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Seven Hundred Projects in iNaturalist Spain: Performance and Lessons Learned

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Abstract: Citizen science projects seem to have a high potential to provide systematized, high-quality biodiversity observations for science and other purposes. iNaturalist offers users purposeful participation by creating projects that allow observations to be grouped with a taxonomic and geographic focus, as well as on a given time scale. Between 2014 and December 2021, 720 iNaturalist projects have been created for Spain, most of them after the establishment of Natusfera—the Spanish branch of the iNaturalist global Community—in 2020. In this paper, we analyze how iNaturalist projects are created; how they perform in terms of engagement, data contribution, and impact; and assess the degree and possible causes of their success. A database with project descriptors and indicators was created for this purpose. We discovered that a high percentage of the projects (more than 25%) perform far short of expectations, and that bioblitzes are in general very successful in terms of creation, dissemination, and participation. Finally, we present some recommendations aiming to make these projects more effective.

Keywords: bioblitz; citizen science; Global Biodiversity Information Facility (GBIF); iNaturalist; Natusfera; projects

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1. Introduction

Although citizen science (CS) has been around for centuries, only recently has it began to spread dramatically around the world, especially in relation to biodiversity data [1,2]. Numerous initiatives and applications have contributed to the collective exchange of biodiversity information, allowing for the active participation of the general public in scientific activities [3]. CS biodiversity observations (species presence data) already account for 50% of the records available through the Global Biodiversity Information Facility (GBIF) (https://data-blog.gbif.org/post/gbif-citizen-science-data/, accessed on 31 January 2022), the largest and most widely used open data platform dedicated to the global occurrence of species in nature [4]. More than two decades ago, a movement began to involve non-scientists in scientific research in order to address real-world problems through CS projects [5,6]. These projects usually have specific goals, with a taxonomic or geographic focus and support from a specific management team [7], and volunteers or participants can contribute at various stages, ranging from data collection to planning, analysis, design, interpretation, and dissemination of scientific data [8].

iNaturalist is an open social network created to collect, organize, map, and share observations of biodiversity across the globe [9]. This platform emerged in 2008 as part of a master's degree final project, and in 2014, iNaturalist became an initiative of the California Academy of Sciences and a joint initiative with the National Geographic Society in 2017 [9]. With about 370,000 species and 90 million observations made by 2 million observers around the world, it is one of the most popular CS platforms for open biodiversity data (https://www.inaturalist.org/observations, accessed on 31 January 2022). These

records, when they reach a certain degree of quality (research grade), are uploaded and shared to the international network Global Biodiversity Information Facility (GBIF.org) [10]. A significant number of the occurrences available through the GBIF come from citizen science datasets [10]. iNaturalist is currently the fourth-largest data provider to the GBIF, with around 49 million published records [11]. Natusfera, the Spanish community of the iNaturalist global network, started in June 2020 (https://spain.inaturalist.org/home). In the two years since its creation, Natusfera has gathered more than 1.2 million observations of some 23,000 species, and a community of nearly 26,000 observers and more than 11,000 identifiers (https://spain.inaturalist.org/observations; accessed on 31 January 2022), with data that is continually updated and increased. iNaturalist is also a valuable platform to create diverse collaborative projects regarding biodiversity (https://www.inaturalist.org/projects). iNaturalist projects enable any user to collect observations under a common framework (territory, species group, time, etc.) for both general and specific objectives. In this way, projects can focus on addressing a variety of purposes (e.g., filling data gaps, detecting invasive species, monitoring protected or threatened species, educational and awareness campaigns, etc. [12–16]) that, in many cases, are impossible or very difficult to conduct using conventional means, such as scientific research projects or censuses. Based on the projects created in the domain of Natusfera/iNaturalist-Spain, we aimed to obtain a fact-based view of the nature of the iNaturalist projects, including their promises, accomplishments and shortcomings, as well as to provide some recommendations to create projects that are more effective.

2. Materials and Methods

In this paper, in addition to giving an overview of iNaturalist projects (scope, geographic, taxonomic and spatial coverage) and assessing their efficacy and relevance, we also aim to detect the potential factors that affect their performance. In order to do this on an objective basis, we determined which projects we would scrutinize, and defined descriptors and indicators to characterize them. The first matter to tackle was to define, in a clear way, the projects we would be analyzing. iNaturalist national communities or branches are not isolated silos, so in some cases, it is not easy to determine whether a project belongs to a specific national branch. As an operative filter, in this study, we have included all iNaturalist projects in which Spain (or a part of its territory) is an important part of the geographic scope of the project (https://www.inaturalist.org/projects/browse?place_id=spain). We limited our study to projects created before 31 December 2021.

We compiled a database with 701 projects from the iNaturalist platform (Table S1). In this study, out of a total of 720 projects, we excluded 19, as they were deleted by the administrator soon after their creation (n = 2), or because their activity period was set after 2021 (n = 17). For the analyses, we defined 26 descriptors covering aspects such as project details, aims, taxonomic coverage, geographic scope, and time range (Table 1, Figure 1).

Table 1. List of descriptors defined for the analysis, with the definition and/or valid values. The order of descriptors in the table follows the method of presentation on the iNaturalist pages.

	Descriptors	Definition and/or Valid Values
1	Project title	Title of the project in iNaturalist
2	Scope	Categorized according to the information provided in the title and description of the project. We established 19 values: audio, biological remains, conservation and threatened species, domesticated animals, ethnobotany, exotic and invasive, flower phenology, monitoring and distribution, mortality, natural disasters, observations of natural World Heritage sites, other interests, plant pathology, pollinators, singular trees, soils, taxonomic diversity, urban flora, and undefined.

Table 1. *Cont.*

	Descriptors	Definition and/or Valid Values
3	Project URL	URL of the project in iNaturalist
4	Type	Type of project according to iNaturalist [1]—two categories: collection, traditional.
5	Bioblitz	Yes/No
6	Umbrella project	Yes/No. If Yes, then 7 and 8:
7	Umbrella name project	Title of the umbrella project.
8	Umbrella URL	URL of the umbrella project.
9	Creation date	Date of creation of the project.
10	Users	iNaturalist "preferred submission model", i.e., possible restrictions on the users for adding observations to the project. These differ according to the project type. Valid values: any (open to anyone), invite-only/anyone (T, only invited users can add observations; observations need no validation), invite-only/project curators (T, only invited users can add observations; observations need to be validated by curators), open/project curators (T, anyone can add observations; observations need to be validated by curators), project members only (C, only observations made by project members are included in the project), specific users (C, only observations made by specific members are included in the project).
11	Flag	We recognized 3 valid values: duplicate project, no description; explanatory title, no description; unexplanatory title.
12	Creation context	Field or sector from which the project is created. This field has been categorized based on the information available in the project description. Valid terms: administration (i.e., government agencies), association (i.e., naturalistic and scientific associations), educational (i.e., educators), particular (i.e., non-professional public), private sector (private businesses), scientific (i.e., researchers).
13	Purpose	Objective or intent of the project. Valid values: educational, knowledge, management and conservation, scientific, other interests.
14	Administrator	Project administrator username.
15	Geographic level	Valid values: biogeographical region, continent, islands (incl. Spanish islands), municipality, nation (Spain), nation (Spain) and surrounding countries, province and region (incl. autonomous community), specific area, undefined, worldwide.
16	Geographic area	Geographic coverage indicated in title, description, or requirements.
17	Taxon target group	Taxonomic coverage indicated in title, description, or requirements.
18	Standardized taxon target group	Taxon target group indicated in "taxonomic categories".
19	Kingdom	Valid values: Animalia, Plantae, Fungi, and Protozoa.
20	Observations	Number of observations of the project by January, 2022.
21	Observers	Number of observers of the project by January, 2022.

Table 1. *Cont.*

	Descriptors	Definition and/or Valid Values
22	Time coverage	Date of coverage indicated in title, description, or requirements.
23	Quality grade	Requested quality level for the project observations. Valid values: research grade, needs ID, casual.
24	Project list	If the project has a species list (only possible in traditional projects).
25	Rules	Mandatory fields to fill before submitting an observation.
26	Extra observation fields	Optional fields to fill before submitting an observation.

[1] Umbrella projects are considered separately.

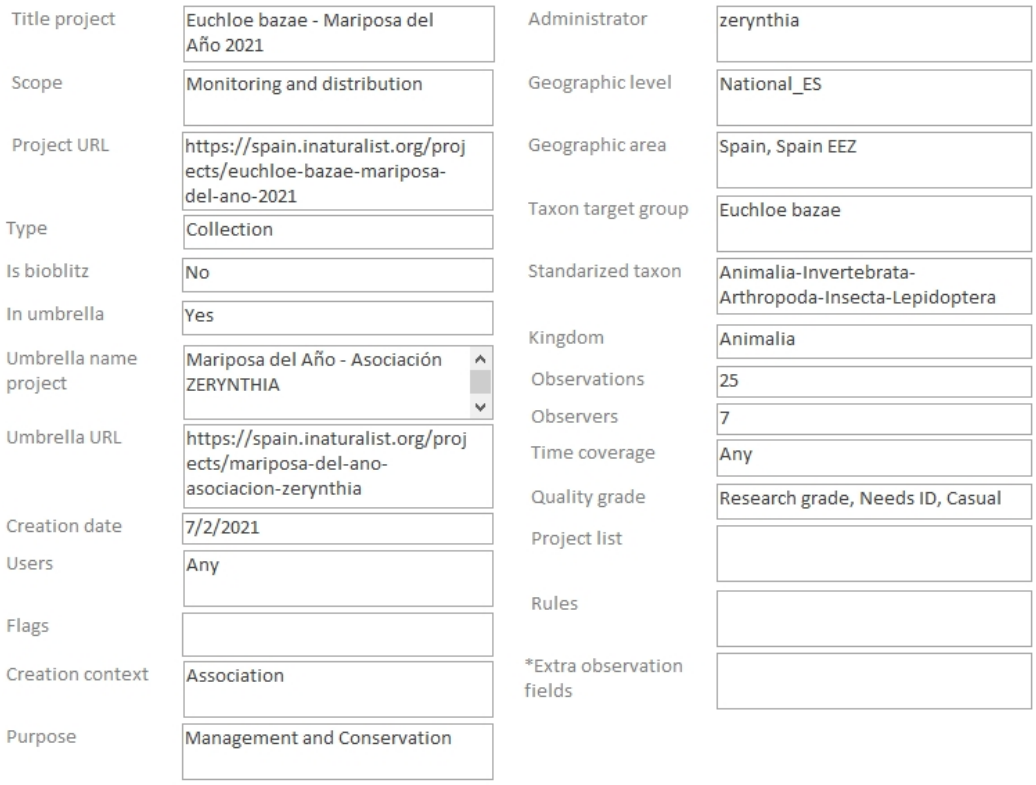

Figure 1. Example of a project record in our database viewed in a Microsoft Access format.

Additionally, a set of indicators was extracted from the projects' pages and documentation. These are: (1) clarity in the description of the motivations and objectives of the project; (2) taxonomic inconsistencies in the project description and requirements; (3) geographic inconsistencies in the project description and requirements; (4) inconsistencies in the project description and requirements; (5) inconsistencies in the activity time in the project description and requirements. While descriptors represent actual information, indicators required some degree of interpretation.

In dealing with iNaturalist projects, it is important to take into account that there are two kinds of projects: (i) *Collection projects*, which are basically a filter (any combination of taxon, place, user, date, or quality grade) that allows the display of dynamic observations that match the criteria, regardless of their origin; and (ii) *Traditional projects*, that allow their creators to set some parameters that may increase the quality of the data at the cost of having fewer observations. In this case, observations must be manually added, and participants must join the project in order to become members and be able to contribute.

It is also possible to add specific fields to record additional information along with each observation (e.g., temperature, lighting, number of individuals) or to refer to customized species lists. As of 16 May 2019, iNaturalist users were required to have made at least 50 verifiable observations before being allowed to create traditional projects. Moreover, several projects can be grouped in what are called *Umbrella projects*, which are created to merge, compare, or promote a set of existing projects with common characteristics. Thus, any project (collection or traditional) can be included under one or more different umbrella projects.

Bioblitzes, that is, recording events focused on finding and identifying as many species as possible in a specific area over a short period, are not a type of project in iNaturalist, but due to their special characteristics, they deserve some attention.

3. Results

3.1. Facts

Applying the criteria set in the previous section, 701 iNaturalist projects were identified and scrutinized. The number of projects created from 2014—when iNaturalist began to be used in Spain—to 31 December 2021, has grown from a few each year, to almost 400 per year, with an explosive increase in 2021 (n = 385, 54.9%; Figure 2). It is worth mentioning here that collection projects were nonexistent before 2018, and that these have become the option of choice. They are, moreover, largely responsible for a recent substantial increase in projects. The unexpected presence of collection projects before 2018 (n = 5; Figure 2) is due to changes a posteriori from a traditional project.

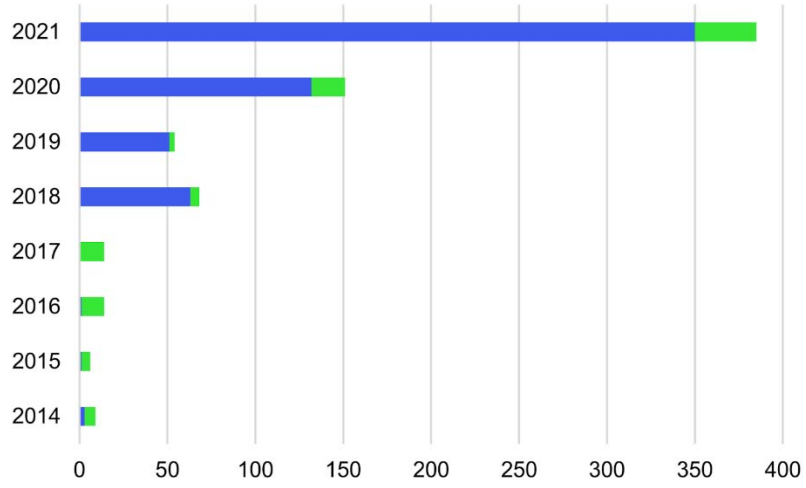

Figure 2. Number of collection projects (blue) and traditional projects (green) created per year.

Months with the most projects created were April (n = 112 projects, 16.0%) and October (n = 80 projects, 11.4%), coinciding with months before the main bioblitzes held in Spain (Figure 3).

These 701 projects were created by just 267 users (out of nearly 30,000 who made at least made one observation for Spain in iNaturalist; 31 January 2022). Nearly 20% of the projects (n = 137) were created by just two very active users. The large majority of the iNaturalist projects in the database are open-ended (n = 592, 84.5%). Projects with termination dates are usually short, lasting less than 1 month, and labeled as bioblitzes.

Most projects are collection projects (n = 601, 85.7%), while only 100 (14.3%) are traditional projects. More than half of the projects (n = 394, 56.2%) are included in 41 umbrella projects. Each of these umbrella projects usually inlcudes traditional or collection projects that pursue a common taxonomic or geographical theme, or projects that have been managed by the same entity/administrator. Regarding the geographic scope of umbrella projects, 31 focus exclusively on Spanish territory or Spain and its neighboring countries, while 10 target larger areas (e.g., the Mediterranean Basin, Europe, the globe, etc.). Most

collection projects are open to anyone (n = 525, 87.4%), while only 40 projects (6.6%) allow only project members to add observations, and 36 projects (6.0%) select specific users; very few (n = 4, 0.7%) explicitly reject certain users. In the case of traditional projects, the percentage of projects open to anyone is not as high (69%), with 31 out of 100 (31%) establishing restrictions for observers (participation per invitation, approval by the project manager, or the adding of observations restricted to the project's curators).

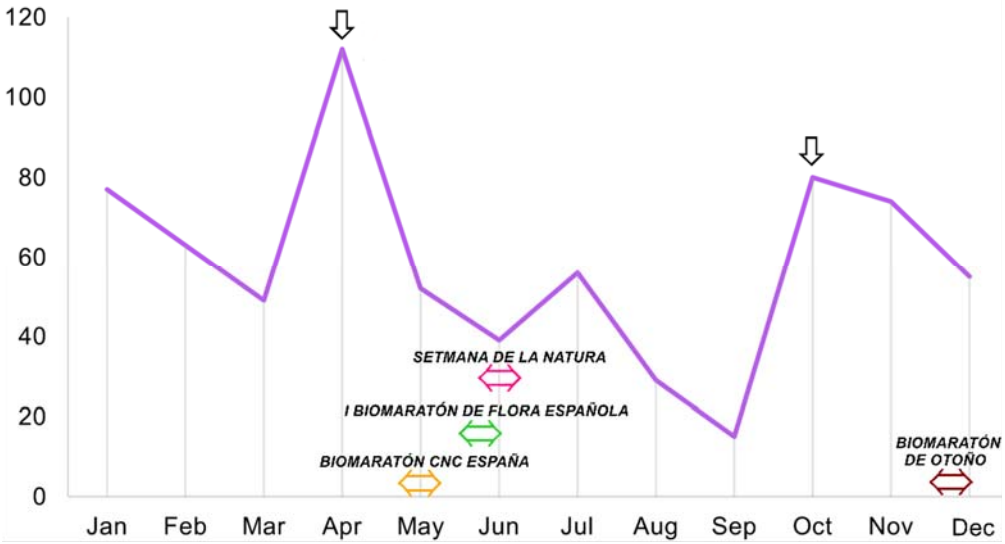

Figure 3. Number of projects created per month. The most popular bioblitzes held in Spain and the time in which they took place are highlighted.

Traditional projects allow the recording of additional information using "project rules" (required) and/or "project observation fields" (optional), serving the objectives of the project (e.g., type of habitat, animal behavior, cycle of life, or damage observed) or to capture optional context information, such as height, diameter, and age of the tree, number and state of nests, or number of individuals sampled, among others. A total of 34 projects out of the 100 traditional projects analyzed have observation fields, and only 7 (7%) projects have required fields (rules). Among these, we even identified a project aiming to register environmental information with no biodiversity observations whatsoever (Programa de Conservación de Suelos de Vitoria-Gasteiz, https://spain.inaturalist.org/projects/programa-de-conservacion-de-suelos-de-vitoria-gasteiz-fc07bdd5-3a15-4d40-b613-6f772430a58f).

3.2. Scope and Purpose

Under these terms, we collect information about the focus project and its objective (purpose). Table 1 contains the controlled vocabularies for these descriptors. Most projects (n = 592, 84.4%) focus on recording taxonomic diversity in a broad sense. About 5.8% (n = 41) have the objective of monitoring and/or improving knowledge of the species distribution area, and a similar percentage (4.6%) focus on exotic and/or invasive species. Less than 1% of the projects (n = 5) are exclusively related to conservation and threatened species. The remaining projects pursue heterogeneous interests, including topics such as ethnobotanical uses of plants, floral phenology, urban flora and fauna, mortality censuses, plant pathology, etc.

Although there is a predominance of projects aiming to record taxonomic diversity at large (for knowledge and entertainment purposes), the percentage is different, depending on the project type (78.4% in collection projects vs. 38% in traditional; Figure 4). On the other hand, the percentage of projects aimed at management and conservation (e.g., those that focus on exotic and invasive taxa, conservation of areas and species, monitoring and distribution, etc.), and education (especially focused on taxonomic diversity) is higher within traditional projects than within collection projects (34% vs. 6.8%, and 20% vs. 11.2%,

respectively). Projects dedicated to scientific research (especially on taxonomic diversity and monitoring) account for about 2% in both types of projects (Figure 4).

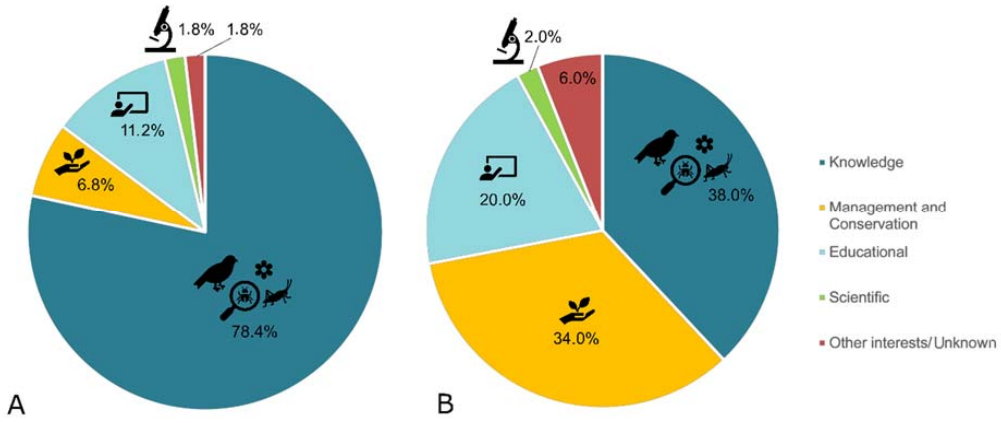

Figure 4. Purpose of the iNaturalist projects: (**A**), collection projects; (**B**), traditional projects.

3.3. Taxonomic Coverage

Almost half of the projects aim to collect data on all taxa (n = 315, 44.9%). Projects with more specific target groups focus mainly on animals (n = 252, 35.9%), followed by plants (n = 95, 13.5%) and fungi (n = 12, 1.7%) (see Figure 5 for a detailed list). Within the animal group, most projects collect data on insects (n = 71, 10.1%), especially on Lepidoptera (n = 32, 4.6%), and birds (n = 29, 4.1%). Within the plant group, most projects focus on vascular plants (n = 35, 5%), where angiosperms are the predominant group (n = 23, 3.28%). A small, but very interesting, group of projects in terms of results (n = 32, 4.6%) target one or a few species which are exceptional in some way. Among these are several butterfly species, such as *Euchloe bazae* (Iberian endemic and critically endangered), and many species of birds that have a large and active community of observers (e.g., swifts, white storks, little bustards, house martins, bearded vultures, and barn swallows). Additionally, there are also some projects on endangered and charismatic mammals (e.g., wolves or dolphins), or even on marine fish (skates, visible in diving activities). Several projects also focus on invasive or exotic plant species (e.g., *Ailanthus altissima*).

3.4. Geographic Coverage

More than one-third of all projects (n = 562, 80.2%) are focused on a relatively small geographic area (i.e., Spanish islands, province and region, municipality, and specific area), while those created at a national (including bordering countries; n = 88, 12.6%) or supranational scale (n = 50, 7.13%) represent a small percentage of the total number of projects (Figure 6). Projects created at site level (n = 139, 19.8%) comprise areas of special interest, such as mountain ranges, national parks, and other protected territories, or areas close to the organizer's bases, especially educational centers. While for each geographical level the percentage of collection projects is always higher, traditional projects are more abundant in smaller areas (Figure 6).

3.5. A Special Consideration Regarding Bioblitzes

Bioblitzes represent more than 30% of the studied projects (n = 220). From 2017 to 2021, the number of bioblitzes has increased exponentially, peaking in 2021 (n = 174, 79.1%; Figure 7). The number of observations per year also shows a similar increase in general, except for a considerable decrease in 2020, where there was less participation. Almost all bioblitzes are created as collection projects (only three are traditional projects). Most bioblitzes are open to anyone (n = 209, 95.0%), while only a few bioblitzes (n = 11, 5.0%) restrict participation to project members or other specific users. These are restricted because they are part of educational or highly controlled activities (e.g., tasks which are part of a syllabus, or a bird census). The purpose of most bioblitzes is to catalog taxonomic diversity,

regardless of the group, although we identified some bioblitzes (1.8%) which were focused on the monitoring and distribution of species. Accordingly, these bioblitzes tend to focus on all living species (n = 122, 55.5%), or very large taxonomic groups (animals, n = 62, 28.2%; plants, n = 23, 10.5%), and only a few target more restricted but charismatic groups, such as birds or butterflies (n = 8, 3.6%) (Figure 5).

	Non bioblitz			
Standardized taxon target group	**Collection**	**Traditional**	**Bioblitz**	**Total number of projects**
All taxa/Biodiversity/Multi-groups	151	40	122	313
Animalia (multi-taxa)	6	8	62	76
Invertebrata (multi-taxa)	1	0	1	2
Arthropoda	5	0	0	5
Arachnida	4	1	0	5
Crustacea	3	0	0	3
Insecta	6	2	0	8
Lepidoptera	24	3	5	32
Coleoptera	11	0	0	11
Odonata	7	0	0	7
Hymenoptera	6	0	0	6
Diptera	2	0	0	2
Trichoptera	2	0	0	2
Ephemeroptera	1	0	0	1
Hemiptera	1	0	0	1
Plecoptera	1	0	0	1
Mollusca	8	1	0	9
Annelida	2	0	0	2
Echinodermata	2	0	0	2
Vertebrata (multi-taxa)	4	0	0	4
Aves	19	7	3	29
Mammalia	13	2	0	15
Reptilia	11	2	0	13
Aves & Mammalia	2	2	0	4
Amphibia & Reptilia	6	0	0	6
Amphibia	2	0	0	2
Actinopterygii	3	1	0	4
Plantae (multi-taxa)	24	8	23	55
Tracheophyta	13	0	0	13
Angiospermae	20	2	1	23
Pteridophyta	2	0	0	2
Bryophyta	1	0	0	1
Fungi	7	2	1	10
Animalia & Plantae	7	9	1	17
Plantae & Fungi	2	2	0	4
Fungi & Protozoa	2	0	0	2
Non-biological	0	1	0	1
Unspecified	3	4	1	8

Figure 5. Number of projects per standardized taxon target group, as indicated in the project pages. The icons highlight the taxonomic groups within the Animalia and Plantae kingdoms with the highest number of projects. Icon colors follow the iNaturalist color code.

Bioblitz promoters include scientific or naturalistic associations (n = 136), educational institutions (n = 9), and administrations (n = 6), or private persons and observers (n = 69) involving a broad range of participants (scientists, educators, students, photography enthusiasts, nature lovers, etc.).

In Spain, bioblitzes cover all possible geographic scales, ranging from a national scope to focus on a province or local area (Figure 6). Most of these are created at the municipal level (n = 152, 69.1%), followed by those created for a specific site (n = 30, 13.6%), or at the province and region level (n = 25, 11.4%), although these are usually included in an umbrella project with a broader scope (national, but also regional, or even international; Figure 6).

Bioblitzes account for 120,244 observations, which make them one of the most successful formats of the projects analyzed in this study. Most bioblitzes (n = 195, 88.6%) are

created under umbrella projects. Umbrella projects provide branding and methodology, key elements for successful engagement. Within the scope of this study, we identified bioblitzes in 12 umbrella projects, of which 9 exclusively hosted bioblitzes (see Table 2). All of these had a national scope, except for two that hosted worldwide bioblitzes. The duration of these events usually ranged from 1 to 3 days (n = 7 umbrella projects), although a few lasted longer: a week (n = 2 umbrella projects), several months (n = 2 umbrella projects), or even a year (n = 1 umbrella projects). Bioblitz dates are often chosen around some special dates (e.g., Fascination of Plants Day, May 18; International Day for Biological Diversity, 22 May; Earth Day, 22 April), and during periods of high biological activity (Spring, Fall).

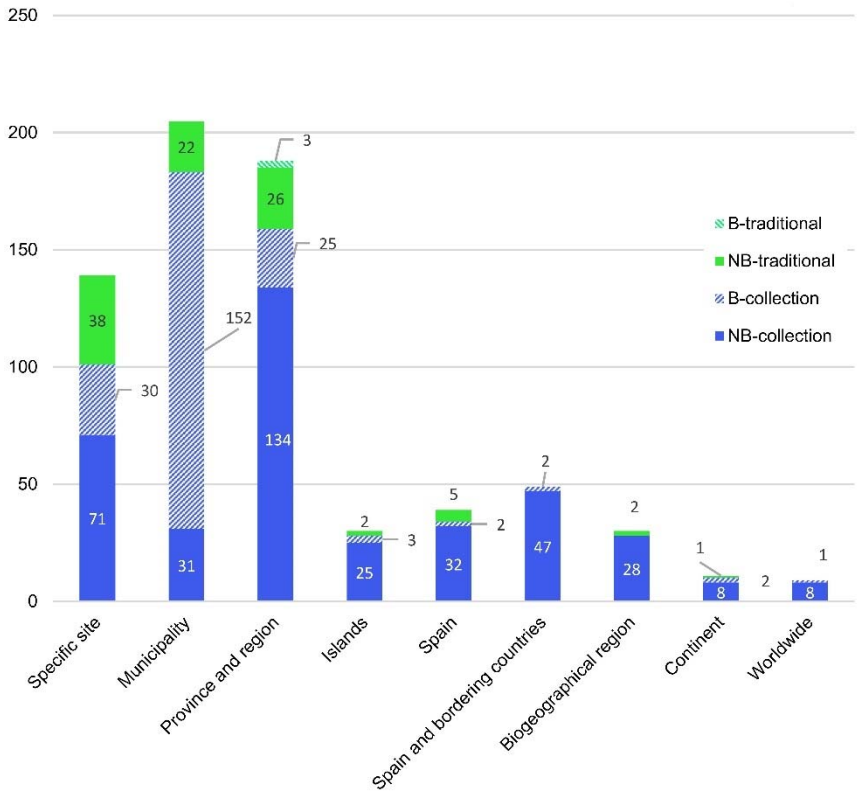

Figure 6. Number of collection (blue) and traditional (green) projects based on the geographical ranges they cover. In the graph, non-bioblitz projects (NB; solid fill) are differentiated from bioblitz projects (B; striped).

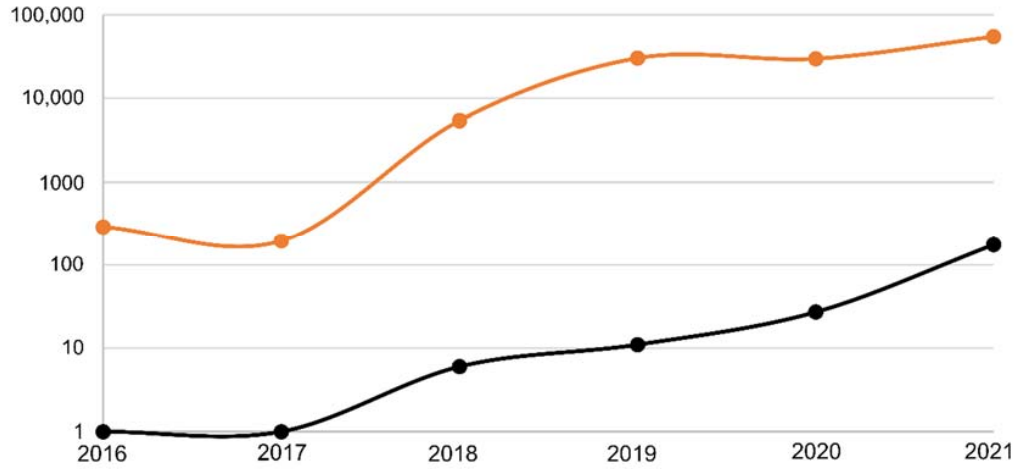

Figure 7. Number of projects created (black) and number of observations (orange) per year regarding bioblitzes—plotted on a logarithmic scale.

Table 2. Bioblitzes included in a bioblitz-exclusive umbrella project. The number of observations, number of species, and % research grade (RG) observations are dated 30 May 2022. Obs.—observations.

Umbrella Project	No. Projects	Access	Taxonomic Coverage	Geographical Scale	Date	Run By	International Support	No. Obs.	RG Obs.	No. Observers	No. Species
I Biomaratón de Flora Española	19	Any	Plants	Spanish autonomous community	3 days	GBIF.ES and association	No	25,353	58.46%	1056	2504
Biomaratón CNC España 2021	31	Any	Biodiversity	Spanish municipality	4 days	Association	Yes. Hosted by International CNC 2021.	17,050	47.47%	432	1679
Biomaratón de Otoño—2020	18	Any	Biodiversity	Spanish municipality	3 days	Association	No. Spain CNC preparatory.	10,712	42.94%	199	1187
Biomaratón de Otoño—2021	26	Any	Biodiversity	Spanish municipality	3 days	Association	No. Spain CNC preparatory.	8892	64.60%	645	1923
Biomaratón de Invierno—2021	21	Any	Biodiversity	Spanish municipality	3 days	Association	No. Spain CNC preparatory.	4738	63.93%	316	688
El Año en Observaciones 2021	60	Any	Animals	Spanish, province and region, national and bordering countries, specific areas	1 year	Particular	No	1277	65.00%	77	558
Rutas de Tres Cantos octubre 2021	7	Any	Biodiversity	Specific site	1 day	Association	No	238	53.78%	41	114
National Moth Week 2018	83 [1]	Any	Moths	Worldwide (countries)	1 week	Association	Yes	32,274	66.84%	5959	4,161
National Moth Week 2019	97 [1]	Any	Moths	Worldwide (countries)	1 week	Association	Yes	80,969	60.42%	13,685	6525

[1] Both umbrella projects include only one project focused on Spain.

Within the bioblitz-exclusive umbrella project, the Spain City Nature Challenge (CNC, https://citynaturechallenge.org/) and CNC-related projects (i.e., preparatory bioblitzes for the Spanish CNC) comprise about 45% of all projects created. The "I Biomaratón de Flora Española", an umbrella project inspired by, but not part of CNC, is the most popular event carried out in Spain, accounting for 1056 participants and 25,353 observations of plants in only three days (Table 2). Moreover, this bioblitz records the highest number of species of all Spanish bioblitz umbrella projects (Table 2). About a year after the execution of these events, between 42% and 65% of the observations reach the "research grade" quality level (Table 2).

3.6. Room for Improvement

Regarding aspects of the projects' definition or execution that may appear dysfunctional, we have detected 9 projects without a description, of which seven also do not have a title that indicates what the project is about. Two duplicate projects have been detected (same description, same requirements). We also found 60 projects with no observations (8.56%; n = 32 collection projects, and n = 28 traditional projects). Another source of concern is related to inconsistency or vagueness in their definitions. We detected around 68 (11.31%) collection projects designate a larger required area than their title indicates. For instance, the title refers to a protected area, and the project requirements delimit the province in which the protected area is, or even further, the taxonomic requirement selects a marine species and the spatial requirement indicates a terrestrial area. We have also found inconsistencies referring to the taxonomic objective of the collection project, where there is a mismatch between the target species indicated in the title or in the description of the project and the requirements. We found 10 (1.66%) such cases (e.g., the title refers to

"fauna," but the requirements are set to "all taxa"). At least 10 additional collection projects contain contradictory or superfluous requirements, for instance, indicating "Animalia," but also "fish & Mollusca & insects." Finally, two projects designate impossible time ranges; for instance, the closing date precedes the start of the project. Regarding the traditional projects, we found that 88 projects (88%) do not have any rules regarding the taxonomic group and/or the geographic area to which the title/description of the project refers.

4. Discussion

The rise of initiatives (such as iNaturalist) focused on facilitating the recording of nature observations, connecting observers, and enabling data integration seems to be the right idea at the right time, as the exponential growth of CS shows. The number of observations made by "citizen scientists" for all types of purposes is astounding. Data are accumulating and becoming available online at a tremendous speed [17]. The support that Natusfera, as the Spanish community of the iNaturalist network, has provided to users and institutional initiatives since its creation in 2020 may have played a role in the remarkable number of observations contributed from Spanish projects in 2021. The large number of projects created for Spain in such a short space of time suggests the simplicity and intuitiveness of the platform for a broad audience. The decrease in observations recorded in 2020 may be attributed to the lockdown periods experienced by the Spaniards due to the COVID-19 pandemic. This decrease in iNaturalist observations and bioblitz participation has also been detected in other countries [18,19], although it should be noted that the pattern of participation was variable and heterogeneous in this period [20–22]. Despite the above observations, there is another side to the lockdown, as supported by the number of species observed—which was very similar to that from previous years—the greater record of urban species [21–23], and the high number of iNaturalist projects created, as detected in this work.

The contribution of iNaturalist project records from Spain to the GBIF between 2014 and 2021 is measured in the hundreds of thousands [11]. This undoubtedly constitutes a large and relevant biodiversity data source. However, this relatively recent data source has some drawbacks, which we have explored in this study. One of the most significant results of our analysis is the fact that about 9% of the iNaturalist projects we analyzed had no observations. In addition, more than 12% of the collection projects showed weaknesses in terms of design and taxonomic, geographic, and temporal coverage, and nearly 90% of the traditional projects did not present rules for the taxonomic group or the geographic area indicated in the title, which means that these projects can include unwanted observations and do not comply with the administrator's initial idea. This data indicates that many people indiscriminately create projects without considering the iNaturalist help documentation (https://www.inaturalist.org/pages/managing-projects).

The clear preference of the collection-type project over the traditional one (by a six-to-one ratio) is explained by the fact that its creation and maintenance is simpler than for traditional projects. Collection projects can be, and are, used to provide a minute-to-minute update of species observations and stats. For instance, up to 240 non-bioblitz collection projects are open to any user and seem to lack any mobilization campaign or action (63% vs. 27% in traditional projects). A number of these, difficult to establish with certainty but around five, might be the result of trials, or testing exercises that are later abandoned or forgotten. These projects are "noise" in the system; they undermine the project creation effort at large and add no value. In contrast, traditional projects allow users to fill in additional information about the observations (not just what, where, and when), therefore, being potentially more useful for more specific projects of an educational or research nature. However, these demand active observation and recording, project membership, and greater dissemination. Moreover, their administrators are required to have at least 50 verifiable observations (iNaturalist, 2022).

One of the main sources of iNaturalist observations are bioblitzes [24]. Bioblitzes have helped advance the knowledge of populations and distributions globally and have

served as a basis for identifying new species, as well as providing an important resource for professional ecologists [12,17,25,26]. We found that most of these projects are correctly defined in terms of taxonomic, spatial, and temporal coverage, with only 23 projects (10% of all bioblitzes) considered imprecise for these variables. As they emphasize participation and engagement, their success is measured in number of observers and number of observations, so open collection projects are the most popular choice for general-purpose bioblitzes. The Spanish bioblitzes with the largest number of observers maintain a cooperative and supportive environment for bioblitz development, practitioners, and participants. Participation and mobilization (including preparatory bioblitzes) is proof of the success of the City Nature Challenge bioblitz (CNC) in its approach, which is: global, distributed, and serving as a model that is recognized and easy to engage in or emulate (https://citynaturechallenge.org/). However, the most successful bioblitz at the national level was the "I Biomaratón de Flora Española". It gathered 1056 participants who contributed more than 25,000 plant observations in only 3 days. Some underlying elements contributing to these outcomes may be the wide and robust group of organizing *partners* (organization and institutional support, such as research centers, educative centers, associations, and administrations), *diverse gathering teams* (projects coordinators and professional assistance, in particular specialists and botanical enthusiasts); solid dissemination strategy *to recruit observers* (websites, social media—Twitter, Instagram, Facebook—, bulk email lists of naturalists, physical fliers/posters in institutions, etc.); multiple *ways to involve participants in data collection, analysis, and interpretation.* For instance: events such as workshops on the use of the iNaturalist platform, botanical itineraries to know the plant diversity or datablitzes focused on the identification of specimens with the help of botanical experts to improve the observations at a research grade (which will be the ones that contribute to the GBIF biodiversity data), and on the exchange of experiences among the participants (https://spain.inaturalist.org/projects/i-biomaraton-de-flora-espanola/journal [27]). All these elements highlight the importance of organization, support, and partnership in a bioblitz [24], contrasting with those created on a personal level, in which participation is very low or non-existent.

Although iNaturalist projects are heterogeneous in scope, and range between well and poorly designed projects, they are, in all cases, a good reflection of social preferences and interests. We found an active interest of the general public (non-professional) in recording all taxa of large territories through open participation. We also observe that a large percentage of projects focused on charismatic groups or had a large community of non-professional enthusiasts, and these preferences are aligned with the taxa-groups with the highest observation numbers in iNaturalist and GBIF [17]. As mentioned by Troudet et al. [28], these biases are closely related to biodiversity data collection, ultimately impacting preferences in taxonomic research.

A wide range of project topics is observed. Our findings support that iNaturalist projects can be a useful data source for management and conservation, as well as educational purposes, as highlighted in previous work (e.g., [17,29,30]). However, projects related to scientific research are almost circumstantial, and this is so despite the abundance of success stories regarding the application of CS to answer scientific questions (e.g., [17,31,32]). Projects aimed at management and conservation reflect some of the current problems, especially regarding the monitoring of exotic and invasive species of plants, censuses (e.g., birds), or within conservation programs (e.g., butterflies and orchids). The use of this platform in the educational field is also valuable, since teachers can design a personalized project (generally focused on a specific site and restricted to users) to evaluate students in an innovative and collaborative way. The low number of projects (about 2%) tagged as originating from research may be due to researchers not always stating explicitly that their iNaturalist projects are intended to contribute to scientific research, and these ended up being counted as "particular interests projects". Moreover, some projects created by associations involved researchers (e.g., project design, assistance with species identification, completing the data analysis or data cleaning and exploration), but this was not explicitly

stated in the project description. On the other hand, the fact that the use of CS projects is still not widespread among researchers in Spain must not be ruled out. In any case, the suggestion of incentivizing the use of CS in scientific project requests—as an effective tool to collect data that could be too costly or too difficult to gather using the traditional procedures—still stands. Scientifically promoted projects are already attractive to participants, as having a clear purpose and contributing to science are motivating factors [33,34].

Recommendations

Regarding how projects are presented to their potential administrators, we have a few suggestions. Firstly, we recommend renaming "Collection projects" to simply "collections", as this would clarify how observations can be grouped and presented in iNaturalist, given that, even though they may serve to bring attention to specific areas or species, there is not really any control of the data submitted into these collections. Besides, this would align iNaturalist with the approach adopted by other biodiversity information platforms in this regard. For instance, the Biodiversity Heritage Library (BHL, https://www.biodiversitylibrary.org/) users can create collections of items connected by one or some features (e.g., publications on carnivorous plants: https://www.biodiversitylibrary.org/browse/collection/carnivorousplants). Likewise, the Encyclopedia of Life (EOL; https://eol.org/) users can create all types of collections (e.g., blue species: https://eol.org/collections/744). Secondly, regarding the so-called "traditional projects": although naming them "traditional" makes full sense to seasoned iNaturalist users, as they were the only projects in existence before 2019, for more recent users, this denomination does not mean very much. We suggest that these could be renamed "full", "complete", or "customizable" projects. Of course, if "collection projects" become simply "Collections", "traditional projects" may be named simply "projects". Nevertheless, we recognized that, in some scenarios, simple and filter-like projects may be the best option. In those cases, it may be advisable to make a focused effort (e.g., making them known, engaging participants, or providing support for them). Exemplary projects of this kind are detailed in the Discussion Section.

As we have detected that many projects present flaws, simply because creators do not follow the guidelines and recommendations provided in the iNaturalist supporting documentation, these guidelines should be featured more conspicuously in the project creation pages. It seems desirable that iNaturalist participants avoid creating duplicate projects. Likewise, they should delete test projects once they are no longer useful.

To eliminate "noise" projects, project creation could be conducted in two phases: a first "trial phase", visible only to the administrator, who can gradually modify the project, and a second phase, in which the project would be active and visible, contributing to the public dataset. In order for a project to go from the trial phase to an active project, it should meet some minimum criteria (e.g., filling in the project description field, among others previously mentioned) through an intermediate "checking" phase.

Another possible way to mitigate issues, such as target species mismatch, incorrectly or vaguely delimited area of interest, or impossible date ranges may be to set up stronger rules for consistency in the requirements; for instance, the starting date of the project must always precede its closing date. A final suggestion to improve projects would be to remove the requirement to have at least 50 verifiable observations in order to create specific areas. We have found that, far from limiting the creation of area-specific projects to expert users, this requirement could be increasing the number of imprecise projects. This is because many novice users get around this limitation by choosing larger areas, which are already defined and available for selection, thus adding observations outside the scope of the project.

Additionally, and in all cases, presenting the project in attractive and clear terms, indicating explicit purpose and support, and promoting partners, is a worthy investment. In other words, if the design and focus of the project are attractive to the participants, it will

gather more participants who will produce more data that can be useful for the participant in terms of both education and learning [16].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su141711093/s1, Table S1: Dataset of the iNaturalist projects analyzed.

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