Chemistry Internal Assessment

Research Question: How does the salinity(percent) of water impact the amount of oxygen dissolved?

Introduction

Within aquatic environments, the effect of water salinity on dissolved oxygen content is crucial to take into account. The amount of dissolved salts, or salinity, has a major impact on how much oxygen can be held in water. Salinity, which is measured as a proportion or parts per thousand (ppt), affects how aquatic habitats are constructed. Understanding oxygen availability is critical for the survival of marine species because it plays a role in crucial biological processes. A key component of water resource conservation and biodiversity preservation is the dynamic interaction between salinity and dissolved oxygen content.

This discovery has practical ramifications for environmental policy and conservation measures in addition to its theoretical value. Understanding how salinity and aquatic ecosystems interact gives us the ability to foresee and reduce the effects of human interventions like urbanisation, industry, and agriculture. Such actions may unintentionally increase the salinity of the water, reducing the dissolved oxygen available to aquatic life. The creation of preventative measures is made possible by anticipatorily understanding these complexities.

This investigation goes beyond environmental issues; its relevance to medicine is increased. Temperature, pressure, and other dissolved chemicals all play crucial roles in the complex interaction between salinity and dissolved oxygen. While these factors are difficult to detect in their natural settings, controlled laboratory experiments reveal their combined influence.

This project's main goal is to decipher the complex interplay between dissolved oxygen and water salinity. We want to understand the complex effects of salinity on dissolved oxygen levels via painstaking testing and thorough analysis. Such discoveries broaden our scientific knowledge of aquatic systems and shed light on the interactions between biotic and abiotic elements. This understanding pervades conservation and environmental management efforts outside of the academic world.

But it's crucial to recognise the constraints this experiment has. Although it provides useful information about the relationship between salinity and dissolved oxygen, other factors like temperature and biological activity may skew the results. These controlled circumstances could not accurately reflect the complexity of aquatic habitats found in nature. However, this study reveals the complex relationship between salinity and water quality

Hypothesis and Background Research

The concentration of dissolved oxygen is expected to decrease as water salinity levels rise. Numerous variables affect the complex relationship between salinity and dissolved oxygen in water. For instance, because warmer water has a lower ability to store oxygen than colder water, the effect of salinity on dissolved oxygen is more noticeable in warmer water. Additionally, freshwater ecosystems may be more sensitive to salinity changes than saltwater ecosystems, which means that the relationship between salinity and dissolved oxygen may be more obvious in freshwater samples than in data from saltwater habitats.

The relationship between salinity and dissolved oxygen in diverse aquatic ecosystems has been the subject of several scientific studies. According to research, changes in salinity can cause large changes in dissolved oxygen levels, which in turn might affect aquatic creatures' survival and behaviour. Understanding these dynamics is essential for conserving and managing water resources effectively, especially in areas where salinity levels are vulnerable to change as a result of both natural and human influences.

Previous studies have emphasised the potential dangers to aquatic ecosystems posed by salinity changes brought on by human activities including agriculture, industrialisation, and climate change. Fish mortality, changes in the distribution of aquatic species, and a decline in biodiversity as a whole may all be consequences.

Methodology

Sample Gathering

a. Collect water samples representing a variety of salinity levels from various sources. Examples might be maritime habitats, brackish estuaries, and freshwater lakes.

b. Collect the water samples using the proper sampling methods, making sure they are representative of the chosen areas.

c. To stop oxygen from evaporating into the atmosphere, place each water sample in an airtight container with a distinct label.

Setup for the Experiment:

a. Install a salinity metre and a dissolved oxygen probe in accordance with the manufacturer's instructions.

b. For reliable readings, calibrate both devices.

Baseline evaluations:

a. Using the salinity metre, determine the starting salinity of each water sample. Using the proper units, such as %, note the values.

b. Using the dissolved oxygen probe, ascertain the initial dissolved oxygen concentrations of each water sample. The values should be written out in milligrammes per litre (mg/L).

Salinity Modification:

a. Using measured amounts of salt, gradually raise the salinity of each water sample. To get optimum salinity levels, gradually add salt.

b. Thoroughly mix and distribute the salt that has been added to each water sample.

c. After each salt addition, gauge and note the new salinity levels of each water sample.

Measurements of Oxygen Dissolved:

a. To guarantee appropriate oxygen diffusion, give each water sample a predetermined amount of time to equilibrate, such 30 minutes.

b. Put the dissolved oxygen probe completely within each water sample, then note the amounts of dissolved oxygen. To account for potential variances, take many measurements of each sample at various places.

Data Evaluation

a. Draw a graph with the dissolved oxygen concentrations (the dependent variable) on the y-axis and the salinity (the independent variable) on the x-axis.

b. Perform an analysis of the data points to look for any trends or patterns. Find out if salinity and dissolved oxygen levels are correlated.

c. To further examine the link, figure out the average dissolved oxygen levels for each salinity level.

d. Use statistical testing, such as correlation analyses, to ascertain the significance and strength of the association between salinity and dissolved oxygen.

<u>Materials</u>

- Water samples
- Airtight containers
- Salt
- Stirring rod
- Dissolved oxygen probe
- Salinity meter

- Beakers or containers
- Temperature-controlled environment
- Light source
- Data recording tools
- Statistical analysis software
- Safety equipment
- Labels and markers
- Timer or stopwatch
- Distilled water
- Pipettes or syringes
- Cleaning supplies
- Waste disposal containers

Table 1: Safety measures taken for Chemicals and materials used in this exploration

Chemicals/Materials	**Safety Measures**
Salt (e.g., NaCl)	1. Handle with care and keep away of mouth, eyes, and skin contact. 2. When handling, put on gloves, safety glasses, and a lab coat. 3. Use in a location with good ventilation to prevent breathing in dust or fumes. 4. Properly dispose of salt waste in accordance with local laws. 5. To avoid fire dangers, stay far of heat sources and open flames. 6. Store far from incompatible materials in a cold, dry environment.
Distilled Water	1. Use to make salt solutions and clean equipment.
	2. Carefully handle containers to prevent spills and breaks.
	3. Avoid getting food or liquids in your eyes or on your skin.
Cleaning Supplies	1. When cleaning equipment, use the proper cleaning supplies, such as purified water, brushes, and wipes.
(e.g., water, wipes)	2. Take the appropriate safety measures while using cleaning products.

Equipment	1. When handling chemicals, put on gloves, safety glasses, and a lab coat.
	2. When required, put on safety gear such face shields or aprons.
	3. Adhere to sanitary procedures and excellent laboratory practises.
Manganese(II) sulfate (aqueous, 0.1 mol/dm^3 solution) **- Potassium iodide (0.1 mol/dm^3 solution)** **- Potassium hydroxide for the acidic conditions required in Step 2 of the Winkler Method (0.5 mol/dm^3 solution)** **- Concentration sulfuric acid** **- Sodium thiosulfate (0.01 mol/dm^3)** **- Starch solution**	

For the methodology I followed throughout this experiment, my controlled variables were:

Controlled Variables	**Description**
Temperature	Maintain a constant temperature throughout the experiment. Fluctuations in temperature can impact the solubility of oxygen in water, confounding the results.
Pressure	Keep the pressure consistent to ensure that changes in dissolved oxygen concentration are solely attributed to salinity variations.
Water Source	Use the same water source for all experimental trials to minimize variability in initial dissolved oxygen levels and other potential factors.
Light Exposure	Control the amount and duration of light exposure, as light influences aquatic plant photosynthesis, which in turn affects dissolved oxygen levels.
Testing Time	Standardize the time duration for each trial to mitigate any time-dependent changes in dissolved oxygen due to biological processes or atmospheric conditions.
Container Type	Use identical containers for all trials to ensure uniformity in experimental conditions. Different container materials may interact differently with water salinity.
Water Mixing	Maintain consistent mixing or agitation of water in containers to prevent localized variations in dissolved oxygen concentration within each trial.
Initial Oxygen Levels	Equilibrate the dissolved oxygen levels at a consistent baseline before altering salinity. This ensures that any changes are due to salinity adjustments rather than initial oxygen differences.

These controlled variables are crucial to ensuring that the observed changes in dissolved oxygen concentration are indeed a result of manipulated variations in water salinity, rather than being influenced by other external factors.

My independent variable was the percentage of salt in the saltwater sample

My dependent variable was the amount of oxygen that the saline water sample could hold naturally

One of the most common and effective procedures for measuring t he oxygen content of water is the Winkler Method.

The Winkler Method uses redox reactions to measure the volume of oxygen in a sample by titration using the following method:

1. Excess manganese (II) sulfate is added to the water sample to be oxidised to manganese dioxide:
   $2Mn^{2+}(aq) + O_2(g) + 4OH^- \rightarrow 2MnO_2(s) + 2H_2O(l)$
2. Manganese dioxide is then reacted with excess iodine ions (I^-), usually found in alkaline potassium iodide, to form iodine molecules (this reaction has to happen in acidic conditions and the solution will turn from clear to brown due to the iodine forming):
   $MnO_2(s) + 2I^-(aq) + 4H^+(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2H_2O(l)$
3. The iodine is titrated with sodium thiosulfate in order to be reduced in the following reaction (sodium thiosulfate dissociates in water to form a Na^{2+} ion and S_2O_{32-} ion and the solution will become clear as the iodine atoms are converted into iodine ions which are colourless):
   $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

The volume of sodium thiosulfate needed to react with the iodine (I_2) in the last step is measured by adding starch solution near the endpoint of the reaction in order to measure when all the iodine has been converted into iodide ions. Since iodine reacts with starch to form a deep blue colour, starch added to the water sample before step 3 will cause it to turn a dark blue, and as the iodine is completely converted to iodide ions in the addition of S_2O_{32-}

Preparation of saltwater sample

1. Using a 500 cm^3 volumetric flask (±0.25 cm^3), measure 2x500 cm^3 of water into a beaker 2.
Add 5.00g of salt (±0.01 g) to the 1000 cm^3 of water
3. Mix well using a glass stirrer until all the salt is dissolved or when there are no more particles seen floating in the solution or resting at the bottom when it is left to rest

This process was repeated for all trials, increasing the weights of salt each time in accordance with the percentage. I mixed the weights of NaCl in Table 2 with 500 cm^3 of water in order to create my solutions:

Table: weight of NaCl per 500 cm^3 of water and percent of salt (2 d.p)

Percent/%	Weight of salt/g
0.00	0.00
1.00	5.00
2.00	10.00
3.00	15.00
4.00	20.00
5.00	25.00

Fixation of oxygen

1. Using a 25 cm^{3}volumetric pipette (±0.03 cm^3), add 50 cm^3 of saltwater sample to a BOD flask. In order to reduce the amount of atmospheric oxygen introduced into the sample by aeration, I inserted the tip of the volumetric pipette just under the surface of the water.
2. Add 2 cm^{3}of manganese sulfate to the BOD flask using a 10 cm^3 graduated pipette, careful not to introduce any oxygen by releasing the manganese sulfate under the surface of the saltwater sample.
3. Add 2 cm^{3}of potassium iodide to the BOD flask using a 10 cm^3 graduated pipette, careful not to introduce oxygen similar by releasing the manganese under the surface of the saltwater sample.
4. Add 2 cm^{3}of potassium hydroxide using a 10cm^3 graduated pipette to make the solution alkaline (released under the surface of the water).
5. Add concentrated sulfuric acid to the solution in a fuming cupboard until the brown precipitate dissolves. The solution will become a clear brown.

Raw Data

Table1 : Results for 0.00% saltwater sample

Trial	**1**	**2**	**3**	**4**	**5**
Initial/cm^3 (±0.05 cm^3)	1.7	10.2	17.8	28.6	36.2
Final/cm^3 (±0.05 cm^3)	9.8	17.8	28.6	36.2	44.8

Table 2: Results for 1.00% saltwater sample

Trial	**1**	**2**	**3**	**4**	**5**
Initial/cm^3 (±0.05 cm^3)	15.6	26.8	35.2	7.9	17.1
Final/cm^3 (±0.05 cm^3)	26.8	35.2	7.9	17.1	25.8

Table 3: Results for 2.00% saltwater sample

Trial	**1**	**2**	**3**	**4**	**5**
Initial/cm^3 (±0.05 cm^3)	9.2	14.8	22.2	27.2	36.8
Final/cm^3 (±0.05 cm^3)	14.8	22.2	27.2	36.8	8.2

Table 4: Results for 3.00% saltwater sample

Trial	**1**	**2**	**3**	**4**	**5**

Initial/cm³ (±0.05 cm³)	30.4	37	29.7	42.1	25.8
Final/cm³ (±0.05 cm³)	37	29.7	42.1	46.5	31.1

Table 5: Results for 4.00% saltwater sample

Trial	**1**	**2**	**3**	**4**	**5**
Initial/cm³ (±0.05 cm³)	1.1	7.9	10.8	21.1	26.6
Final/cm³ (±0.05 cm³)	7.9	10.8	38.8	26.6	34.1

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Table 6: Results for 5.00% saltwater sample

Trial	**1**	**2**	**3**	**4**	**5**
Initial/cm³ (±0.05 cm³)	3.8	8.8	14.1	11.4	22.2
Final/cm³ (±0.05 cm³)	8.8	14.1	11..4	22.2	26.4

Qualitative observations:

- When salt was added to distilled water, it resulted in the formation of microscopic bubbles that rose to the top of the water.
- After the starch was added, it took each drop of sodium thiosulfate around 30 seconds to completely react with the iodine in the solution.
- I added potassium hydroxide to the solution, which caused it to become brown and produce a dark brown precipitate.
- The precipitate disintegrated when sulfuric acid was added, and the solution became purple when starch was

added.
- When enough sodium thiosulfate was added, the purple hue of the solution changed white.

Analysis

I calculated the concentration of sodium thiosulfate used in its titration with the solutions:

Example calculation for 0.00% solution Trial 1:

Initial Burette reading: 1.70 cm^3
Final Burette reading: 9.80 cm^3
Change in volume of sodium thiosulfate: 9.80 cm^3 - 1.70 cm ^{3} = 8.10 cm^3

Table: Volume of sodium thiosulfate used in each trial

	Volume of sodium thiosulfate used in each trial/cm3				
Salt content of water sample/ %	Trial 1 (±0.10 cm^3)	Trial 2 (±0.10 cm^3)	Trial 3 (±0.10 cm^3)	Trial 4 (±0.10 cm^3)	Trial 5 (±0.10 cm^3)
0.00%	8.1	7.6	10.8	7.6	8.6
1.00%	11.2	8.4	-27.3	9.2	8.7
2.00%	5.6	7.4	5	9.6	-28.6
3.00%	6.6	-7.3	12.4	4.4	5.3
4.00%	6.8	2.9	28	5.5	7.5
5.00%	5	5.3	-2.7	10.8	4.2

Table: Average volume of sodium thiosulfate used for each concentration of salt solution

Percentage of salt in water/%	0.00	1.00	2.00	3.00	4.00	5.00
Average volume of sodium thiosulfate used/cm^3	7.216667	4.05	4.366667	7.85	0.95	7.216667

Calculations for the amount of oxygen in a sample of water:

For the water which was 0.00% salt, the average amount of sodium thiosulfate used was 8.8 cm^3. Convert this first to dm^3.

$$7.210\ cm^3 \div 1000 = 0.007210\ dm^3$$

Convert this into moles by multiplying it by the concentration of the sodium thiosulfate solution, which was 0.01mol/dm^3.

$$\text{Moles} = \text{concentration} \times \text{volume}$$

$$\text{Moles } (Na_2S_2O_3) = 0.007210\ dm^3 \times 0.01\ mol/dm^3 = 0.00007210\ mol$$

I then worked backwards through the steps of the Winkler method, using the molar ratios in the equations in order to find out the original amount of oxygen (in moles) of the sample of water.

Recall the reactions for the different stages of the Winkler Method:

1. $2Mn^{2+}(aq) + O_2(g) + 4OH^- \rightarrow 2MnO_2(s) + 2H_2O(l)$
2. $MnO_2(s) + 2I^-(aq) + 4H^+(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2H_2O(l)$
3. $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

We know that

$$\text{moles of } Na_2S_2O_3 = \text{moles of } S_2O_3^{2-} = 0.00007210\ mol$$

This is the amount of moles of $S_2O_3^{2-}$ which was needed to react with all of the iodine formed in Step 2 of the process. We then divide the moles of $S_2O_3^{2-}$ used to react with the iodine by 2 as we can see that the molar ratio of $S_2O_3^{2-}$:I_2 in Step 3 is 2:1.

$$\text{moles of } I_2 = 0.0000810mol \div 2 = 0.00003605mol$$

This was the number of moles of I_2 formed in Step 2. We can see that the molar ratio of MnO_2:I_2 is 1:1, and therefore know that

$$\text{moles of } MnO_2 = \text{moles of } I_2 = 0.00003605\ mol$$

This was the amount of MnO_2 produced in Step 1 of the Winkler Method. The MnO_2 is a product of the oxygen fixation, and we can see that the molar ratio of MnO_2:O_2 = 2:1. We therefore divide the number of moles of MnO_2 by 2 in order to determine the number of moles of oxygen which was present in the sample of water.

$$\text{moles of } O_2 = 0.0000405\ mol \div 2 = 0.00001803\ mol$$

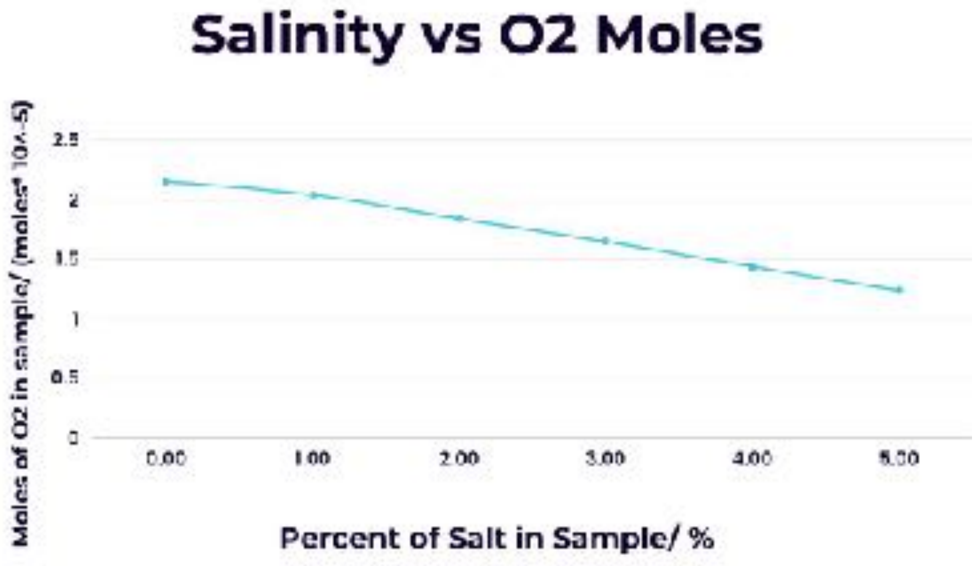
We have deduced the average amount of O_2 in the sample of water with 0.00% salt content: approximately 0.0000218 mol.

Using the method described above, an excel sheet was programmed to calculate the amount of oxygen for each water sample. The results are presented below in Table 15 and Figure 1.

Table 16: The average moles of O_2 in the samples of water

Percent of salt in sample/%	0.00	1.00	2.00	3.00	4.00	5.00

O_2 in original sample/mol	1.803×10^{-5}	2.06×10^{-5}	1.91×10^{-5}	1.68×10^{-5}	1.52×10^{-5}	1.18×10^{-5}



Statistical Analysis and Calculation:

Result Details & Calculation

X Values
$\sum = 15$
Mean = 2.5
$\sum(X - M_x)^2 = SS_x = 17.5$

Y Values
$\sum = 10.15$
Mean = 1.692
$\sum(Y - M_y)^2 = SS_y = 0.486$

X and Y Combined
$N = 6$
$\sum(X - M_x)(Y - M_y) = -2.475$

R Calculation
$r = \sum((X - M_y)(Y - M_x)) / \sqrt{((SS_x)(SS_y))}$

$r = -2.475 / \sqrt{((17.5)(0.486))} = -0.8482$

Meta Numerics (cross-check)
$r = -0.8482$
The value of R^2, the coefficient of determination, 0.7194.

From the graph in Figure 1, we can see that there is a clear trend: as the concentration of the saltwater sample increases, the amount of oxygen in the sample decreases. This confirms my hypothesis, that **as the concentration of salt in a sample increases, the oxygen in the sample will decrease**. The experiment's raw data clearly shows a tendency towards lower oxygen absorption as salinity rises. By examining the dissolved oxygen values at various salinity levels, this pattern may be seen.

Salinity and dissolved oxygen have a high negative link, as seen by their coefficient of correlation of -0.84. This indicates that there is a significant tendency for the concentration of dissolved oxygen to drop as salinity rises. When a connection has a negative sign, it means that when one variable rises, the other variable falls.

The link between salinity and dissolved oxygen is extremely linear and exhibits a considerable degree of association, with a coefficient of correlation close to -1.
There are a number of causes for this decline in oxygen absorption as salinity rises. The reduction in oxygen solubility in water with increasing salinity is one hypothesis that could be true. The solubility of gases, including oxygen, tends to decline as the water gets more salty. This can be linked to the increased concentration of dissolved salts, which can jostle for space inside of water molecules with oxygen molecules.

Conclusion

In summary, my findings align harmoniously with the initial hypothesis, underscoring that an elevation in salt concentration correlates with a reduction in oxygen content within the sample. This correspondence is a direct result of the Na+ and Cl- ions disrupting the attractive forces between $\overset{2}{O}$ and H2O molecules, consequently curtailing the oxygen solubility in water. My confidence in the observed trend and conclusions is fortified by the robustness of the line of best fit, substantiated by an R2 value proximate (0.72).

This investigation sought to explore the intricate link between dissolved oxygen levels and water salinity, quantified as a percentage. By meticulously scrutinizing the amassed data, incorporating the determination of correlation coefficients, and visually portraying trends through a line graph, we gained substantial insights into the dynamics of this association.

The theoretical proposition asserting that an increase in water salinity would precipitate a decline in dissolved oxygen concentration found overwhelming support in the empirical findings. The computed coefficient of correlation, a striking -0.84, illuminates a highly pronounced and meaningful inverse connection between dissolved oxygen and salinity. Bolstering this notion, the line graph, an artefact of the acquired data, tangibly showcases a discernible descending trajectory. This salient trend is rooted in the counteractive influence of Na+ and Cl- ions on the affinity between O2 and H2O molecules, thereby curtailing oxygen solubility. The corroborative robustness of the line of best fit is further affirmed by the proximity of the R value to (0.84), enhancing our comprehension of the implications for species, particularly within marine environments.

As validated by the correlation coefficient's remarkable value of -0.84, the decrease in dissolved oxygen concentrations within water samples holds steadfast as salinity ascends. The negativity of the correlation coefficient echoes the inverse relationship, intensifying as the coefficient approaches zero, denoting a heightened interdependence between the variables. A vivid portrayal of this relationship unfolds within the line graph—a visual testament to the coherent decline in dissolved oxygen levels with increasing salinity. The inclination of the graph mirrors the hypothesis, substantiating the conjecture that heightened salinity significantly hampers oxygen solubility and casts its influence on aquatic organisms' physiological functioning.

The ramifications of this study reverberate within the realm of our understanding regarding the repercussions of salinity fluctuations on aquatic ecosystems. The oscillations in salt concentration can emanate from diverse sources, encompassing both natural fluctuations and anthropogenic activities like coastal development and climate-induced alterations. The repercussion of declining dissolved oxygen due to augmented salinity can detrimentally impact the vitality and population of aquatic organisms, particularly those with minimal tolerance for salinity fluctuations.

To augment the causal link between salinity and dissolved oxygen, further research encompassing a broader spectrum of factors and environmental contexts would be indispensable. Such investigations would fortify our comprehension and augment the robustness of conclusions. In summation, our study resoundingly attests to the potent correlation between water salinity and dissolved oxygen levels. The pronounced descent depicted by the line graph, coupled with the formidable negative correlation coefficient of -0.84, constitutes compelling validation for the assertion that elevated salinity profoundly diminishes dissolved oxygen absorption. These insights enrich our understanding of the intricate dance between salinity shifts and aquatic ecosystems, bestowing a compass for conservation and management strategies aimed at safeguarding the biodiversity and water quality within salinity-impacted regions.

Limitations and Strengths of the Experiment:

Limitations	***Strengths***

1. Limited Sample Size: The study could have used a small number of water samples, which could limit how broadly the findings can be applied. 2. Simplified Experimental Conditions: The experiment was carried out in a controlled laboratory setting, which might not accurately reflect aquatic settings in the real world. 3. Potential Confounding Factors: The experiment did not properly control for all of the variables that may have affected the results, including temperature, pressure, and biological activity. 4. The experiment only used single-point measurements of dissolved oxygen and salinity, which would have missed any potential temporal fluctuations in the variables. 5. Limited Scope: The study did not take into account other environmental variables or biological interactions; instead, it concentrated only on the link between salinity and dissolved oxygen.	1. A Specific and Well-Defined Hypothesis: The study's clear hypothesis allowed for a narrowly focused research. 2. Controlled Experimental design: To guarantee consistency and dependability of the results, the study used a controlled experimental design. 3. Statistical Analysis: The study was given more rigour thanks to the application of statistical analysis, which included calculating the coefficient of correlation and providing quantitative proof of the association between salinity and dissolved oxygen. 4. Clear Data Presentation: The results were backed by data that was presented clearly and effectively, including the line graph that depicted the declining trend. 5. Possibility for Future Research: The study provides avenues for more research, including analysing the effects of other variables, examining real-world circumstances, and researching the effects on particular aquatic creatures.

Citations

Bruckner, M. (2017). Dissolved Oxygen by the Winkler Method. [online] Microbial Life Educational Resources. Available at: http://serc.carleton.edu/microbelife/research_methods/environ_sampling/oxygen.html [Accessed 10 Jun. 2017].

Fondriest Environmental, Inc., (2013). *Dissolved Oxygen - Environmental Measurement Systems*. [online] Environmental Measurement Systems. Available at: http://www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/ [Accessed 11 Apr. 2017].

National Ocean Service, (2015). *Why is the ocean salty?*. [online] Oceanservice.noaa.gov. Available at: http://oceanservice.noaa.gov/facts/whysalty.html [Accessed 11 Apr. 2017].