Scientific Paper Digest - About this Resource

This resource focuses on:

- Using the scientific method to study or verify an observation and develop experimental design to answer a research question.
- Introduction to cold water corals and the accumulation of marine litter across cold water coral habitats.
- How effective are SAC's at protecting marine habitats.
- Exploring visualization of research data.

Subject

Science
Geography
C.S.P.E.

Strand

The Scientific Method
Environmental Awareness
Social Responsibility

Skills:

Comprehension skills, Scientific Method, Evaluating, Data Analysis, Spatial Analysis

Learning objectives:

Introduction to the importance of cold water coral reefs in Ireland.
Introduction to SAC's, exploration of litter distribution linked to typography and human activity amongst cold water corals.

This resource Includes:

Steps of the scientific method.
A popular science summary for non-scientists of the research paper.

Glossary of terms
Questions on the paper to further explore understanding of the topic.

Core relevance: Marine Litter in oceans and marine food chains, litter hotspots linked to human activity, support for marine protection policies.

Study highlights human recreational activities and commercial fishing activities are main contributor to coral reef pollution.

Green-Schools Marine Week is an initiative of the Green-Schools Global Citizenship Marine Environment theme, and is proudly supported by the Department of Climate, Energy and the Environment.

Scientific Method

1 OBSERVE

- Observations are usually the first step in an investigation.
- They help scientists ask questions and make hypotheses e.g. Why could this be happening?
- Good observations lead to more accurate experiments.
- For example: Researchers have seen that plants only grow when exposed to light. They do not grow well in darkenss.

2 DO SOME RESEARCH

During this phase, scientists read as much information as they can about the topic. This helps them understand what is already known and what scientists are still unsure about. By looking at previous research, they can find gaps in knowledge and use these to narrow down their research question and decide what new questions need to be answered.

3 FORMULATE A HYPOTHESIS

Formulating a hypothesis is a fun of asking your research question. Oftentimes, research questions are answered using a quantifiable approach, meaning you need to be able to measure what you are asking in your hypothesis. There are always 2 possible outcomes to any experiment: either the hypothesis is accepted or rejected. In our plant example, the hypothesis would be: Plants grow better when exposed to light.

4 EXPERIMENTATION

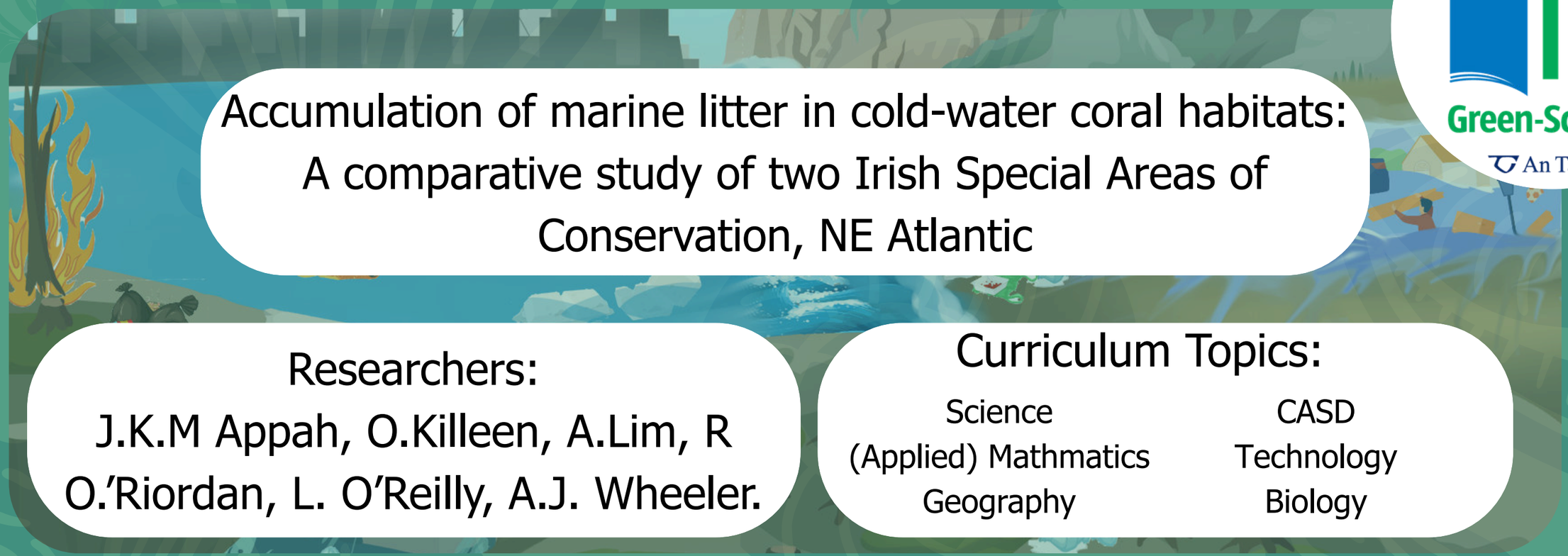
Experimentation is a key stage of the scientific method. Experiments are carefully controlled, randomised, and repeated to ensure results are accurate and free from bias. They are designed to collect reliable data by manipulating variables in order to observe outcomes. These results are then compared with existing knowledge or used to generate new scientific understanding. In the plant example, researcher for grow 3 sunflowers in darkness and 3 sunflowers in light. They would make sure that temperature and water levels are the same for all plants.

5 ANALYZING DATA

The data collected during the experimentation phase is now analysed to determine if the intervention used during the experimentation had a signification effect on the study specimen or not. In our plant case, we would measure all plants and use statistics to determine if light had a significant impact on plant growth or not.

6 COME TO A CONCLUSION

During the conclusion, researchers often put their data into perspective with other similar research. Often, researchers discuss what research should follow and how it fits within the research topic. In our plant example, researchers might suggest to run further experiments to test how different wavelength of light impact growth or various temperatures.



Accumulation of marine litter in cold-water coral habitats: A comparative study of two Irish Special Areas of Conservation, NE Atlantic

Researchers:

J.K.M Appah, O.Killeen, A.Lim, R O.'Riordan, L. O'Reilly, A.J. Wheeler.

Curriculum Topics:

Science
(Applied) Mathmatics
Geography
CASD
Technology
Biology

Abstract

Cold water Coral Reefs are extremely important biodiversity hubs, and are home to many different kinds of marine life. However, Coral is extremely sensitive to human activities, such as fishing. In Europe, some cold water coral areas are protected by law an are known as Special Areas of Conservation (SACs).

This study investigates how much marine litter is found in cold water coral in two SACs off the coast of Ireland, and where that litter comes from. Remote control submersibles were used to capture videos of the seafloor. This video footage was then analyised to count and catagorise the different kinds of litter.

The study found that The amount and type of litter differed between the two areas. The shape of the seafloor played a role where litter built up. The Corals and rocky areas acted as a trap for litter. A significant amount of the litter came from fishing activities, over 80% of the litter found was from fishing.

The results suggested that although these areas are protected, they are still heavily affected by marine litter. This means that current protections may not be enough to fully protect cold-water coral habitats from human activities.

Introduction

Marine litter has become a global issue since it found its way into all the world's oceans. Once in the sea, litter can travel long distances, even reaching the deep ocean. What happens to it depends on ocean currents, the shape of the seabed, sediments, an tiny organisms such as microbes. Most marine litter lasts a very long time because it breaks down very slowly. As larger items break into smaller pieces, they become easier for marine animals to eat by mistake, making them more dangerous.

Plastic makes up around 60-80% of marine litter in the northeast Atlantic Ocean. Fishing activities also add a lot of waste, with about 11,000 tonnes of fishing-related litter entering European seas each year. Around 20% of fishing gear is thought to be lost at sea due to storms or being abandoned.

Marine litter can damage life on the seabed, by physically harming organisms or changing the chemical conditions of the environment. It can also help invasive or harmful species spread by giving them surfaces to attach to. Marine litter can also be dangerous for marine animals as they can become entangled, have trouble moving or feeding or become injured. However in some cases, litter can also act as a home for certain seabed animals.

This study looks at how much litter is found and where it is located within two deep sea areas: The upper Porcupine Bank Canyon (uPBC) and the western Belgica Mound Province (wBMP). These areas are both protected under EU law as SACs, this is due to the presence of cold water corals. Cold water Corals live in the dark, cold parts of the ocean, they grow very slowly and take a long time to recover if they are damaged. Due to this they are especially vulnerable to disturbance.

Method

Mapping the seabed: A ship-mounted sonar system was used to map the depth of the seabed in the upper Porcupine Bank Canyon. The sonar created detailed maps showing depth and slop of the seabed. These maps were then grouped into different depth ranges and slope angles to help analyse where marine litter was found.

Measuring Ocean Currents: Ocean currents were measured using an instrument called an Acoustic Doppler Current Profiler (ADCP). This device was placed on the seabed an recorded water movement above it. The ADCP was deployed for several weeks to help understand how currents might move litter through the canyon.

Remote Control Submersibles: Marine litter was recorded using a Remote Operated Vehicle (ROV) fitted with high definition cameras. The ROV travelled slowly and closely to the seabed, filming areas between 570m and 2100m deep. Laser beams spaced 10cm apart were used to measure the size of litter items. The video footage was later analysed to identify the type and use of each litter item.

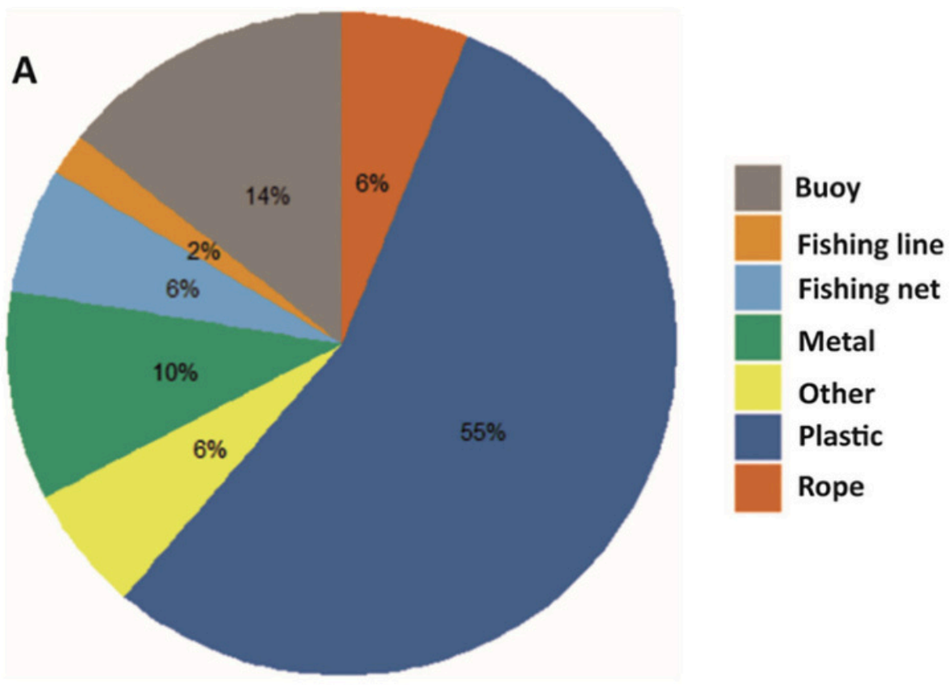
Estimating Litter Amounts: The number of litter items was counted from the video footage and compared with the area of seabed studied. This allowed scientists to calculate how dense the litter was in different depths and slope areas. The size of some litter items was also measured using image analysis software.

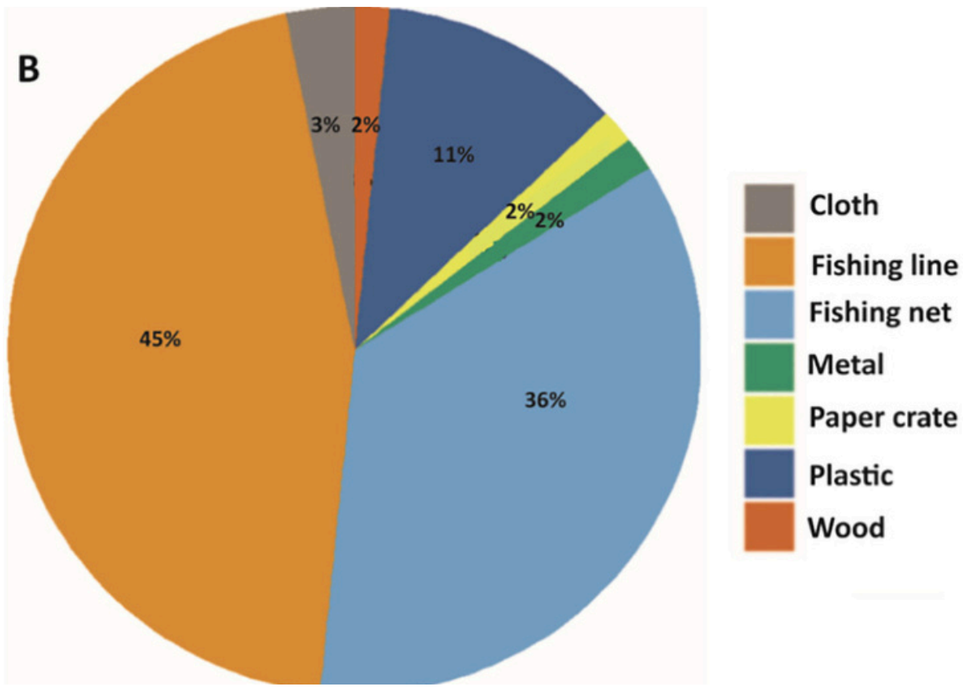
Results

Marine litter was found at both study sites, the upper Porcupine Bank Canyon (uPBC) and the western Belgica Mound Province (wBMP), showing that even protected deep sea areas contain human waste. However, the amount, type, and distribution of litter differed between the two locations.

Type of Litter

In the Porcupine Bank Canyon, the scientists recorded 62 pieces of litter, while 49 pieces were found in the Belgica Mound Province. In the Belgica area (A), plastic items like bags and floating buoys were more common. Most of the litter in the canyon (B) was made up of fishing gear such as nets and ropes. This suggests that different human activities affect each area in different ways.





Distribution of Litter

The litter was not spread evenly across the sea floor. It was more likely to collect in flatter areas rather than on steep slopes, and in the canyon it was most often found at depths between 600 and 1,000 metres. This shows that the shape of the sea floor and ocean currents play an important role in where litter ends up.

Impact on Sealife

Some of the litter was found interacting with marine life. Fishing lines were seen tangled around corals and other animals, and in one case a crab and a sponge were living on a discarded fishing net. These observations show that marine litter can directly affect deep-sea organisms. Overall, the results show that marine litter, especially fishing gear, is still reaching protected coral habitats and may be harming them.

Discussion

Marine Litter was found in both habitats, despite their status as Special Areas of Conservation. This shows that protected designation alone does not fully prevent human impacts in deep-sea environments. The presence of litter in these areas highlights ongoing pressures from activities such as fishing, even where conservation measures are in place.

Fishing activity is considered the main source of litter observed, particularly lost or discarded fishing gear. Nets and lines can become caught on coral structures and remain there for long periods. In deep-sea conditions, materials break down very slowly, which allows litter to build up and increases the risk of long term damage to the habitat.

Seabed topography and ocean currents influence the distribution of litter. Flatter areas and underwater canyons act as natural collection zones, where debris transported by currents is more likely to settle. This explains the uneven distribution of litter across different depths and locations and is consistent with patterns observed in other deep-sea studies. These findings indicate that physical characteristics of the seabed play a significant role in shaping litter accumulation.

Marine litter poses a substantial threat to cold-water coral ecosystems. Fishing gear can physically damage coral branches, smother living organisms, and trap or injure associated animals. Due to the extremely slow growth rates of cold-water corals, recovery from damage may take decades or even centuries, rendering these habitats particularly vulnerable to disturbance.

The results highlight the need for enhanced management and conservation measures. Effective protection of deep-sea coral habitats requires stricter control of fishing activities, improved monitoring of protected areas, and strategies to reduce marine litter at its source. Such measures are essential to mitigate the long-term impacts of human activities and to preserve the ecological integrity of these vulnerable deep-sea ecosystems.

Conclusion

Marine litter was recorded in both cold-water coral habitats studied, despite their designation as Special Areas of Conservation. The presence of litter in these protected deep-sea environments shows that human activities continue to impact coral ecosystems even where conservation measures are in place.

The proportion of fishing-related litter observed in the study areas was higher than the global average, which is typically estimated at 10–20% of total marine litter. This suggests that fishing activity represents a particularly important source of debris in these deep-sea habitats and that existing protection measures may not be sufficient to prevent litter associated with this activity.

Seabed features such as canyons and flat areas were shown to influence where marine litter accumulates, acting as natural traps for debris transported by ocean currents. This pattern contributes to the persistence of litter in coral habitats and increases the likelihood of long-term environmental impacts.

Overall, the findings highlight the vulnerability of cold-water coral ecosystems to marine litter. Improved regulation of fishing activities, enhanced monitoring of protected areas, and reductions in marine litter at its source are required to better protect these slow-growing and sensitive deep-sea habitats.

Glossary of Terms

SAC: Special area of Conservation
Marine Litter: any persistent man made solid materials discarded, dispose of or abandoned in the sea or coast
Biodiversity: The variety of all living things in a particular habitat
Microbes: Tiny living organisms that are too small to be seen without a microscope
Invasive Species: A non-native organism that spreads in a new environment and can cause harm to native species or ecosystems.
Sonar: A technology that uses sound waves to detect and locate objects underwater
Acoustic Doppler Current Profiler: An Acoustic Doppler Current Profiler (ADCP) is an instrument that uses sound waves to measure the speed and direction of water currents
Topography: The shape and features of the land or sea floor, including its slopes, hills, and valleys.
Conservation: The protection and careful management of natural environments and wildlife
Accumulation: Gradual build-up of something over time

References

Appah, J.K.M. et al. (2022) 'Accumulation of marine litter in cold-water coral habitats: A comparative study of two irish special areas of conservation, ne atlantic', Marine Pollution Bulletin, 180, p. 113764. doi:10.1016/j.marpolbul.2022.113764.
Link: https://www.sciencedirect.com/science/article/pii/S0025326X22004465

Further Reading

- theoceancleanup.com - A non-profit organisation commited to ridding the world's oceans of plastic waste. The project is developing an scaling technologies to clean our oceans.
- cleancoasts.org - Ireland's national program dedicated to cleaning our beaches and taking care of our oceans. Lots of fantastic information on the importance of protecting our oceans
- Nationalgeographic.org - MarineDebris - Gives an in depth explanation of what happens to litter in our oceans, the scale of litter and how it can affect our oceans
- GreenPeace.org/Bottomtrawling - Explains this unsustainable method of fishing and the long term environmental impacts.
- fairseas.ie/ SAC - Explains the different kinds of protected areas

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Q&A

Check your understanding

Q1: What affects what happens to litter once in the ocean?

Q2: What were the methods used for gathering data for this study?

Q3: Was there a difference in the types of litter? If so what?

Q4: What were the main findings from the the study?