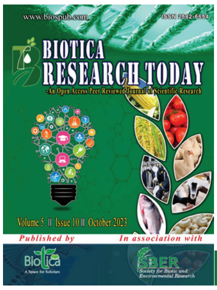

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Popular Article

Recent Innovations in Marine Science

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Abstract

Recent advancements in marine science have propelled our understanding of marine ecosystems and facilitated effective strategies to address critical environmental challenges. This overview highlights several cutting-edge innovations, including a cost-effective gittings trap designed to control invasive lionfish populations, infrared camera technology for continuous monitoring of whale migration, drones enabling comprehensive data collection and analysis in marine environments and the use of fluorescence techniques to study coral populations. Additionally, an overview of an advanced monitoring system integrating satellite remote sensing, autonomous underwater vehicles, buoy-based sensor networks, acoustic monitoring, environmental DNA analysis, LIDAR, marine weather stations and deep-sea monitoring systems showcases the comprehensive approach to studying and preserving marine ecosystems. These innovations collectively contribute to enhancing our knowledge of marine life, supporting conservation efforts and promoting sustainable practices in the world's oceans.

Keywords: Advanced monitoring systems, Drones, Innovation, Technologies

Introduction

Marine science, a dynamic and interdisciplinary field, is experiencing a transformative era driven by unprecedented advancements in technology and innovation. In recent years, groundbreaking developments in robotics, automation, data analytics and sensor technologies have revolutionized the way we explore, understand and sustainably manage the vast and mysterious world beneath the ocean's surface. These innovations are enabling scientists, researchers and marine experts to delve deeper, gather more precise data and uncover the previously inaccessible realms of our oceans. This article explores the remarkable recent innovations in marine science, showcasing how cutting-edge technology is reshaping our understanding of marine ecosystems, climate change impacts, underwater archaeology, fisheries and much more. By leveraging these innovative tools, we are not only unravelling the secrets of the ocean but also devising informed strategies to protect and conserve these crucial ecosystems for future generations. Join us on this voyage through the waves of innovation that are propelling marine science into an era of unparalleled discovery and sustainability.

Recent Innovations

Trap to Control Invasive Fishing

Recent research conducted by Harris *et al.* (2020) suggests that a cost-effective and straightforwardly designed trap holds the potential as an effective tool for addressing the issue of invasive lionfish.

Lionfish, originally from the South Pacific, Indian Ocean, Western Atlantic Ocean and Caribbean Sea, threaten native ecosystems much like other invasive species. Their population growth is concerning as they lack natural predators and reproduces prolifically, leading to predation on native species. While underwater spear fishing proves effective in controlling lionfish numbers, it has depth limitations, with scuba diving typically reaching depths of less than 40 m. Lionfish have been observed at depths exceeding 300 m, surpassing the reach of conventional scuba diving (Harris *et al.*, 2020).

Gittings Trap

The Gittings trap, named after its creator Steve Gittings, the chief scientist at NOAA's Office of National Marine Sanctuaries, is a device composed of netting affixed to

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a round frame made of metal or PVC tubing. The trap is equipped with hinges that allow it to operate like a clamshell, opening and closing in a similar manner. When deployed on the ocean floor, the trap showcases an upright section constructed using a plastic lattice material commonly found in gardening centres.

Camera to Monitor Whale Migration

Gaining insights into whale behaviour and migration patterns is crucial for their protection; however, obtaining this data is expensive, time-intensive and restricted to daylight hours. Toyon Research Corporation has devised a solution for continuous tracking of whale blows, day and night, utilizing infrared cameras placed on ships or the shoreline. NOAA employs this data to estimate whale population sizes by analyzing the blows' quantity, whereabouts and timing. Recently, the National Oceanic and Atmospheric Administration (NOAA) acknowledged Toyon Research Corporation for its technological collaboration in monitoring whale migration through infrared camera technology.

Drone that Sails in Pursuit of Ocean Data

They are more affordable and flexible than traditional methods and they can be used to collect data in a wider range of conditions. This allows scientists to study marine life and ecosystems in more detail and to identify causal processes.

Drones are being used for a variety of marine science applications, including:

• Monitoring coastal processes, habitats and species: Drones can be used to assess wave run-up, ocean temperatures, ocean aerosols, algae biomass and coastal geomorphology.

• Mapping sea surface salinity: New sensors have been developed for high-resolution mapping of sea surface salinity.

• Assessing the health of coral reefs and seagrass beds: Drones can be used to assess the health of coral reefs and seagrass beds, which are important marine ecosystems.

• Conducting shoreline habitat mapping and coastal erosion studies: Drones can be used to map shoreline habitats and study coastal erosion (Mancini *et al.*, 2013).

• Assessing the abundance and health status of marine vertebrates: Drones can be used to assess the abundance and health status of marine vertebrates, such as whales, dolphins and sea turtles.

Drones are also being used for conservation and management tasks, such as:

• Assessing both legal fishing and illegal, unreported and unregulated fishing: Drones can be used to monitor fishing activity and identify illegal fishing.

• Monitoring marine and protected areas: Drones can monitor marine and protected areas for signs of damage or disturbance (Maxwell *et al.*, 2014).

Overall, drones are a powerful tool for marine science and conservation. They are revolutionizing the way we study and protect the oceans.

Fluorescent Flashlights to Study Coral

The Coral Fluorescent Protein Checker Flashlight is a new tool that allows reefers to quickly and easily see the fluorescent potential of corals. It comes in seven different colors of light, each with a specific wavelength that is known to excite the fluorescent pigments in corals. With a set of seven CRF Checker Flashlights, you can quickly glance at the fluorescent potential of corals in aquariums and stores. Fluorescence techniques can be used to study coral populations at a very early stage, which can help us to better understand how they are affected by different factors, such as early post-settlement mortality. This information can then be used to develop strategies for protecting and managing coral populations.

Fluorescence census techniques can be used to detect coral recruits at a very early stage when they are still very small and difficult to see with the naked eye (Baird *et al.*, 2006). This is because coral recruits fluoresce when exposed to blue or ultraviolet light, which makes them stand out from their surroundings. Using fluorescent filters at night can increase the accuracy of juvenile coral counts by up to 300%. This is because cryptic individuals and individuals that are too small to see during the day are more easily visible at night under fluorescent light. Fluorescence census techniques are particularly useful in regions where fluorescent taxa are dominant, such as most Indo-Pacific reefs. This is because they allow researchers to detect coral recruits that would otherwise be overlooked. In other words, fluorescence census techniques are a powerful tool for monitoring coral recruitment and assessing the health of coral reefs.

Advanced Monitoring System

An advanced monitoring system in marine science involves the use of various technologies and methodologies to gather comprehensive data about marine ecosystems, biodiversity, environmental conditions and human activities at sea. Here are some technologies commonly utilized in advanced marine science monitoring systems:

1. Satellite Remote Sensing: Utilizing satellites to observe and monitor marine environments, including sea surface temperature, chlorophyll levels, ocean currents and sea level changes.

2. Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (*ROVs*): These are robotic platforms that can autonomously or remotely collect data from the ocean, such as water samples, images, videos and physical measurements.

3. Buoys and Sensor Networks: Deploying buoys equipped with various sensors (*e.g.*, for measuring temperature, salinity, pH and oxygen levels) to monitor water conditions in specific areas continuously. Sensor networks help collect real-time data from multiple points.

4. Acoustic Monitoring: Using sonar and acoustic devices to study marine life, including tracking movements, identifying species and assessing fish populations. This technology is particularly important in fisheries research.

5. Environmental DNA (*eDNA*) *Analysis*: Extracting and analyzing genetic material (eDNA) from the water to identify and monitor marine species present in an area without directly capturing or observing them.

6. LIDAR (*Light Detection and Ranging*): Utilizing LIDAR to measure seafloor topography and map coastal areas, aiding in habitat assessment and coastal zone management.

7. Marine Weather Stations: Establishing weather stations at sea to monitor meteorological conditions, including wind speed, air pressure, humidity and precipitation, which are critical for maritime operations and safety.

8. Deep-Sea Monitoring Systems: Implementing specialized instruments and systems to monitor deep-sea habitats and phenomena, such as deep-sea cameras, pressure sensors and submersibles capable of deep-sea exploration.

9. Real-Time Data Analysis and Predictive Modelling: Employing advanced analytics and machine learning algorithms to process real-time data, identify patterns and develop predictive models for marine ecosystems, climate change impacts and resource management.

Conclusion

Marine science epitomizes a transformative era for understanding and safeguarding our oceans. Innovations like the gittings trap, infrared camera technology and drone applications are revolutionizing marine research, allowing us to combat invasive species, monitor whale migrations and conduct comprehensive environmental assessments. Fluorescence techniques illuminate new possibilities for studying coral populations, aiding in their preservation. Moreover, the integration of cutting-edge technologies in advanced monitoring systems offers a holistic view of marine ecosystems, enabling effective conservation and sustainable management strategies. These advancements collectively mark a significant stride towards a deeper understanding of marine life, emphasizing the importance of proactive conservation and sustainable practices to preserve the marine world for generations to come.

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