

# The sea is more than just salty

Other changes that accompany smoltification  
and influence salmon performance

Jesse Trushenski / Lofotseminaret / 12-14 June 2024 / Henningsvær





# Smoltification—a unique feature of salmonid biology



PARR MARKS, YELLOWISH COLORATION  
OF FINS AND SKIN  
HIGHER CONDITION FACTOR  
TERRITORIAL BEHAVIOR  
LOW SURVIVAL, DOES NOT THRIVE IN SW

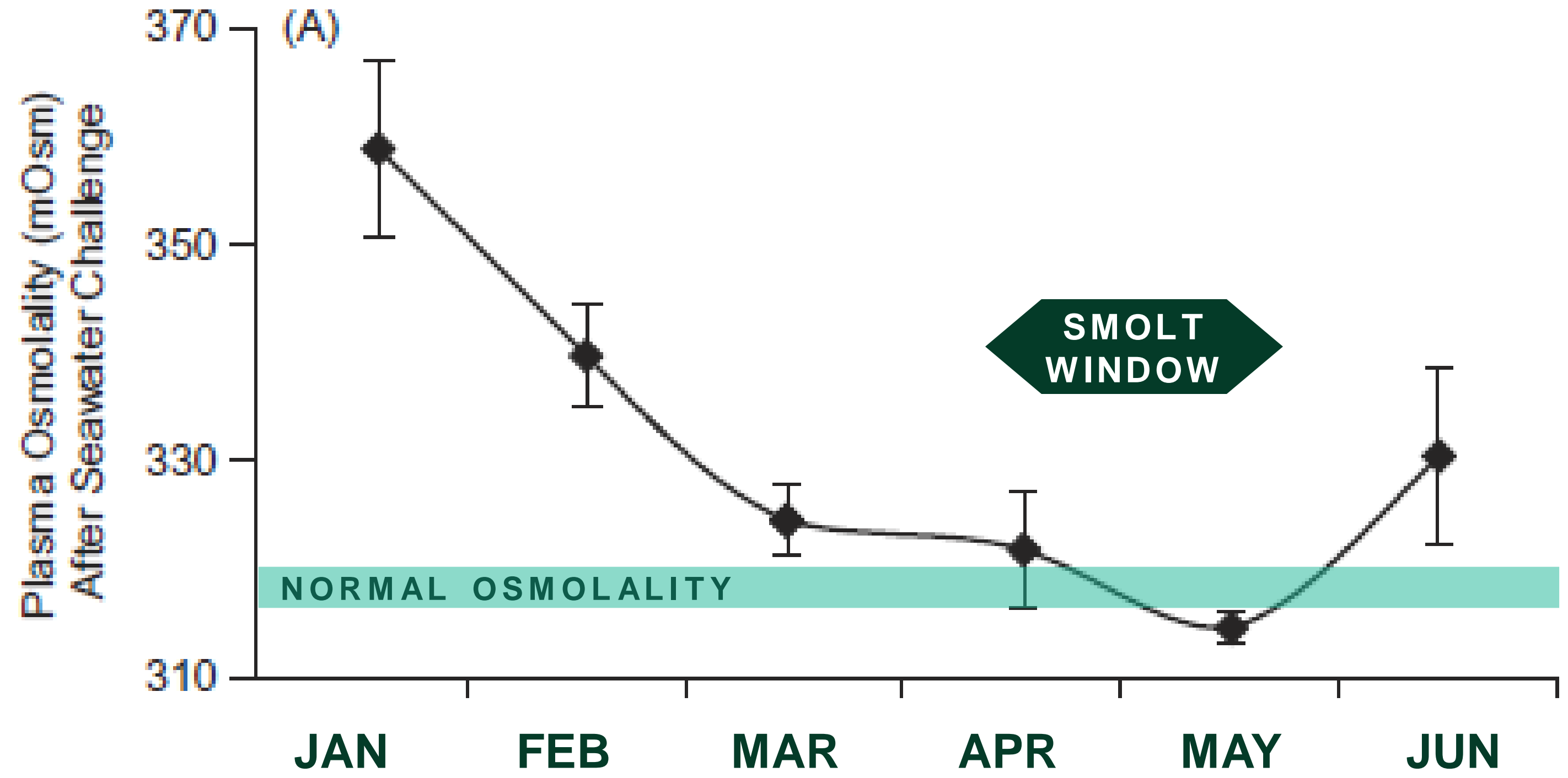


DARKENED FIN MARGINS, SILVERED SKIN  
LOWER CONDITION FACTOR  
SCHOOLING BEHAVIOR  
HIGH SURVIVAL AND RAPID GROWTH IN SW

**Smoltification is a profound change in morphology, physiology, and behavior that is necessary for successful anadromous life histories**



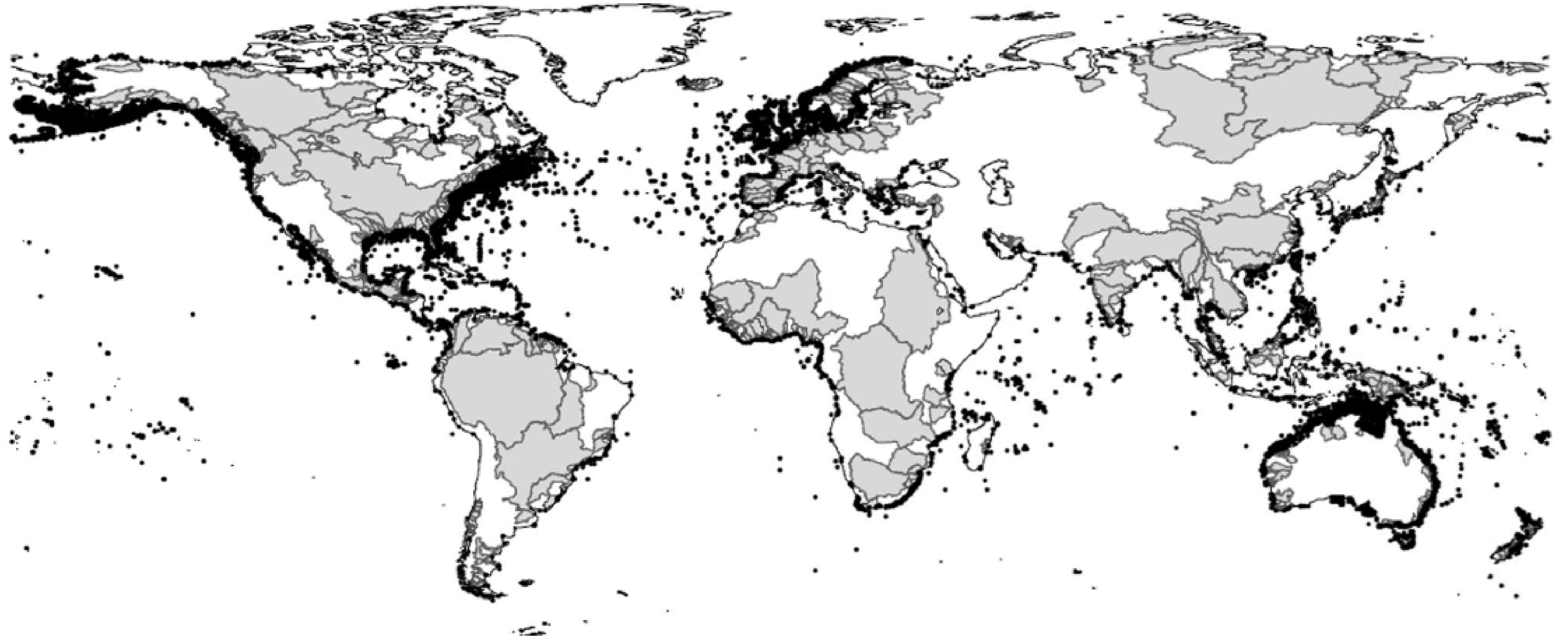
# Osmoregulatory dysfunction is easily identified



Fish unable to osmoregulate in SW are physiologically compromised and will die if homeostatic balance is not restored

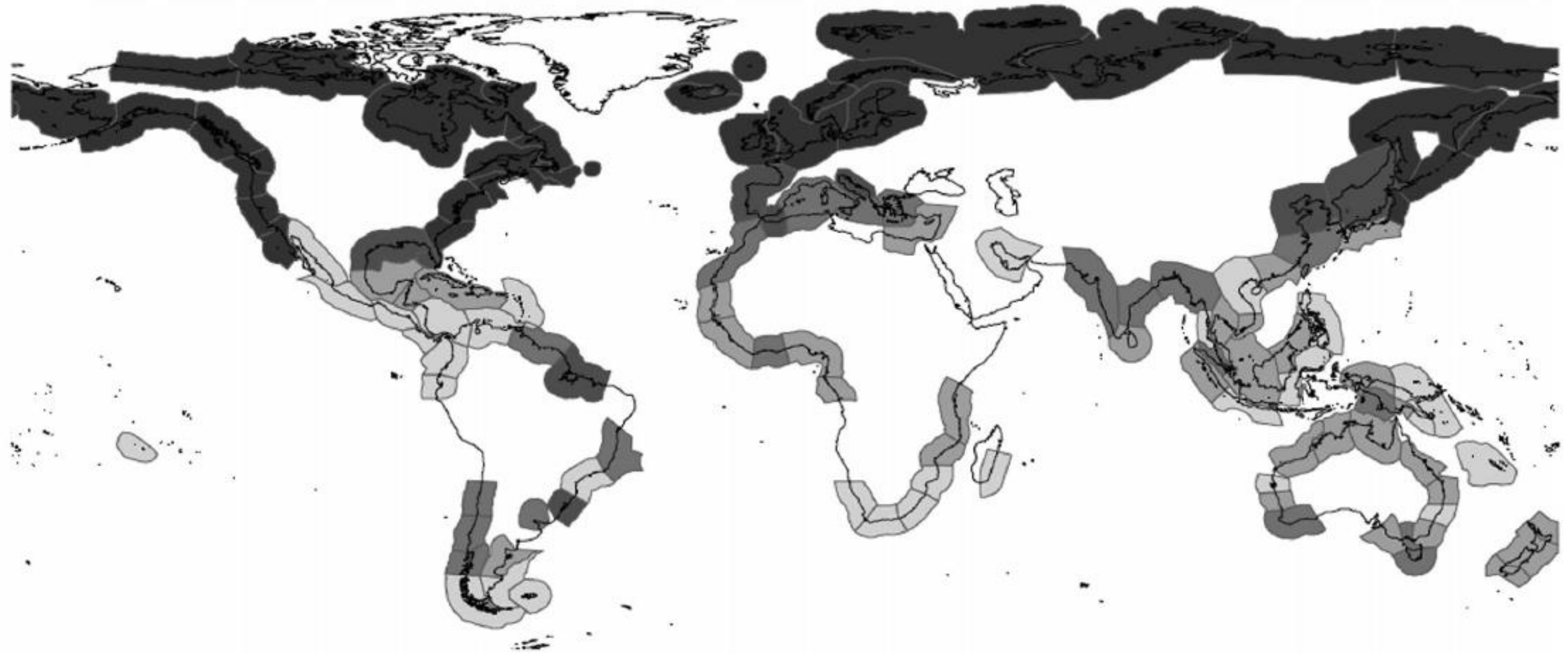


# Diadromy is common

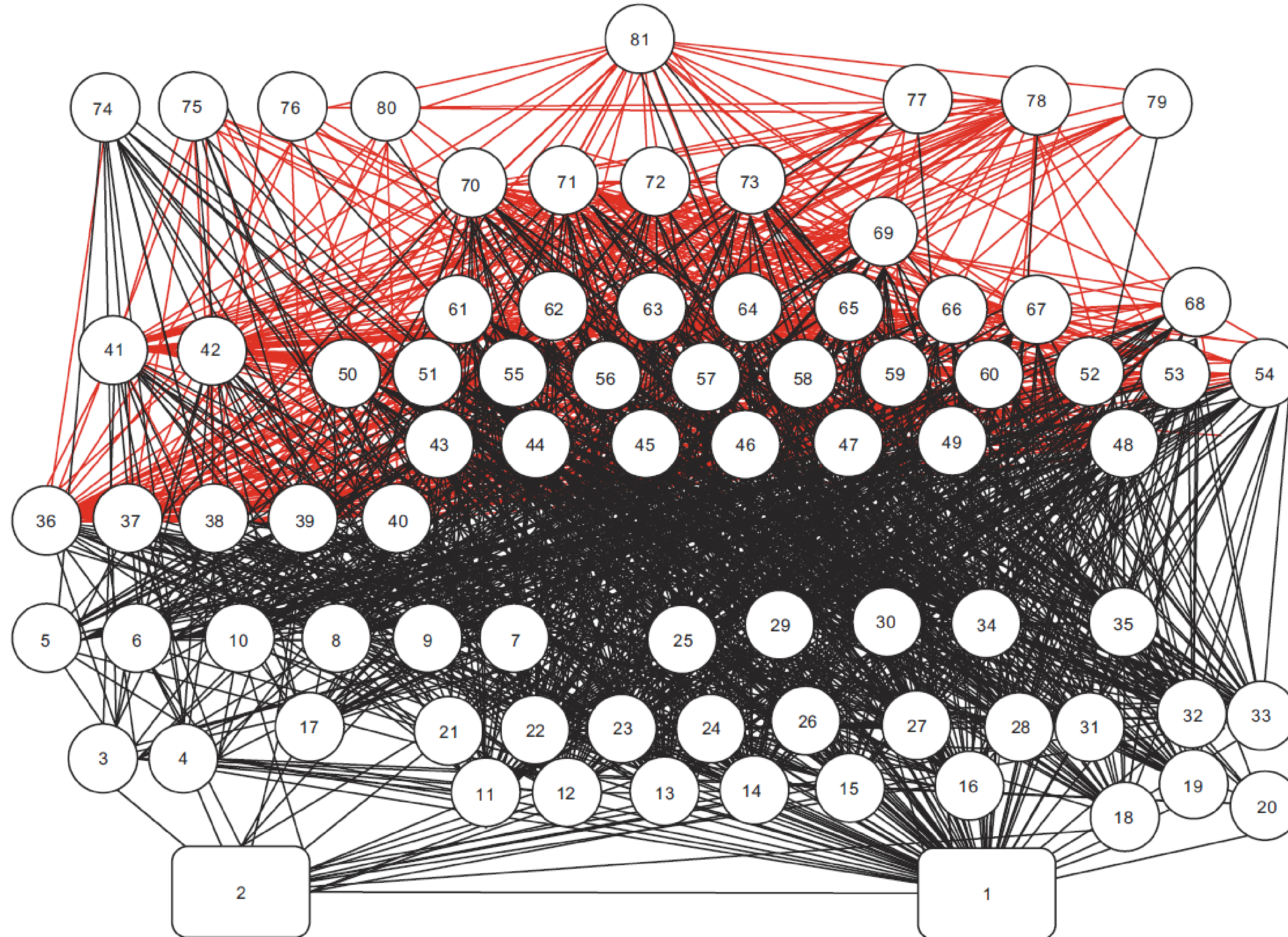




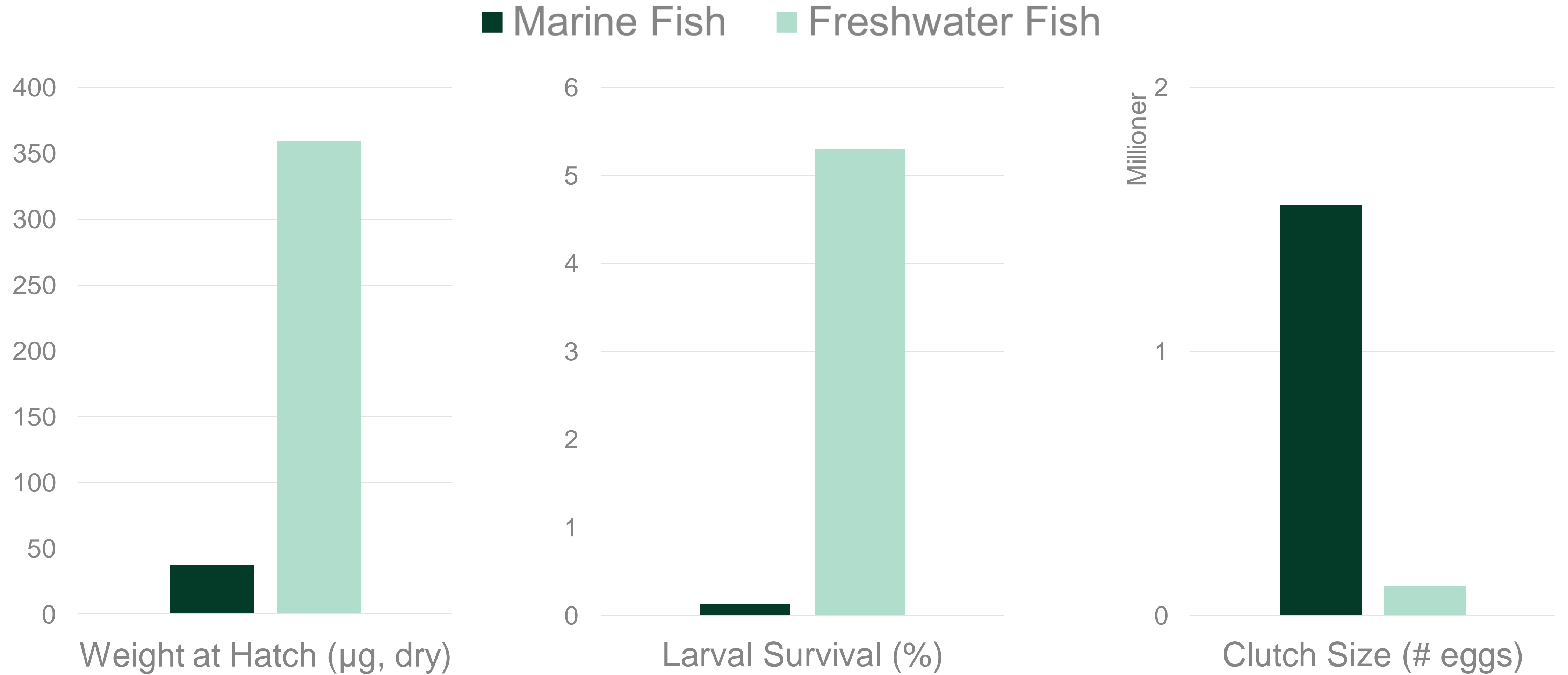
# Why be anadromous?



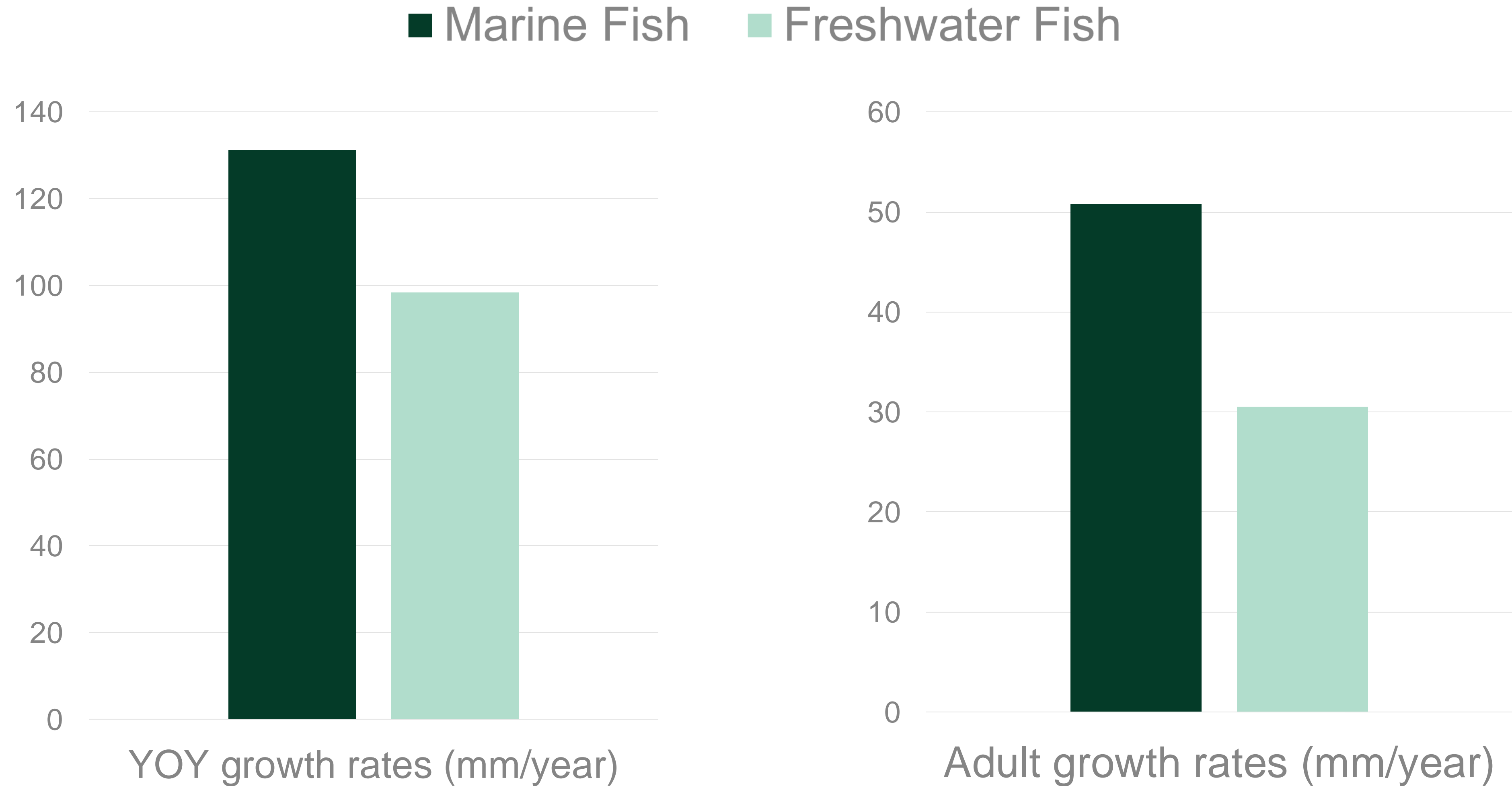
# Why be anadromous?



# The ocean is a bad place to be small...

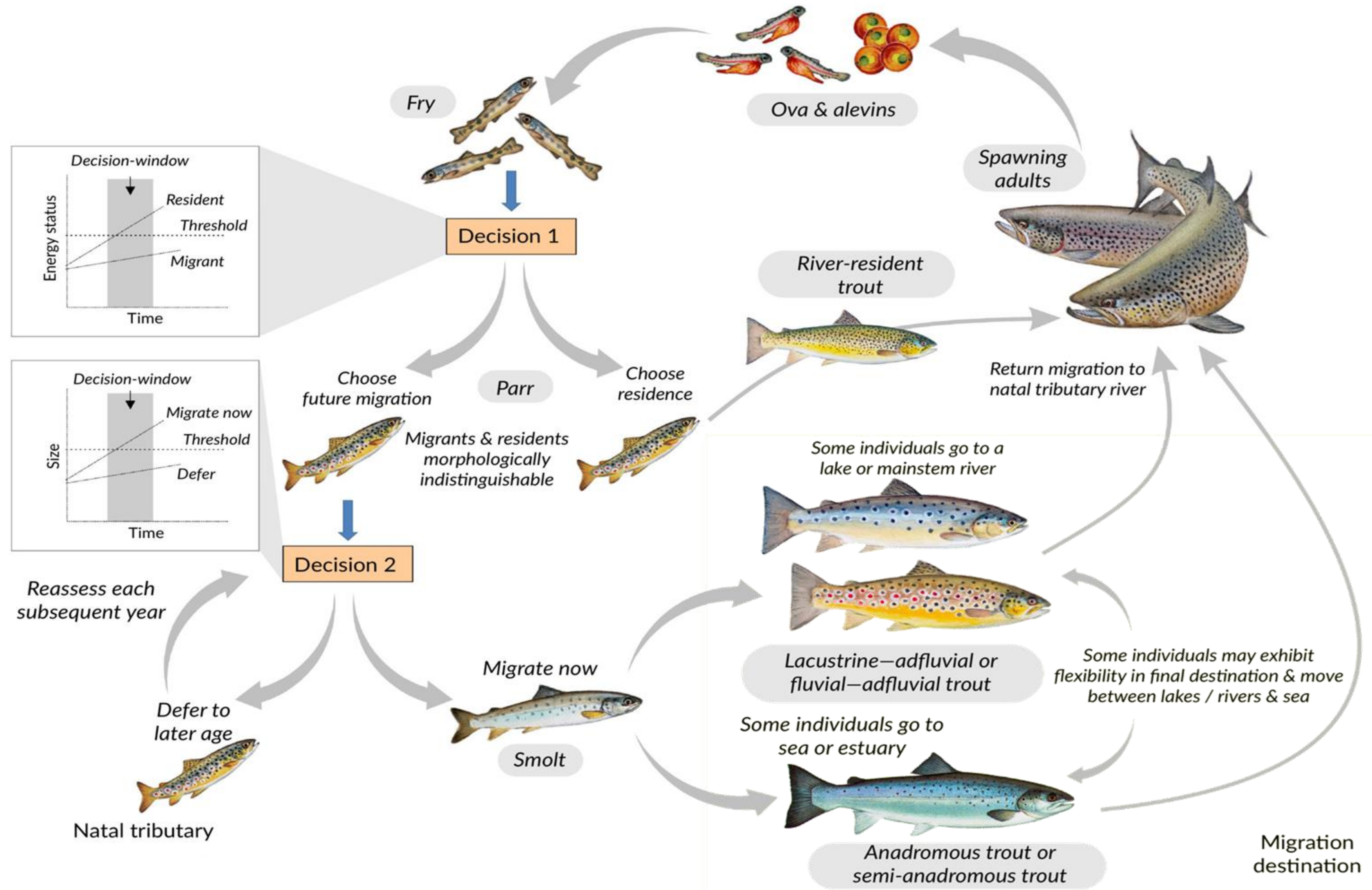


# ...but it's a good place to get bigger





Some fish *choose* an anadromy when FW food resources are limiting—if food is plentiful in FW, there is no reason to migrate



### EARLY LIFE IN FW

- Water is cold or poor quality?
- Food is scarce?
- Many competitors?

### SMOLT OUT-MIGRATION & LIFE IN SW

- Migration distance is short?
- Migration is easy, conditions are good?
- Greater opportunities in SW?

### SPAWNING MIGRATION & HABITAT

- Return migration is short?
- Migration is easy, conditions are good?
- Large size is important for success?

**NO**

**YES**

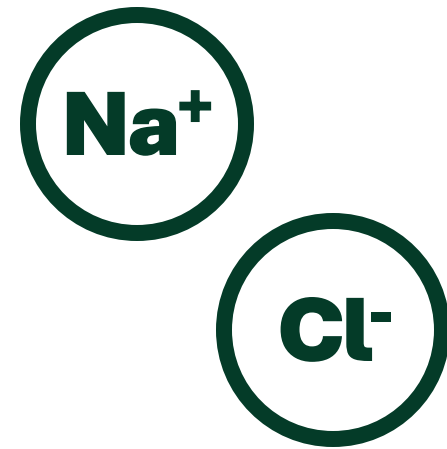
**Less  
anadromy**

**More  
anadromy**



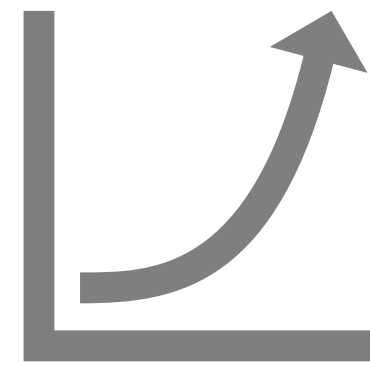


# How is the marine environment different?



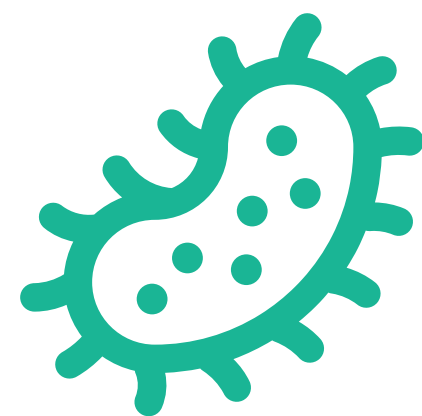
## OSMOREGULATION IN SW

Remodeling of gill  
Increase in ATPase activity  
Increase in drinking behavior  
Excretion of excess ions



## INCREASED GROWTH CAPACITY

Metabolic upregulation  
Increased feed intake  
Increased growth hormone, IGF-1



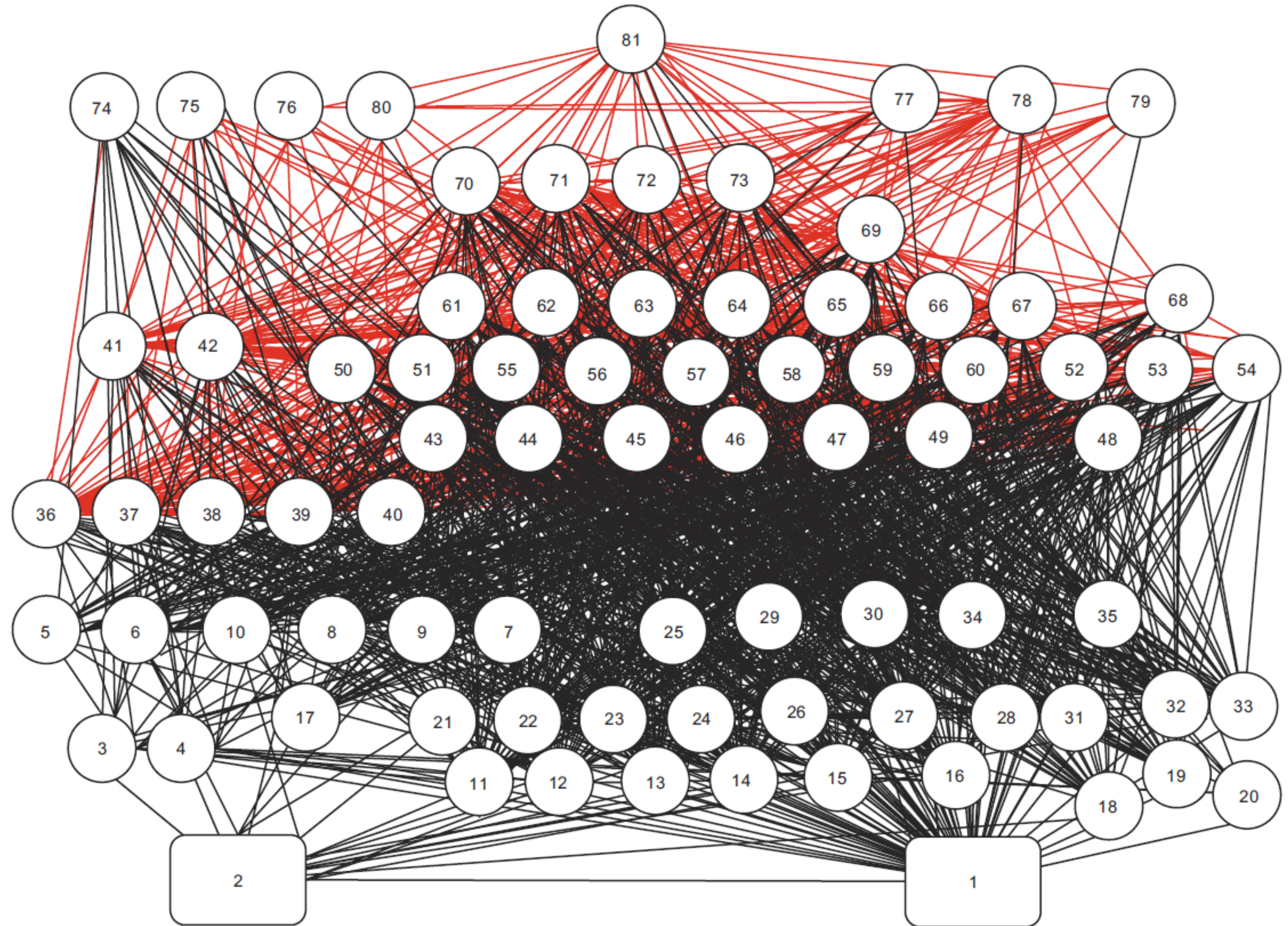
## IMMUNOLOGICAL RESET

'Stress' related immunosuppression  
Reduction of antiviral protections  
Increase in nonspecific protections



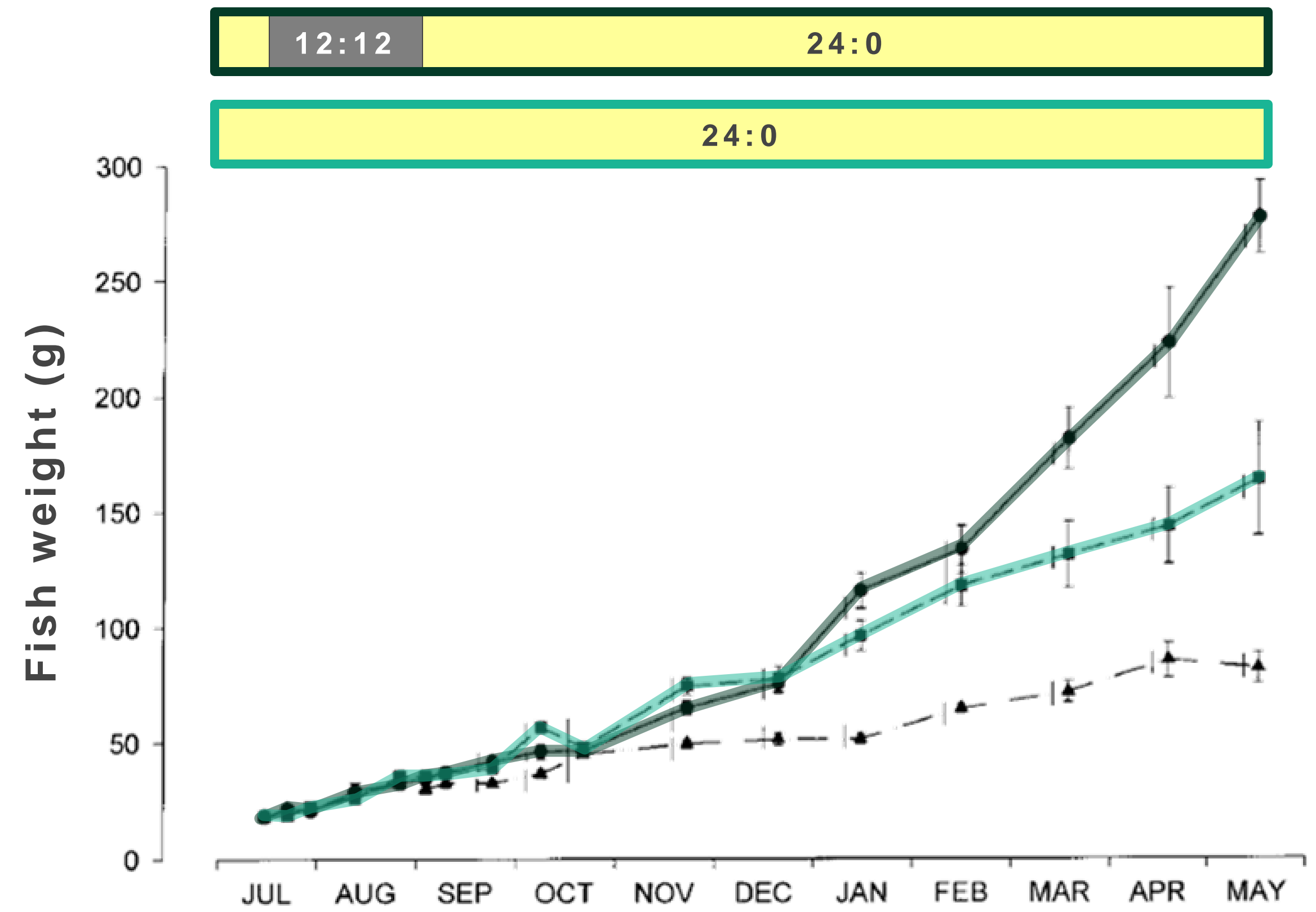
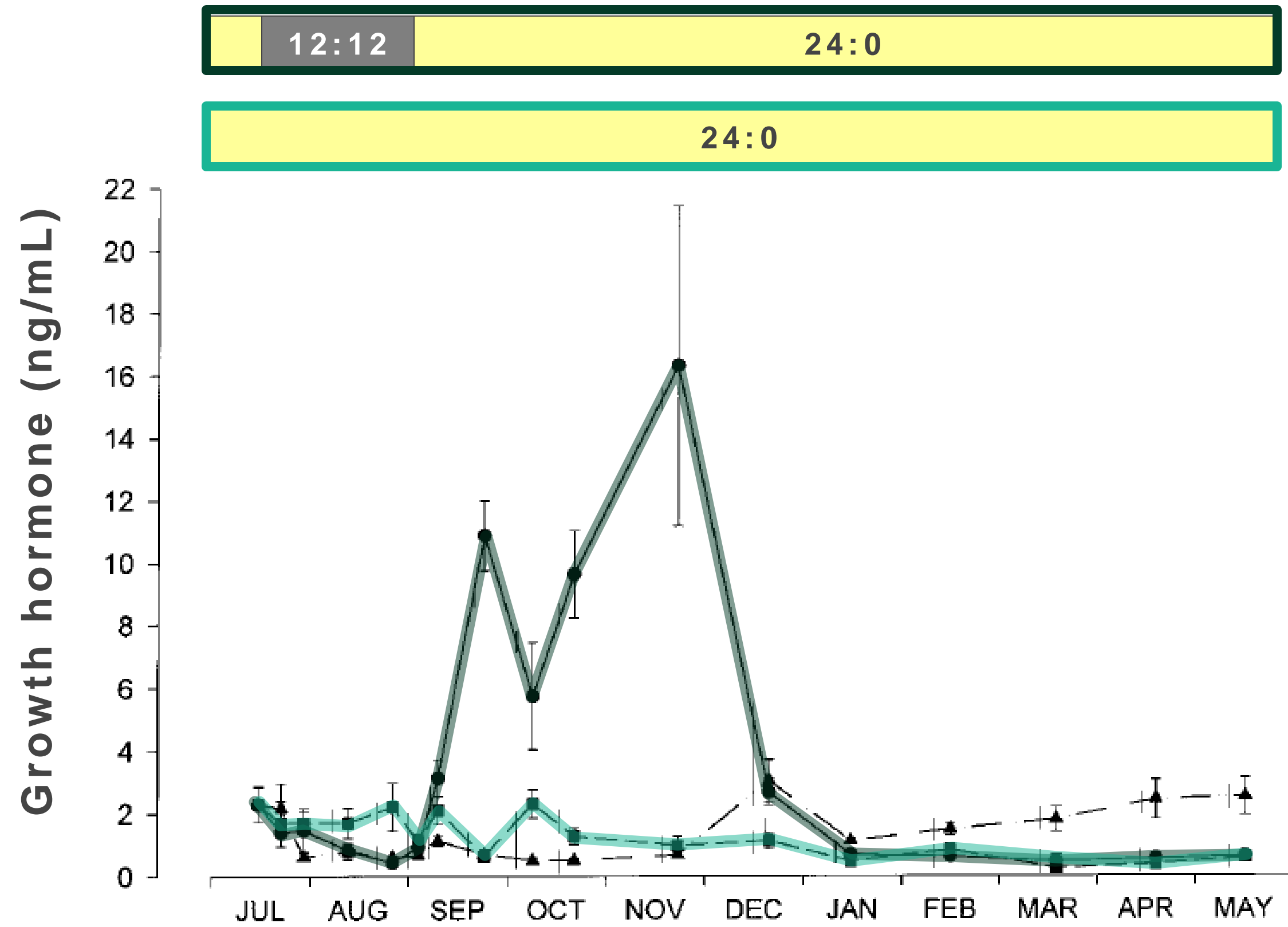


Anadromy  
means a  
change in food  
availability and  
growth potential





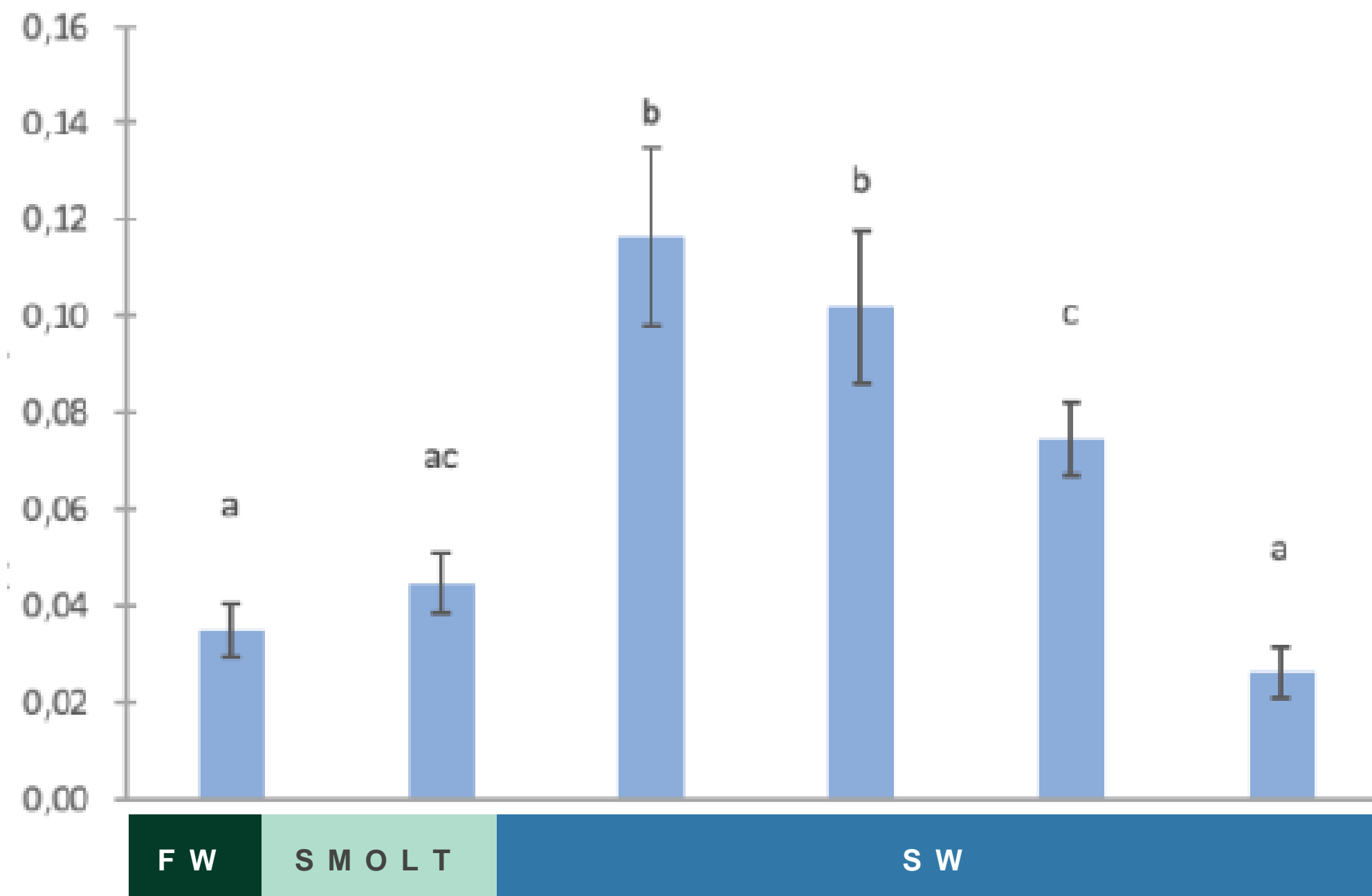
# Smoltification influences growth



# Smoltification influences appetite

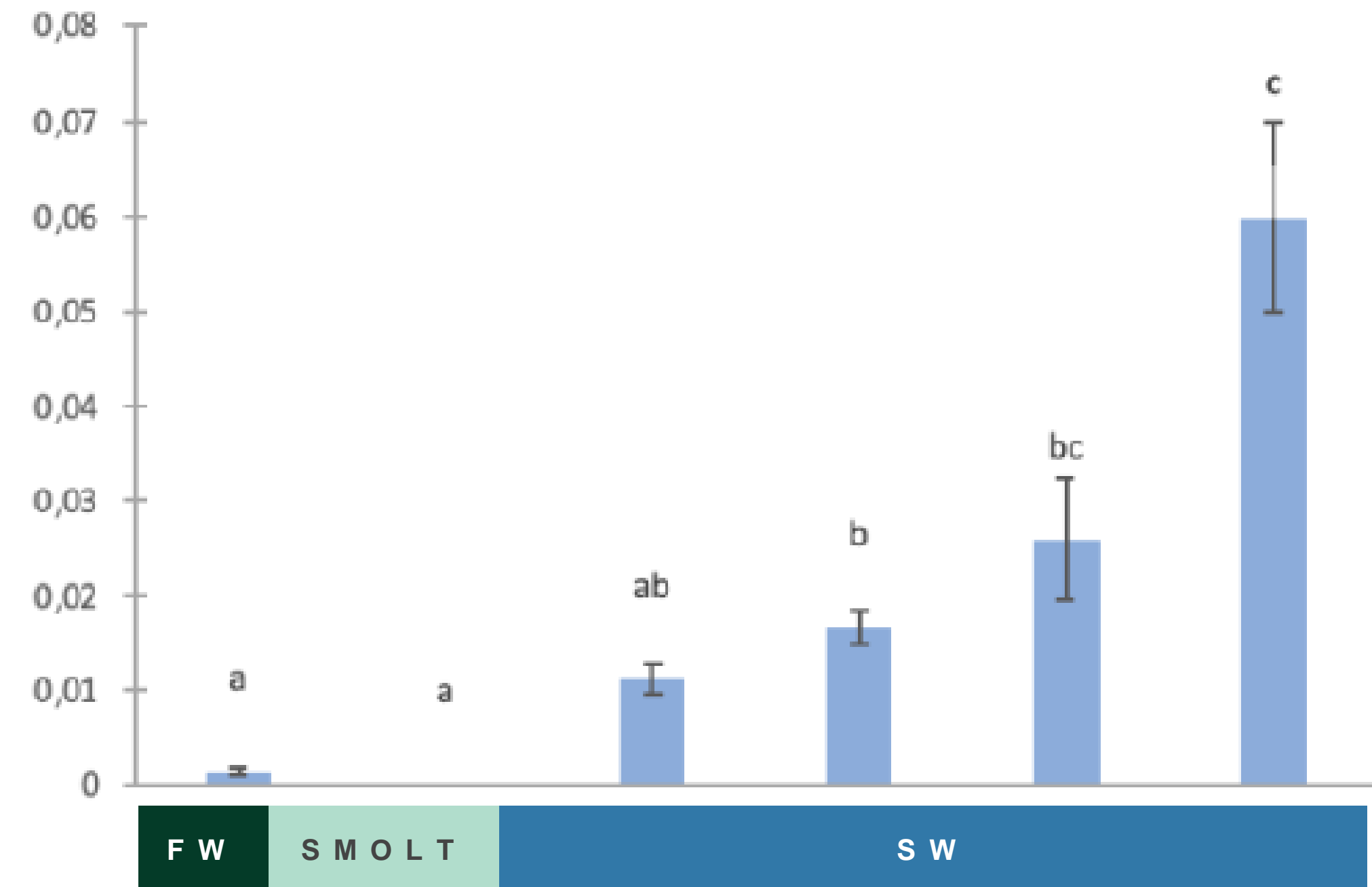
*npv*

Fast-acting stimulant of feed intake



*agrp-1*

Potent and long-lasting appetite stimulant, increases food intake and decreases energy expenditure

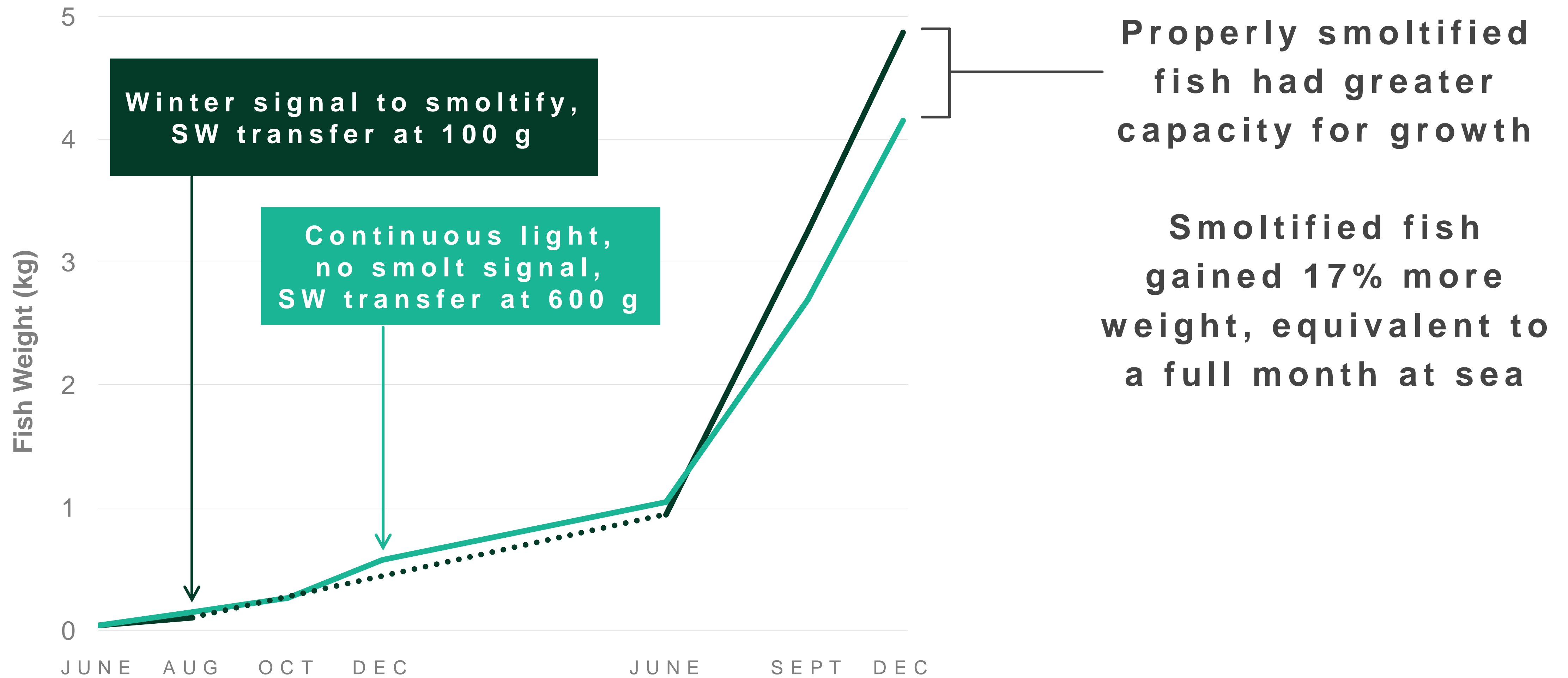


**Feed intake increases following smoltification and seawater transfer in anticipation of greater feeding opportunities**





# Smoltification primes salmon for growth

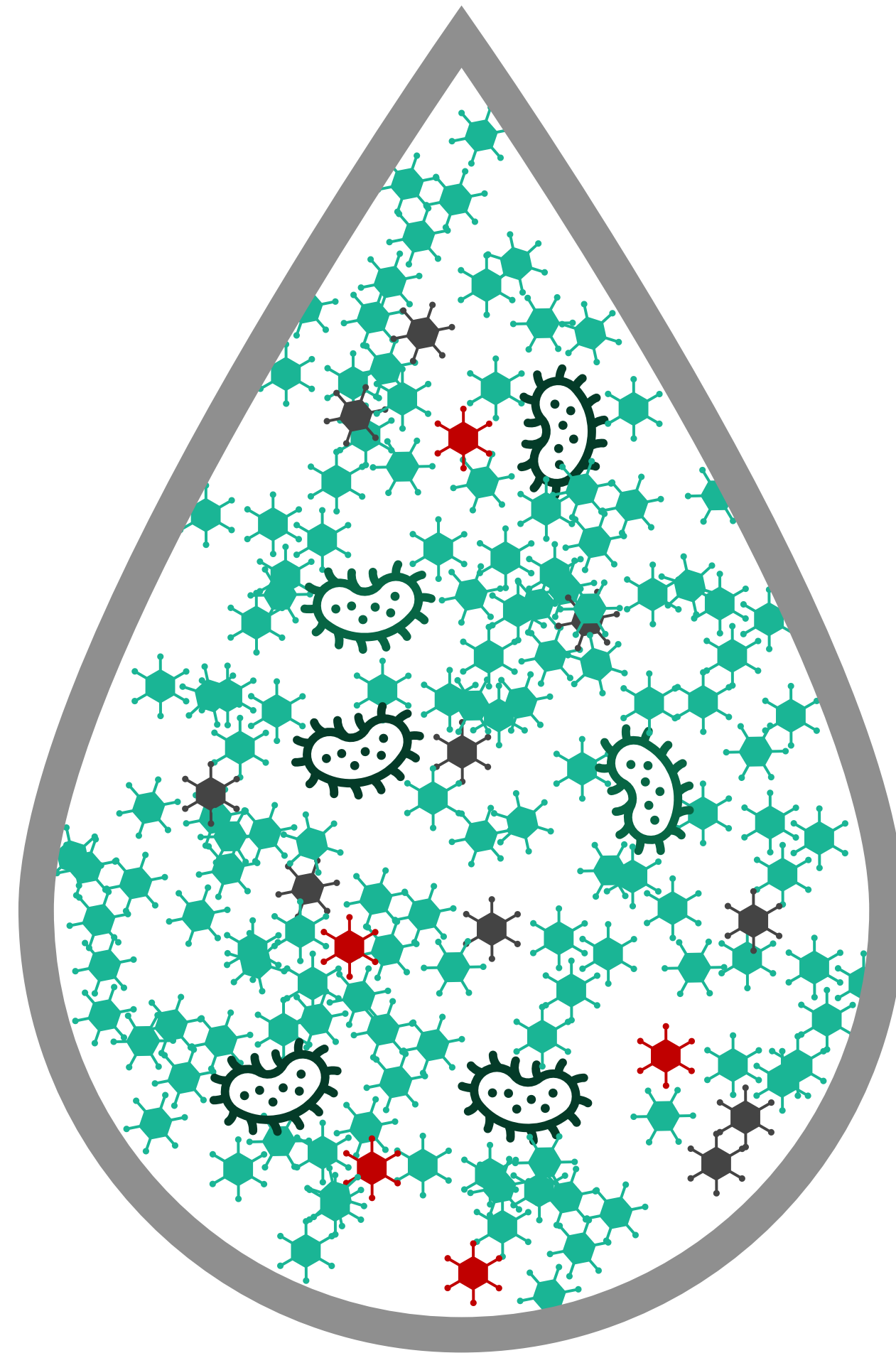


**Properly smoltified fish had greater capacity for growth**

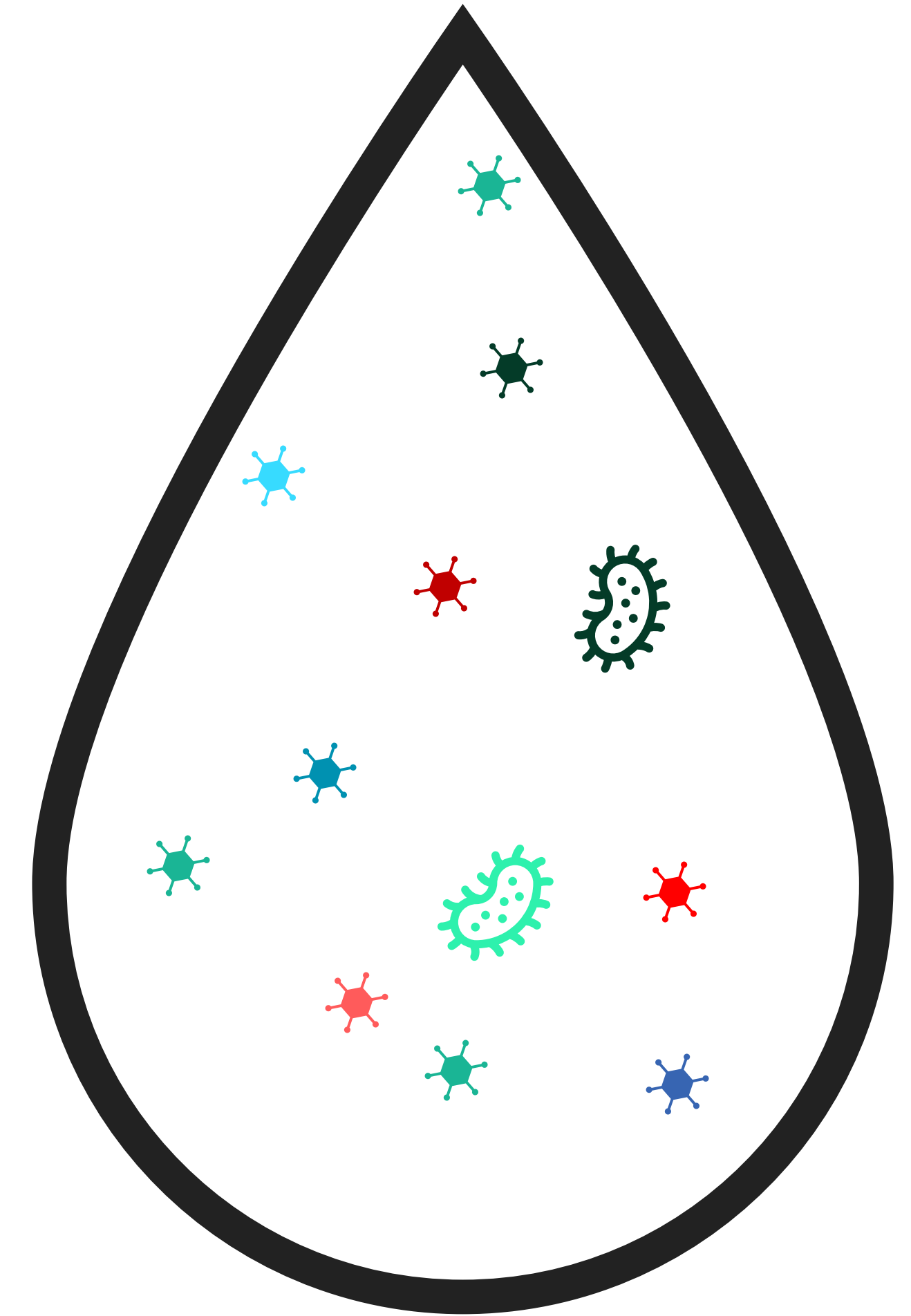
**Smoltified fish gained 17% more weight, equivalent to a full month at sea**



Anadromy  
means a change  
in the abundance  
and diversity of  
pathogens



FRESHWATER

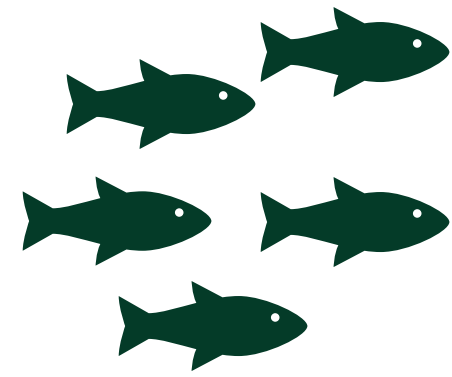


SALTWATER

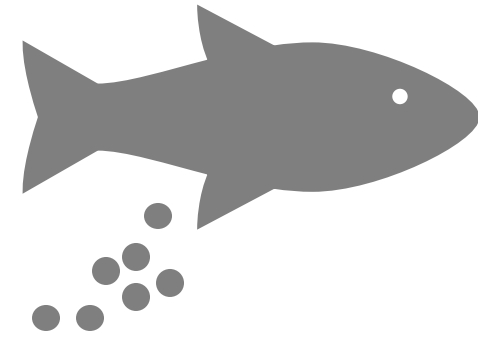




Routes of pathogen transmission are also different



**HORIZONTAL TRANSMISSION**  
Infected individuals or carriers transmit pathogens via shedding or physical contact



**DIRECT VERTICAL TRANSMISSION**  
Infected parents transmit pathogens via gametes or sexual fluids

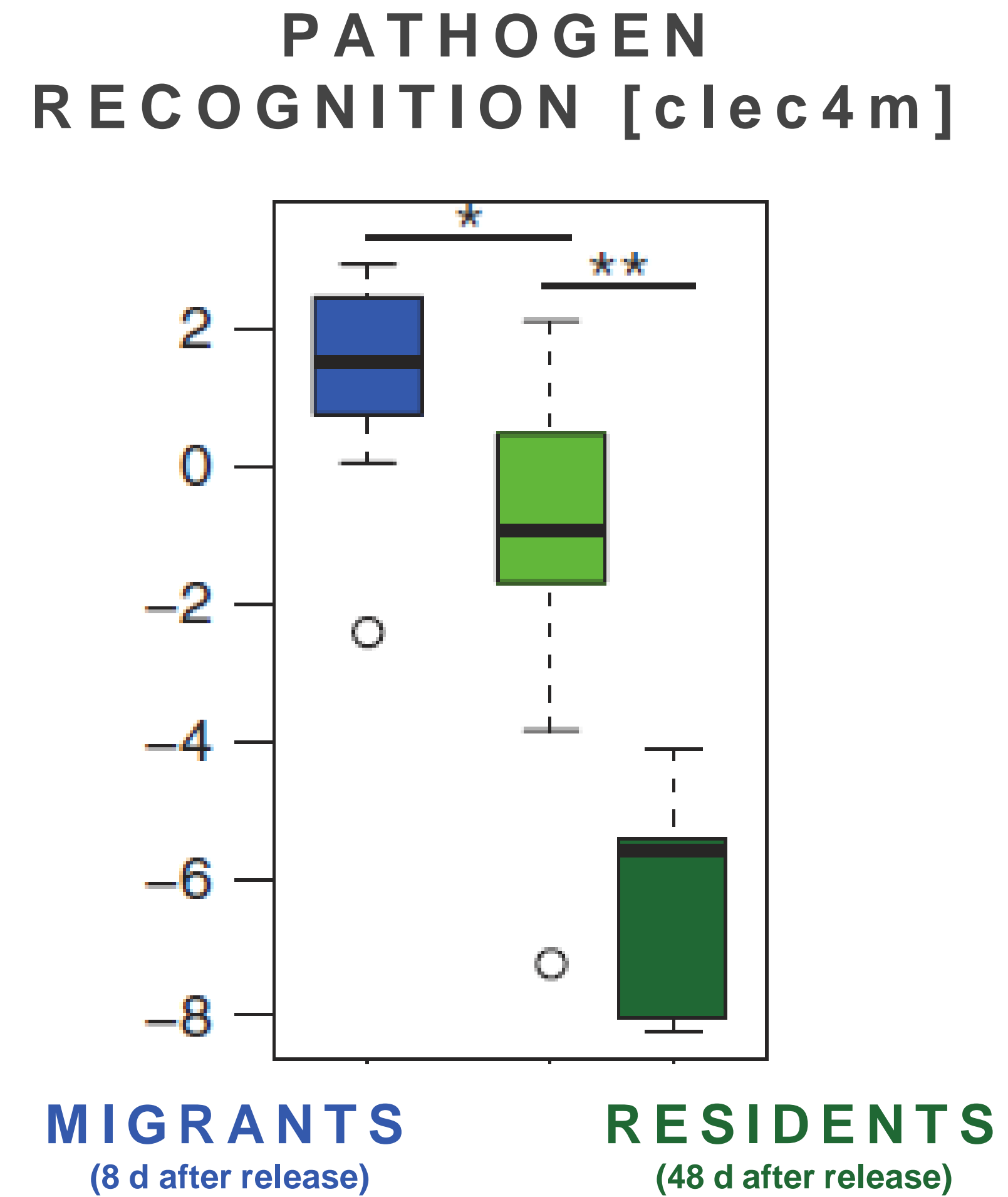
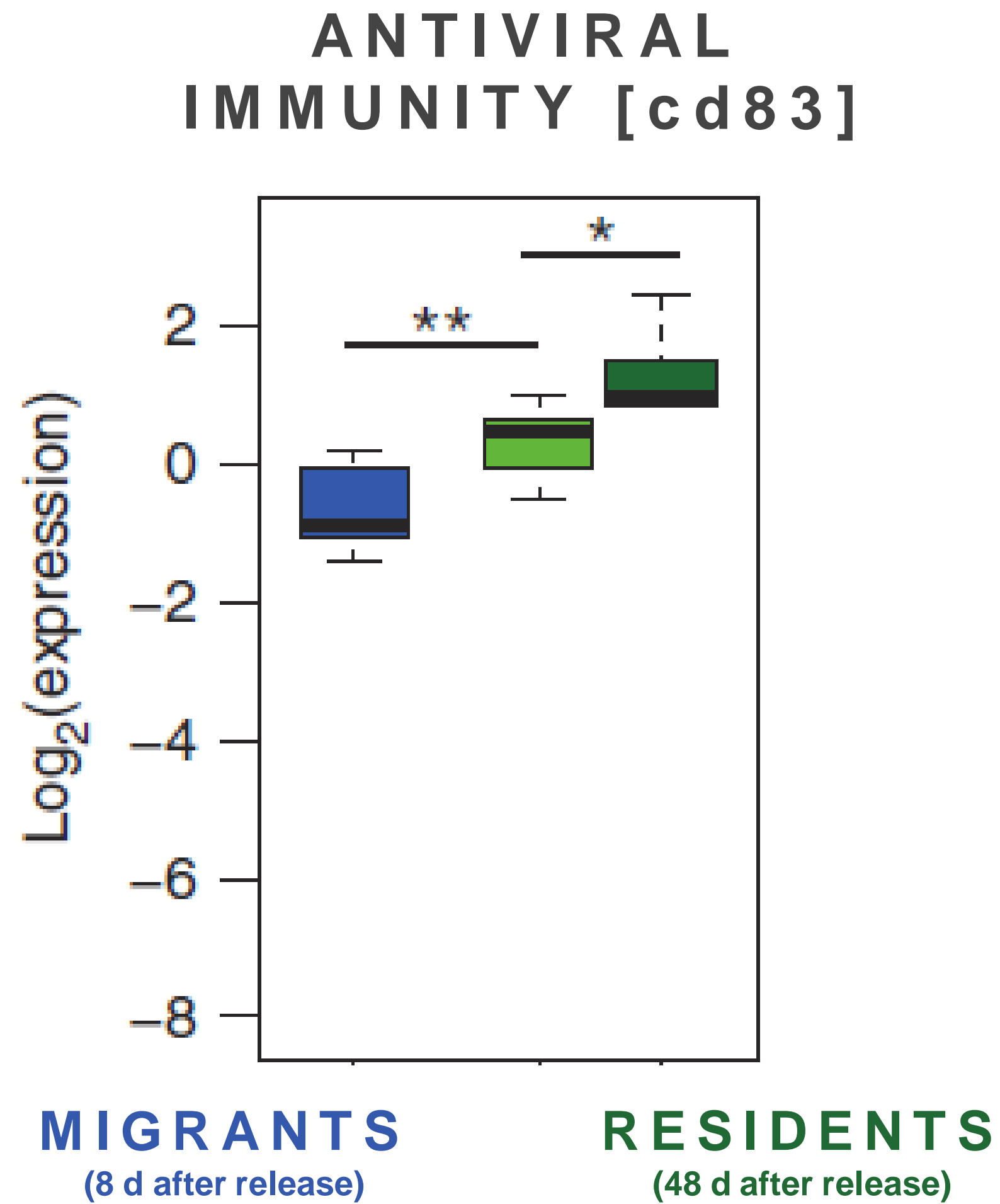


**INDIRECT VERTICAL TRANSMISSION**  
Infected parents transmit pathogens via post-mortem shedding

Pathogen community is likely to be more stable in freshwater and dominated by pathogens that can persist in adults in a carrier state



# The immune system changes in anticipation of SW entry



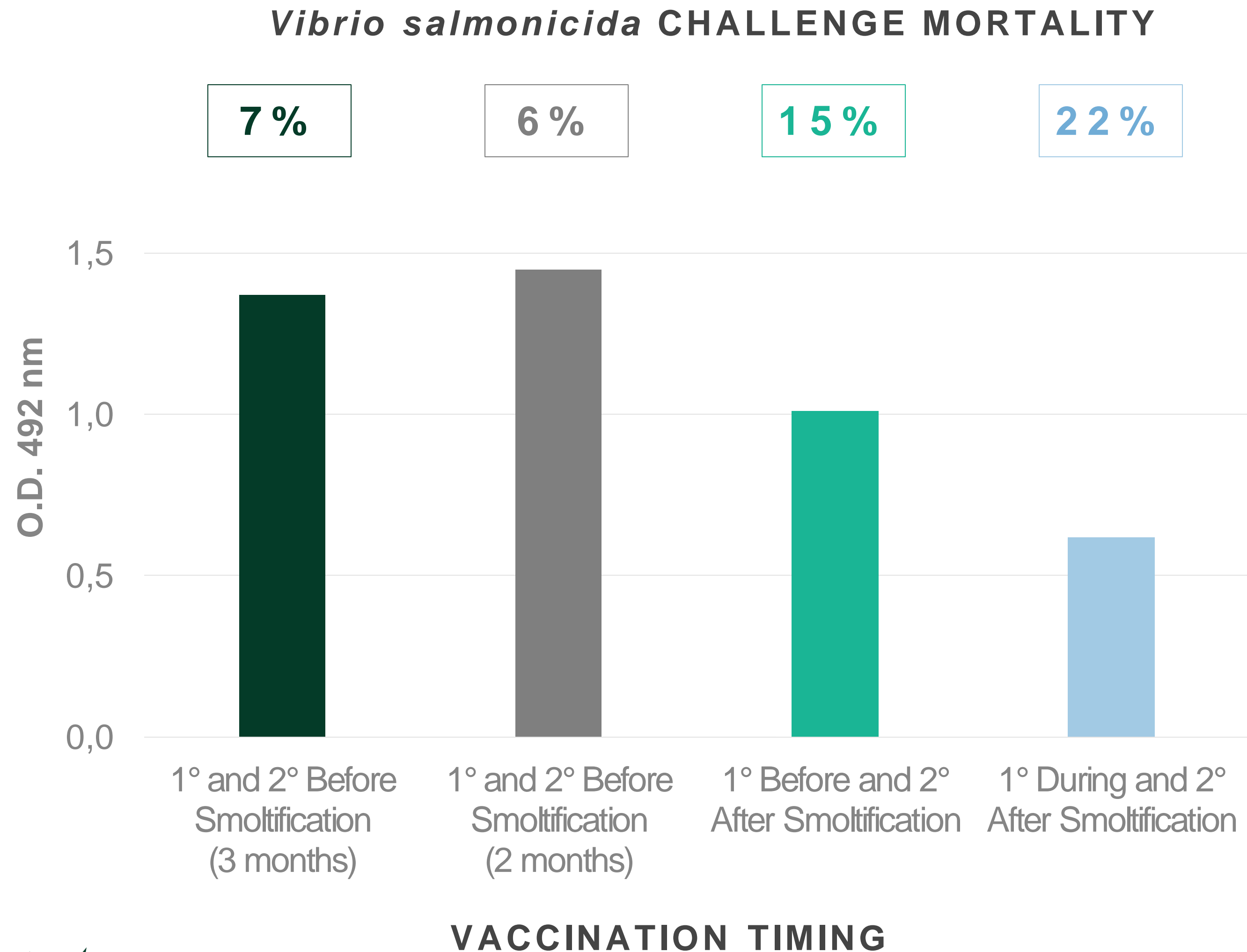
**RESIDENTS**  
(8 d after release)

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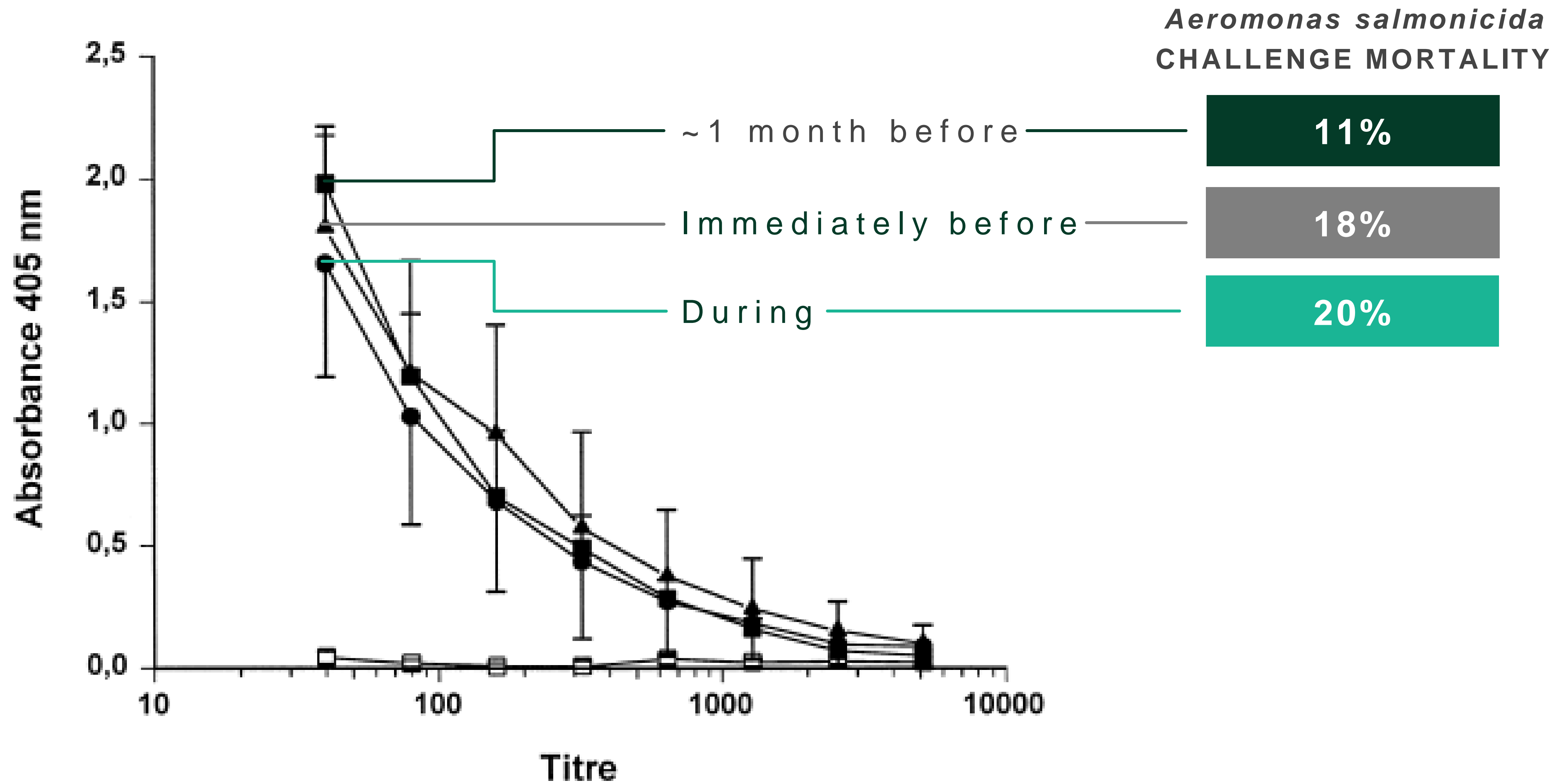
# Vaccination during smoltification is less protective



“...the smolting and seawater transfer period were an **unfavorable time** for vaccination of salmon...”



# Vaccination during smoltification is less protective



The sea is more  
than just salty





There is more to

**S M O L T I F I C A T I O N**

than just seawater tolerance.

