

Introduction

- Global average sea level has risen 8-9 inches since 1880. Sea-level rise can increase the potential for saltwater intrusion in coastal aquifers (Lindsey., 2023).
- Groundwater pumping can draw the freshwater saltwater interface inland.
- Salt Intrusion along Long Island waterways has resulted in major issues: Lack of safe and accessible public-water supply and Osmotic stress to aquatic ecosystems

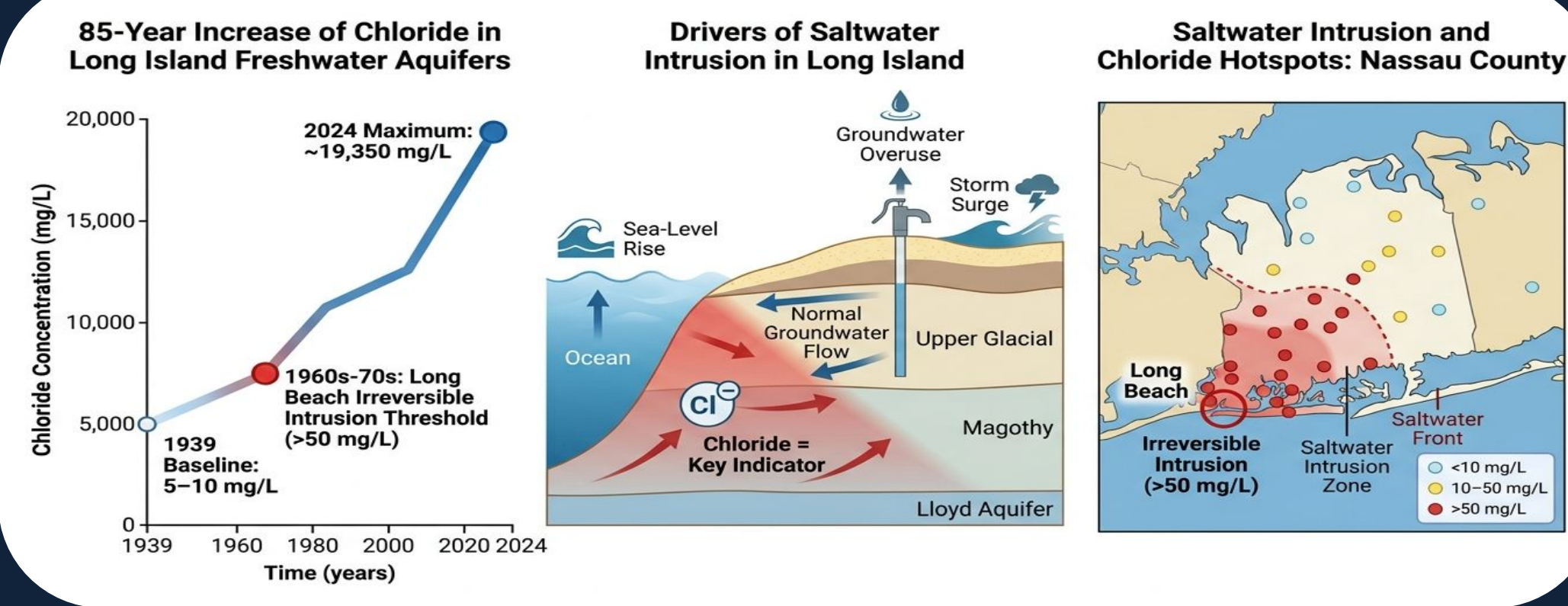


Figure 1: Image prepared by finalist in Figure Labs using information from U.S. Geological Survey, 2024, 2026

Literature Review

Saltwater Intrusion in Coastal Regions of North America

Barlow, P. M., & Reichard, E. G. (2010). Saltwater intrusion in coastal regions of North America. *Hydrogeology Journal*, 18(1), 247-260.

Molecular Structure

Goal: Quantify types of Saltwater intrusion, such as Lateral Intrusion, when saltwater is pushed back offshore, upward intrusion, over pumping occurs and human altered drainage occurs.

Findings: Major water supply problems due to the amount of groundwater being pumped, sea levels constantly changing, and aquifer structures. When sea levels change, water leaves behind trapped saline in the aquifers causing saltwater intrusion.

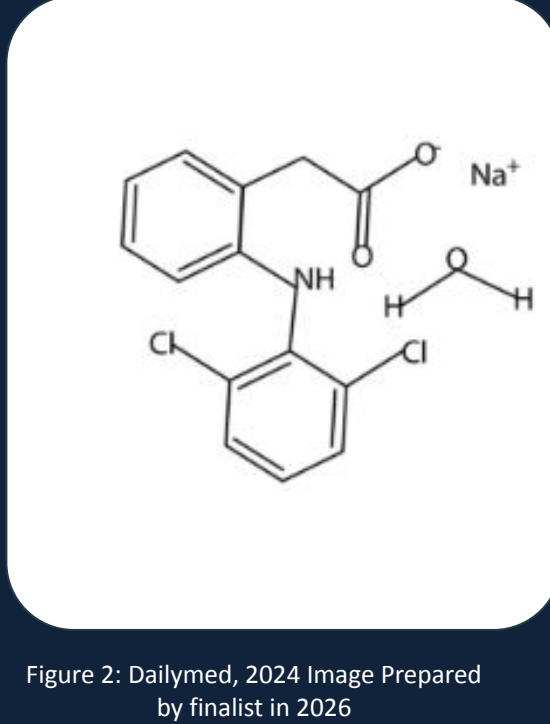


Figure 2: Dallymed, 2024 Image Prepared by finalist in 2026

Effects of Salinity Changes on Aquatic Organisms in a Multiple Stressor Context

Velasco J, Gutierrez-Ca'novas C, Botella-Cruz M, Sanchez-Fernandez D, Ambas P, Carbonell JA, Milla'n A, Pallares S. 2019 Effects of salinity changes on aquatic organisms in a multiple stressor context. (2018)

Goals: Examine how changes in salinity affect aquatic organisms, including their survival, growth, metabolism, and other physiological responses. Determine how salinity interacts with environmental stressors. Compare the effects among different types of aquatic organisms and habitats to better understand the overall impact of salinity changes.

Findings: Salinity itself had a strong negative effect on aquatic organisms. Salinity generally had a greater individual impact than other stressors, such as temperature. The effects depended on the type of stressor, habitat, and organism.

Gaps in Literature

Saltwater intrusion current research lacks data on how increasing salinity affects both freshwater keystone species like *Daphnia magna* and agricultural crops, revealing ecosystem and food system vulnerability.

Research Questions & Hypotheses

1 - How do increasing NaCl concentrations affect plant growth and development?

H₀- All NaCL concentrations have no effect on the growth and development of *V.radiata*

H_a- Increasing NaCl decreases the growth and development of *V.radiata*

2 - How do increasing NaCl concentrations affect cardiac activity of aquatic organisms?

H₀-All concentrations of NaCl have no effect on the heart rate or survival of *D.magna*

H_a- Increasing NaCl decreases the heart rate and survival of *D.magna*

Investigating Saltwater Intrusion on the Development and Growth of *Vigna radiata* and Heart Modulation of *Daphnia magna*

Purpose

Quantify the impact of salt intrusion on agricultural cash crops and keystone aquatic species.

Impact

Salt intrusion has occurred in local waterways since the 1940's, harming aquatic life and agriculture which affects human health.

Methodology

NaCl Stock Solution Preparation

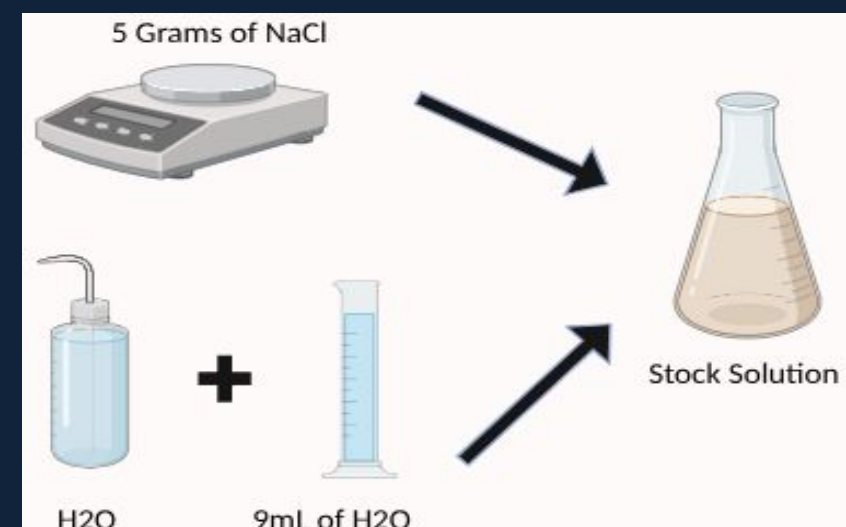


Figure 3: Prepared by Finalist in Biorender, 2026

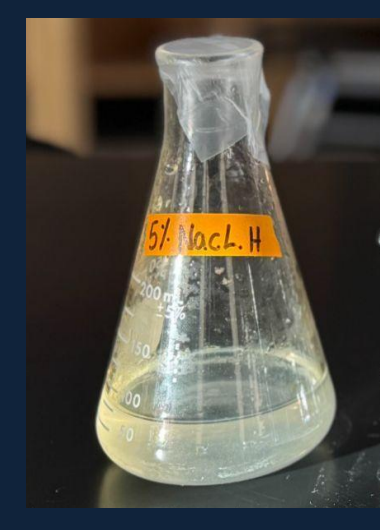


Image of NaCl Stock Solution: Images taken by Finalist using an iPhone 15, 2026

Plant Germination & Growth Assay

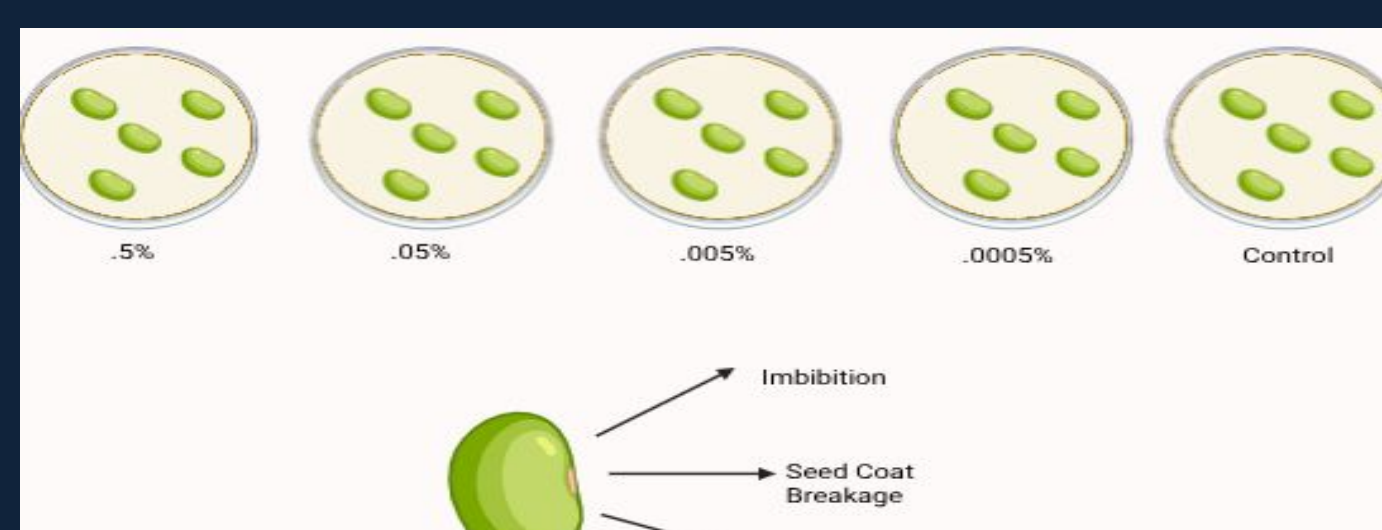


Figure 4: Prepared by Finalist in Biorender, 2026

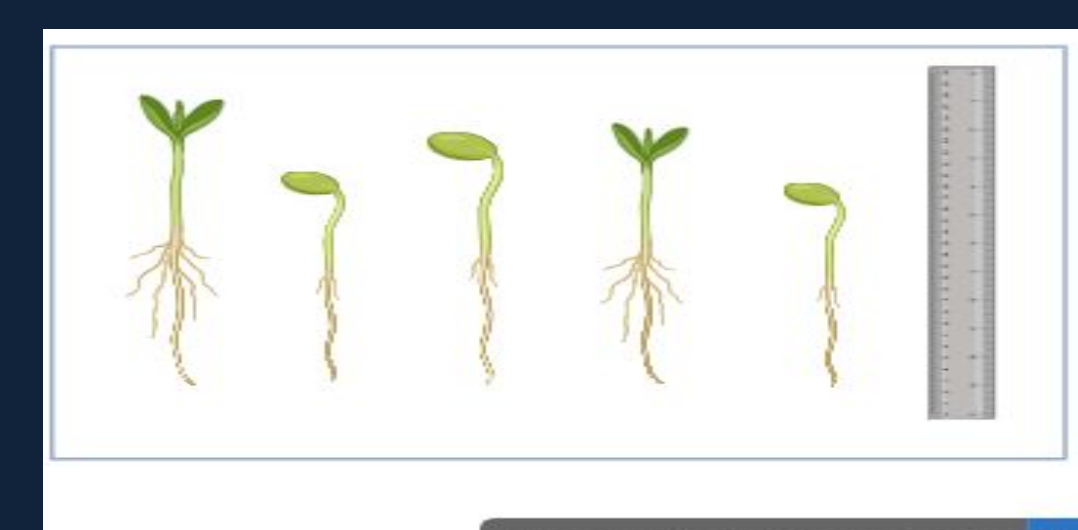


Figure 5: Prepared by Finalist in Biorender, 2026

Preparation of 1:2 Dilution

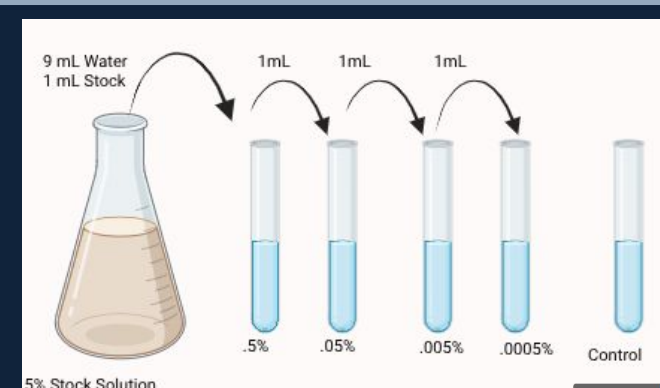


Figure 6: Prepared by Finalist in Biorender, 2026



Image of NaCl concentrations after 1:2 Dilution: Images taken by Finalist using an iPhone 15, 2026

Daphnia Cardiac Response Assay

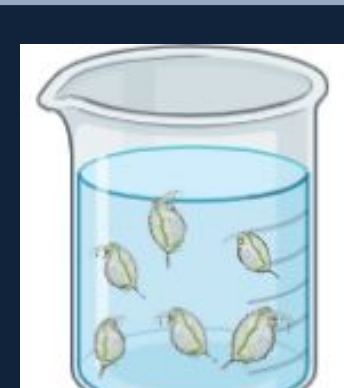


Figure 7: Prepared by Finalist in Biorender, 2026

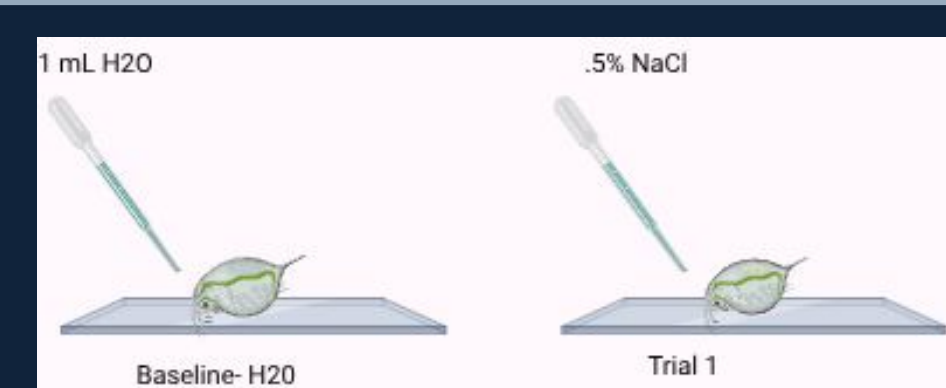


Figure 8: Prepared by Finalist in Biorender, 2026

Daphnia magna Maintenance



Figure 9: Prepared by Finalist in Biorender, 2026

- Daphnia magna* was maintained in a water tank with a spongy filter
- Water was changed once a week
- Daphnia magna* was fed pellets made of algae

Microscopic Imaging of Daphnia magna

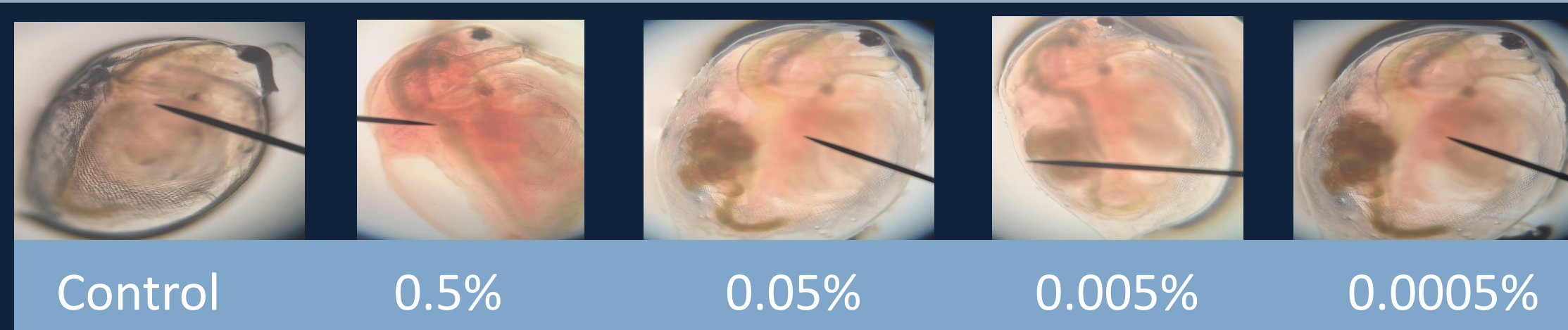


Figure 10: Images taken by Finalist using an iPhone 15 and a compound light microscope under 40X, 2026

Results

Average Growth of V. radiata

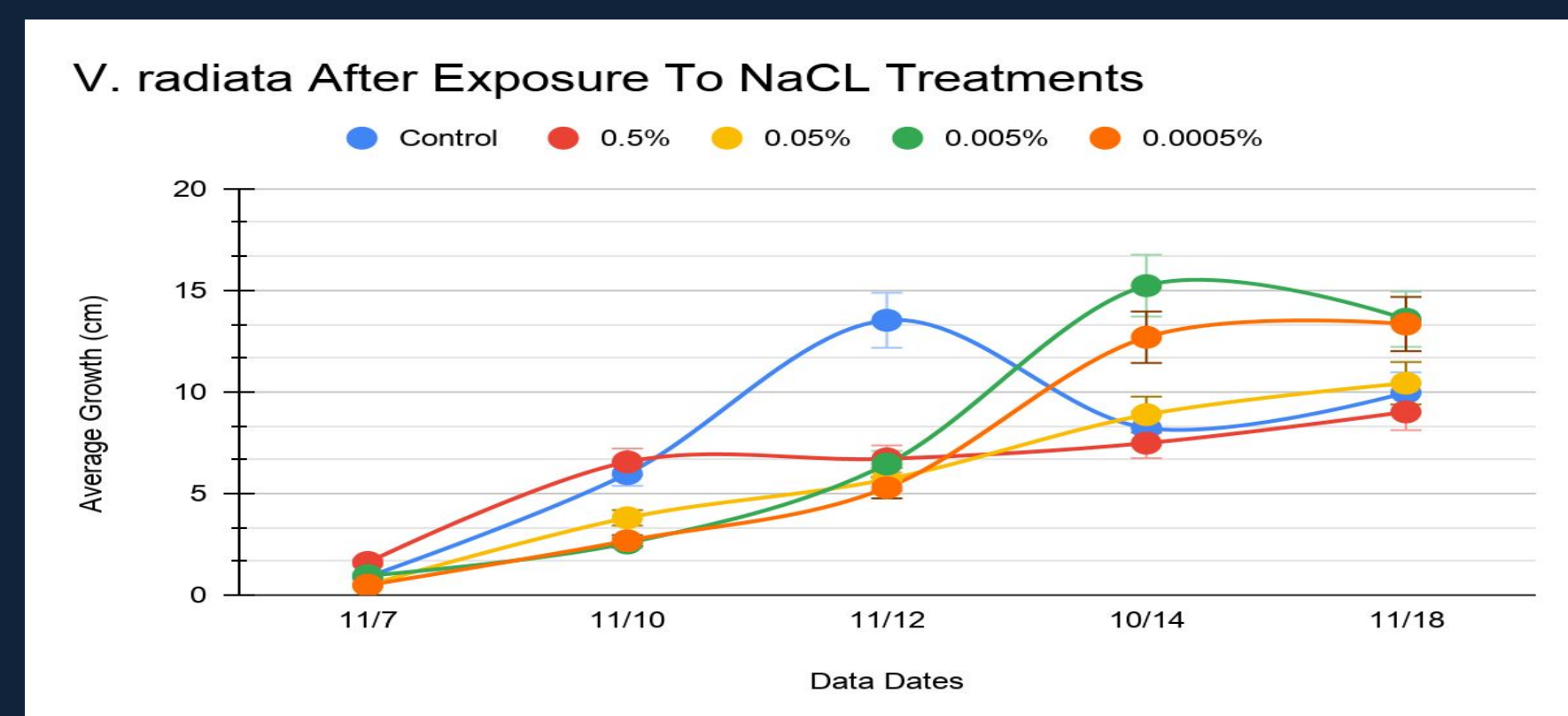


Figure 12: Prepared by Finalist in Google Sheets, 2026

Germination of V. radiata

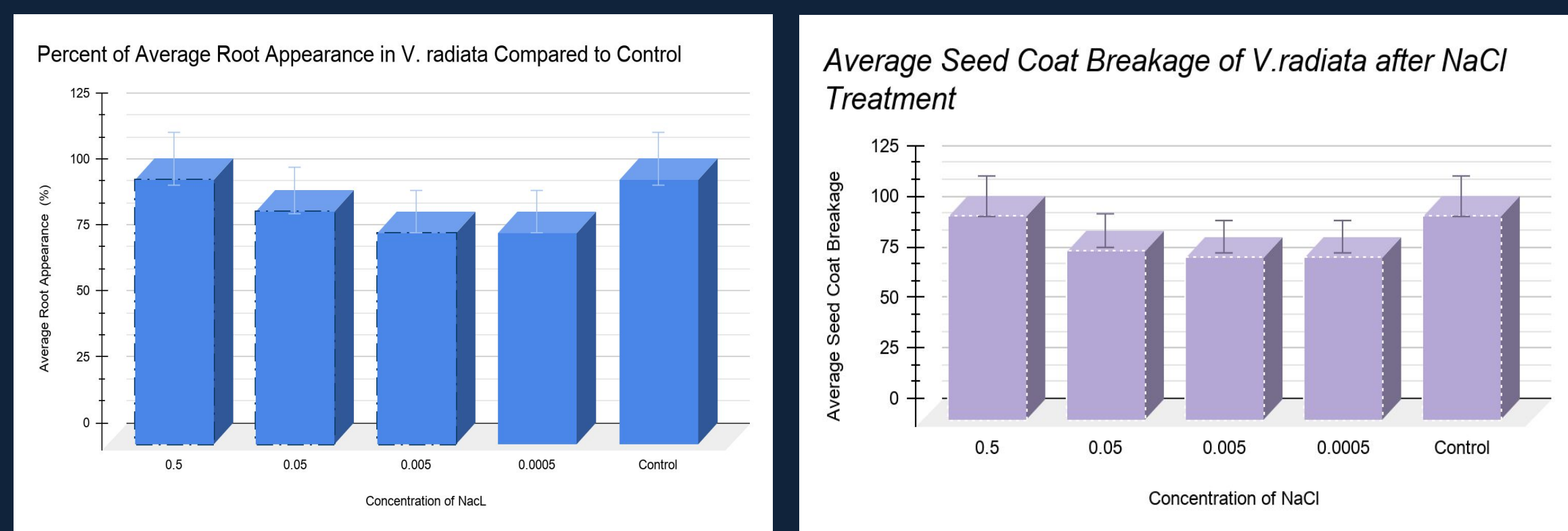


Figure 13: Prepared by Finalist in Google Sheets, 2026

Figure 14: Prepared by Finalist in Google Sheets, 2026

Average Percent Change of D. magna

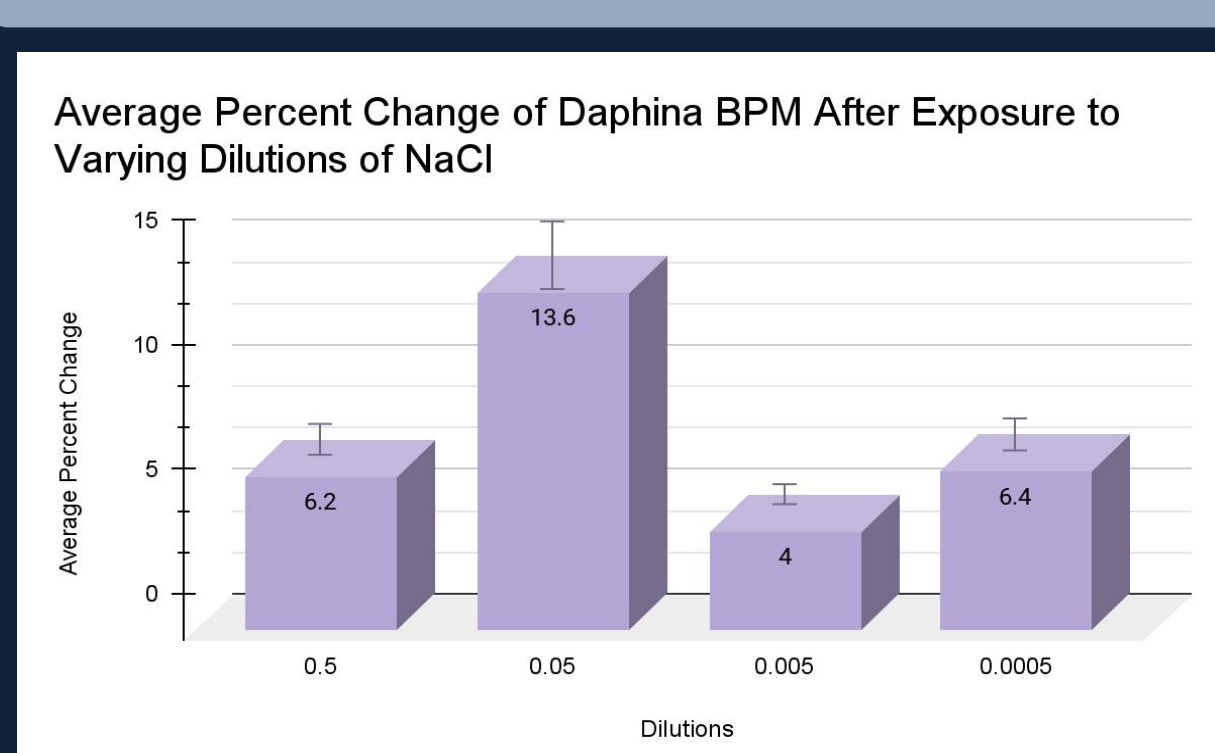


Figure 15 Prepared by Finalist in Google Sheets, 2026

Average BPM of D. magna

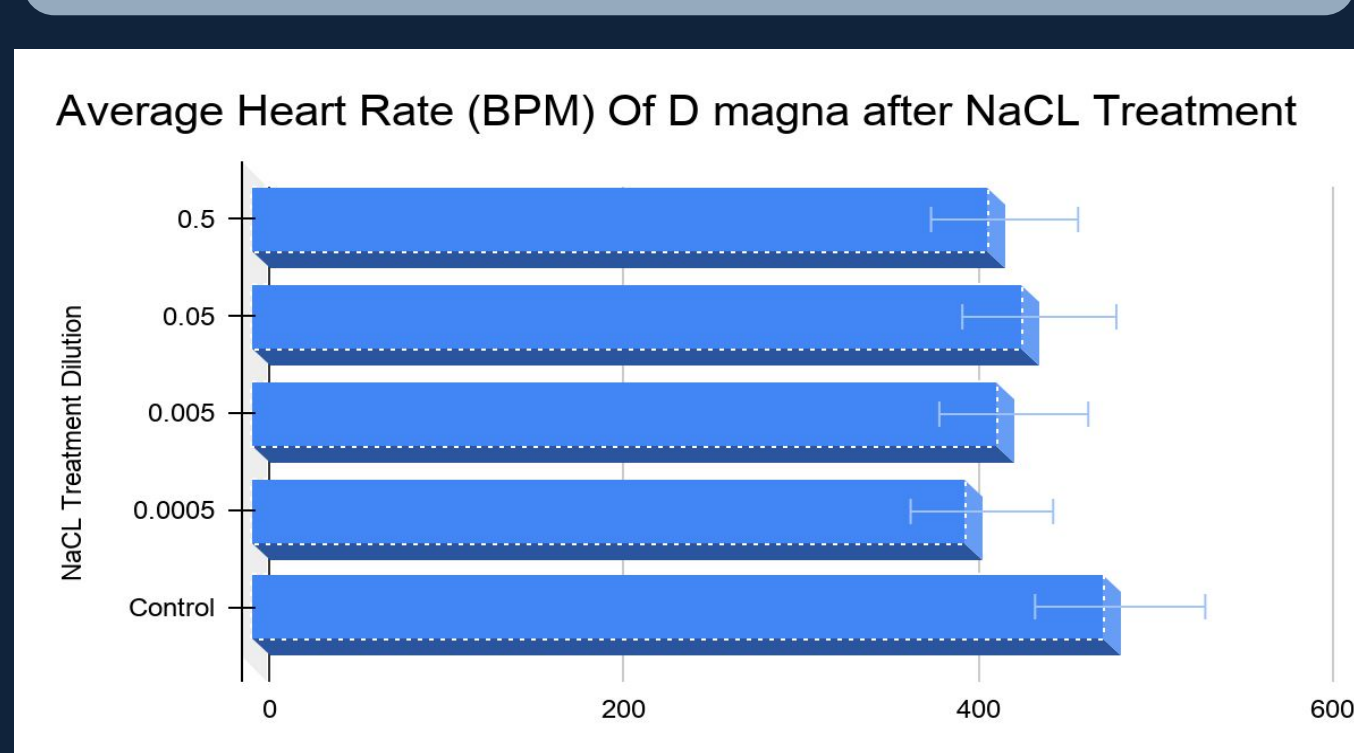


Figure 16: Prepared by Finalist in Google Sheets, 2026

Individual Heart Rate Compared to Control

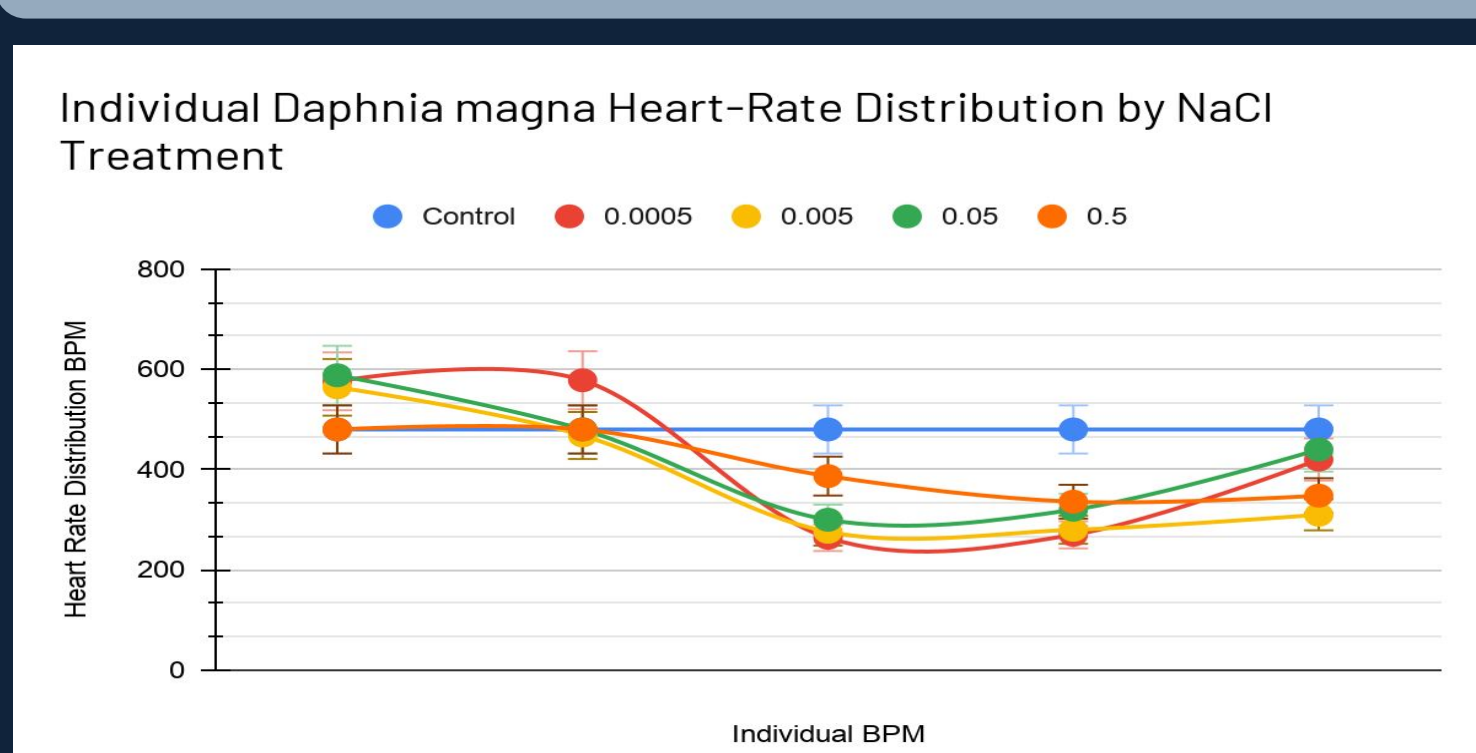


Figure 17: Prepared by Finalist in Google Sheets, 2026

V. radiata images After Exposure to NaCl Treatment

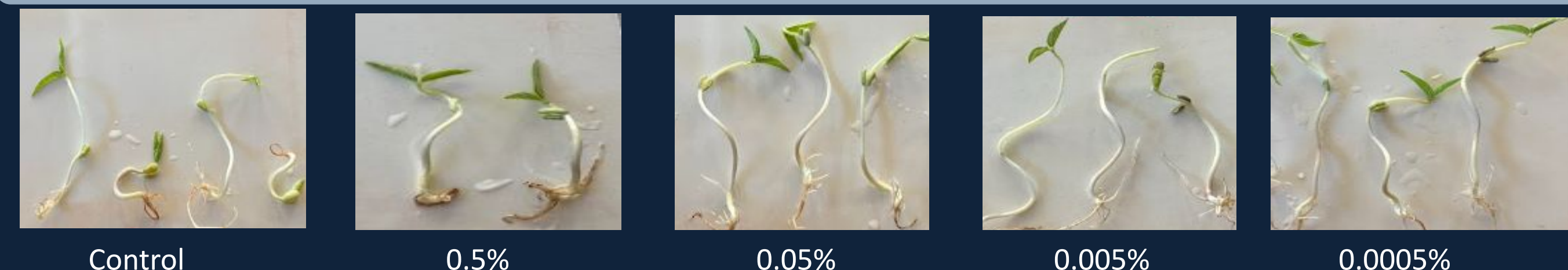


Figure 18: Images taken by Finalist using an iPhone 15 and a compound light microscope under 40X, 2026

Discussion

I Daphnia Cardiac Response

Result 1

Exposure to 0.05% NaCl produced the greatest percent change in heart rate 13.6% in *D. magna*, compared to a 4.0% change at 0.005% NaCl.

Key Takeaway

The greater percent change in heart rate at higher NaCl concentrations suggests that increased salinity had a greater effect on the cardiac response of *D. magna*.

Result 2

The control group maintained a higher baseline BPM compared to *D. magna* exposed to 0.0005% NaCl.

Key Takeaway

The lower BPM observed in NaCl-exposed *D. magna* suggests that exposure to NaCl affected normal cardiac activity.

II Plant Germination and Growth Assay

Result 1

Seed coat breakage occurred in 80%, 75% of *V. radiata* seeds exposed to 0.05%, 0.005%, and 0.0005% NaCl, respectively, compared to 100% in the control group.

Key Takeaway

NaCl exposure was associated with lower seed coat breakage rates compared to the control, indicating that salinity may inhibit germination.

Result 2

The control group had the highest average growth, reaching 14 cm, compared to the seedlings exposed to 0.5%, 0.05%, 0.005%, and 0.0005% NaCl.

Key Takeaway

The reduced growth observed under NaCl exposure indicates that increased salinity can negatively affect *V. radiata* seedling development.

Statistical Analysis and Data Processing

Daphnia Cardiac Response

Average growth across dilutions
One-way ANOVA
 $p=6.587 \times 10^{-6}$
 $p > \alpha=0.05$
Reject the Null hypothesis

Plant Germination & Growth

BPM across all dilutions
One-way ANOVA
 $p=1.56 \times 10^{-5}$
 $p < \alpha=0.05$
Reject the Null hypothesis

Figures 18 and 19: The data collected in Google Sheets were transferred into Statistics Kingdom, where a One- way ANOVA was performed to determine whether there were statistically significant differences among the groups.

Conclusion

- Average plant growth did not differ significantly among NaCl treatments. This may be species specific, further investigation with other agricultural crops are necessary.
- Higher NaCl concentrations were associated with changes in the measured biological responses.
- The observed responses to NaCl exposure demonstrated that salinity can influence biological processes in freshwater organisms
- This study contributes to evaluating the potential ecological consequences of changing coastal water chemistry and processes associated with saltwater-induced coastal erosion.

Limitations

This study was conducted under controlled laboratory conditions and may not fully represent natural coastal freshwater ecosystems.

Future Research

- Future studies should investigate AI/ Coding to map and monitor when and where saltwater intrusion will occur.
- Salinity requires further investigation as a freshwater environmental stressor. These laboratory findings provide evidence that controlled NaCl exposure can alter biological responses.