Microplastics in Shortfin Scads (*Decapterus macrosoma*) in Northern Philippines

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ABSTRACT

Microplastic pollution poses persistent threats to marine ecosystems and human health via seafood consumption. This study quantified prevalence, abundance, and morphology of microplastics in shortfin scads (*Decapterus macrosoma),* a key pelagic fishery species, from National Stock Assessment Program (NSAP) sites in Ilocos Norte, Pangasinan, and Cagayan. Twelve specimens (3/sites x 4 NSAP sites) underwent gastrointestinal tract dissection, 10% KOH digestion at 80°C, density separation, and Nile red staining under fluorescence microscopy for identification. Microplastic prevalence varied spatially: 66.67% in Pantal, Dagupan City (Pangasinan; 1-6 particles/specimen), 33.33% in Palawig, Sta. Ana (Cagayan) and Poblacion 1, Pagudpud (Ilocos Norte; 1-2 particles), and 0% in Taggat Norte, Claveria (Cagayan). Dominant forms were fragments (irregular shapes) and fibers (linear), exhibiting intense orange fluorescence indicative of synthetic polymers. Findings establish baseline contamination patterns linked to coastal anthropogenic activities, highlighting risks to food safety and SDG 14 (Life Below Water). Enhanced monitoring, waste management, and polymer-specific analyses are recommended to mitigate pelagic fishery impacts.

Keywords: microplastics, shortfin scads, Nile red staining, marine pollution, Northern Philippines

INTRODUCTION

The extensive use of plastics has triggered a global environmental crisis, with microplastics persisting as pervasive pollutants across ecosystems. These particles pervade coastal and marine environments, penetrating multiple trophic levels in key aquatic species (Flores, 2025; Oceana in the Philippines, 2021). In the Philippines, heavy dependence on plastic products, coupled with poor solid waste management - generating around 2.3 million tons of plastic waste yearly, of which only 28% gets recycled - allows most to pollute surroundings and build up in marine systems (Pustadan, 2024).

Among the most economically valuable and widely consumed seafood in the Philippines are pelagic species, such as shortfin scads, which are extensively harvested in the waters of Northern Luzon (Villarao et al., 2023). Studies have shown that microplastics can be ingested by various marine organisms, including shortfin scads, where they accumulate in edible digestive tissues (Flores, 2025). This poses ecological risks by impairing growth, reproduction, and survival, while also serving as vectors for toxic chemicals that threaten food safety and human health (Jeong et al., 2024).

Despite the awareness of microplastics' environmental and health risks is increasing, research on their occurrence in seafood consumed in Northern Philippines remains scarce. Assessing these risks is essential for crafting targeted management and mitigation approaches.

This study addresses that gap by examining microplastic prevalence and distribution in popular seafood species from Northern Philippine waters. Its results offer key insights into contamination levels, potential human health impacts, and the broader state of marine ecosystems.

This study specifically aimed to (1) determine the prevalence of microplastics, (2) quantify microplastic particles, and (3) characterize their morphology in shortfin scads collected from selected landing sites in Northern Philippines.

MATERIALS AND METHODS

Experimental Design

This cross-sectional study analyzed twelve (12) shortfin scads (3/site × 4 NSAP sites: Taggat Norte-Claveria, Pantal-Dagupan City, Palawig-Sta. Ana, Poblacion 1-Pagudpud), randomly selected via fishbowl method from 10 specimens/site.

Collection Procedure

The biota sampling and preparation of samples was adopted from the procedures described by AMAP Litter and Microplastics Monitoring Guidelines (Version 1.0, 2021) cited by Onda et al., (2021). Quantification of microplastics in samples was adopted from the procedures described by Onda et al., (2021). Characterization of microplastics was adopted from Harshvardhan and Jha (2013); Jung et al. (2018) (Onda et al., (2021) and Hidalgo-Ruz et al., (2012). The use of appropriate Personal Protective Equipment (PPE) during laboratory procedures to safeguard against potential hazards associated with handling biological samples.

Biota Sampling and Preparation

Specimens were washed with pre-filtered water, wrapped in aluminum foil, stored in ice boxes, and frozen at 20°C until laboratory processing (AMAP Litter and Microplastics Monitoring Guidelines, Version 1.0, 2021 cited by Onda et al., 2021).

Extraction of Microplastics from Samples

Gastrointestinal tracts (esophagus to 2-3 mm pre-anus) were dissected, weighed, and digested in 10% KOH solution (3× tissue volume) at 80°C for 48 hours with manual agitation every 12 hours. Density separation was followed by vacuum filtration (Buchner funnel), 2-3 drops 30% H2O2 treatment, and drying at 60°C overnight (Onda et al., 2021).

Quantification and visualization of Microplastics

Filters were stained with Nile red and examined under fluorescence microscopy (Olympus CX43; blue light/orange filter). Fluorescing microplastics were manually counted (Onda et al., 2021).

Characterization of Microplastics

Microplastics were characterized by visual morphology (fragments/fibers; irregular/linear shapes) per Harshvardhan and Jha (2013); Jung et al. (2018) (Onda et al., (2021) and Hidalgo-Ruz et al. (2012). FT-IR spectroscopy was not performed due to particle size <20 μm.

Statistical Analysis

Frequency and percentage analyses summarized prevalence, quantity, and morphology across sites.

Study Limitation

Small subsample (n=3/site, total n=12) due to low budget and laboratory processing capacity limits statistical power and generalizability. Future studies recommend n≥10 specimens/site.

RESULTS AND DISCUSSIONS

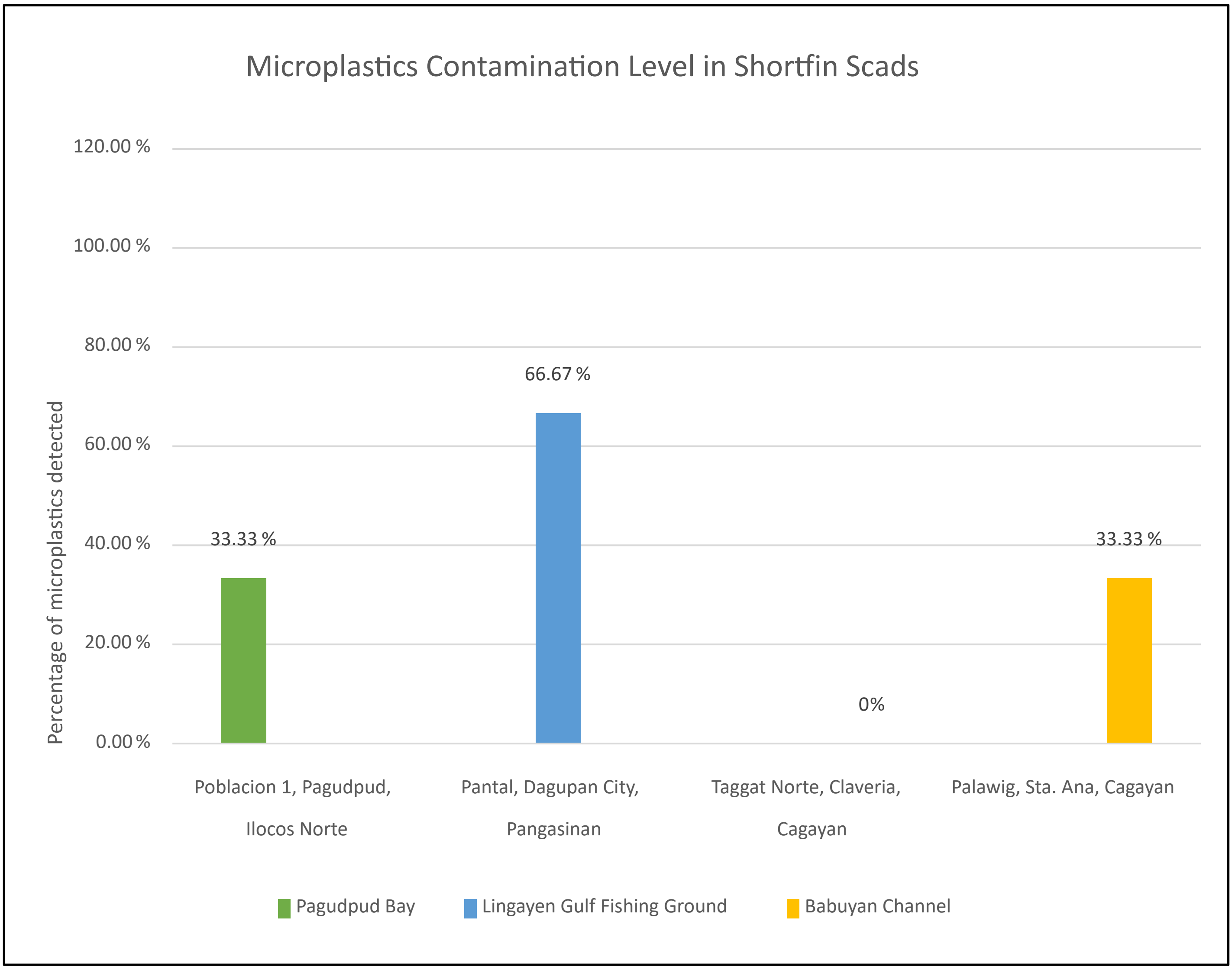
Microplastics contamination across coastal locations

Assessment on the prevalence of microplastic contamination in shortfin scads collected from various landing sites monitored by the National Stock Assessment Program (NSAP) across northern Philippines. The percentage of seafood samples containing microplastics varied across locations, revealing localized contamination patterns in Northern Philippines. Figure 1 shows 66.67% prevalence in Pantal, Dagupan City shortfin scads, while

Palawig, Sta. Ana, Cagayan and Poblacion 1, Pagudpud, Ilocos Norte demonstrated 33.33% presence of microplastics, on the other hand, no microplastics were detected in Taggat Norte, Claveria, Cagayan.

Higher prevalence in Pantal, Dagupan (66.67%, 2/3 samples) reflects its proximity to urban centers, intensive fishing activity, and Lingayen Gulf tributaries carrying plastic waste via riverine inputs (Pustadan, 2024). The lower prevalence (33.33%, 1/3 samples) at Taggat Norte, Palawig, and Poblacion 1 corresponds to their relative remoteness from major anthropogenic sources. These spatial patterns align with the vulnerability of pelagic shortfin scads to suspended microplastics in the water column (Rochman et al., 2019)

Figure 1. Percentage of shortfin scads containing microplastics from selected monitored landing sites.



Statistical Analysis of Prevalence

Prevalence varied across sites: 66.67% (2 of 3 samples) in Pantal, Dagupan City versus 22.22% (2 of 9 samples) across Taggat Norte, Palawig, and Poblacion 1. Fisher's exact test compared contamination rates (Pantal: 2 positive/1 negative vs others: 2 positive/7 negative), yielding $p=0.52$. This non-significant result ($p>0.05$) reflects limited statistical power due to small sample size ($n=12$ total), consistent with the study's baseline characterization objectives.

These findings reflect localized differences in marine pollution levels, influenced by coastal development, waste management practices, and proximity to human activity. With microplastics now being found in seafood from both relatively pristine and urbanized landing sites, this study provides clear evidence of the urgent need for coordinated marine plastic mitigation efforts. Ultimately, this study contributes important baseline data toward achieving Sustainable development Goals 3 (Good Health and Well-being), 12 (Responsible Consumption and Production), and 14 (Life Below Water), in the face of prevailing microplastic pollution.

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Characteristics and quantity of microplastics present in selected seafood species analyzed using Nile red staining

The analysis was conducted using Nile red staining, a rapid and reliable method for identifying synthetic polymers in biological samples. Nile red selectively binds to hydrophobic materials such as plastics and under fluorescence microscopy, produces an intense orange glow, which allows clear distinction from organic particles (Maes et al., 2017). This technique provided a consistent means to detect and evaluate the quantity and morphological characteristics of microplastics in different locations.

Table 1. Characteristics and quantity of microplastics detected in shortfin scads from selected monitored landing sites.

Location	Sample Code	Quantity Detected	Characteristics of Microplastics		
			Type	Shape	Color
Taggat Norte, Claveria, Cagayan		0	-	-	-
Pantal, Dagupan City, Pangasinan	1	3	Fibers (2), Fragment (1)	Lines (2), Irregular (1)	Intense Orange
	2	6	Fragments (6)	Irregular (6)	Intense Orange
Palawig, Sta. Ana, Cagayan	2	1	Fragment (1)	Irregular (1)	Intense Orange
Poblacion 1, Pagudpud, Ilocos Norte	3	2	Fragments (2)	Irregular (2)	Intense Orange

Quantity of Microplastics

The results (Table 1) showed varying levels of microplastic contamination in shortfin scad samples depending on the collection site. The highest concentrations were recorded in samples from Dagupan City, Pangasinan - particularly from Barangay Pantal - with individual samples containing up to 3 and 6 microplastics, respectively. In contrast, shortfin scads collected from Taggat Norte, Claveria, Cagayan, showed no microplastics, suggesting relatively low environmental contamination in that area. Moderate amounts were detected in samples from Palawig, Sta. Ana, Cagayan and Poblacion 1, Pagudpud, Ilocos Norte, Cagayan with microplastic counts ranging from 1 and 2 particles per sample respectively. These variations may be attributed to the ecological behavior of shortfin scads as pelagic species, making them more susceptible to suspended microplastics. The notably higher counts in Dagupan City, Pangasinan sites likely reflect local coastal pollution sources, including proximity to urban settlements, fishing activities, and riverine inputs from nearby Lingayen Gulf tributaries. These findings align with previous studies highlighting the vulnerability of pelagic species to microplastic exposure through ingestion of suspended particles in the water column (Rochman et al., 2019; Hantoro et al., 2019).

Characteristics of microplastics in terms of: Type, Shape, and Color

The microplastic particles extracted from shortfin scads were too small to generate detectable signals using available FTIR-ATR equipment. Consequently, polymer identification was not possible, limiting characterization to morphological features and fluorescence response via Nile red staining. Despite this limitation, visual and morphological data provided valuable insights into microplastic types and forms in shortfin scads. Detected microplastics were predominantly fragments and fibers (Figures 2 and 3), categorized as irregular shapes and lines. Fragments - believed to result from larger plastic item degradation - were most frequent, particularly in Pantal, Dagupan City samples. Fibers, likely from synthetic fishing nets, textiles, and wastewater, were also

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common. All particles showed intense orange fluorescence under Nile red staining, confirming their synthetic polymer nature despite lacking spectral data. This consistent fluorescence validates the method's reliability for microplastic detection and indicates widespread pelagic contamination affecting coastal fish populations.

Such findings emphasize the ecological vulnerability of shortfin scads due to their mid-water schooling lifestyle, exposing them to water-column microplastics prevalent in vast waters. The morphological characteristics - particularly the irregularity and fibrous nature - raise concerns about their potential to absorb toxic substances and enter the food chain through bioaccumulation. These observations align with global research showing that secondary microplastics, formed from environmental degradation of larger plastic debris, are pervasive in marine ecosystems (Maes et al., 2017). Additionally, contamination in shortfin scads, a commonly consumed seafood, underscores the pressing need for localized plastic pollution mitigation, stricter coastal waste management, and community awareness to prevent further microplastic infiltration into human food supplies and marine environments (Free et al., 2014; Hantoro et al., 2019).

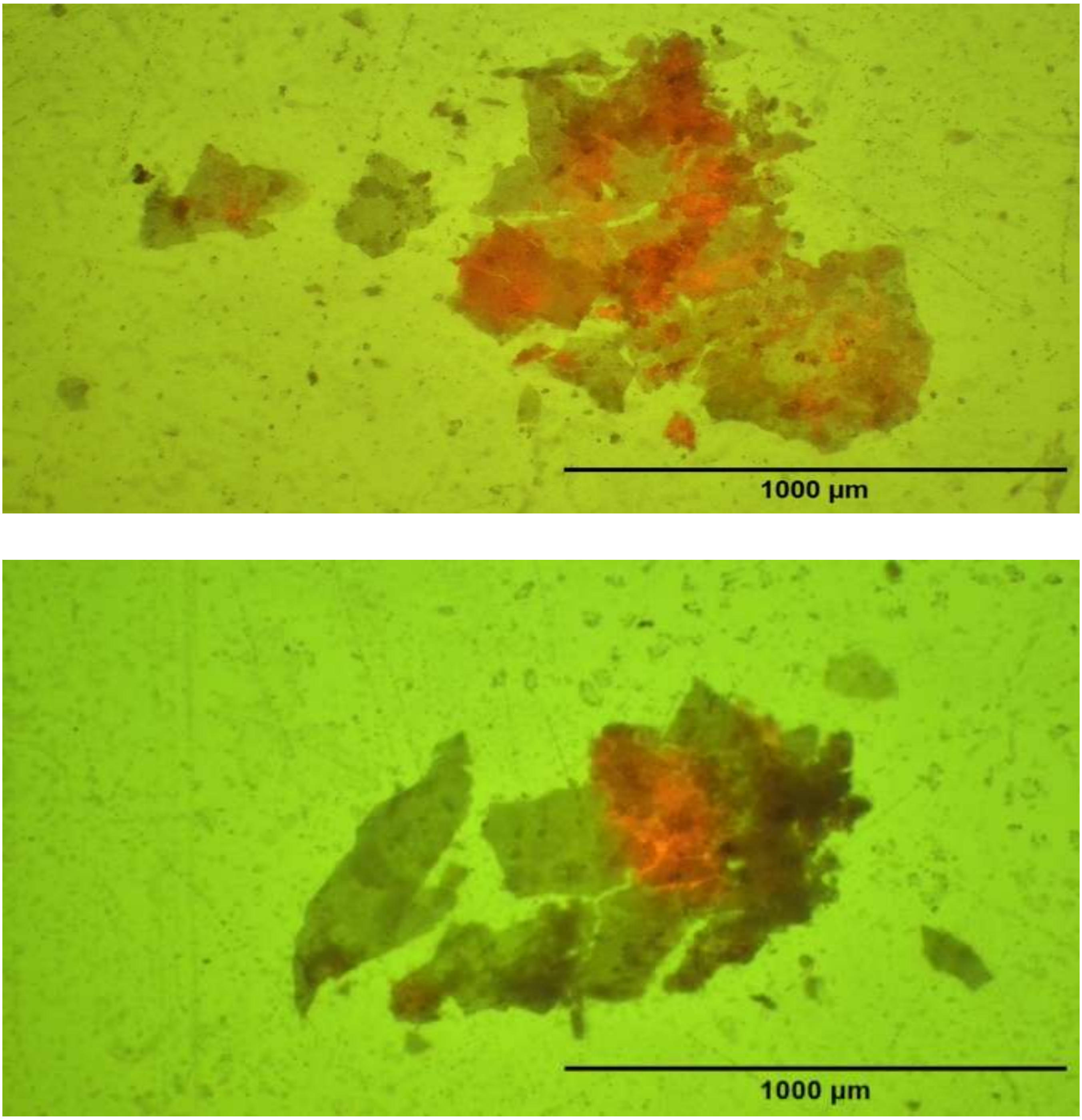

Figure 2. Fragment-type microplastics (irregular-shape, 100µm scale bar) under Nile red staining, Olympus CX43 fluorescence microscope

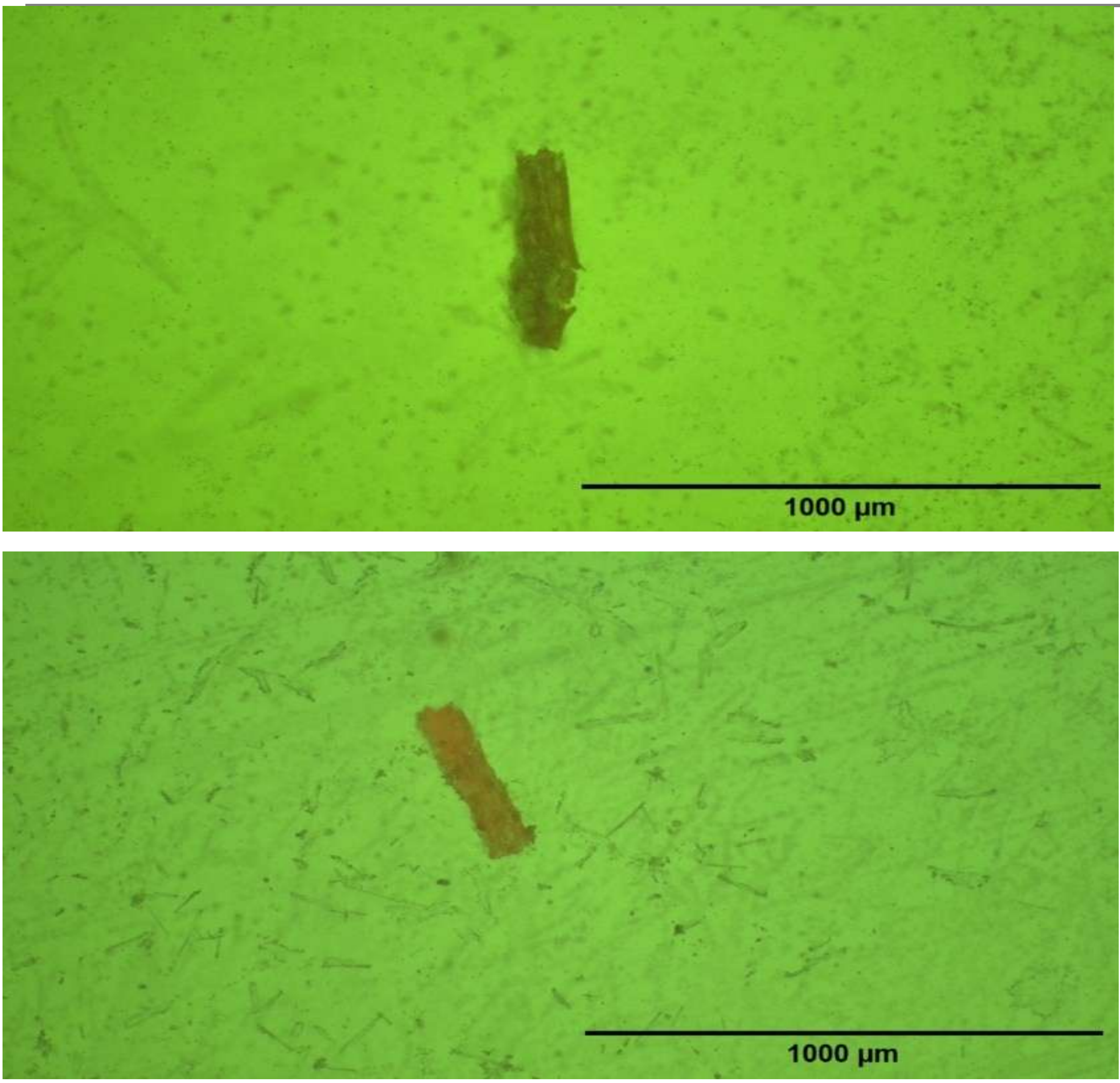

Figure 3. Fiber-type microplastics (linear-shape, 100µm scale bar) under Nile red staining, Olympus CX43 fluorescence microscope

CONCLUSION

This study reveals significant microplastic contamination in shortfin scads (Decapterus macrosoma) from Northern Philippine waters, with prevalence rates reaching 66.67% in urban-adjacent sites like Pantal, Dagupan City, and varying by location due to localized pollution sources. Predominant fragments and fibers, confirmed via Nile red staining, highlight the species' vulnerability as pelagic feeders and underscore risks to human health through seafood consumption and broader marine ecosystem disruption. These baseline findings emphasize the urgent need for region-specific monitoring to support Sustainable Development Goals 14 (Life Below Water), 12 (Responsible Consumption), and 3 (Good Health).

RECOMMENDATIONS

Implement routine microplastic screening in national fish stock assessments by BFAR-NSAP, prioritizing high contamination sites like Dagupan for expanded surveillance. Enforce stricter coastal waste management policies, including riverine plastic barriers in Lingayen Gulf tributaries, and promote community-based cleanups with LGUs in Cagayan and Ilocos Norte. Advance research by integrating FT-IR spectroscopy or Raman spectroscopy for polymer typing in future studies and foster public awareness campaigns on sustainable fishing practices to reduce secondary microplastic inputs from nets and gear.

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Conflict Of Interest

The author declares no conflict of interest.

Data Availability Statement

Raw microplastic count data and microscopy images are available from the corresponding author upon reasonable request.

Author Contributions

JDO: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft & editing, Visualization, Project administration.

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