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KFUPM "MEWA FISHING METHODS PROJECT" NEWSLETTER

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ABANDONED, LOST, OR OTHERWISE DISCARDED FISHING GEAR (ALDFG) PILOT STUDY-JANA ISLAND

Abandoned, lost, or otherwise discarded fishing gear (ALDFG) introduced into the marine environment through fisheries-related activities contributes significantly to adverse environmental and socioeconomic impacts. Despite being a major global concern, adequate data from the world's oceans remain limited. In this study, data on ALDFG were collected through visual surveys and remotely operated vehicle (ROV) surveys conducted around Jana Island, a potential fishing area and a known nesting ground for green and hawksbill turtles in the Arabian Gulf. We surveyed an area of 7.58 km² and identified 46 distinct locations containing derelict fishing gear, along with one case of turtle entanglement. The most commonly observed items included gillnets, followed by metal debris from fishing activities and ropes, and then monofilament lines and trawl nets, either submerged on the seafloor or entangled. Spatial clustering of ALDFG observations was assessed using Kernel Density Estimation (KDE), which identified hotspots located approximately 800 m from the shoreline of Jana Island. These findings provide baseline information on the distribution, composition, and potential ecological risks of ALDFG in this understudied region, supporting future monitoring and mitigation strategies.

Depth Surface Generation

Water depth was recorded at ALDFG observation stations during visual and ROV surveys. To assess spatial bathymetric variability, point-based depth measurements were interpolated to generate a continuous surface. All datasets were projected from WGS84 to UTM Zone 39N to ensure accurate spatial analysis. A regular grid was created over the survey area, and depth values were interpolated using deterministic spatial methods commonly applied in environmental mapping. The resulting surface represents relative bathymetric variation within the survey footprint and was used for contextual interpretation rather than as a high-resolution bathymetric model.

Kernel density hotspot analysis

Spatial clustering of ALDFG observations was evaluated using two-dimensional kernel density estimation, a non-parametric method widely applied to identify spatial hotspots in ecological and environmental studies (Silverman, 1986; Worton, 1989). KDE was applied to projected ALDFG coordinates using a Gaussian kernel function. Bandwidth selection followed a data-driven approach to balance spatial smoothing and local variability (Scott, 1992; Silverman, 1986). Density estimation was performed over a regular grid covering the surveyed footprint, producing a continuous surface representing relative clustering intensity. To evaluate potential bathymetric influence on clustering patterns, a depth-weighted KDE was additionally performed.

In this approach, each ALDFG observation was assigned a weight proportional to its associated depth prior to density estimation, allowing the resulting surface to reflect the combined effects of spatial concentration and bathymetric variability. All KDE-derived outputs were normalized to a 0-1 scale to facilitate comparison of relative intensity patterns across analyses. These normalized values are unitless and represent relative clustering rather than absolute density or abundance.

Distance-from-shoreline gradient analysis

To assess spatial gradients relative to proximity to Jana Island, the shortest Euclidean distance from each ALDFG observation to the island shoreline polygon was calculated in projected space. One-dimensional Gaussian kernel smoothing was applied to the distance values to examine clustering intensity along the shoreline gradient (Silverman, 1986). This approach enabled the identification of peak accumulation zones relative to shoreline proximity; however, as the analyses relied on presence-only observations, the resulting hotspot maps reflect relative spatial clustering within the surveyed area rather than quantitative estimates of ALDFG.

Spatial analysis of ALDFG classification

All ALDFG observations were compiled into a georeferenced point dataset, where each record represents a single observed ALDFG item with associated latitude and longitude coordinates. The corresponding ICES category code (e.g., A5, A6, A7, A8, C3) was extracted from the descriptive field and treated as a categorical variable. Records lacking valid spatial coordinates were excluded from the spatial analyses. Jana Island was incorporated into all spatial plots using a polygon provided in KML format to ensure accurate geographic context. All spatial analyses, interpolations, density estimations, and visualizations were performed using Python (version 3.13.9) with standard geospatial and scientific computing libraries.

Results

The observed nearshore accumulation of ALDFG is likely driven by the high intensity of fishing activities in coastal waters, which increases the probability of gear loss due to gear conflicts and the frequent deployment and retrieval of fishing equipment. Distribution of ALDFG in relation to water depth shows higher densities in shallow nearshore environments (2–3 m depth, Fig. 1c), where fishing gear is particularly susceptible to snagging on reefs, rocky substrates, or other hard-bottom features, resulting in accidental loss or intentional abandonment of nets and ropes.

urthermore, hydrodynamic forcing, including wave action and coastal currents, can transport semi-buoyant fishing gear toward the shoreline, facilitating its retention and accumulation in coastal zones. The KDE hotspot map showing the relative spatial clustering of all recorded ALDFG observations is presented in Fig. 1d.

The spatial distribution of ALDFG observations buy ICES category is illustrated in Fig. 2. Predominantly, fishing nets (A8) especially gillnets, were distributed near the shoreline. All nets were found settled on the seabed and were observed as fragmented gillnet pieces with attached floats and sinkers, indicating extensive use of this gear in the area. Monofilament fishing lines and synthetic ropes were also recorded. Longline, handline, and trolling fishing methods were prevalent in the region and are commonly used to harvest groupers, emperors, and carangids. Metal fishery debris (C3), mainly lost traps and associated accessories such as supporting base iron bars, was found farther offshore at depths of 18–20 m, within the typical deployment range of fish traps (10–35 m).

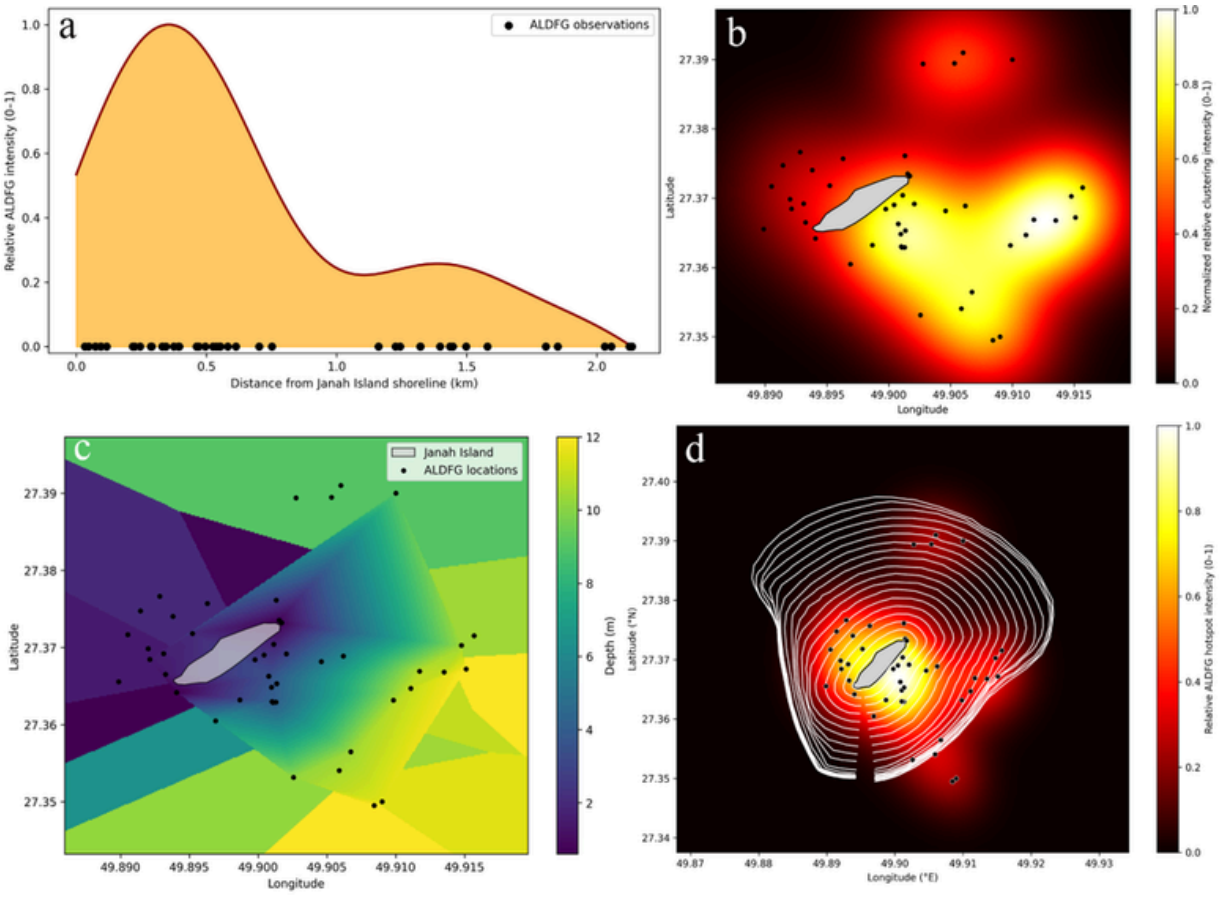


Fig. 1 (a) Spatial distribution of ALDFG hotspots relative to the Jana Island shoreline, (b c) spatial distribution of ALDFG in relation to water depth, (d) KDE hotspot map showing relative spatial clustering of all recorded ALDFG observations

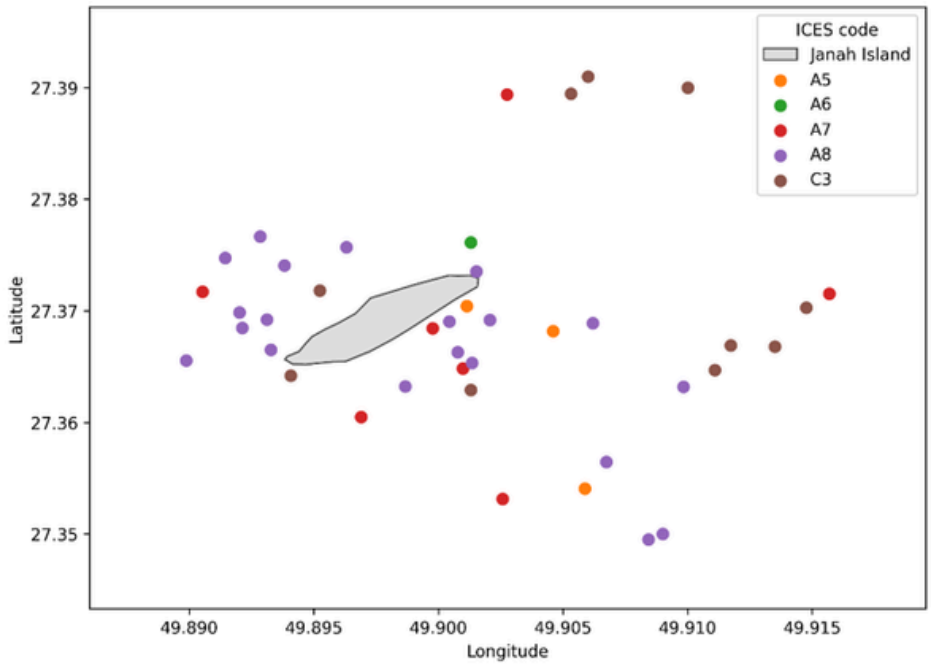
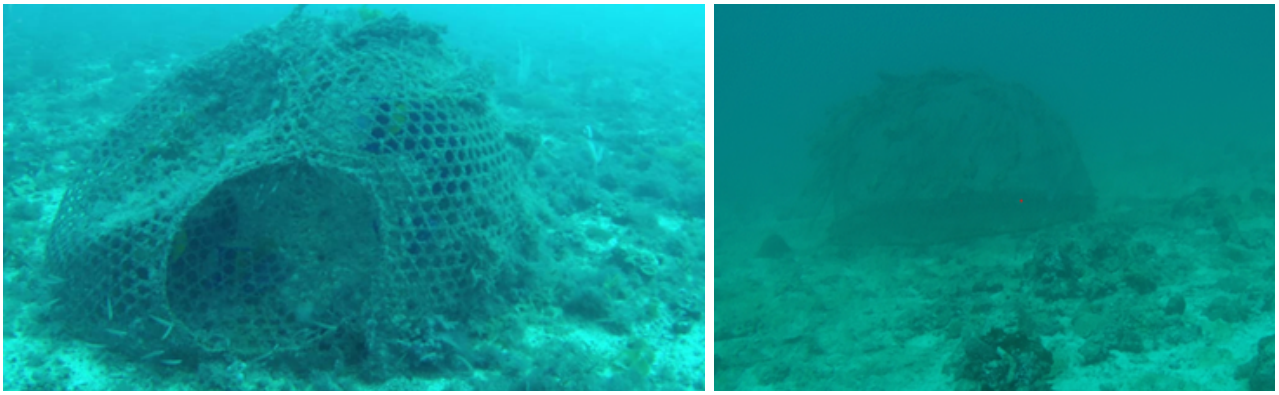


Fig. 2. Spatial distribution of ALDFG by ICES category, points represent individual observations symbolized by gear type, and the grey polygon denotes Jana Island. A5 (fishing line monofilament), A6 (entangled fishing line), A7 (synthetic rope), A8 (fishing nets), A16 (other fishing related plastic, buoys), B3 (sinkers) and C3 (metal from fisheries).



Photographs of abandoned or lost fishing gears in th Arabian Gulf coasts and islands



Photographs of abandoned fish traps in Karan island



Drone shots of abandoned fishing nets in Salwa region



Abandoned fishing nest in Farsan Island (Red Sea)

References

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