Apr 21st, 10:30 AM - 12:00 PM

Sublethal effects of the sea lice pesticides ivermectin and SLICE® on starry flounder behaviour and physiology when exposed to contaminated sediments

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The sublethal effects of sea lice pesticides on juvenile starry flounder (*Platichthys stellatus*)

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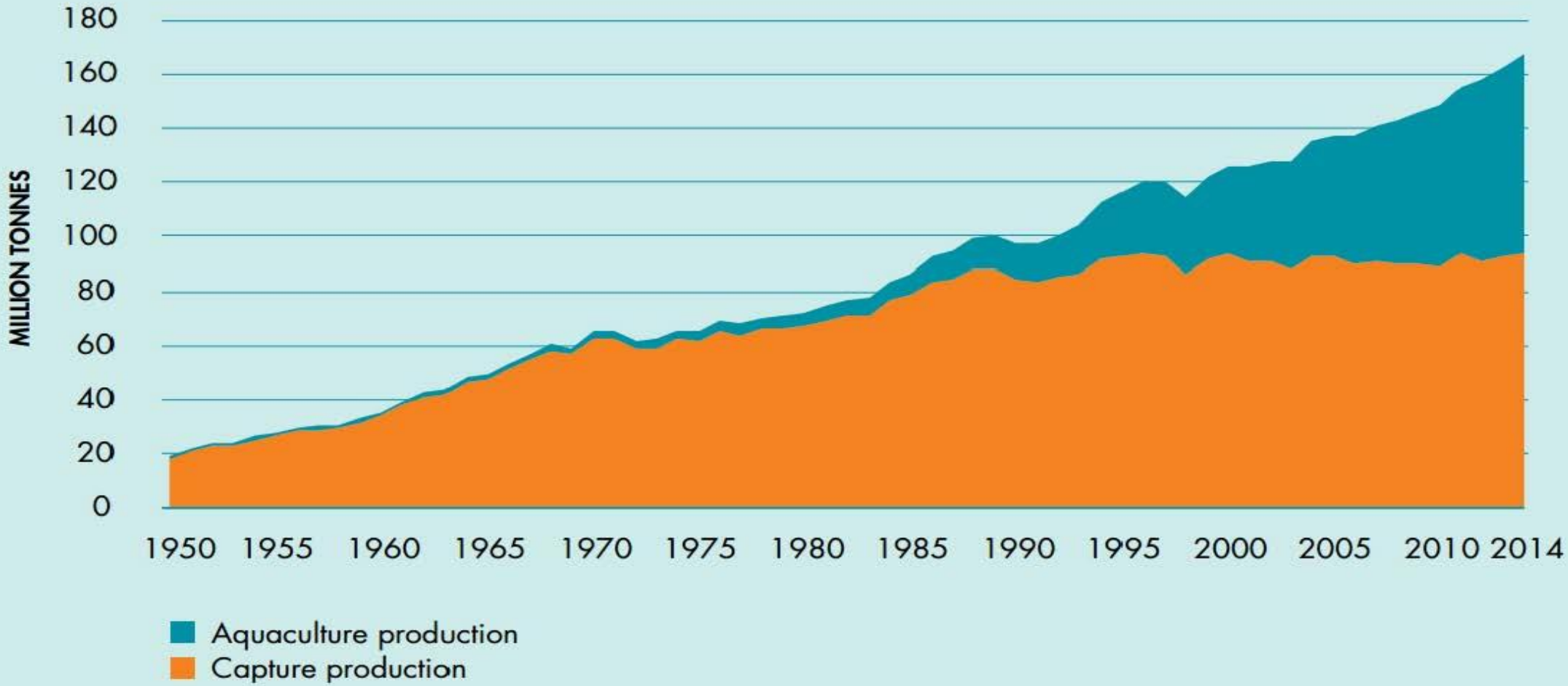
Introduction

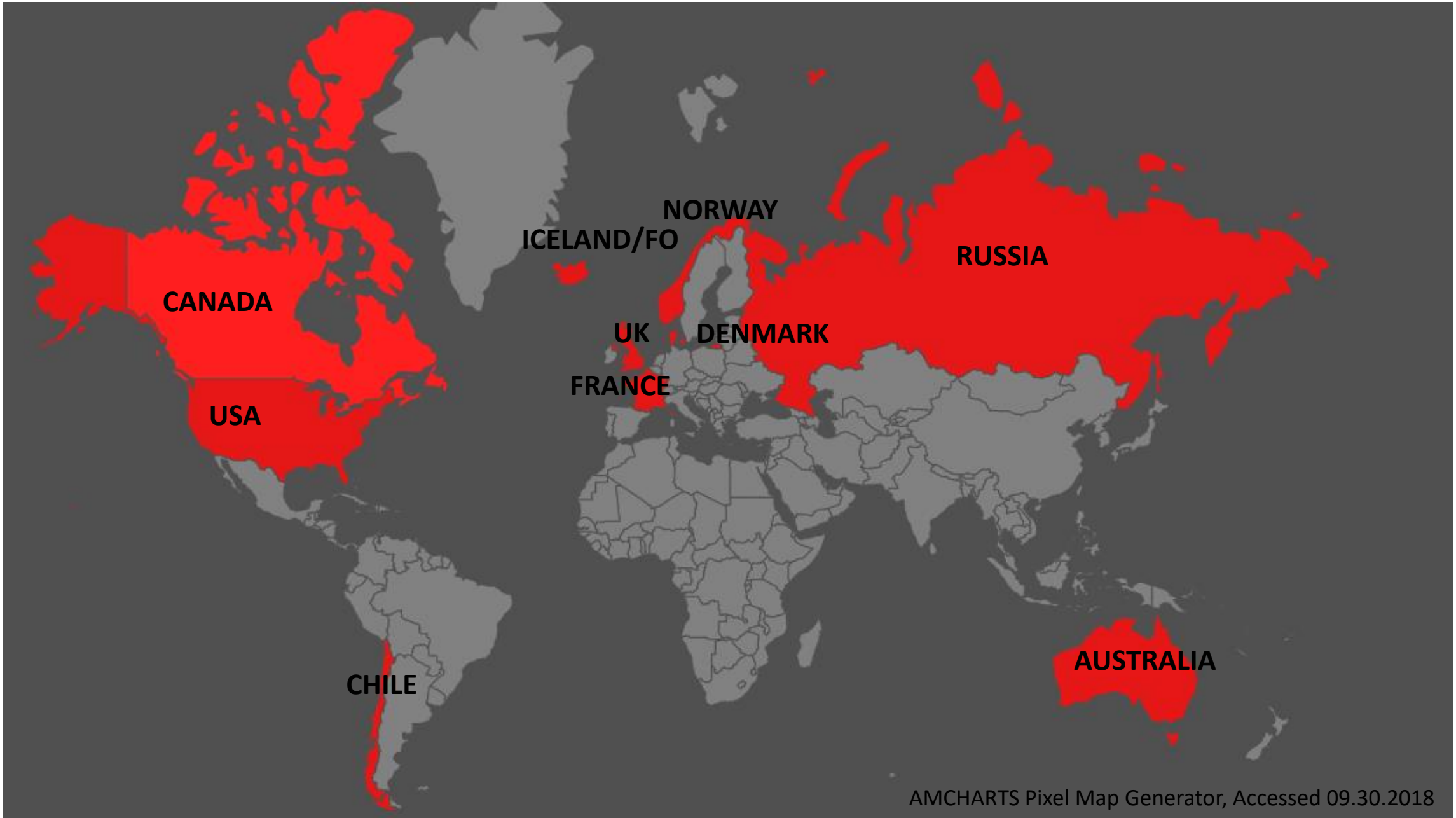
FIGURE 1

WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION



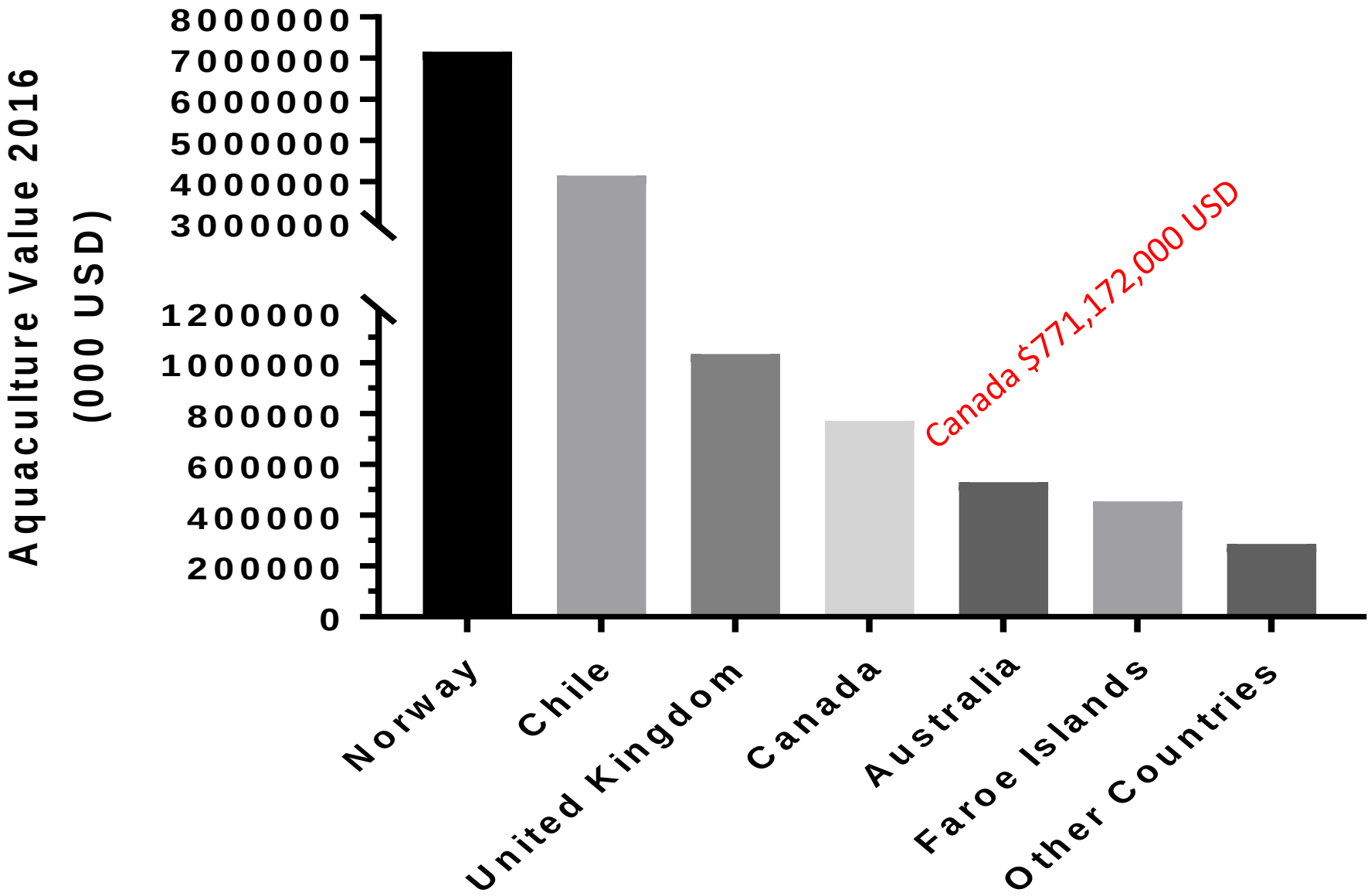
FAO State of the worlds fisheries and aquaculture 2016, Accessed 09.30.2018

Introduction

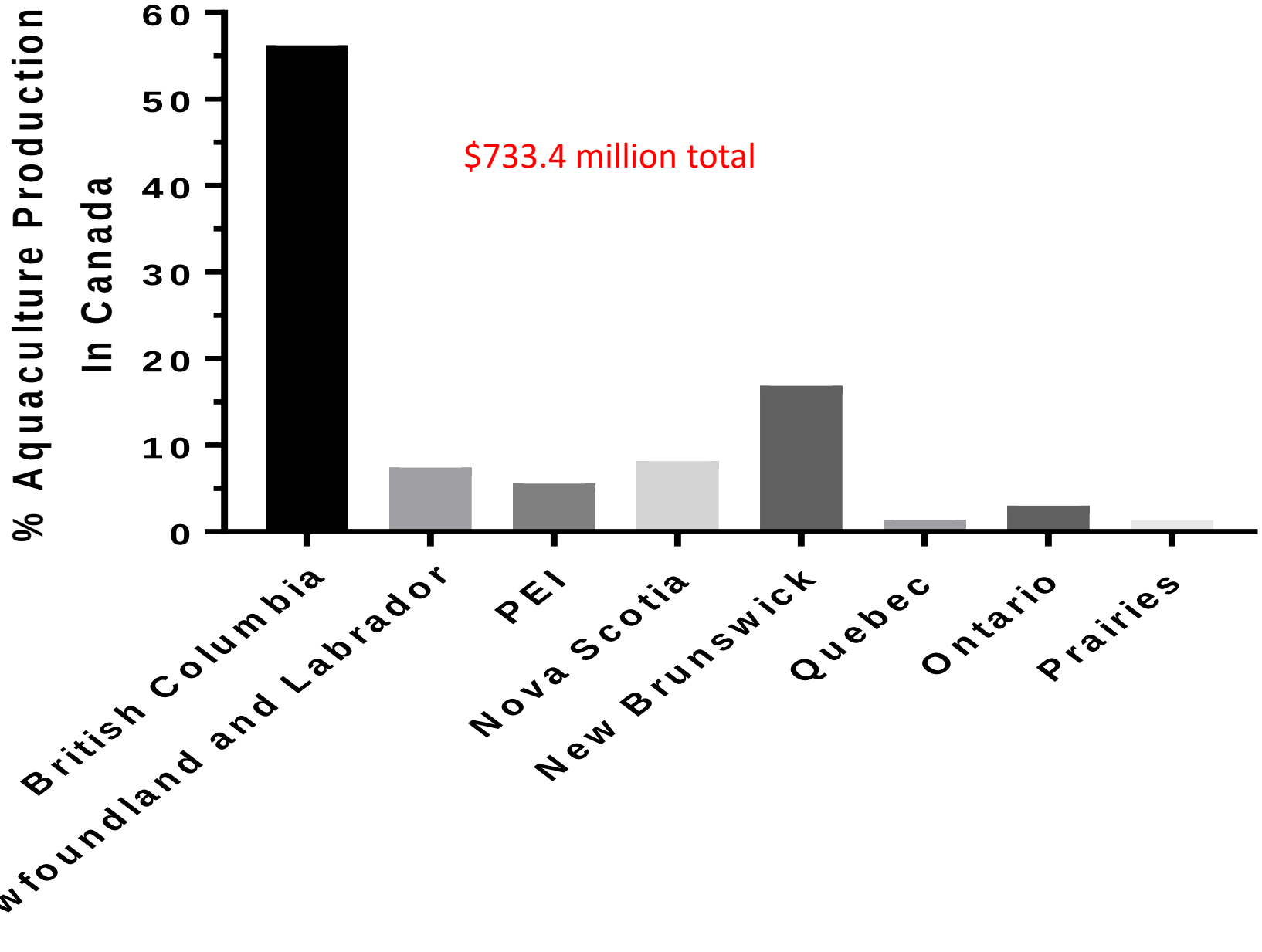


AMCHARTS Pixel Map Generator, Accessed 09.30.2018

Introduction

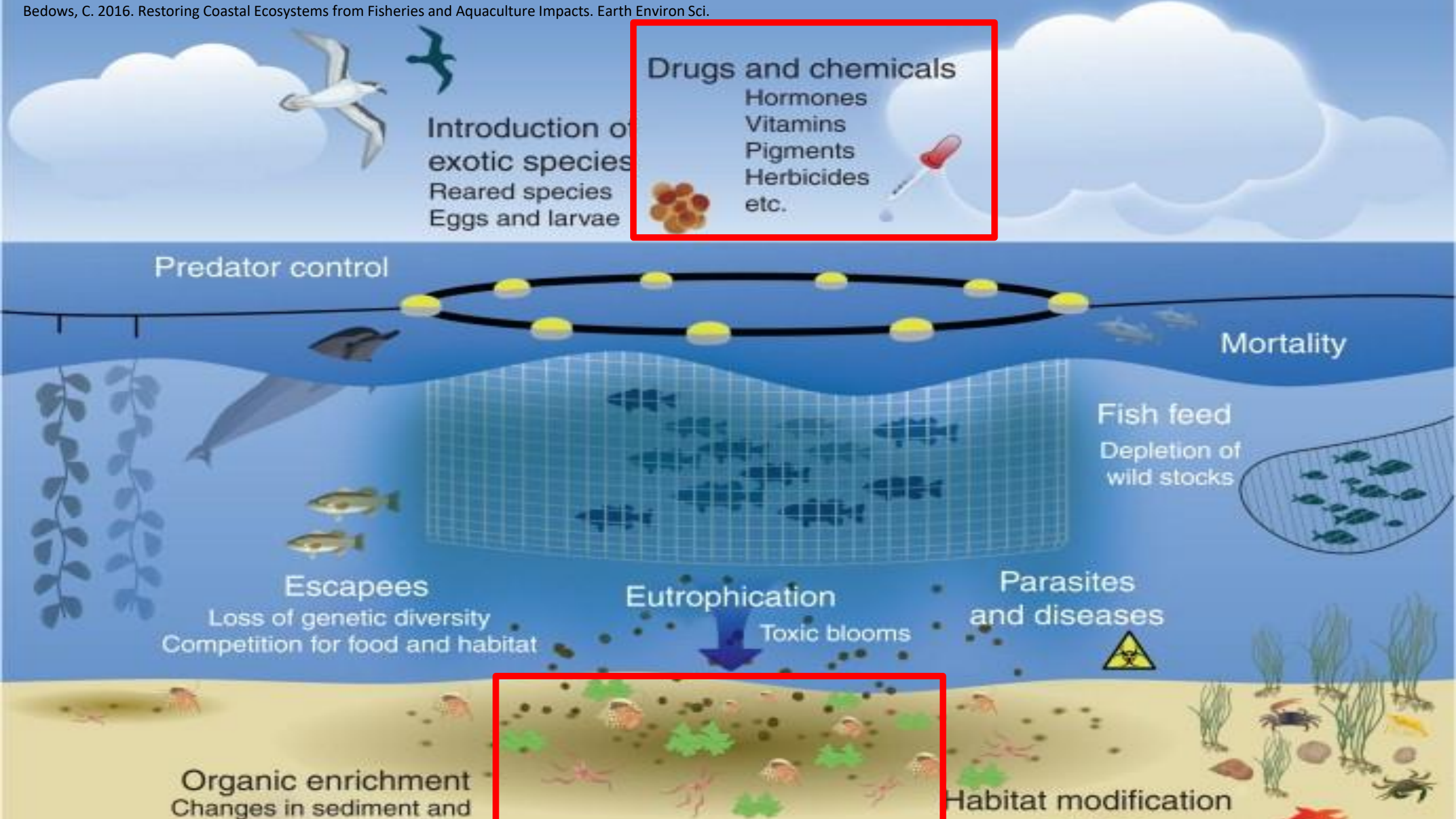


Introduction

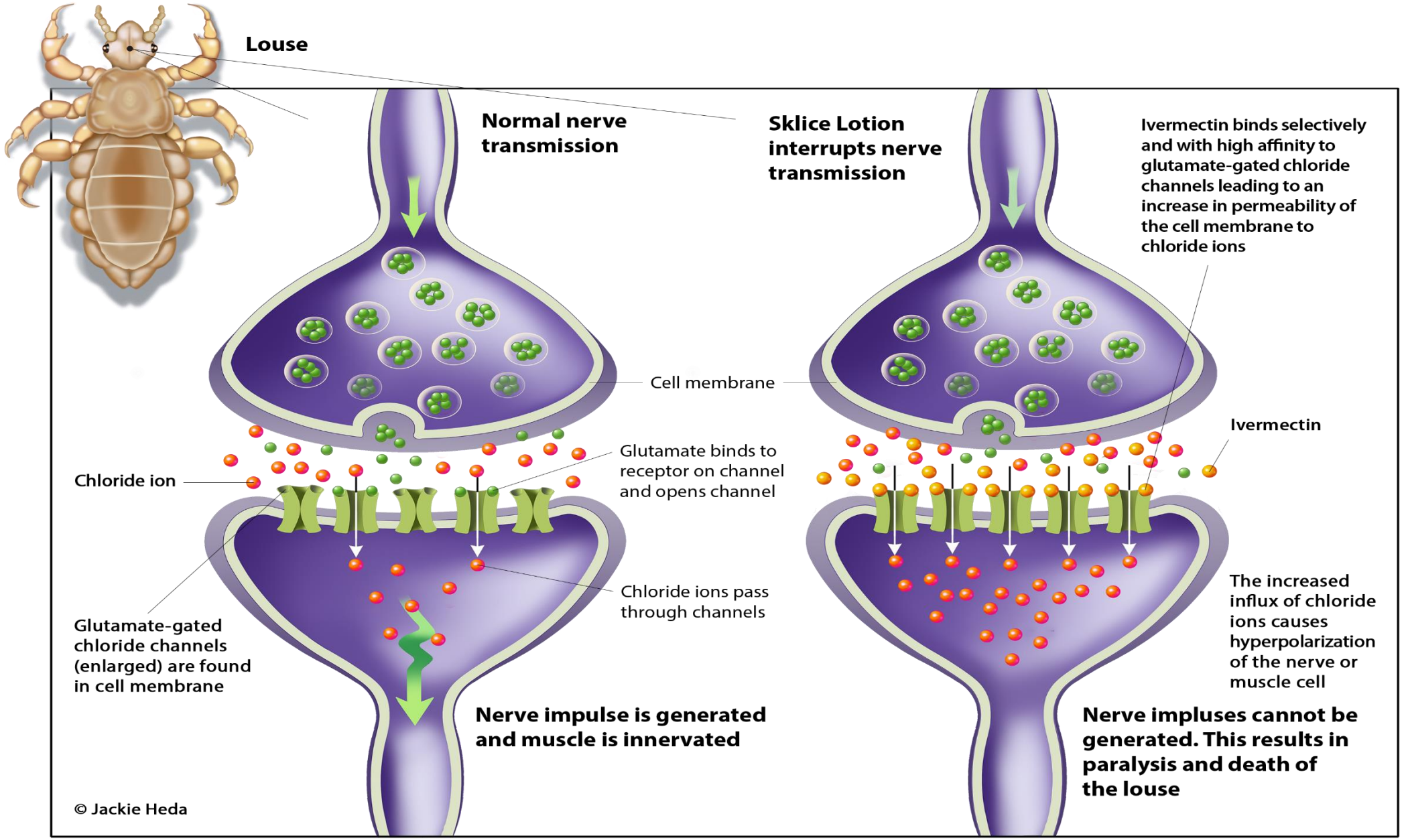


DFO and Statistics Canada.http://www.dfo-mpo.gc.ca/aquaculture/collaboration/ccfam-eng.html. Accessed 09.30.2018

Bedows, C. 2016. Restoring Coastal Ecosystems from Fisheries and Aquaculture Impacts. Earth Environ Sci.

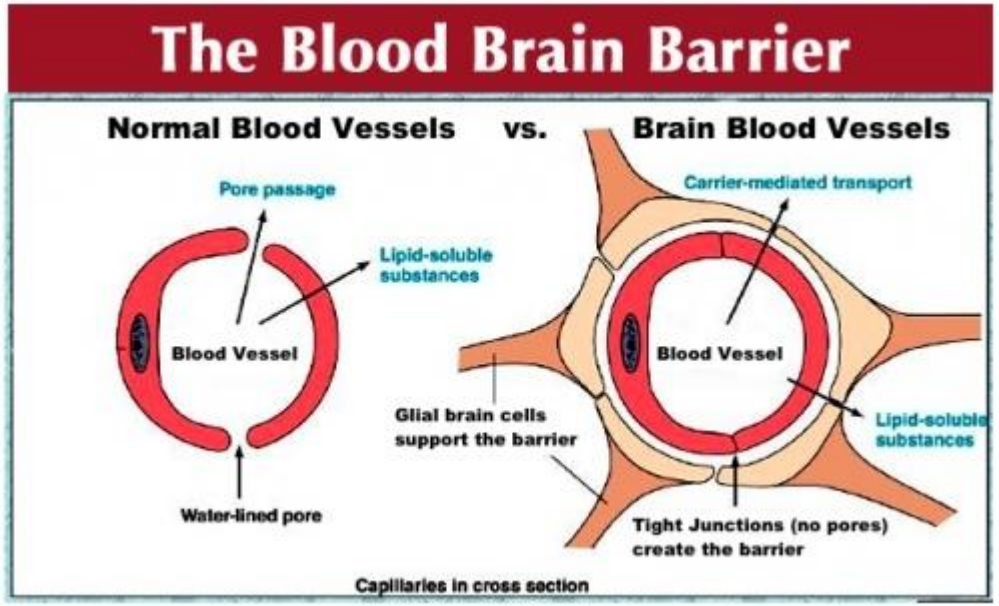


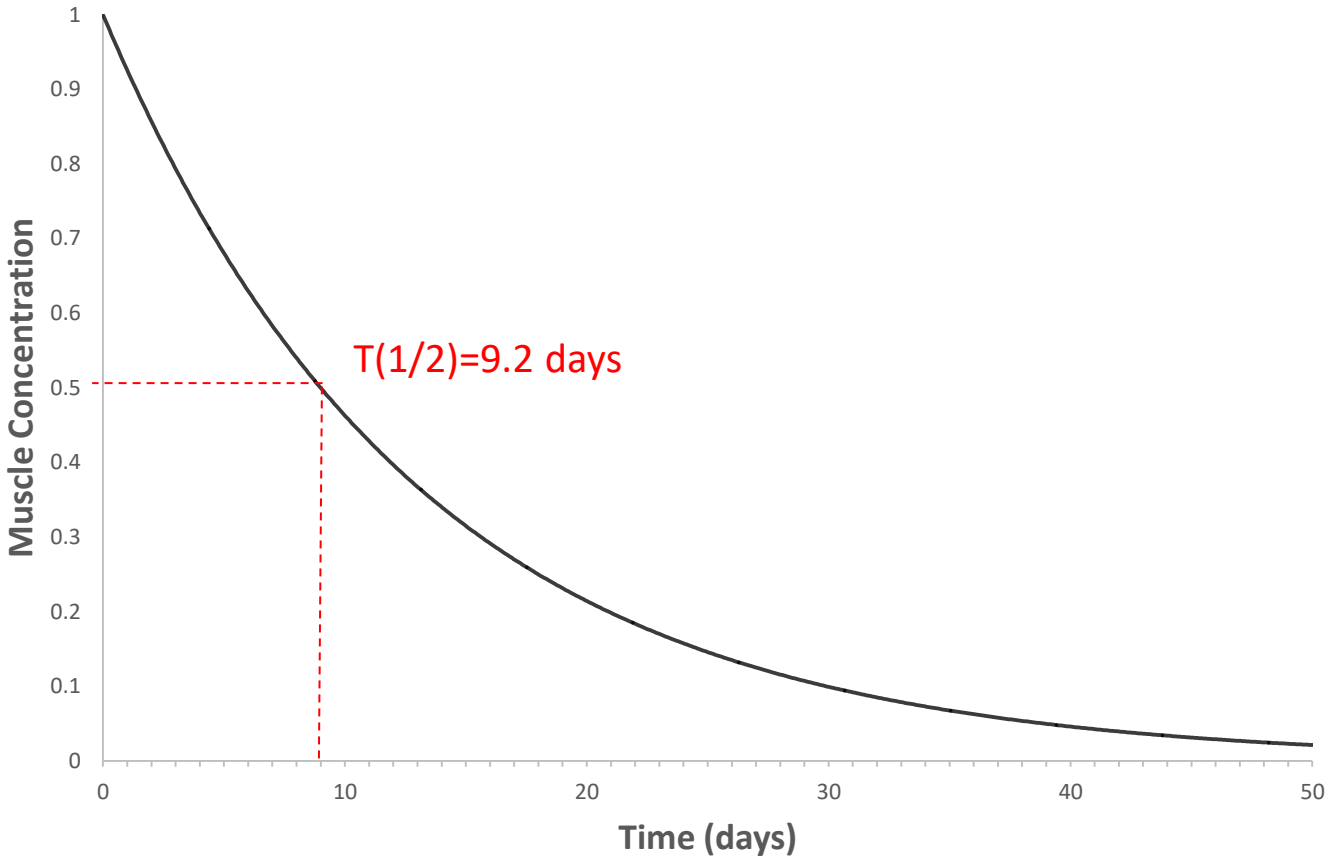
Introduction: Why Avermectins?

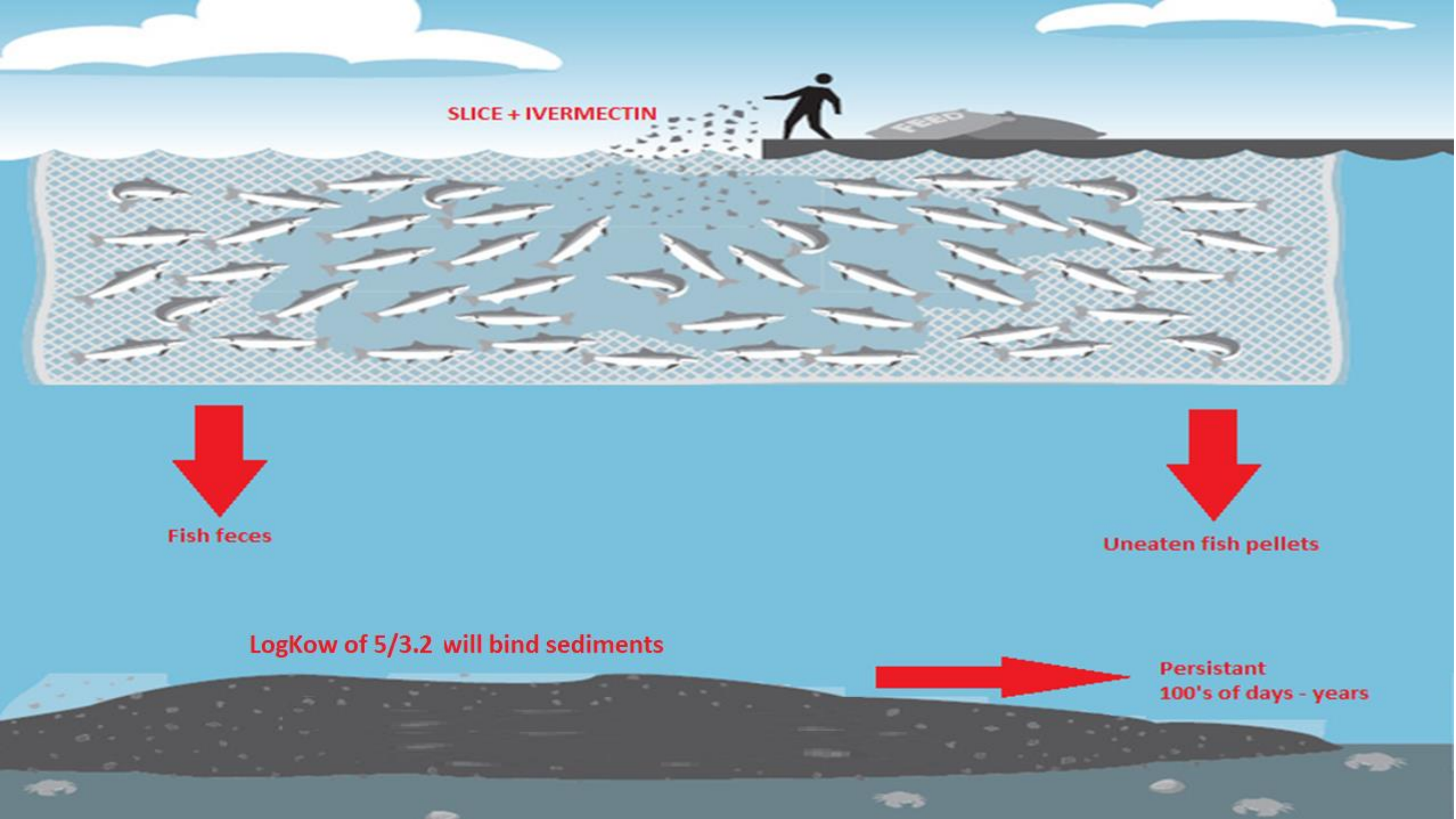


https://www.sklice.com/hcp/about-ivermectin

Introduction: Why Avermectins?

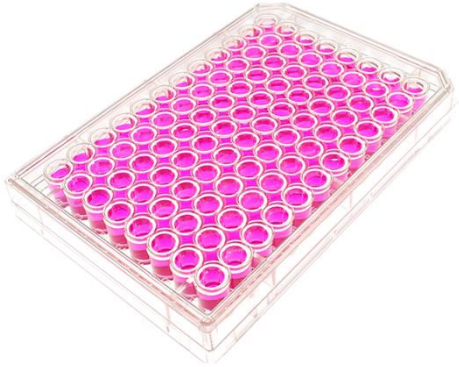


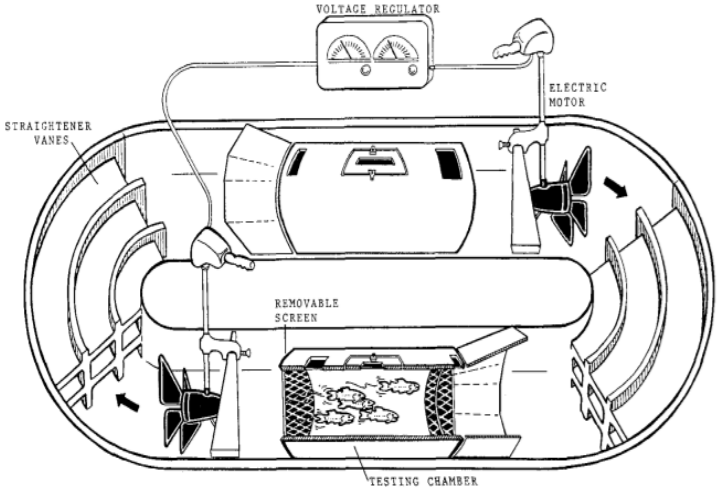



SLICE + IVERMECTIN
Fish feces
Uneaten fish pellets
LogKow of 5/3.2 will bind sediments
Persistant
100's of days - years

Materials and Methods: Project Design

- Two Parts
  1. Physiology and biochemistry





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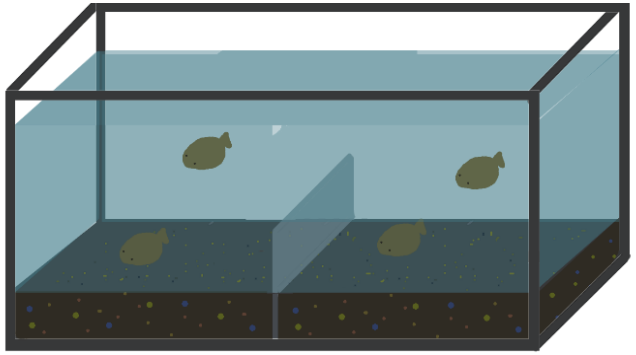
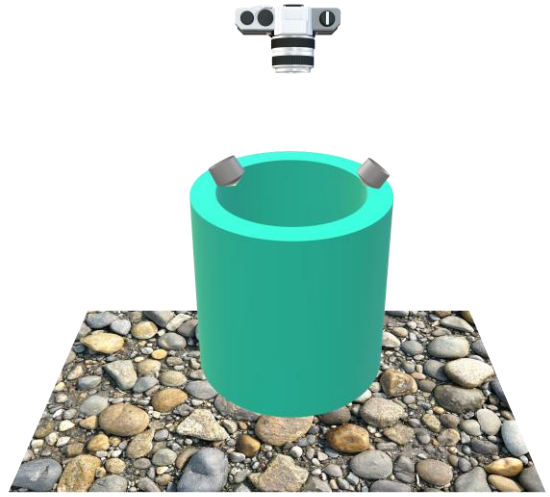
  2. Avoidance behaviour and camouflage



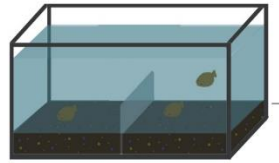


Materials and Methods: Avoidance and Camouflage

Fish Harvest:
Boundary Bay and Lower Fraser River

2 Week Fish Acclimation

3 Fish No Exposure
48h Avoidance Assay

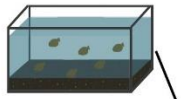


3 Fish 48h Avoidance Assay

Endpoints:

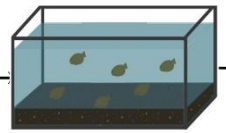
- Initial time/side
- Mean # fish/side over 48h
- Count of fish/side at 48h
- # camouflaged over 48h
- # burrowed over 48h

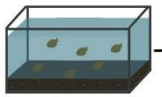
3 Replicate Tanks per Dose



6 Fish per Tank

Anesthetize
VIE Tag
Measure/Weigh
30 d Exposure





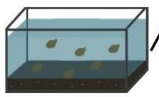
3 Concentrations/Chemical

1200 and 12 µg/kg SLICE

1000 and 10 µg/kg IVM

1200 and 12 µg/kg SLICE
+ 1000 and 10µg/kg IVM

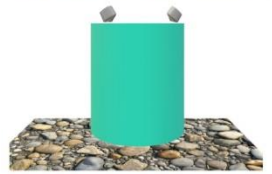
- CTRL



Sediment Collection:
Centennial Beach, Boundary Bay

Bulk Sediment Stock Mixing

Serial Dilutions of Stock



3 Fish Camouflage Assay

Endpoints:

- Difference in power or pattern vs substrate
- Change in power/time

Fish Harvest:
Boundary Bay and Lower Fraser River

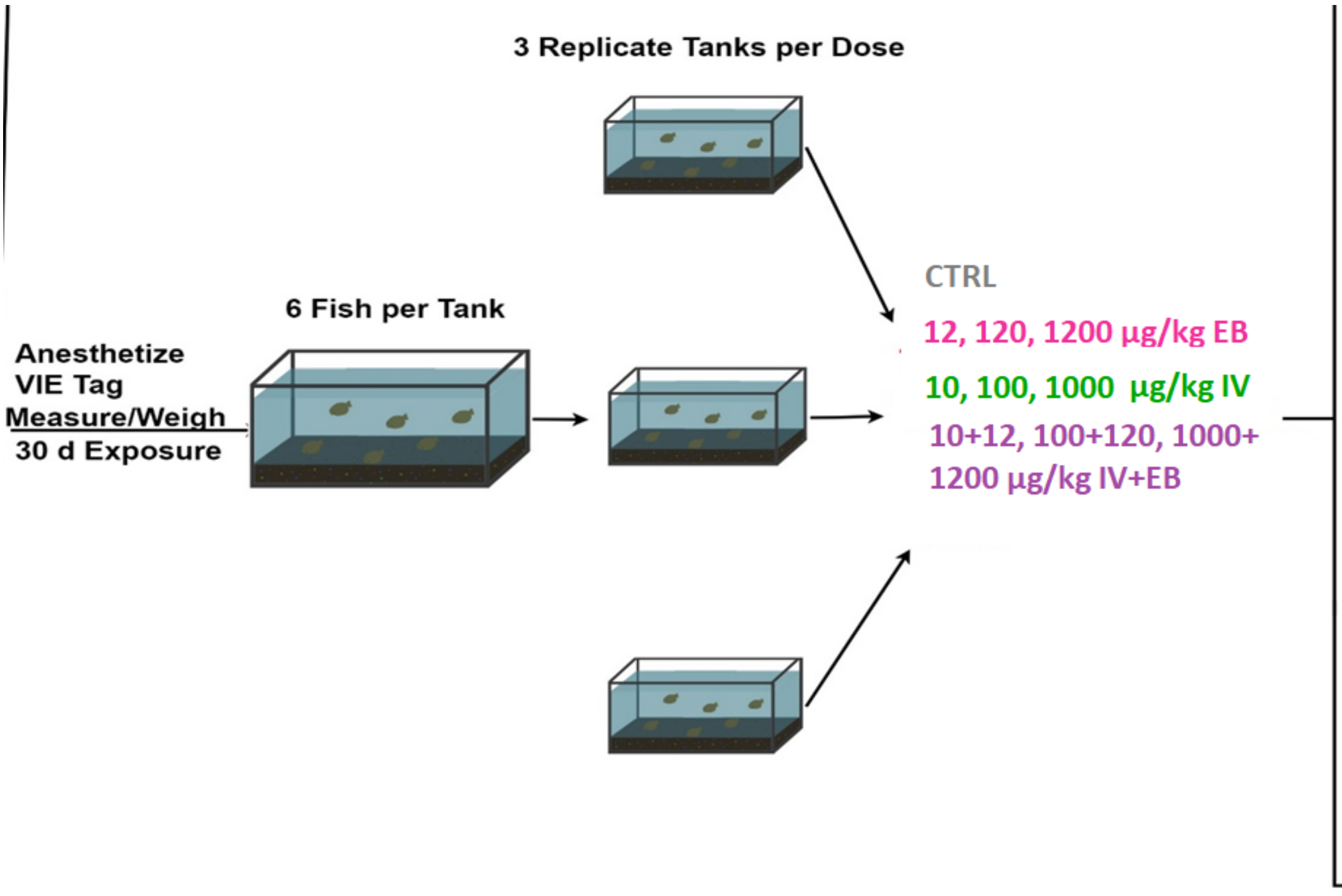
2 Week Fish Acclimation

Anesthetize
VIE Tag
Measure/Weigh
30 d Exposure

Sediment Collection:
Centennial Beach, Boundary Bay

Bulk Sediment Stock Mixing

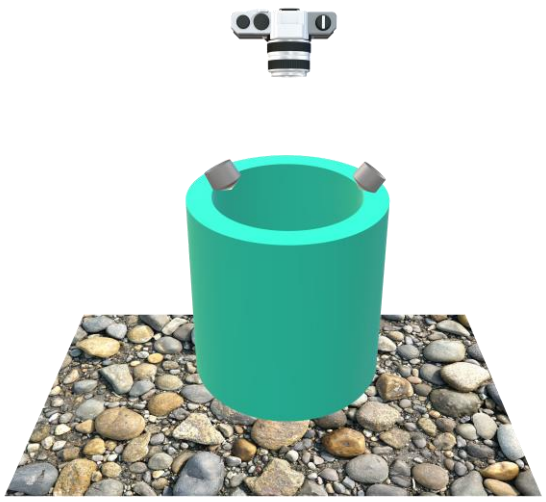
Serial Dilutions of Stock

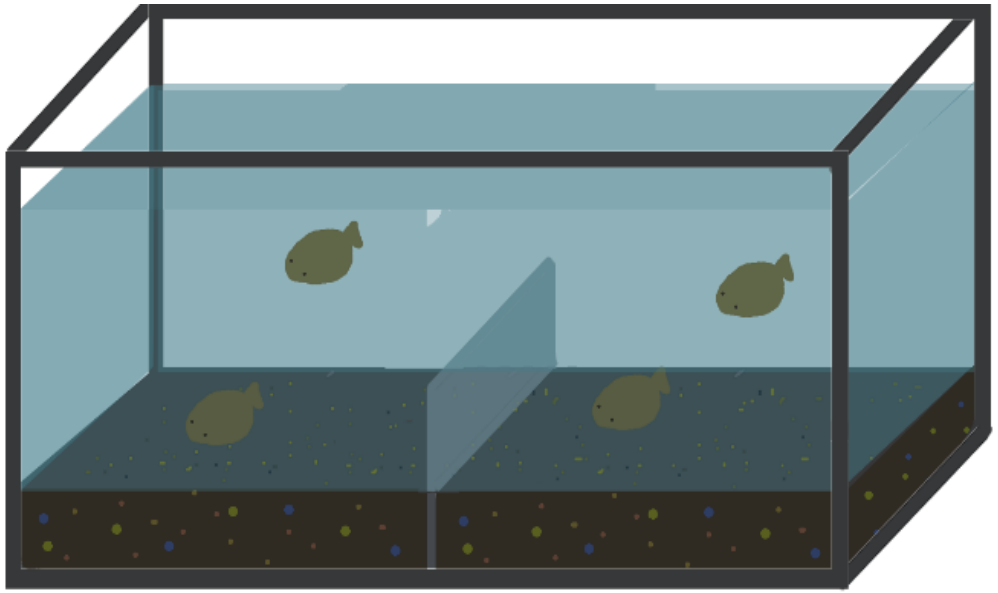

3 Replicate Tanks per Dose
6 Fish per Tank
Anesthetize
VIE Tag
Measure/Weigh
30 d Exposure
CTRL
12, 120, 1200 µg/kg EB
10, 100, 1000 µg/kg IV
10+12, 100+120, 1000+
1200 µg/kg IV+EB

Materials and Methods: Avoidance and Camouflage

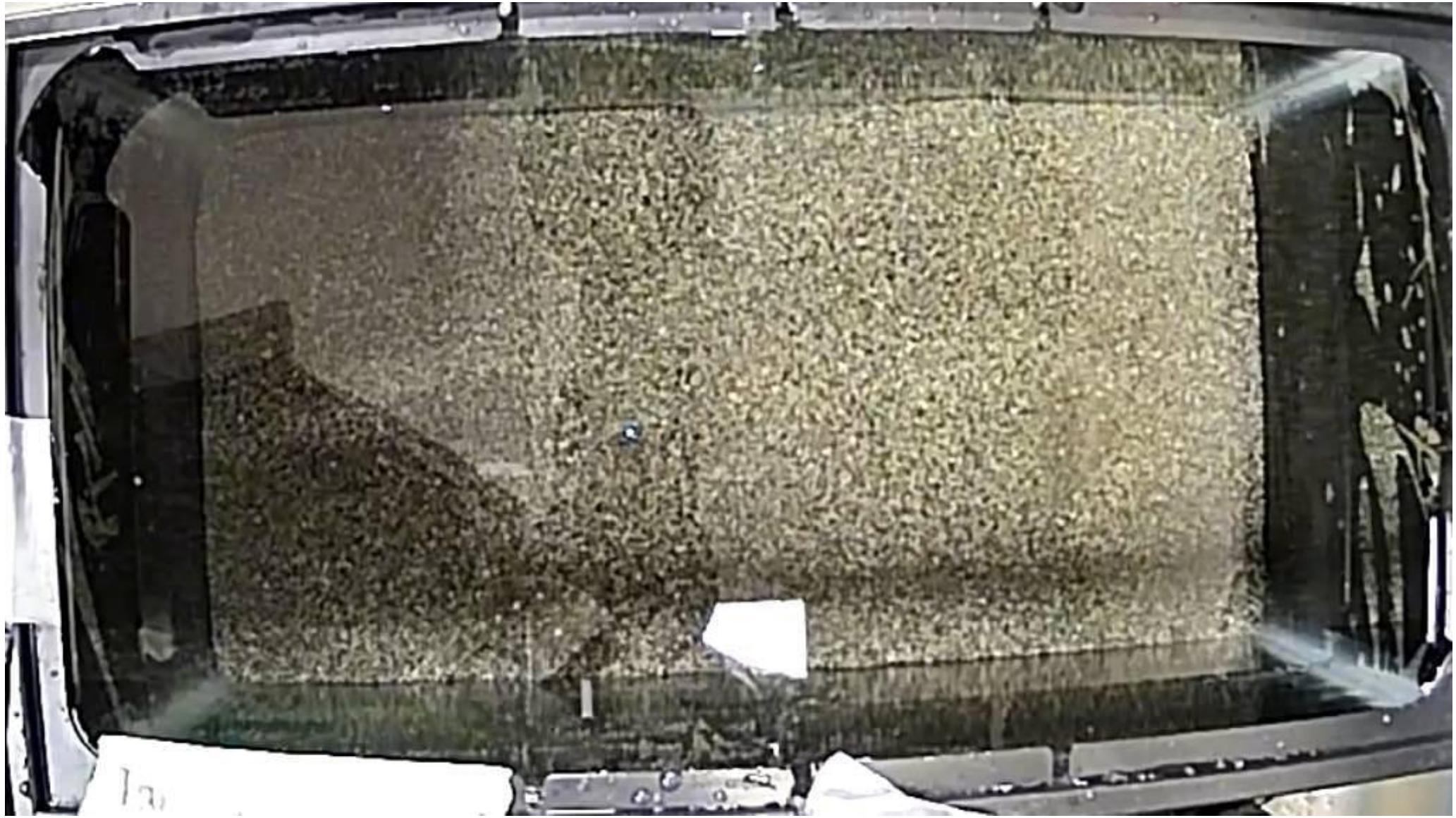
- Two components
  1. 48h avoidance assay with no previous exposure to the pesticides

  2. 30d exposure, 6 fish
     a) 3 fish from 30d exposure same 48h avoidance assay
     b) Other 3 fish camouflage assay

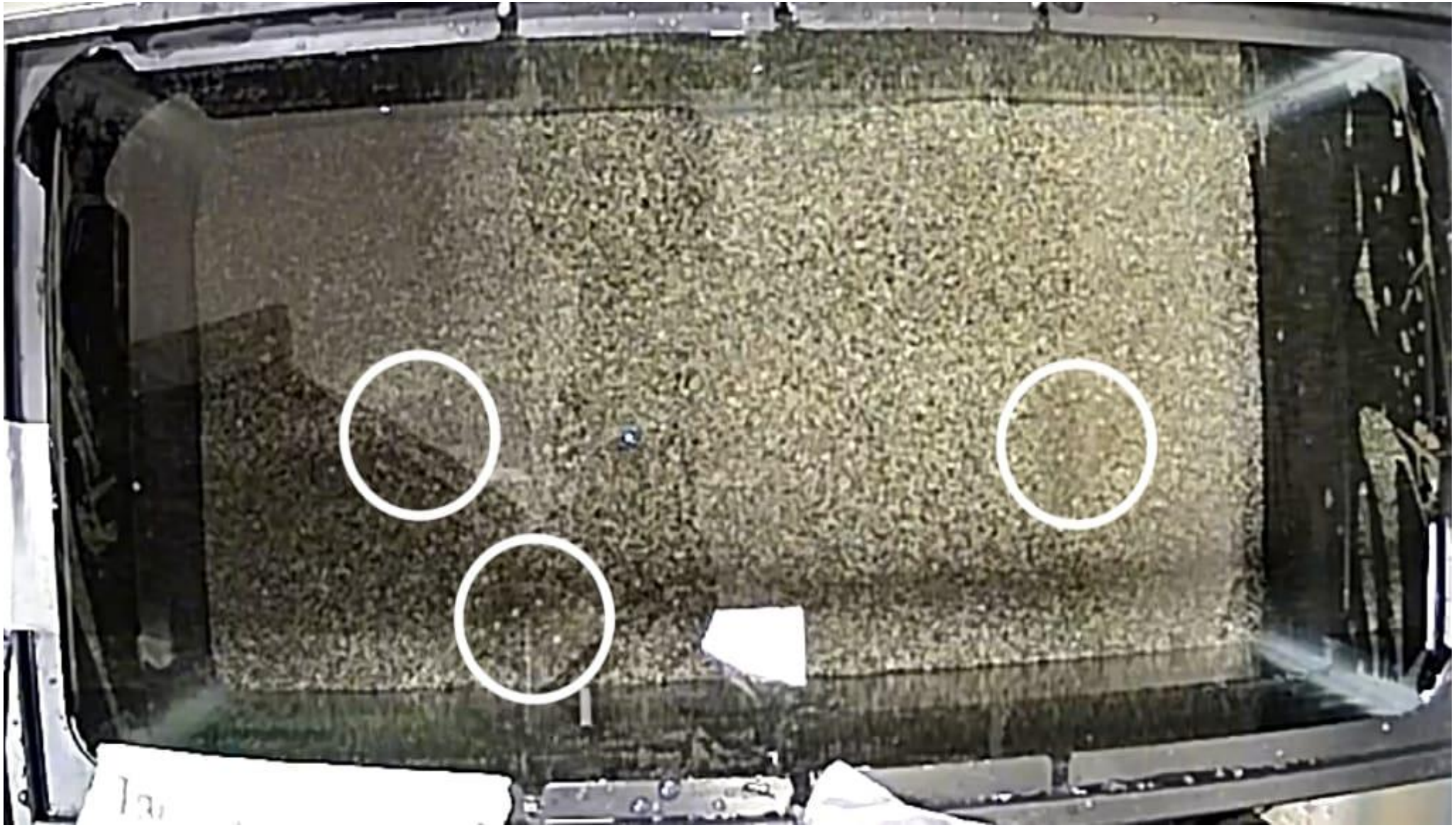




Materials and Methods: Avoidance and Camouflage



Materials and Methods: Avoidance and Camouflage



Results:

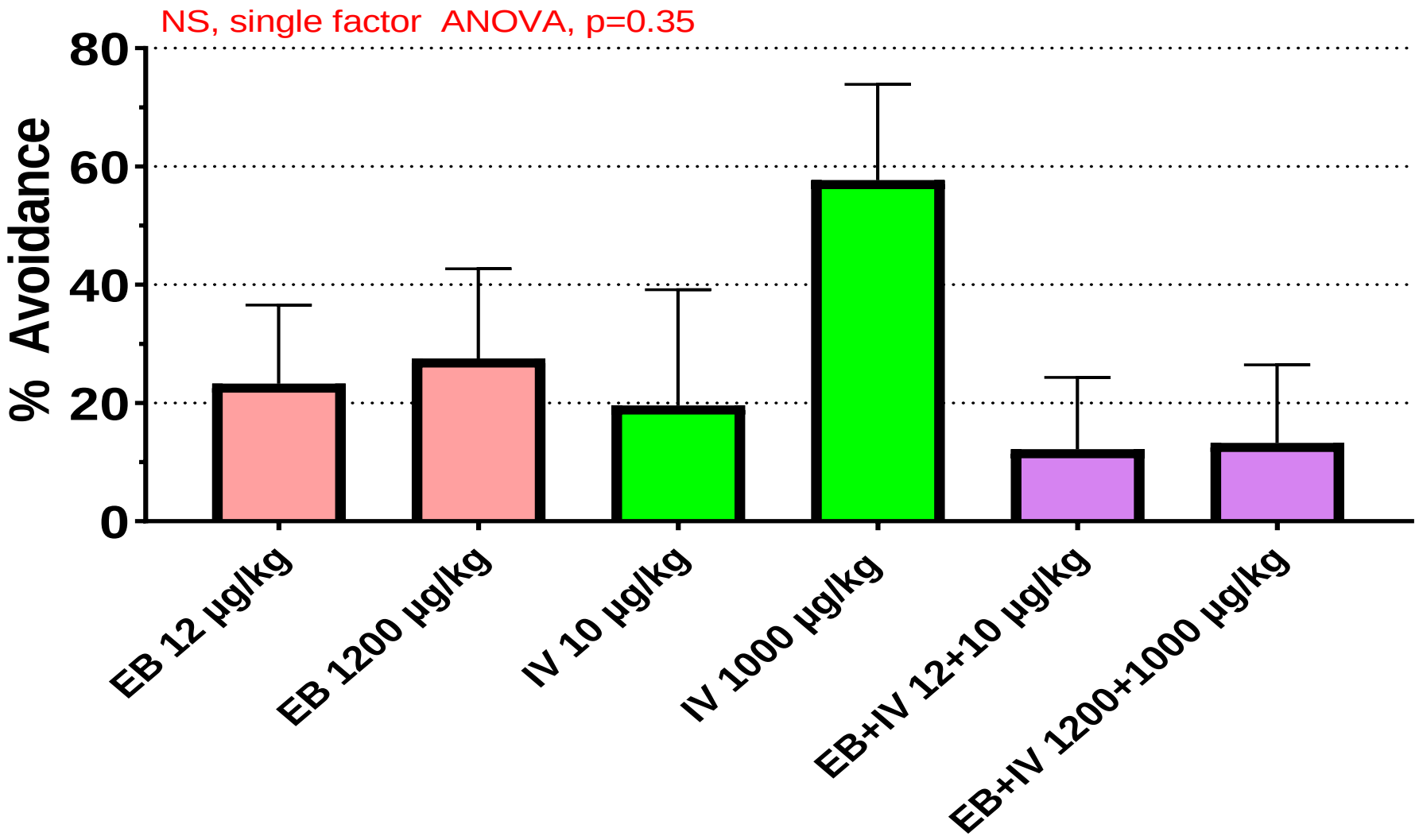
Avoidance and Camouflage

Avoidance Chamber Validation

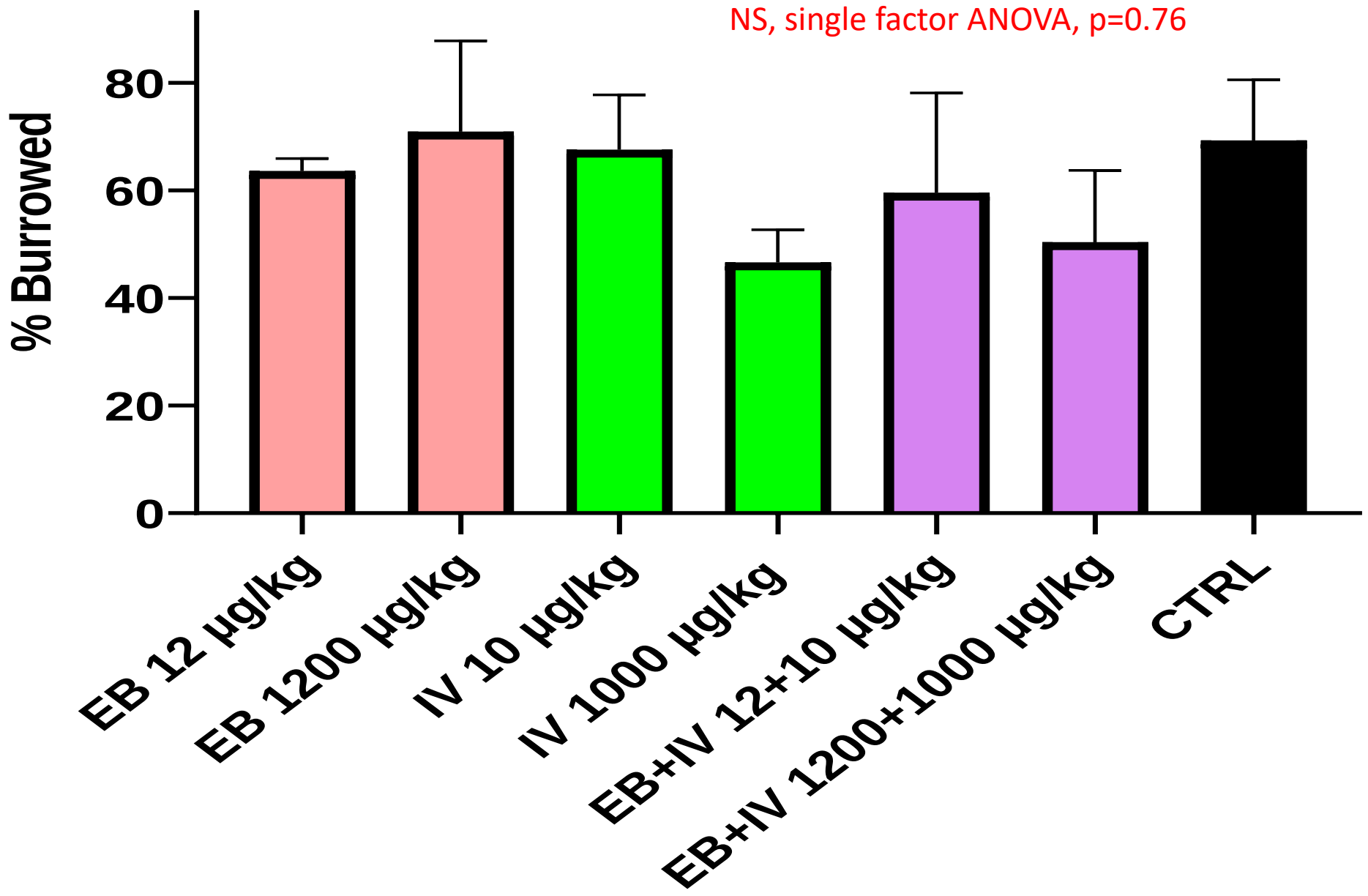
- Both sides clean sediment
- Distribution max 40:60 per side
- Avoidance 0 exposure 46:54
- Avoidance 30 d exposure 45:55

Results: Avoidance, no pre-exposure

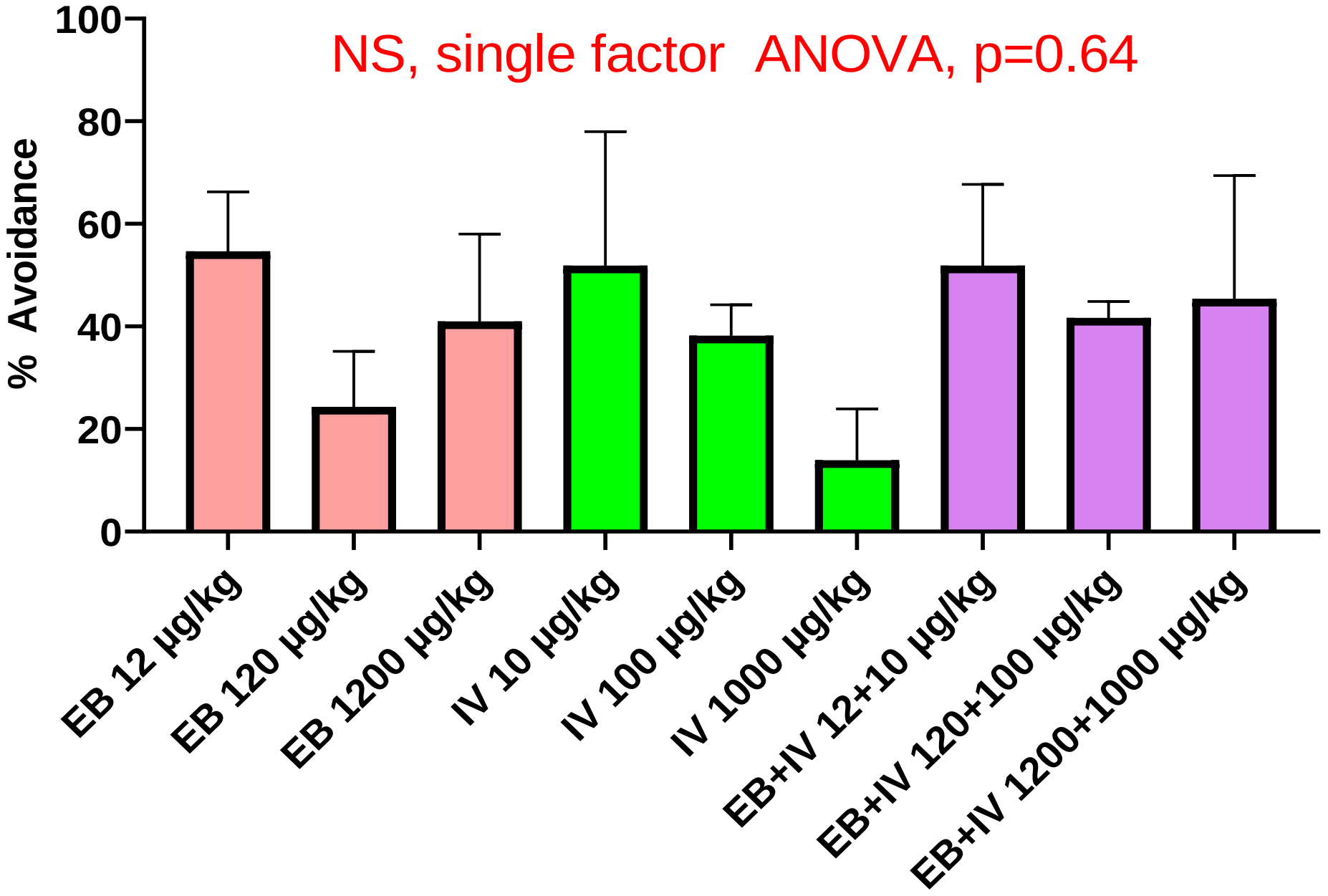
$$\%Avoidance = \left(\frac{\#clean - \#dosed}{3} \right) x100$$



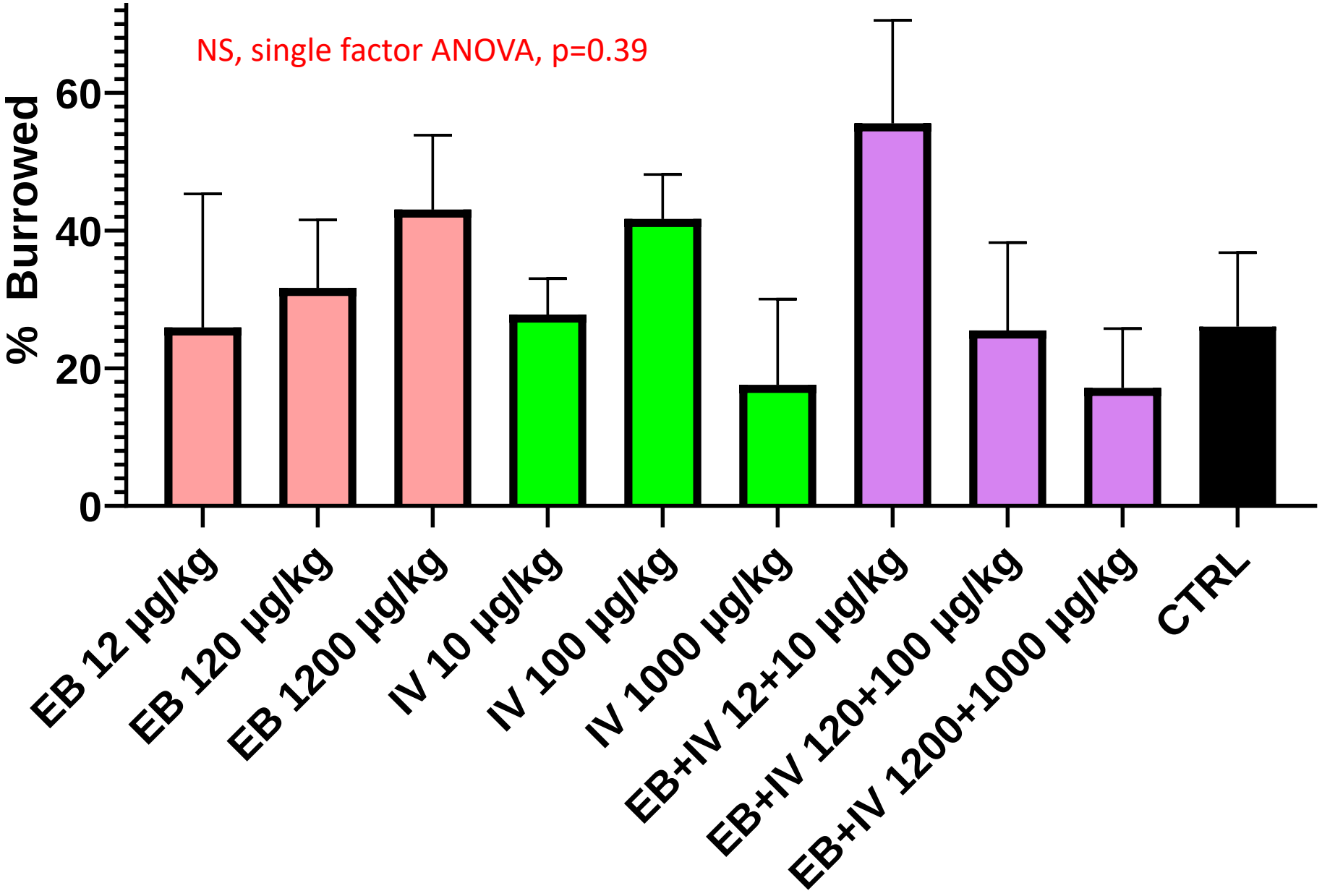
Results: Avoidance, no pre-exposure



Results: Avoidance, 30 d Exposure



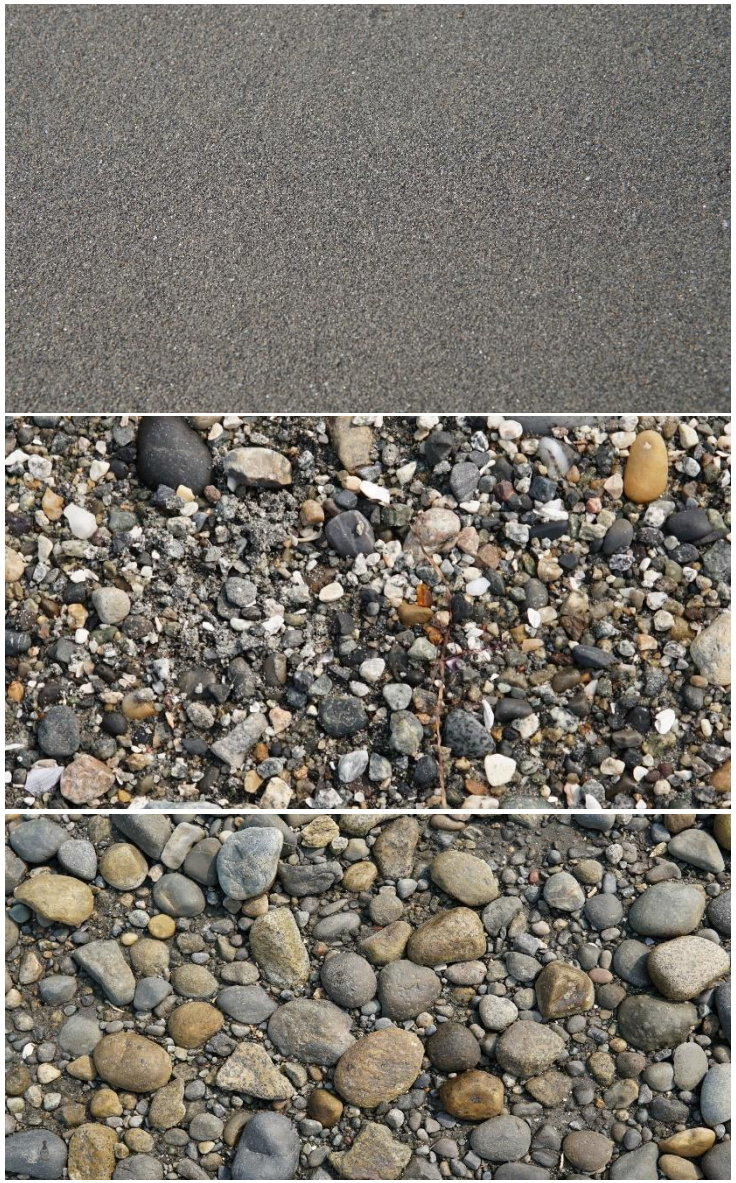
Results: Avoidance, no pre-exposure

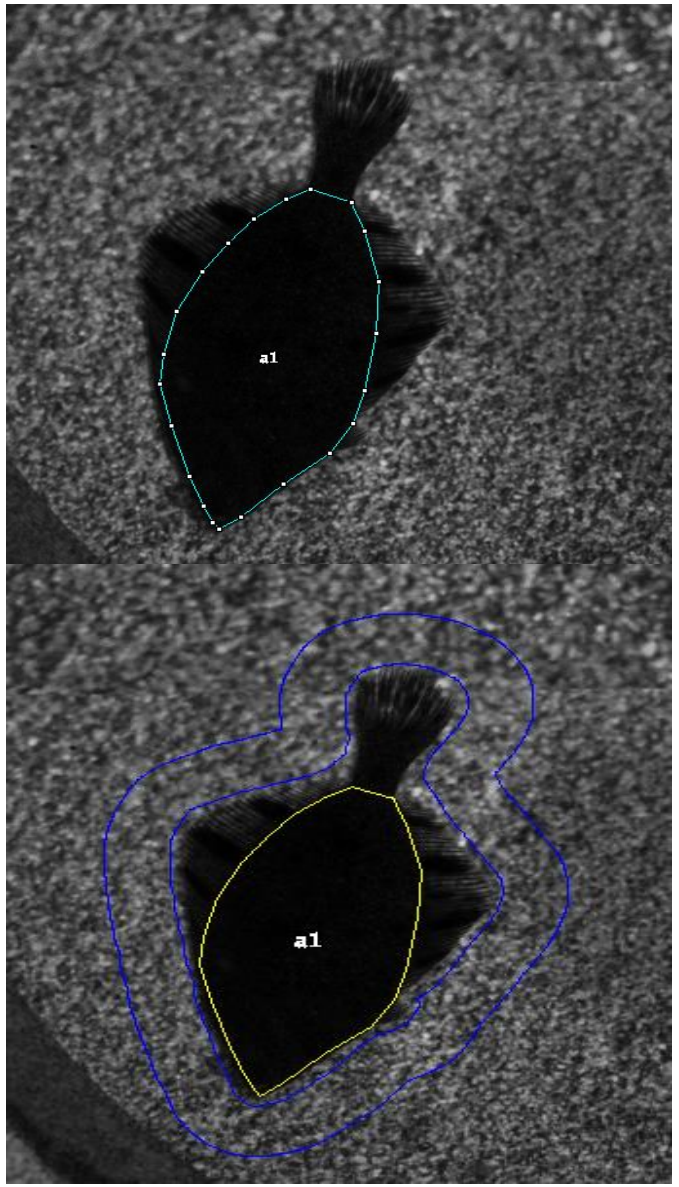


Avoidance Results Summary:

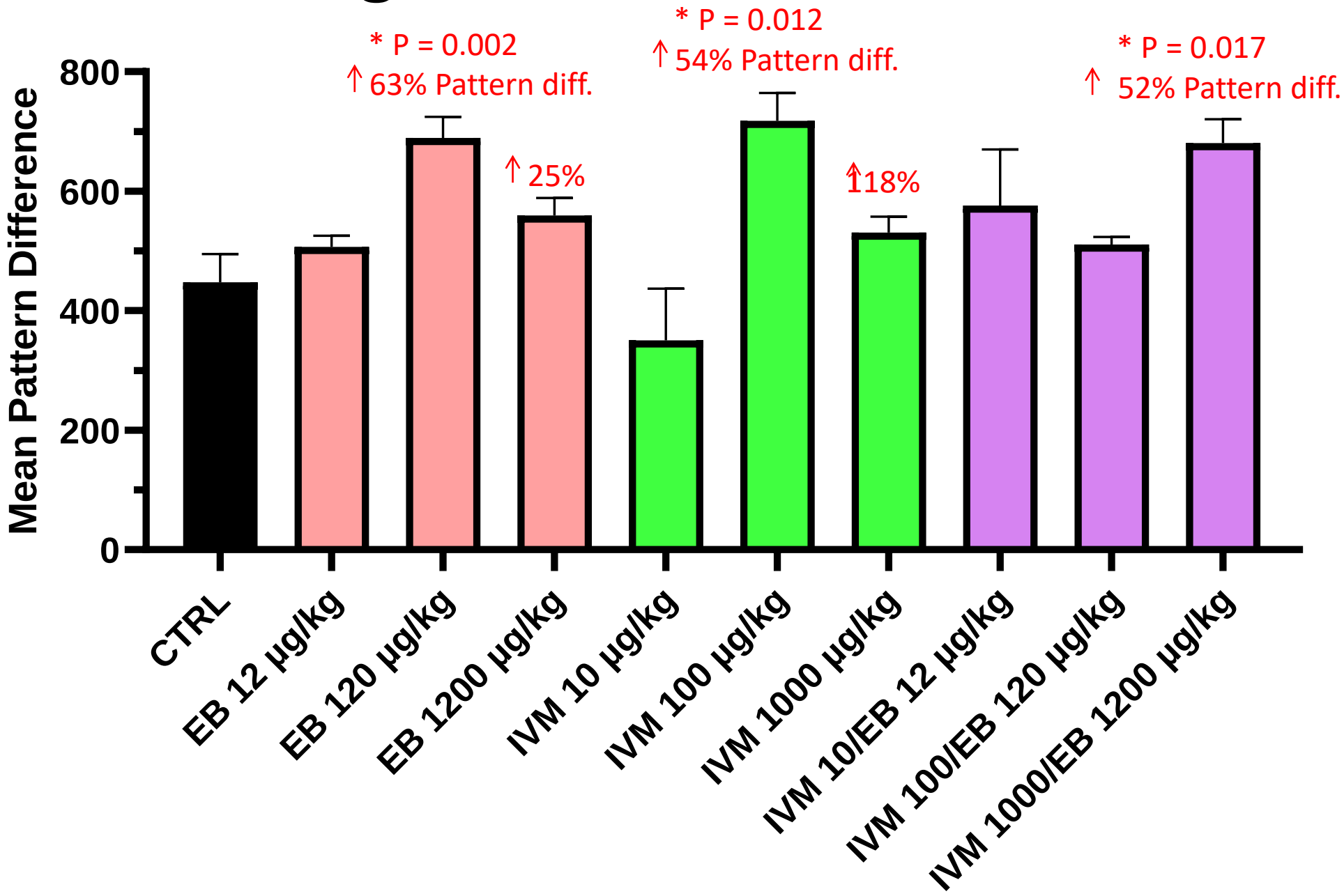
- No evidence of fish avoiding dosed sediment
- No evidence of reduced burrowing behaviour
- Future avoidance assays:
  - Larger tank with more fish
  - More tank replicates
  - Flow through system for observation over weeks instead of days

Results: Camouflage

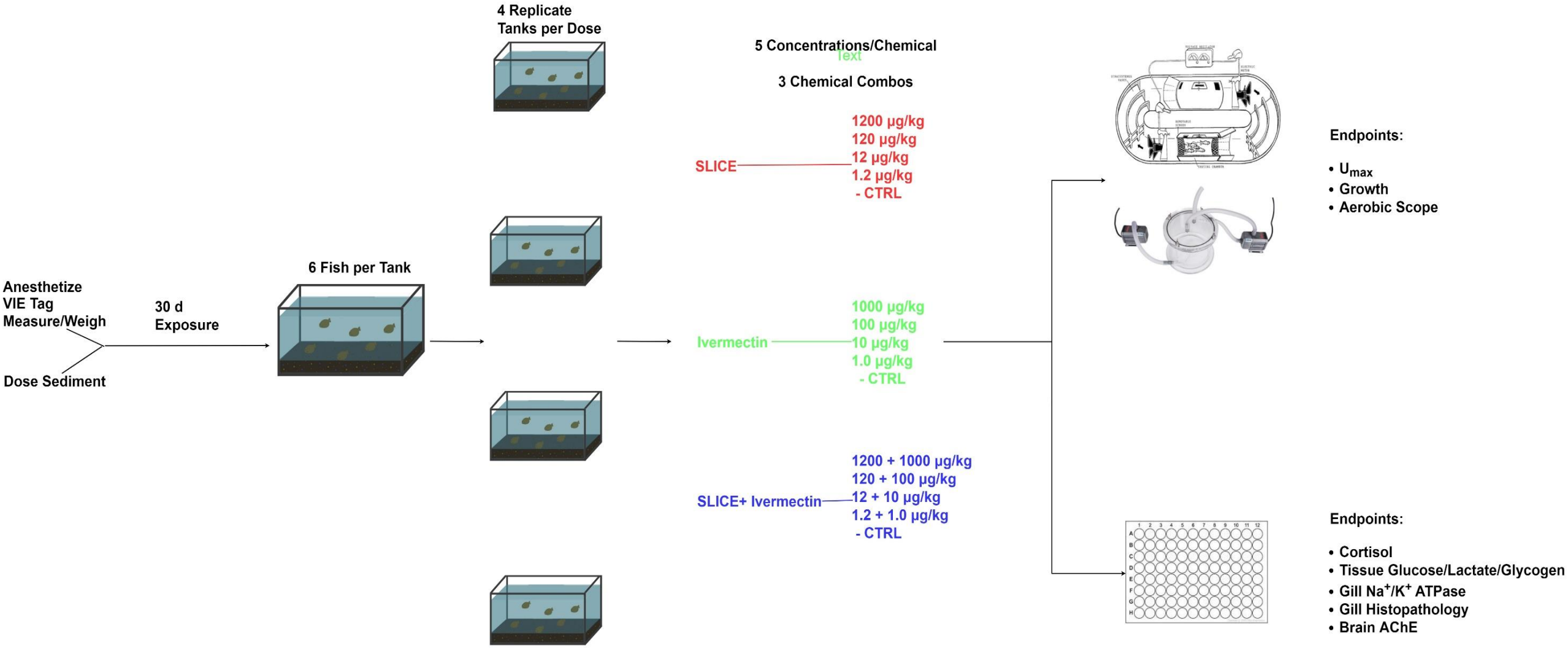




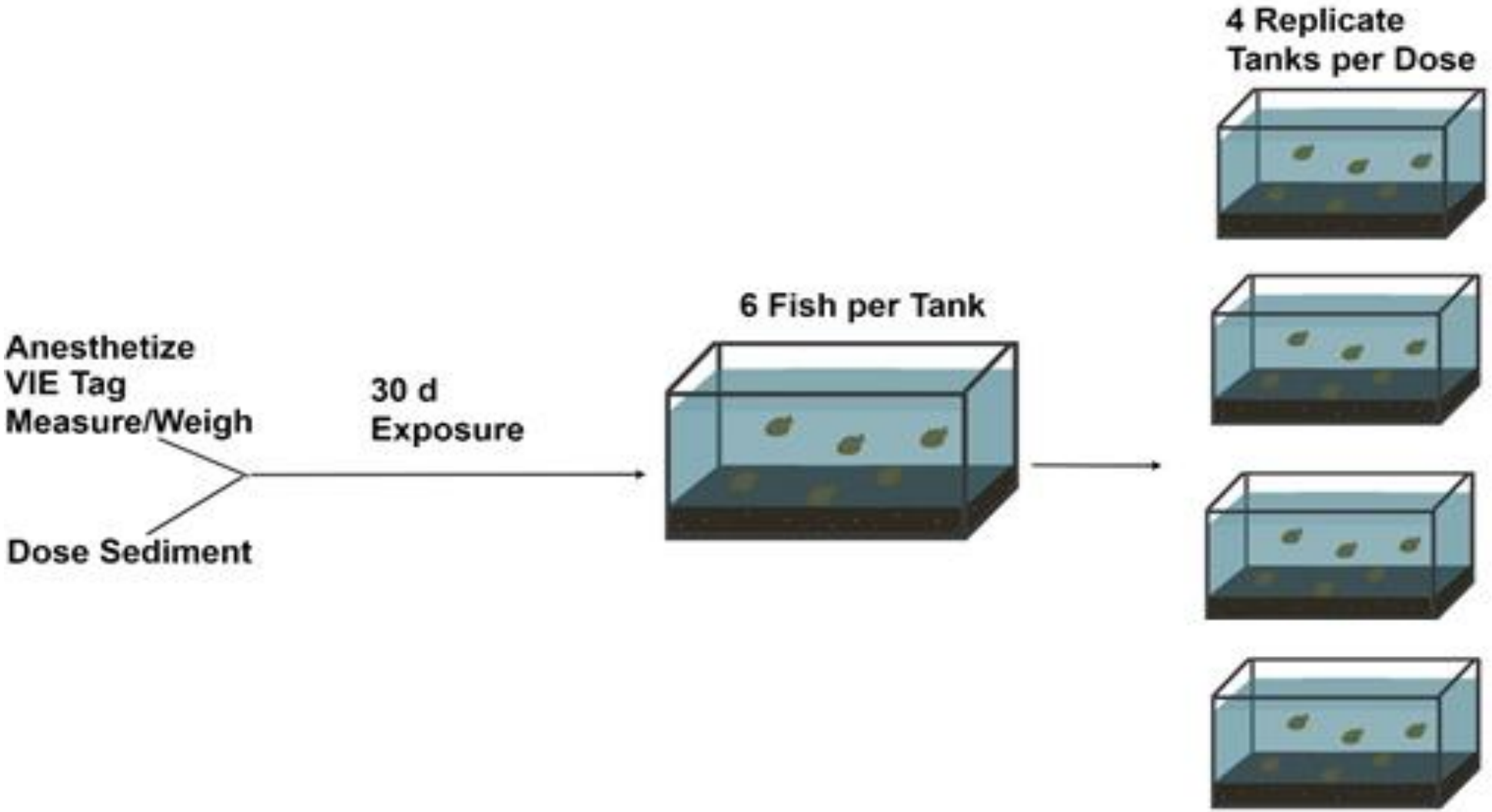
Results: Camouflage



Methods: Swim Performance, Respirometry and Biochemistry



Methods: Swim Performance, Respirometry and Biochemistry



Methods: Swim Performance, Respirometry and Biochemistry

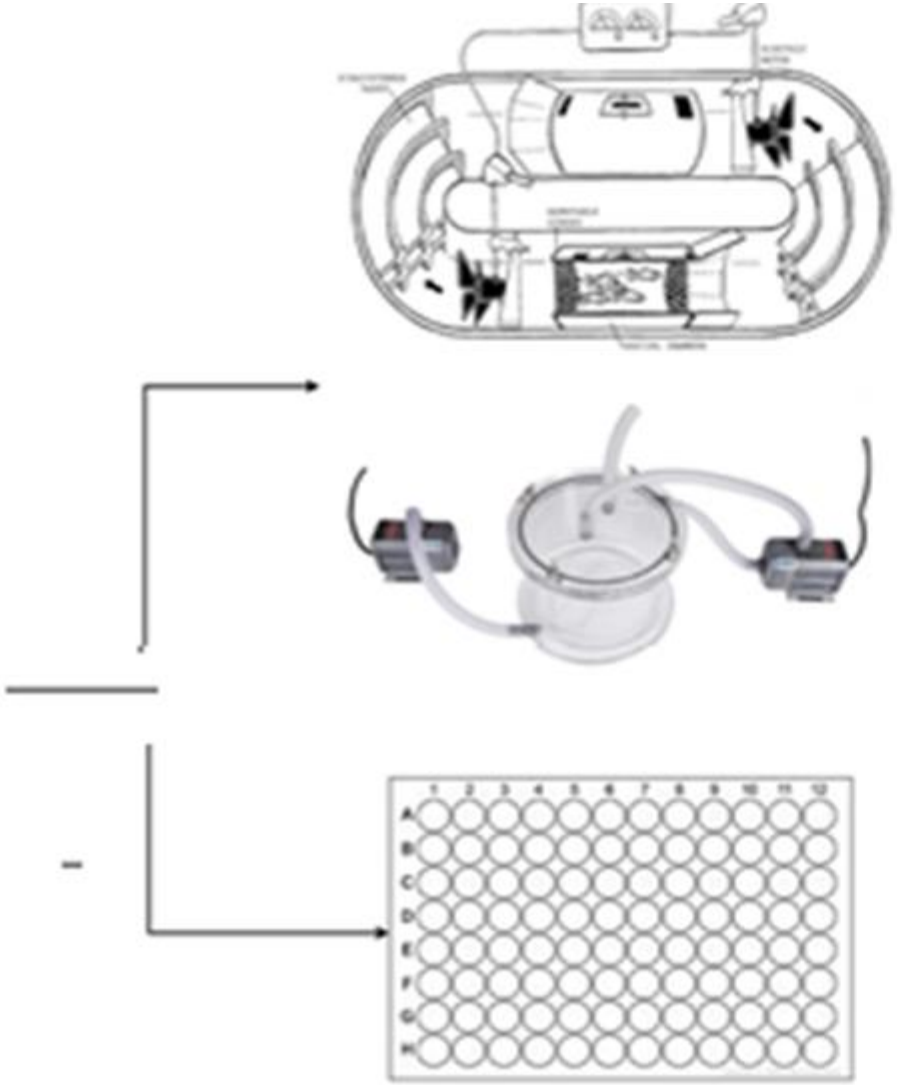
6 Concentrations/Exposure
3 Exposures

EB (SLICE ®) - CTRL, 1.2, 12, 120, 600, 1200 µg/kg

IV - CTRL, 1.0, 10, 100, 500, 1000 µg/kg

IV+EB - CTRL, 1+1.2, 10+12, 100+120, 500+600, 1000+1200 µg/kg

Methods: Swim Performance, Respirometry and Biochemistry



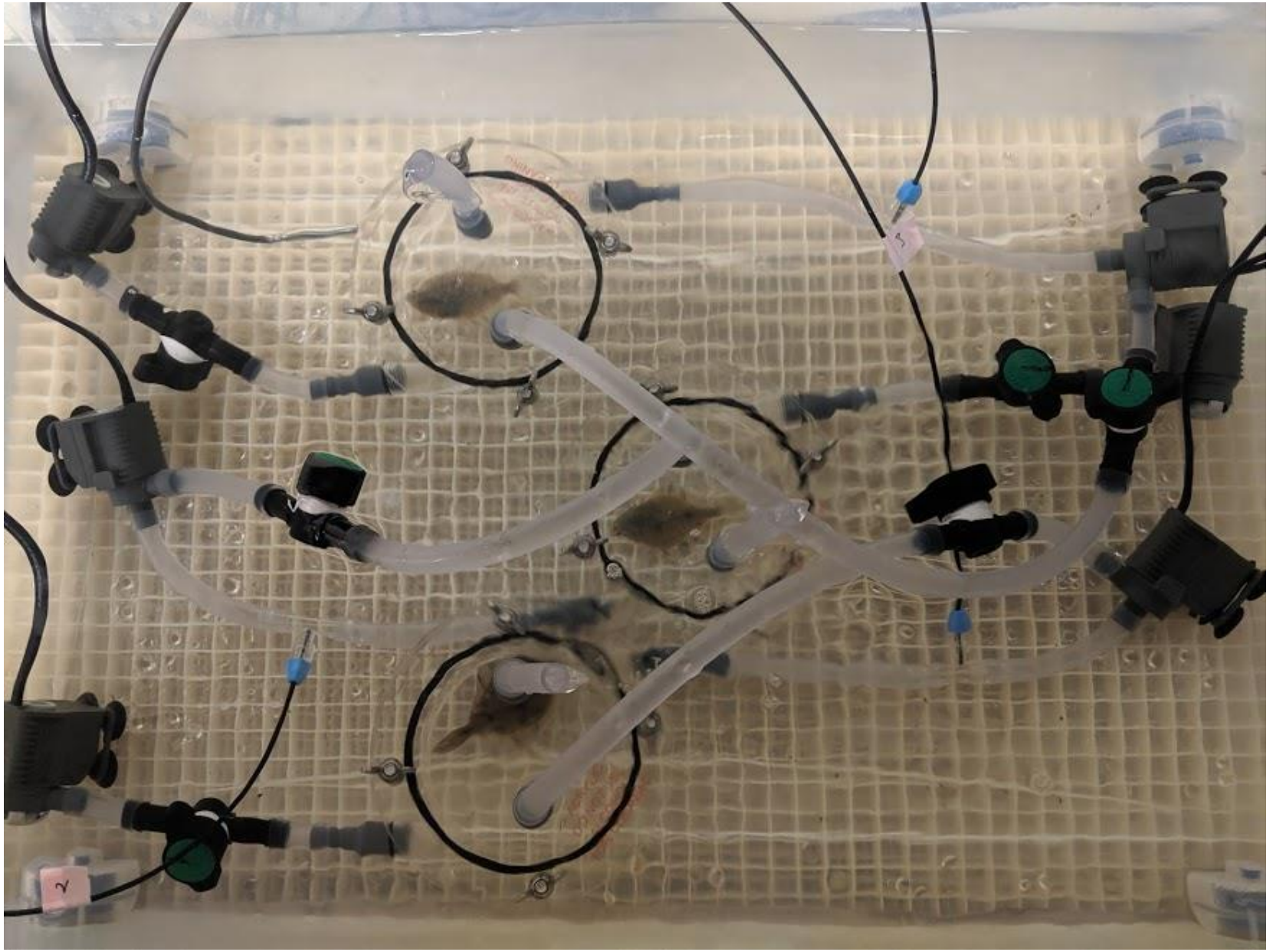
Endpoints:

- U_{max}
- Growth
- Aerobic Scope
- NMR Metabolomics

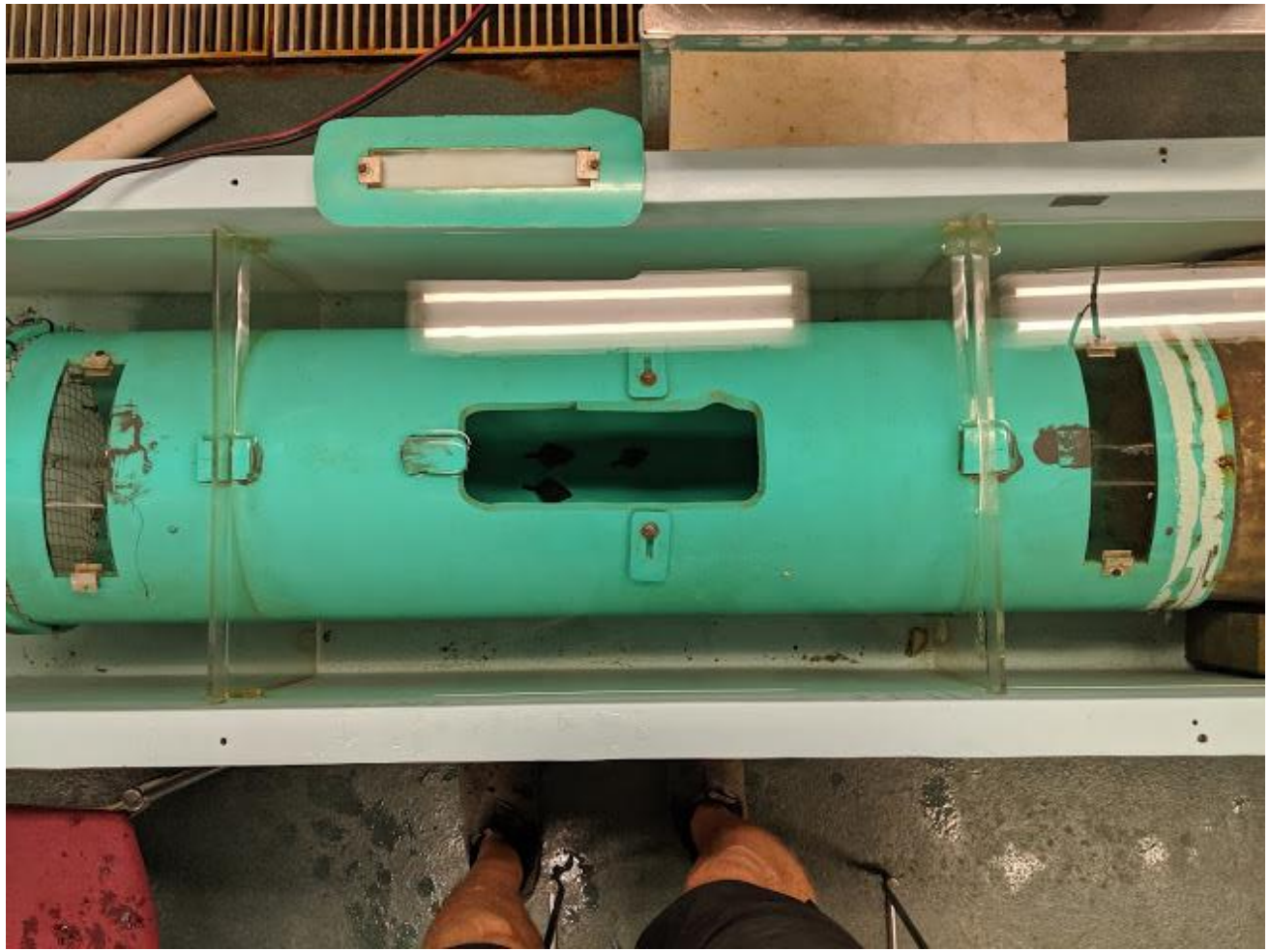
Endpoints:

- Cortisol
- Tissue Glucose/Lactate/Glycogen
- Gill Na^+/K^+ ATPase

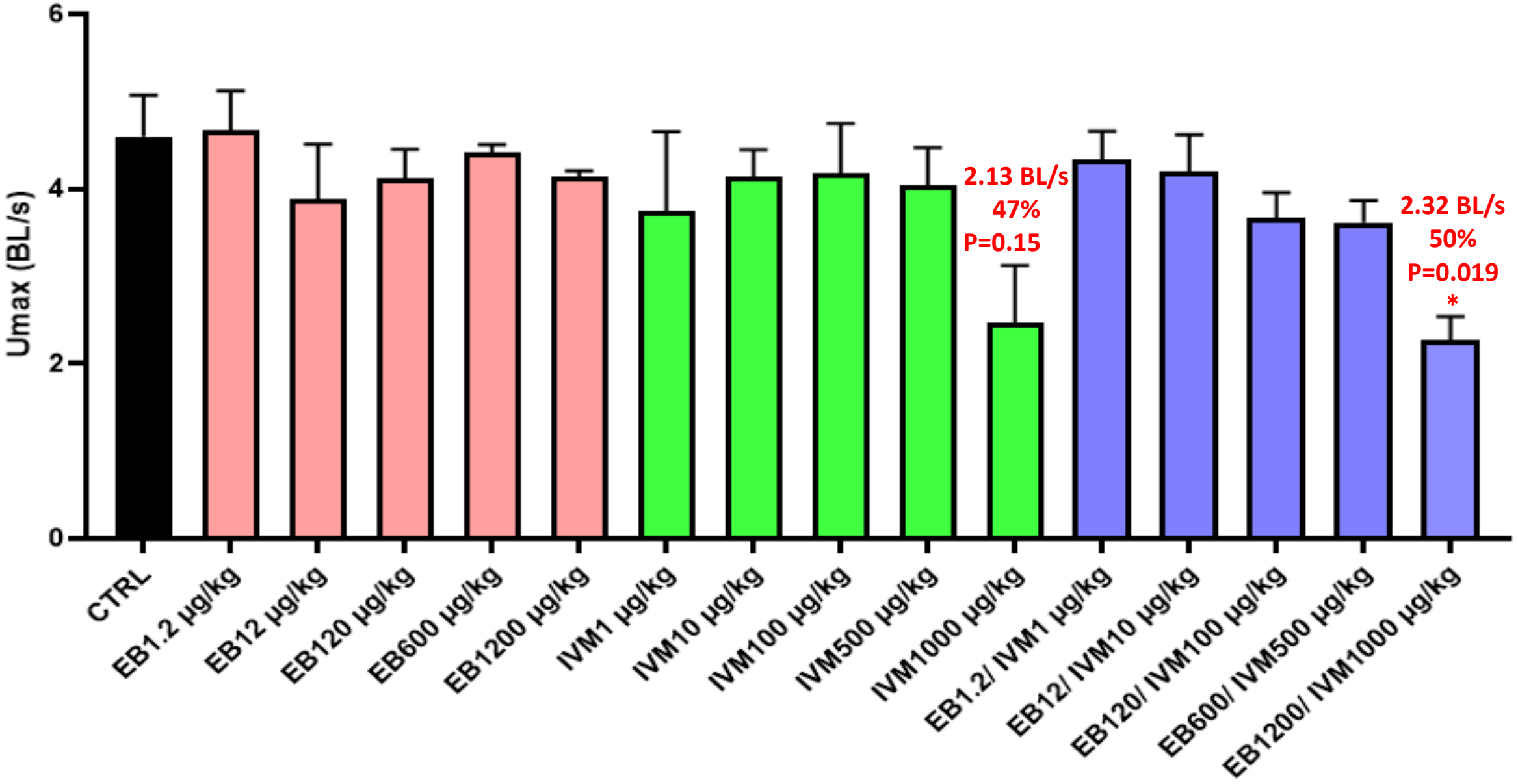
Methods: Swim Performance



Methods: Swim Performance



Results: Swim performance



Still to come!

- Aerobic scope analysis (Max O_2-resting O_2consumption)
- Biochemistry assays (almost ready for analysis)
- NMR metabolomic analysis of fish liver and white muscle tissue (tissues prepared, need to run spectra and **seeking collaborator!**)
- Measured sediment concentrations vs nominal
- Integrate behaviour, physiology and biochemistry

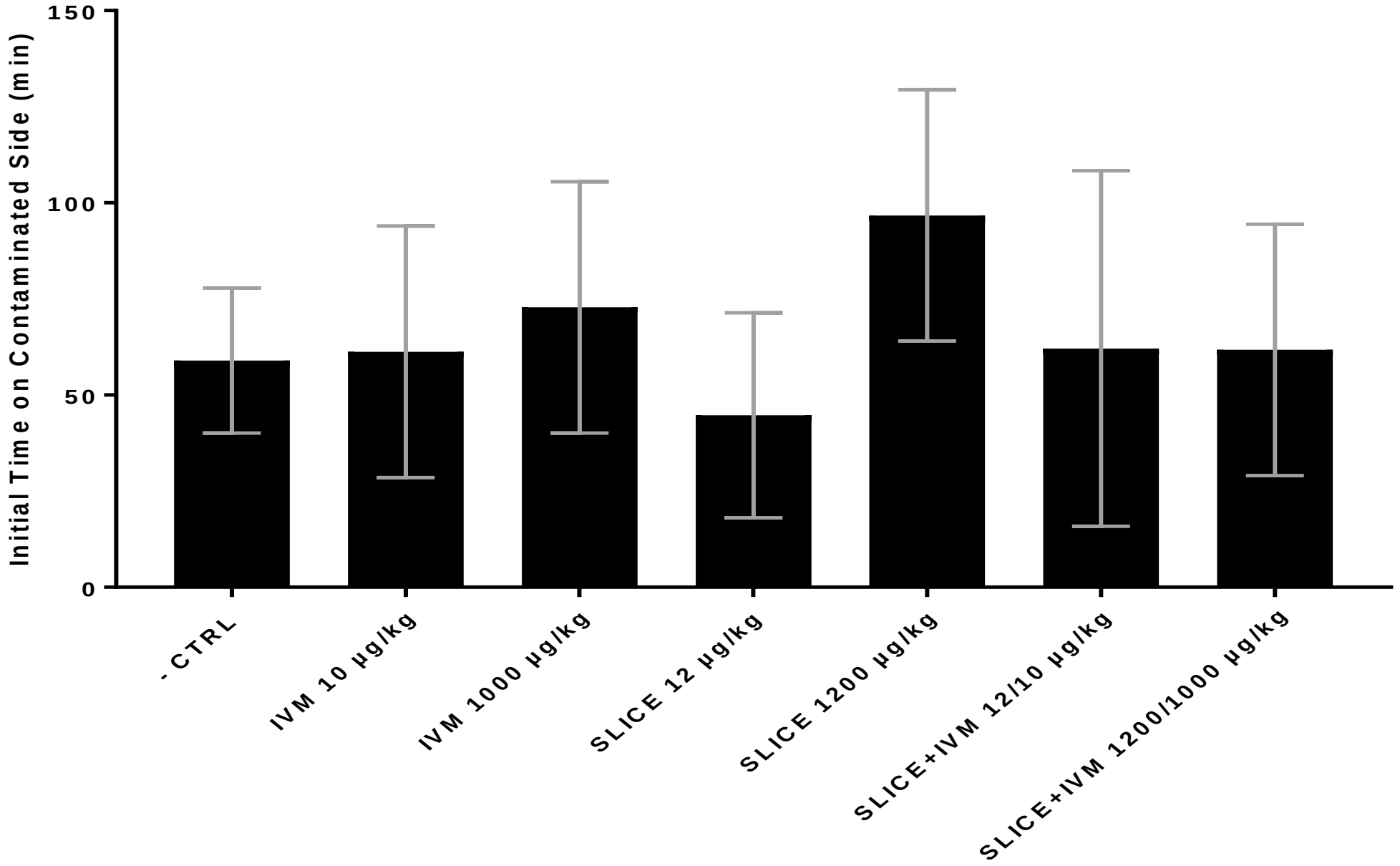
Acknowledgements

- DFO National Contaminants Advisory Group
- Dr. Christopher Kennedy
- Kennedy and Marlatt lab members, Tom Iwanicki
- Karan Parekh, Camelia Tavakoli, Matteo Larosa, Reg Paran
- #1 volunteer, gpa

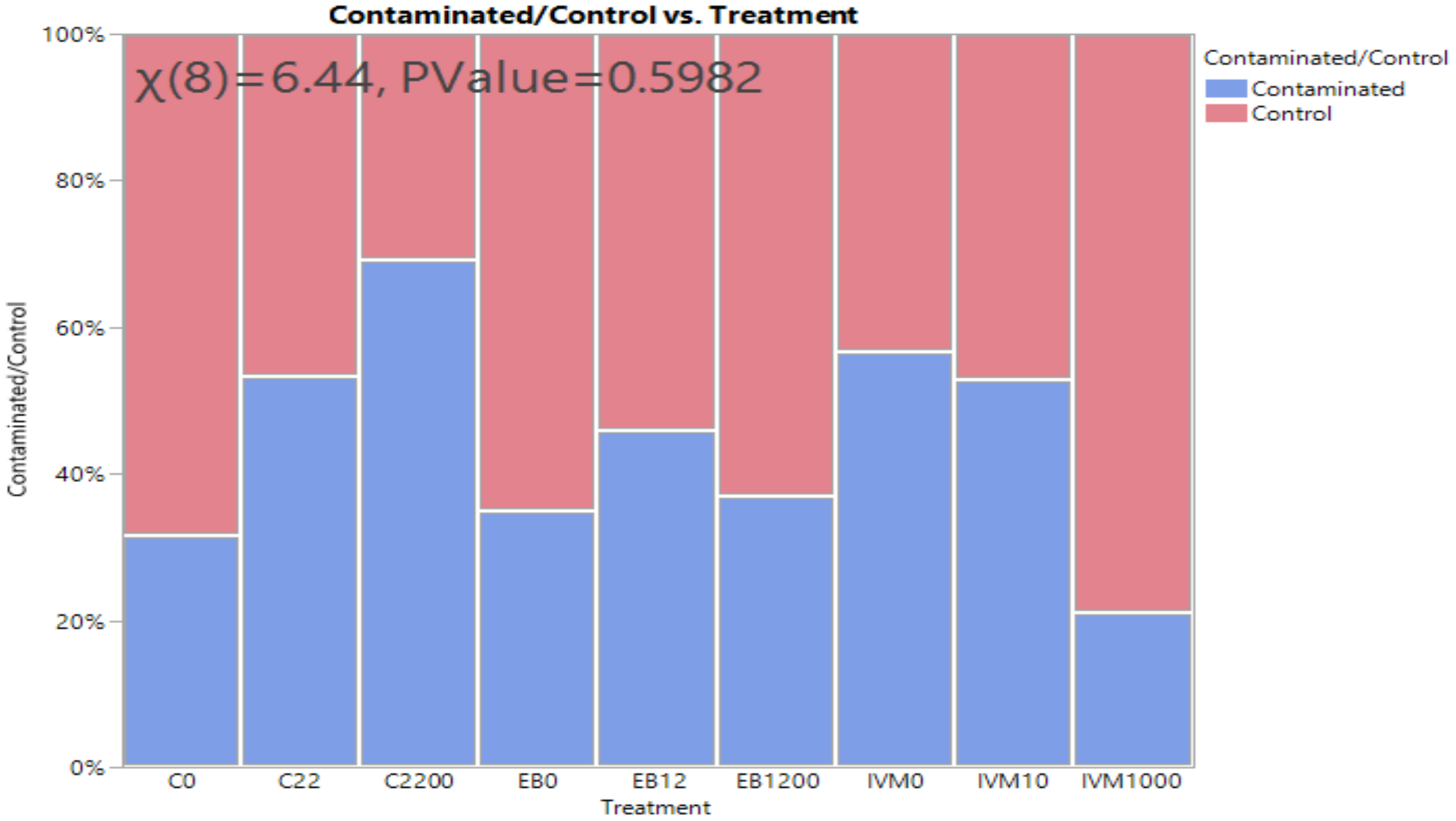
SFU

Fisheries and Oceans Canada

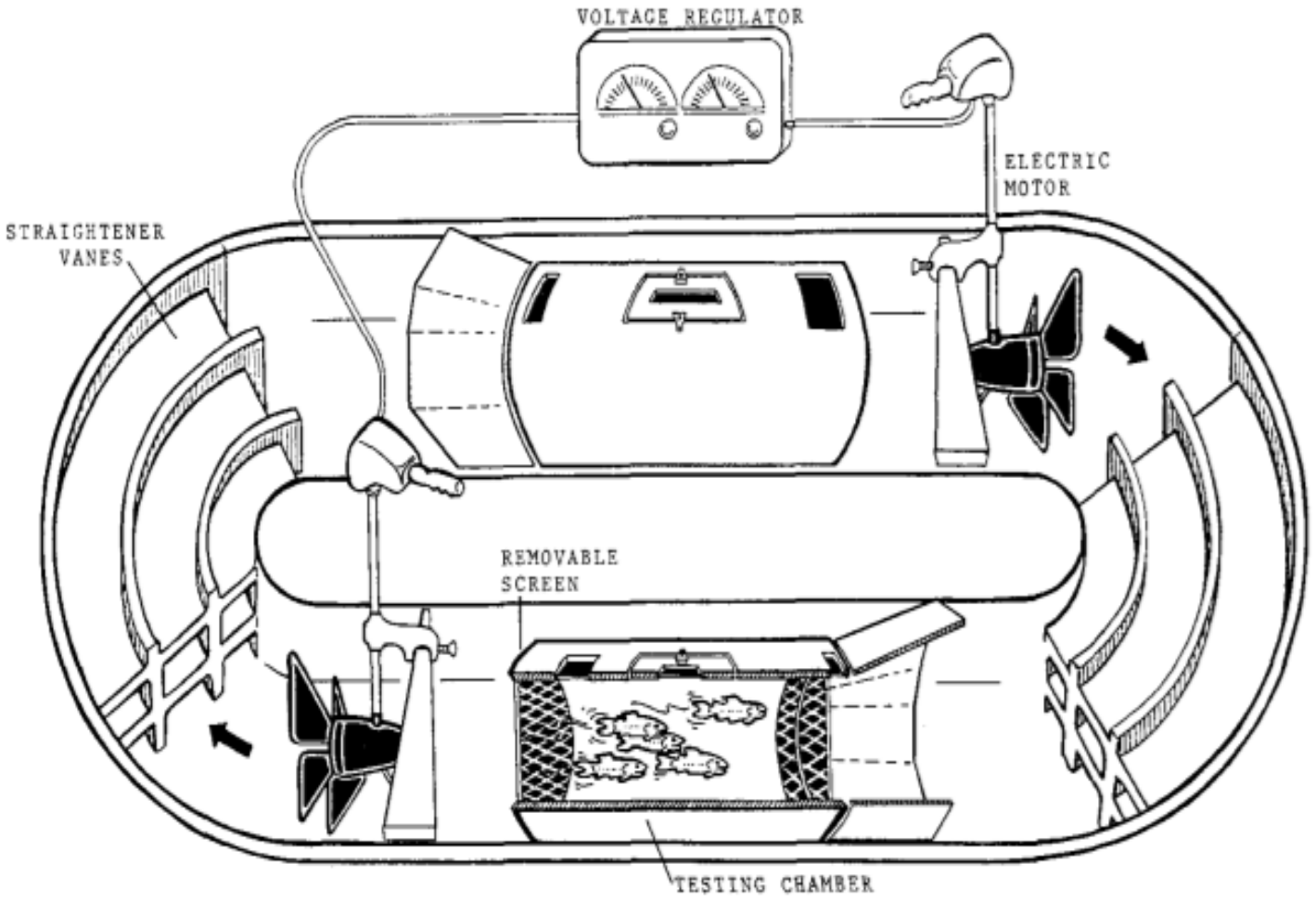
Results: Avoidance Assay



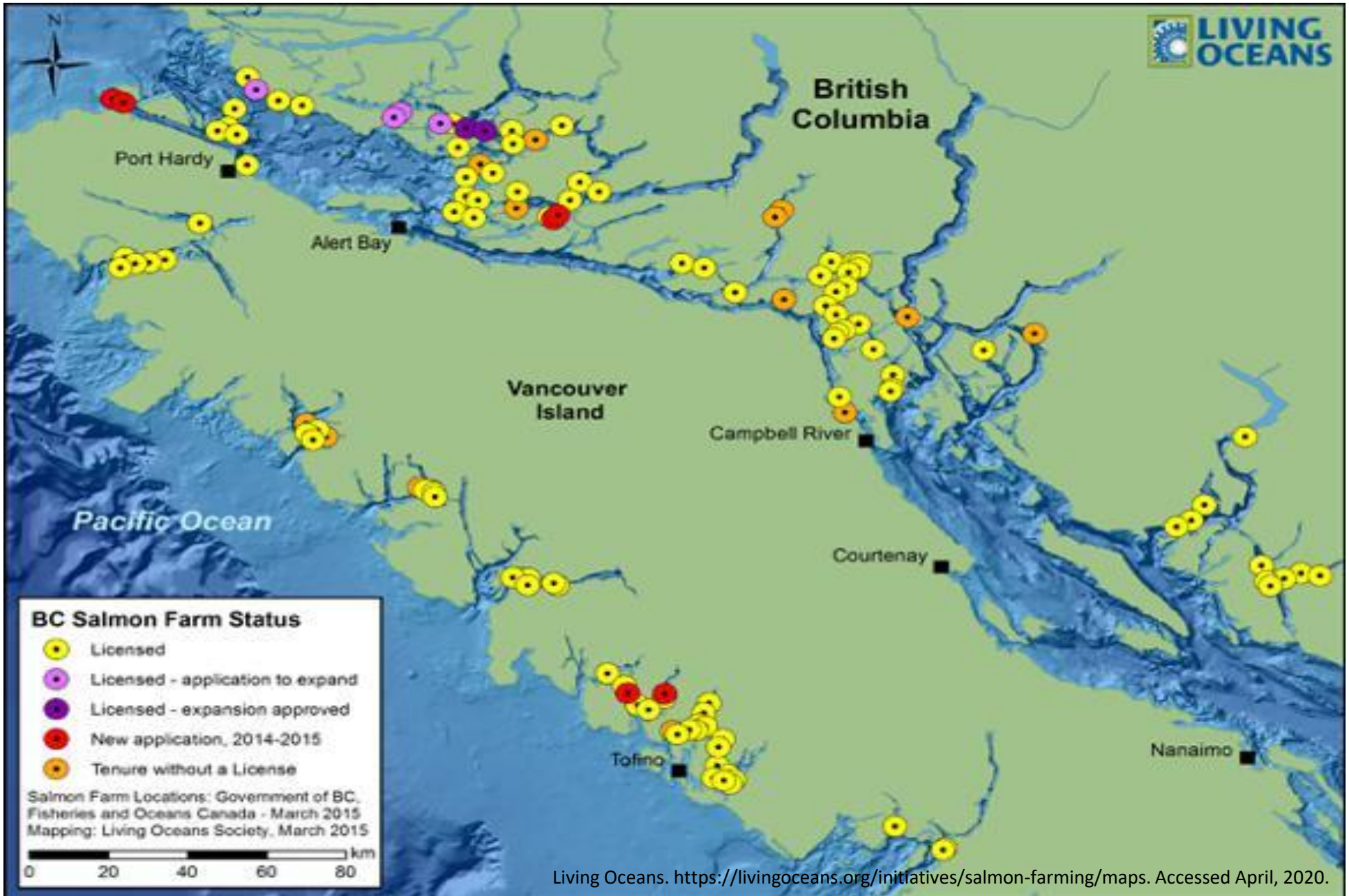
Results: Novel Exposure Avoidance X2



Methods: Swim Performance + Respirometry



Introduction



Living Oceans. https://livingoceans.org/initiatives/salmon-farming/maps. Accessed April, 2020.

Materials and Methods

Species Selection

- Starry Flounder (*Platichthys stellatus)*
- *Juvenile life stage age 0-1*
- Harvested via beach seine in Lower Fraser and Boundary Bay areas

Raincoast Conservation Foundation Lower Fraser River Salmon Conservation Program. https://www.raincoast.org/lower-fraser/. Accessed 09.30.2018