

Citizen science data elucidates prevalence of skin pigmentation abnormalities in congeneric mesopredator sharks in the UK

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Abstract

Sharks are globally threatened and continued depletion risks undermining marine ecosystem function. Environmental pressures such as habitat loss, climate change, and pollution have been linked to physiological changes in marine species, including skin colour aberrations characterised by lack of (hypomelanosis) or excessive (hypermelanosis) pigmentation. Yet relatively little is known about this phenomenon in sharks, nor its implications for ecological fitness. Here we approach this data paucity through interrogation of citizen science data available through the open access image sharing platform iNaturalist. Given widespread nearshore distribution and importance in structuring regional marine communities, we use smallspotted catsharks *Scyliorhinus canicula* and nursehounds *Scyliorhinus stellaris* in the UK as model species to elucidate prevalence, and spatial and temporal distribution of this phenomenon. Assessing a total of 691 selected images screened from an original dataset of 2,608 observations uploaded between 2008 and 2025, we uncover new records of both hypomelanosis and hypermelanosis and, to our knowledge, the first of a completely dark phenotype in *S. stellaris*. While our findings suggest that skin colour aberration prevalence may be higher than currently estimated, at least in these species, tentative conclusions regarding spatial and temporal trends are subject to inherent bias in *ad hoc* rather than structured citizen science. We nevertheless demonstrate applicability and make recommendations for how to strengthen this approach to address a key knowledge gap in this important predatory guild.

Introduction

Overexploitation has globally depleted chondrichthyans [sharks, rays, and chimeras, hereafter “sharks”; 1–3], compounded by habitat loss, climate change, and pollution [1]. Environmental pressures including diet [4], disease [5], pollutant exposure [6], and water temperature [7] can cause physiological changes in marine wildlife, such as skin colour aberrations [8]. Colouration can influence organismal environmental interactions [9, 10]. Abnormal pigmentation may therefore have fitness implications including inhibited predator avoidance, impaired predation, or reduced UV protection [8, 10, 11]. Skin colour aberrations in sharks, however, are a relative knowledge gap, seldom documented, and therefore presumed rare [8, 12–16]. Given important ecological roles, ongoing shark depletion threatens ecosystem function [17, 18]. Investigating the prevalence and potential fitness implications of this phenomenon in sharks is therefore warranted.

Skin colour aberrations include both excessive (melanosis or hypermelanosis) and reduced pigmentation (hypomelanosis) [8, 14]. Melanosis presents as a partially or completely dark phenotype [13, 19], and can arise from melanocortin system disruption [20]. Hypomelanistic pigmentation deficiencies include albinism and leucism. While both are genetically inherited [21, 22], albinism describes non-functional or absent melanin from the iris and skin [23], whereas leucism is partial or complete pigment loss but normal retinal pigmentation caused by a recessive allele [8, 14, 15, 22]. Piebaldism is a subcategory of leucism with light patches amongst normal pigmentation [16, 24]. Leveraging citizen science data could address spatial and temporal observation gaps for rare

phenotypes [16, 25, 26]. As of the end of 2025, the open access platform iNaturalist had over 5 million users and 286 million observations uploaded [27]. Databases of high quality observations are obtainable given a user consensus system that yields “Research Grade” images [28], supported by further verification by experienced identifiers [29].

Here we use iNaturalist records to investigate UK prevalence of colour aberrations in two congeneric mesopredators, the smallspotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris* [trophic levels 3.8 ± 0.3 and 4.0 ± 0.3 , respectively; 30]. *Scyliorhinus canicula* is widely distributed and abundant throughout the Northeast Atlantic, listed as Least Concern by the International Union for Conservation of Nature [IUCN; 31], and therefore a suitable model for prevalence of this phenomenon. In contrast, *S. stellaris* is listed Vulnerable by the IUCN [32], and relatively understudied. Mesopredator release projections and elevated relative trophic level [17] could increase the importance of these sympatric species in structuring regional marine communities. To investigate spatiotemporal patterns in citizen science observations of skin colour aberrations in sharks in the UK, we interrogated the iNaturalist database with the following research questions as related to *S. canicula* and *S. stellaris*: (i) How prevalent is the phenomenon? (ii) What temporal patterns are identifiable? (iii) What spatial patterns are identifiable?

Methods

Data collection

We used the search box and the scientific name for each species to first obtain all observations submitted to iNaturalist for both *S. canicula* and *S. stellaris*, with dates set from 1st January 2008 to 31st October 2025. We excluded observations from before 2008 to capture the first full year of observations post-platform launch (2007). We then filtered location to the UK and used the “Export data” function to yield a target dataset. We included observations of “Needs ID” in the initial download as these are not necessarily taxonomically inaccurate [28] and can reach “Research Grade” with additional verifications.

Data screening

We removed images prohibitive to assessing skin colour aberrations as follows: first, all egg case images were excluded (both *S. canicula* and *S. stellaris* are oviparous), followed by ventral view images; head-on images were then excluded given insufficient body coverage to assess skin colour abnormalities, as were images with less than 50% of a specimen visible. Since it is impossible to assess pigmentation in highly degraded specimens, we developed a qualitative scale with consensus between at least two researchers (Supplementary Figure 1). Observations were scored as low, moderate, high, or extreme degradation, with the latter two removed to yield a dataset of images for quality assessment. Finally, observations with poor image quality were removed. For example, if a specimen was covered in sand or the image was blurred or dark, or if an observation could not reach “Research Grade”, it was excluded. Data screening yielded 691 usable images (Figure 1).

Data annotation

Here we identified hypomelanosis as lighter pigmentation, pale appearance, irregular or unusual spot patterns, or absence of spots on fins, and hypermelanosis as dark pigmentation or totally dark specimens. Specimens potentially displaying these features were first identified by one researcher (FB), then evaluated by two other researchers (SP, NC) for consensus. A star rating system was developed to report confidence based on specimen deterioration and image quality, from 1 (low) to 3 (high). See Supplementary Figure 2 for the final list of observations and categories.

Results

Screening of a preliminary dataset (*S. canicula* n = 2128; *S. stellaris* n = 480) yielded a final dataset of 691 observations (*S. canicula* n = 626; *S. stellaris* n = 65). Screened observations were divided between Marine Plan Areas in England, Wales and Northern Ireland and Scottish Marine Regions to address heterogeneous spatial distribution.

Skin colour aberration types and prevalence

Leucism

Reduced pigmentation was identified in 26 of 626 (4.15%) and 5 of 65 (7.69%) *S. canicula* and *S. stellaris* observations, respectively, with three broad patterns evident: sides of the head, flank and caudal fin (Figure 2 a, b and c), across the dorsal area (Figure 2 , d and e), and on the dorsal fins (Figure 2 f). Only one *S. stellaris* was assigned a 3-star rating, with reduced pigmentation across the back, the top of the caudal fin and on the dorsal fins (Figure 2 g).

Melanism

Excess pigmentation was identified in 33 of 626 (5.27%) and 2 of 65 (3.08%) *S. canicula* and *S. stellaris* observations, respectively. This presented as dark patches (Figure 2 h) or larger black spots (Figure 2 i). One *S. stellaris* was completely melanistic (Figure 2 j).

Temporal distribution

Despite the number of *S. canicula* and *S. stellaris* observations uploaded to iNaturalist increasing from 2008 to 2025, the proportion with skin colour aberrations remained low. Regarding *S. canicula*, a total of 7 observations were recorded between 2008 and 2016 (none with abnormal colouration), increasing to 626 observations by 2025. In years when reduced pigmentation was identified, the proportion of observations ranged from 2.4% in 2024-25 to 7.9% in 2020-21. Similarly, the proportion of observations showing melanism ranged from 2.6% in 2020-21 to 7.1% in 2016-17 (Figure 3). Only six *S. stellaris* observations were screened before 2020, with no instances of reduced pigmentation prior to 2020-2021. Where reduced pigmentation was identified, the proportion of observations ranged from 5.3% in 2022-2023 to 13.3% in 2024-2025. The proportion showing melanism ranged from 33.3% in 2016-2017 to 5.3%

in 2022-2023. One completely melanistic *S. stellaris* was recorded in 2016. The only other period with instances of melanism was 2022-2023 (5.3%; Figure 4).

Spatial Distribution

The majority of specimens included in the analysis were found on the west coast of Wales and on the south and northwest coast of England, with fewer observations recorded in Scotland and the northeast of England (Figure 5).

Scyliorhinus canicula observations were recorded in 15 of 19 regions around the UK (Figure 6). There was, however, considerable variation in sample size between areas. For example, there were 224 observations in the Welsh Inshore region, compared to just one in the North Coast region in the north of Scotland and none in four of the Scotland regions. No specimens were identified as having reduced pigmentation in Scotland. The South West Inshore region showed the highest proportion of observations with reduced pigmentation (10.8%). The Northern Ireland Inshore region also had a larger proportion (10%) compared to other areas. 2.7% of observations displayed reduced pigmentation in the Welsh Inshore region. This is the lowest proportion of areas showing specimens with hypomelanosis, but it is also the region with the highest number of observations. The single observation from the North Coast region in Scotland showed partial melanism and therefore yielded the highest proportion of 100% of observations. Elsewhere, however, where sample sizes were larger, proportions ranged from 4.4% of observations in the South East Inshore region to 7.7% in the South West and North West Inshore region of England.

Scyliorhinus stellaris observations were not as dispersed as *S. canicula* (Figure 7); the majority were found within the South Inshore, South West Inshore and Welsh Inshore regions, with no observations in either Northern Ireland or Scotland. The South Inshore region had the greatest proportion showing hypomelanosis (20%), although sample size was only five. Distribution of specimens with reduced pigmentation shows some clustering in the south and southwest of the UK, however this also corresponds to the areas with the highest number of *S. stellaris* observations included in the analysis. Specimens with melanism were only observed in the South West Inshore region (8% of observations in this area).

Discussion

Skin colour aberrations have seldom been documented for sharks [8, 14]. Yet here we report abnormal colouration in 59 *S. canicula* (26 hypomelanistic, 33 hypermelanistic) and seven *S. stellaris* (5 hypomelanistic, 2 hypermelanistic) iNaturalist observations from the UK, with potential clustering on the south and west coasts. Not only does this suggest that skin colour aberrations are more common amongst Scyliorhinidae than previously estimated but also demonstrates applicability of open access databases to address key ecological knowledge gaps.

Reduced pigmentation has only been documented for *S. canicula* in the Irish Sea [33–35], the Central Mediterranean Sea [12], and in Welsh waters [36]. The morphological patterns of pigment loss presented here broadly align with prior observations (see Supplementary Fig. 3). Further work is needed to determine whether these patterns are a common and consistent manifestation of hypomelanosis. We also report here, to the best of our knowledge, the only documentation of total melanism in *S. stellaris*, with the limited similar observations in other elasmobranchs most notably in manta rays *Mobula birostris* and *M. alfredi* [13, 15, 37].

Abnormal colouration in fish has been linked to pollutant exposure [5, 6]. The mechanisms and relative importance of potential factors driving colour aberrations in sharks remain, however, unclear, as do the ecological implications. More generally, the link between sub-lethal environmental stressors and extinction risk in sharks is an important knowledge gap [38]. Addressing this likely depends in part on identifying where phenomena are commonly observed. Here we obtained few observations from either Scotland or the east and northeast of England. This likely reflects lower population density than elsewhere in the UK, since citizen science data are generally disproportionately abundant in highly populated and easily accessible areas [39]. As such, despite the potential for novel insights, iNaturalist data are subject to inherent spatial bias. Additional factors including target species abundance, visibility, and public engagement can further confound true ecological and citizen science trends [40]. Broad conclusions regarding UK-wide spatial distribution of skin colour aberrations should therefore be treated with caution, as demonstrated by the solitary observation of *S. canicula* from the North Coast region in Scotland that showed partial melanism. Similarly, temporal bias arising from data paucity prior to 2017 likely obfuscates, to some extent at least, accurate insights into skin colour aberrations during these early years. As a result, it cannot be definitively concluded that the proportion of Scyliorhinidae with reduced pigmentation has decreased since 2020, since the increased sample size may lead to more accurate insights rather than reflect any real ecological patterns. Nearly 25% of the screened images included in our analysis also showed some physical deterioration; whilst some showed areas clearly lacking pigmentation, it was unclear whether this constituted hypomelanosis or resulted from deterioration or scavenger damage. Additionally, since most observations were of dead specimens (80.3% of observations with skin colour aberrations), behavioural insights were impossible. *In situ* observations of leucistic sharks have, however, been obtained using baited remote underwater video stations [41], including for *S. canicula* [36]. Whilst beyond the scope of this study, future research could use this approach to investigate behaviour in areas identified as hotspots for skin colour aberrations.

Despite inherent limitations, a citizen science approach may be the most feasible means of elucidating at scale the prevalence of skin colour aberrations in sharks, particularly if spatial and temporal bias can be resolved through targeted citizen scientist recruitment in underrepresented areas. Recreational angler catch data can elucidate commercially and recreationally important species abundance [42], and both *S. canicula* and *S. stellaris* are common recreational angling species in the UK [43]. Leveraging angling community knowledge could therefore yield a significant database of high-quality observations and enrich ecological insights. One experienced angler and iNaturalist user, for example, explained (personal comms., J. Pickett):

I added it to iNat myself as it didn't look typical to the usual *S. canicula* I've caught. Interestingly, it felt much smoother than others in comparison [...]. Whether this was from a thicker mucus layer, or shallower denticles, I have no clue.

Our study also demonstrates that citizen science can yield insights into less frequently observed species (here, *S. stellaris*). This supports extending target species to include critically endangered shark species such as tope *Galeorhinus galeus* and angelshark *Squatina squatina*, for which there is minimal such data [see 8, 16]. Targeted recruitment strategies [44], such as using social media and engagement with marine conservation organisations, recreational fishers, and angling groups could encourage new and current iNaturalist user engagement. Development of an iNaturalist project page, including guidelines for photo requirements such as dorsal or lateral perspectives, clear view of second dorsal fin origin and anal fin insertion to aid species differentiation, and ensuring over 50% of a specimen is visible, would standardise datasets and increase robustness of interpretations.

Although further work is needed to address iNaturalist spatial gaps in the context of skin colour aberrations in sharks, our study nevertheless leverages a large citizen science database to add to limited existing records and overcome resource challenges associated with extensive marine surveying [15]. We demonstrate that broad spatiotemporal aspects of such datasets can advance knowledge obtained through more traditional methods [26, 44] and are a promising pathway towards elucidating the prevalence of this phenomenon and the potential ecological implications, both for sharks and marine ecosystems more generally.

Declarations

Data availability

The data used in this study are available Open Access at: <https://doi.org/10.5281/zenodo.19222058>

Ethics, Consent to Participate, and Consent to Publish declarations

Not applicable

Clinical trial number

Not applicable

Author contributions

FB: Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Visualisation.
NDC: Conceptualisation, Methodology, Validation, Writing - review & editing, Visualisation, Supervision.
SLP: Conceptualisation, Methodology, Validation, Resources, Writing - review & editing, Visualisation, Supervision.

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Figures

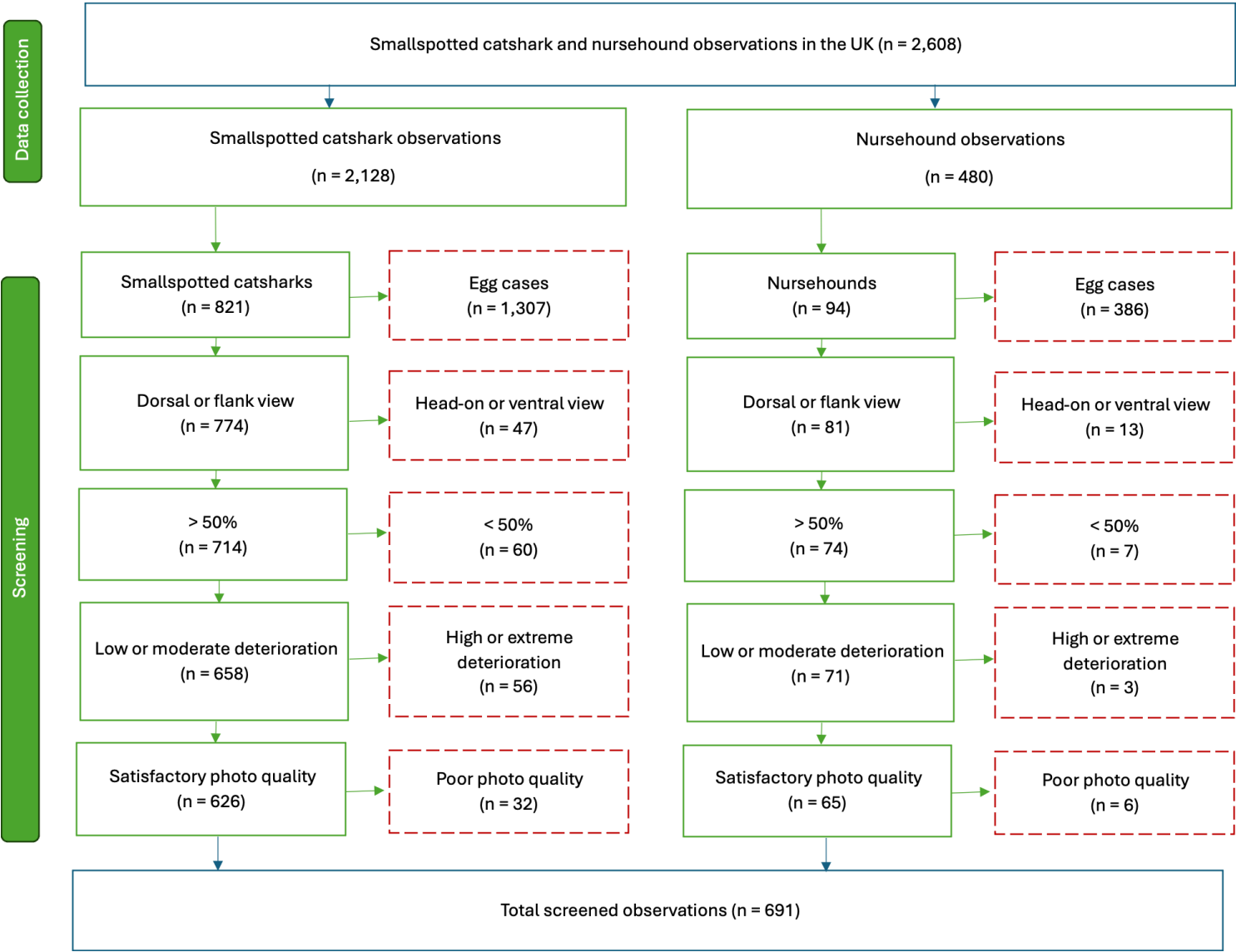


Figure 1

Regional UK iNaturalist records of smallspotted catsharks *Scyliorhinus canicula* and nursehounds *S. stellaris*; image screening process to investigate spatial and temporal incidence of skin colour aberrations; green (solid) lines indicate observations included in the next stage, red (dashed) lines indicate excluded observations



Figure 2

Smallspotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris* identified with abnormal pigmentation from UK iNaturalist records. a – c: reduced pigmentation on head, flank and caudal fin (*S. canicula*); d – e: reduced dorsal pigmentation (*S. canicula*); f: light patches on dorsal fins (*S. canicula*); g: reduced pigmentation across the dorsal area, caudal and dorsal fins (*S. stellaris*); h-i: partial melanism (*S. canicula*); j: complete melanism (*S. stellaris*)

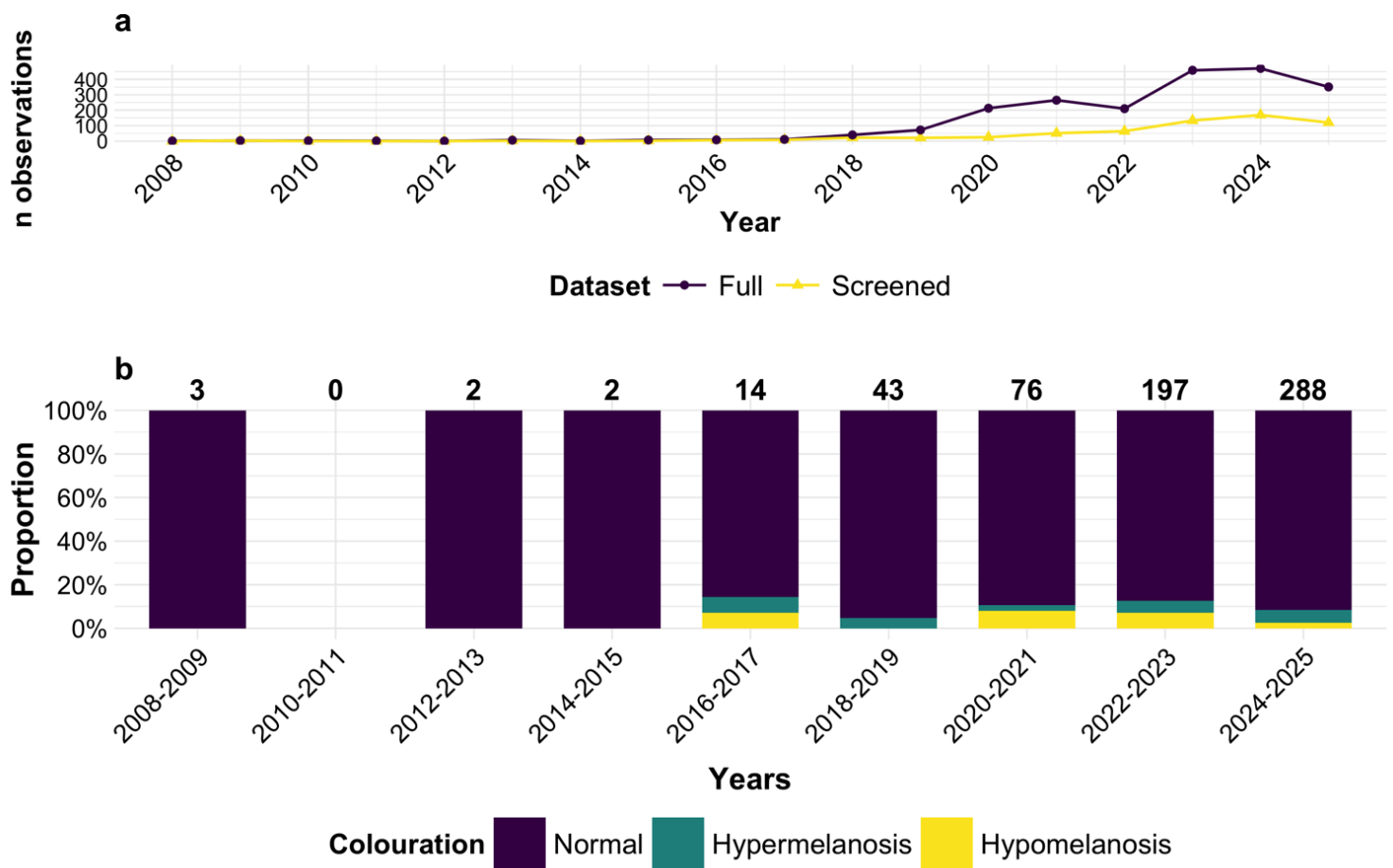


Figure 3

Temporal distribution of UK smallspotted catshark *Scyliorhinus canicula* observations uploaded to iNaturalist between 01/01/2008 and 31/10/2025. Panel a: Time series displaying total number uploaded per year, and the number of screened observations included in the analysis. Panel b: Stacked bar plot showing proportion of observations with potential hypermelanosis (blue), hypomelanosis (yellow), and normal colouration (purple) in 2-year blocks, with the number of screened observations above each bar

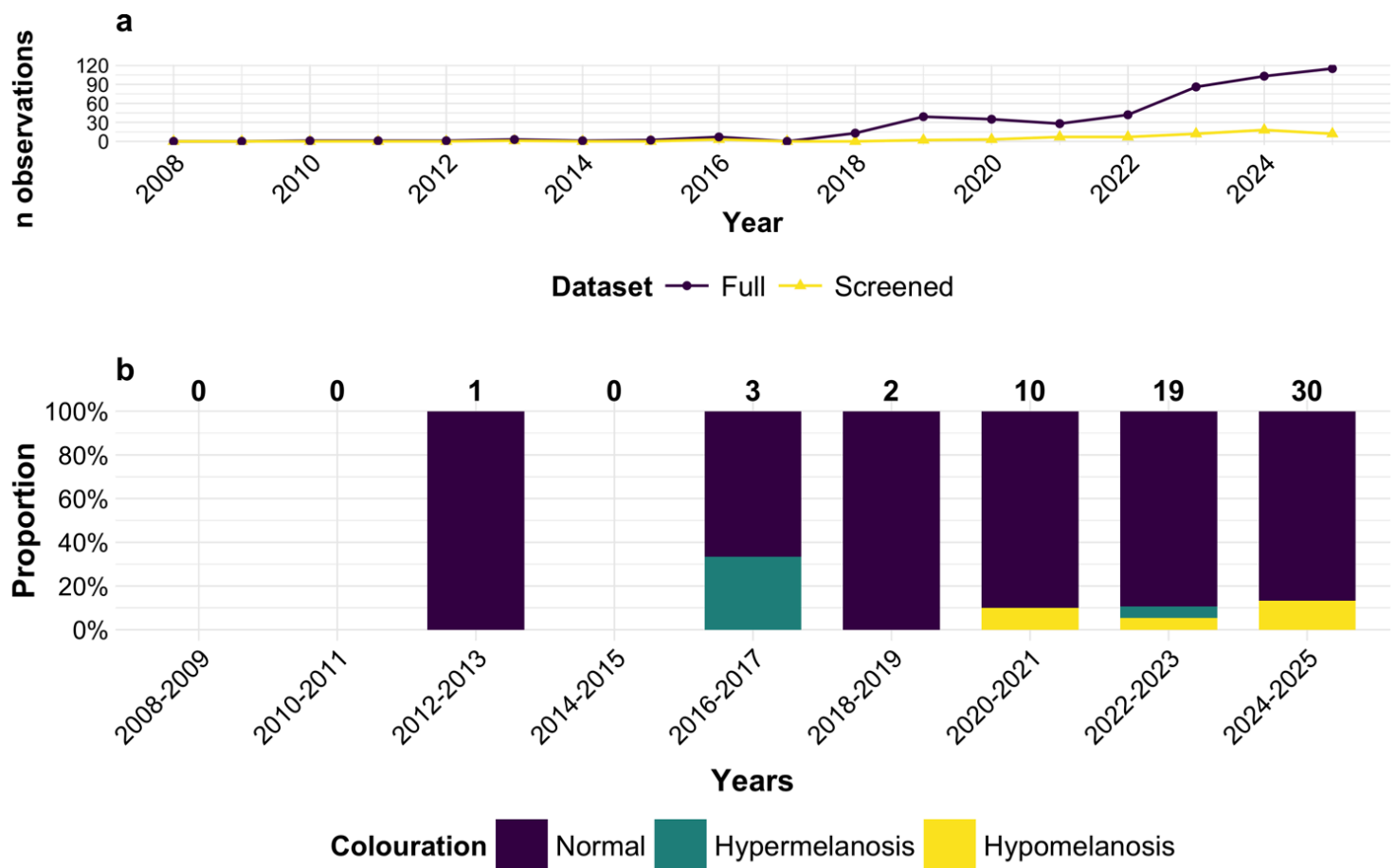


Figure 4

Temporal distribution of UK nursehound *Scyliorhinus stellaris* observations uploaded to iNaturalist between 01/01/2008 and 31/10/2025. Panel a: Time series showing total number uploaded per year, and the number of screened observations included in the analysis. Panel b: Stacked bar plot showing proportion of observations with potential hypermelanosis (blue), hypomelanosis (yellow), and normal colouration (purple) in 2-year blocks, with the number of screened observations above each bar

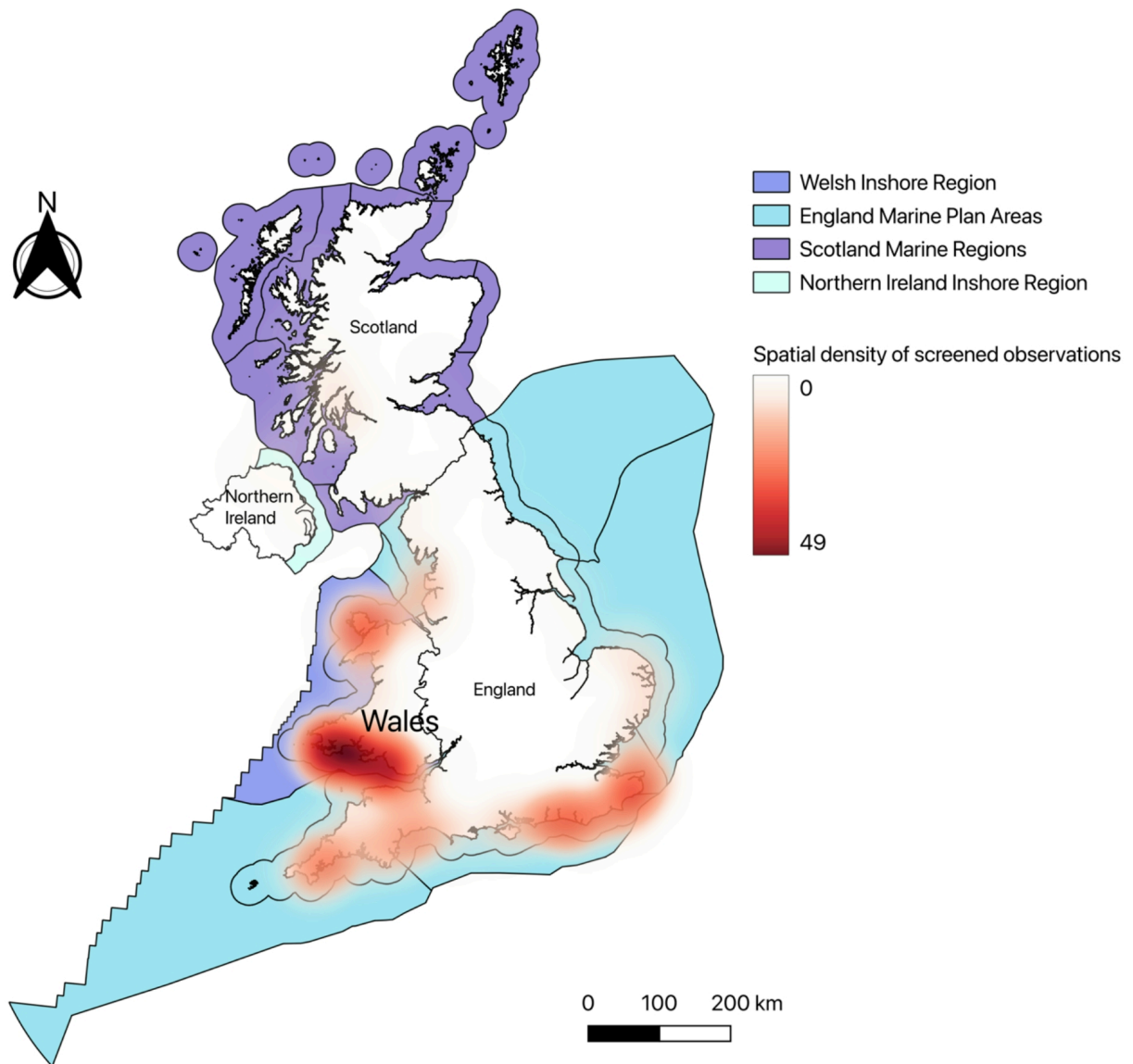


Figure 5

Spatial distribution of screened UK iNaturalist observations of smallspotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris* alongside regional divisions of the study area represented by coloured polygons. Lighter red areas reflect lower density of observations with darker red areas representing higher density of observations

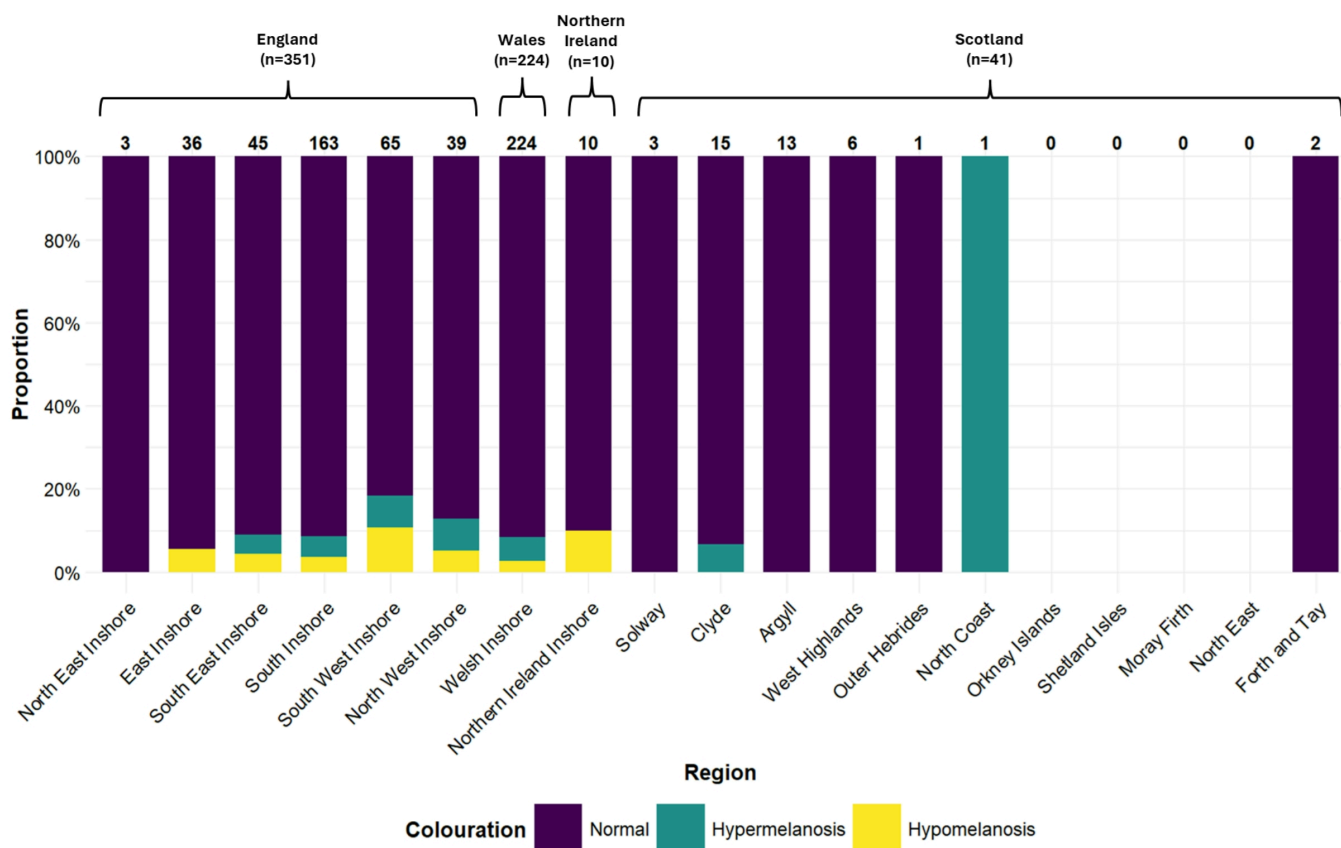


Figure 6

Spatial distribution of UK smallspotted catshark *Scyliorhinus canicula* observations uploaded to iNaturalist between 01/01/2008 and 31/10/2025. Stacked bar plot showing the proportion of screened UK observations with normal colouration (purple), hypermelanosis (blue) and hypomelanosis (yellow) are shown. Total number of included observations for each region is shown above bars

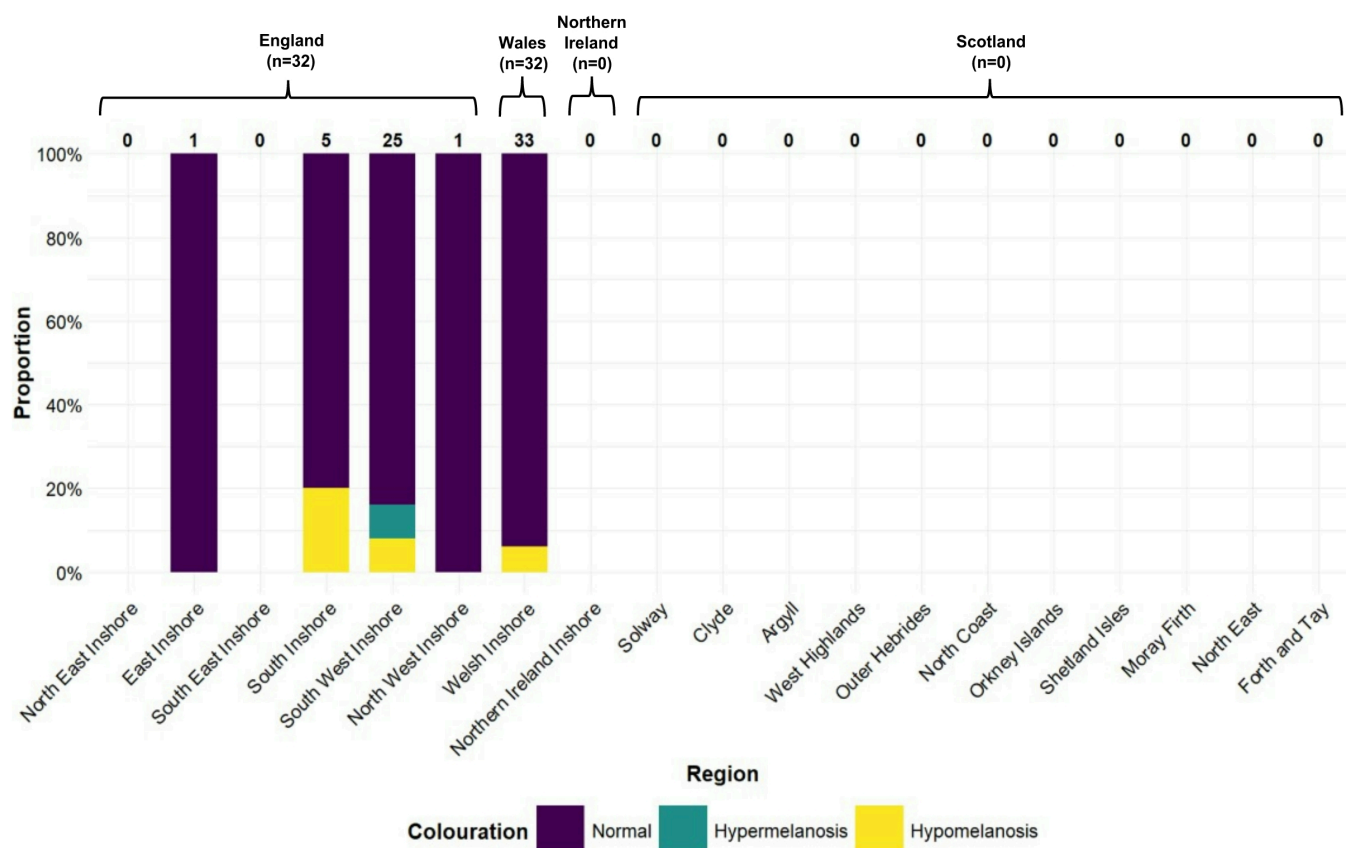


Figure 7

Spatial distribution of UK nursehound *Scyliorhinus stellaris* observations uploaded to iNaturalist between 01/01/2008 and 31/10/2025. Stacked bar plot showing the proportion of screened UK observations with normal colouration (purple), hypermelanosis (blue) and hypomelanosis (yellow) are shown. Total number of included observations for each region is shown above bars

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [BrosnahanetalNatScyliorhinussupplementary.docx](#)