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Applications of Artificial Intelligence in Advancing Sustainable Fishing Practices

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Abstract

Artificial intelligence (AI) is revolutionizing the fishing sector by increasing the sustainability of harvesting, monitoring, and resource management. This concise overview explores recent advancements in AI-driven methodologies, including machine learning, computer vision, and predictive analytics, that facilitate ecologically friendly fishing practices. AI-driven technologies provide real-time surveillance of fish populations, species identification, and bycatch reduction, hence mitigating environmental effects. Intelligent sensors and autonomous vessels equipped with artificial intelligence optimize fishing routes and improve energy efficiency, hence reducing carbon emissions. Moreover, AI facilitates data-informed policy decisions by precisely simulating fish population dynamics and the effects of climate change. The use of AI in conventional fisheries enhances compliance, traceability, and ecosystem conservation. However, challenges such as data deficiencies, elevated costs, and inadequate digital infrastructure remain. This study emphasizes the necessity of collaborative efforts to democratize AI access in coastal and small-scale fisheries, leading to more resilient and sustainable fisheries for future generations. Artificial intelligence transcends mere utility; it embodies the future of ethical fishing practices.

Keywords: Fishery, artificial intelligence, machine learning, real-time monitoring, energy efficiency, bycatch

Introduction

The worldwide fisheries sector has substantial issues, such as overfishing, diminishing fish populations, and environmental degradation, jeopardizing marine biodiversity and the lives of millions that rely on fishing. The FAO's State of World Fisheries and Aquaculture (FAO, 2024) indicates that fish consumption has reached a record high of over 21.2 kg per capita, whereas 35.4% of world fish stocks are currently overfished, indicating a significant rise from prior decades (FAO, 2024). Climate change, habitat deterioration, pollution, and the proliferation of illicit, unreported, and unregulated (IUU) fishing operations have exacerbated the stress on marine ecosystems. The ecological pressure, together with socioeconomic reliance on fisheries, demands the immediate adoption of creative, sustainable, and adaptable management practices (Halpern et al., 2015).

Sustainable fishing methods aim to maintain fish populations within ecologically sustainable limits, minimize environmental impacts, and offer socioeconomic benefits for future generations. The complexity of marine ecosystems and the unpredictable behaviour of fish make traditional management tactics increasingly inadequate. Static quota systems, limited monitoring capabilities, and outdated stock assessment techniques often fail to correspond with the changing dynamics of marine resource utilization (Pauly and Zeller, 2016). Artificial intelligence (AI) has become an essential enabler, offering precise, data-driven instruments that improve monitoring, forecasting, and decision-making in unpredictable conditions.

Artificial intelligence in fisheries includes diverse methodologies, such as machine learning (ML) for predictive stock modelling, deep learning (DL) for image and video analysis, computer vision for species identification and bycatch detection, and expert systems for regulatory compliance and decision support. The integration of AI with digital technologies, such as Internet of Things (IoT) sensors, satellite imagery, and geographic information systems (GISs), enables real-time, adaptive, and ecosystem-focused fisheries management. Neural networks have been utilized to predict fish movement concerning sea surface temperature and chlorophyll-a concentration (Nguyen et al., 2022), whereas AI methodologies enable vessel surveillance and anomaly identification to combat illegal, unreported, and unregulated fishing (McCauley et al., 2016).

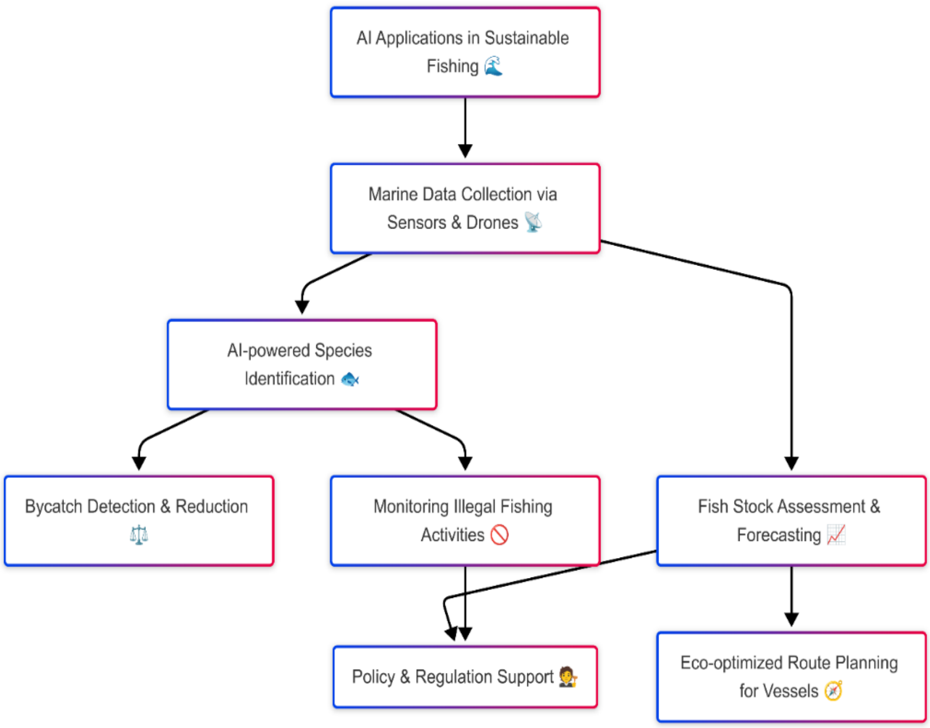

Figure 1: AI applications in advancing sustainable fishing practices

This review explores novel applications, current challenges, and prospecti63ve advancements of AI in improving sustainable fishing methods (Figure 1).This discourse aligns with Sustainable Development Goal 14 (SDG 14) of the United Nations, which emphasizes the conservation and sustainable use of oceans, seas, and marine resources (United Nations, 2015).This paper examines the role of AI in capturing fisheries, ecosystem monitoring, policy formulation, and enforcement, illustrating how intelligent technology might improve ecological resilience, economic sustainability, and equitable governance within the fisheries sector.The deployment of AI must be guided by ethical, inclusive, and region-specific considerations to ensure the long-term viability of the blue economy (Aung et al., 2025).

Overfishing and sustainability challenges

Overfishing has led to the depletion of fish populations, as indicated by the State of the World's Fisheries and Aquaculture Report (FAO, 2024), which shows that 37.7% of fish stocks have overfished, up from 35.4% two years prior (Marine Stewardship Council, 2024). This trend endangers food security, especially for coastal populations that are dependent on fish as a principal protein source, and impacts marine ecosystems. Sustainable fishing methods are essential for balancing economic needs with ecological integrity, and AI offers tools to enhance monitoring and management for this balance.

Artificial intelligence techniques used in fisheries

Artificial intelligence methodologies such as machine learning, computer vision, and neural networks are transforming fisheries through real-time monitoring, species identification, and catch forecasting (**Figure 2**). These intelligent instruments enhance sustainability, diminish bycatch, and maximize resource management in both the aquaculture and wild capture sectors.

a. *Machine Learning (ML):* Machine learning is critical in fisheries for predictive modelling and decision-making. Machine learning systems anticipate fish population distributions via historical capture data, environmental conditions, and fishing efforts, allowing for more sustainable management (Cheng et al., 2023). Machine learning algorithms may detect patterns in fish migration, enabling fishermen to select areas with sustainable populations, hence reducing overfishing.
b. *Deep Learning (DL):* Deep learning, a type of machine learning, excels in picture recognition tasks, including species identification and population monitoring. Deep learning algorithms analyse underwater photos to accurately distinguish fish species, hence aiding conservation initiatives (Camps-Valls et al., 2025). This is especially beneficial for observing fish habits and evaluating stock health in realtime.

c. *Computer Vision:* Computer vision technologies are employed to oversee fishing efforts and enhance catch composition. Through the analysis of pictures captured by onboard cameras, computer vision can identify bycatch and assess fish sizes, hence improving transparency and adherence to rules (Saqib et al., 2024). This method minimizes manual labor and enhances data precision for fisheries management.

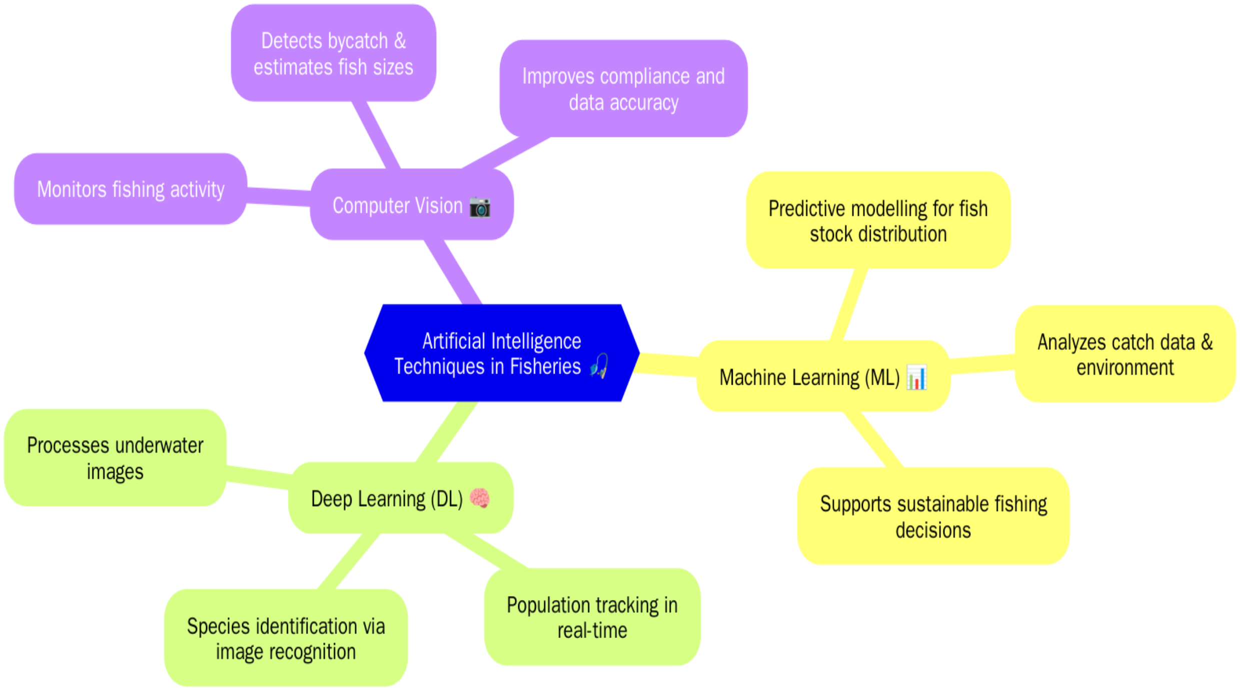

Figure 2: Artificial intelligence techniques used in fisheries

AI tools used for fisheries management and their application

Artificial intelligence (AI) is transforming fisheries management by enabling educated, data-driven decisions that improve sustainability and efficiency. **Table 1** provides a comprehensive list of several AI technologies utilized in fisheries, along with their respective applications.

Table 1. AI tools for fisheries management and their applications

AI Tool/System	Application	Reference
Sonofai (Fujitsu)	Employs ultrasonography and artificial intelligence to evaluate the fat content of tuna, hence improving quality classification for sashimi and sushi.	AP News (2025)
VIAME (NOAA)	Facilitates automated video analysis for the detection and tracking of fish,	NOAA Fisheries

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	hence enhancing survey efficiency.	(2023)
CatchVision (Ai.Fish)	AI-enhanced video analysis for electronic surveillance, minimizing manual annotation requirements.	Ai.Fish (2025)
eFishery	Intelligent feeders use sensors and artificial intelligence to enhance feeding efficiency in aquaculture, hence minimizing feed expenses.	The Fish Site (2020)
AquaCloud	Utilizes artificial intelligence to forecast sea lice infestations in salmon aquaculture, facilitating preemptive actions.	The Fish Site (2020)
FarmMOJO (Aquaconnect)	A mobile application utilizing artificial intelligence for disease forecasting and water quality assessment in shrimp aquaculture.	The Fish Site (2020)
SHOAL	Artificially intelligent robotic fish designed to identify underwater pollution in proximity to aquaculture facilities.	The Fish Site (2020)
XpertSea	Employs computer vision and artificial intelligence to assess shrimp growth, hence improving harvest timing.	The Fish Site (2020)
Shinkei Systems	Utilizes artificial intelligence to automate the ike-jime fish killing method, hence fostering humane and sustainable practices.	Food & Wine (2024)
AI-Powered Sonar & Acoustic Sensors	Monitors piscine movements and categorizes species instantaneously, facilitating sustainable fishing	OceanTech Insider (2025)

	practices.	
AI in Satellite Imaging	Monitors marine alterations to forecast fish habitats, facilitating effective fishing methodologies.	OceanTech Insider (2025)
Machine Learning Models for Catch Prediction	Evaluates historical data and marine conditions to predict fish habitats, hence mitigating overfishing.	OceanTech Insider (2025)
Neural Networks for Species Recognition	Immediate categorization of fish species to avert bycatch and ensure adherence to regulations.	OceanTech Insider (2025)
Big Data Analytics for Fishery Health	Predicts risks of fish stock depletion by the analysis of several data sources.	OceanTech Insider (2025)

AI applications in capture fisheries

a. *Predictive Modelling of Fish Stock Distribution:* Artificial intelligence facilitates the predictive modelling of fish stock dispersal through the analysis of environmental variables such as water temperature and currents.
b. *Smart Fishing Gear and Catch Optimization:* AI-enhanced fishing equipment employs sensors and algorithms to maximize capture efficiency while reducing bycatch.
c. *Bycatch detection and reduction:* Bycatches are a significant sustainability challenge, and AI systems mitigate them by employing computer vision to identify nontarget animals.
d. *Illegal, Unreported, and Unregulated (IUU) Fishing Surveillance:* Artificial intelligence addresses illegal, unreported, and unregulated fishing by analysing satellite pictures and vessel tracking data to detect anomalous activity.

AI in Ecosystem Monitoring and Marine Resource Management

a. *AI-Enabled Remote Sensing and Oceanographic Data Analysis:*AI enhances remote sensing by analysing satellite data to monitor ocean conditions such as sea surface temperature and chlorophyll levels.
b. *Species Recognition and Population Tracking:* AI-driven computer vision systems identify fish species from photos, facilitating population monitoring.

c. *Integration with Geographic Information Systems (GIS):* Artificial intelligence interacts with geographic information systems to develop spatial models of fishing activity and marine ecosystems.

d. *Climate impact modelling:* AI models predict how climate change affects fish populations and habitats by analysing historical data and projections.

Challenges and Limitations in AI Adoption

The application of artificial intelligence in fisheries faces a number of scientific and practical challenges that limit its widespread implementation. The absence of sufficient and consistent data, particularly in small-scale and artisanal fishing, impedes the usefulness of AI models that rely on substantial, high-quality information to make accurate predictions. The lack of standardized standards for data collection and exchange impedes interoperability amongst AI systems. Significant upfront investment costs, low technical skill in coastal locations, and concerns about data privacy all hamper spread. Furthermore, the ethical and regulatory frameworks regulating AI use in fisheries are yet underdeveloped, raising concerns about transparency, accountability, and potential ecological biases in automated decision-making.

Conclusion

AI can transform sustainable fishing through data-driven decision-making, predictive modelling, and real-time marine environment monitoring. AI improves stock evaluation, bycatch reduction, vessel monitoring, and ecosystem modelling using machine learning, deep learning, and computer vision, harmonizing conservation with commercial feasibility. AI integration must address data accessibility, digital infrastructure, algorithmic transparency, and socioeconomic inclusion in resource-limited and small-scale fishing. Interdisciplinary cooperation, egalitarian regulatory systems, and inclusive technology that respects traditional knowledge and fosters innovation are key to the future of AI in fisheries. AI can help fisheries management be flexible, resilient, and really sustainable by combining technology innovation with ethical governance and stakeholder empowerment.

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