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Conservation In Practice

Map the Giants: a new citizen-science portal to map, study and protect the largest coral colonies

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Abstract

Coral reefs are rapidly degrading under escalating local and global pressures and some centennial coral colonies may disappear before they are even documented. These giant colonies embody resistance and resilience in a changing ocean, can archive long-term environmental histories and may hold valuable clues to the traits that have enabled their survival. Yet, coordinated, large-scale information on their distribution, condition and ecology is still lacking.

Map the Giants is a global citizen-science initiative launched in 2024 to locate, document and help protect giant coral colonies. This paper has two main aims: first, to synthesise the scientific and practical motivations for focusing on giant corals as both research targets and conservation symbols; and second, to present the design, protocol and operational workflow of Map the Giants. We describe how the project integrates citizen-science principles, user-centred website design, standardised reporting methods and multi-expert validation into a coherent framework, with a public, interactive map and dedicated learning materials to support ocean literacy.

Preliminary outcomes from the first 18 months: 195 submissions from 22 countries, of which 133 entries have been validated and added to the public database, demonstrate the feasibility and scientific value of this approach. Contributors routinely exceeded minimum data requirements and high validation rates indicate strong data quality despite heterogeneous participant backgrounds. Together, these elements show that Map the Giants can generate robust, scalable data on giant coral colonies while simultaneously engaging the public, providing a methodological reference for future studies and similar large-scale monitoring initiatives.

Key words: Climate change, coral reef monitoring, giant coral colonies, marine conservation, ocean

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Marine citizen science, ocean literacy and the need for large-scale data

Citizen science has been described as a research methodology in which large numbers of individuals, including non-scientists, collect, categorise, transcribe and even analyse scientific data (Bonney et al. 2014). In recent years, this approach has proved instrumental in overcoming key research constraints by mobilising non-trained people willing to contribute to conservation efforts (Theobald et al. 2015). This approach enables the collection of data that researchers alone would not be able to gather because of large spatial or temporal scales and financial limitations (Edgar and Stuart-Smith 2014; Garcia-Soto et al. 2017) and offers opportunities for responsiveness (Mayfield 2025). Citizen science represents not only a resource for data collection, but also a tool to bridge the gap between science, society and conservation (Dickinson et al. 2012). Active participation can spark pro-environmental behaviour by increasing public awareness (Haywood et al. 2016; Wyles and Ghilardi-Lopes 2023) and may even mitigate some of the negative effects of growing tourism pressure on marine environments (Branchini et al. 2015; Skarakis et al. 2023).

Despite this considerable potential, the engagement of non-professionals in marine initiatives remains largely underutilised (Butler et al. 2023). In ocean research, scuba divers tend to be positively disposed towards participatory projects (Lucrezi et al. 2018), yet recruiting and retaining volunteers, especially over the long term and across large spatial scales, remains challenging (Pecl et al. 2019).

Nevertheless, population studies of specific marine organisms are often carried out with the support of volunteer observers, covering areas that would otherwise be impossible to monitor (e.g. Beeden et al. (2014); Edgar and Stuart-Smith (2014)). Frequently targeted organisms include charismatic species that are attractive to tourists and easy to identify, such as whale sharks (e.g. Araujo et al. (2017); Norman et al. (2017)), manta rays (e.g. Ehemann et al. (2022)) and sea turtles (e.g. Dunbar et al. (2021)). Although species identification was once considered a potential obstacle in marine citizen-science projects (Martin et al. 2016), recent tools, such as *iNaturalist*, have demonstrated that quality-checked data can also support more complex studies (DiBattista et al. 2021; Di Cecco et al. 2021). In recent years, the integration of citizen science with Artificial Intelligence (AI) offers a promising avenue for expediting data collection and analysis (Chen et al. 2024), overcoming traditional limitations on data accuracy and cost efficiency (McClure et al. 2020; Fortson et al. 2024). Projects such as the Great Reef Census, which have successfully combined citizen science with deep-learning, have already demonstrated that they can produce accurate results (Lawson et al. 2025).

The recent widespread availability of relatively inexpensive yet high-quality photo and video equipment has created further opportunities for both active (Azzurro et al. 2013; Raoult et al. 2016; Andrachuk et al. 2019) and passive citizen science (Edwards et al. 2021; Nascimento et al. 2024). While social media mining entails limitations related to data reliability (Daume 2016), the growing number of wildlife encounter reports represents a valuable source of information, especially when entries are verified individually. In parallel, the increasing use of drones has expanded the scope of citizen-science projects. Despite constraints, such as limited battery life and restricted survey areas (Tmušić et al. 2020), consumer-grade drones have been effectively deployed in citizen-science research (Papakonstantinou et al. 2021; Pucino et al. 2021), enabling various marine surveys through high-resolution imagery and geospatial data.

Several long-running programmes illustrate how marine citizen science can generate robust data while being engaging for contributors. Redmap Australia (https://www.redmap.org.au/), which collects opportunistic data on the occurrence of unusual species, relies on expert validation of entries and provides contributors with an immediate automatic response, a subsequent follow-up after verification and a final publication on the project website. This process simultaneously addresses the need for data robustness and offers formal recognition to participants, both key elements of successful citizen science (Rotman et al. 2012; Hunter and Hsu 2015; Aceves-Bueno et al. 2017; Robinson et al. 2018). Reef Check is a long-standing citizen-science project (Hodgson 1998) that adopts a standardised monitoring protocol, based on easy-to-identify, high-value indicator organisms to survey coral reefs worldwide. The protocol has been adapted to reflect regional features (Hodgson et al. 1998; Done et al. 2017; Turicchia et al. 2021) and relies on the training of citizen scientists in data collection. Despite the time investment required for training, this initiative has a strong record of engagement and scientific publications (e.g. Done et al. (2017); Isdianto et al. (2025); Pancrazi et al. (2026)). Similarly, Reef Life Survey, monitoring shallow rocky areas and coral reefs, requires intensive training and commitment and has produced valuable data over time (Edgar and Stuart-Smith 2014).

Beyond their research value, citizen-science projects play an increasingly recognised role in fostering ocean literacy and in leading to increased awareness and knowledge amongst participants (Bonney et al. 2016). Citizen science is now viewed as a key tool for bridging the gap between society and the ocean (Parkinson et al. 2025). The growing importance of ocean literacy was highlighted by the United Nations' "Ocean Literacy for All Toolkit" (Santoro et al. 2017), which seeks to help diverse audiences navigate ocean-related issues and build knowledge about the marine environment. Within this framework, project websites and social media channels have become central interfaces where science and the public converge, serving as both communication hubs, outreach and ocean literacy tools. Environmental organisations and research institutions increasingly rely on digital platforms to disseminate their work, with science communication and citizen science emerging as key strategies for connecting research and society, including in coral reef research (Roche et al. 2023).

Despite the recognition of the role of citizen-science projects in generating knowledge (Bonney et al. 2016), influencing attitudes and behaviour (Toomey and Domroese 2013), there is a growing need to investigate the breadth of these impacts (Pateman and West 2023; Baechler et al. 2024; Wehn et al. 2025).

Coral reefs, knowledge gaps and giant colonies as overlooked assets

Coral reefs are globally threatened by both natural and anthropogenic drivers (Hughes et al. 2017a, 2017b). Their degradation poses risks to millions of people who depend on them (Woodhead et al. 2019; Morrison et al. 2020) and raises serious concerns regarding biodiversity loss (Cardinale et al. 2012). Although reef ecosystems are amongst the most biodiverse on Earth (Fisher et al. 2015; Hoeksema 2017), they occupy less than 0.1% of the ocean surface (Spalding and

Grenfell 1997; Spalding et al. 2001). Scleractinian corals, the framework-building organisms of coral reefs, are particularly threatened: over 44% of warm-water coral species are currently considered at risk (IUCN 2025). Climate change, pollution, disease outbreaks, destructive fishing practices and coastal and marine development all exert major pressures on reefs. These impacts can affect virtually every coral colony and its associated fauna worldwide (Hoegh-Guldberg et al. 2007; Riegl et al. 2009), including both fast- and slow-growing species.

Globally, more than 800 species of tropical, shallow-water scleractinian corals (Dietzel et al. 2021) exhibit diverse morphologies and growth rates, shaped by species-specific traits and environmental conditions (Veron 2000; Darling 2012). Linear extension varies markedly amongst taxa: fast-growing Acroporidae can reach 100–150 mm year^{-1} (Dullo 2005), whereas massive species, such as *Porites lobata* and *Diploastrea heliopora*, grow at a much slower rate, at about 10 mm year^{-1} and 3–6 mm year^{-1}, respectively (Watanabe et al. 2003; Bagnato et al. 2004; Bagnato et al. 2005). Lifespans also differ considerably: fast-growing *Pocillopora verrucosa* may reach 3.6–3.9 years and *Acropora hemprichii* can live 13–24 years (Bythell 2018). Yet, under specific circumstances, some colonies have attained exceptional sizes and ages that remain only partially understood (Montano et al. 2024; Siena et al. 2025; Strona and Montano 2025). For instance, although the mean age of *Porites* spp. in one Great Barrier Reef study was estimated at 41 ± 12 years (Darke and Barnes 1993), some colonies of this genus can exceed 1000 years (Bythell 2018) and *Diploastrea heliopora* colonies 2.6 m in height have been dated at over 600 years (D'Olivo et al. 2024).

Despite their scientific and conservation relevance, exceptionally large coral colonies have received limited dedicated attention. A few notable examples include a giant *Porites* sp. reported off Taiwan, 31 m in circumference and 12 m in height (Soong et al. 1999), another *Porites* sp. documented off Australia measuring 10.4 m in circumference and 5.3 m in height (Smith et al. 2021) and a giant *Pavona decussata* studied in Japan for its reproductive capacity and measuring 50.9 m in length (Mezaki et al. 2014). The reefs surrounding Ta'U Island in American Samoa represent one of the few areas where a systematic effort has been made to classify large coral colonies following the discovery of what was thought to be one of the largest corals known at the time (Brown et al. 2009), measuring 7 m in height, 17 m in diameter and 41 m in circumference. Subsequent surveys around Ta'U (Coward et al. 2020) highlighted the potential of focused research: around 400 colonies over 5 m in diameter were identified, including a *Porites* sp. 22.4 m in diameter, 8 m in height and 69.2 m in circumference. Although such colonies are highly conspicuous, they may often go unreported when they are not the explicit focus of research. In American Samoa, they had been mentioned in technical reef assessment reports (Green 2002), but the broader scientific community had little indication that the area would later be dubbed the "Valley of Giants" by NOAA.

Long-lived corals provide high-resolution archives of past climate and environmental conditions through their skeletons (Lough and Barnes 1997; Lough 2010; Canesi et al. 2024; D'Olivo et al. 2024) and their large, three-dimensional structures support diverse associated organisms (Graham and Nash 2013; Coker et al. 2014; Blackall et al. 2015; van der Schoot and Hoeksema 2025). Their longevity may also reflect strong resistance and resilience to environmental changes via refugia, tolerance, acclimatisation, genotypic differences, adaptation or epigenetics (Camp et al. 2018; Drury 2020). Culturally, these very large corals may act as charismatic organisms (Ducarme et al. 2013; Schuster 2019), analogous to monumental trees, valued and protected for ecological and symbolic reasons (Mattioni et al. 2020; Sladonja et al. 2023), yet no individual marine organism has received comparable protection. Exceptionally large corals, therefore, offer unique opportunities for science, conservation and public awareness.

These considerations underscore both the ecological and symbolic value of these unique colonies despite the current lack of coordinated, large-scale information about them. Their monumentality, longevity and potential resistance traits make them unique research targets as well as compelling ambassadors for reef conservation. At the same time, their detection and monitoring require observational coverage across vast and remote reef areas, a task that surpasses the capacity of conventional scientific surveys alone. The combination of growing awareness of the potential of citizen science, the availability of low-cost and essential tools, such as underwater cameras and drones, the value of exceptionally large coral colonies and the recognition of what dedicated studies can achieve (Coward et al. 2020), collectively provided the motivation to establish a global database for their identification and mapping.

For these reasons, we launched Map the Giants, a global framework for the systematic identification and mapping of these coral colonies.

Therefore, the present work has two overarching aims. First, it synthesises the scientific and practical motivations for establishing a global initiative dedicated to identifying and documenting these unique coral colonies, highlighting why these organisms represent both valuable research targets and important conservation symbols. Second, it presents the design, protocol and operational workflow of Map the Giants, detailing how the project integrates citizen-science principles, standardised reporting methods, expert validation and open-data practices to build a reliable global database. By outlining this framework, we aim to provide a transparent methodological reference that can support future studies on giant corals and provide information for similar large-scale monitoring initiatives.

Mapping giant coral colonies via citizen science: discovery, monitoring and open data

Map the Giants is a global citizen-science initiative launched in January 2024 to locate, study and safeguard giant coral colonies (corals over 5 m in two-dimensional linear length, defined as the straight-line projection of the longest dimension; see below for full definition). The project has three linked aims: (1) to crowd-source reports of potential giant colonies from divers, citizens and researchers (according to definitional criteria described below); (2) to validate and prioritise verified colonies for targeted, multidisciplinary field studies; and (3) to collaborate with various stakeholders to explore protection measures for colonies of outstanding value.

Citizen participation is essential to achieve global spatial coverage at feasible costs (Goffredo et al. 2010; Pecl et al. 2019). To ensure data robustness despite heterogeneous contributor backgrounds, the project uses a clear reporting protocol, standardised metadata fields and a multi-expert validation workflow.

The project is designed and managed in line with the ten European Citizen Science Association (ECSA) principles (European Citizen Science Association

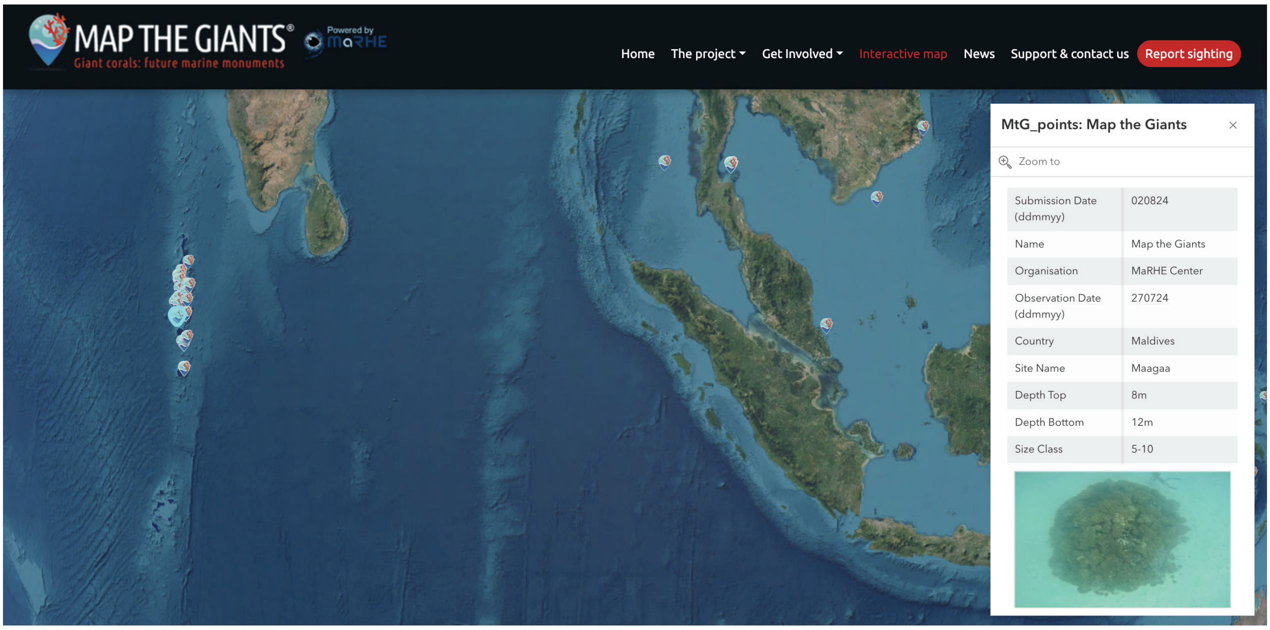

Figure 1. Landing view of the interactive map on https://www.mapthegiants.com, which serves as the central interface for visualising the curated archive of validated giant coral colonies reported to date. The map is hosted on ESRI ArcGIS Online.

2015). It actively involves people from diverse backgrounds — divers, researchers and ocean enthusiasts — who may submit one-off reports or act as long-term stewards of specific colonies by providing periodic photo and video updates. The project produces genuine scientific outcomes: it generates new biogeographic knowledge on giant corals and creates a validated sampling frame that supports peer-reviewed studies. Benefits are reciprocal. Scientists gain scalable, otherwise unattainable data and access to rare colonies; contributors gain skills, recognition and a deeper understanding of reef vulnerability. Citizens can participate at multiple stages, from discovery to longitudinal monitoring and, where appropriate, co-producing local stewardship actions.

Participants receive timely feedback: an instant confirmation, a unique entry ID and, when needed, follow-up requests. Validated records appear on the interactive map, making contributors' impact visible and concrete (Fig. 1), an essential motivational lever in citizen science (Tiago et al. 2017; Land-Zandstra et al. 2021) and resulting publications and reports are shared in free-to-read online versions. Contributors are acknowledged and images are credited. Finally, the project complies with European legal and ethical standards — including privacy, copyright and intellectual property, data-sharing agreements and environmental care — using Creative Commons licensing and non-extractive protocols to minimise impact.

The dedicated website (https://www.mapthegiants.com) serves both as the submission repository and as an educational hub, sharing validated data, guidance and open-access outputs with the wider community.

Website design and information architecture

Recognising the central role of communication and usability in citizen-science initiatives, Map the Giants was conceived as a user-centred web ecosystem that reduces friction fr om initial interest to action. Grounded in user-centred design (UCD) principles — clarity, progressive disclosure, error prevention, accessibility and timely feedback — the site guides users through a gradual journey: learning the basics, preparing a report and finally visualising validated sightings.

This sequence is reflected in the top-level navigation: The Project (About, Aims, Partners/Team), Get Involved (Learn, How to Monitor, Share), Interactive Map, News and Support and Contact. Each section has a clear purpose: first orientation (plain-language explanations and visuals), then step-by-step, task-focused guidance (what to observe, what to record and how) and, finally, submission and feedback.

To reduce cognitive load, the reporting workflow uses plain language, sensible defaults and field-level cues (e.g. examples and validation prompts), while keeping a prominent, persistent Report Sighting call-to-action for fast entry. Consistent labelling and layout strengthen predictability. Mobile-responsive pages, legible typography and accessible contrasts support use in real-world conditions (e.g. on boats or beaches). Immediate confirmations and follow-up requests provide closure and build trust, while the interactive georeferenced map closes the loop by rendering contributors' efforts visible.

Overall, the information architecture aligns navigation, content and forms with users' tasks, contexts and constraints, so that both researchers and non-experts (e.g. divers or tourists) can contribute confidently and efficiently.

Building ocean literacy: Map the Giants "Learn" page and outreach

One of the objectives of Map the Giants is to promote understanding of scientific concepts amongst general audiences. Special care has, therefore, been devoted to the Learn page within the Get Involved section. From the title onward, the aim is to maximise public engagement with the data-collection and scientific activities that underpin the monitoring programme, guiding contributors through a gradual, task-orientated pathway that culminates in data submission. This section represents an educational component designed to advance ocean literacy. Here, readers find concise explanations and practical cues for reporting a giant coral: an accessible overview of coral reef ecology, followed by clear descriptions of the ecological parameters required in the submission form. References to relevant scientific literature are included to support deeper exploration by interested participants. The introductory materials define the project's focal taxa (i.e. tropical, reef-building scleractinian corals) and situate them within the broader reef ecosystem in which Map the Giants operates.

The page then outlines the main coral growth forms, providing examples of coral species within each category, citing some linear growth rates and clarifying the rationale for including or excluding specific forms from the database. In particular, branching coral colonies are currently excluded, as this growth form often develops into monospecific thickets that cover extensive areas via fragmentation and ramet dispersion (Highsmith 1982; Lirman 2000). As a result, it is difficult to determine whether a reported structure represents a single connected genotype without specific genetic studies.

To strengthen field capacity and improve data quality, the page also includes a paragraph on coral health conditions. Given the increasing threats to coral reefs, particularly the rise in coral disease (Burke et al. 2023), more frequent bleaching events (Hughes et al. 2017a, 2017b; Reimer et al. 2024) and outbreaks of predators (Zhang et al. 2024; Meekan et al. 2025), the global need for diffused and long-term monitoring has been recognised as essential to better inform science, management and policy (Obura et al. 2019). This section provides a basic toolkit for recognising and reporting selected health parameters in the field. Contributors are introduced to key distinctions, such as those between bleached and dead corals, to help track the fate of giant colonies over time. In addition, photographs and descriptions of common potentially harmful organisms are provided, along with basic information on growth anomalies and some of the most frequent coral diseases. The goal is not to enable participants to diagnose diseases, something that would require specific training, but to help them notice unusual conditions and report them.

To further enhance Ocean Literacy, the project's social media channels are managed through an editorial plan that disseminates information on the research protocol, results and outreach activities, while also covering topics related to coral reef ecosystems.

Beyond online communication, outreach events have played a central role in advancing ocean literacy and engaging potential citizen scientists. Activities have included online presentations for diving groups, in-person events at scuba exhibitions and participation in public science events in urban or virtual settings (e.g. podcasts, radio interviews). Through immersive 360° VR videos, giant colonies can be showcased to wider audiences in emotionally impactful ways, with potential benefits for awareness and environmental engagement (Thoma et al. 2023).

Standardising reports: eligibility criteria and monitoring methods

Another central element of the website is the How to Monitor page, which introduces and explains the monitoring protocol to prospective contributors. The first paragraph outlines best practices to avoid damaging giant colonies and the reef in general. These guidelines were developed in recognition of the importance of pre-dive and snorkelling briefings in mitigating the negative impacts of tourism on coral reefs (Krieger and Chadwick 2013; Roche et al. 2016) and in light of documented damage to giant colonies in the past (Soong et al. 1999). The Green-Fins Code of Conduct (Hunt et al. 2013) served as a key reference for these recommendations.

The page then clarifies what is meant by "giant corals" within the project. This definition is based on two main components. First, it adopts Done's (2011) description of a coral colony as "the limestone skeleton plus the living polyp tissue, produced by replication of the primary zooid and all its descendants". Second, it sets a size threshold. Accordingly, a colony qualifies as a giant coral if it meets multiple criteria: (1) it measures at least 5 m in one of its two-dimensional projected linear lengths; and (2) it presents continuous live tissue and/or (3) a continuous skeleton (Fig. 2A–D). While relying on continuous skeleton rather than tissue alone may introduce some inaccuracies and while only genetic analysis would confirm the colony is of one single genotype, this trade-off was considered necessary to facilitate data collection by non-experts.

The chosen minimum size ensures inclusion of both colonies with particularly slow linear extension (for example, *Diploastrea heliopora* growing a few millimetres per year (Canesi et al. 2024)) and fast-growing corals that have reached unusual sizes (e.g. tabular Acroporids). In the latter case, reports may

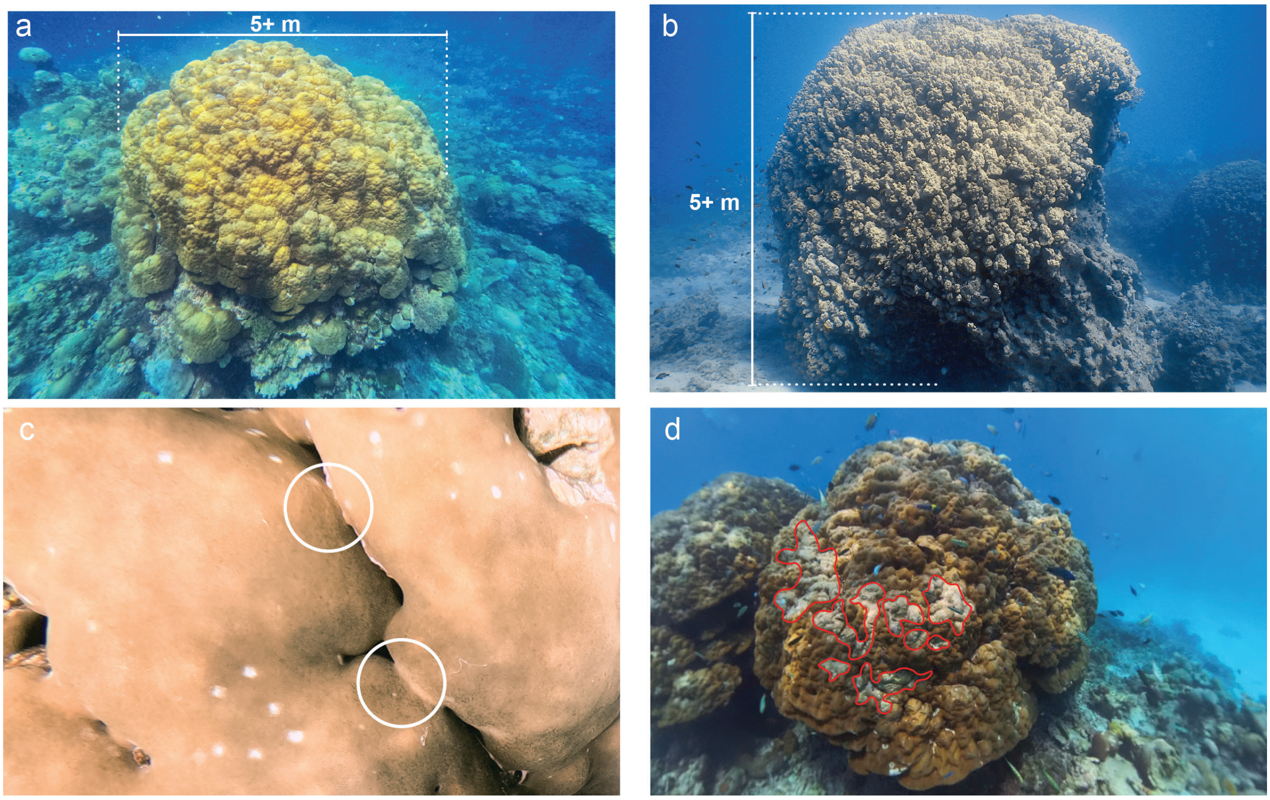

Figure 2. Criteria for the inclusion of giant coral colonies within the database. **A.** Colonies with a straight projected linear length of 5 m or greater; or **B.** Colonies with a height of 5 m or greater; and **C.** Continuous tissue (circles mark areas of tissue fusion); and/or **D.** Continuous skeleton (areas in red mark partial mortality of the colony).

be especially important given the short life-span (Bythell 2018) and susceptibility of certain fast-growing species (McClanahan et al. 2009).

To accommodate contributors with different levels of experience and time availability, the protocol offers two complementary methodologies, simple and advanced, that can also be combined. Both are explained and illustrated to provide clear visual references, particularly for less experienced users.

The simple methodology is designed for participants who encounter a giant coral opportunistically during recreational activities and may lack specific expertise or equipment. A simple survey (see Supporting File 1) includes the minimum set of data required for a submission to be valid: an estimate of colony size, growth form, location, depth and photographs. Colony size is assigned to one of three classes (5–10 m, 10–20 m, > 20 m) based on its longest straight dimension. Growth form options include massive, submassive, encrusting, tabular, foliose, columnar, branching or other. For georeferencing, contributors provide the country and site name, as well as estimated depth. Including GPS coordinates is optional, but strongly recommended to improve accuracy.

The advanced methodology, described in more detail in Supporting File 2, targets more experienced contributors with greater time availability and access to specific tools. In addition to the information required in a simple survey, participants may provide further optional data. These include a more detailed taxonomic identification (to genus or species where possible), environmental parameters, such as depth at the lower and upper colony limits and water temperature and a structured assessment of colony health. Health-related fields encompass the proportion of live tissue (classified into percentage classes), bleaching status, the presence of growth anomalies and observations of nearby competing or potentially harmful organisms (e.g. Crown-of-Thorns Seastar, Pin-Cushion Seastar, corallivorous snails *Drupella* sp., *Terpios hoshinota* sponge, *Dendropoma* sp. mollusc and overgrowing algae).

Contributors can also submit reports derived from drone surveys. Drones have proven valuable for shallow-water benthic surveys (Fallati et al. 2020), generating high-resolution images from which measurements of potential giant colonies can be extracted. Although the information gained from drone surveys is limited, this methodology is useful for locating potential giant coral colonies over larger areas, followed by dedicated in-water surveys for completeness. The methodology for acquiring and processing these images is briefly outlined to support consistent data collection within the How to Monitor section.

To facilitate reporting, a dedicated submission page is accessible from various sections of the website, including the Share subsection. Here, users can upload their data through a straightforward form that combines open questions, dropdown menus and multiple-choice fields. The page clearly explains the terms and conditions under which coral and user data are stored and used for.

Upon submission, contributors receive an automatic email thanking them for their entry and providing a summary of the information they submitted. To address common criticisms of citizen science, particularly concerns about inaccuracy and unreliability (Burgess et al. 2017), all data are manually filtered: photos are checked and entries are assessed for compliance with the project's definition of giant corals by multiple researchers individually. Independently, two to three researchers analyse all the photos received and the correspondence with the data provided and provide feedback on whether the coral is compliant, non-compliant or whether additional proof is required. When initial assessments differ, validators discuss the case and reach consensus, ensuring that borderline cases are resolved consistently rather than by a single rater. Within a few days, a personalised follow-up email assigns the report an ID number, provides feedback and may request additional information, photos or videos if needed to confirm the validity of the submission. This one-to-one approach has proven valuable for formally recognising citizen-scientists' contributions and supporting participant retention in other citizen-science programmes (Nursey-Bray et al. 2018).

Once validated, submissions are displayed on the Interactive Map section of the website. Each giant coral is represented by a Map the Giants pin and accompanied by the associated data (excluding the email address), a selection of photos and the specific licence under which data and images can be reused. The map is hosted on the ESRI ArcGIS Online platform and is manually updated as entries are verified (Fig. 1). Although publicly accessible, the dataset cannot be bulk-downloaded from the website.

Privacy, transparency and features of the platform

While most contributors are willing to share information, some may be concerned about the public display of entries on a map (Pecl et al. 2019), particularly due to potential risks associated with over-tourism or tensions amongst stakeholder groups (Soong et al. 1999; Wolf et al. 2019). To respect contributors' privacy and address these sensitivities, personal data as well as GPS coordinates are handled with particular consideration. In fact, while precise GPS coordinates are essential for data quality and follow-up monitoring, public-facing coordinates are rounded to two decimal places (reducing spatial precision) by default, with full-precision data available upon request.

The website is updated regularly so that contributors can clearly see that the project is active, follow its progress and access the latest findings. Key features include:

- Up-to-date data: submissions are reviewed and incorporated on a rolling basis, leading to a constantly evolving and comprehensive map;
- Accessible language: the platform is designed for a wide audience, including non-scientists; clear and simple language is used and technical jargon is avoided to foster engagement, including amongst younger users;
- Downloadable guidance: the monitoring methodology is available as downloadable flyers, enabling participants to bring concise instructions into the field and follow the protocol easily;
- User-friendly submission form: data can be entered through straightforward dropdown menus and open-ended fields; the form is accessible from several sections of the website to facilitate quick reporting;
- Automated confirmation: automatic, real-time email responses give contributors a record of their report and allow them to verify the accuracy of the information submitted;
- Visibility for partners: a dedicated sponsors and supporters page acknowledges collaborators and provides visitors with a set of potentially useful contacts.

Preliminary outcomes and engagement metrics

In 2025, global coral reefs were reported as the first Earth system to exceed the central estimated thermal tipping point of 1.2 °C above pre-industrial levels (Lenton et al. 2025). With continued warming, coral reefs are considered virtually certain (> 99%) to cross critical thresholds even if temperatures stabilise at 1.5 °C within the next decade (Bevacqua et al. 2025). Emerging evidence indicates increased thermal tolerance in some taxa (Lachs et al. 2024), suggesting that giant colonies may represent particularly promising targets for further investigation. Against this backdrop, projects such as Map the Giants acquire heightened relevance and urgency (Strona and Montano 2025).

Participation and validation outcomes

During the first 18 months, Map the Giants received a total of 195 submissions, of which 146 were contributed by citizen scientists and 49 originated from dedicated expeditions conducted by the project team. After multi-expert review, 92 citizen-science entries and 44 expedition entries were validated and incorporated into the online database (e.g. Fig. 3A, B). The overall validation rate of 69.3% underscores the importance of expert assessment in ensuring data robustness and filtering out submissions that do not meet the project's criteria.

The responsiveness of contributors to follow-up questions was generally high, with only a small number of cases lacking sufficient supplementary material for validation. Consistent with other large-scale citizen-science programmes

Figure 3. Examples of validated giants. **A.** *Turbinaria* sp. reported by MaRHE Center team from the Maldives measuring 11 m in diameter; **B.** *Porites* sp. reported from the Seychelles measuring 5.3 m in diameter (Photo credit Daniel Bichsel).

— such as Redmap Australia, which relies heavily on expert verification — this multi-step process strengthens confidence in the resulting dataset while offering recognition and feedback to contributors (Pecl et al. 2019).

Out of all the entries, only 10 (5.1%) were received by private individuals; the remaining contributions came from 44 different organisations (excluding the Map the Giants team), involving 58 individuals. Notably, one group submitted 28 entries, of which 19 were validated. Although this group significantly enriched the dataset, the proportion of invalid reports highlights the essential role of the validation workflow. To date, no contributor has requested that the data be kept private.

Patterns in metadata submission

Analysing entries made by each contributor, in practice, no submission provided only the mandatory data. Most reports combined elements from both approaches, with contributors frequently opting to provide more detail than minimally required.

For example, although GPS coordinates are categorised as advanced data, all validated entries eventually included them, either at submission or after follow-up. Only 39 of 195 submissions relied solely on size-class estimates; the remaining 80% provided at least one specific measurement (length, width, diameter or height), whether estimated in situ or obtained through underwater tape measurements or Structure-from-Motion photogrammetry.

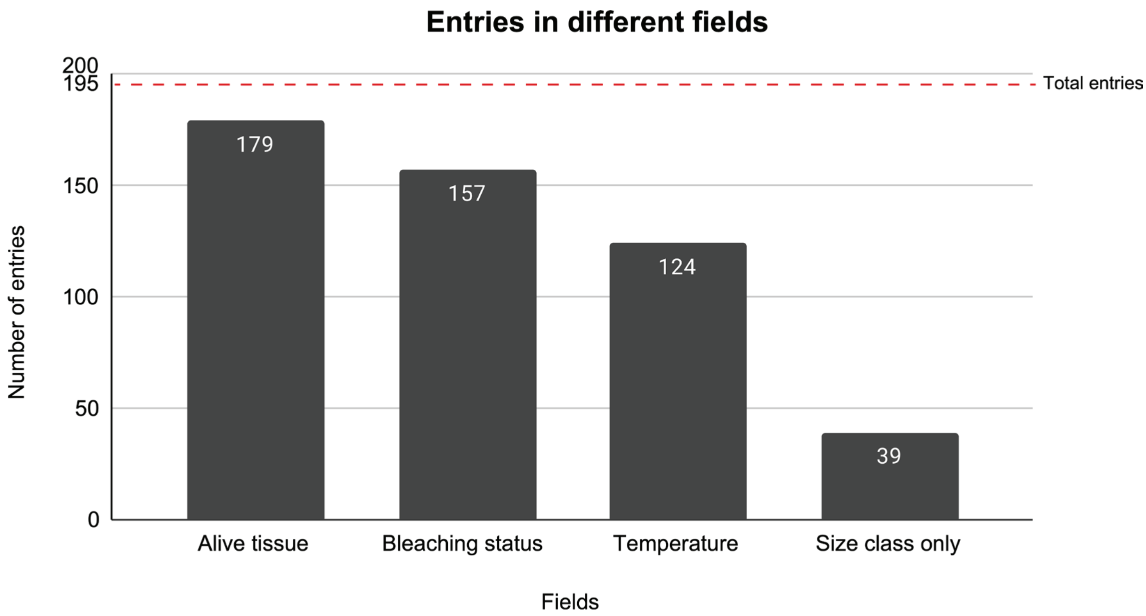

Figure 4. Number of entries in some of the fields.

Beyond the datasets collected by the project team, only four contributors shared photogrammetry products, which is unsurprising given the specialised expertise, hardware and time required.

Regarding colony health, almost all fields were consistently completed: bleaching status was reported for 157 entries, health condition for all, but 14 and water temperature for 124 submissions (Fig. 4). Information on potentially harmful or competitive organisms was more variable and represented the least consistently reported category.

These patterns suggest that, while flexibility in data requirements facilitates broad participation, certain currently optional fields, particularly GPS coordinates, could be made mandatory without deterring contributors.

Geographical distribution and future expansion needs

To date, submissions have been received from 22 countries, with no reports from the Atlantic Ocean. Strengthening social-media strategies or establishing local ambassadors could increase geographic coverage and improve representation across ocean basins. The absence of Atlantic records indicates a need to expand outreach strategies or increase efforts in regions where giant colonies may be less common as a result of long-standing pressures (Hughes 1994; Connell 1997; Gardner et al. 2003; Weil 2004; Mumby et al. 2007; Miloslavich et al. 2010; Papke et al. 2024). Although initial analyses of the geographical distribution of a subset of giant coral colonies have shown that many are located in thermal refugia, some have already experienced and survived several instances of thermal stress over time (Strona and Montano 2025), generating hopes to discover giant corals even in highly degraded areas.

Implications and future directions

The first 18 months of Map the Giants demonstrate the feasibility and scientific value of a global citizen-science initiative for documenting giant coral colonies. Although the project is still in its infancy, it has already produced a consolidated and rapidly expanding public database of validated giant coral records. The volume and quality of early submissions indicate strong engagement, with contributors consistently exceeding the minimum data requirements, an encouraging signal for the long-term sustainability of the initiative. Current high validation rates, along with broad participation, point to the emergence of a community of practice capable of supporting systematic monitoring efforts.

With this in mind, we will trial transforming some discretionary parameters into mandatory ones, such as the GPS coordinates, as this will significantly contribute to more complete data and reduce the need for follow-up emails. Additionally, although not applied in the present study, machine learning could be a natural extension of our approach to reduce observer bias during validation and extract additional features. As a necessary future step, it is paramount to expand the project into currently unreached areas and to conduct research that updates historical data in literature with current information.

As data are regularly uploaded, reports will become obsolete over time, requiring updates from the field. This would also be necessary following possible large-scale disturbances. The website will be periodically updated to include information on the current status of the reports. Each validated record is, in fact, associated with a persistent identifier that allows it to be updated through follow-up submissions linked to the original entry (e.g. health status after disturbance events, updated photos and re-measurements). The open nature of the portal's data will also allow managers and practitioners to access giants' locations and assess, on a voluntary basis, their fate over time. The continued involvement of regional ambassadors, despite not ensuring consistent commitment, appears to be the most feasible approach for long-term monitoring, at least until governmental protocols include giant corals into regular demographic studies (Edmunds and Riegl 2020; Pisapia et al. 2020).

Looking ahead, the project's growth prospects are substantial. To facilitate participation and improve accessibility, the development and release of a dedicated native mobile application, freely available on major app stores, could be considered. Such a tool would offer a more immediate and user-friendly reporting interface, enabling contributors to submit sightings, upload photographs and videos and access guidance materials directly from the field.

As the database expands, Map the Giants will also be able to support increasingly robust ecological analyses, enhance comparisons across regions and provide information for conservation planning and potential heritage-orientated protection measures for exceptional colonies. Future developments may include strengthening collaborations with marine managers, integrating drone-based or photogrammetric workflows more systematically and broadening training and outreach activities to enable contributors to participate not only in discovery, but also in the long-term stewardship of giant coral colonies. Collectively, these advances will reinforce the project's role as a scalable, data-rich and community-driven framework for understanding and protecting some of the ocean's most remarkable organisms.

Conclusions

Given the urgent need to improve the management of coral reef ecosystems and prevent further loss, current research is increasingly focused on strategies that can overcome spatial, temporal and economic constraints. Centennial coral colonies remain largely understudied, despite their potential vulnerability to unprecedented pressures, their importance as archives of the past conditions of the ocean and as conservation ambassadors. The lack of comprehensive global data on these organisms represents a critical knowledge gap that must be addressed.

In Siena et al. (2025), we analysed the first ecological results of the project, while this paper is protocol- and workflow-focused. Here, we outlined the rationale behind the development and implementation of a novel research initiative specifically designed to fill a knowledge gap and to broaden the concept of which organisms are considered worth protecting. The project builds on a citizen-science framework that employs a robust yet adaptable protocol and is supported by a comprehensive communication strategy, including a dedicated website, social media channels and outreach events. Together, these elements provide an essential tool for advancing knowledge of giant corals at scales that would otherwise be unattainable.

This framework also embeds key principles of participatory research and Ocean Literacy, thereby enhancing both scientific understanding and public engagement. Giant corals not only serve as archives of ocean history, but they may also reveal mechanisms of resistance and resilience, becoming powerful symbols for marine conservation. The present project illustrates the potential of citizen science to generate valuable scientific data while simultaneously fostering ocean literacy and raising global awareness of the fate of these exceptional organisms.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

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No ethical statement was reported.

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Author contributions

Federica Marialuisa Siena: conceptualisation, data curation, writing - original draft, writing - review and editing; Alessandro Gabbiadini: conceptualisation, writing – original draft; methodology; Luca Fallati: methodology, data curation, writing – original draft; Paolo Galli: validation, supervision; Simone Montano: conceptualisation, methodology, writing – original draft, supervision.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Simple survey method

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Data type: pdf

Explanation note: Template of the simple survey method for the data collection.

Link: https://doi.org/10.3897/natureconservation.63.182923.suppl1

Supplementary material 2

Advanced survey method

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Data type: pdf

Explanation note: Advanced survey method for data collection.

Link: https://doi.org/10.3897/natureconservation.63.182923.suppl2