THE CONSERVATION FUND

America's Partner in Conservation

Effects of Hydrogen Peroxide Disinfection and Aeration Column Packing on Off-Flavor Depuration Kinetics of Atlantic Salmon Purged in Replicated Partial Reuse Systems

John Davidson, Bruce Swift, Eric Ruan, Jennifer Aalhus, Manuel Juarez, Kevin Schrader, Bill Wolters, Gary Burr, and Steven Summerfelt

Aquaculture Innovation Workshop 5
NCTC, Shepherdstown, WV

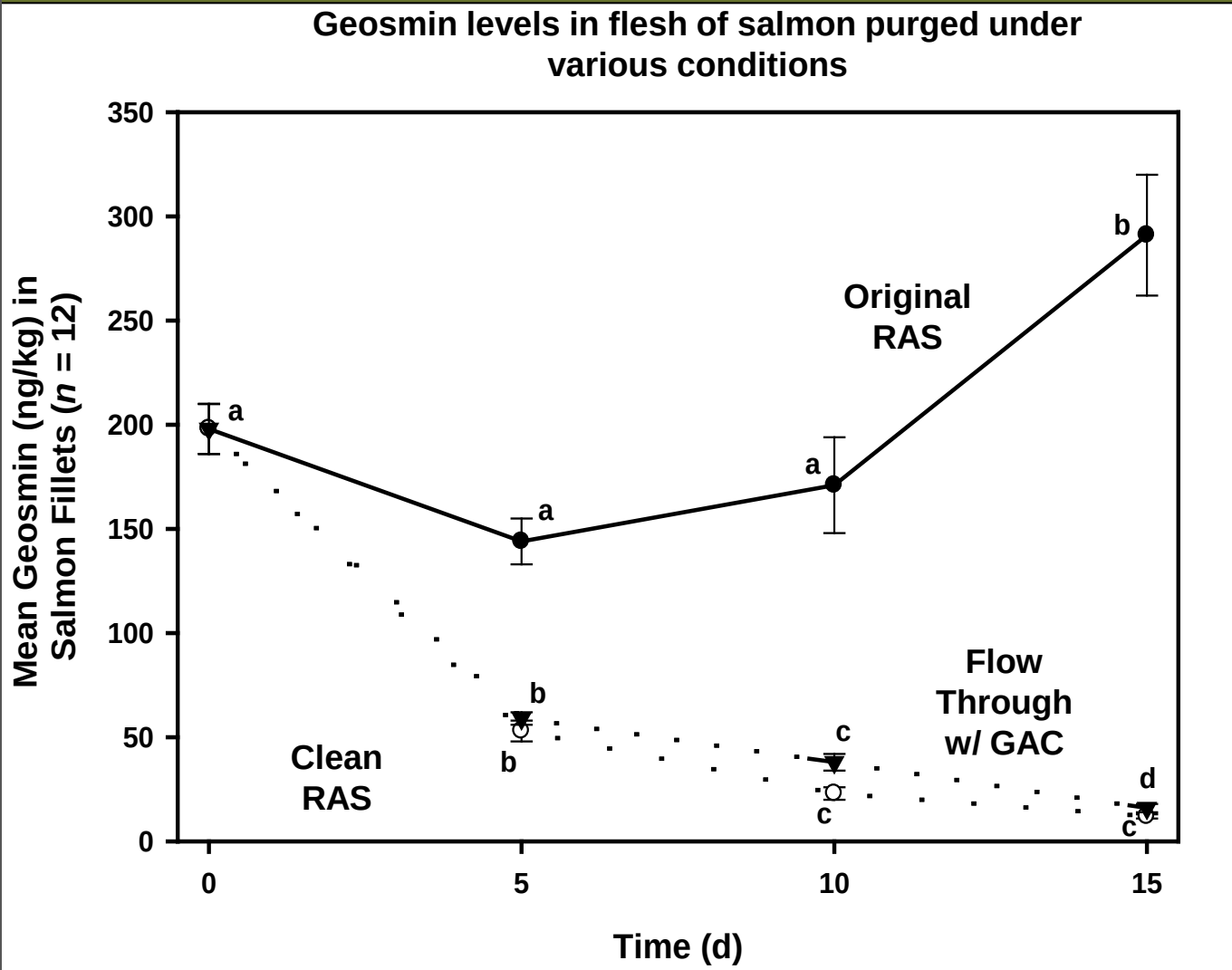
Background

- Many advantages of RAS, but one drawback
  - Bioaccumulation of off-flavor compounds within fish flesh
  - Create earthy or musty taste
- Caused by microbial metabolites produced by actinomycetes and cyanobacteria
  - 2-Methylisoborneol (MIB)
  - Geosmin
- Off-flavor not reported for salmon cultured in ocean net pens
- For RAS to be viable technology, methods for off-flavor removal are necessary!

Depuration within Separate Clean-Water Systems

Burr et al., 2012. Impact of depuration of earthy-musty off-flavors on fillet quality of A. salmon cultured in RAS. Aquacult. Eng. 50, 28-36.

Salmon *did not* purge well in original RAS!!

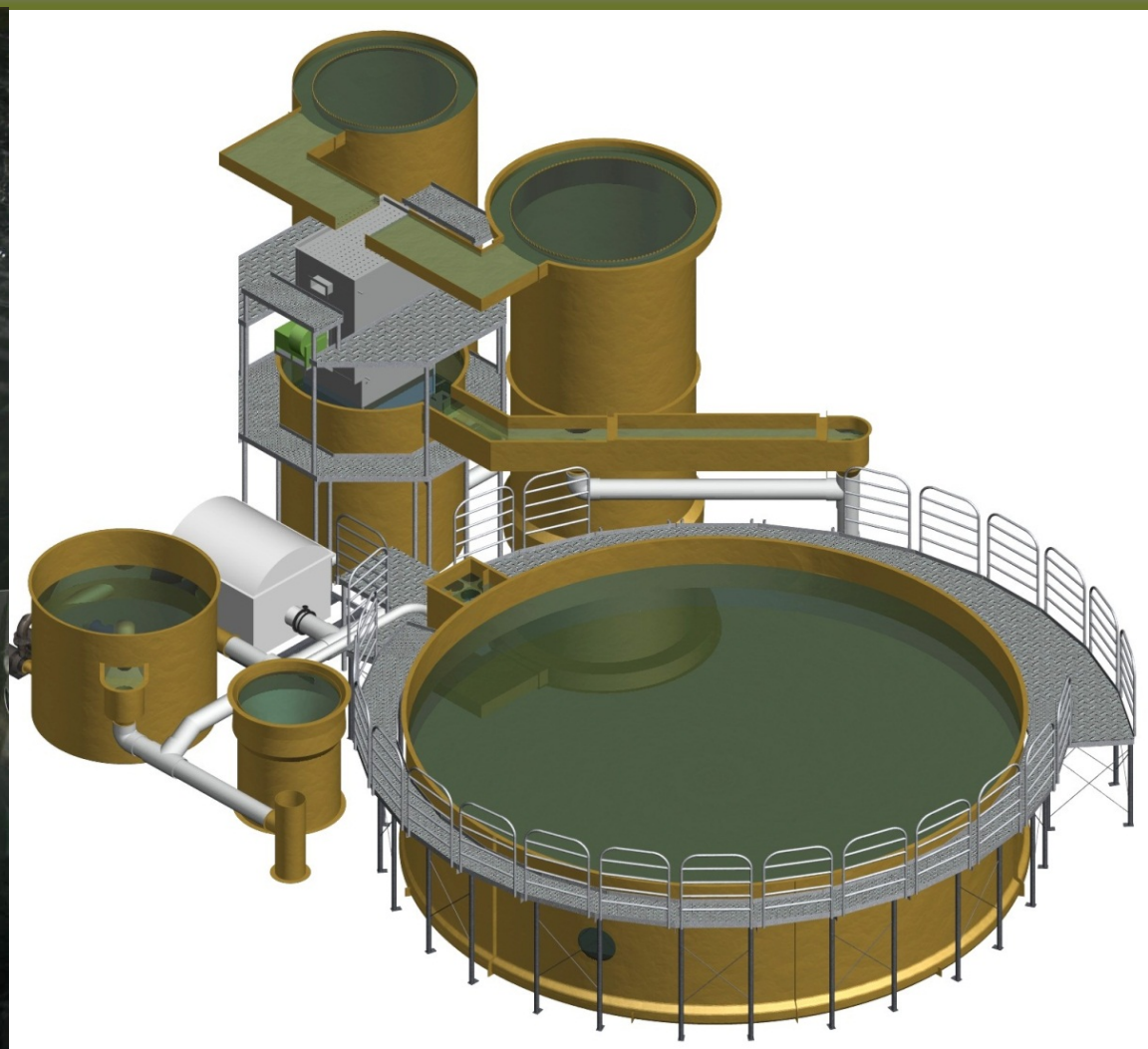


THE CONSERVATION FUND
America's Partner in Conservation

0.5 m^3 Experimental Partial Reuse Systems

THE CONSERVATION FUND
America's Partner in Conservation

150 m^3 Commercial Scale Grow-out RAS

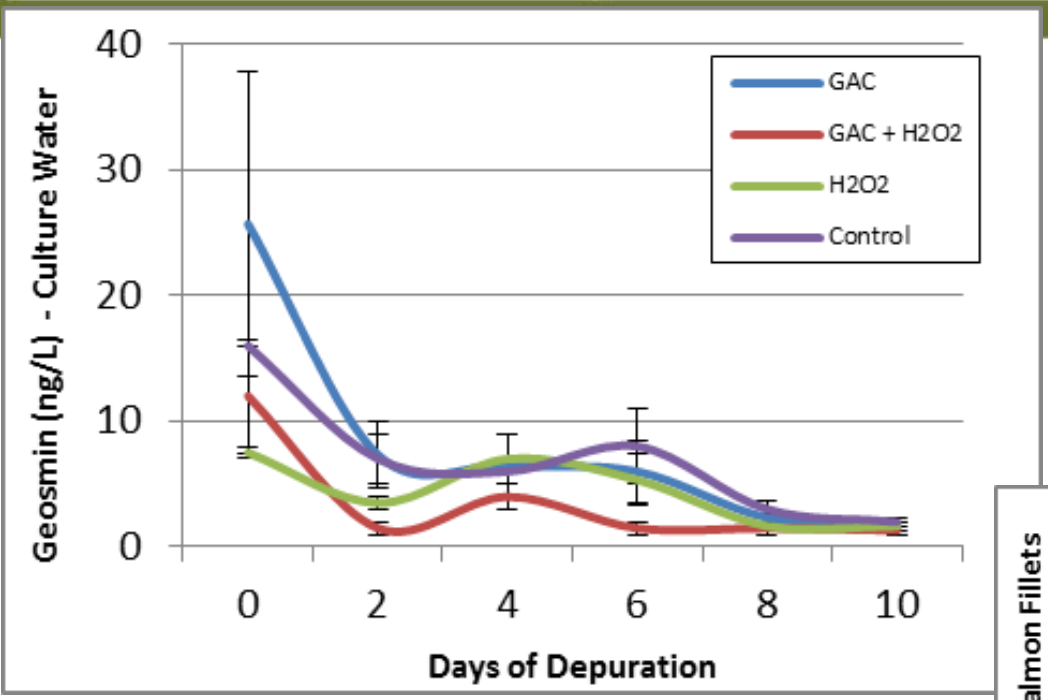


THE CONSERVATION FUND
America's Partner in Conservation

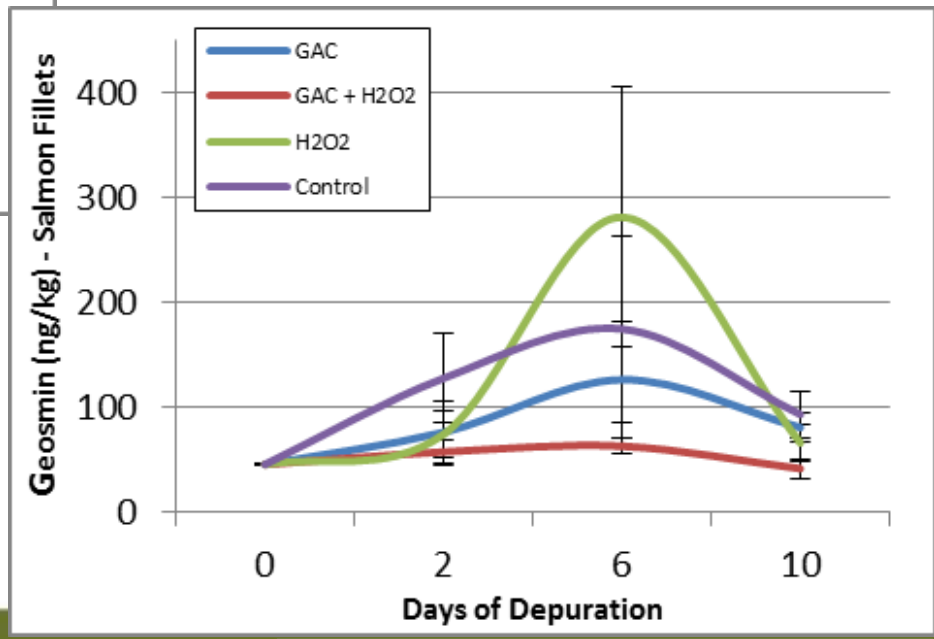
Experimental Design
Depuration Trials 1 & 2

Experimental Tanks per Treatment	Granular Activated Carbon (GAC)	Hydrogen Peroxide
3	✓	✓
3	✓	
3		✓
3		

Depuration Trial 1

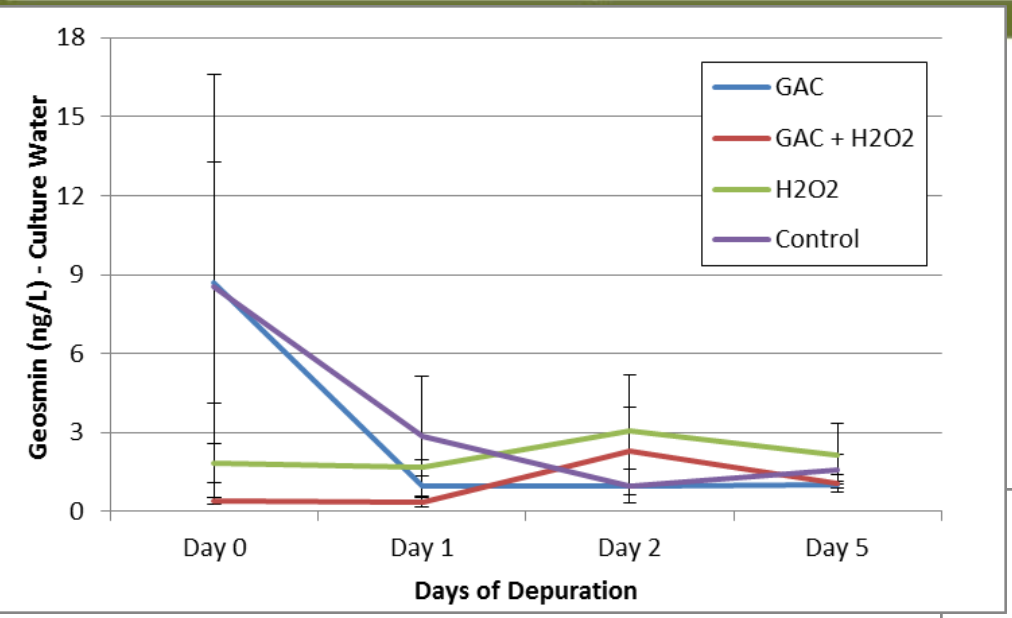


- Geosmin concentrations in water declined over 10-day period



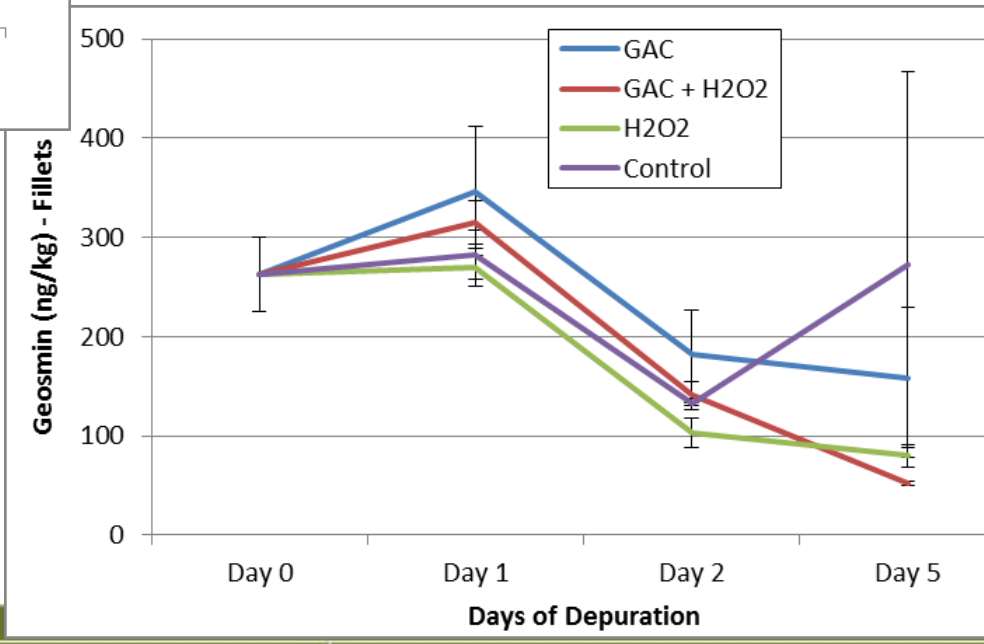
- Geosmin in fillets increased for all treatments except GAC + H_2O_2
- Increase in off-flavor would not be expected in clean, biofilm-free depuration system

Depuration Trial 2



- Disinfection techniques allowed us to start with less geosmin!!!

- Lowest geosmin in salmon harvested from H_2O_2 and GAC + H_2O_2 treated systems



Conclusions – Trials 1 & 2

- Thorough pre-cleaning is critical so that depuration systems are clean/ biofilm-free to begin
- Off-flavor concentrations in fillets can increase in "dirty" depuration systems with biofilm on walls of unit processes
- GAC combined with H_2O_2 disinfection appears to be best treatment option, but H_2O_2 disinfection alone was just as effective

Depuration Trial 3

- Communication with industry indicates aeration columns and media can harbor off-flavor producing bacteria even within depuration systems

Experimental Design
Depuration Trial 3

Experimental Tanks per Treatment	Hydrogen Peroxide Disinfection	Water Aeration Media Present
3	✓	✓
3	✓	
3		✓
3		

Trial 3 Methods

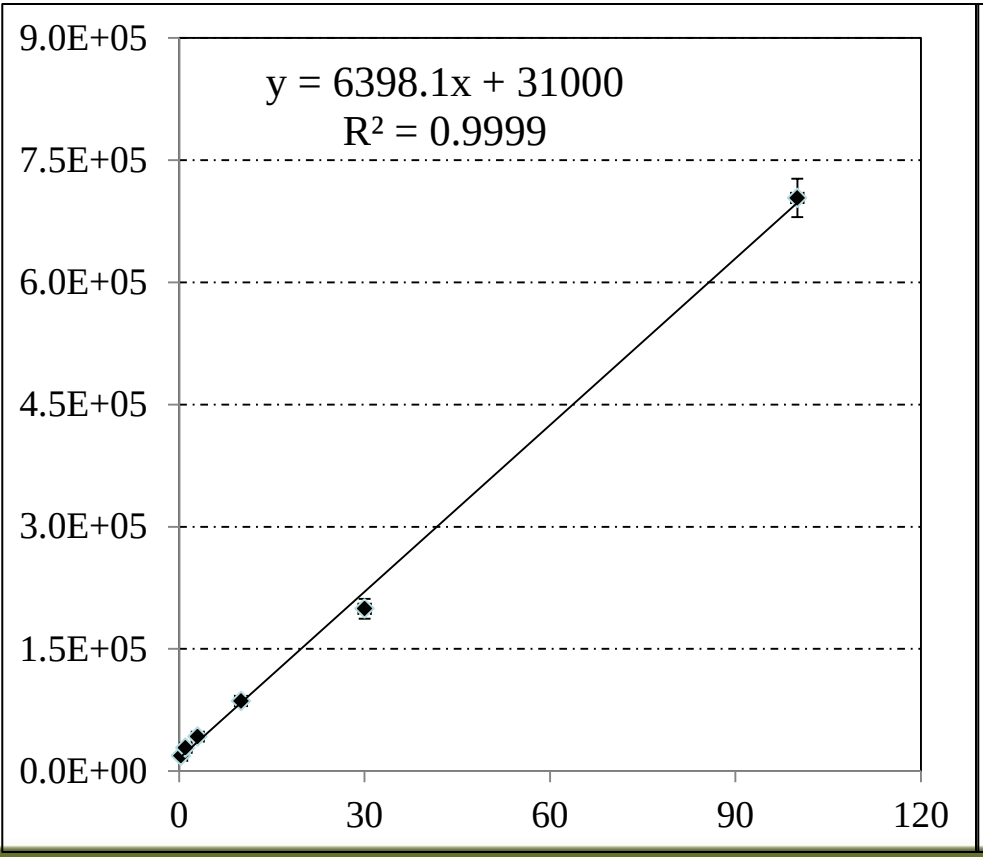
- Prior to the study, depuration systems were used to culture rainbow trout to create biofilm coated surfaces
- Trout were removed one day prior to study and tanks brushed and cleaned
- Six systems were disinfected with 250 mg/L hydrogen peroxide as a static treatment for 1 hr
- Atlantic salmon (3-5 kg) were stocked, approximately 14 per tank

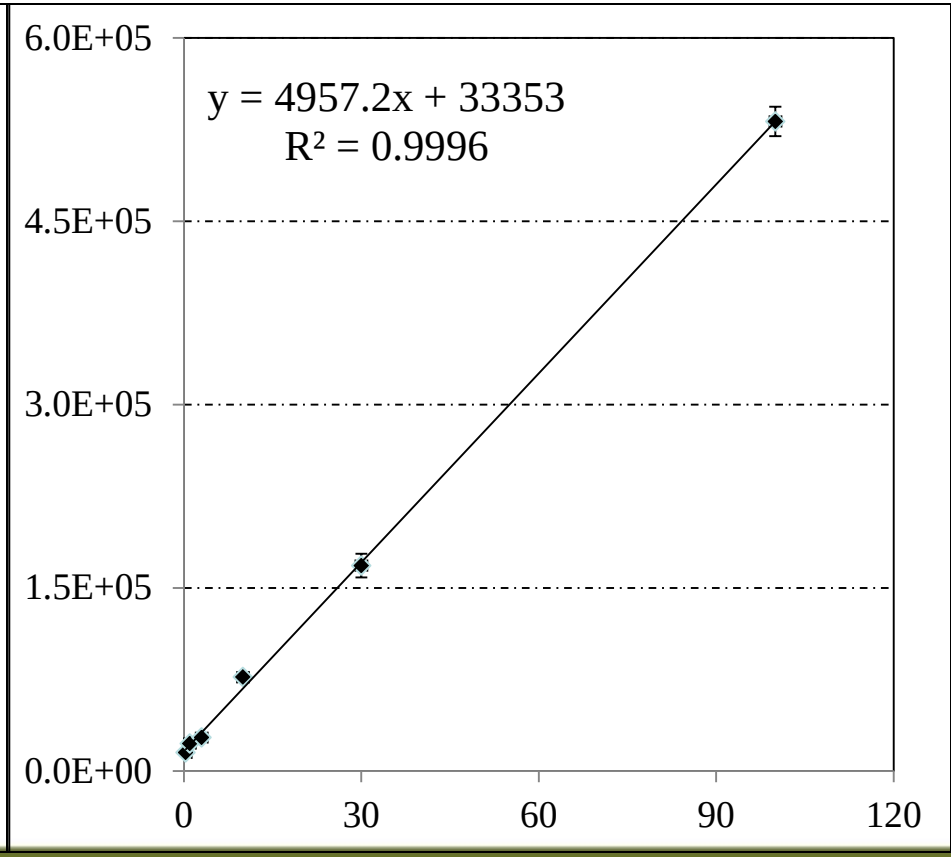
Trial 3 Methods

- Six salmon harvested at Day 0 directly from commercial scale RAS
- Salmon (n = 3-4) harvested on Days 3, 6, and 10 from each depuration system to evaluate off-flavor kinetics
- Fillets were vacuum sealed, frozen, and shipped for analysis to the Lacombe Research Centre, Agriculture and Agri-Food Canada, Alberta, CA
- Lacombe researchers developed a new and very accurate technique to measure MIB and geosmin off-flavors

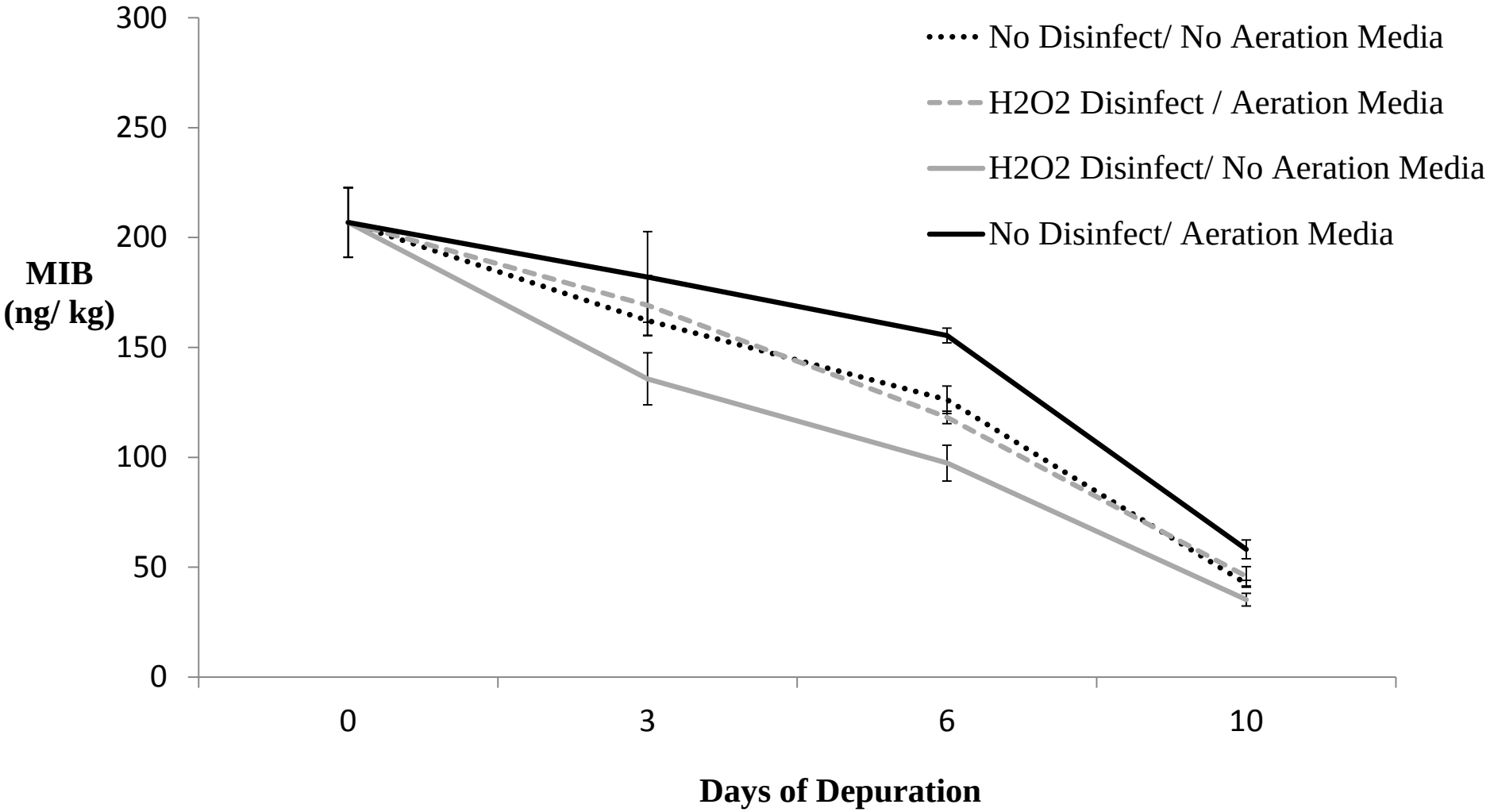
Trail 3 – New Off-flavor Measurement Technique

- Off-flavor measured using stir-bar sorptive extraction-thermal desorption coupled with gas chromatography-mass spectrometry

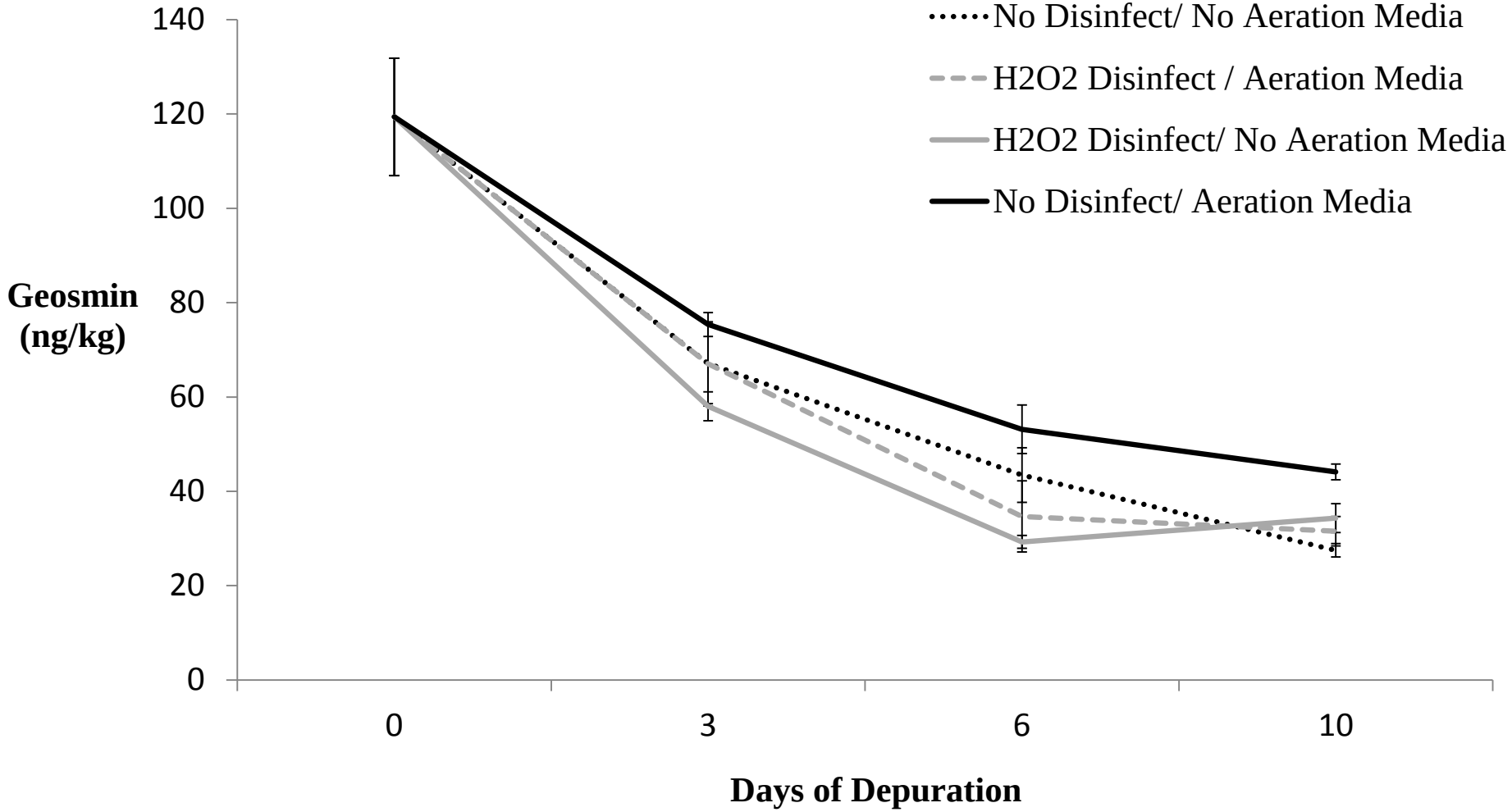




Trail 3 - Depuration of MIB



Trial 3 - Depuration of Geosmin



Trial 3 - Conclusions

- Pre-disinfection of depuration systems using a 1-hr static H_2O_2 treatment (250 mg/L) is effective in optimizing off-flavor removal from harvest-size Atlantic salmon

- Water aeration media ***should not*** be used within depuration systems
  - Difficult to clean
  - Labor intensive to remove/replace
  - Incomplete disinfection with hydrogen peroxide

- Depuration system design should be simple
  - Partial reuse
  - Void of unit processes with difficult to clean areas

Conclusions

- Superior quality of end product from closed containment aquaculture is critical!!!
- Consumers are paying attention to details and the ***story*** behind the seafood that they eat
- Strive for final product that consumers will choose again and again
- Color, ***clean flavor***, texture, freshness, sustainably-produced, health benefits, etc.

Promising News

- Marketing research using optimal depuration techniques indicates success!

- 2012 - Blind taste tests - 2 panels of seafood professionals in Seattle indicated preference for Freshwater Institute closed containment salmon vs. commercially available ocean-raised salmon
  - Cooked flavor
  - Cooked smell
  - Cooked texture

- Test marketing with Albion Fisheries Ltd. has also been a success

Acknowledgements

- Research supported by the Gordon Betty Moore Foundation, the Atlantic Salmon Federation, and the United States Department of Agriculture - Agriculture Research Service.

- All experimental protocols were in compliance with Animal Welfare Act (9CFR) and have been approved by the Freshwater Institute Animal Care and Use Committee.

- Special thanks to Justin Sabrio, Phil Backover, Leslie Vegas, and Karen Schroyer for technical assistance.

Photo Courtesy Andrew Wright

Bon Appetit!!