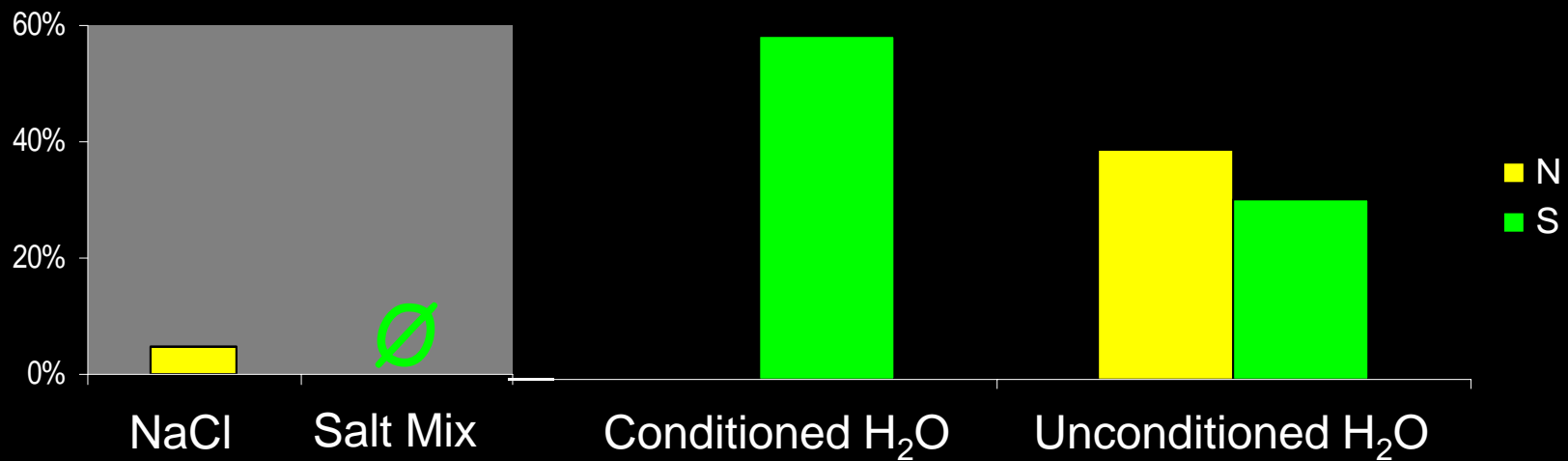
Apr 07= 11/48 (23%)

*18 additional fish for blood sampling

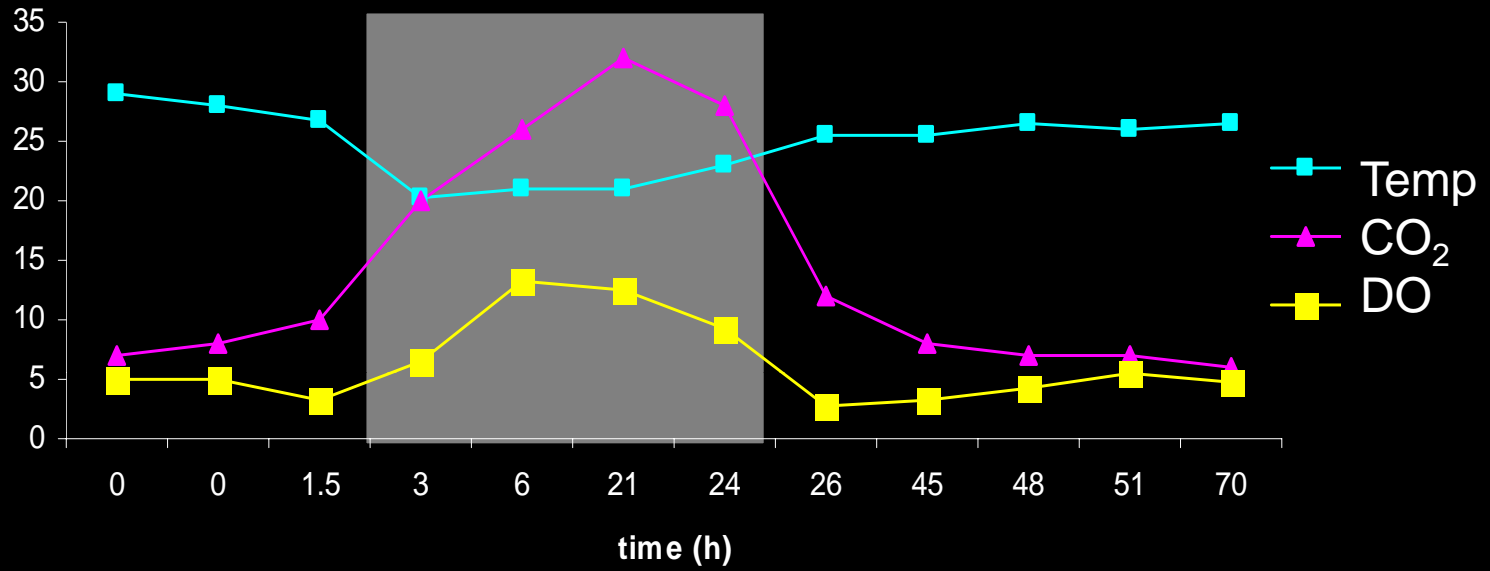
January '07



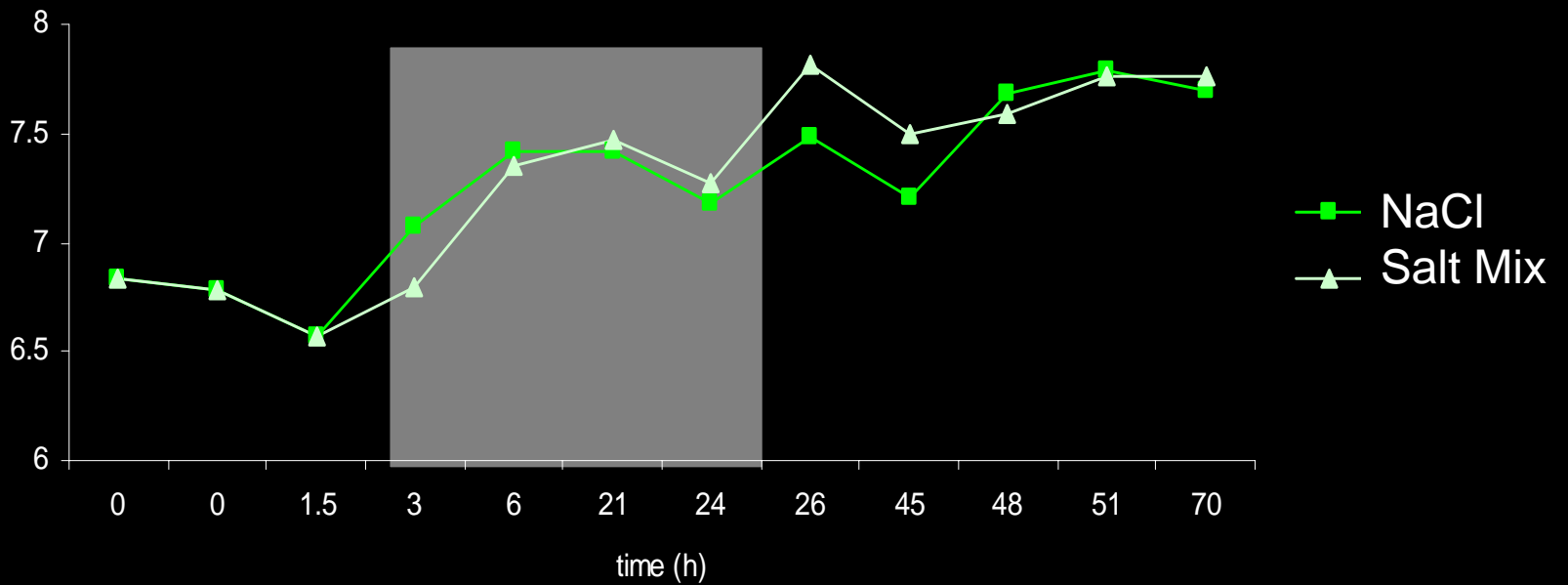
April '07



Results: Water Quality



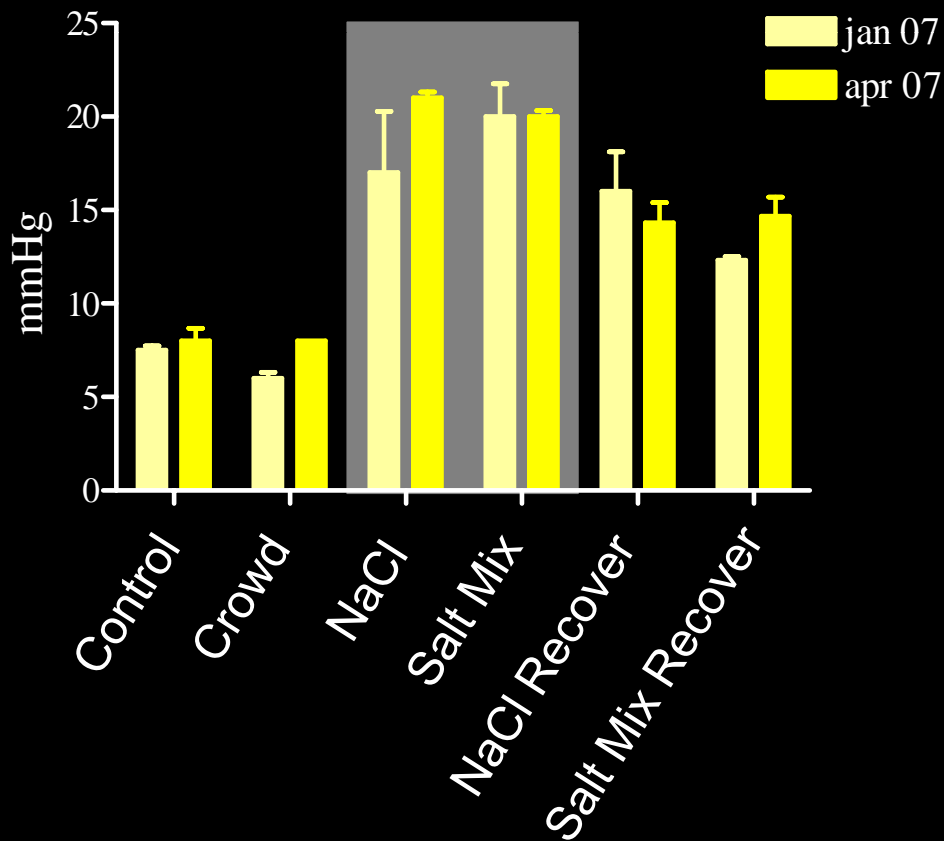
pH



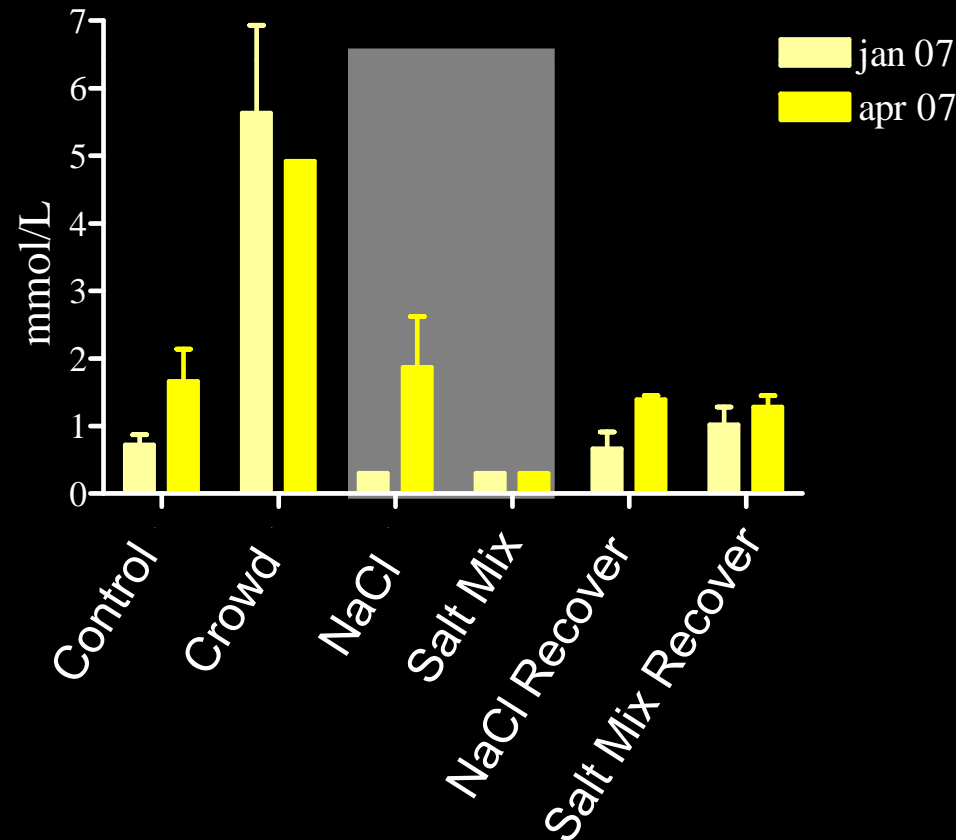
Results: Blood Chemistry

Also measured: $p\text{CO}_2$, $p\text{O}_2$, $s\text{O}_2$, HCO_3 , pH

TCO_2

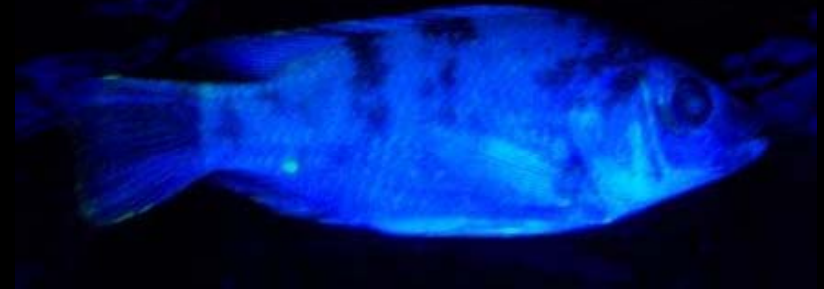
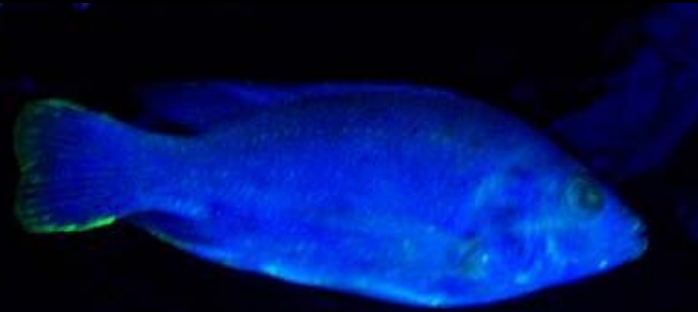
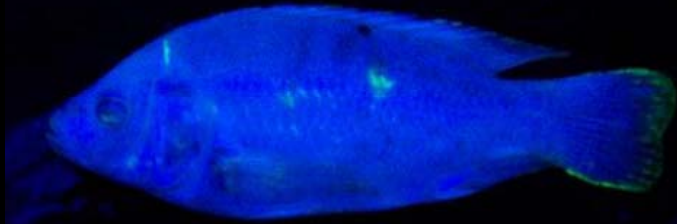


Lactate



Results

Bodily Injury: Small control fish



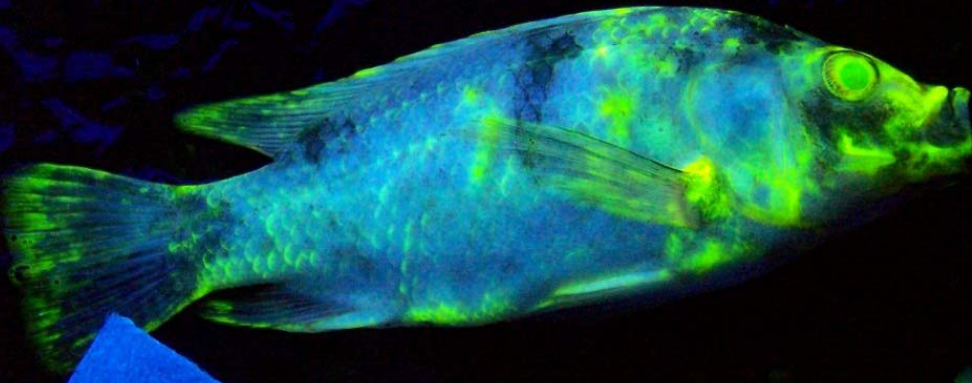
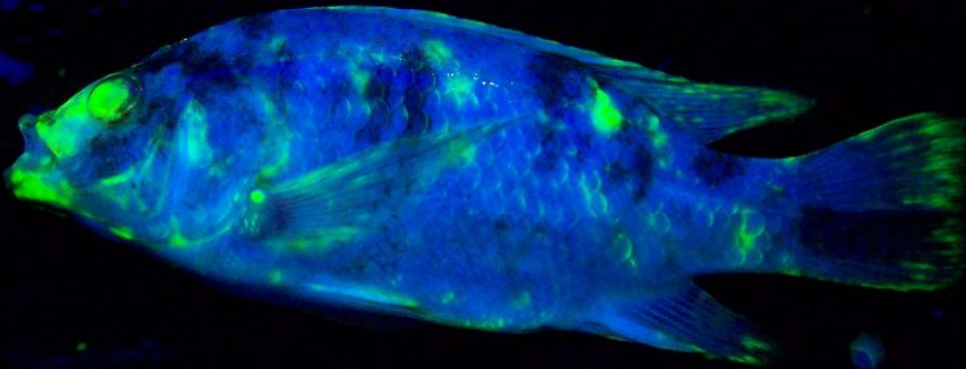
Results

Bodily Injury: 2 h Net Stress



Results

Bodily Injury: 2 h Net Stress

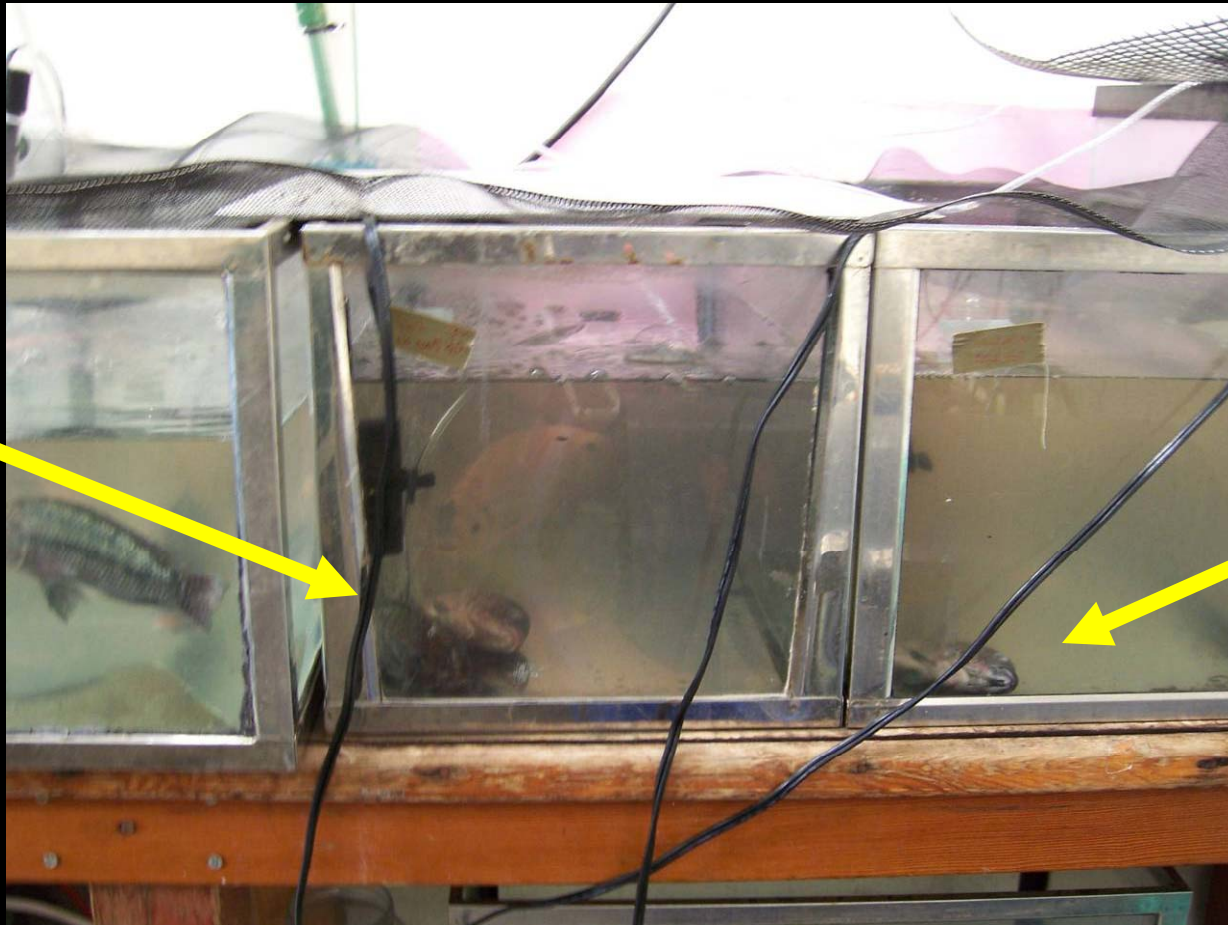


Average

Results

Bodily Injury: Mortalities after 24 h transport and 24 h recovery

1 & 2

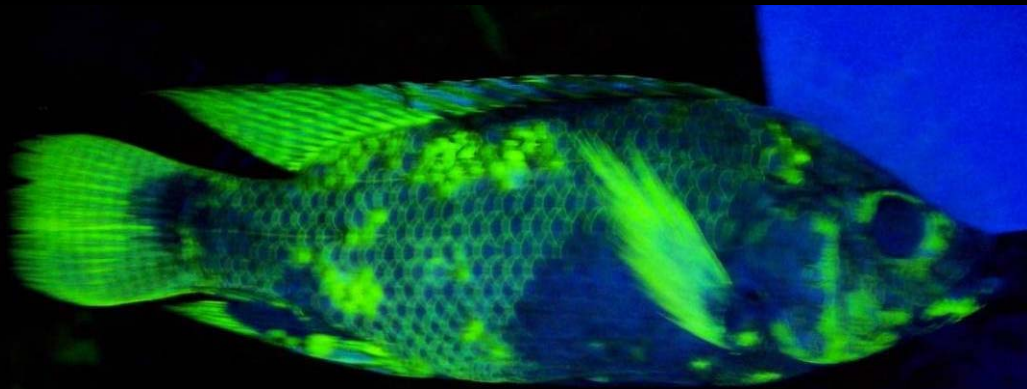


3

Results

Bodily Injury: Mortalities after 24 h transport and
24 h recovery

Fish 3



Lab Experiments: Summary

- Mortality: only in NaCl haul
- No differences between recovery treatments
- Blood gases variable
- Rapid decrease in lactate levels
- Bodily injury evident after crowding and worsens with transport
- Bodily injury not different between treatments

Haul to OSU

Objective: Understand effects of a pre-transport salt dip on survival

- Salt Dip: 1 minute in 3% Sea Salt (Instant Ocean)
- Hauling medium



Truck that hauled fish



Tanks in back of truck



Lucky intern!!



Happy new home for tilapia!!

Improved Hauling Mixture Input Data - Purity

Chemical Purity Assumptions

	Purity		
NaCl	98%	<-----	Input
KCl	95%	<-----	Input
CaCl ₂	90%	<-----	Input
MgCl ₂	90%	<-----	Input
NaHCO ₃	95%	<-----	Input

Improved Hauling Mixture

Input Data - Tank Information

Tank and Fish Inputs

Tank Volume (gallons)

160

gallons

Weight of Fish Added (lb)

300

lb

Volume of Water

124

gallons

469

liters

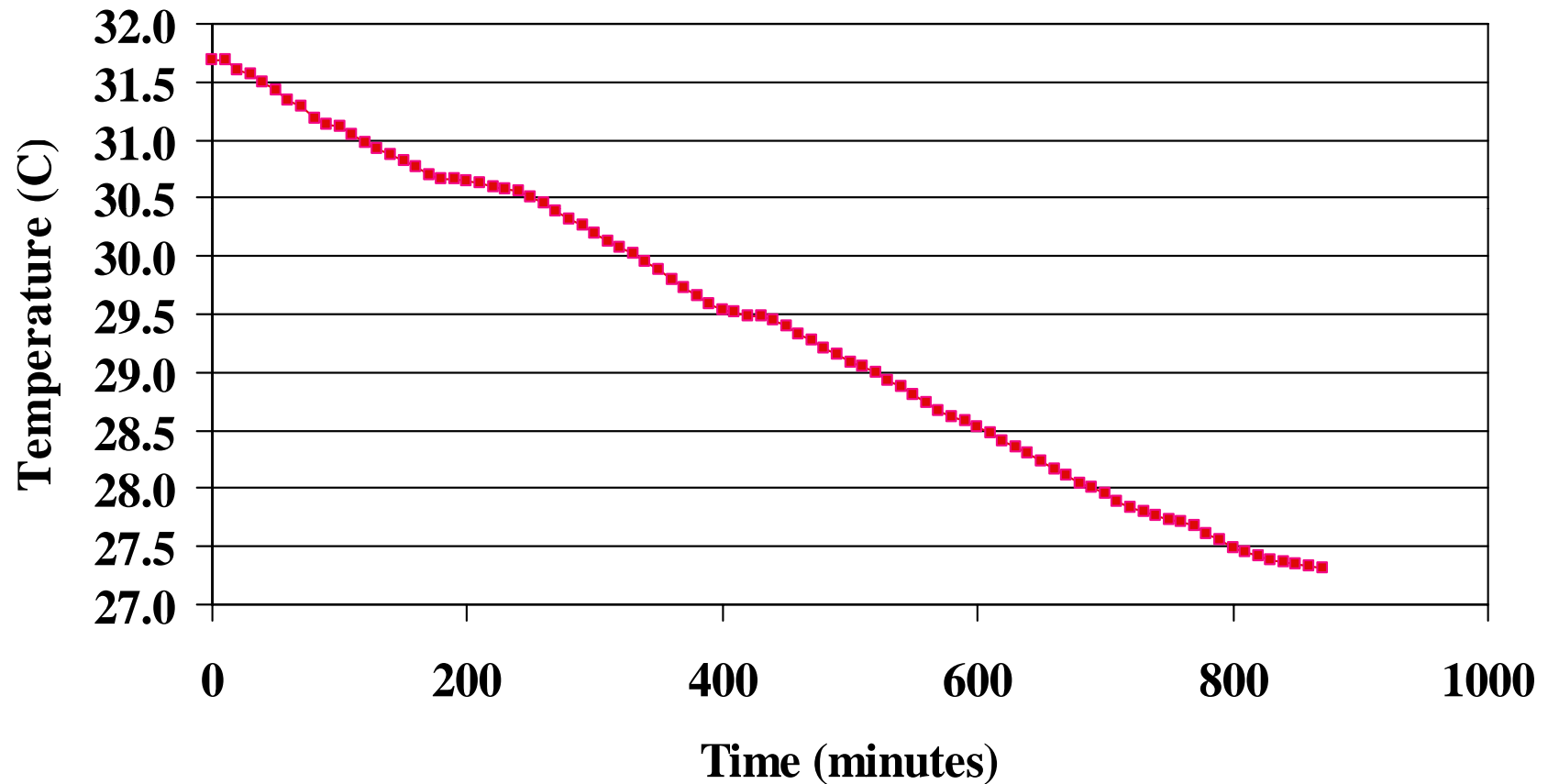
Improved Hauling Mixture Salt Addition

Compute concentration of ions added from each compound

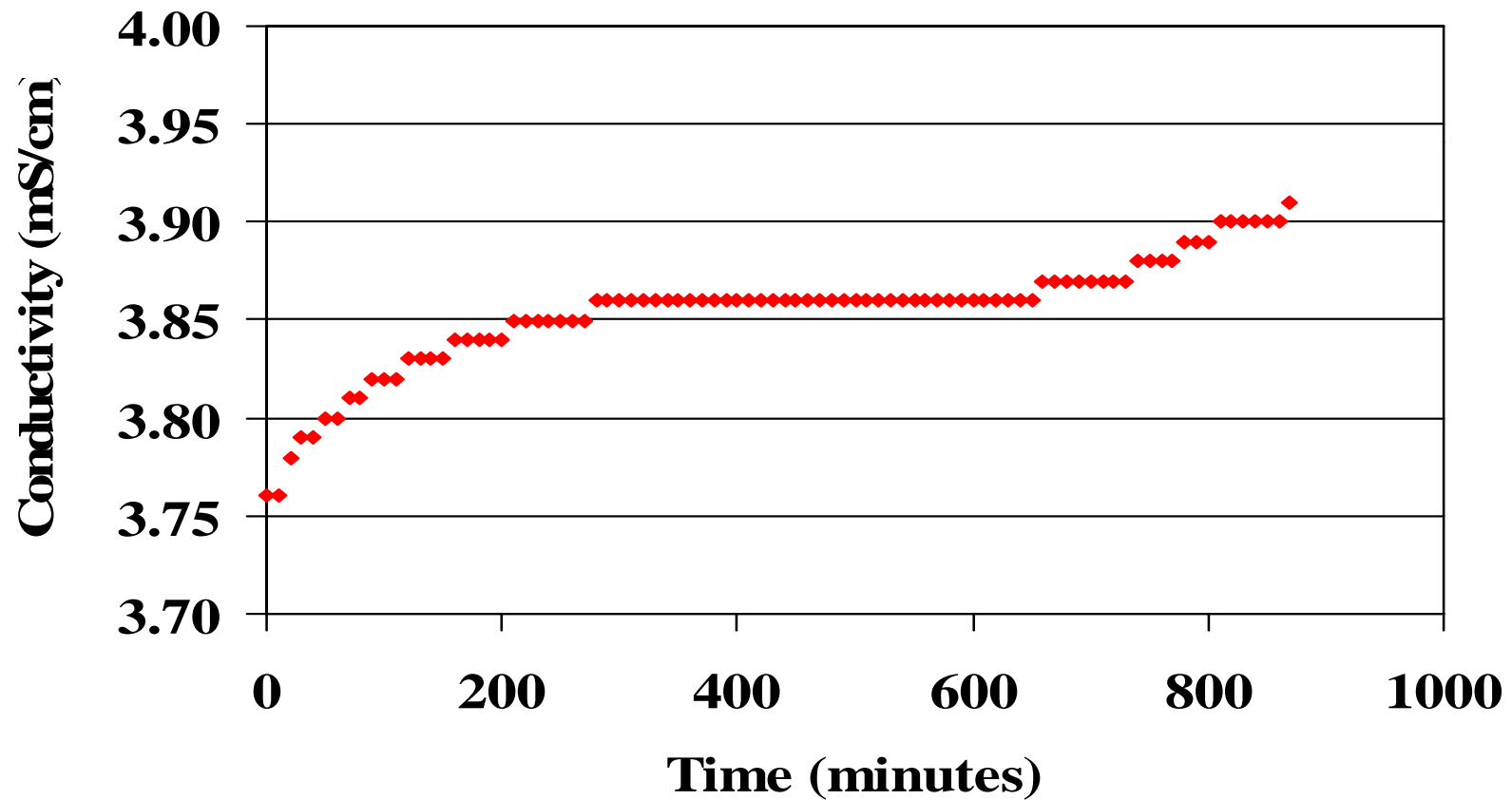
		Na	K	Ca	Mg	Cl	HCO ₃
NaCl		3,289				5,072	
KCl			213			193	
CaCl ₂				156		276	
MgCl ₂					61	179	
NaHCO ₃		55					171
Total	mg/kg	3,345	213	156	61	5,719	171

Criteria	mg/kg	3,473	189	145	62	4,893	200
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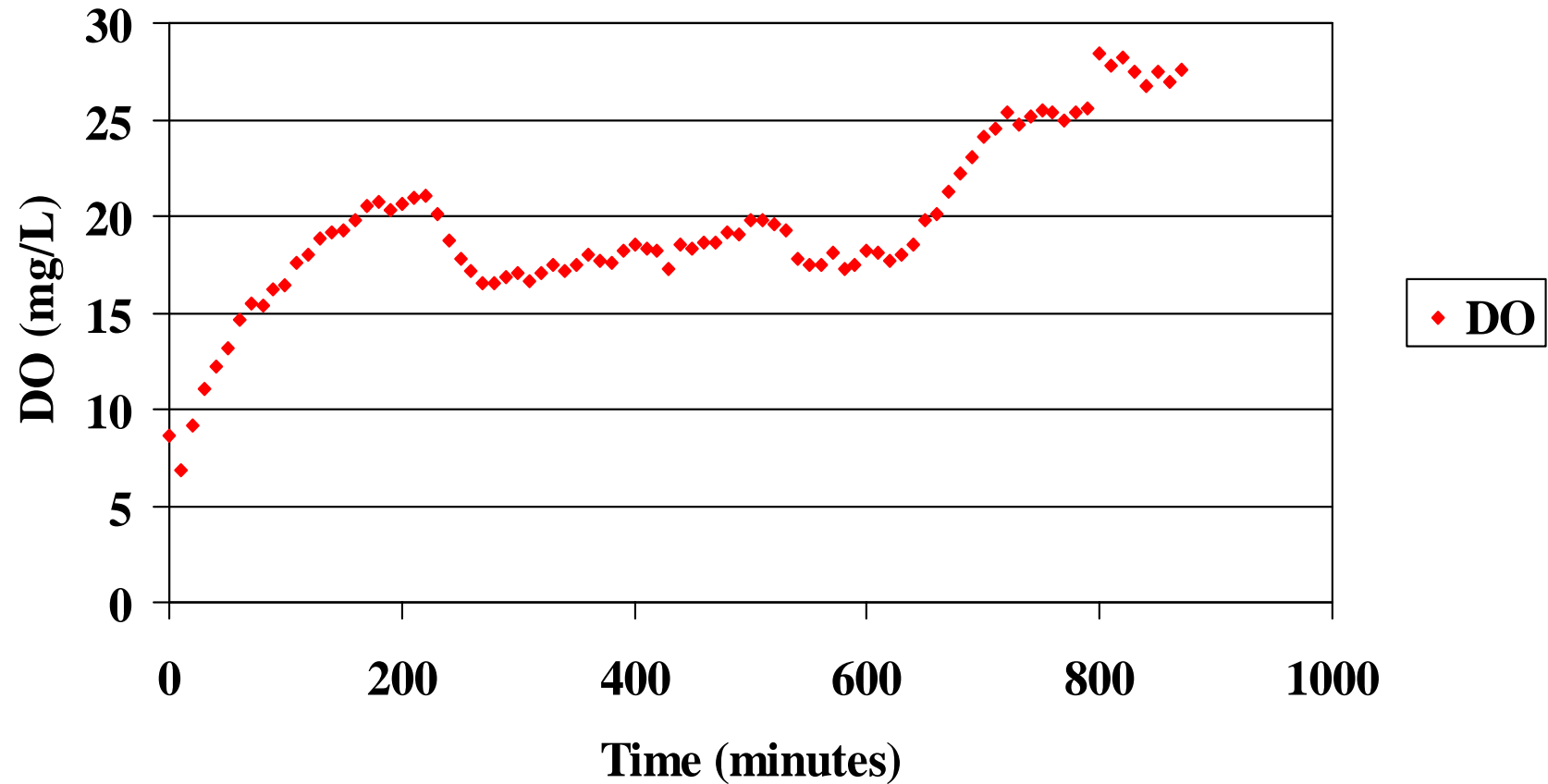
Williams to OSU Haul Change in Temperature



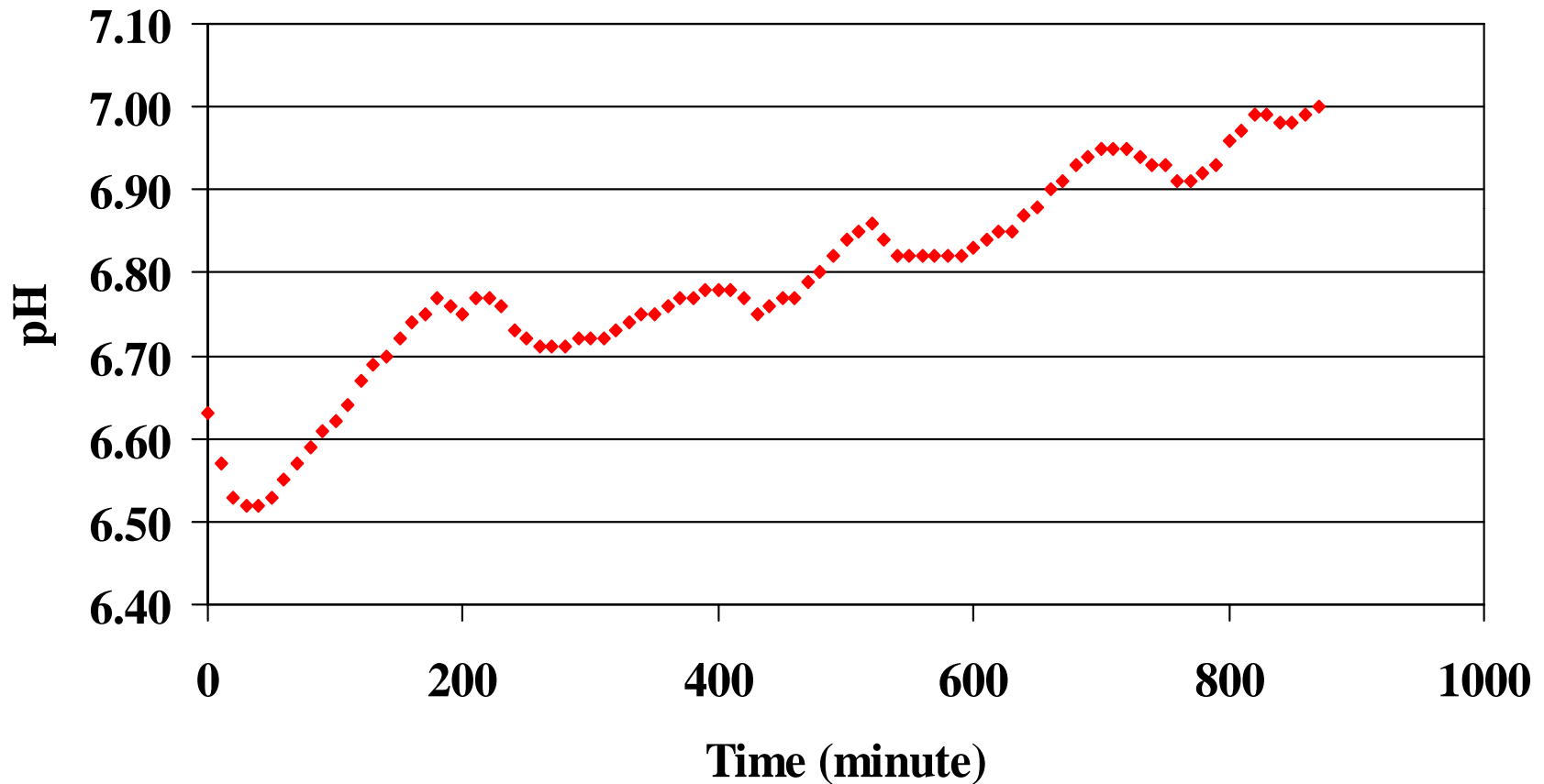
Williams to OSU Haul Change in Conductivity



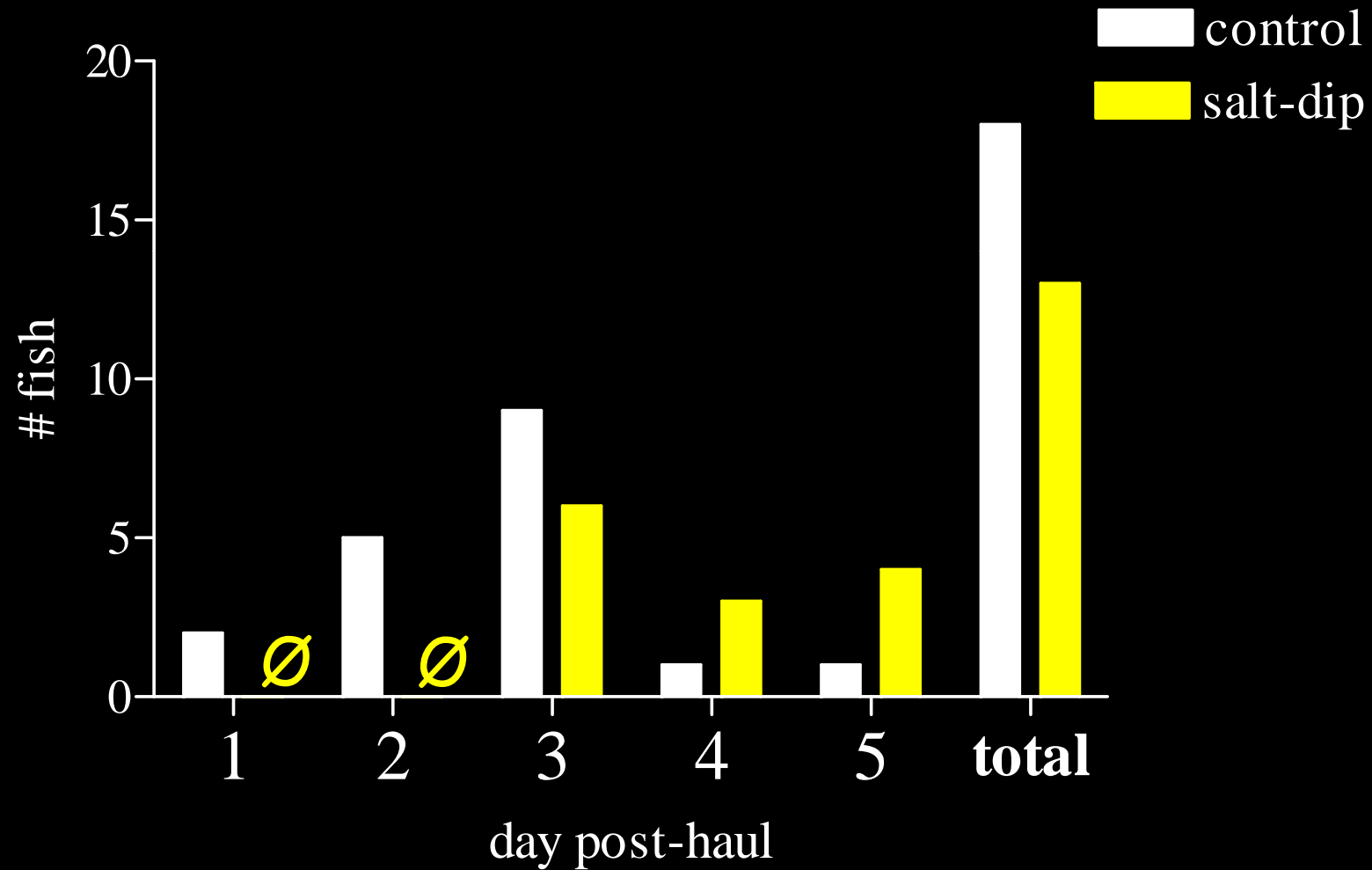
Williams to OSU Haul Change in DO



Williams to OSU Haul Change in pH

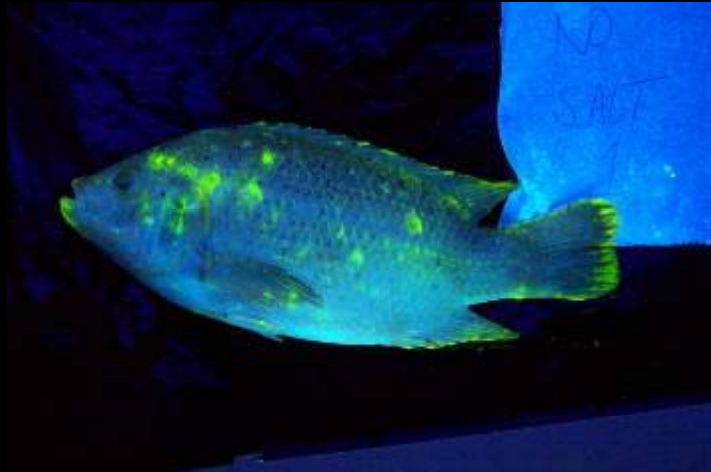


Post-haul Mortality/Day



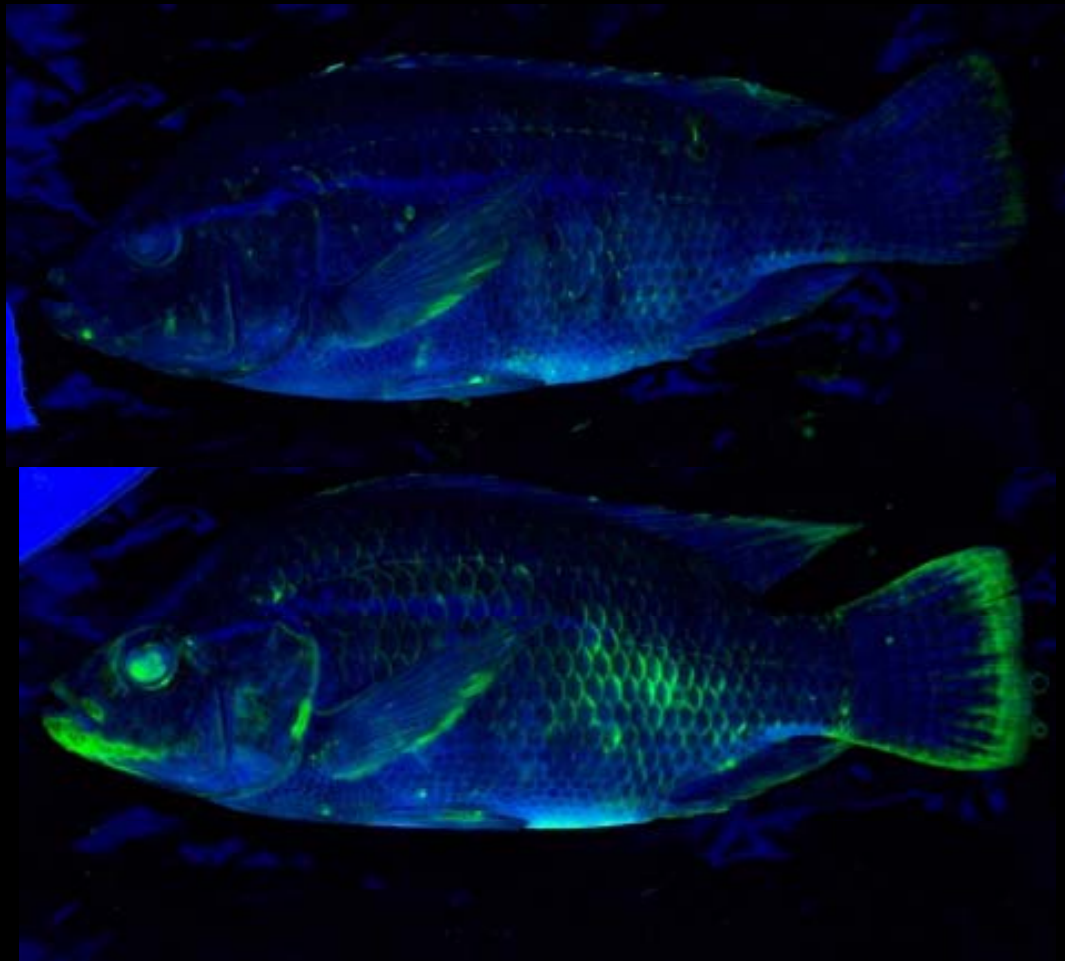
Results

Bodily Injury: Control



Results

Bodily Injury: Salt-dip



(June 1, 2007)

Results

Pathology: Fish sampled after transport, at arrival

- No external signs of disease
- No parasites found
(except 1 *Trichodina* found in gill)
- Gram (–) bacteria in kidney of all 5 fish
- Mix of APS (aeromonad/pseudomonad) colonies

Results:

Pathology: Fish sampled 5 d after transport



(June 6, 2007)

Results

Pathology: Fish sampled 5 d after transport

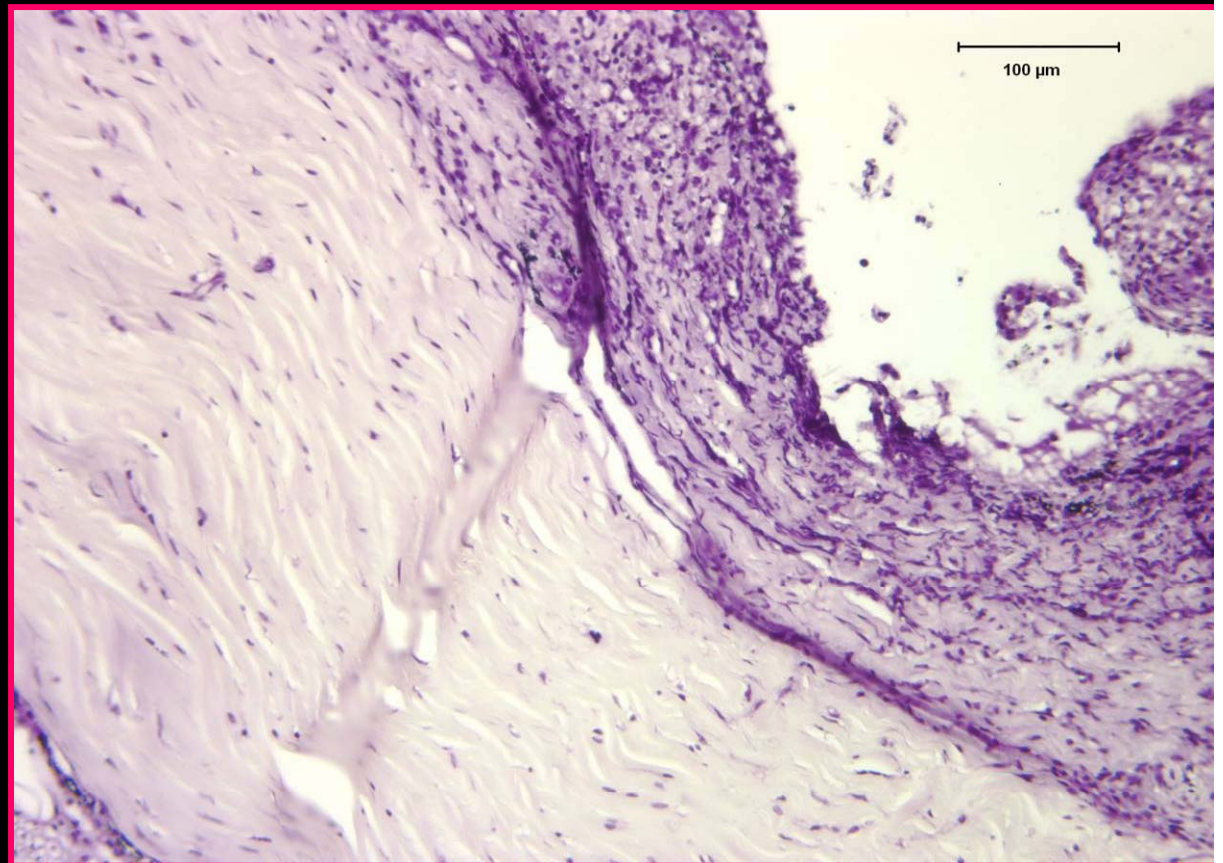
- Lesions, frayed caudal &/or hemorrhaging under scales
- Parasites & bacteria in gills, skin, & lesions
- Mostly gram (-) rods in kidney
- 2 of 6 fish had no bacteria observed in kidney
- Bacterial culture revealed great mix of bacteria, noted mostly APS
- Most bacteria opportunists

Results

Pathology: Histology of skin section from moribound fish 5 d after transport



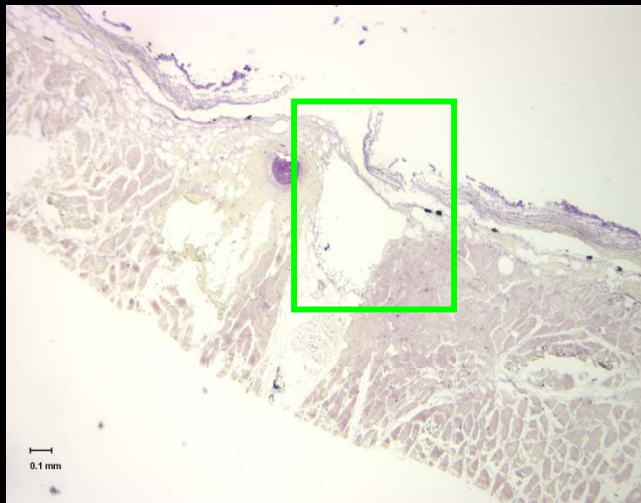
Gram-5x



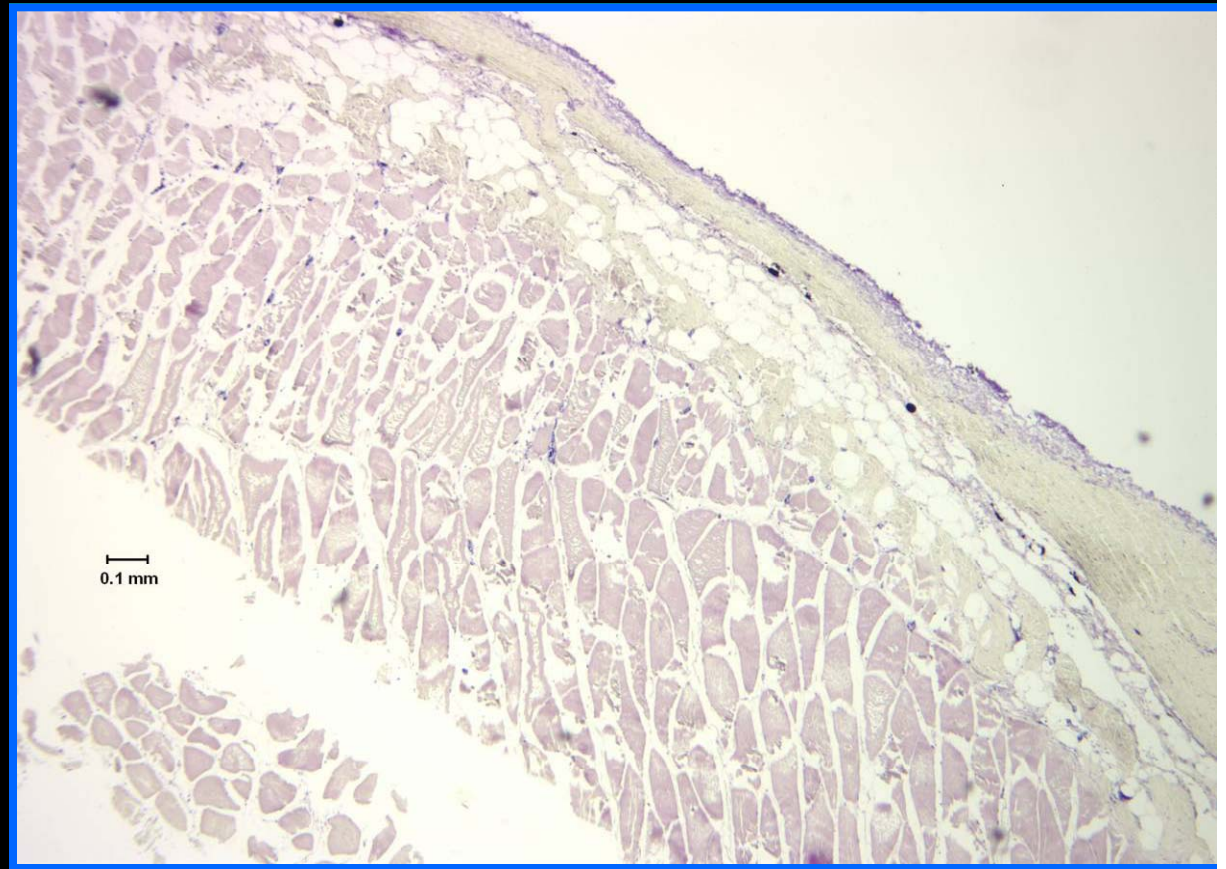
20x

Results

Pathology: Histology of skin section from moribound fish 5 d after transport

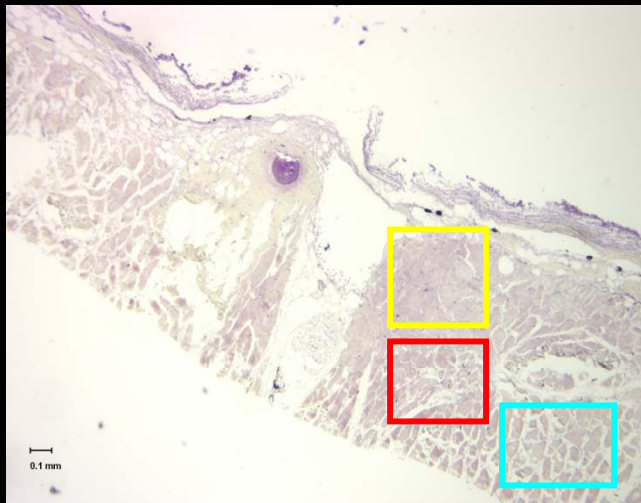


Gram-5x

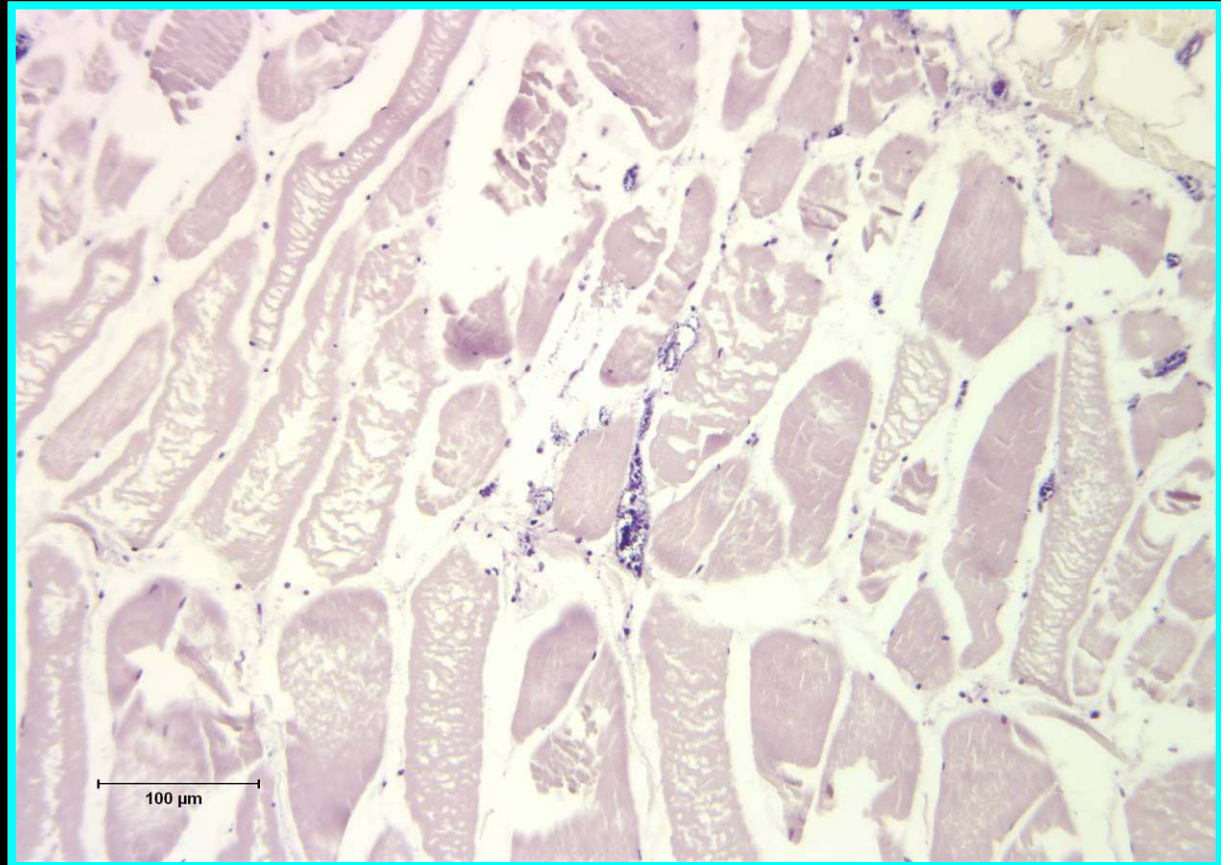


Results

Pathology: Histology of skin section from moribound fish 5 d after transport



Gram-5x



Haul to OSU Summary

- Reduced mortality in salt-dip treatment
- Accelerated rate of mortality in non-treated fish
- No difference in bodily injury between treatments

Fish Inoculate Each Other?



Field Sampling From Idaho to Richmond, BC

Objective: Assess physical injury and pathology of tilapia during loading, hauling and retail holding

Methods

Pathology:

- Bacteria cultures taken from skin, lesion and kidney
- Tissue samples of skin, kidney and spleen taken for histology
- Fish sampled at 2 different retailers in BC

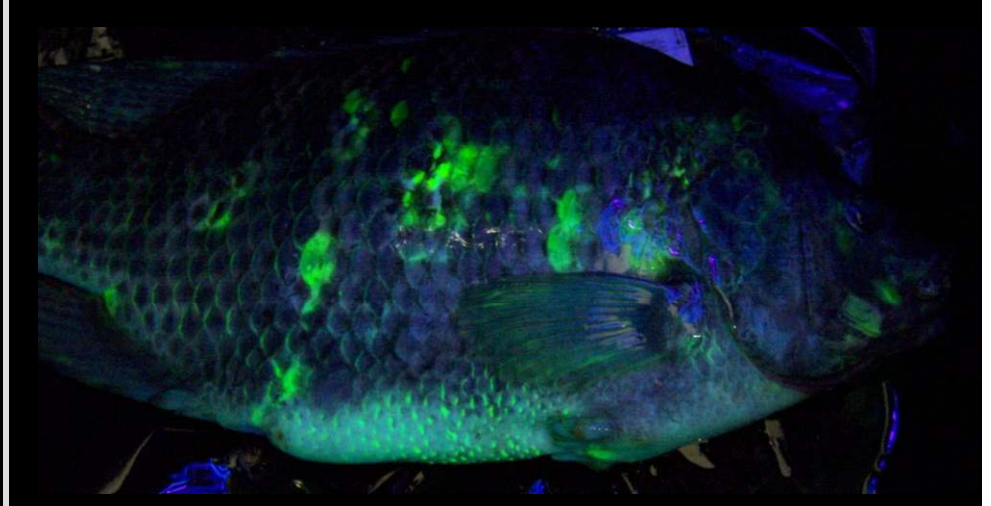
"Lab On The Go"

Sampling in Idaho



Results:

Bodily Injury: "Pre-crowd fish"

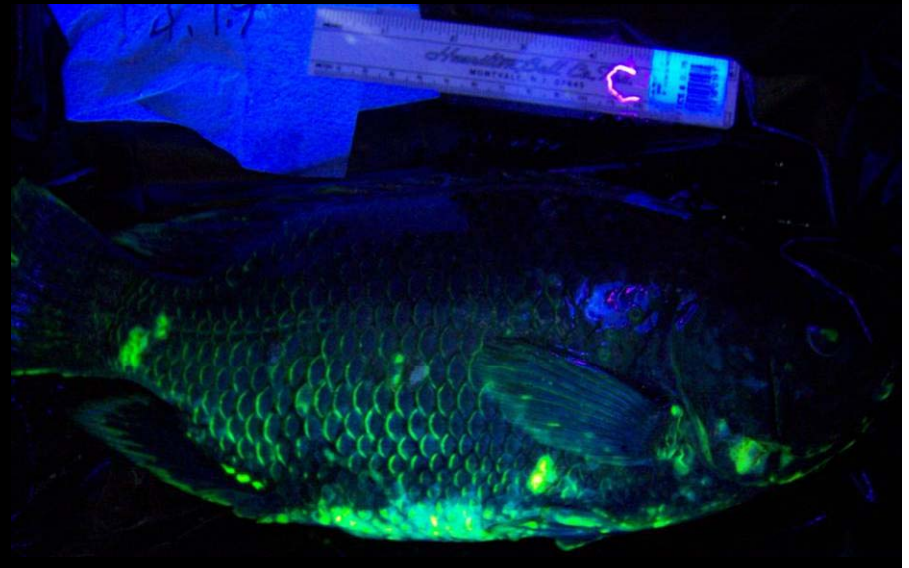
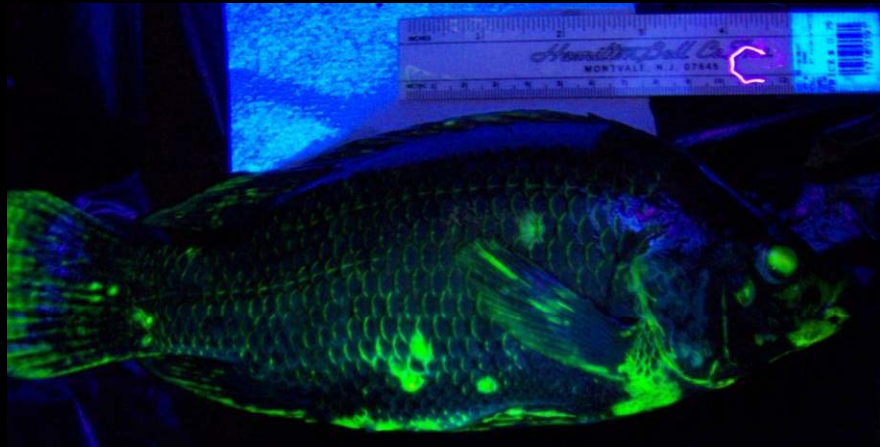


After Crowding



Results:

Bodily Injury: After Crowding

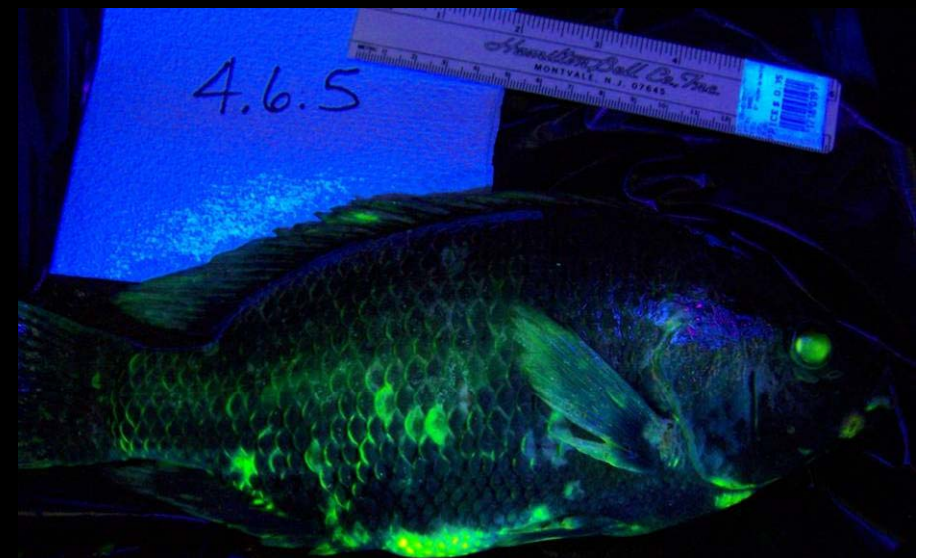
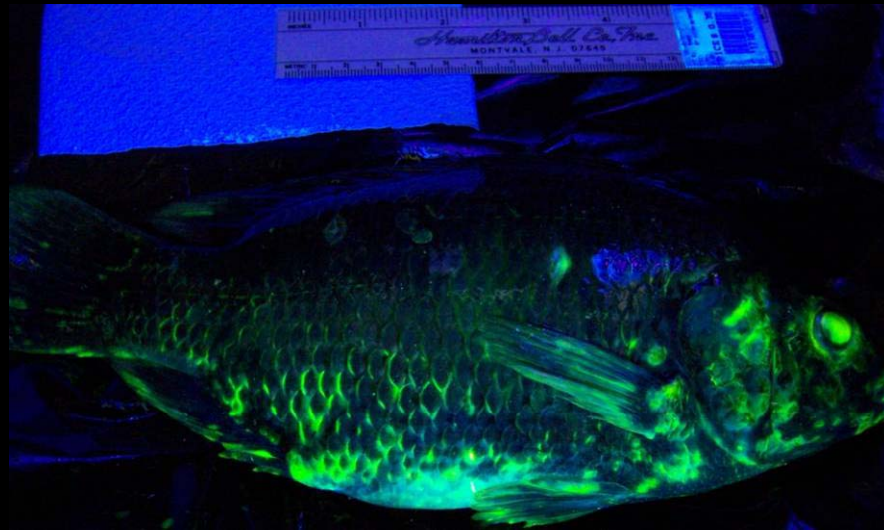
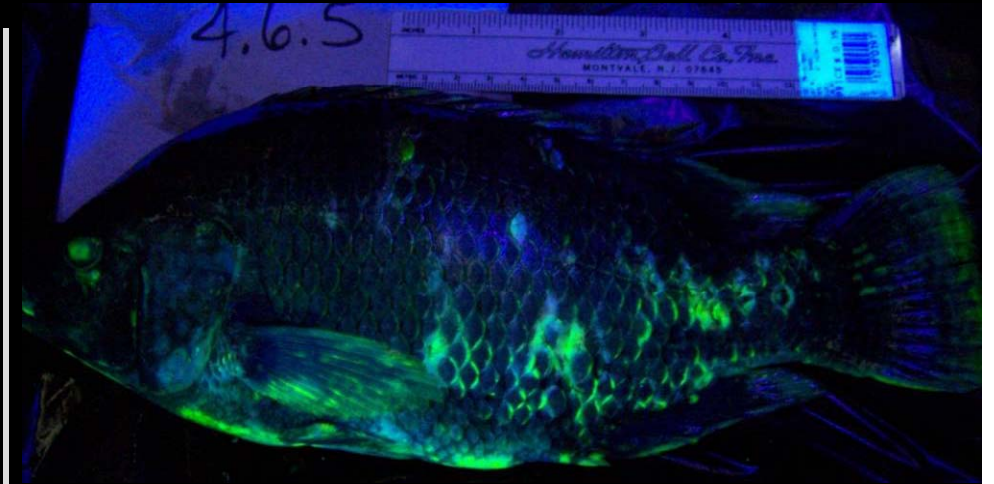
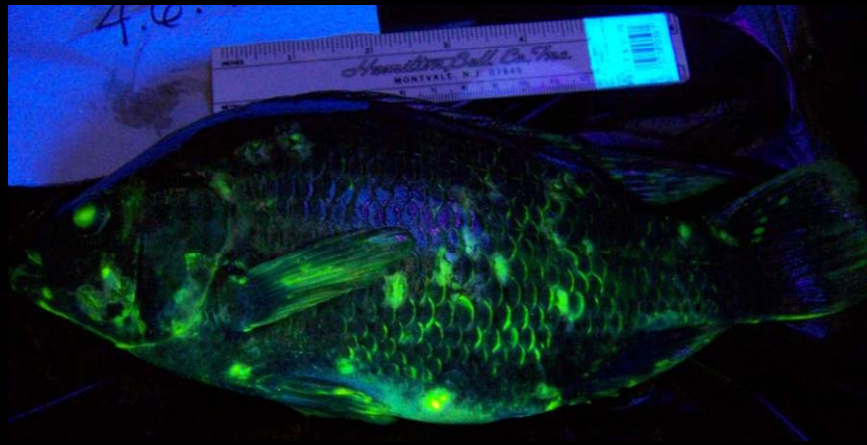


After Loading



Results:

Bodily Injury: After loading onto truck

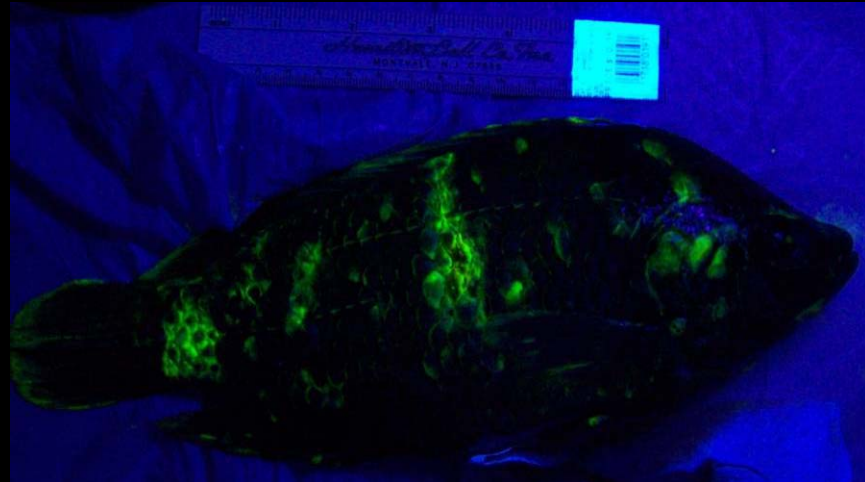
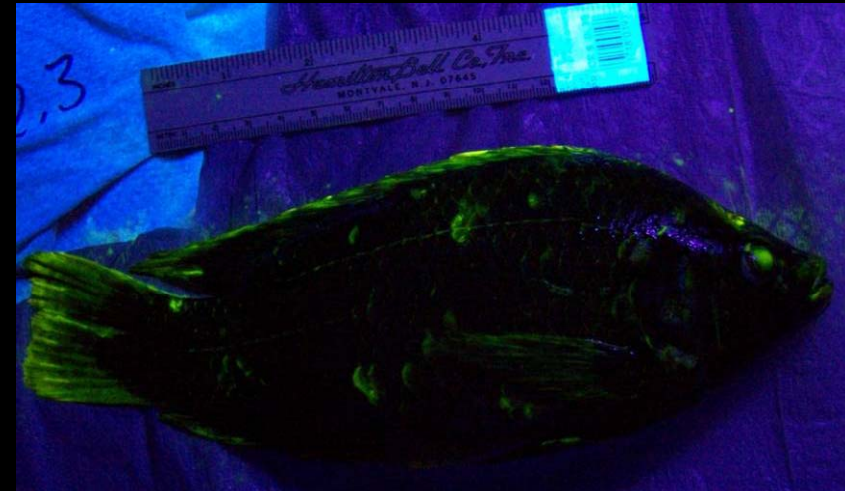
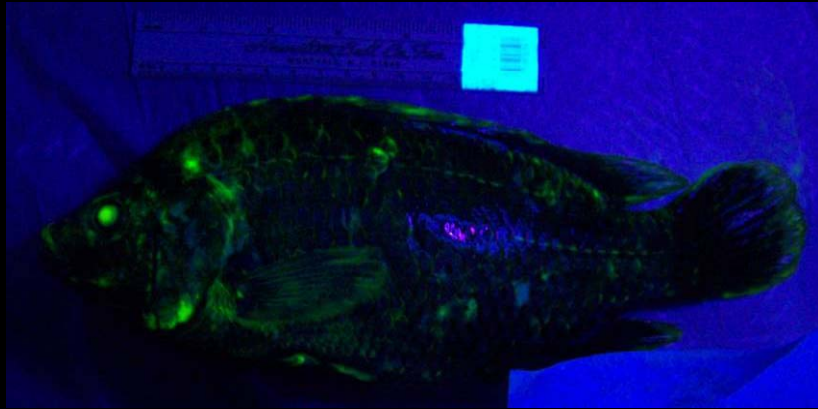


Post-Haul to BC



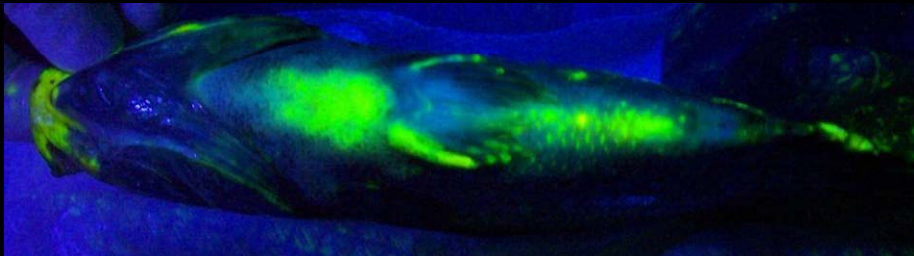
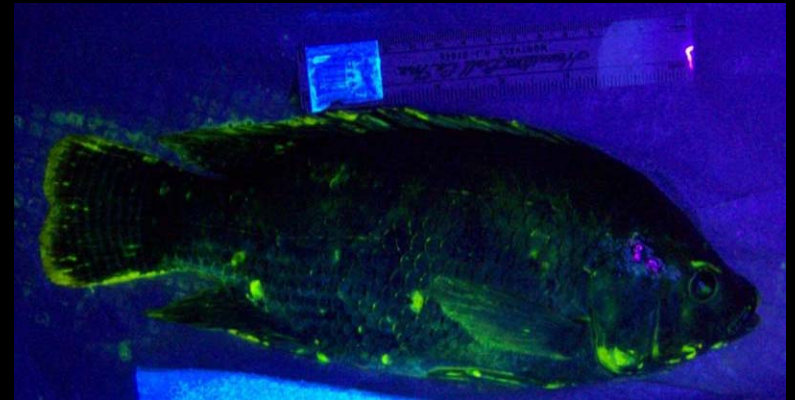
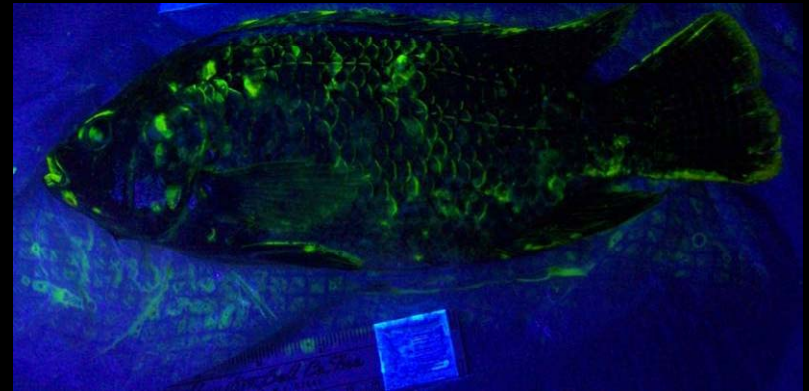
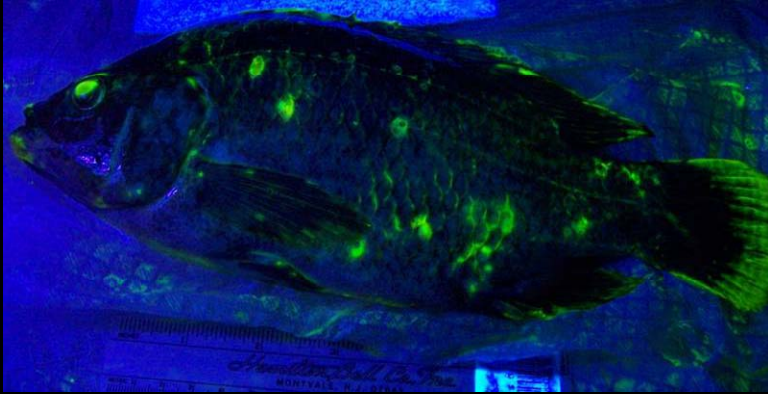
Results:

Bodily Injury: After transport from ID to BC



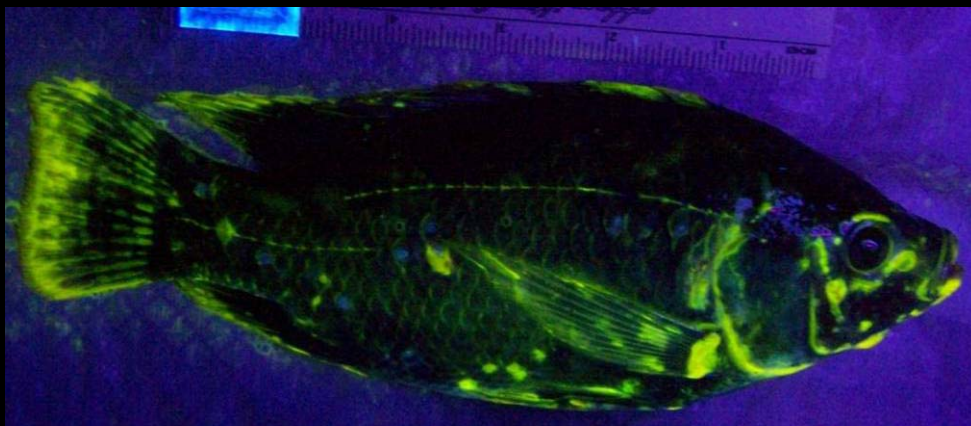
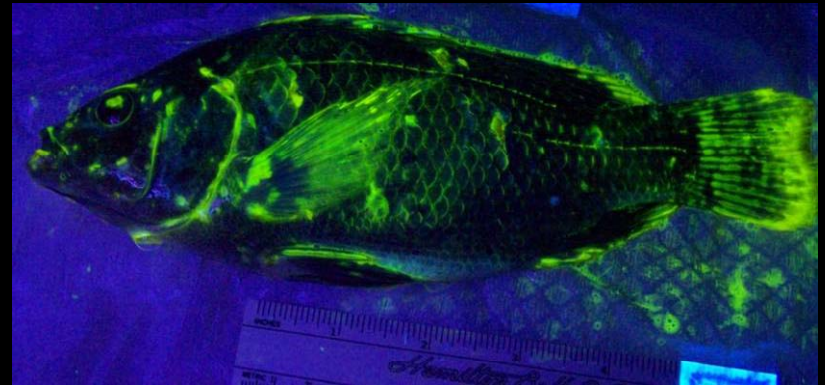
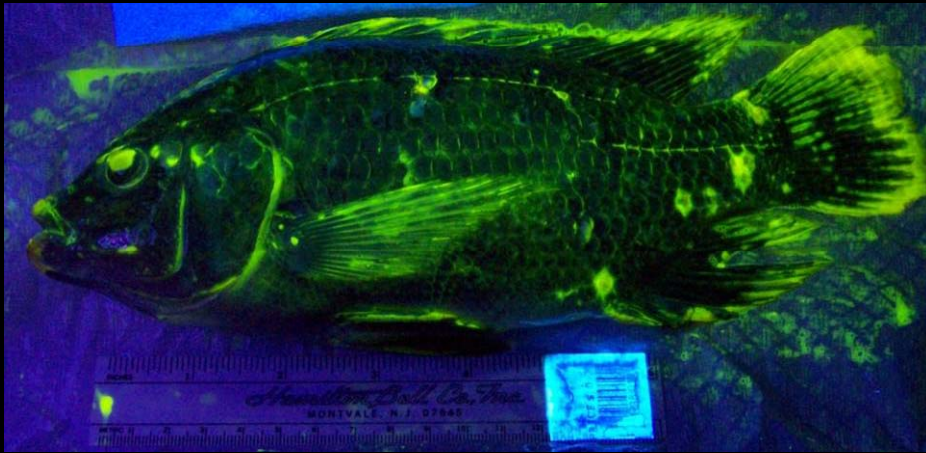
Results:

Bodily Injury: 24 h post-haul~City Fresh Market



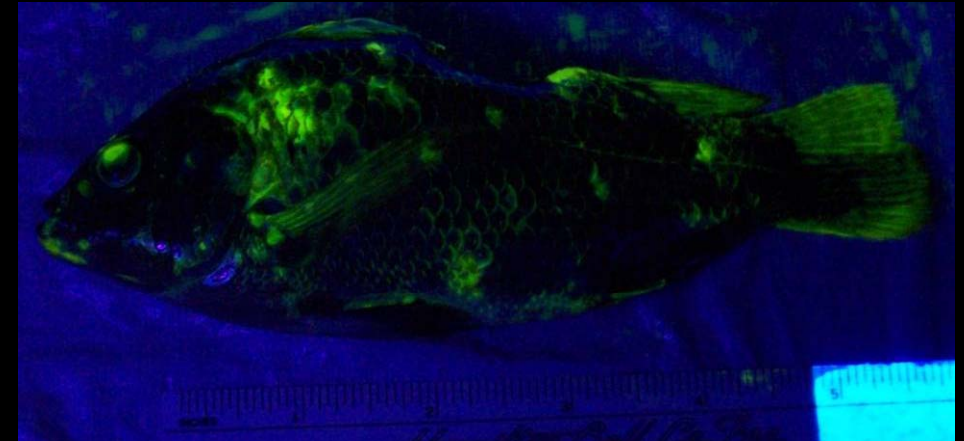
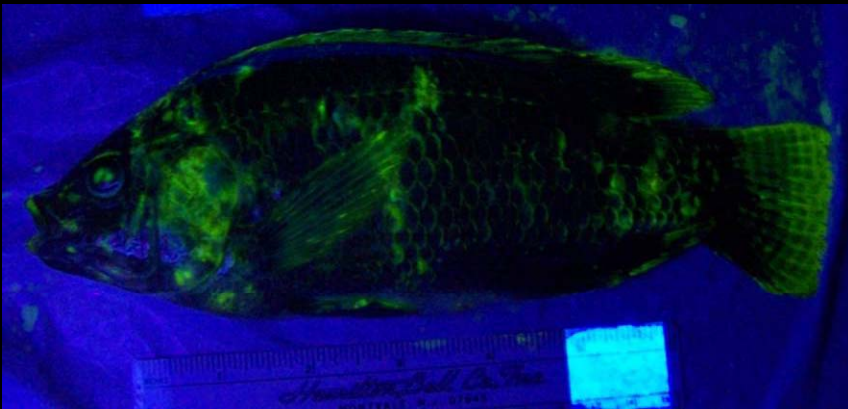
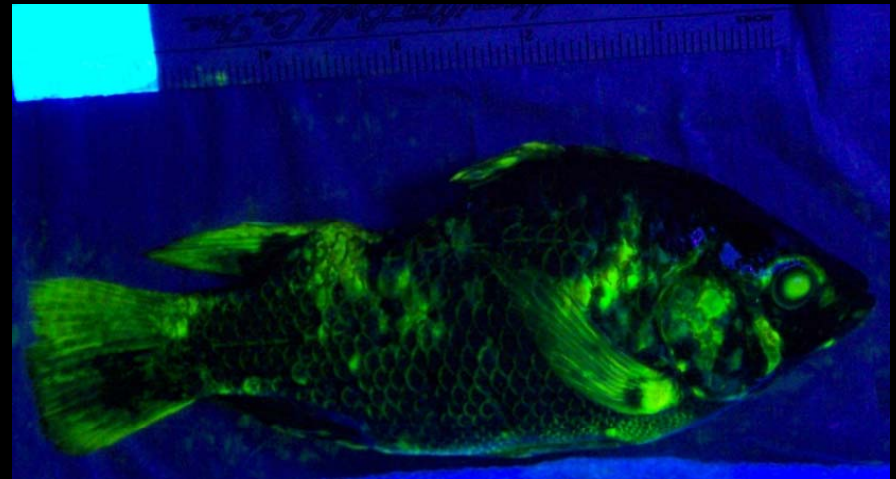
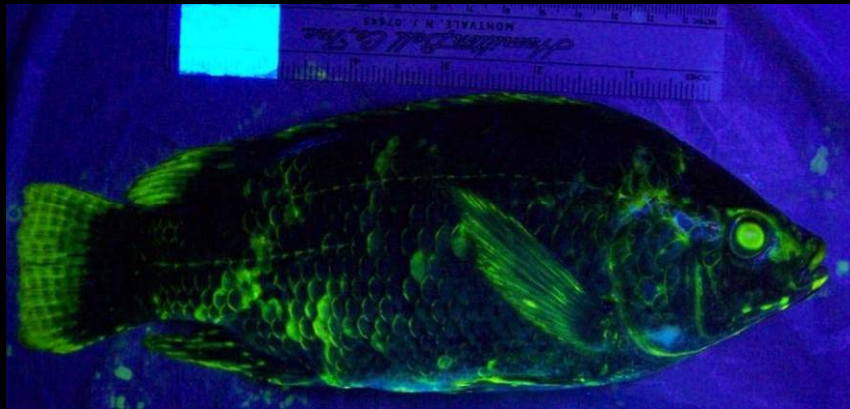
Results:

Bodily Injury: 24 h post-haul ~Richmond Public Market



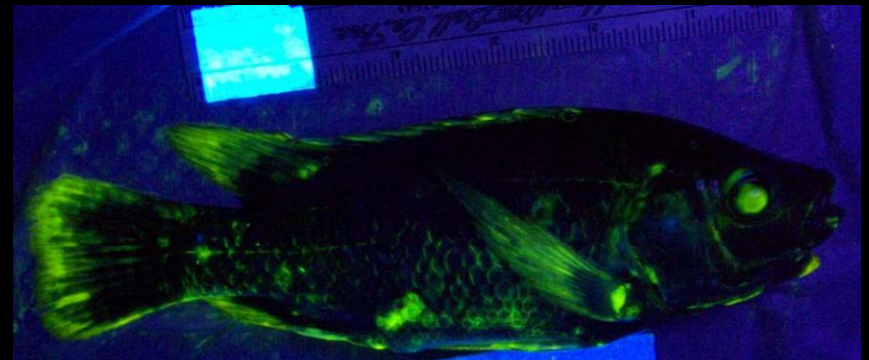
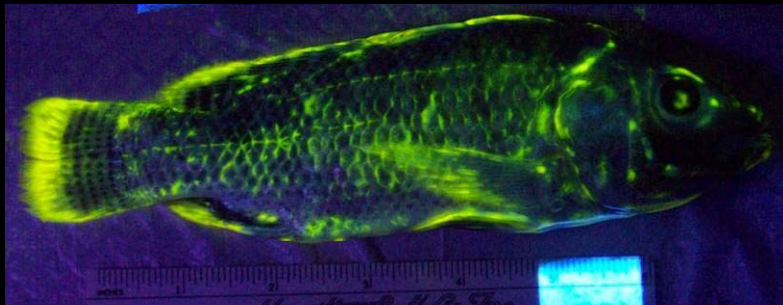
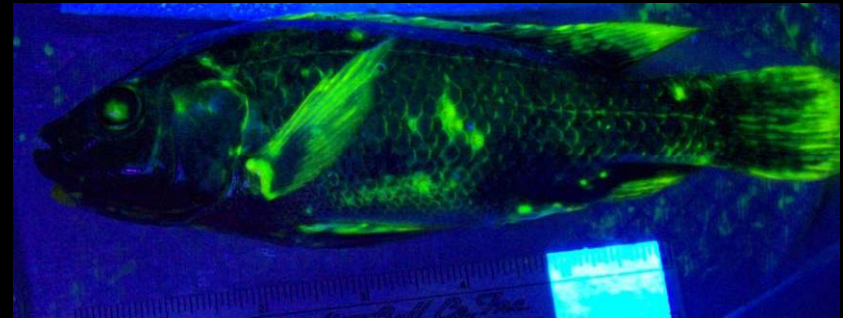
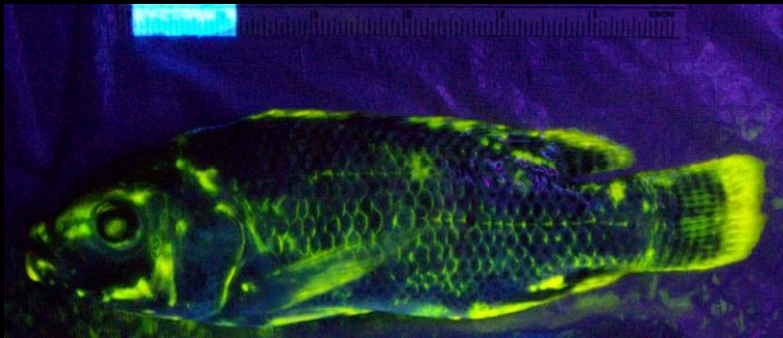
Results:

Bodily Injury: 48 h post-haul ~City Fresh Market



Results:

Bodily Injury: 48 h post-haul ~Richmond Public Market



Results:

Pathology: Bacteria culture and Gram Staining

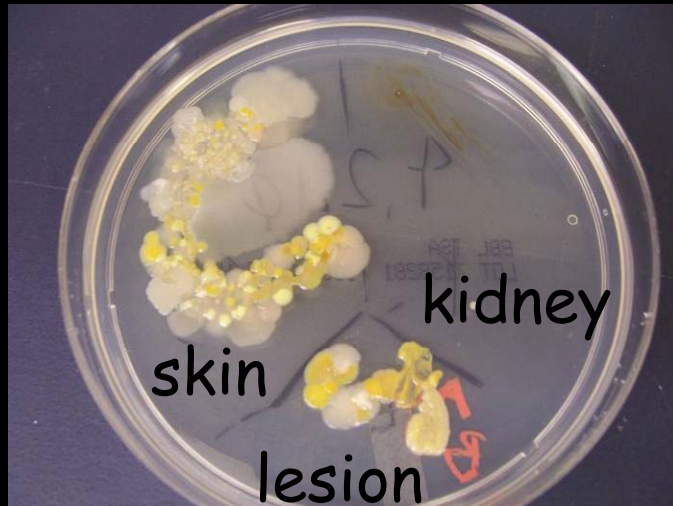
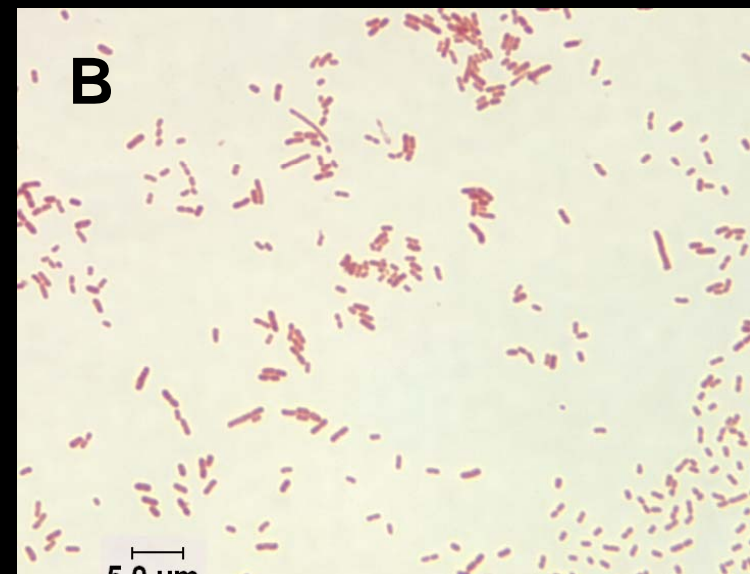
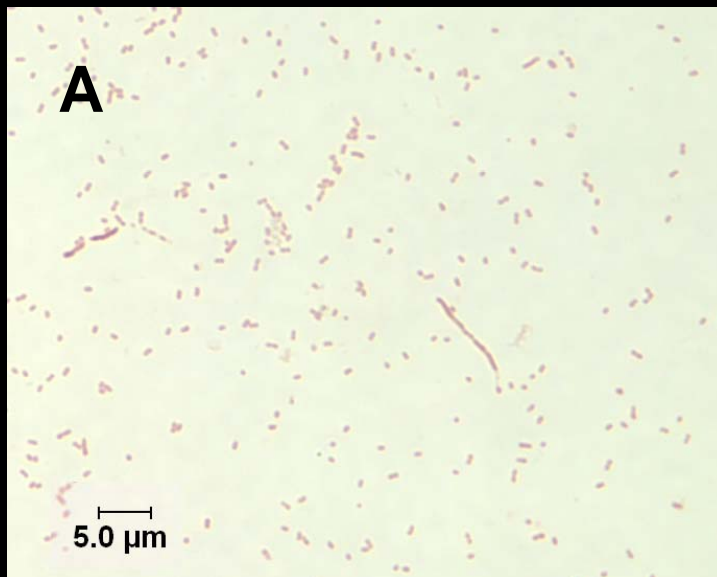


Plate from field: 8 d



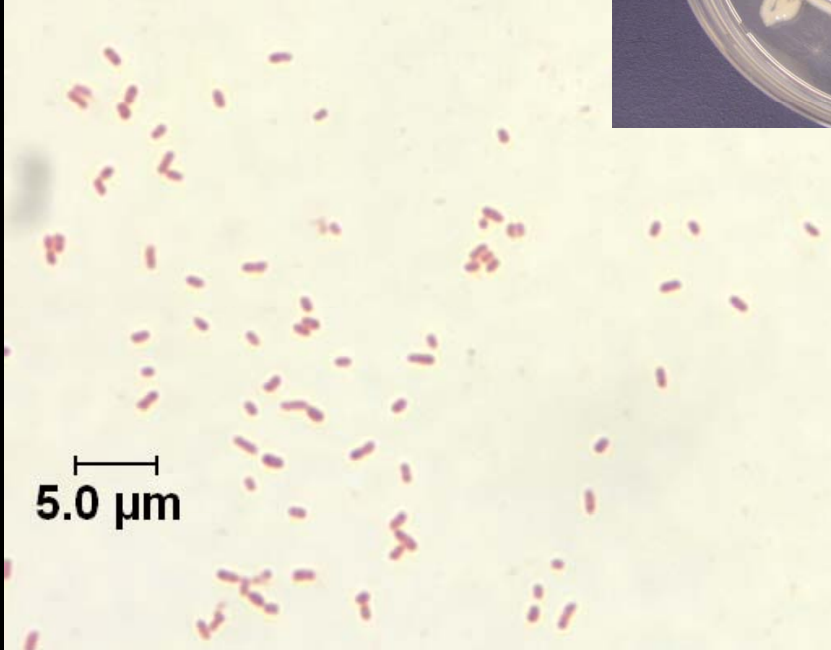
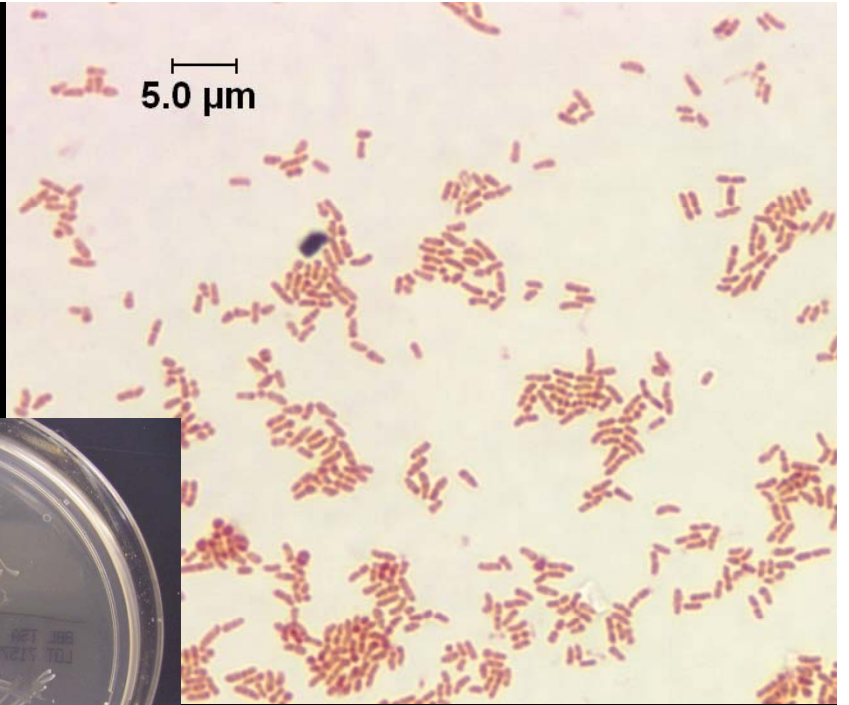
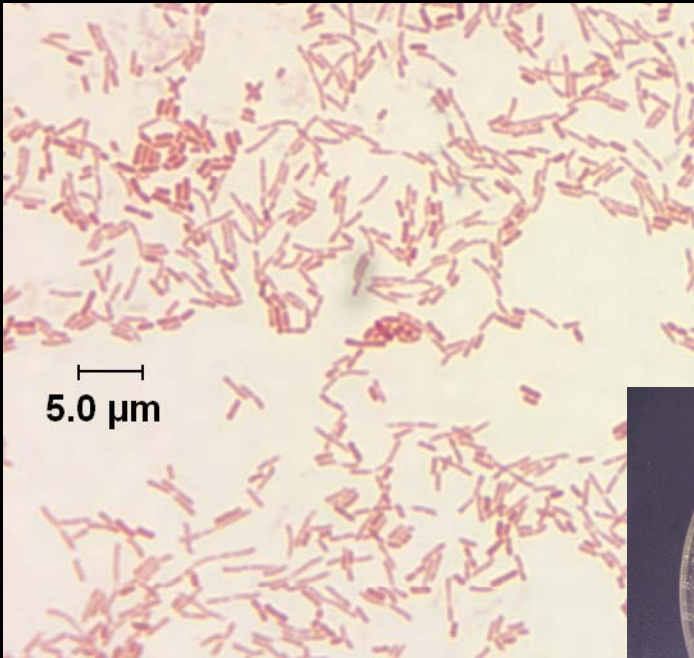
Isolated cultures (2 d of growth)



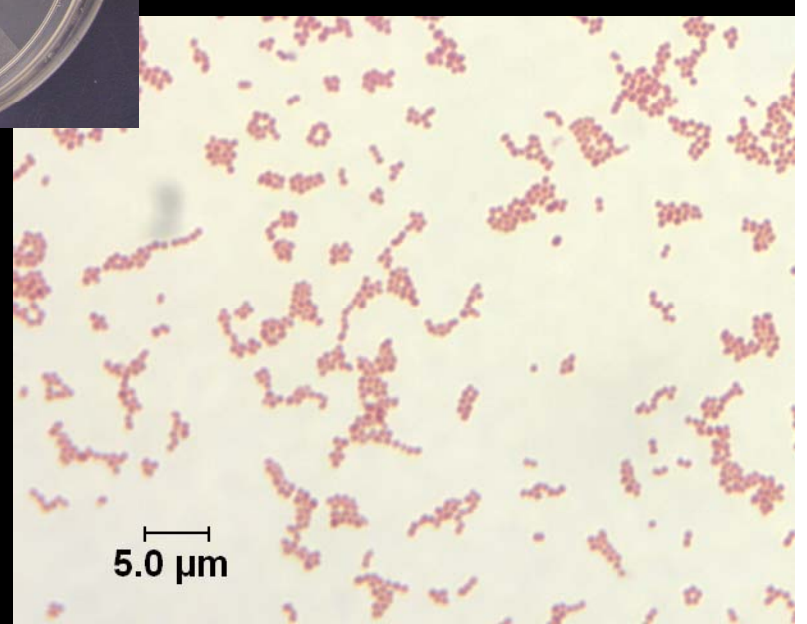
Results:

Pathology: Bacteria culture and Gram Staining





4.4.6



Summary of ID-BC Field sampling

Bodily Injury:

- Puncture wounds & eye injury after crowding & loading
- Fin abrasion after transport
- Visual lesions and fin loss at retailers

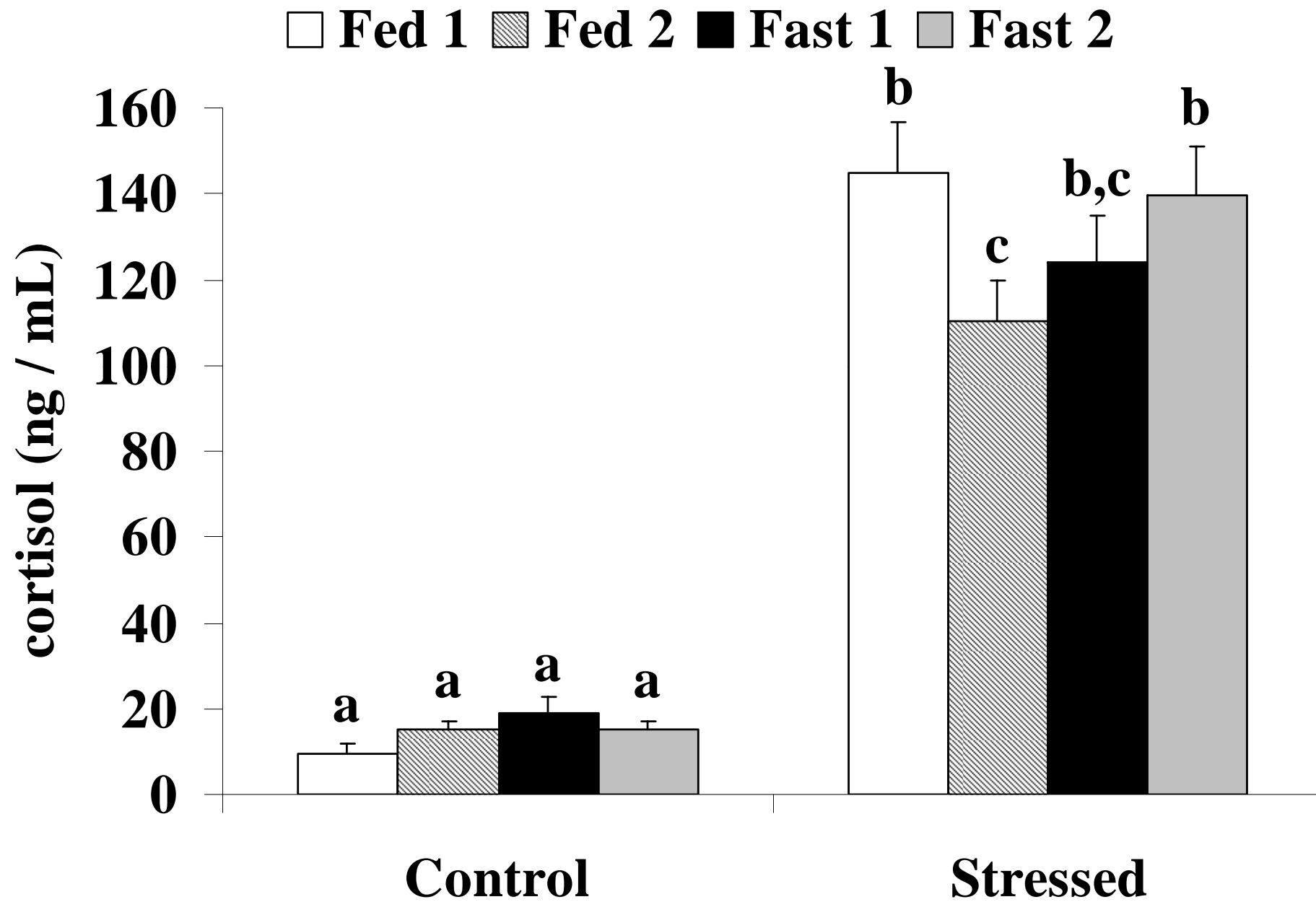
Pathology:

- 3 different bacteria identified by morphology
- 2 types by Gram staining
- 1 type by genetic analysis
- Genetic analysis ongoing
- Histological analysis still pending

Rainbow Trout







What's Next?

Trout:

- Initiate studies to determine trout mortality during live transport for stocking
 - Identify issues (transport or receiving?)

Tilapia:

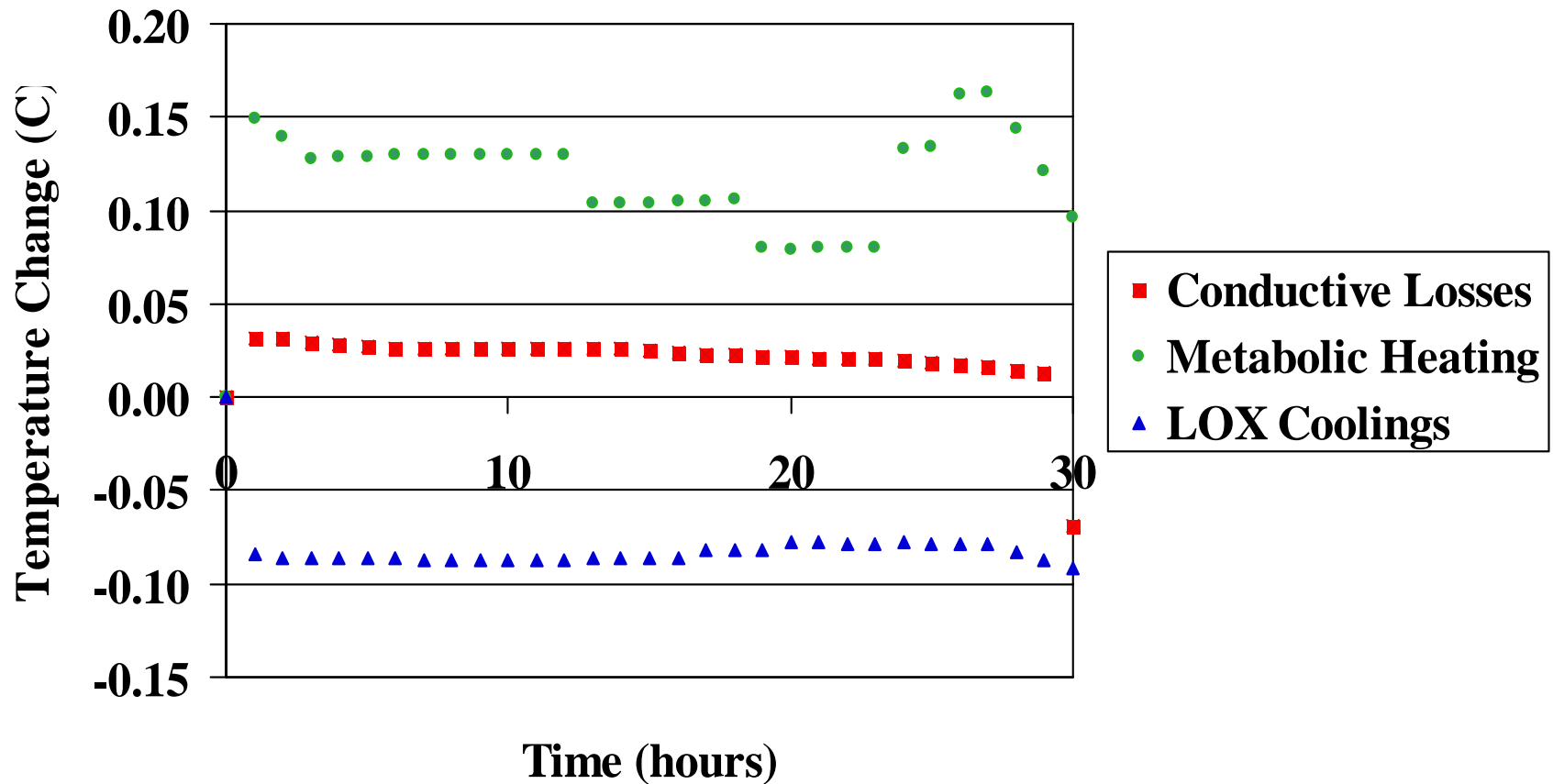
- Refine salt dip treatment to reduce hauling mortality
 - Repeat experiment
 - Monitor parasite and bacterial load
 - How to reduce injury from loading?
- Diagnose extent of physical injury from transport and consequent pathology-related mortality

Fish Inoculate Each Other?



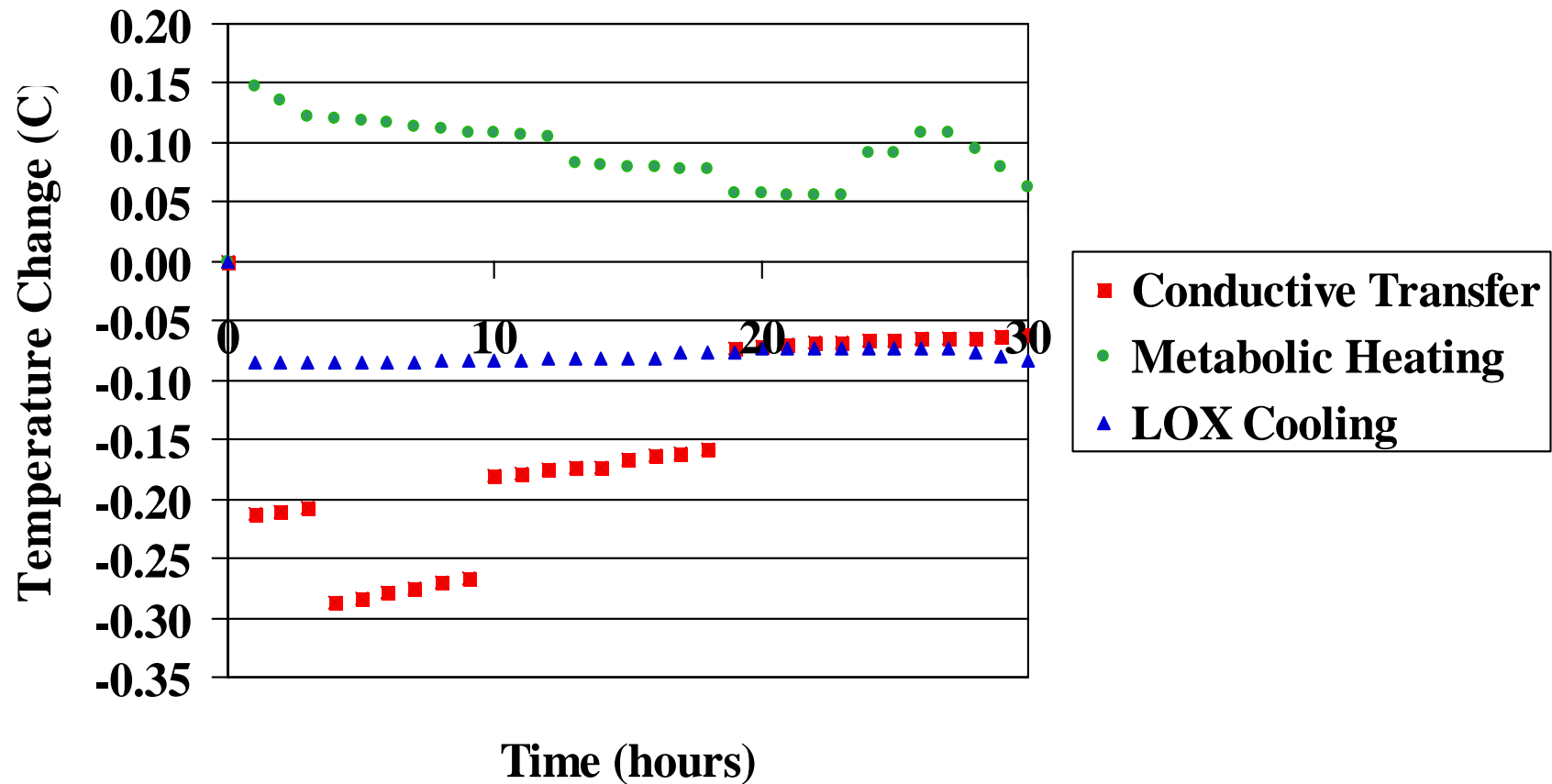
Hauling Simulation (Summer Conditions)

Initial Temperature = 28.00; Final Temperature = 29.17



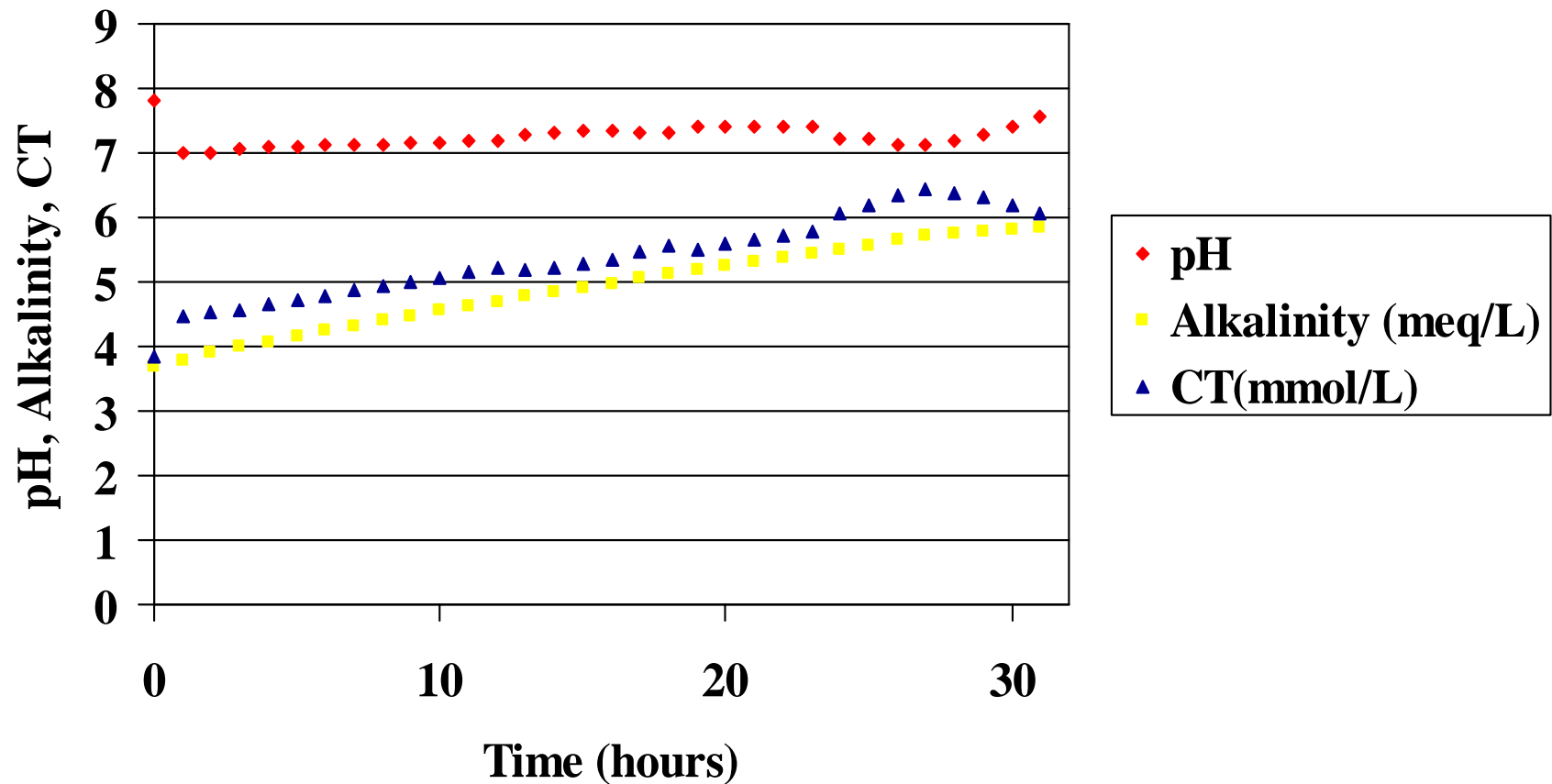
Hauling Simulation (Winter Conditions)

Initial Temperature = 28.00; Final Temperature = 23.71



Hauling Simulation

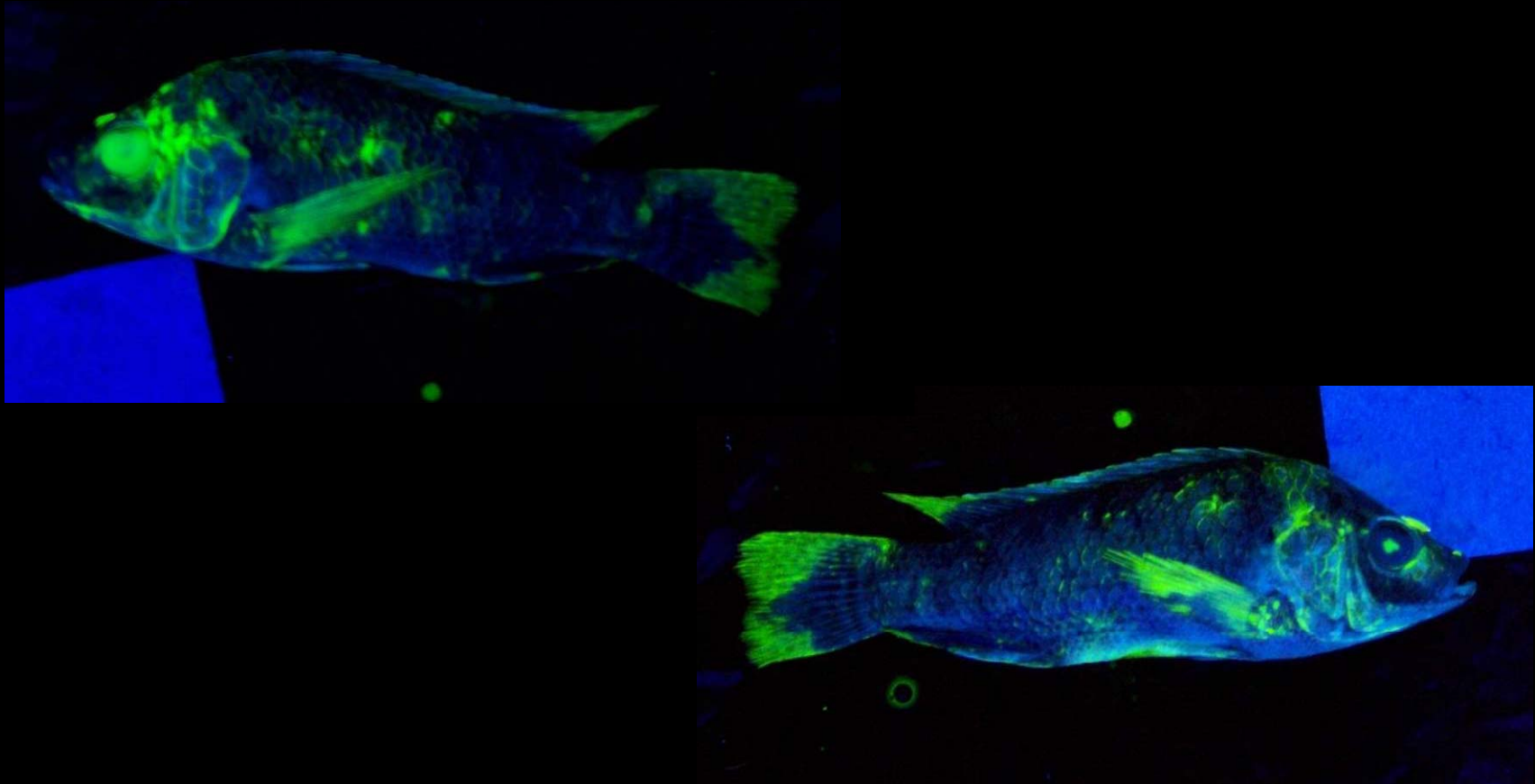
(Variation in pH and carbonate parameters)



Results

Bodily Injury: Mortalities after 24 h transport and
24 h recovery

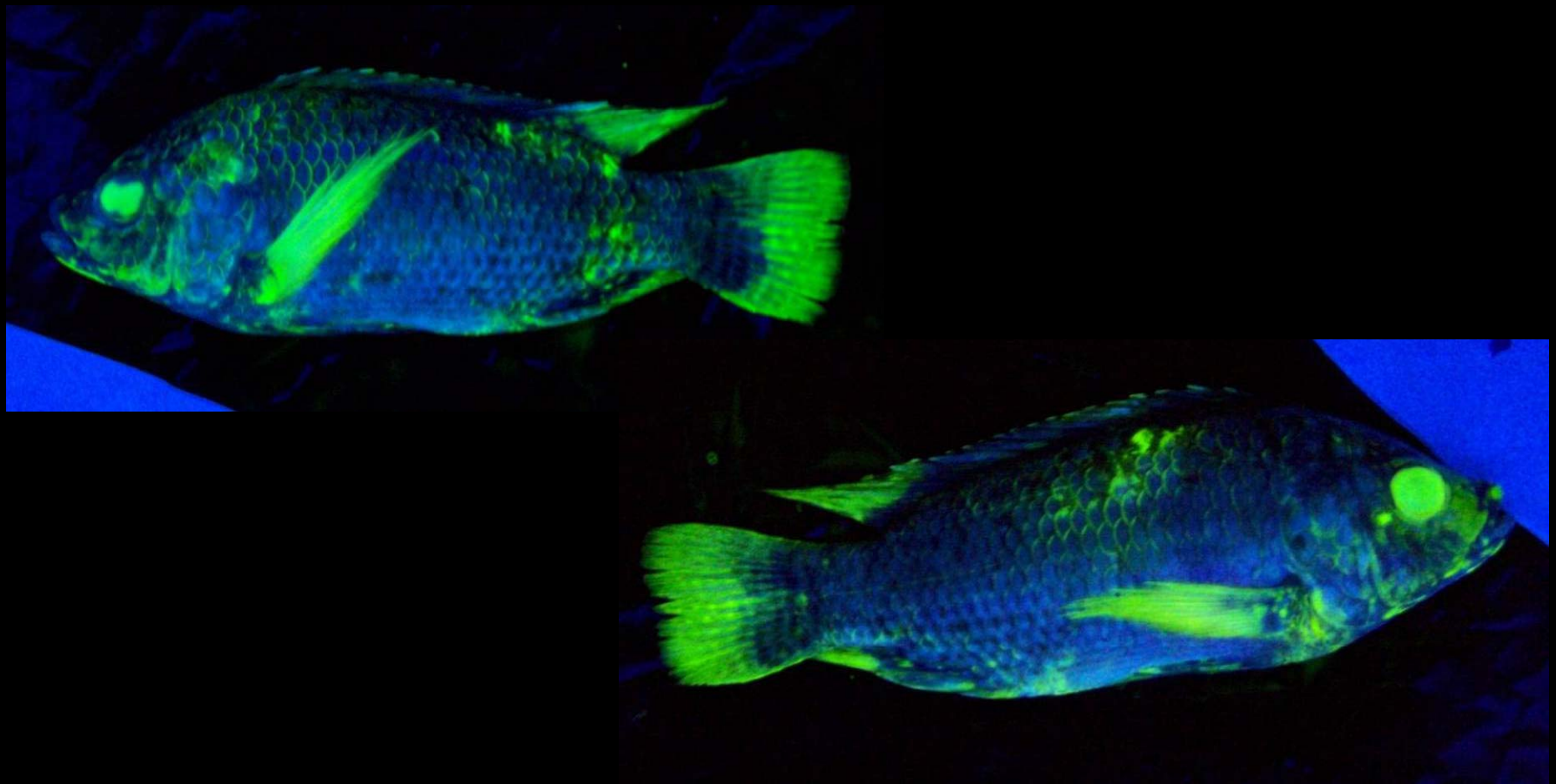
Fish 1



Results

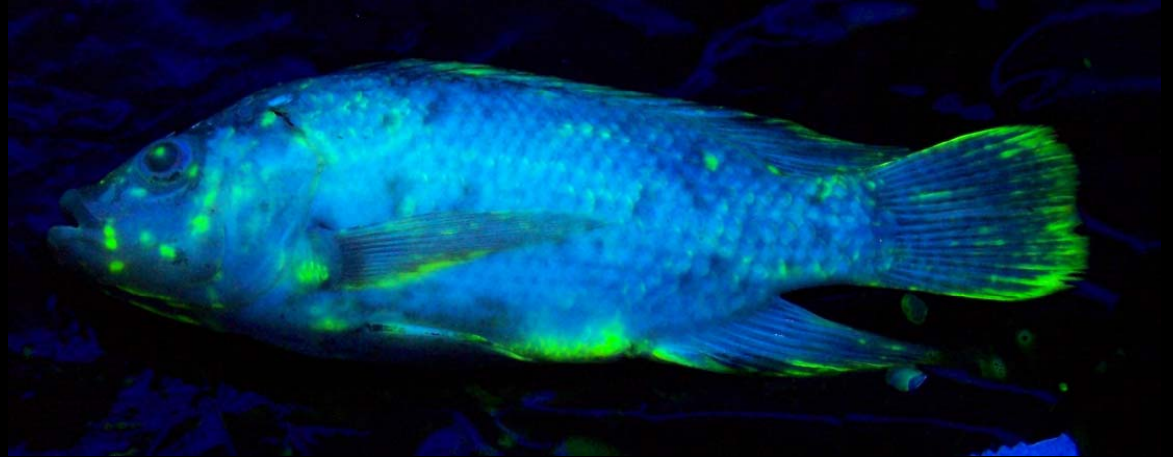
Bodily Injury: Mortalities after 24 h transport and
24 h recovery

Fish 2

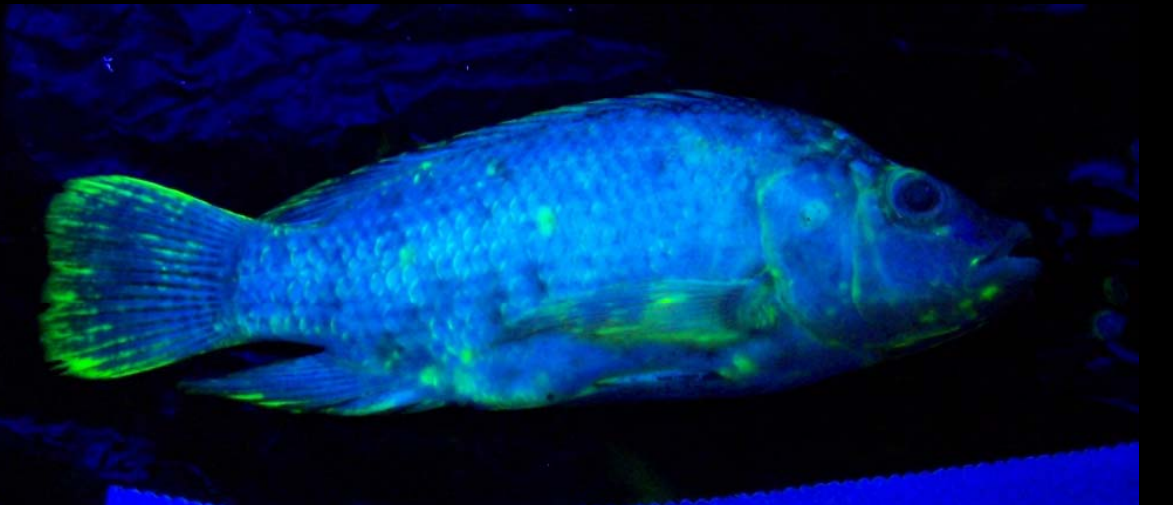


Results

Bodily Injury: 2 h Net Stress

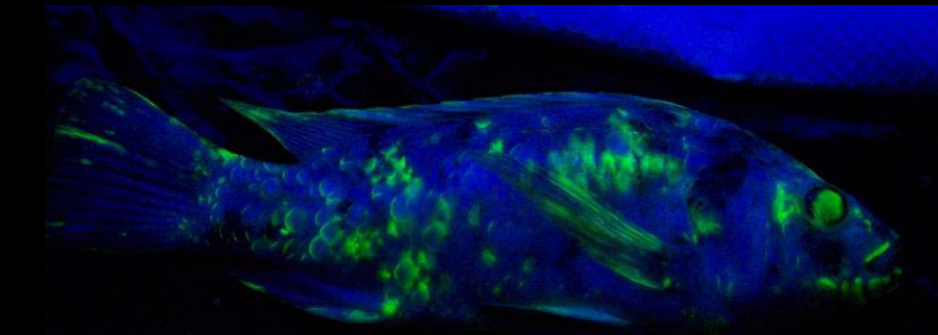
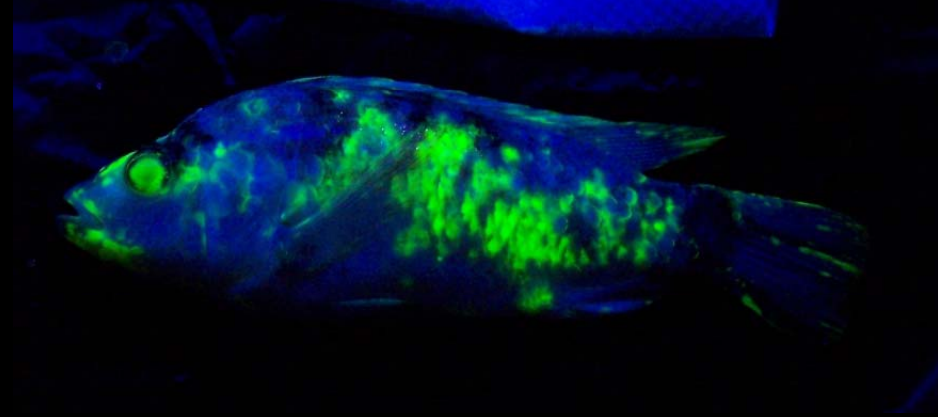


Best



Results

Bodily Injury: 2 h Net Stress



Worst

NMFS- Work Completed in 2006-2007

- Physical and water quality sampling at retail stores (continued)
- Water quality sampling during hauling trips
- Develop simulation models for alkalinity-pH-carbon dioxide
- Recommend improved hauling mix
- Evaluation of water quality at John Lambregt's farm

NMFS - Work 2007-2008

- Finish retail stores monitoring
- Determine impacts of tilapia on the carbonate-pH system and ionic composition of hauling water
- Determine thermal characteristics of commercial hauling systems
- Determine the oxygen consumption of tilapia using a mass balance approach

NMFS - Work 2007-2008 (continued)

- Determine ammonia excretion rate of tilapia
- Determine the impact of hauling on the K_{la} for oxygen and carbon dioxide
- Evaluate pre-hauling dips and improved hauling mixes