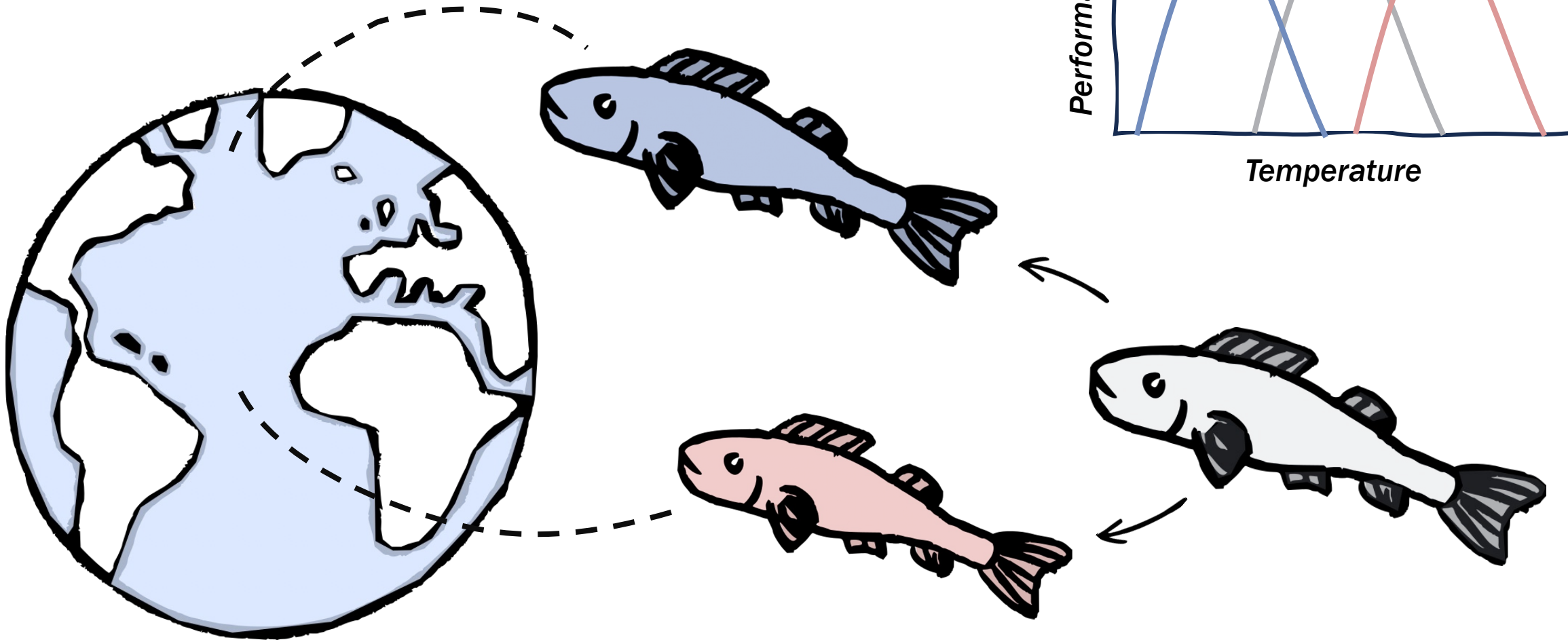
# LOCAL ADAPTATION TO SALINITY STRESS: PHYSIOLOGICAL AND TRANSCRIPTOMIC INSIGHTS

Alexandra Hahn

EMB Science Webinar - 20th March 2025

GEOMAR

# WHAT IS LOCAL ADAPTATION?



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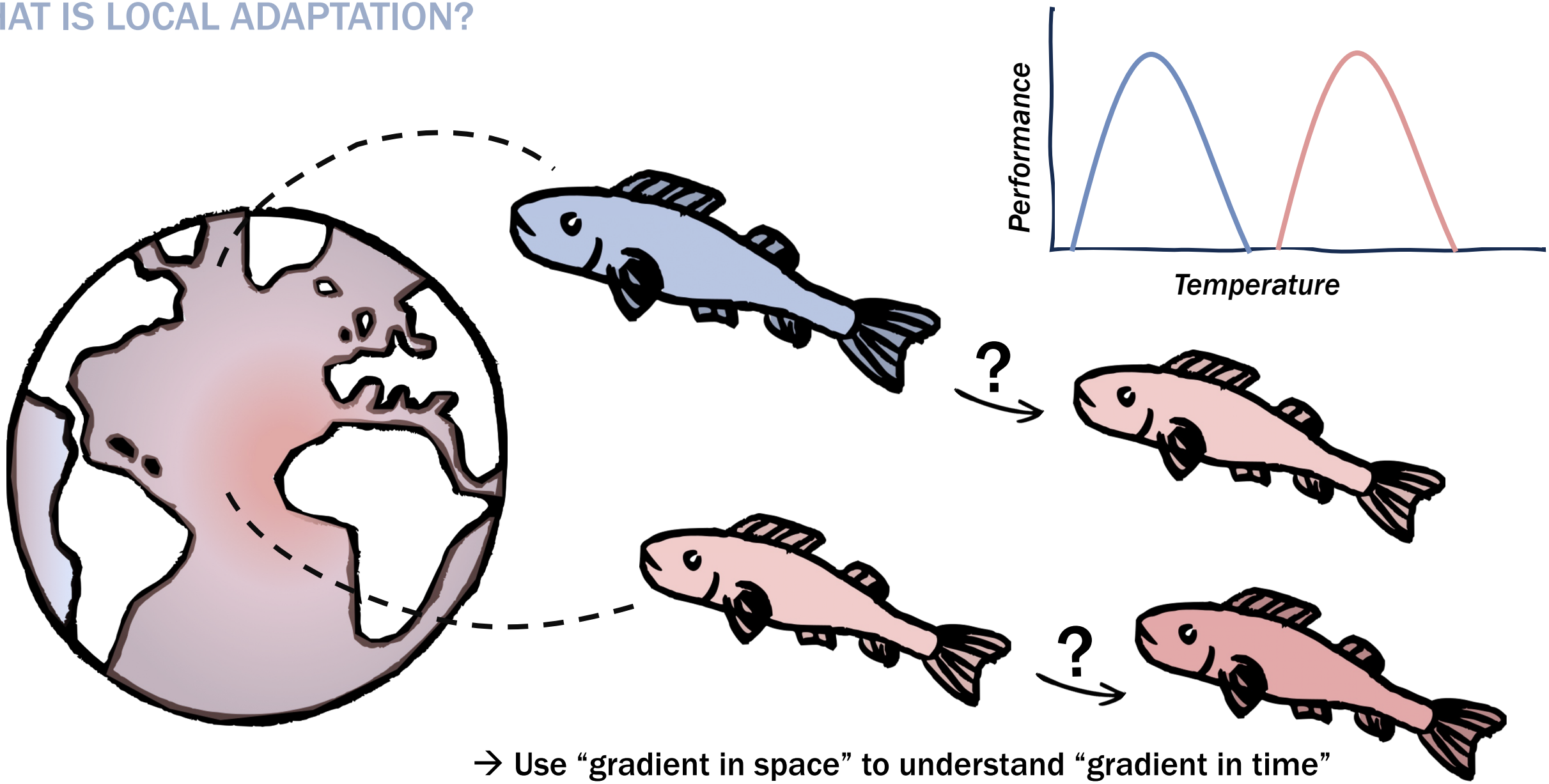


→ Use “gradient in space” to understand “gradient in time”

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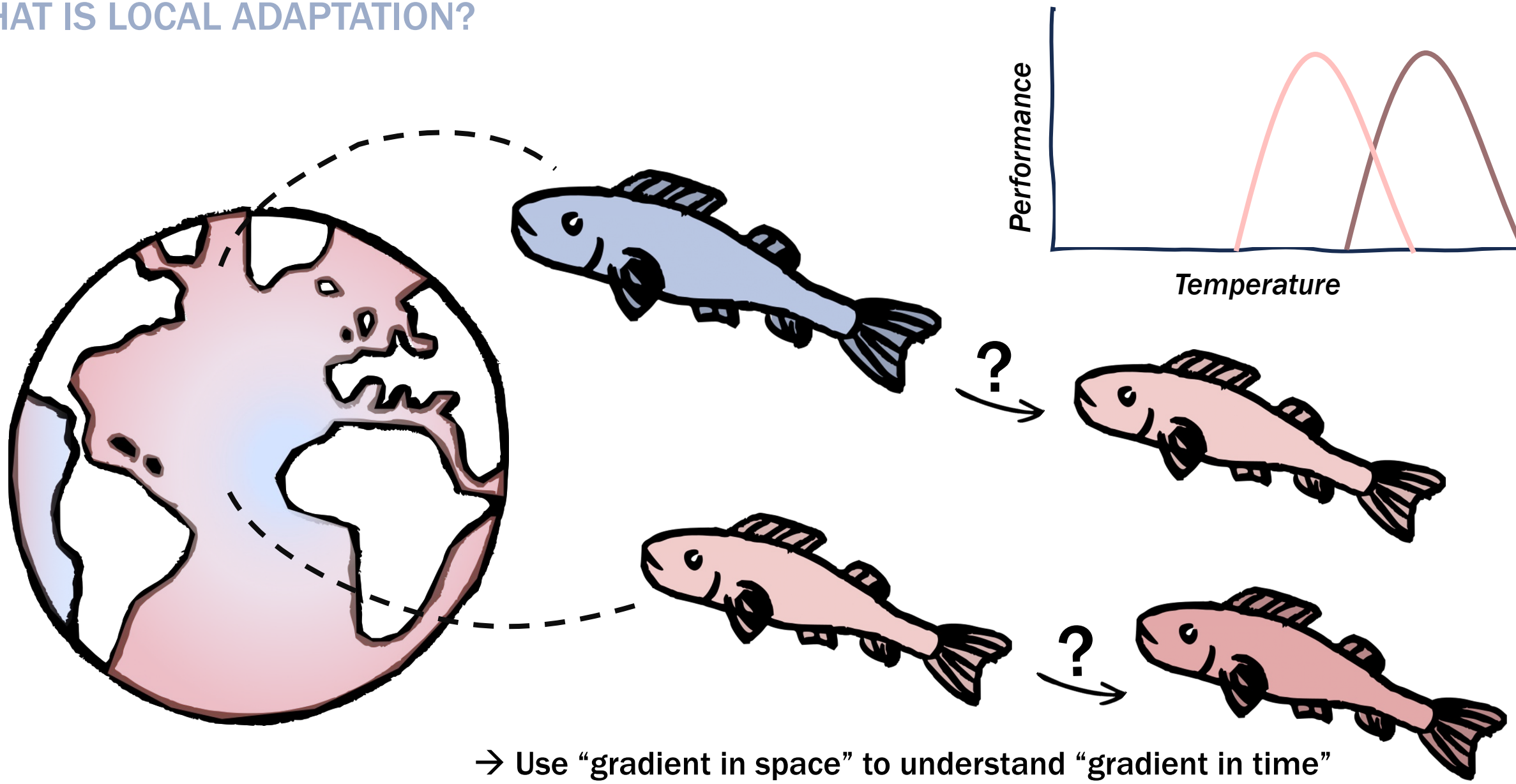


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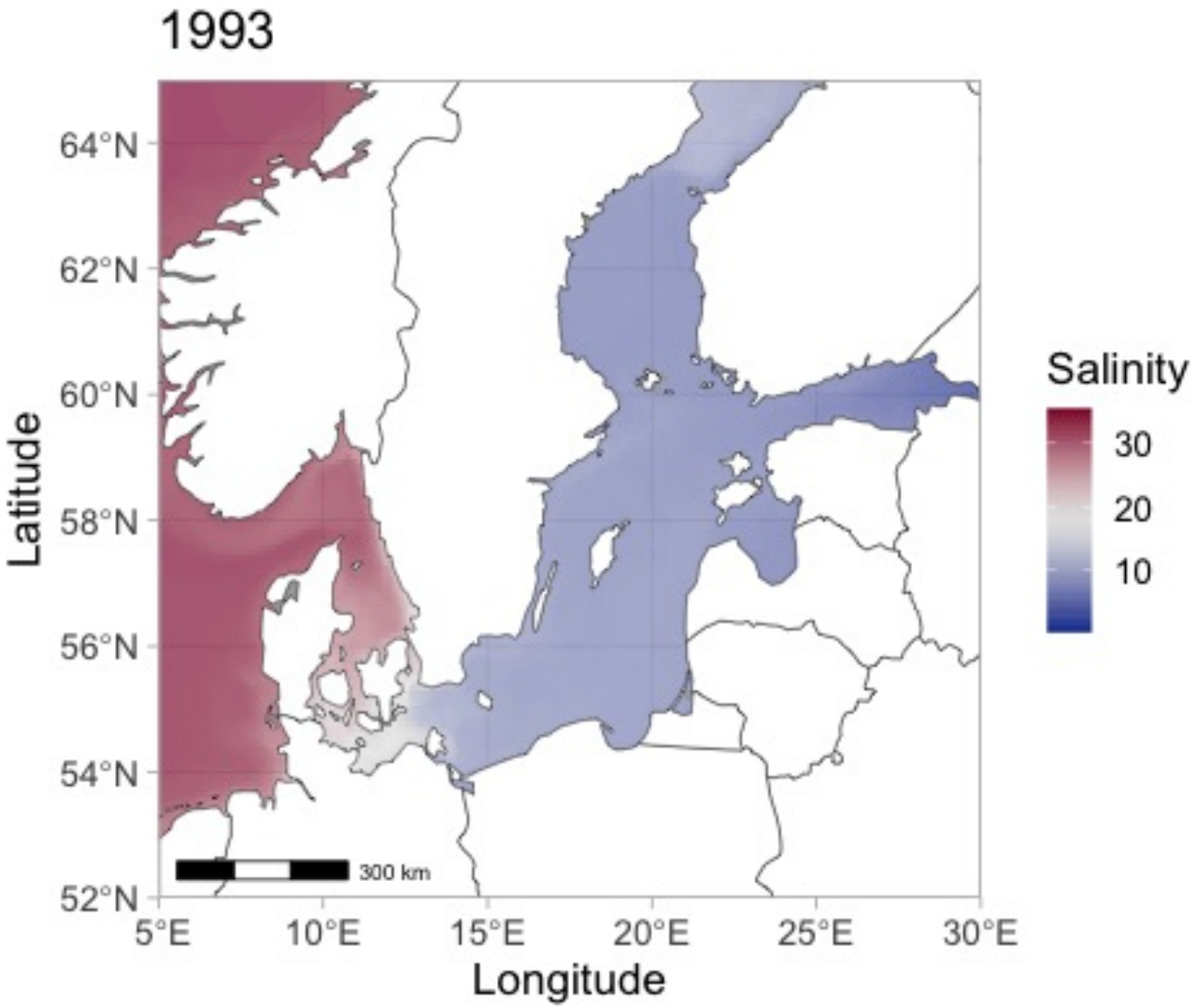
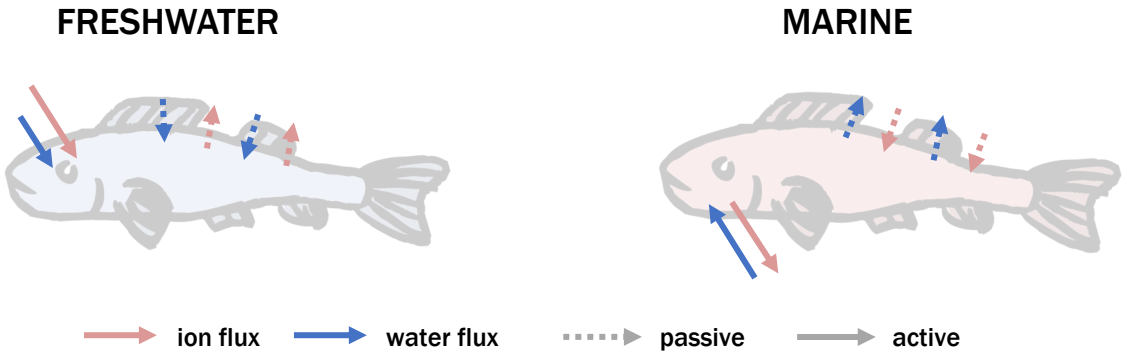
# THE BALTIC SEA AND ADAPTATION



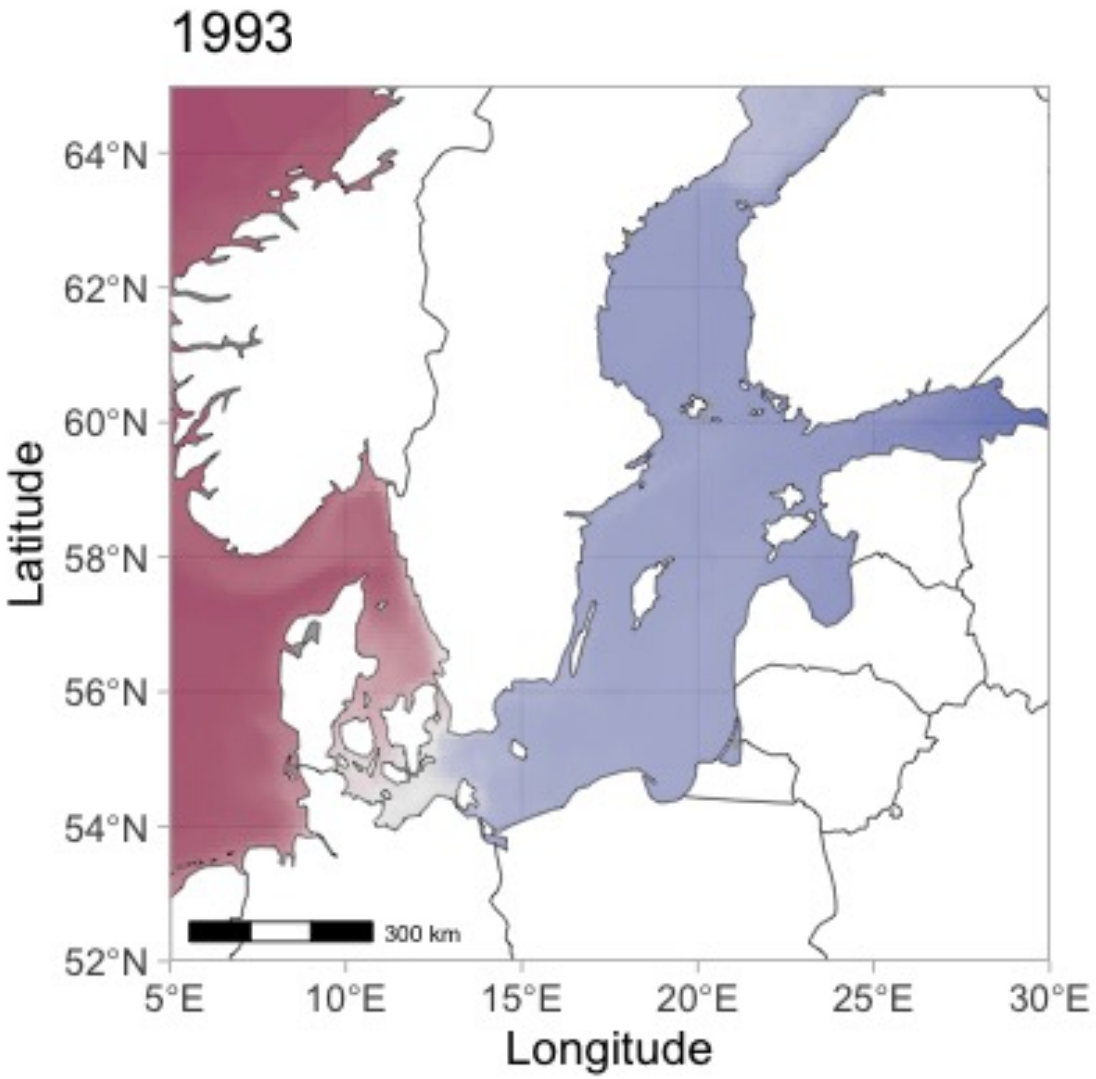

Salinity gradient forces organisms to compensate or adapt

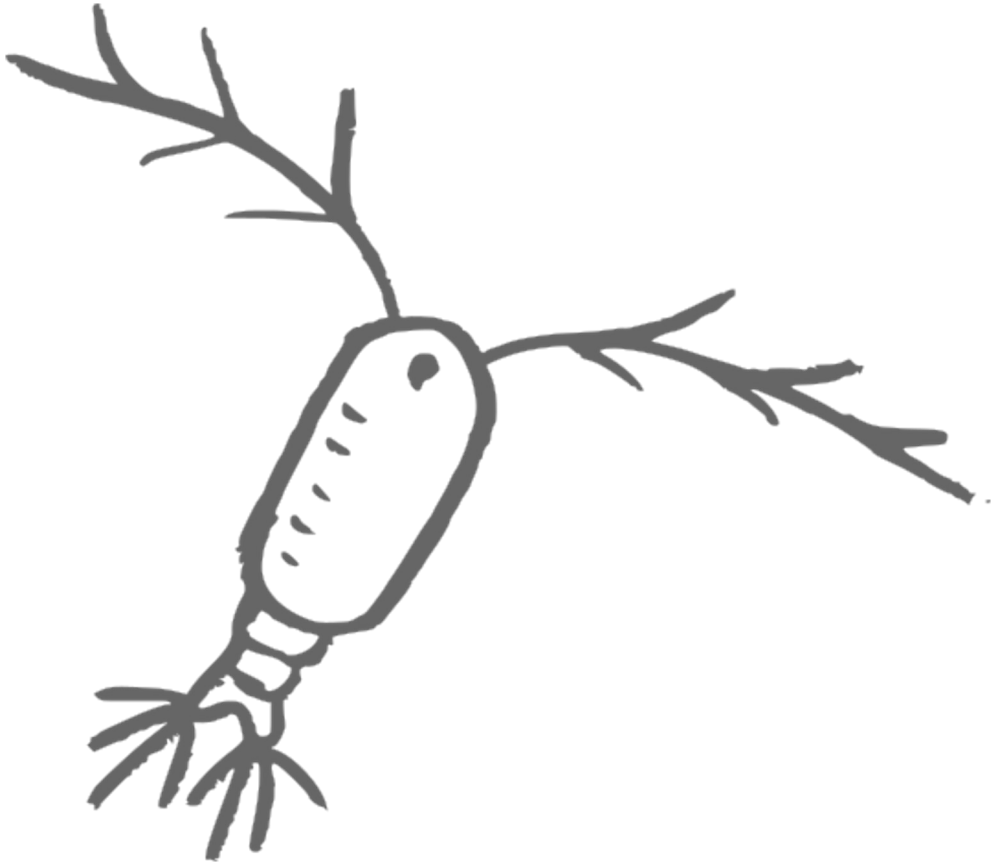
→ Local adaptation shown in Baltic mussels, fish, and phytoplankton

→ Understanding adaptive capacity and population structure helps to predict how climate change might affect organisms

Study system: Coastal copepod *Acartia tonsa*

# THE BALTIC SEA AND ADAPTATION



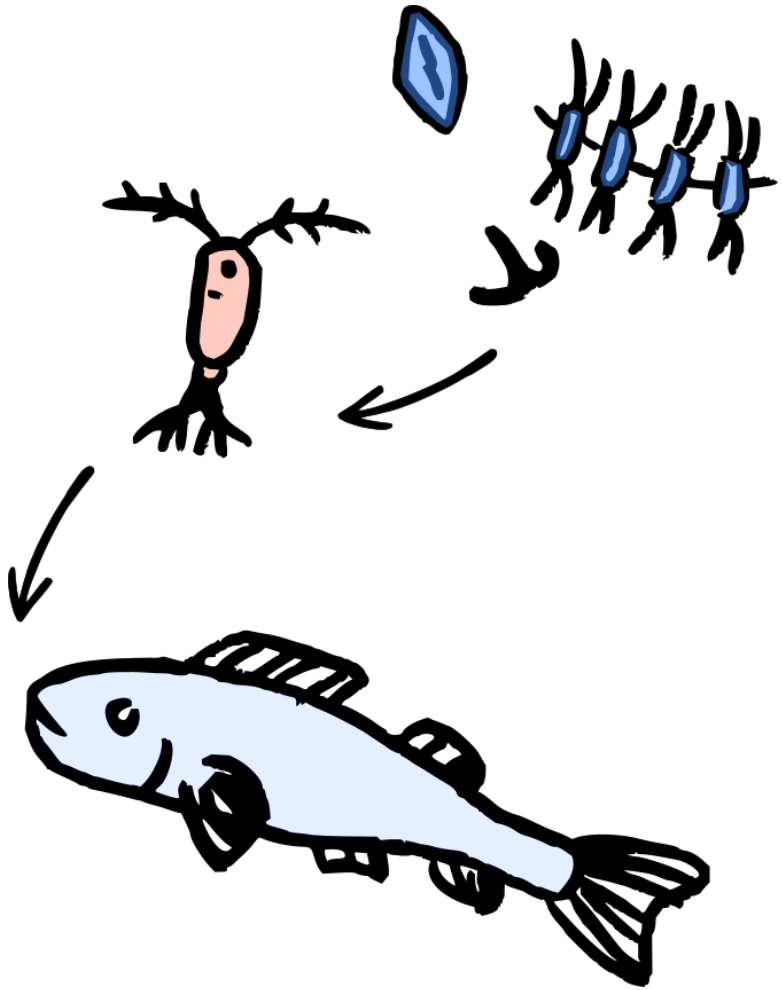



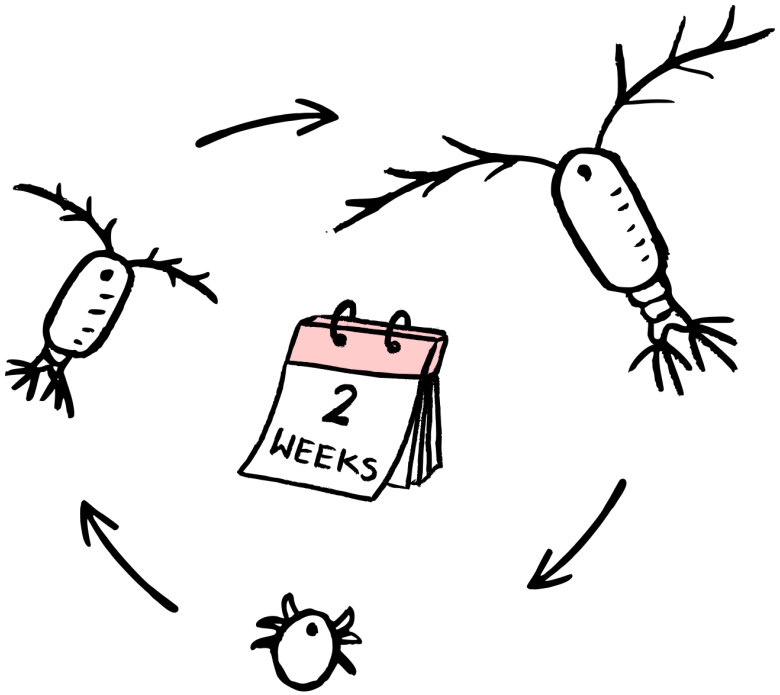
**Study system: Coastal copepod *Acartia tonsa***

# WHY COPEPODS?

**GLOBAL DISTRIBUTION**

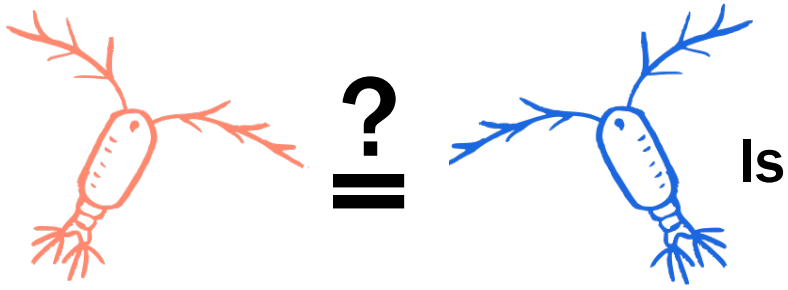
**ECOLOGICAL IMPORTANCE**



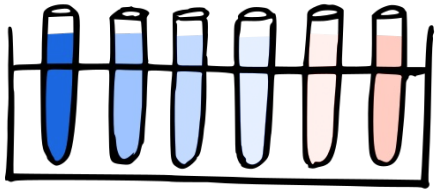



**SHORT LIFECYCLE**

# STUDY QUESTION



Is *Acartia tonsa* locally adapted to salinty in the Baltic Sea?



FITNESS EXPERIMENTS

GENE EXPRESSION

POPULATION GENOMICS

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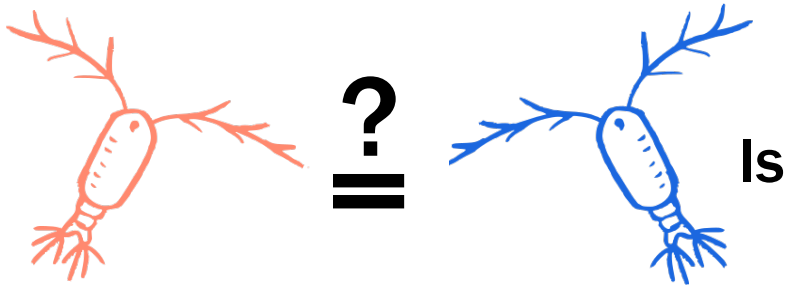

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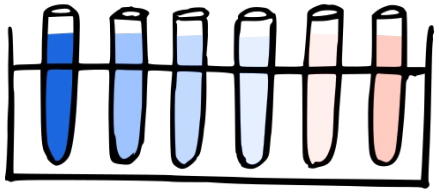


FITNESS EXPERIMENTS

GENE EXPRESSION

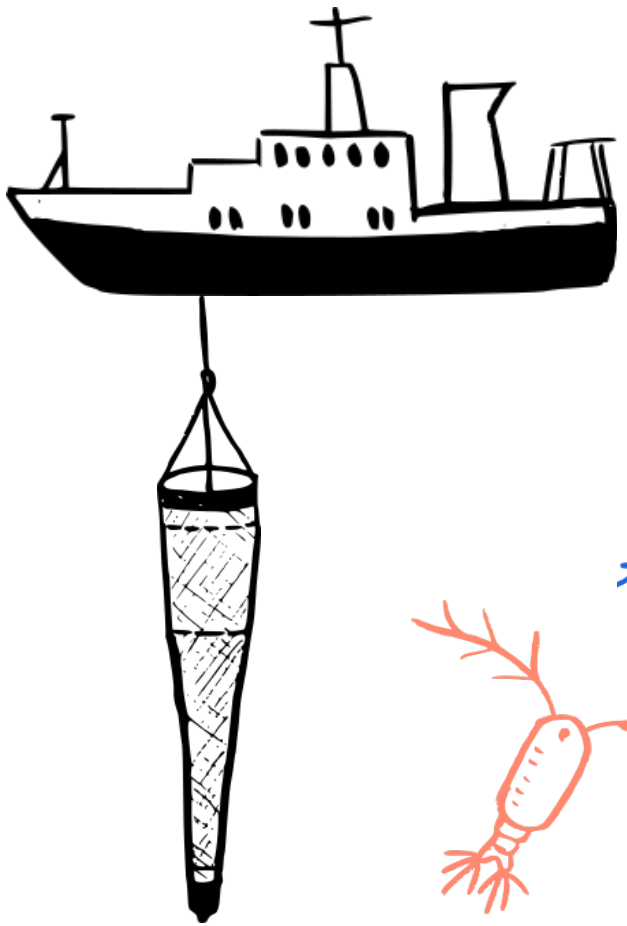


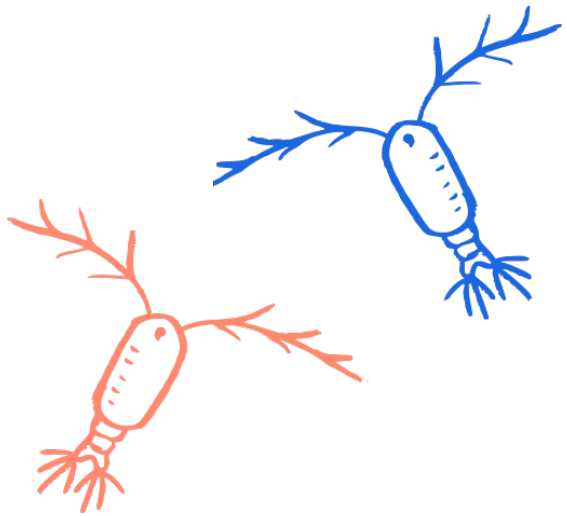
POPULATION GENOMICS

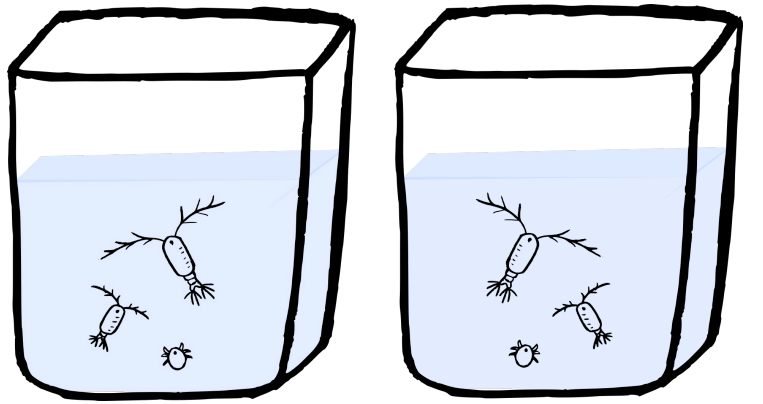
# PHYSIOLOGY

Is there a difference in fitness at low salinity?

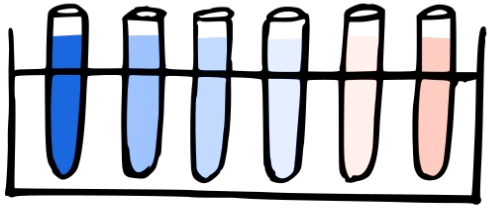
# EXPERIMENTAL APPROACH

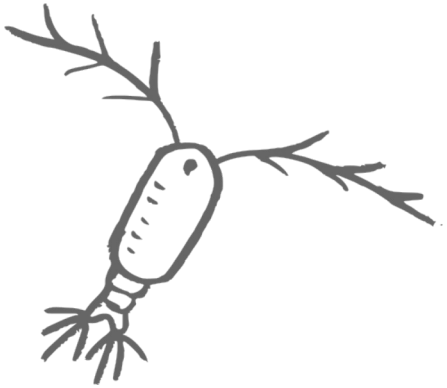






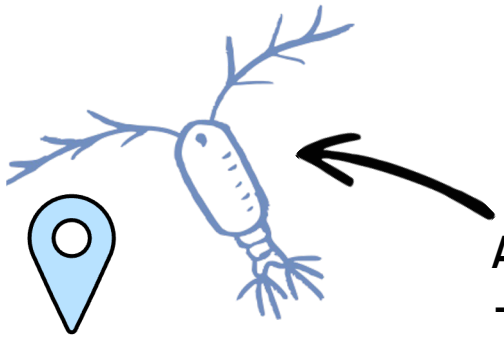
Expose to low salinity



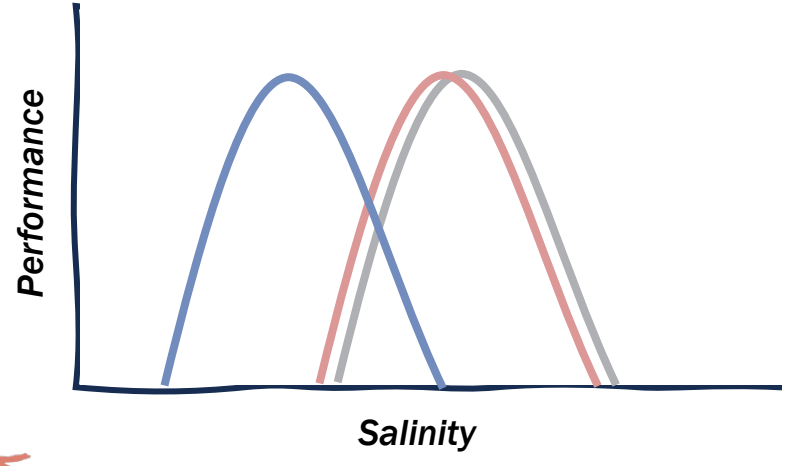


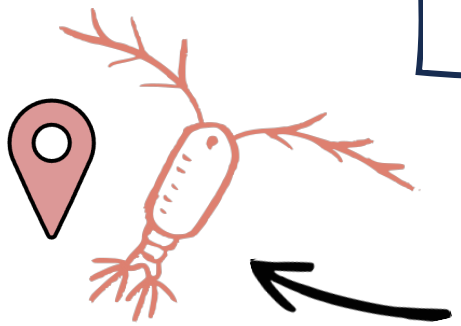
**How many copepods survive?**

# EXPECTATIONS

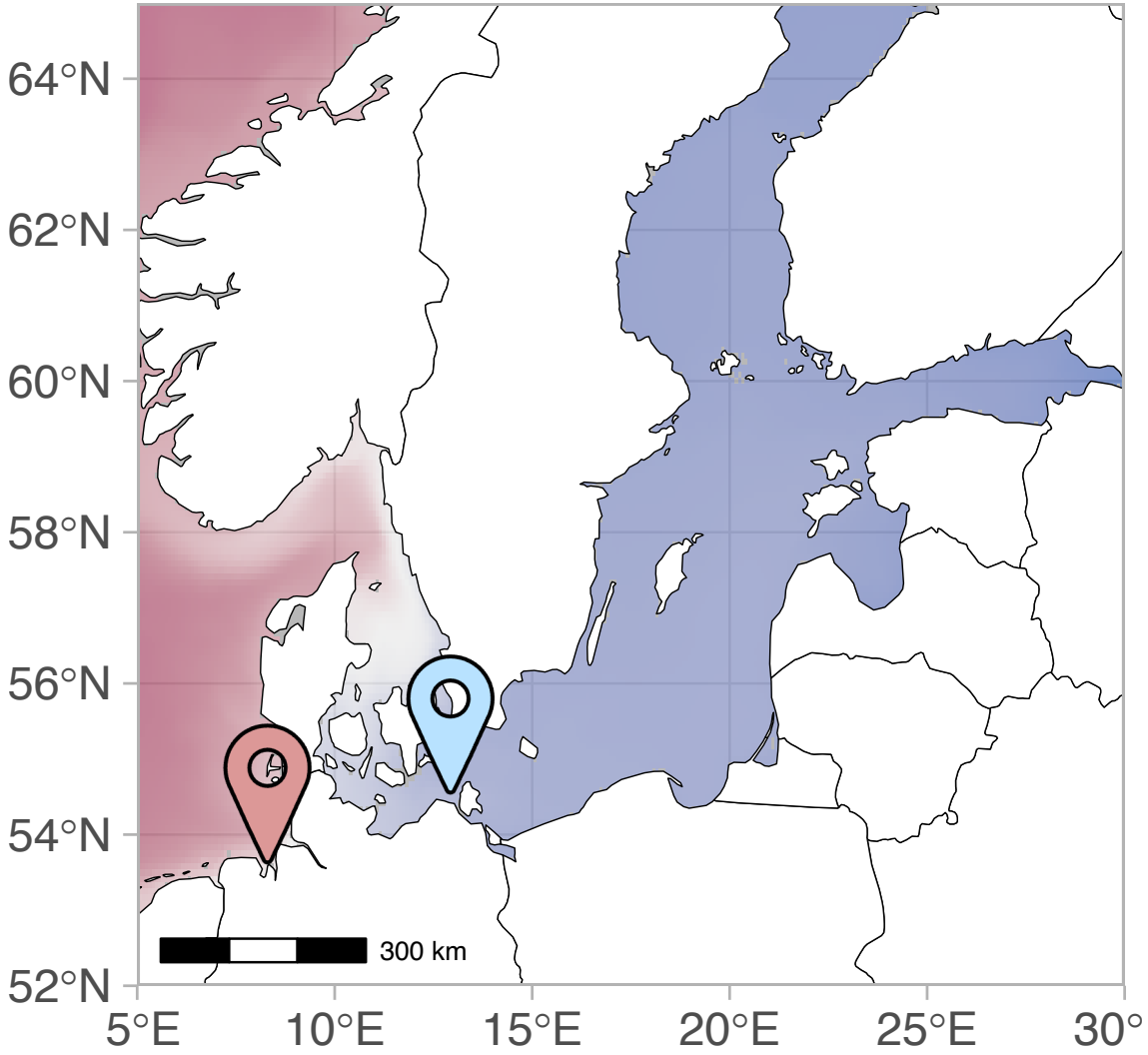


Adapted to low salinities
→ higher survival at low salinity

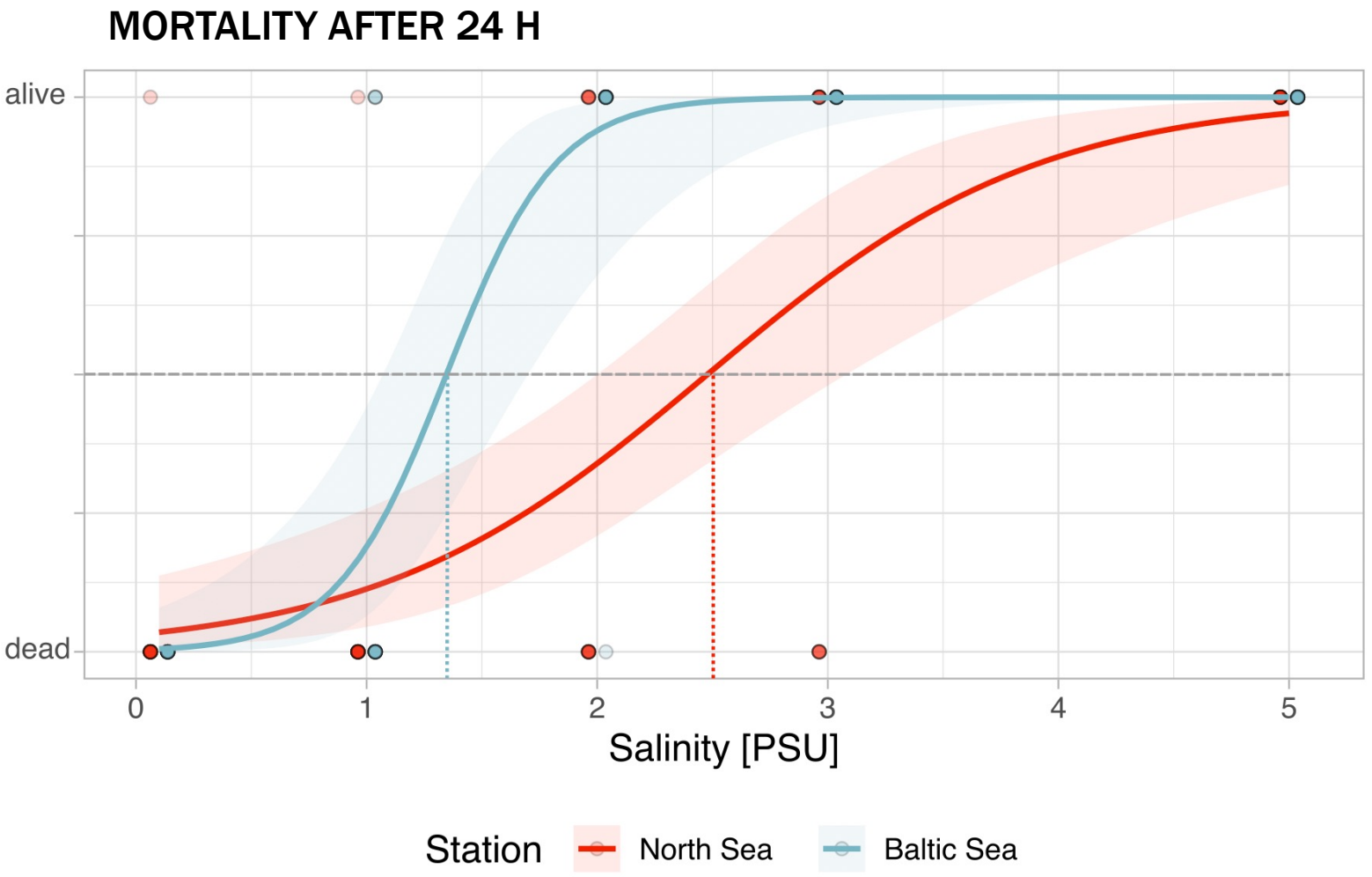


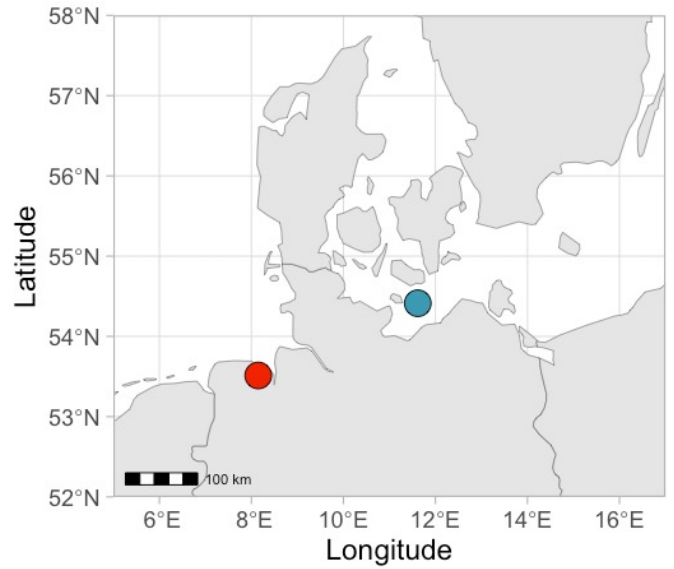



Adapted to high salinities
→ lower survival at low salinity

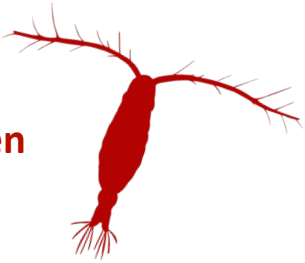


# HIGHER SURVIVAL IN BALTIC COPEPODS




**Baltic Sea**
**Mecklenburg Bight**



**North Sea**
**Wilhelmshaven**

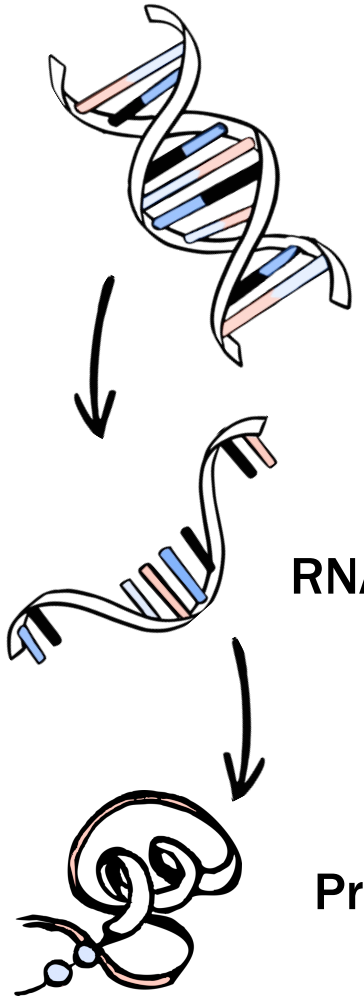
→ **What are the mechanisms behind salinity tolerance?**

Hahn et al. in prep

# TRANSCRIPTOMICS

How does gene expression differ between populations?
Is there a common/unique response to low salinity stress?

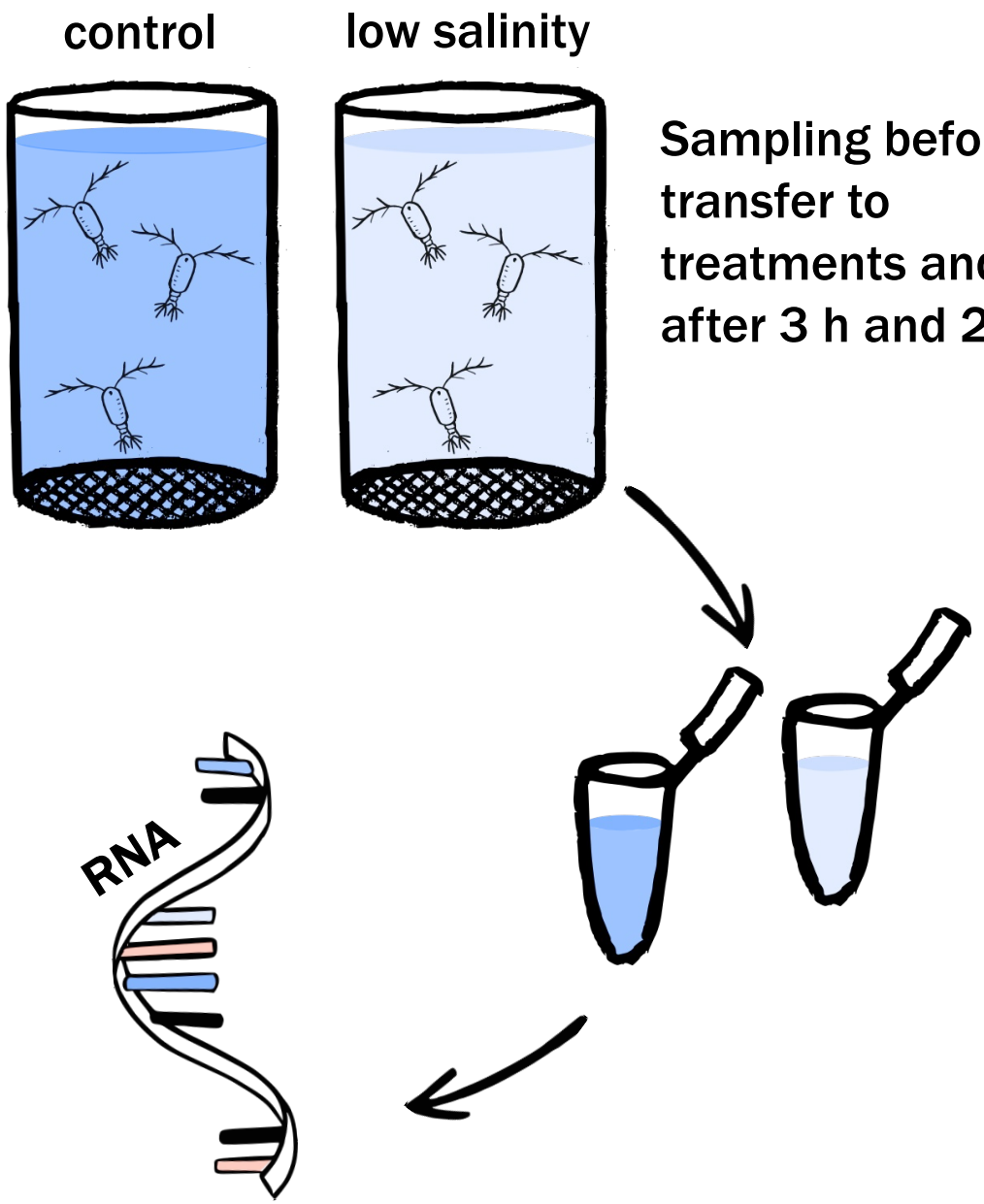
# CONCEPT AND EXPERIMENTAL SETUP



DNA: all genetic information
"blueprint"

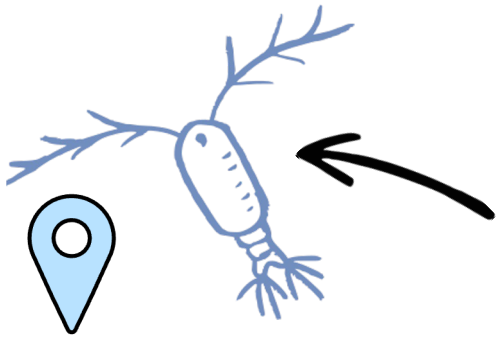
RNA: transcript of DNA, coding for proteins

Protein = Phenotype

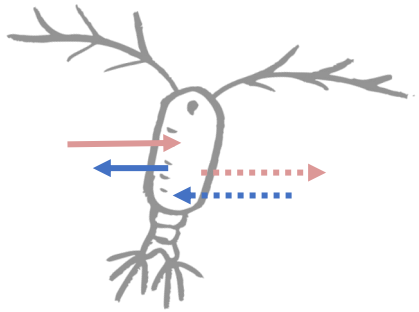


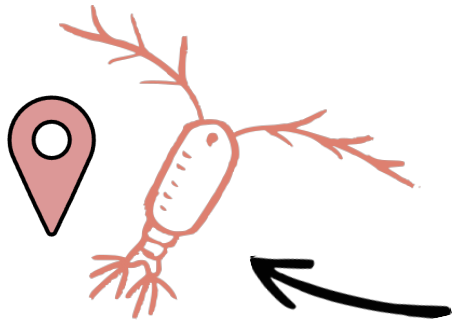

Transcriptomics = Analysis of all RNA transcripts at a given time to understand what processes are active or inactive

# EXPECTATIONS



Adapted to low salinities
→ less stress at low salinity



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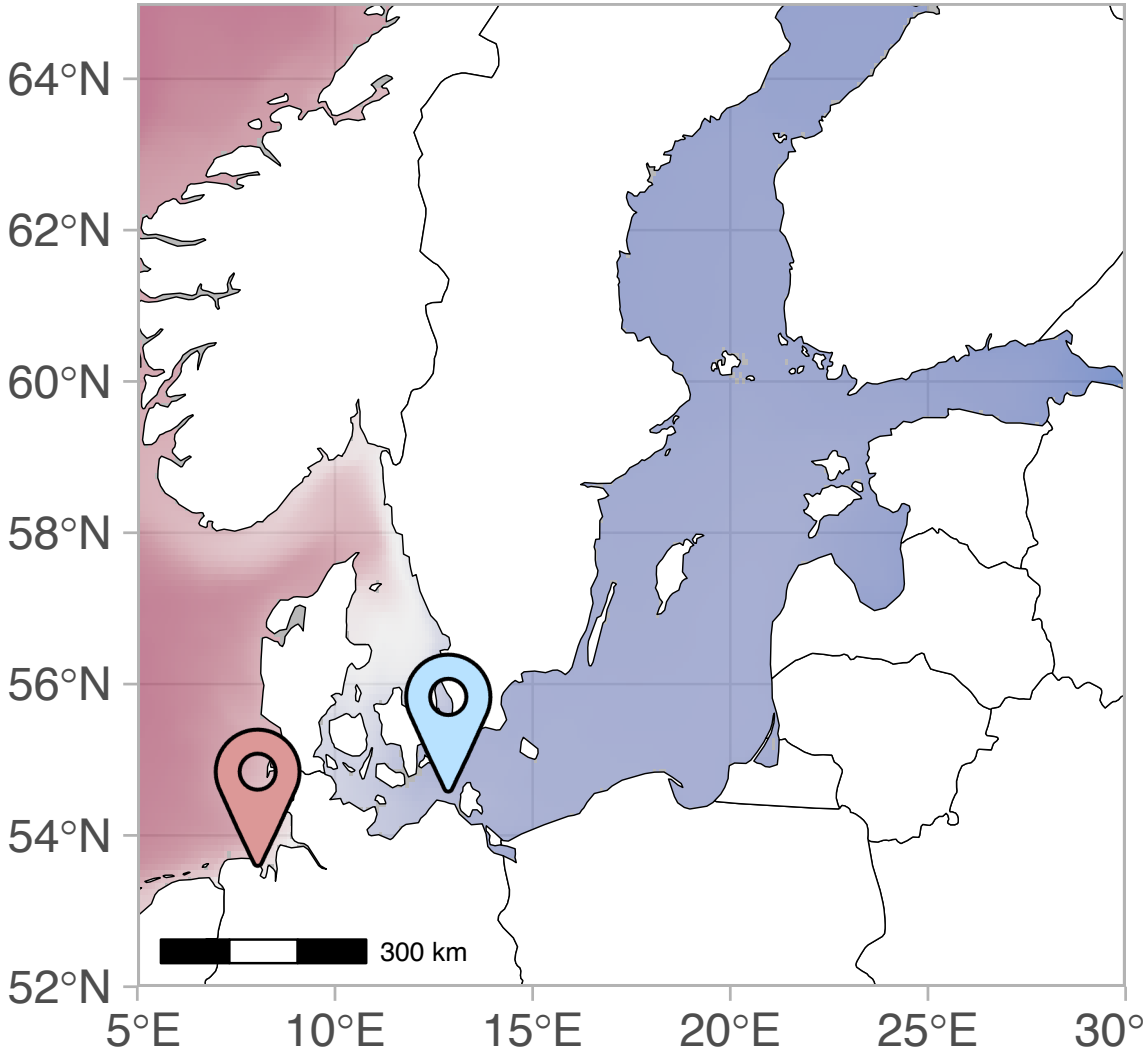
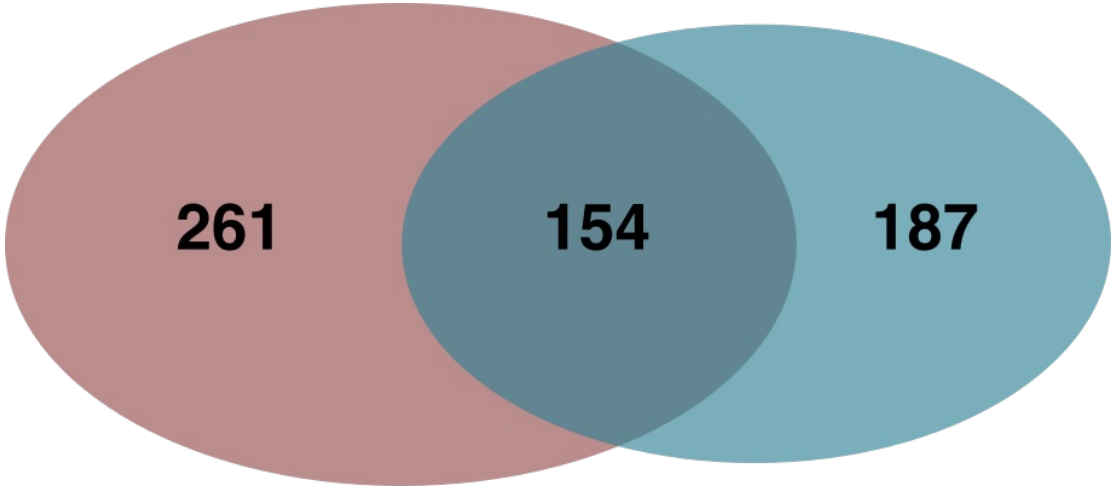
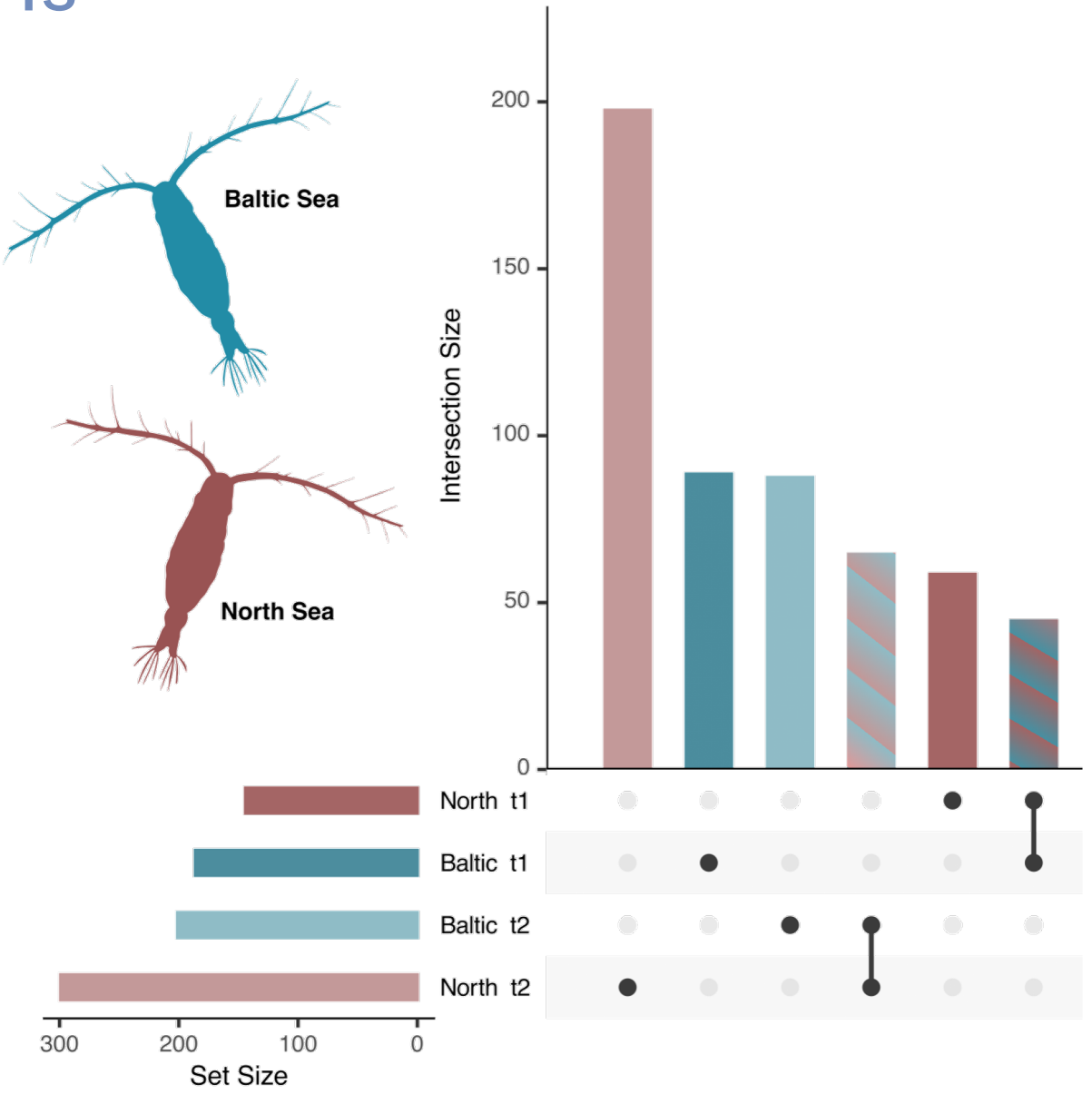


# SOME SHARED BUT MANY UNIQUE TRANSCRIPTS




North Sea copepods have more differentially expressed genes, especially after 24 h

→ Struggle to conform

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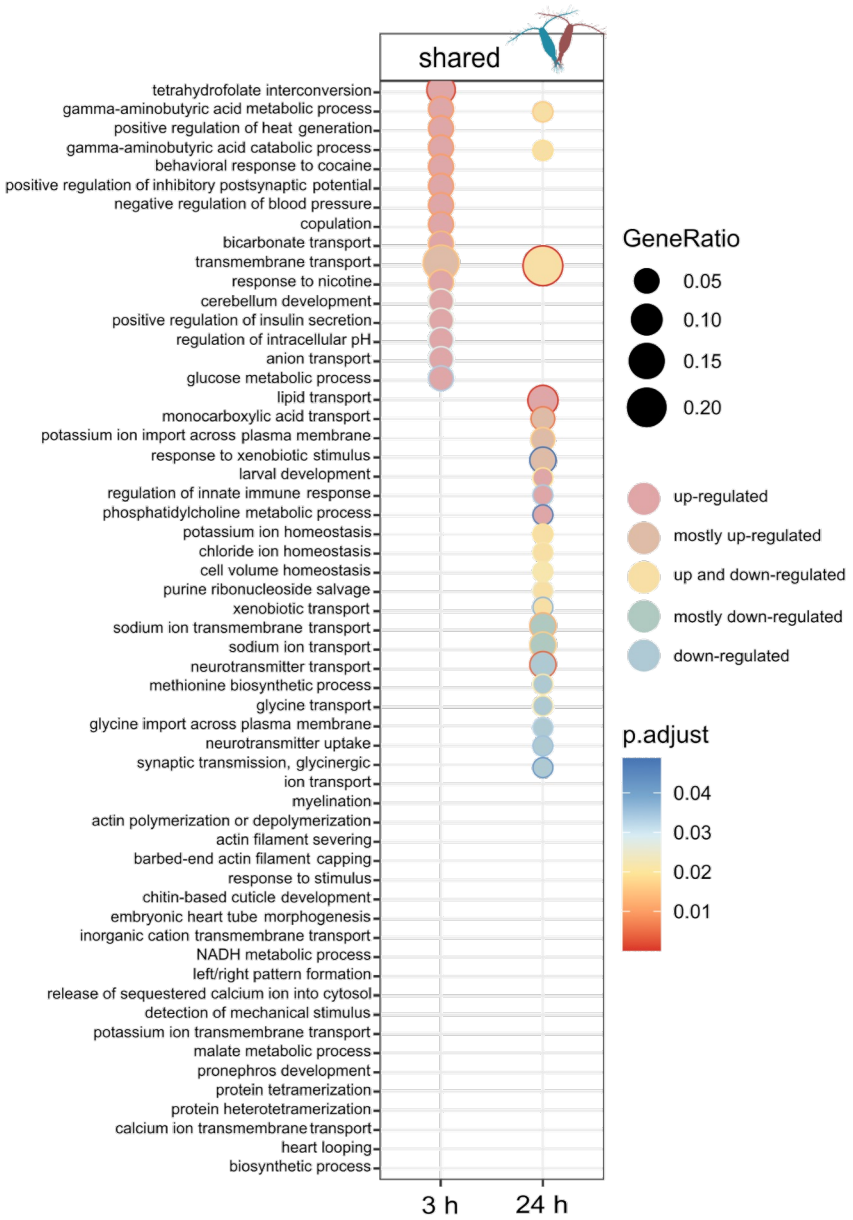
# COMMON RESPONSE TO LOW SALINITY STRESS




**After 3 hours:**

→ **Metabolic regulation**

→ **Neurological and behavioral regulation**

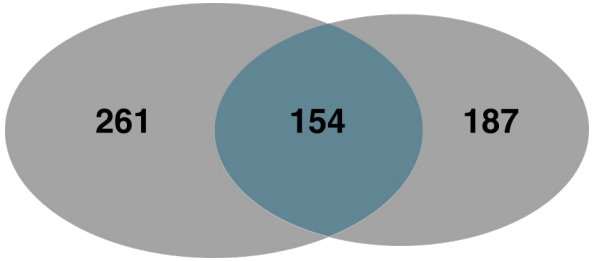
→ **Ion transport and pH regulation**

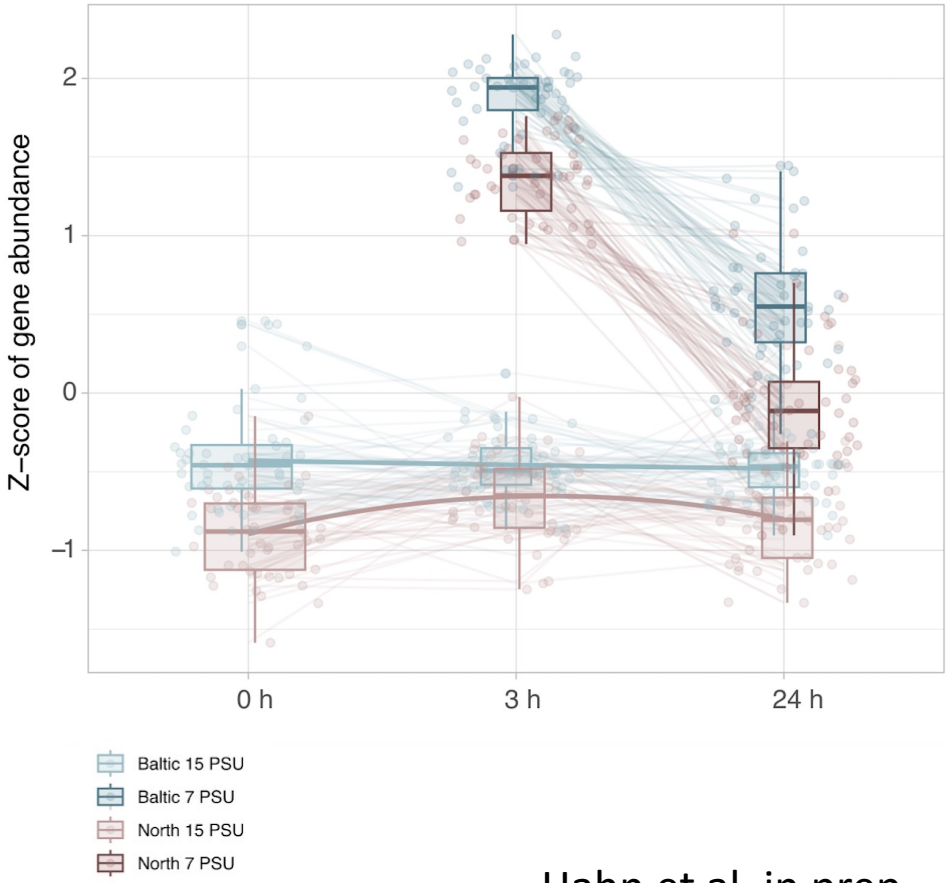
**After 24 hours:**

→ **Various transport functions**

→ **Homeostasis**

→ **Not only up-regulation but more nuanced response**

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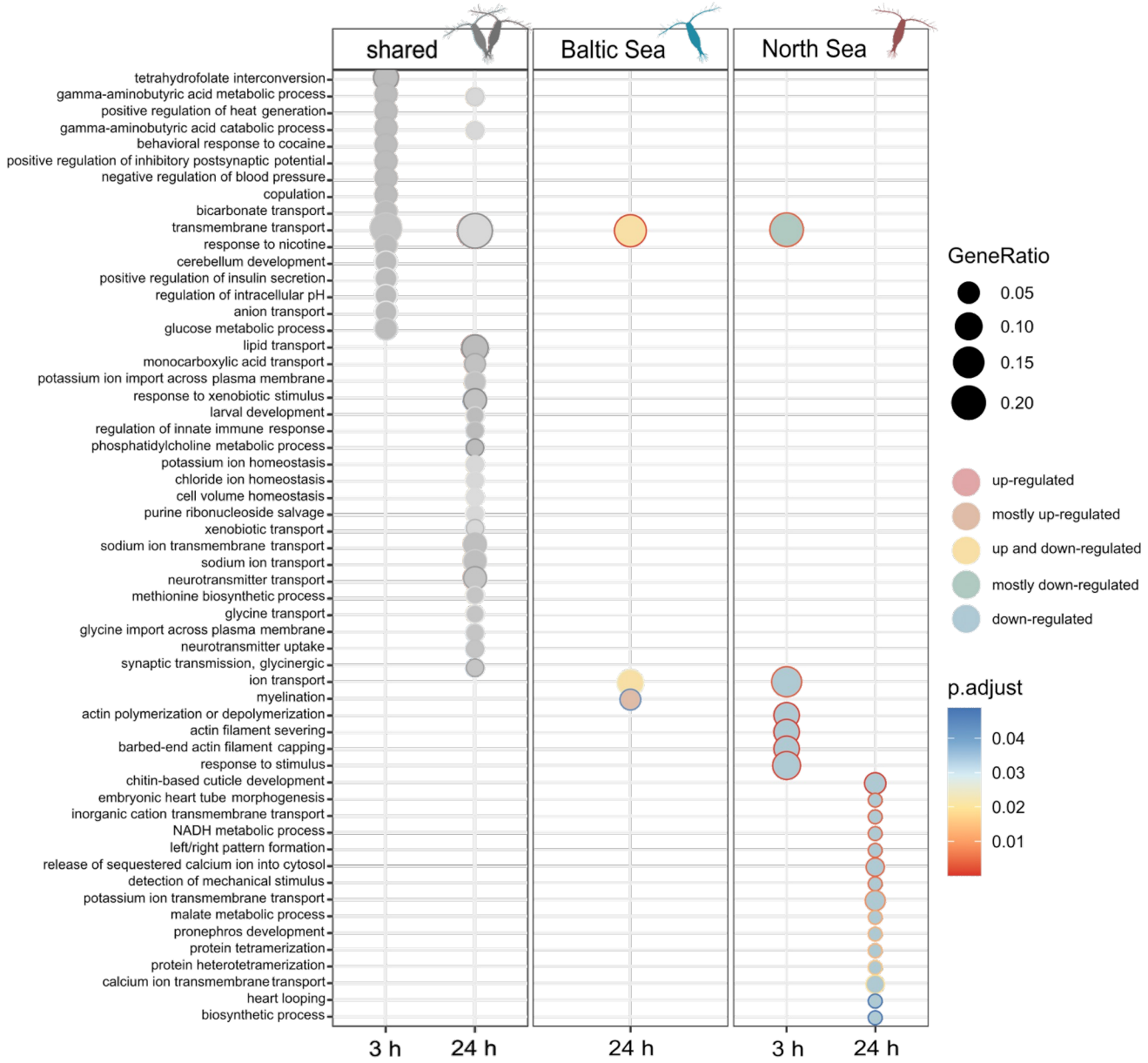
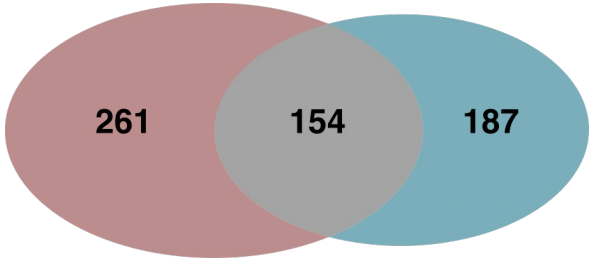
# UNIQUE RESPONSE TO LOW SALINITY STRESS




**Baltic Sea:**

→ **Few additional functions, none for t1**

**North Sea:**

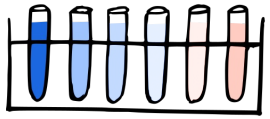
→ **Many additional functions, time differentiation**

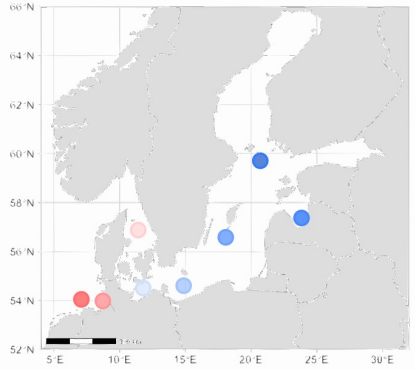
→ **Mostly downregulation, suppression of metabolic functions to conserve energy**

→ **Struggle to comply with low salinity**

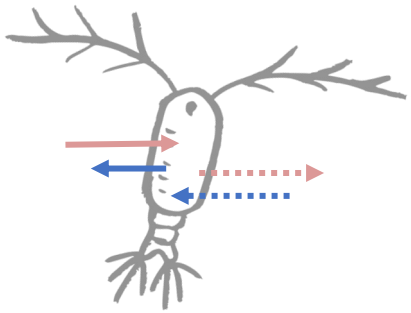
Hahn et al. in prep

# TAKE HOME MESSAGES

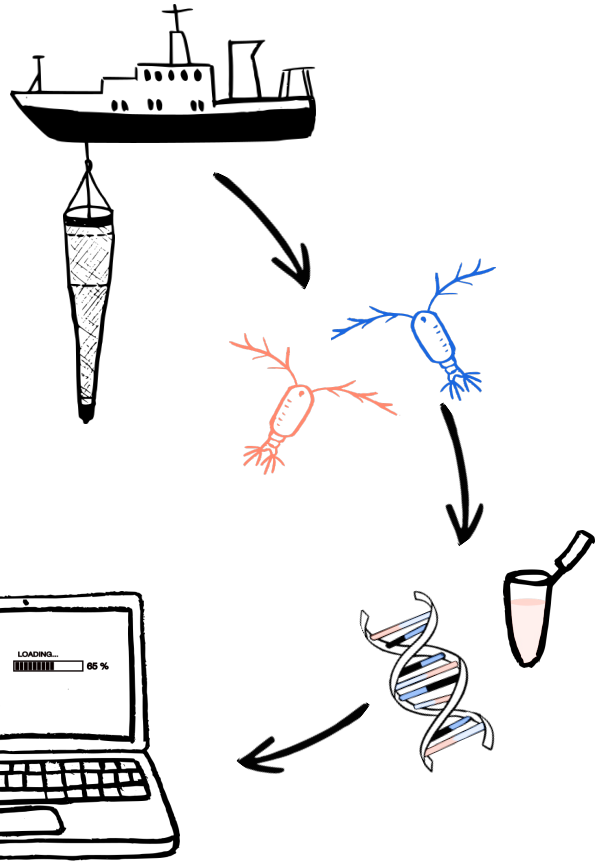




Differences in gene expression and fitness
→ Local adaptation



Tolerance to low salinity in both populations
→ Osmoregulatory strategy

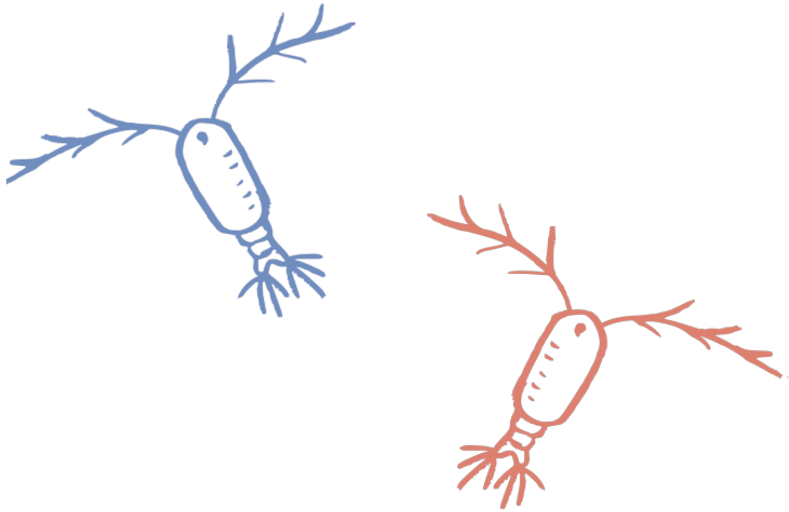



ONGOING: population genomics to identify genetic basis and verify findings

# OUTLOOK

High resilience to environmental stressors is evident in both populations → ensure survival and buy time for adaptations to occur

Adaptive potential could help copepods cope with future environmental change



# QUESTIONS?


**THANKS TO**

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Gianina Consing
HPC @ CAU
RD3 @ GEOMAR
Scientists and crew aboard cruise AL580