

ORIGINAL ARTICLE OPEN ACCESS

Using Photographs in Fishers' Ecological Knowledge Research: A Review and Field Study on Small-Scale Fishers' Knowledge of Coastal Habitats in the Central Mediterranean Sea

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Received: 5 May 2026 | **Revised:** 15 July 2026 | **Accepted:** 23 July 2026

Keywords: coastal zone | fishers' ecological knowledge | habitat | methodology | small-scale fisheries | stakeholder engagement

ABSTRACT

Fishers interact daily with coastal environments, which generate a deep understanding of habitat characteristics, species associations and ecological change. Fishers' ecological knowledge (FEK) is therefore a critical source of insight for marine science, offering observations that uniquely complement scientific data and, when incorporated into policy and governance, can strengthen the legitimacy and acceptance of management decisions. Yet, tacit and embodied dimensions of FEK are difficult to access through verbal cues alone, which may leave important components of FEK hidden. Photo elicitation (PE), the use of photographs during interviews, has been suggested as a method to help overcome this difficulty. This study examines how PE can support engagement with FEK, particularly regarding knowledge of coastal habitats. For this purpose, we performed a literature review of PE in FEK research together with a field study using semi-structured interviews with PE to assess how photographs can be systematically used to facilitate discussions of coastal habitats, their role in supporting faunal communities and ecological changes over time. The review revealed that, although PE is widely applied, most studies offer limited methodological reflection, obscuring the full role and potential of PE in fisheries science. Our field study showed how PE can effectively support fishers' descriptions of fishing habitat and species identification in both shallow and deep-water contexts can help identify changes in species distributions and elicit insights into how habitats influence fishing practices. Together, these results suggest that a reflective and systematic approach to PE can be a powerful tool for elucidating multiple dimensions of FEK, improving scientists and managers' engagement with the richness of fishers' knowledge and strengthening its contribution to marine research and management.

1 | Introduction

Sustained and regular interaction with marine environments enables fishers to develop a rich understanding of the ecosystems that support their livelihoods and the interrelationships between living organisms and their environment. This understanding, often termed as fishers' ecological knowledge (FEK), is widely

recognised as a legitimate and complementary form of knowledge that can deepen scientific understanding of aquatic ecosystems (Bélisle et al. 2018; Stephenson et al. 2016; Haggan et al. 2007; Johannes et al. 2000; Pálsson 1995). FEK can successfully contribute to data acquisition on species distribution and population trends over time (Alexopoulos et al. 2025; Bastari et al. 2017), which is particularly valuable in data-poor regions or where

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possibilities for long-term and fine-scale monitoring are limited (Lima et al. 2017; Silvano and Begossi 2012). FEK can also help to identify environmental change and its impact across social and ecological dimensions of coastal systems. For instance, the effect of increasing water temperatures on species distribution, which, in turn, alters catch composition, increases travel distances during fishing trips and generates economic consequences on fishing communities (McClenachan et al. 2025; Pinsky et al. 2021).

The importance of engaging with and accounting for FEK extends also beyond its contribution to scientific knowledge. Fishers' livelihoods are deeply intertwined with marine environments and their resources, making them key stakeholders in marine resource governance. It is widely recognised that stakeholder participation is central to just governance (Linke et al. 2022; Boonstra et al. 2017) and therefore a key aspect of ecosystem-based fishery management (Long et al. 2015).

Communication between fishers, scientists and policy makers can, however, be challenging, which hinders cooperation between these key stakeholder groups (Hoschke et al. 2024; Glenn et al. 2012; van Densen and McCay 2007). Fishers' mistrust in the scientific surveys and analyses that underpin fishery regulations can undermine the perceived legitimacy of fishery regulations and reduce compliance (Calderwood et al. 2023; Boonstra et al. 2017; Hønneland 2000). In this context, facilitating fishers' participation and accounting for FEK in the drafting of marine resources management policies represent key steps towards a more legitimate and effective fisheries governance (Linke et al. 2022; Boonstra et al. 2017), where multiple forms of knowledge contribute to shape shared understandings of the fishery and the resources it depends upon (Calderwood et al. 2023).

Despite the growing recognition of its importance, methodological challenges remain in how to effectively engage with FEK. Much of FEK is derived through day-to-day activities at sea. Such practical knowledge is often tacit, meaning that it is difficult to verbalise or communicate directly, particularly in an off-line setting (i.e., not during fishing activities) (Björkvik et al. 2021; Wilson et al. 2006; Pålsson 1995). This poses challenges for conventional research approaches, such as interviews and questionnaires, which depend on verbal articulation and which are often conducted when the fisher is not out at sea. Although these methods can be effective at successfully recording explicit aspects of FEK, there is a risk that they overlook tacit knowledge and thus engage only partially with the depth and diversity of FEK.

One methodological approach with potential to capture tacit dimensions of FEK is photo elicitation (PE), an interview technique that introduces photographic material to facilitate discussion and reflection (Harper 2002). First formalised by Collier (1957) in anthropological research, PE has since been applied in various disciplines such as education, psychology and sociology, to enhance the accuracy of verbal communication and facilitate tacit and emotional engagement during interviews (Glaw et al. 2017; Pain 2012; Harper 2002).

The potential of PE to facilitate interviews derives from what Lapenta (2011) described as the two key informational characteristics of photographic material: their *encyclopaedic* and *projec-*

tive qualities. Encyclopaedic qualities refer to the photographs' 'immediate character of realistic reconstruction' (Lapenta 2011, 203). Photographs thus can help ground the conversation by offering a visual reference shared by the researcher and the participant (Collier and Collier 1986). Projective qualities describe instead the ability of photographs to reach beyond this descriptive function, eliciting the participants' emotions and memories (Lapenta 2011; Harper 2002). Projective qualities have been linked to visual processing regions of the brain being more closely connected to emotional systems than those involved in language processing, meaning that images can trigger stronger emotional responses than verbal cues (Holmes et al. 2008). Together, encyclopaedic and the projective qualities of photographs suggest that PE can be a valuable technique to support explicit communication while also accessing tacit aspects of FEK.

PE is conducted according to three approaches—research-generated, participant-generated and collaborative PE—which differ in the degree to which researchers or participants have control over the photographs chosen (Richard and Lahman 2015). Researcher-generated PE gives full control to the researcher over the context, topics and categories investigated, facilitating hypothesis testing and allowing comparability across studies using the same or similar photos (Romera Iruela 2023). This control can help address some of the concerns regarding the poor standardisation of FEK studies expressed in the literature (Davis and Ruddle 2010). Participant-generated and collaborative PE instead offer the participants the opportunity to show what is most important to them, which can be overlooked with the use of pre-selected photographs only (Zhang and Hennebry-Leung 2023).

PE is widely adopted in social and behavioural sciences, as shown by published literature and methodological reflections on its use (e.g., Bautista García-Vera 2023; Zhang and Hennebry-Leung 2023; Hidalgo Standen 2021). In these fields, PE typically relies on photographs that represent elements of the respondents' lived visual experience (Zhang and Hennebry-Leung 2023; Harper 2002). When applied to fisheries research, however, the visual foundation of PE calls for a further layer of methodological consideration. Fishers do visually encounter many components of the marine environment, such as the species they catch, but their experience of marine habitats is significantly mediated through gear, boat use, bathymetry and embodied stimuli. Because FEK includes both visually experienced and non-visually experienced knowledge, the function of photographs in facilitating interviews may differ depending on the specific topic investigated.

In this study, we evaluate the use of PE to investigate FEK of coastal habitats and their relationship with targeted species. This focus is motivated by two main considerations. First, species-habitat relationships can vary considerably across locations due to contextual factors such as seascape configuration, predator pressure and local environmental conditions (Bradley et al. 2019, 2020); therefore, fishers' situated observations can provide key place-specific information on habitat use by marine fauna (Funk et al. 2020; Bergmann et al. 2004), which can support conservation scientists and managers in identifying and sustaining critical habitats. Second, although numerous studies have engaged with FEK of marine habitats, some authors have noted limitations in eliciting the detailed descriptions of marine habitats features

through verbal communication alone (Bergmann et al. 2004; Pederson and Hall-Arber 1999, as cited in Bergmann et al. 2004). This makes a focus on marine coastal habitats an ideal context for assessing the role of PE in facilitating interviews and improving data generation.

To assess the use of photographs in FEK research and to evaluate their potential and limitations as knowledge-generating tools, the study proceeds in three steps. First, we conducted a systematic review of how PE has been used in interviews with fishers, identifying the purposes and assumptions underlying its application in this field. Second, we performed a broader scan of how photographs were used in FEK studies more generally, regardless of whether their use was labelled PE. Finally, we conducted a field study consisting of semi-structured interviews using photographs of habitats with small-scale fishers in the island of Salina, Italy, in the central Mediterranean Sea. The purpose of this field study was to develop and evaluate a systematic approach to PE for capturing tacit and explicit aspects of FEK of coastal habitats and to explore the potential influence of subjective interpretation of photographs on participants' responses. Given the limited number of participants, this empirical component should be regarded as testbed for exploring the potential of a systematic PE approach to investigate FEK and for identifying further methodological developments. The interviews were guided by three research questions: (a) In which marine habitats do fishers on Salina work; (b) what functions do they attribute to habitats in supporting marine fauna; and (c) what changes over time do they perceive in habitats or species–habitat relationships?

2 | Materials and Methods

2.1 | Literature Review: PE in FEK Research

To map the literature that explicitly uses PE during interviews with fishers, we conducted a systematic search through Web of Science Core Collection (WoSCC) and SCOPUS using the keywords 'photo elicitation' and fisher* (up to 11 November 2025; all fields; English language only; a full list of WoSCC sub-databases is provided in Table A1). In addition to this systematic literature search, we also conducted a broader, non-exhaustive exploratory scan of the FEK literature searching for the additional identifiers 'picture' and 'photo' (which would also return hits for 'pictures', 'photos', 'photograph' and 'photographs') to identify articles that used photographic material during interviews with fishers, but did not refer to it as PE. As our study focuses specifically on the use of photographic material, keywords referring to other visual media (drawings, diagrams or other visual methods) were not used.

2.2 | Empirical Study: FEK of Coastal Habitats in Salina (Italy)

To assess the role of photographs in facilitating interviews, improving the accuracy of the information elicited and engaging with tacit aspects of FEK, we systematically applied PE in an interview study with small-scale fishers in the island of Salina, Italy, central Mediterranean Sea (Figure 1). To ensure methodological transparency, we developed an interview protocol

defining when the PE component was presented (in Table A2) and based the selection of subjects depicted on a rationale (reported in Table A3). Given the limited scope of the field study, methodological triangulation with participant observation was performed to enhance data trustworthiness and validation.

2.2.1 | Study Area: The Island of Salina

The island of Salina (38°33'55" N, 14°50'0" E, Figure 1) is the second largest island of the Aeolian Archipelago, a group of seven inhabited islands north of Sicily, Italy. The island is of volcanic origin, with a coastal zone characterised by steep slopes and complex seafloor topography, including seamounts, canyons and hummocks (Favalli et al. 2005). Extended hydrothermal systems are also present, which create localised, highly dynamic physico-chemical conditions (Esposito et al. 2018). Together, these features provide a diverse mosaic of marine habitats of high ecological importance that support diverse biological communities and high endemism (Aguilar et al. 2018; Esposito et al. 2018; Bellissimo et al. 2014). However, the region is subjected to intense anthropogenic pressures including fisheries, rising water temperatures and spreading of diseases, which impact essential habitats and their associated species (Gil et al. 2025; Toso et al. 2025; Lejeune et al. 2010). The combination of ecologically important and diverse coastal habitats and increasing anthropogenic pressures made Salina a suitable setting for the field study. Moreover, the first author's ability to conduct interviews in her native language (Italian) facilitated direct communication with the participants and helped the generation of rich qualitative material.

2.2.2 | The Fishery Sector in Salina

Small-scale fisheries represent the entirety of the fishing sector in Salina (Di Natale and Navarra 2019). The number of active fishing boats in the three municipalities in Salina according to the most recent investigations is shown in Table 1.

Fishers in Salina typically use at least two gear types, rotating them seasonally (Di Natale and Navarra 2019; Battaglia et al. 2010). The most commonly used are trammel nets, set gillnets and bottom longlines, all passive gears that interact, at least to some degree, with the sea bottom. Different configurations of these gears, varying in mesh size, nets height or hook size, exist to target specific organisms (Di Natale and Navarra 2019; Battaglia et al. 2010). Seasonality of the stock, regulations and market value are among the most important factors influencing fishers' choice of which fishing activity to conduct (Di Natale and Navarra 2019).

2.2.3 | Semi-Structured Interviews

Semi-structured interviews were conducted with small-scale fishers located in the three municipalities of Salina (Figure 1) between September and October 2024. Eligibility of participants was limited to fishers that were active in small-scale fisheries and that fished for an income. Fishers were initially contacted either with the help of members of the local community or researchers working for a marine conservation charity operating

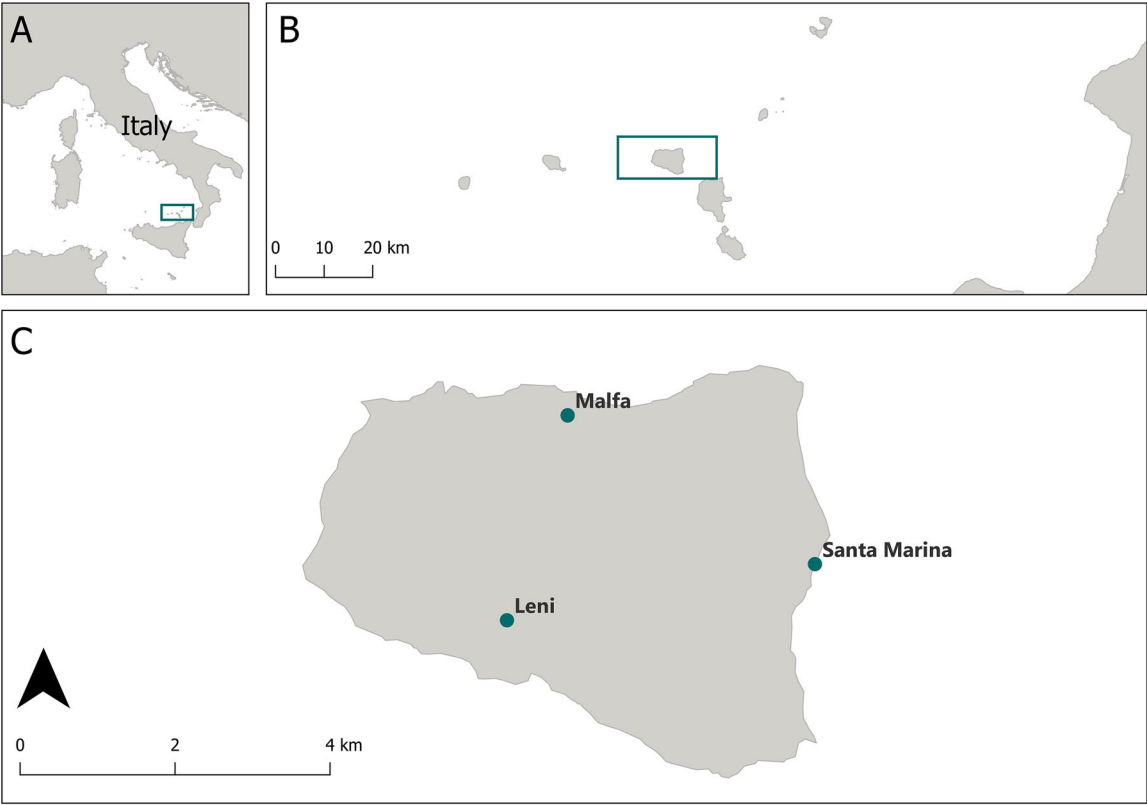


FIGURE 1 | Maps of the study area. (A) The Aeolian Archipelago in the central Mediterranean Sea (green rectangle); (B) the island of Salina within the Aeolian Archipelago (green rectangle) and (C) the three municipalities in the island of Salina.

TABLE 1 | Number of registered active vessels and proportion of the total in the three municipalities in the island of Salina.

Municipality	Total population	Number of active fishing vessels	% of the total fishing fleet in Salina
Malfa	1004	8	44.4
Santa Marina	856	7	38.9
Leni	677	3	13.7

Source: Population data from ISTAT (2023). Fishery data from Di Natale and Navarra (2019).

in the territory (i.e., Blue Marine Foundation) or were directly approached at the harbour. Before each interview, fishers were informed about the aim of the study, the intended data use, and the fully anonymous and voluntary nature of their participation. Consent was obtained either in written or oral form, depending on the fisher’s preference.

An interview protocol was developed where photos were introduced at designated moments in the interview. Participants’ verbal responses and emotional reactions elicited by photographs were documented through audio recordings and field notes. The semi-structured interview protocol consisted of four parts: biographical details, fishing practices, habitat used and associated species, and additional reflections (script in Table A2). PE was performed before the additional reflections. The average duration of an interview was about 50 min. All the interviews were conducted in the native language (Italian) by the first author.

2.2.4 | Photo Elicitation

The PE used for the interview study was researcher-driven, motivated by two considerations. First, retaining control over the habitat categories allowed for a degree of comparability with future studies using similar protocols (Romera Iruela 2023). Second, a researcher-driven design made it possible to include habitats that fishers cannot easily photograph themselves (e.g., deep-water habitats) and habitats that may not be of direct practical relevance to their fishing activities but are ecologically important, such as deep-water macroalgae. The photographic material used in the interviews was selected on the basis of the documented presence of the habitat in the coastal zone of the study area and their distribution at different depths, including deeper waters (i.e., >40 m depth) (UNEP/MAP 2021).

Priority was given to photographs showing organisms out of the water, reflecting how fishers typically encounter them. All of the subjects belonged to broader habitat categories while also functioning as habitats themselves. The set included a total of nine photographs, one for each subject, consisting of two seagrass species (the endemic Neptune seagrass *Posidonia oceanica* and the introduced Halophila seagrass *Halophila stipulacea*), two brown macroalgae (*Ericaria brachycarpa* and the Mediterranean deep-water kelp *Laminaria rodriguezii*), a green macroalga (the grape alga *Caulerpa cylindracea*), two representatives of attached habitat-forming organisms (the endemic noble pen shell *Pinna nobilis* and a coralligenous community) and two representatives of unattached habitat-forming organisms (rhodoliths and pencil urchins in the Cidaridae family). These habitats are associated with high biodiversity and are impacted by multiple anthropogenic pressures (UNEP/MAP 2021); within this set, *P. oceanica*, *L. rodriguezii* and *P. nobilis* are listed in the Barcelona Convention Annex II of endangered or threatened species (UNEP/MAP and SPA/RAC, 2018), and *P. nobilis* is also an IUCN critically endangered species (Kersting et al. 2019). Images were either the first author's own photographs or derived from published sources, oceanic research institute websites or the World Register of Marine Species (WoRMS). Details on the selection rationale and full set of photos with references are provided in Table A3.

Several steps were implemented to minimise researcher bias and to ensure that the images were clear and recognisable. First, the subject had to be displayed in the foreground so that its overall morphology was readily identifiable. For small subjects, such as *C. cylindracea*, close-up photographs were selected to clearly depict their architecture. In contrast, for larger organisms, such as *P. nobilis*, photographs showing the subject within its surrounding environment were chosen to provide a sense of scale. For photographs depicting benthic communities rather than single organisms (e.g., rhodolith beds and coralligenous reefs), images containing likely familiar organisms were selected to aid participants in judging scale and water depth. For example, fish were visible in the photograph of the coralligenous community, and pencil sea urchins in the photograph of the rhodolith bed.

During the interviews, some fishers offered to show their own pictures, depicting gears, boats and species caught; one participant also utilised their phone to search internet for images of the marine species that were discussed during the interviews. These examples of spontaneous participant-driven PE were fully accepted in the methodology and used in the assessment of the role of photographs during interviews.

2.2.5 | Participant Observation

Participant observation immerses the researcher in the context of the study, enabling a richer and more situated understanding of practices, interactions and environments (Saldaña 2011). In this study, participant observation included: (a) joining fishing trips, observing the catch, viewing habitats from the boat and examining material brought up with the gear (Figure 2A–C); (b) attending events organised by the local fishers' cooperative; (c) visiting harbours and observing fish landings; (d) visiting public

places where fish was sold; and (e) snorkelling in proximity of fishing spots (Figure 2D).

2.3 | Analysis

The interviews were analysed using the structure–dynamics–function (SDF) framework, an analytical tool previously applied to analyse fishers' knowledge of aquatic food webs (Garavito-Bermúdez et al. 2016; Garavito-Bermúdez and Boonstra 2022; see also its original formulation by Hmelo et al. 2000).

In ecological studies, the terms 'structure', 'dynamics' and 'function' are often used to mean different things depending on the process investigated (Bellwood et al. 2019; Jax 2005). To avoid ambiguity and to better align the framework with our research focus, we adapted the definitions by Garavito-Bermúdez et al. as follows: *Structure* denoted fishers' accounts of habitat features, including physical characteristics such as depth, substrate type, vegetation and associated faunal species; *dynamics* reflected the definition by Garavito-Bermúdez et al., indicating descriptions of changes over time (in habitats or species–habitat relationships); and *function* denoted the ecological role of habitats, such as shelter or nursery functions.

The coding of interviews was performed by the first author. To enhance the consistency and trustworthiness of the analysis, interview transcripts (translated from Italian to English), together with interview extracts and their associated codes, were shared with all co-authors. The co-authors independently reviewed the coding and subsequently discussed their interpretations with the first author to ensure that it accurately reflected the interview data and that a consensus was reached.

First-order categories were identified applying the SDF framework, followed by thematic analysis to explore more in-depth the *function* and *dynamics* elements of the framework. Codes relative to habitat function and dynamics were first grouped together into potential shared themes. The themes were then revised after re-reading the interview extracts, and adjusted until the identified themes were coherent both at the level of the single extracted codes and the level of the whole dataset (Braun and Clarke 2006; Table A5). Comments, observations and further descriptions elicited by photographic materials were noted for the assessment of the role of PE during interviews.

3 | Results and Discussion

3.1 | Literature Review: How Has PE Been Used in the Study of FEK?

The systematic literature search identified 18 studies, nine of which were discarded as not relevant, whereas the remaining nine used PE in interviews with fishers (Table 2A). These studies were conducted across diverse social-ecological contexts and in various geographical locations along the Atlantic, Pacific and Indian Oceans. Most (80%, seven studies) adopted a researcher-driven PE approach, one used collaborative PE (Banuet-Martinez et al. 2025), and one did not specify how PE was implemented (Adjei 2024).

TABLE 2 | (A) Results from the systematic literature and (B) results from the broader literature scan.

(A) Systematic literature search						
Ocean (sub-region or sea)	Location	Main topic	PE approach	Main use of PE	Comments	Reference
Atlantic Ocean (North Atlantic)	Azores	Narratives on the complex meanings that people in a fishing community associate with the sea	Researcher-driven	To elicit richer conversations		Neilson et al. (2016)
Atlantic Ocean (Baltic Sea)	Sweden	Craftmanship, embodied and tacit knowledge	Researcher-driven	To elicit richer conversations, engaging with tacit and embodied knowledge		Mellegård and Boonstra (2020)
Pacific Ocean (South Pacific)	Mo'orea	The Ecosystem Services framework as a situated practice, instead of a neutral tool to elicit peoples' values	Researcher-driven	To elicit richer conversations, discussing values and perceptions connected		Hunter and Lauer (2021)
Pacific Ocean (Eastern Pacific)	Galapagos	FEK about: (a) which marine species use mangrove habitats; (b) connectivity and trophic interactions between mangroves and other marine habitats; and (c) location of mangroves	Researcher-driven	To extract values and known connections among mangrove ecosystem services and discuss these through a photocollage		Pontón-Cevallos et al. (2022)
Pacific Ocean (South Pacific)	Samoa	Perceptions of gender roles in seaweed value chain within fishing communities (note: fishers constituted a minority, i.e., 10%, of the participants)	Researcher-driven	To elicit richer conversations, engaging with emotional dimensions and perceptions about gender roles in seaweed value chain		Anderson et al. (2023)

(Continues)

TABLE 2 | (Continued)

(A) Systematic literature search						
Ocean (sub-region or sea)	Location	Main topic	PE approach	Main use of PE	Comments	Reference
Atlantic Ocean (North Atlantic)	Ghana	Interrelationships between places, gender and decision-making of fishers' couples	Unclear	To elicit richer conversations, engaging with emotional dimensions and perceptions of how physical spaces are used by man and women in the fishery	No information on how PE was used	Adjei (2024)
Indian Ocean (Western Indian Ocean)	Zanzibar	Perceived impacts of octopus closures	Researcher-driven	To elicit richer conversations, exploring perceptions of self and own identity as a fisher		Drury O'Neill, Daw, Slade, et al. (2024)
Ocean (sub-region or sea)	Location	Main topic	PE approach	Main use of PE	Comments	Reference
Indian Ocean (Western Indian Ocean)	Zanzibar	Attitudes towards octopus closures, including (non)compliance	Researcher-driven	To elicit richer conversations, engage with emotional dimensions related to fishing regulations		Drury O'Neill, Daw, Mwaipopo, et al. (2024)
Pacific Ocean (Eastern Pacific)	Mexico	Perception of impacts of climate change on socio-ecological-health systems in fishing communities	Collaborative	To elicit richer conversations		Banuet-Martinez et al. (2025)

(Continues)

TABLE 2 | (Continued)

(B) Literature scan						
Ocean (sub-region or sea)	Location	Main topic	PE approach	Main use of PE	Comments	Reference
Atlantic Ocean	Brazil	FEK of reproductive seasons, breeding places and migrating behaviour of targeted species	Researcher-driven	Species identification		Silvano et al. (2006)
Pacific Ocean (South Pacific)	Western Solomon Islands	Mapping benthic habitats, describing ecology of marine species and monitoring environmental change. Ultimately, with the aim of testing assumptions on theories on 'indigenous knowledge' ^a	Researcher-driven	Species identification, mapping of habitats, engaging with tacit knowledge, eliciting richer understanding of FEK	Used aerial photographs	Lauer and Aswani (2009)
Atlantic Ocean (Mediterranean Sea)	Italy	Investigating emerging patterns of species distribution due to climate change	Researcher-driven	Species identification	Protocol developed for a monitoring programme later applied in 79 locations (Azzurro 2018; Garrabou et al. (2019)	Azzurro et al. (2011)
Atlantic Ocean (South Atlantic)	Brazil	Developing a protocol for engaging with FEK to support ecosystem-based management	Researcher-driven	Species identification		Leite and Gasalla (2013)
Pacific Ocean (South Pacific)	Western Solomon Islands	Perceptions of before–after impact of catastrophic events on benthic habitats	Researcher-driven	Comparing before–after photos of benthic habitats; discussing in-depth participants' perception of change of these habitats	Used aerial photographs	Aswani and Lauer (2014)

(Continues)

TABLE 2 | (Continued)

Ocean (sub-region or sea)	Location	Main topic	PE approach	Main use of PE	Comments	Reference
Indian Ocean (Western Indian Ocean)	Zanzibar and Kenya	Assessing whether sea urchin predators are targeted by small-scale fisheries and, in that case, what are the drivers behind their exploitation	Researcher-driven	Species identification		Wallner-Hahn et al. (2015)
Atlantic Ocean (Adriatic Sea)	Italy	Perceptions of change in the abundance of habitat-forming benthic species	Researcher-driven	Species identification		Bastari et al. (2017)
Atlantic Ocean (North Atlantic)	Massachusetts (USA), New York (USA), Maine (USA), Nova Scotia (Canada)	Mapping cod spawning grounds	Researcher-driven	Life-stage identification		DeCelles et al. (2017)
Atlantic Ocean (Mediterranean Sea)	Italy, Croatia, Montenegro and Slovenia	Occurrence and distribution of non-indigenous species	Participants' own pictures if available; researcher-driven material when needed	Species identification; documentation of species occurrences	Using protocol described in Garrabou et al. (2019)	Azzurro, Bolognini, et al. (2019)
Atlantic Ocean (Mediterranean Sea)	Sub-sections: Adriatic, North-Aegean, Algero Provincial, Ionian, Levantine, Strait of Sicily and Tunisia, Thyrrenian	Changes in fish distribution and abundances	Researcher-driven	Species identification	Building on Azzurro et al. (2011) and Garrabou et al. (2019)	Azzurro, Sbragaglia, et al. (2019)

(Continues)

TABLE 2 | (Continued)

Ocean (sub-region or sea)	Location	Main topic	PE approach	Main use of PE	Comments	Reference
Indian Ocean (Western Indian Ocean)	Zanzibar	Evaluating if FEK varies across different fisher groups defined by habitat use, fishing range, gear type and biographies, and how it aligns with scientific knowledge on connectivity from the same area	Researcher-driven	Species identification, species–habitat linkages, connectivity		Berkström et al. (2019)
Atlantic Ocean (Southern Atlantic)	Brazil	Reliability of fishers' recognition of individual dolphins	Researcher-driven	Recognition of individual dolphins		da Rosa et al. (2020)
Indian Ocean (Western Indian Ocean)	Madagascar	Seagrass-related ecosystem service contributions to food security	Researcher-driven	Species identification		Wallner-Hahn et al. (2022)

Note: Reported are the oceanic system, the location of the study, the research topic, the approach to PE, how the photos were used, any additional comment and reference to the study.

Abbreviations: FEK, fishers' ecological knowledge; PE, photo elicitation.

^aThe term 'Indigenous knowledge' overlaps with 'local ecological knowledge' and 'traditional ecological knowledge'. Fishers' ecological knowledge has been described using all three terms (Garavito-Bermúdez and Boonstra 2022, 1843).



FIGURE 2 | (A) A participant to the study hauling a net; (B) one of the fish captured, a Mediterranean parrotfish *Sparisoma cretense*; (C) a fragment of brown algae (order: Sargassaceae), retrieved with the net; (D) a shallow water (about 2 m depth) infralittoral habitat with hard substrate and brown macroalgae, and a school of salemas *Sarpa salpa*. Photo 2D was taken in the same area of A–C. Photos: C. D'Agata.

Across all studies, PE was used primarily to leverage on the projective value of photographs to elucidate participants' emotions, values and perceptions. This attention to emotional dimensions and personal processes was reflected by the research topics, which included: (a) fishers' perspectives and responses following regulations of marine resources (Drury O'Neill, Daw, Slade, et al. 2024; Drury O'Neill, Daw, Mwaipopo, et al. 2024); (b) how people in fishing communities assign meanings to the marine environment (Neilson et al. 2016); (c) valuation of ecosystem services (Pontón-Cevallos et al. 2022; Hunter and Lauer 2021); (d) embodied and tacit knowledge in the fishery as a form of craftsmanship (Mellegård and Boonstra 2020); (e) the impact of climate change on fishing communities, examined through a socio-ecological-health systems framework (integrating ecosystems, society and human health) (Banuet-Martinez et al. 2025); and (f) the perception of gender roles in seaweed aquaculture (Anderson et al. 2023) and the role of gender in shaping labour, decision-making and practices in fishing households (Adjei 2024).

The additional exploratory scan detected many FEK studies that used photographs during interviews without identifying their approach as PE (Table 2B). It is therefore difficult to fully determine how often and in what ways PE is used in FEK research, as the use of material, variably termed 'photos', 'photographs' or 'pictures', was often mentioned only briefly in methods sections without further elaboration.

As in the systematic PE search, these studies were conducted across different regions, including the Atlantic, Pacific and Indian Oceans (Table 2B). They all used a researcher-driven approach, with one study also incorporating participants' own photographs (Azzurro, Bolognini, et al. 2019). The majority of the studies addressed biological or ecological aspects of marine

environments, including species ecology and migration (Silvano et al. 2006), spatial distributions (Azzurro, Bolognini, et al. 2019), species–habitat linkages (Berkström et al. 2019) and spawning grounds (DeCelles et al. 2017). Others examined fishers' perception of ecological change (Azzurro et al. 2011; Bastari et al. 2017; Azzurro, Sbragaglia, et al. 2019) or habitat alteration following catastrophic events (Aswani and Lauer 2014). Additional studies incorporated human dimensions, such as links between fisheries and trophic cascades (Wallner-Hahn et al. 2015), seagrasses and food security (Wallner-Hahn et al. 2022), assessing FEK reliability (da Rosa et al. 2020), improving FEK integration into management (Leite and Gasalla 2013) and critically evaluating the assumptions behind theories of knowledge and FEK research practices (Lauer and Aswani 2009).

In contrast to the PE-specific literature, photographs in these studies were used mainly for species or habitat identification, with the exception of Lauer and Aswani (2009) and Aswani and Lauer (2014). The difference likely reflects disciplinary traditions. Most of the authors of studies that did not explicate their PE approach were affiliated with institutions or departments operating within ocean and environmental sciences, marine and fisheries research, wildlife conservation and ecology. Visual materials in these fields have long served as a key tool for identification and classification, from the detailed drawings of the 18th and 19th centuries (Scharf 2009) to the progressively more common use of photographs (Leggett and Kirchoff 2011). Field guides and species compendia remain standard tools in ecological and biological research and monitoring. In some of the studies reviewed, field guides used in scientific surveys were also used during interviews (e.g., DeCelles et al. 2017). The strong identification-oriented use of photographs appears consistent with methodological norms in ecology and biology. This may also explain why their use of photos was not referred to as 'PE', a

concept rooted (as seen in the Introduction) in anthropological rather than biological research tradition.

The literature review revealed the flexibility with which PE has been applied in the field. Photographs have been used in one-to-one interviews (e.g., da Rosa et al. 2020) as well as in focus groups (e.g., Pontón-Cevallos et al. 2022); as tools for identification as well as prompts that facilitate richer discussions of participants' perceptions, values and embodied knowledge across diverse social and ecological contexts (See Table 2 for full list of references). The heterogeneity of these studies in terms of disciplinary and geographical spread suggests that PE is a potentially powerful method in FEK research, capable of being adapted to suit a wide range of aims and research questions and contexts. However, the review also highlighted some recurring challenges in the use of PE in FEK research. In particular, there was an overall lack of shared 'best practices' for reporting key methodological choices, such as which photographs were selected and at what point in the interview they were used. This variation in methodological reporting makes it difficult to assess the role that photographs play in shaping participants' responses and to determine how methodological differences affect comparability of findings between studies. In addition, Hunter and Lauer (2021) reported that photographs assumed to represent recognisable categories were instead interpreted in unexpected ways by the participants, highlighting the inherently subjective nature of image interpretation and the need for applying reflexivity both during photo selection and analysis of the interviews (Hunter and Lauer 2021).

3.2 | Semi-Structured Interviews

Six fishers took part in the study: one woman and five men, with ages ranging from 33 to 66. All fishers started fishing very young (<6 years old), either with a parent or another elder. One fisher was also an experienced diver, licensed to manually harvest invertebrates using SCUBA. For two of the participants fishing was the only source of income, whereas the remaining four reported alternative income deriving from the tourism sector on the island. Two of the participants were married and fished together for years; at their request, they were interviewed together.

Although the limited number of interviews in this field study prevents a robust assessment of data saturation, the credibility of interview findings can be strengthened by methodological triangulation, defined as the use of multiple data sources (Ahmed 2025). In this study, methodological triangulation was achieved through the integration of participant observation, which helped contextualise and validate the interview findings. In particular, accompanying fishers in fishing trips (Figure 2A) allowed for the direct observation of marine habitats from the boat, including the depth at which key features of the sea floor remain visually discernible, as well as the examination of catches and other materials brought up by the nets (Figure 2B,C). Visits to harbours and fish points of sale provided opportunities to cross-check species identification and gain insight into fish demand and market value, which is known to influence fishing choices and target habitats (Di Natale and Navarra 2019). Finally, snorkelling in proximity of fishing grounds enabled direct visual inspection of

habitat structure and the presence of both target and non-target species (Figure 2D).

In line with reports from the literature (Di Natale and Navarra 2019; Battaglia et al. 2010), all fishers practiced a polyvalent fishery, rotating gears depending on daily weather conditions, time of year, presence of temporal closures and market demands. Overall, a total of 49 marine animal taxa were named during the interviews, including 39 teleosts, five crustaceans, eight molluscs, two echinoderms, one cnidarian, one cetacean, one elasmobranch, one annelid and one nematode (see Table A4 for a full list of taxa). The habitats discussed (structure), their role in the ecosystem (function) and their perceived changes over time (dynamics) are presented below.

3.2.1 | Marine Habitats Described by Fishers: Structure

The interviews revealed that Salina fishers operate within a multitude of coastal habitats across a wide range of depths. On the basis of fishers' descriptions of depth, habitat features and associated species, these habitats can be broadly categorised as (a) pelagic; (b) midlittoral rocks; (c) infralittoral hard, soft and mixed substrates with *P. oceanica* and macroalgae; (d) circalittoral hard substrate of rock, mixed sediment and biogenic substrates; and (e) deep waters (>400 m depth). The elements and characteristics described that allowed for the identification of each habitat are reported in Table 3.

3.2.2 | Habitat Functions

The interviews revealed a rich understanding of the multiple roles that these habitats play in supporting marine communities. Fishers described habitats not only as places where species are found, but also their functional importance as spawning and nursery grounds, food provision and shelter.

Both pelagic and vegetated habitats were identified as important for species reproduction and recruitment. In the pelagic habitat, Fisher 1 identified, for instance, areas of seasonal passage of young swordfish in the pelagic waters around the archipelago. This is in line with the scientific literature, which reports that the waters surrounding the Aeolian Islands represent a central spawning and nursery area for swordfish in the Mediterranean Sea, with seasonal migrations to and from this area (MacKenzie et al. 2021; Romeo et al. 2011). Vegetated habitats, and in particular *P. oceanica*, were also recognised by fishers as key nursery habitats for numerous of fish and invertebrate species, aligning with the literature (Cheminée et al. 2021; Díaz-Gil et al. 2019). The following quote provides an example of how Fisher 4 referred to *P. oceanica* as a habitat of key importance for marine communities:

All [species] start from the Posidonia and then move deeper. All of them. Spiny lobsters, slipper lobsters, fish, scorpionfishes, everything. Because the Posidonia is basically the nursery, the area where fish go to reproduce. So all [species] start from the Posidonia and then move away.

TABLE 3 | Habitat elements described by fishers, the corresponding habitat identified from these descriptions and the participant providing the information.

Element described	Habitat identified	Fisher
Swordfishes	Pelagic (various depths)	1
Currents (strength, direction)		1, 2, 3, 4 and 6
Migration corridor		1
Flying squids		1, 5 and 6
Bogues		2
Jellyfishes	Midlittoral rocks (from the surface to <1 m depth, not permanently submersed)	2
Limpets		3 and 4
Rocks		3 and 4
Edible macroalgae		3
<i>Posidonia oceanica</i> ^a		1, 2, 3, 4, 5 and 6
Macroalgae ^a	Infralittoral rocks and mixed substrates with macroalgae and <i>P. oceanica</i> (depth <40 m)	2, 4 and 6
<i>Caulerpa cylindracea</i> ^a		1, 2, 3 and 4
Mixed substrates		4
<i>Pinna nobilis</i> ^a		1, 2, 3 and 4
Sand		1 and 6
Rocks	Circalittoral rocks and coastal detritic bottoms (depth: from around 40 to 150 m)	2 and 4
Juveniles (fish and crustaceans)		4
Purple sea urchins		4
Mediterranean slipper lobster		4
Blotched picarels		4
Spiny lobsters		1, 3, 5 and 6
Coralligenous ^a		3 and 4
Cidaridae ^a		1, 2, 3, 4, 5 and 6
Rhodoliths ^a		1, 3, 5 and 6
Caves		1, 5 and 6
Rocks		1, 3, 5 and 6
<i>Laminaria rodriguezii</i> ^a		1, 2, 3, 4, 5 and 6
Algae (unspecified)		3, 4 and 6
Stargazers		5 and 6
Weeverfishes		5 and 6
Lizardfishes		5 and 6
Spiny topshell	Deep waters (depth >150 m) with various bottom types, including rocks and caves	6
Pink lady		6
Small animals (invertebrates and smaller fishes, which are eaten by larger fish)		3
Gilted breams		5 and 6
Rocks and caves		5 and 6
Conger eels		5 and 6
Moray eels		5 and 6

Note: For species scientific names, see Table A4.

^aIncluded as a photograph in photo elicitation.

Food provision was another function assigned to both pelagic and benthic habitats. In pelagic habitats, Fisher 2 noted that bogues often aggregate where jellyfish accumulate, such as in small bays, an observation consistent with evidence of bogue predation on the mauve stinger jellyfish *Pelagia noctiluca* in nearshore waters (Milisenda et al. 2014). In benthic habitats, vegetation was described as an important food source, both directly and by hosting small fish and invertebrates that support higher trophic levels. For example, Fisher 3 described scorpionfishes (*Scorpaena* spp.) feeding on algae and associated invertebrates and small fish in rocky habitats, aligning with scientific accounts of their diet and habitat use (Ferri et al. 2012; Tiralongo 2024).

Fishers further highlighted the shelter function of caves and rocks, particularly for the Mediterranean slipper lobsters (*Scyllarides latus*), European conger eels (*Conger conger*) and Mediterranean moray eels (*Muraena helena*; Fishers 4, 5 and 6). Fisher 3 further noted that scorpionfishes are found in shallow habitats (around 10 m depth) as juveniles, whereas older individuals inhabit deeper water habitats (around 100–150 m depth). Scorpionfishes in the genus *Scorpaena*, which are targeted by the fishery, produce pelagic eggs (Dulčić et al. 2007), but, once settled, these species typically display low mobility (Tiralongo 2024; Ordines et al. 2009). Depending on settlement, they can occur in shallow areas, often in association with *P. oceanica*, as well as in deeper habitats, where rhodoliths and other red algae provide food and shelter (Tiralongo 2024; Ordines et al. 2009). The pattern observed by the fisher could therefore indicate, rather than an ontogenetic shift, a higher fishing pressure in shallow habitats, where scorpionfishes are more accessible.

Additional functions of coastal habitats described by the participants included sediment stabilisation and oxygen production by *P. oceanica* (Fisher 4), and the influence of active hydrothermal vents on local environmental condition, benefitting some marine organisms. As Fisher 6 described for vents near the neighbouring island of Vulcano:

[the island of] Vulcano produces much more fish because there are the fumaroles [...], and that type of thing is important at sea. Many types of fish reproduce where there are bubbles, the water temperatures are different, it's completely different there from other islands.

3.2.3 | Dynamics in Marine Habitats: Changes Over Time

Fishers described several changes affecting vegetated habitats, including a decade-long decline of the deep-water kelp *L. rodriguezii* (reported by Fishers 1–4), the decline of edible macroalgae (likely the sea spaghetti *Himanthalia elongata*) from the mid-littoral (Fisher 3) and the poor status of *P. oceanica* in areas with intense boat anchoring (Fisher 4).

All fishers also described shifts in marine species distribution and abundance. Some, including the Mediterranean parrotfish

(*Sparisoma cretense*) and the bearded fireworm (*Hermodice carunculata*), were reported by all fishers as both spreading spatially and increasing in numbers. These are thermophilic species currently undergoing a northern shift in distribution in the Mediterranean Sea (Esposito et al. 2021; Righi et al. 2020). Although parrotfishes were not only considered desirable, but also not problematic for the fishery, bearded fireworms were unanimously described by the fishers as a nuisance because they aggregate to feed on fish entangled in fishing gear, consuming the catch and making handling difficult due to their urticating setae. This opportunistic predation of bearded fireworms on fishers' catch has been documented in small-island coastal fisheries in Italy over 15 years ago, highlighting also a direct negative economic impact on the fishery (Celona and Comparetto 2010). From an ecological perspective, increasing abundances of bearded fireworms can also have potential negative impacts on benthic fauna. Bearded worms have shown to feed on bivalves, octopus, jellyfish, bryozoans, thaliaceans, sponges, tubeworms, among other organisms, but the full impact of their increasing presence in coastal habitats remains poorly understood (Righi et al. 2020).

In contrast, the purple sea urchin was reported as declining (Fisher 4). This species is a seafood delicacy with high market demand that is under high fishing pressure (Toso et al. 2025). The reasons for this shift were attributed by Fisher 4 to multiple interacting drivers, exacerbated by insufficient legislation regulating the exploitation of this species:

F4: By law, with the authorisation I have, I can fish up to 1000 sea urchins a day with a diameter of [minimum] 70 millimetres, including the spines. A tourist who arrives here can catch up to 50 sea urchins a day, but they don't catch 50 sea urchins a day with a diameter of 70 mm, they catch everything. So, when you give tourists the chance to catch 50 sea urchins a day each, in the summer, you can imagine ... 100 tourists are going to catch 50 sea urchins that aren't the right size ... They cause a massacre. Consider also that the waters have warmed up. Consider that there is the bald-urchin disease that kills the sea urchins and causes them to lose their spines. Consider that storms have become much stronger in recent years, which completely change the conformation of the seabed where they live. It becomes a massacre....

The fishers' reflections also align with a recent study combining surveys and historical analysis of purple sea urchin density by Toso et al. (2025), which documented a clear negative trend in its density in this area of the Mediterranean over the past 30 years, driven by overfishing, increasing sea water temperatures, severe storms and natural predation.

Fishers also described a shift of several species to deep-water refugia. Fishers 5 and 6 reported that Atlantic stargazers (*Uranoscopus gaber*), weeverfishes (*Trachinus* spp.) and John Dories (*Zeus faber*) now occur mainly only below depths of 100–150 m. However, their interpretation of this shift differed, with Fisher 5 attributing it to warming waters forcing fishes towards colder

waters, whereas Fisher 6 argued that the main driver of this change is the increasing pressure from recreational fishers in shallow waters. Fisher 6 further elaborated on how advances in fishing technologies have expanded human access to habitats that were previously inaccessible, intensifying pressure on marine populations. Referring to European flying squid (*Todarodes sagittatus*), the fisher contrasted past and present fishing practices:

F6: In the past, they used a carbide lamp. You would add carbide and water, and you had light to catch the squid [at night]. Now they catch squids even during the day, they go at depths of 600–700 meters [...] this is why there are no more squids. It should be prohibited, and go back in time. [If] you only have a small lamp and the otranto [hand jig line], you only get what you find there, you do not go looking for squids at 600–700 meters depth. Now they go looking for squids during the day and they catch squid mothers weighing 7–9 kg. When you destroy a mother, you have destroyed hundreds of squids. It should be prohibited.

This quote reflects both a detailed understanding of the ecology of European flying squid, a highly spatially dynamic species that undertakes extensive spawning and feeding migrations with temporal habitat differentiation between females and males (Quetglas et al. 1998), and a critical reflection on how technological advancements are asynchronous with regulations and controls, which ultimately contributes to the decline of the species.

3.3 | The Role of PE

The use of photographs during interviews contributed to the accuracy and richness of the data generated in our field study, thus further corroborating the findings of the literature review. First, at the empirical level, PE supported the identification of species and habitats, including deep-water, non-target organisms such as the kelp *L. rodriguezii*. Other than helping accuracy, photographs elicited responses that would not have emerged through verbal prompts alone that can help understanding fishers' perceptions of marine habitats. For example, Fisher 1 reacted strongly to the photograph of a pencil sea urchin, explaining that its presence in the nets is such a nuisance that areas with high densities are actively avoided. Similarly, moments of disinterest were also informative: Both Fishers 1 and 2 showed little interest when presented a photograph of the seagrass *P. oceanica*, offering insights into its perceived direct relevance for their fishing activities. Photographs also appeared to facilitate associative thinking, as illustrated by Fisher 3 spontaneously linking the bivalve *P. nobilis* to the previously seen *P. oceanica*, which helped discussing the habitat used by *P. nobilis*. Finally, the spontaneous use of participants' own photographs, as well as their searches for images online, further suggests that visual material can be a highly effective aid when engaging with fishers' knowledge, particularly now that most fishers carry phones capable of taking photographs or accessing internet. That said, it should be emphasised from the point of research ethics that it

is important to ensure that fishers do not feel pressured to share personal images, but rather that they can contribute with them voluntarily and when they find it meaningful.

The interviews also underscored some limitations of PE. As highlighted in the literature review, photographs assumed by researchers to represent clear, universally recognisable categories may, nevertheless, be interpreted in unexpected ways (Hunter and Lauer 2021). Findings from our field study support this observation, showing that despite the photograph selection steps described in Section 2.2.4 aimed at reducing researcher's bias and increase recognisability, some photographs were not interpreted by participants as representing known habitats or species. This challenge was particularly evident in the case of the rhodolith bed photo, which participants did not identify as a familiar habitat, even though they readily recognised rhodoliths when these were described verbally. Moreover, although photographs were selected to represent easily recognisable species, some taxa (e.g., *E. brachycarpa* and other algae) may remain difficult to distinguish from morphologically similar species. Taken together, our literature review and field study underscore the importance of recognising that photographs are inherently subject to individual interpretation, and that it is crucial to evaluate the broader ecological context as well as assessing the likelihood of ambiguous identifications when selecting both the subject of the photograph (e.g., the species or habitat) and the specific photographic representation used in PE.

These methodological considerations are of particular relevance when engaging with FEK of marine habitats. For most of the fishers operating from boats, experiential knowledge of underwater habitats can be limited to what can be seen from the surface (which is influenced by depth, wind and turbidity), experienced through the use of fishing tools, or known through the use of technology (Hall-Arber and Pederson 1999). Investigating knowledge of underwater habitats constitutes therefore a particular case of FEK, because fishers do not have the same sensory experience of underwater habitats compared to other contexts they experience in their everyday life. It might therefore be plausible that photographs of species and habitats might be hard to link with sensory experience of, for example, broad deep-water habitats. Photographs of elements of these habitats caught in gear and brought to the surface may elicit different responses. In this sense, Fisher 4, who also harvested invertebrates by SCUBA diving, offered an interesting case, because he directly observed habitats and species under water, and reported mechanical damage on *P. oceanica* caused by anchoring, storm-driven impacts on benthic habitats, and in situ animal behaviour.

In light of our findings, some key best practices we suggest for conducting PE in the study of FEK are (a) reporting the criteria for choosing the subject (organism or habitat) of the photograph; (b) reporting the general guidelines used when selecting the photographs (e.g., the subject is in the foreground; the subject is depicted alone or with other organisms for scale; if relevant, priority given to photographs of the subject out of water, to reflect how fishers encounter them); (c) reporting the full set of photographs utilised; (d) if appropriate, present multiple photographs of the same subject that vary in scale, level of detail and perspectives to increase the likelihood that the participants recognise the species or habitat depicted.

3.4 | Implications for Conservation

By assessing how PE can be best used to engage with both tacit and discursive dimensions of FEK of coastal habitats, this study generates three main implications for conservation. First, by improving habitat identification, PE addresses a challenge identified in the literature concerning accurate identification of benthic habitat-forming organisms when relying on verbal cues alone (e.g., Bergmann et al. 2004). By helping participants to accurately identify habitats, PE can facilitate discussions of fine-scaled short- and long-term dynamics, including in sensitive deep-water habitats. In turn, this knowledge can help conservation scientists and managers in identifying habitats and communities that may be declining, stable or recovering. By exploring also emotional responses and tacit dimensions of FEK elicited by photographs, PE also showed the potential for revealing spatial and operational avoidance of non-target species who nevertheless impact fisheries (e.g., 'nuisance' pencil sea urchins), and as such influencing fisher–habitat interactions and seascape use that would likely remain undetected using more conventional approaches. For these insights to effectively inform management, however, PE should be implemented with careful attention to selection of photographs, the risk of ambiguous identification and the subjective nature of image interpretation.

Second, the method assessed in the field study may have potential for a broader implementation at larger regional and, under comparable conditions, potentially global scales. The integration of a semi-structured interview protocol with a defined PE component, along with a transparent rationale for the selection of photograph selection with full set of photographs used (Tables A2 and A3, respectively) can facilitate the development of future comparable studies. Similar approaches have been proposed, for example, to reconstruct historical changes in fish species abundances and distribution by Garrabou et al. (2019) on a Mediterranean basin level. With careful selection of comparable habitats and species selected, the method could help reveal general patterns of change in focal habitat types at multiple scales.

Third, by facilitating a deeper engagement with tacit aspects of FEK, this study suggests a possible way to help reduce the gap between marine conservation scientists, practitioners and key stakeholders. Deeper engagement with FEK can contribute to shaping a common understanding of a fishery and the habitats it depends upon, a key step towards a more legitimate and effective governance (Calderwood et al. 2023; Boonstra et al. 2017).

4 | Conclusion

In this article we have, for the first time, collected and compared studies that used photos to study FEK. Our review of this dedicated literature has demonstrated the potential of PE for studies of FEK in terms of accessing tacit dimensions of knowledge and its application in a wide range of geographical and disciplinary contexts. It also highlighted aspects of PE that could receive more attention related to the selection of photographs used and the possibility that photographs are interpreted differently by researchers and respondents. Both aspects were discussed in more depth in relation to a field study that aimed to explore

the possibility and performance of PE in FEK research. The field study included the systematic use of PE during interviews following the application of the SDF framework. This approach contributed to a rich understanding of FEK in Salina and revealed changes in habitat structures, species abundances and habitat use relevant for management. PE appears to support recognition and emotional responses to benthic habitats and associated species, whereas the SDF framework enabled systematic identification of accounts of habitat structure, ecological roles and perceived changes across all habitats discussed, including deep-water habitats. Notably, this structured approach also captured insights into pelagic habitats, which could not be meaningfully represented through photographs. Given the inherent challenges of studying pelagic and deep-water habitats (Paulus 2021; UNEP/MAP 2013) a systematic use of PE together with the SDF framework offers promising potential for advancing scientific studies of FEK. The review and field study thus reinforce the potential of PE as a useful tool for elucidating multiple dimensions of FEK. More research is needed to confirm how this tool can be used as a critical source of insight for marine conservation and strengthen the legitimacy and acceptance of management decisions.

Author Contributions

Chiara D'Agata: conceptualisation (lead), fieldwork (lead), analysis (lead), writing manuscript (lead), writing – editing (equal). **Sieglinde Wallner-Hahn:** conceptualisation (supporting), fieldwork (supporting), analysis (supporting), writing (supporting), writing – editing (equal). **Wiebren Johannes Boonstra:** conceptualisation (supporting), analysis (supporting), writing (supporting), writing – editing (equal).

Acknowledgements

The authors are deeply grateful to the six fishers who took part in the empirical study, sharing their knowledge with us. We extend our gratitude to Santino Taranto for his invaluable help and friendship, Francesca Cantarutti, Dr. Enrico Navarra, Salvo Salamone and Dr. Giulia Bernardi, senior Italy projects manager at Blue Marine Foundation. We also sincerely thank the communities in Malfa, Santa Marina and Rinella for the warm welcome and generosity. Finally, we thank the two anonymous reviewers for their constructive comments.

Funding

The research was funded by Uppsala University (Grant UFV 2019/118).

Ethics Statement

Ethical considerations were guided by the guidelines established by Vetenskapsrådet (2017), in accordance with the requirements of the EU General Data Protection Regulation (GDPR), and in line with the ethical principles expressed in the Carta dei Principi per la Ricerca (Ethical Charter on Social Sciences and Humanities Research) issued by the Italian National Research Council (2017). Prior to participation, all respondents were informed about the purpose of the study. They were also informed about the voluntary nature of their participation and their right to withdraw at any time without consequences. Informed consent was obtained either in written or oral form, as preferred by the participant. To ensure confidentiality, personal data were anonymised.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Due to the risk of participant identification, the full interview data are not publicly available in accordance with ethical considerations. The interviews can, however, be provided on request and prior to redaction of potential identifying parts.

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APPENDIX

Photo Elicitation in Fishers' Ecological Knowledge Research: A Review and Case Study on Coastal Habitats Knowledge From the Central Mediterranean Sea

TABLE A1 | List of the Web of Science Core Collection sub-databases utilised in the systematic literature review and their abbreviation.

Index	Abbreviation
Science Citation Index Expanded	SCIE-Expanded
Social Sciences Citation Index	SSCI
Arts and Humanities Citation Index	AHCI
Emerging Sources Citation Index	ESCI
Conference Proceedings Citation Index-Science	CPCI-S
Conference Proceedings Citation Index-Social Sciences and Humanities	CPCI-SSH
Book Citation Index-Science	BKCI-S
Book Citation Index-Social Sciences and Humanities	BKCI-SSH
Current Chemical Reaction Index Chemicus	CCR-Expanded IC

TABLE A2 | Script (translated from Italian) of the semi-structured interviews.

Section	Question
1. Biography	<ul style="list-style-type: none"> • How did you become a fisher? When did you start? <ul style="list-style-type: none"> • Are other members of your family fishers? <ul style="list-style-type: none"> • How old are you?
2. Fishing practices	<ul style="list-style-type: none"> • Do you have other occupations besides fishing? Which ones? • Do you fish from a boat? Is it yours? What type/length is it? <ul style="list-style-type: none"> • How many people work with you? • How much time do you spend at sea (months/year, weeks/month, days/week, hours/day)? Does this vary seasonally? • Approximate catch last year/per year/on a typical high-season day? • Which species do you catch? Does this change with the season? <ul style="list-style-type: none"> • Which gears do you use for each species? • At what depths do you fish? Does this vary by species/gear? <ul style="list-style-type: none"> • Can you describe a typical day at sea? <ul style="list-style-type: none"> • How do you decide where to fish? <ul style="list-style-type: none"> • For 1–3 key species of choice: <ul style="list-style-type: none"> • What is the seabed like? • (for pelagic fishing) How would you describe the water where you fish? (currents, appearance) • Photo elicitation: show pictures and record observations and reactions • Is anything else present where you fish (e.g., algae, litter)? How do you see these? <ul style="list-style-type: none"> • How do you know which marine environment you are in? • Do you know why these species use the areas where you fish? <ul style="list-style-type: none"> • Do they use other environments? Which ones? How? • What makes a marine environment ‘good’ for you? And for the fish? <ul style="list-style-type: none"> • Are any environments here deteriorating? Or any changes over time? Do you know the causes?
3. Habitats and ecological knowledge (FEK)	
4. Additional thoughts	<ul style="list-style-type: none"> • Would you like to add anything?

TABLE A3 | Rationale for selecting the habitats depicted in photographic material.

Habitat	Photo	Reference
<p><i>Posidonia oceanica</i></p> <p>This seagrass species, endemic to the Mediterranean Sea, is a slow-growing, key habitat-forming species (UNEP/MAP 2021). Although in the study area its presence is restricted due the limited extent of suitable mixed or sandy substrates, several <i>P. oceanica</i> meadows are present around Salina, particularly along the southern coast (Marin-Guirao and Procaccini 2018). Depth distribution ranges from surface to about 40 m depth (UNEP/MAP 2021). <i>P. oceanica</i> is included in the Barcelona Convention Annex II List of endangered or threatened species</p>		Photo credit: Chiara D'Agata
<p><i>Halophila stipulacea</i></p> <p>A seagrass species native to the Red Sea, Arabia Gulf and Indian Ocean, <i>H. stipulacea</i> colonised the Mediterranean Sea following the opening of the Suez Canal in 1869 (Winters et al. 2020). Its occurrence in the study area is recent, with the first report in 1995 off the coast of the island of Vulcano (Acunto et al. 1997)</p>		From https://inpn.mnhn.fr/espece/cd_nom/368620/tab/fiche (accessed May 2024). Photo credit: Philippe Monnier
<p><i>Ericaria brachycarpa</i></p> <p>Coastal habitats in the study area are characterised by high macroalgal biodiversity. Algal forests composed of fucales, including <i>E. brachycarpa</i>, are among the most productive habitats and host high biodiversity (Marletta et al. 2023; Cheminée et al. 2021; Benedetti-Cecchi et al. 2001)</p>		From Marletta et al. (2023)

(Continues)

TABLE A3 | (Continued)

Habitat	Photo	Reference
<p><i>Laminaria rodriguezii</i></p> <p>The endemic Mediterranean deep-water kelp <i>L. rodriguezii</i> is a key habitat-forming species occurring in deeper waters (usually at depths >70 m) (Žuljević et al. 2016). Following its substantial recent decline, <i>L. rodriguezii</i> has been included in the Barcelona Convention Annex II</p>		<p>Verlaque et al. (2019). Photo credit: Marc Verlaque</p>
<p><i>Caulerpa cylindracea</i></p> <p><i>C. cylindracea</i> is a potentially invasive species, with the ability to respond plastically to stressful conditions such as marine heatwaves (Santamaría et al. 2021)</p>		<p>Alvarez et al. (2019), photo credit: OCEANA</p>
<p>Coralligenous</p> <p>It is a biogenic habitat produced by the accumulation of encrusting coralline algae and rich assemblages of sessile invertebrates, including bryozoans, serpulids and sponges. Because of their inherent diversity and complexity, coralligenous outcrops are essentially a combination of different habitats and host high biodiversity (UNEP/MAP 2021). These habitats are usually found at depths >30 m and can be distinguished into algae-dominated and invertebrate-dominated (UNEP/MAP 2021)</p>		<p>https://www.institut-paul-ricard.org/en/list_biotope/coralligenous-habitats/ (accessed May 2024)</p>

(Continues)

TABLE A3 | (Continued)

Habitat	Photo	Reference
<p>Rhodoliths</p> <p>Rhodoliths are free-living calcareous red algae in the Corallinophycidae subclass, which form unattached nodules at depths of about 40–60 m in coastal detrital bottoms (Basso et al. 2015). These habitats are associated with high biodiversity (UNEP/MAP 2021)</p>		<p>Alvarez et al. (2019). Photo credit: OCEANA</p>
<p><i>Pinna nobilis</i></p> <p><i>P. nobilis</i> is a large bivalve often found in association with <i>P. oceanica</i>. Between 2017 and 2018 a wide mass mortality event of <i>P. nobilis</i> was observed in the Western Mediterranean Sea (including a location in north-east Sicily, close to Salina), due to a mycobacterial disease (Carella et al. 2019). <i>P. nobilis</i> is included in the Barcelona Convention Annex II and, following events of mass mortality in 2019, it was also included in the IUCN Red List as a critically endangered species (Kersting et al. 2019)</p>		<p>From Rubino et al. (2024)</p>
<p>Cidaridae</p> <p>In the Mediterranean Sea, there are two morphologically similar species: <i>Stylocidaris affinis</i> and <i>Cidaris cidaris</i>, with partially overlapping depth distribution, and reaching depths of up to 2000 m (Terribile and Schembri 2013). Other than being found characteristically within key habitat types such as coastal detrital bottoms (Astruch et al. 2023), these vagile organisms are also habitats in themselves, hosting epibionts such as cirripeds and serpulids on their shell and spines (Basho 2021)</p>		<p>https://marinespecies.org/photogallery.php?album=694&pic=144451. Photo credit: Heinke Schultz, from Schultz (2006)</p>

TABLE A4 | List of marine species named during the interviews, including their Italian, local and scientific names.

Group	Italian name	Local names	English name	Latin name
Annelida	Vermocane		Bearded fireworm	<i>Hermodice carunculata</i>
Cetacea	Capodoglio		Sperm whale	<i>Physeter macrocephalus</i>
Cnidaria	Anemone	Fragole di mare	Anemone	(Likely) <i>Calliactis parasitica</i>
Crustacea	Aragosta		Spiny lobster	<i>Palinurus elephas</i>
Crustacea	Gamberetto		Shrimp	Penaeidae and Aristeidae families
Crustacea	Gamberetto (di nassa)		Shrimp	<i>Plesionika</i> spp.
Crustacea	Granchio eremita		Hermit crab	(likely) <i>Pagurus/Dardanus</i>
Crustacea	Cicala	Magnosa	Mediterranean slipper lobster	<i>Scyllarides latus</i>
Echinodermata	Riccio matita	Spina rizza Spina riccia Pungiere	Pencil urchin	Cidaridae
Echinodermata	Riccio di mare	Rizzu fimmina	Purple/stoney sea urchin	<i>Paracentrotus lividus</i>
Fish	Scorfano		Scorpionfish	<i>Scorpaena</i> spp.
Fish	Pezzagna	Mupa Occhiata	Blackspot seabream	<i>Pagellus bogaraveo</i>
Fish	Pesce spada		Swordfish	<i>Xiphias gladius</i>
Fish	Boga	Opa	Bogue	<i>Boops boops</i>
Fish	Occhiata		Saddled bream	<i>Oblada melanurus</i>
Fish	Ricciola		Greater amberjack	<i>Seriola dumerili</i>
Fish	Ombrina		Shi drum	<i>Umbrina cirrosa</i>
Fish	Sarago		Seabream/porgies	<i>Diplodus</i> spp.
Fish	Barracuda	Aluzzo	Barracuda	<i>Sphyræna sphyræna</i>
Fish	Cernia		Grouper	Epinephelidae
Fish	Alalunga		Albacore	<i>Thunnus alalunga</i>
Fish	San pietro		John dory	<i>Zeus faber</i>
Fish	Sugarello	Sauro	Atlantic horse mackerel	<i>Trachurus trachurus</i>
Fish	Sciarrano/perchia	Buddaci Precchia	Comber	<i>Serranus</i> spp.
Fish	Cefalo		Flathead grey mullet	<i>Mugil cephalus</i>
Fish	Salpa		Salema porgy	<i>Sarpa salpa</i>
Fish	Torpedine		Torpedo	<i>Torpedo torpedo</i>
Fish	Razza		Ray	Rajiformes
Fish	Pesce lucertola		Atlantic lizardfish	<i>Synodus saurus</i>
Fish	Murena		Mediterranean moray	<i>Muraena helena</i>
Fish	Mennola	Minnula (female) Cavallone (intermediate) Ciaula (male)	Blotched picarel	<i>Spicara maena</i>
Fish	Mustina	Mustella	Fork beard	<i>Phycis phycis</i>
Fish	Pesce sciabola	Spatola	Silver scabbardfish	<i>Lepidopus caudatus</i>

(Continues)

TABLE A4 | (Continued)

Group	Italian name	Local names	English name	Latin name
Fish	Pesce pappagallo		Mediterranean parrotfish	<i>Sparisoma cretense</i>
Fish	Pesce prete		Atlantic stargazer	<i>Uranoscopus scaber</i>
Fish	Tracina		Weever	<i>Trachinus</i> spp.
Fish	Grongo	Rungu Gronchio	European conger	<i>Conger conger</i>
Fish	Orata		Gilthead sea bream	<i>Sparus aurata</i>
Fish	Triglia di scoglio	Sparaganaci	Striped red mullet	<i>Mullus surmuletus</i>
Fish	Triglia di fango	Trigghia i fangu Saponara	Red mullet	<i>Mullus barbatus</i>
Mollusca	Totano		European flying squid	<i>Todarodes sagittatus</i>
Mollusca	Seppie		Cuttlefish	Sepiidae
Mollusca	Calamaro		Common squid	<i>Loligo</i>
Mollusca	Polpo		Octopus	<i>Octopus</i> spp.
Mollusca	Patella		Sea limpet	<i>Patella</i> spp.
Mollusca	Ostrica		Oyster	Ostreidae
Mollusca	Tritone	Rogna	Pink lady	<i>Charonia</i> spp.
Mollusca	Trottola rugosa	Occhio di Santa Lucia	Spiny top shell	<i>Bolma rugosa</i>
Nematoda	Anisakis		Anisakis	<i>Anisakis</i>

TABLE A5 | Clustering of codes into themes for the *dynamics* and *function* components of the structure–dynamics–functions framework.

Framework category	Theme	Code
Structure	—	—
Dynamics	Shifts in species distribution and abundance	Fish/invertebrates used to be more abundant Vegetation used to be more abundant New fish/invertebrate/vegetation species are present New fish/invertebrate/vegetation species are getting more abundant
Function	Habitats supporting species reproduction and recruitment	Fish/invertebrate/vegetation species distribution is changing in space Where fish/invertebrates spawn or lay eggs Where fish/invertebrates live in early life stages Where fish/invertebrates need to travel to reproduce
	Habitats supporting food provision	Where fish/invertebrates feed What fish/invertebrates feed on
	Habitats providing shelter	Where fish/invertebrates find cover