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Audio-Visual Tools in Science Communication: The Video Abstract in Ecology and Environmental Sciences

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In recent years, the use of videos by the scientific community has evolved continuously. Researchers, communicators, and other players are using audio-visual media to reinvent their stories, to deconstruct complex phenomena and to increase the outreach and impact of their scientific publications. An example of this trend is the video abstract: an audio-visual representation of the key findings described in the written abstract. Much of the research in this area is new and focused on content analysis and classification of online science videos. Furthermore, studies with videos and environmental communication are attached to specific topics like climate change. So far, a small fraction of publications has explored the study of the video abstract, its effects, and its potential, as one general scientific area. This paper provides the first characterization of video abstracts in the areas of Ecology and Environmental Sciences. We identified video abstracts in 29 scientific journals, based on impact, representativeness and visibility criteria. A database of 171 videos, from 7 publishers and 17 different video channels was created. Each video was analyzed for different parameters. The analysis considered not only characteristics of each video, but also characteristics from the corresponding scientific papers. Results indicate that between 2010 and 2018 the number of video abstracts increased sevenfold. Despite this growth, there was no solid strategy for disseminating the videos. While most of them are still associated with classic models, such as documentaries, disruptive formats such as animation are the ones that arouse greater interest. Professional shorter videos (2–3 min in length) showed a significantly higher number of daily views and their papers garnered a higher number of citations per day. This data, combined with future qualitative research, will help to develop a model for validating the quality of an Ecology video abstract and provide new insights into the global study of audio-visual communication of science.

Keywords: audio-visual formats, ecology, environmental communication, science and media, science communication, online video, video abstract, visual communication

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INTRODUCTION

Science communication is usually associated to the written press format (Bentley and Kyvik, 2011) and, scientific papers continue to be the most used format in academia to disseminate the research produced (Jamali et al., 2018). However, with the rise of the internet and the science of information technology the way science is communicated has witnessed profound changes. Nowadays,

publications can benefit from these new communication tools that go far beyond written papers with graphs and tables (Rodrigues and Godoy-Viera, 2017; Jamali et al., 2018). Sharing results through audio-visual resources has gained an important role in this process: video recordings or live events, conferences, school classes, experiments and projects, each method having its own ability to illustrate practical knowledge in a much more effective way (Plank et al., 2017). Indeed, a wide range of audio-visual resources are available nowadays, with increasing adoption by the scientific community; amongst these resources, videos have gained special prominence (León and Bourk, 2018).

Science online videos can be defined as short scientific audio-visual content that aims to reach a wider audience using resources that demystify science features for the general public while keeping its rigor and precision (Morcillo et al., 2016; García-Avilés and de Lara, 2018). It is not a standardized communication tool since it is characterized by a great variety of formats and an increasing mix of genres (Erviti and Stengler, 2016; García-Avilés and de Lara, 2018).

In this context, the video abstract, the main object of study for this paper, emerges as a relatively new genre in science communication, having been already well defined and described by Spicer (2014): it is a video presentation of a scientific paper, which communicates the framework of the study, the methods, the results, and the conclusions and future goals. It is the filmed version of the written abstract, i.e., audio-visual summaries of scientific papers (Berkowitz, 2013). Unlike conference and lecture videos, such as TED Talks (Shah and Marchionini, 2013; Sugimoto and Thelwall, 2013; Tsou et al., 2014), and experimental and protocol videos like the ones published in the Journal of Visualized Experiments (JoVE, 2018; (Rodrigues and Godoy-Viera, 2017), the video abstract allows one to present content in multiple formats: it can be an interview, a documentary, an infographic, a monologue or an overlap of all these formats. The creators of these videos use an array of analogical and digital tools without any specific guidelines (Plank et al., 2017); however, in some particular cases, journal editors have assigned rules and recommendations, and provide production and design tips to establish a defined model for the publication of a video abstract in a specific scientific area. These guidelines differ from area to area and may include technical specifications, review process, copyright, use of English and use of content, structure and tone (Spicer, 2014). Cell Press, Springer Nature, Elsevier, Wiley, IOP Science, IEEE Xplore and American Chemical Society are among the publishers that accept video abstracts as a complement to the published paper (Plank et al., 2017).

Furthermore, some of these publishers have established partnerships with specialized platforms in the production of multimedia content (e.g., Research Square (Research Square, 2018)). Through a set of paid services, researchers can see their work come to life in the form of a video abstract (2–3 min in length) or a video byte (1-min in length), using all sorts of techniques and animation. Also, universities and institutes have been promoting courses in science communication to instruct researchers and students on how to produce their videos (e.g., Filmmaking for Scientists, Popular Science Video Workshop, Low Budget Science Film Making Course) (Plank et al., 2017; Angelone et al., 2019; Chan, 2019). We are moving from a generation of "scientists-turned-filmmakers" to a generation of "scientists-as-filmmakers," researchers who integrate subjects on film production and directing into their academic training (Angelone, 2019). The growth of such initiatives reflects, in some way, the demand by the scientific community to communicate their research in a visual, modern and appealing way in order to increase the outreach and impact of their scientific publications.

The benefits of using videos as a science communication tool include the ability to describe scientific and complex processes in a more effective way; and the potential to increase research visibility, to decrease the costs of training and experimentation and to foster reproducibility of methods and approaches (Rodrigues and Godoy-Viera, 2017; Jamali et al., 2018). While, fifteen years ago the video format had a single distribution channel, i.e., television broadcast, built on a unidirectional model, nowadays, with the advent of the internet, things have changed and video producers can think about universal online distribution, without additional investment, in an increasingly low-cost system (Granado and Malheiros, 2015). Very few scientists are heard outside the television environment and video abstracts can help to change that reality by bringing the message to a wider audience (Erviti, 2018). Also, previous studies have shown that scientific papers coupled with a video abstract are downloaded more and have more citations than papers without such an addition (Plank et al., 2017; Zong et al., 2019), and that optimized videos disseminate the scientific content to non-expert audiences in a more clear way, in comparison to written texts (Putortì et al., 2020).

Science video is a complex tool, an hybrid product that, like science communication itself, is based on different disciplines and knowhow, being interconnected with the universe of social networks and their users, who are today's producers (Bruns and Schmidt, 2011; Welbourne and Grant, 2016). Despite the need to create communities, to produce unique and innovative content (Erviti and Stengler, 2016), to work on new narratives (Angelone et al., 2019), to maintain scientific rigor (Frances and Peris, 2018) and to train researchers in these new areas (Plank et al., 2017; Angelone, 2019), the use of video-abstracts for those purposes still presents some constraints. In particular, it is important to understand if a video abstract is suitable for all subjects, what models should we use as guidelines to produce a successful video abstract, what is the real effect of video abstracts on research dissemination and learning of sciences, and what are the best approaches for measuring these effects.

In pursuit of this purpose, an inventory of video abstracts present in 29 scientific journals was made, with an overall number of 171 video abstracts being selected, viewed and categorized. We did a general characterization using descriptive and content metrics. Also, we tried to understand what were the most important factors that affect the research popularity, measured by the number of citations per day, value of Altmetric of the scientific paper and number of views of the video abstract. Based on the literature review we examined four content factors—video

length, production, format and audio quality—for their influence on research popularity. Understanding the influence of these factors on research popularity will allow the producers to create more effective and more engaging content. This is the first step toward a conceptual framework about video abstracts in Ecology and Environmental Sciences. In the next section, "Ecology and Environmental Sciences under the lens", we present the reasons on choosing this scientific area; then in "Literature Review" we briefly review the previews works on video categorization, focusing on the content factors chosen for the analysis. In "Design and Methods" we describe the sampling and codification processes, as well as the descriptive and statistical analysis used. The "Results" are divided into five sections—general characterization, video length, production, formats and audio quality—where we do a global description and then analyze the content factors with the research popularity. Finally, in the "Discussion" and "Conclusions" we debate the main findings, point out the research limitations and establish new guidelines for future research.

Ecology and Environmental Sciences Under the Lens

The world's growing population has led to problems of rapid climate change, over-exploitation of our natural resources, degradation of natural habitats and biodiversity loss. Ecological and Environmental Sciences help us understand these issues, and address some of the biggest environmental challenges that our planet faces. Over the past decades, these issues have cultivated a growing interest in academia, governmental agencies, and the general public. The EU Biodiversity Strategy for 2030 (European Commission, 2020) and the 2030 Agenda for Sustainable Development (United Nations, 2015) are goals and efforts that need to be supported by a communication matrix. Concepts such as visual literacy (Bucchi and Saracino, 2016; Krause, 2017; Rigutto, 2017; Trumbo, 1999) go hand-to-hand with others like environmental literacy, ecological literacy and eco-literacy (McBride et al., 2013) to create new tools and new responses to these problems. Moving images can transmit emotions and indorse engagement in the citizens, especially on the environmental areas where the visuals are used to promote behavioral change (León and Bourk, 2018). Studies that explore the visual rhetoric, that try to "understand how images communicate, how they function in a social and cultural environment, and how they embody meaning" (Margolis and Pauwels, 2011), start to show their importance: for example, Finkler et al. (2019) studied the impact of video on changing attitudes and good practices in whale watching. The authors concluded that following the viewing, almost all participants demonstrated their intention to choose a tour operator that promotes sustainable and responsible whale watching practices (Finkler et al., 2019; Finkler and León, 2019).

Studies dedicated to environmental videos have focused on specific and current themes such as fracking (Jaspal et al., 2014) environmental activism (Slawter, 2008; Uldam and Askanius, 2013) or climate change (León and Bourk, 2018; Allgaier, 2019); thus, no work focuses specifically and transversally in the area of Ecology and Environmental Sciences. Given its potential for the production of highly visual video-abstracts, these study areas are extremely relevant for pursuing the goals of this study.

Literature Review

The video abstract raises new questions on evaluating the success of research communication and opens the door to new dynamics. Traditionally, written articles see their impact assessed through the number of citations (Thelwall et al., 2012) and, more recently, through new metrics such as Altmetric (Altmetric, 2012). These can include "citations on Wikipedia and in public policy documents, discussions on research blogs, mainstream media coverage, bookmarks on reference managers like Mendeley, and mentions on social networks such as Twitter" (Altmetric, 2012). It is therefore important to take these two values into account when it comes to the popularity and scope of a written paper. Furthermore, the popularity of videos is directly associated with a series of metrics such as the number of views, viewing time, retention time, engagement, among other metrics. Many of these metrics are available to the public, but others only for internal management by the author of the video, using tools such as YouTube Analytics. Video's popularity is associated with two kinds of factors: content factors, directly related to the production of the videos, such as length, format, theme, and agnostic-content factors, such as the sharing network and recommendation systems (Borghol et al., 2012; Figueiredo et al., 2014). Although this is a dynamic function, the content factors seem to be the most informative and most used to understand what makes a video have more or less impact (Welbourne and Grant, 2016). Most of the studies on online video, are recent and focus on studying these factors that can be altered, changed and modified by the authors, researchers, and producers.

Although most experts agree that online science videos should be brief, visually appealing and easy to see (García-Avilés and de Lara, 2018) it is vital to have an idea of what videos have been made and what factors can be improved. Realizing what kind of content can be effective and popular and who produces it seems to be mandatory questions for the future of the area (Allgaier, 2019). In fact, in the last decade, research efforts have focused on these two major topics. Categorization and content analysis was one of the first types of study to emerge and has been maintained over the years, highlighting documentaries, reports and animations as the most present and most popular formats (Thelwall et al., 2012; Morcillo et al., 2016; Plank et al., 2017). One of the most recent classifications suggests 18 different formats, divided into two major groups: television formats—videos that were initially broadcast on television and then uploaded online—and web formats—videos produced from scratch to the internet (García-Avilés and de Lara, 2018). Video blogs, TV news stories and TV features or documentaries were the most frequent video formats used on science communication (García-Avilés and de Lara, 2018).

The question of form and content is directly related to the production and its actors. The type of channel, and by default the production contexts, are particularly important when we examine video popularity (Welbourne and Grant, 2016). Léon and Bourk

(2018) identifies media companies as producers of more than half of the analyzed videos, in contrast to the scientific institutions that produce much less; however, both are more represented by traditional formats such as news and documentaries (Erviti, 2018). The most experimental and emerging genres are in charge of non-professional users and their entitled User Generated Content (UGC) (Erviti, 2018), content that despite being less numerous is more popular in science communication (Welbourne and Grant, 2016).

In the production process, other elements, adding to the narrative format, have to be taken into account. First, it is important to understand what the ideal length of a video is. The average video length on YouTube is 11.7 min (Statista, 2020a). Depending on the category the video length can vary a lot, from 24.7 min in "Gaming" to 6.8 min in "Music" (Statista, 2020a). Also, looking at the most popular video content categories that year, we can assume that shorter videos are not the most popular ones (Statista, 2020b). So, it's important to adapt the length of our film to the area, category and target audience. Concerning the sound, recent findings suggest that good audio quality is in the researcher's or reporter's interest and that the technical quality of recordings can affect the evaluation of the research (Newman and Schwarz, 2018). The average quality of the audio and the narrator's voice of popular science videos are good and very good, showing values of production and a certain degree of professionalism on this feature (Morcillo et al., 2016). Scarce literature on the effects of length and audio quality on video popularity and the future research tasks on producing a video abstract lead us to include these two features in our study.

Design and Methods

The first stage of the work involved restricting the research to Ecology journals and ensuring that only journals with a high reach that is the impact factor—a metric that evaluates the frequency with which a paper is cited in a given year or period in a specific journal—were used. Thus, according to the Journal Citation Reports 2018 (Journal Impact Factor, 2018), the top 40 journals of Ecology in terms of impact factor were selected (**Supplementary Appendix A**). The journal with the highest impact factor was "Trends in Ecology and Evolution" (15.938) and the one with the lowest impact factor was "Behavioral Ecology" (3.347). From this selection, only five scientific journals, from the same publisher (Wiley), used video abstracts with their papers and on their video channels. Since this sample represented a set of less than a hundred videos, in a second stage, the research field was extended to Ecology and Environmental Sciences. Thus, 24 extra scientific journals from 6 different publishers (Springer, Springer Nature, Nature, AAAS, Cell Press and New Phytologist Trust) were added.

After that, a thorough search on the webpages of scientific journals and in their video channels was made. No limitations were imposed on the length or the use of still images in the videos, thus including hybrid formats such as the "video article" (Vázquez-cano, 2013), the "audioslide" (Yang, 2017) or the "video byte" (Research Square, 2018) in the definition used for video abstract. All the videos that did not fit this definition were excluded. In a final stage, the research was extended using keywords in search engines, to researcher's personal pages, social networks and specific platforms associated with the production of science videos such as Research Square. This process resulted in a corpus (database) of 171 videos, from 17 video channels (from YouTube and Vimeo platforms), 29 journals and 7 publishers (**Table 1**) (**Supplementary Appendix A**).

The categorization of the video abstracts (**Supplementary Appendix B**) was based on the grid analysis presented by Morcillo et al. (2016), on technical bibliography (Bordwell and Thompson, 2003; Vachon, 2018) and a pre-analysis of the videos (Coutinho, 2018). Data coding, considering the characterization of each video abstract constituting the corpus, was made manually and was divided into three steps (Morcillo et al., 2016):

(1) Collection of general metrics for each video:

- (a) video title;
- (b) channel name;
- (c) number of subscribers of the channel;
- (d) number of likes;
- (e) number of dislikes;
- (f) number of views;
- (g) number of comments;
- (h) length of the video: measured as the complete duration of the video;
- (i) video age: in number of days from the date of publication to the date of data collection;

(2) Collection of general metrics of scientific papers associated with the video abstracts:

- (a) number of citations;
- (b) Altmetric value;
- (c) publication date;
- (d) number of days online;
- (e) scientific field;
- (f) country of origin of the first author.

(3) Collection of content factors for each video:

- (a) production: amateur (a video produced by the author(s)/researcher(s) with limited resources), semi-professional (a video that mixes professional with amateur resources, normally associated to a university or research center) or professional (a video produced by a media company, producer or science magazine);
- (b) number of narrators: a specific number or no narration;
- (c) gender of narrators: female, male or no gender;
- (d) type of narration: first-person narration or third-person narration;
- (e) type of thumbnail: a miniature of a frame, designed titles or any other option;
- (f) shooting location: exterior locations, interior locations or both;
- (g) number of takes used in the film;
- (h) shots used: extreme long shot, long shot, medium-long shot, medium shot, medium closeup, closeup, extreme closeup;

TABLE 1 | Number of video abstracts by video channel, scientific journal and publisher.

Publisher	Channel	Journal	Number of videos
Wiley	Functional Ecology	Functional Ecology[a]	23
	American Museum of Natural History	Functional Ecology[a]	1
	Journal of Ecology	Journal of Ecology[a]	18
	Ecography	Ecography[a]	13
	Journal of Animal Ecology	Journal of Animal Ecology[a]	10
	Wiley	Ecohydrology[a]	1
	Wiley	Environmental Toxicology and Chemistry	1
	Wiley	Fisheries Magazine	2
	Wiley	Ecology and Evolution[a]	1
	Wiley	WIREs Water[a]	1
	Wiley	Global Change Biology[a]	1
	Research Square	Land Degradation and Development[a]	1
New Phytologist Trust	New Phytologist Trust	Plants, People, Planet[a]	9
Springer	Research Square	Sustainability Science	1
	Springer Videos	Ambio	1
Springer Nature	Research Square	Parasites and Vectors	1
	BMC	BMC Biology	1
	BMC	BMC Evolutionary Biology	1
	BMC	BMC Zoology	2
	BMCseriesJournals	BMC Zoology	1
Nature	Research Square	Nature Climate Change	2
	Eltahir Research Group at MIT	Nature Climate Change	1
	Nature Videos	Nature Climate Change	1
	Nature Videos	Nature Ecology and Evolution	2
	Nature Videos	Nature Physics	1
	Nature Videos	Nature	5
	Nature Videos	Nature Genetics	1
	Nature Videos	Nature Communications	1
	Nature Videos	Nature Plants	1
	Scientific Reports	Scientific Reports	6
AAAS	Science Magazine	Science	13
	Science Magazine	Science Advances	3
	Miguel Araujo	Science Advances	1
Cell Press	Current Biology	Current Biology	43

[a]*Journals with video abstracts published on their official webpages.*

(i) video format: animation (video that uses animation techniques, as motion graphics, stop motion or whiteboard animation), documentary (live footage video that presents its themes in a factual and informative way, using numerous clips and different techniques, similar to a tv documentary or reportage), dynamic presentation (video with still images and titles animations, normally with music instead of narration), monologue (video in which the author, improvising or following a script, speaks directly to the camera on a scientific topic) or simple presentation (video that is mostly shaped by still images, narrated like a slide presentation);
(j) intro description: design and characteristics of the opening credits;
(k) outro description: design and characteristics of the opening credits;
(l) additional elements: maps, graphics, diagrams or others;
(m) sound design: the presence of background music, sound effects or others;
(n) audio quality: measured as the narrator's voice quality (good, bad or no narration).

As the initial coding process was carried out by just one person, we decided to strengthen the analysis. Therefore, a group of 30 coders was invited to analyze a representative sample of the corpus. The group had researchers from exact sciences and social sciences, and professionals from audio-visual, marketing and education fields. The sample of 21 videos (12% of the total) was representative of the main characteristics under study. After the coding, we measured the agreement between the coders using the Fleiss Kappa measure (Coutinho, 2018), for three of the four content factors used in our correlation (production, format and audio quality). The values obtained were all below 0.3 what represents a poor agreement between coders (Coutinho, 2018). To improve reliability, the categories were redefined and reformulated, as described above. A new coding process was led by all the authors of the paper. The key content factors were independently coded, and the values obtained varied between a strong (0.83 for video format and 0.80 for video production) and a good agreement (0.72 for audio quality).

All the links and web addresses from the selected papers, journals, videos, and channels were also collected (**Supplementary Appendix A**).

Descriptive analyses were made for the number of video abstracts per year (from 2010 to 2019), publishers of the

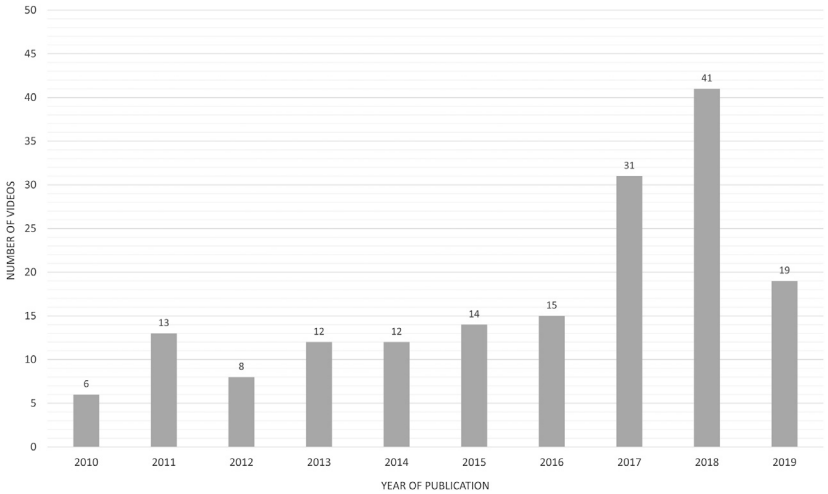

FIGURE 1 | Number of video abstracts per year of publication (from 2010 to September 7th, 2019).

scientific journals associated with each video, production, additional elements, shooting location, the number of takes, shots used, intro and outro descriptions, number and gender of the actors/narrators, type of narration and the video format. Generalized linear mixed models (GLMMs) were used to explore the effect of production, video format and audio quality (given as narrator's voice quality) in video length, number of views per day, number of citations per day of the corresponding scientific paper, and Altmetric, including scientific journal as random factor. Because, the variance of the random factor was lower than the variance of the residuals, the random factor was removed and generalized linear models (GLMs) were used (Bolker et al., 2009). A Poisson distribution with a log link function was used in video length and Altmetric, and a Gaussian distribution and an identity link function were used for number of views per day of the video and citations per day of the corresponding scientific paper.

All analyses were performed in R software version 3.0.1 (R Core Development Team, 2016), using the packages "ggplot2" for graphics build-up, "car" for Type-III analysis of variance (Fox et al., 2012), "lme4" for generalized linear models and generalized linear mixed models (Bates et al., 2014) and "multcomp" for multiple comparisons after Type-III analysis of variance (Hothorn et al., 2016).

RESULTS

In **Table 1** the number of video abstracts for each video channel, scientific journal and science publisher is given. Of this set, only ten journals have their videos published on their official webpages, in addition to their video channels.

General Characterization

Between 2010 and 2018 the number of video abstracts produced increased sevenfold and the growth rate stayed more or less constant (**Figure 1**). The small number of video abstracts uploaded in 2019, compared to the previous year, is directly related to the last date of data collection (September 7th, 2019). Wiley is the publisher with the most videos associated (43%), followed by Cell Press (25%) and Nature (13%). Almost half of the studied videos have a duration comprised between 1 and 3 min (25% between 2 and 3 min and 22% between 1 and 2 min). Videos with 4–5 and 5–6 min correspond to 12% and 13% of the cases, respectively. Longer videos account for approximately 19% of the cases and there is a decreasing number of videos with increasing length (**Figure 2A**).

Looking at production contexts there is a prevalence of amateur videos (50%), created by the researchers/authors of the work. Professional videos, produced by a media company or producer, comes in second place, representing 38% of the surveyed videos. Videos that mixes professional with amateur resources, defined as semi-professional videos, are the least frequent (12%) (**Figure 2B**).

Almost half of the surveyed videos (47%) mix the use of still images with moving images. Also, the sole use of moving images (33%) prevails over the sole use of still images (20%). The most used additional elements were graphs and maps. In the videos where film shooting is included, the majority is made outdoors (42%) or combines indoors with outdoors footage (45%). Videos shot exclusively indoors are a minority (13%). Furthermore, 85% of these videos have a story with more than three takes, and 66% include the use of more than one shot. The intros and outros of the videos are mainly based on a simple composition of titles or credits, which can appear solo, with still images or with videos.

Most of the voiceover is done by a single narrator/researcher (73%), followed by videos with no narration (12%) and videos with two narrators (10%); videos with three and four different narrators are residual (**Figure 2C**). Regarding the way the story is narrated, the majority of the videos (61%) presents a third-person narrator instead of a first-person narrator (18%) (**Figure 2D**). As for the adopted format, most of the videos tell their story in more traditional ways recurring to the documentary style (46%) or simple presentations (23%). More disruptive formats, like animations (16%) or dynamic presentations (11%), have a small representation, and monologue is the least used format

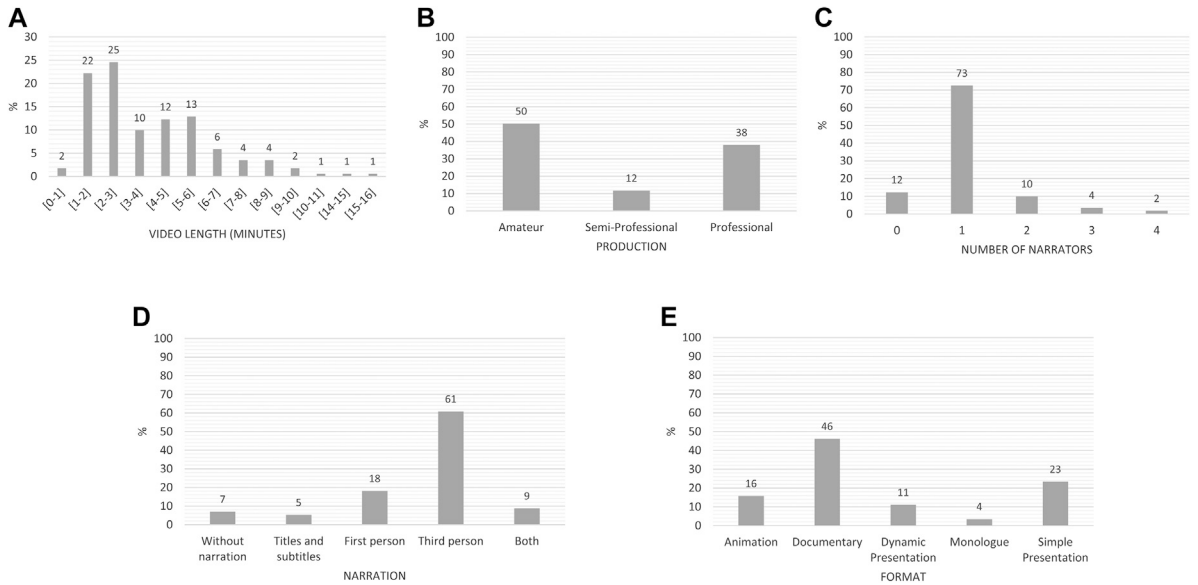

FIGURE 2 | Proportion of video abstracts (%) according to the video length **(A)**, the type of production **(B)**, number of narrators **(C)**, type of narration **(D)** and video format **(E)**.

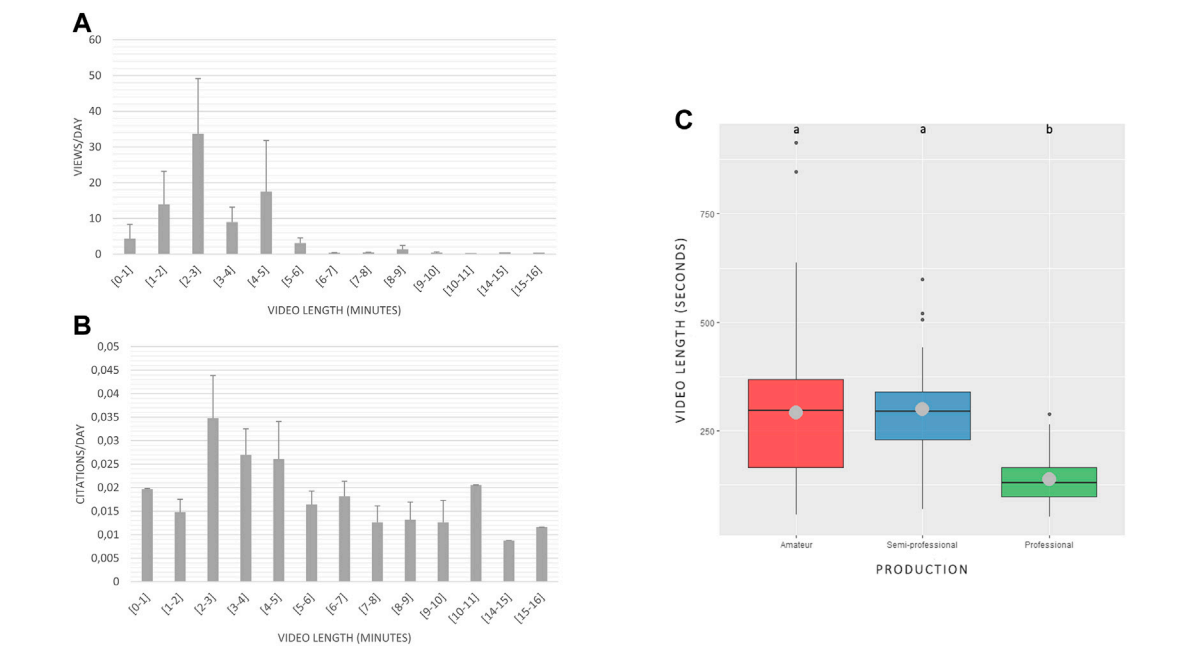

FIGURE 3 | Video length according to the number of views per day **(A)**, the number of citations per day **(B)** and production type **(C)**. In A and B values are given as mean and standard error of the mean. In C, the lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

(**Figure 2E**). Finally, more than half of the researchers who narrate the videos are male (57%), while females appear less represented (36%); the joint narration is not so popular (7%).

Video Length

Videos with 2–3 min length presented the highest number of views per day and the respective scientific papers presented

TABLE 2 | Statistical results from Generalized Linear Models of the effect of production, video format and audio quality (given as narrator's voice quality) in video length, number of views per day of the videos, and number of citations per day and Altmetric of the corresponding scientific paper. Statistically significant differences at $p < 0.01$, are highlighted in bold.

Factor	Variable	Df	χ^2 values	*p* value
Production	Video lenght	**2,168**	**37.34**	**<0.001**
	Number of views per day	2,168	0.22	0.801
	Number of citations per day	**2,168**	**8.00**	**<0.001**
	Altmetric	**2,168**	**9.93**	**<0.001**
Video format	Number of views per day	4,166	0.40	0.810
	Number of citations per day	**4,166**	**3.34**	**0.01**
	Altmetric	**4,166**	**4.89**	**<0.001**
Audio quality	Number of views per day	2,168	0.76	0.470
	Number of citations per day	2,168	3.43	0.415
	Altmetric	**2,168**	**4.52**	**0.01**

the highest number of citations per day (on average) (**Figures 3A,B**). Therefore, there seems to be a clear preference for shorter content, with a tendency for the abovementioned variables to decrease as the running time of the videos increases. Statistically significantly differences were detected among the production types ($\chi^2_{2,168} = 37.34$; $p < 0.001$, **Table 2**), with shorter videos being significantly associated with professional productions; on the other hand, amateur and semi-professional productions are significantly longer, with no significant differences being observed between both production types (**Figure 3C**).

Video Production

Videos with professional ($n = 65$) and semi-professional ($n = 20$) production presented more views per day on average than the amateur productions ($n = 86$), but the differences were not statistically significant ($\chi^2_{2,168} = 0.22$; $p = 0.801$; **Table 2**) (**Figure 4A**). Also, the median values of views per day were lower for videos with semi-professional production in comparison with those with professional production. The same trend was observed for the number of citations per day of the respective scientific papers, with the highest average values being obtained for professional production, but in this case videos with professional production led to a significantly higher number of citations than amateur production ($\chi^2_{2,168} = 8.00$; $p < 0.001$; **Table 2**), with semi-professional productions presenting intermediate values not differing significantly from the other productions types (**Figure 4B**). For the Altmetric value of the publication, statistically significant differences were obtained among the three production types ($\chi^2_{2,168} = 9.93$; $p < 0.001$; **Table 2**), with professional videos leading to statistically significant higher Altmetric values than semi-professional and amateur productions. Amateur productions led to the lowest Altmetric values, and semi-professional productions presented intermediate values (**Figure 4C**).

Video Format

The formats with the highest average number of views per day were the documentary ($n = 79$), simple presentation ($n = 40$) and animation ($n = 27$), but no statistically significant differences were obtained among video formats ($\chi^2_{4,166} = 0.40$; $p = 0.810$; **Table 2**). It should be noted that simple presentation format presented some outlier values that might have influenced the average values, but presented median values similar to monologue ($n = 6$) and dynamic presentation ($n = 19$) formats (**Figure 5A**). Statistically significant differences were obtained for number of citations per day ($\chi^2_{4,166} = 3.34$; $p = 0.01$; **Table 2**). Animation and documentary formats are highlighted with the highest average number of citations per day, but significant differences were only obtained between animation and dynamic presentation and between animation and simple presentation (**Figure 5B**). For the Altmetric, statistically significant differences were obtained among videos formats ($F_{4,\ 166} = 2{,}876.74$; $p < 0.001$; **Table 2**), with animation

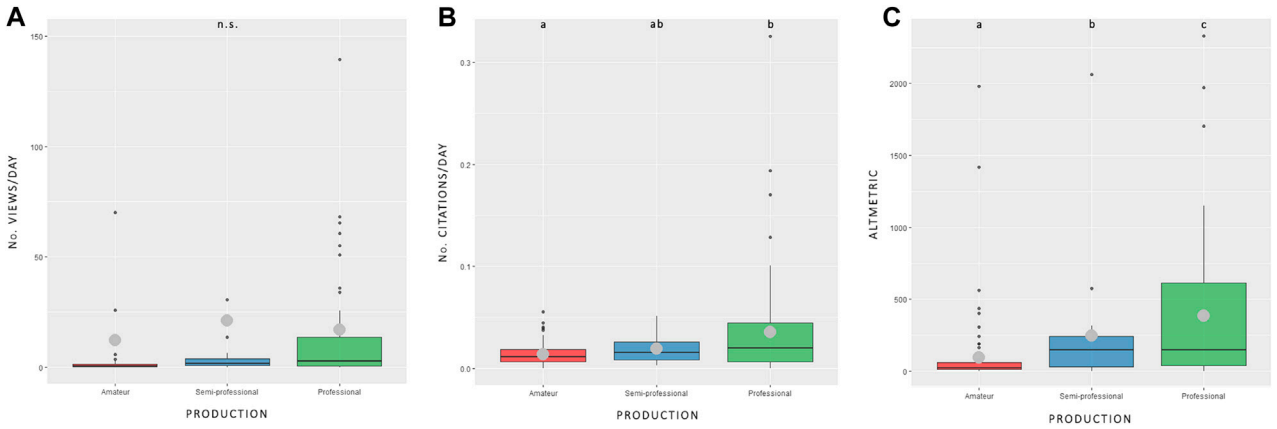

FIGURE 4 | Video production according to the number of views per day **(A)**, and number of citations per day **(B)** and Altmetric values **(C)** of the corresponding scientific paper. The lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

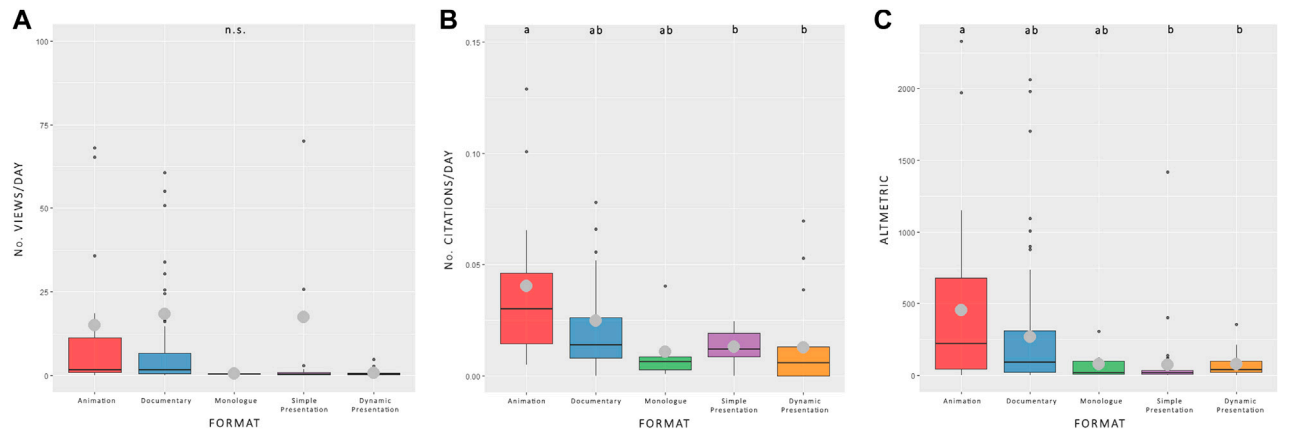

FIGURE 5 | Video format according to the number of views per day **(A)**, and number of citations per day **(B)** and Altmetric values **(C)** of the corresponding scientific paper. The lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

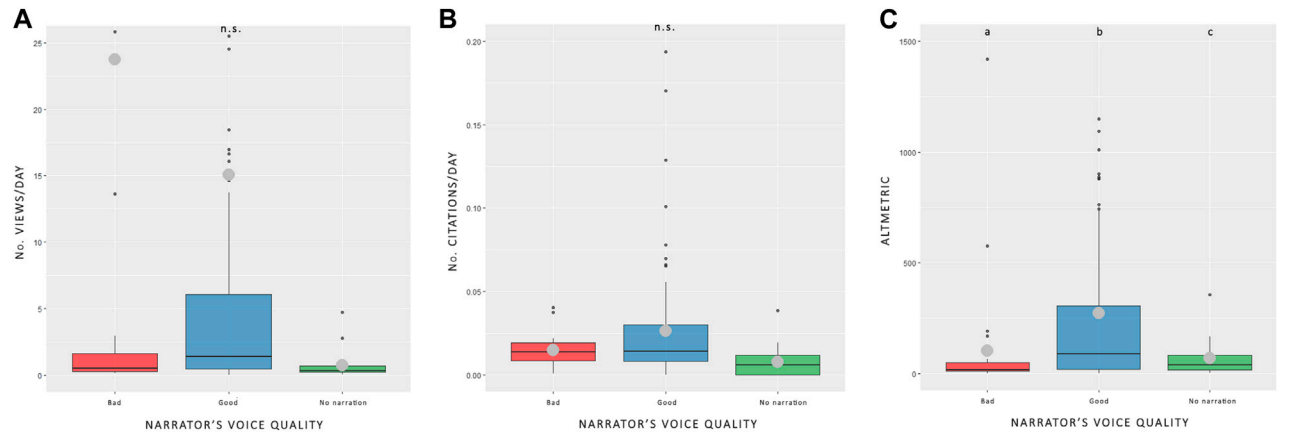

FIGURE 6 | Narrator's voice quality according to the number of views per day **(A)**, and number of citations per day **(B)** and Altmetric values **(C)** of the corresponding scientific paper. The lower and upper hinges of each boxplot correspond to the first and third quartiles (the 25th and 75th percentiles) and whiskers extends from the hinge to the largest value no further than 1.5 * the inter-quartile range. Medians are depicted as a horizontal line within the boxplot, means as a gray bullet and outliers as black bullets (for visualization purposes online, some of the outliers are not depicted in the graphic); different letters represent statistical differences at $p < 0.05$.

format leading to higher Altmetric values than the other formats; however, significantly higher values for the animation format were only obtained when compared with the values obtained for dynamic and simple presentations, which are among the lowest ones (**Figure 5C**).

Audio Quality

Videos where the quality of the narrator's voice is bad ($n = 28$) had a higher average number of views per day than the videos with good ($n = 125$) or no narration (**Figure 6A**), despite no significant differences were obtained among the three groups ($\chi^2_{2,168} = 0.76$; $p = 0.470$; **Table 2**). It should be noted that this was probably influenced by some outlier values in videos where the quality of the narrator's voice is bad as the median value is the lowest one, being even lower than that obtained for videos with no narration (**Figure 6A**). On the other hand, the number of citations per day and the Altmetric value of the corresponding scientific paper showed higher average values when the videos have good narration (**Figures 6B,C**, respectively). However, such differences were only statistically significant for the Altmetric value ($\chi^2_{2,168} = 4.52$; $p = 0.01$; **Table 2**). For the number of citations per day, despite the tendency referred above, the values were not significantly different ($\chi^2_{2,168} = 3.43$; $p = 0.415$; **Table 2**).

DISCUSSION

The results of this study highlight the fact that the use of video abstracts in Ecology and Environmental Sciences is a complex and dynamic process. Our corpus presented us with very different approaches toward the production of a video abstract in this area: from a single researcher in his office to professional

documentaries, from still images of the fieldwork to ingenious animations, from long presentations to very short explanations. This enormous variety of elements represented a huge challenge on the processes of content analysis and categorization. It is difficult to design a typology that represents such diversity (García-Avilés and de Lara, 2018). Our study provides relevant information to understand how this genre is evolving and contributes to establishing new directions toward more effective audio-visual communication.

The study sample and its detailed analysis revealed a strong dispersion and disorganization of the contents: videos from the same publisher and the same journal are often uploaded on different channels, showing lack of a real communication strategy (**Table 1**). This is in line with previous studies in the field of video production, that revealed no or small articulation between the different offices of an institution and the various outputs, suggesting that a single and stable language is lacking (Santos and Santos, 2014) and that it is necessary to create a strategy for disseminating videos in an online environment (Erviti and Stengler, 2016). Effective dissemination implies a strategy, that in itself requires contacts, time and money (Vachon, 2018). When a film is planned it is important to include promotion as an independent task and think about it since the beginning. As researchers, the communication can be under our responsibility or be in charge of other professional (e.g., science communicators or journalists on communication offices); the important thing to ensure it is a focused voice, that determines when, how and where. It is vital to collaborate with all the institutions involved in the research (e.g., universities, research centers, research groups, science journals, science centers, newspapers) to upload the video in one unique platform, and spread the word from there. This is particularly important when we want to measure popularity metrics, being more rigorous and reliable if all the data come from one platform.

Despite this disorganization, the annual growth of video production follows the positive trend described, in general, for online scientific videos (García-Avilés and de Lara, 2018) (**Figure 1**). This evolution demonstrates a growing involvement of the scientific community and its partners with this dissemination tool and represents a clear sign of a growing interest in these new ways of communicating science. Also, although the methodology for surveying the video abstracts in Ecology and Environmental Sciences was based on exhaustive research on the webpages of scientific journals, video channels, search engines, social networks and other relevant platforms, some interesting content may still have passed unnoticed.

Unsurprisingly, most of the video abstracts followed classic models, rooted in television, such as documentaries and reportages (Welbourne and Grant, 2016; Davis and Léon, 2018): an individual, indirectly narrating a story or presenting research. It is possible that these specific areas (Ecology and Environmental Sciences) also amplify the use of these formats, once there is a great tradition on nature documentaries, very rooted in popular culture. The dominance of moving images and a certain complexity of production—in the number of takes, in the mix of indoor with outdoor shooting and in the type of elements used—are strong examples of this style. In contrast to what was observed by Erviti (2018), the bigger expression of amateur videos, and the so-called User Generated Content (UGC), does not represent, in this sample, more experimental content (Erviti, 2018). This probably reflects the need for specific training in these areas (Plank et al., 2017; Vachon, 2018; Angelone et al., 2019). In advanced courses in the area of science video production, after coming into contact with new ways of storytelling, most researchers opt for these alternatives, instead of the linear narratives they previously were aware of (Angelone et al., 2019). In the eyes of the public, disruptive genres such as motion graphics seem to cultivate greater interest, as reflected in the number of citations per day and Altmetric of the associated papers. However, the more traditional formats and narratives prevail largely. This can also be related to the fact that this kind of expository style is believed more (Davis et al., 2020). Also, the audience of this videos may be an engaged one, with peers and people with a university education, with whom the infotainment style is not so effective (Davis et al., 2020).

With this study, it seems clear that the most recommendable length for video representations of scientific works in Ecology and Environmental Sciences, taking into account the video (given as the number of videos/day) and paper (given as the number of citations/day) outreach, is between two and three min. This average length is also associated with professional contexts. Professional and semi-professional productions also usually led to higher video and paper outreach. This possibly reflects better content dissemination mechanisms (reflected in high Altmetric values), actors with more experience in the field and the establishment of stronger bridges between audio-visual content and written content. Despite the relevance of this data, further research regarding video length (Welbourne and Grant, 2016) and production values, using a larger amount of samples and other variables, such as the impact of video-abstracts in science learning (Slemmons et al., 2018), is needed.

Although previous studies have shown that ensuring good audio quality should be in the researcher's interest (Newman and Schwarz, 2018), in our case, the quality of narrator's voice, given by the general audio quality, was not a determining factor for video viewing. However, it had a positive impact on the scientific reach of the written paper, measured as the Altmetric. As it happens with some of the other results, strong conclusions should be viewed with caution, as factors such as the reach and effort that each researcher and journal have invested in promoting its video, variables that are very difficult to measure, may prevail as explanatory variables. For future work, once audio quality is a difficult metric to quantify, we recommend the use of quantitative metrics like the number of words per minute (Morcillo et al., 2016).

Another variable that could help to clarify some of the results we have obtained is the audience retention. This measure tells us how many people are still watching a video during video playback, indicating when viewers stop watching (e.g., YouTube Analytics). Understand the viewer's interest throughout the video can give us insights into what segments are working well and what sections need to be improved. Also, if the number of views measures popularity, it fails to translate impact or ensure that the content was viewed in its entirety; unfortunately, such data is only available for the authors/owners of the videos. Future research will focus on the production of our own video abstracts in the area of Ecology and Environmental Sciences, and this will enable to evaluate these

metrics, allowing us to explore new content data and new visual features. Due to time constraints and research purposes not all the visual components were coded and interpreted. These elements can be explored on a visual rhetoric approach (Finkler and León, 2019), exploring the different elements of the science storytelling, for example creating and testing two different versions of the same video abstract, where only one feature differs.

Furthermore, there is also a series of non-controllable variables that were not taken into account in this study and that can somehow affect the results, including the characteristics of the video channels (number of subscribers) and the scientific papers (number of authors, presence of international co-authors, number of characters in the title and the abstract, number of keywords, references and pages and funding). Future studies considering all these variables are highly recommendable.

CONCLUSION

This work intends to be the first step in the characterization of video abstracts in Ecology and Environmental Sciences and bring added value to the general characterization of scientific videos. Along with previous works (Morcillo et al., 2016) the intention is to describe and classify the state of the art, working mostly with outreach metrics. However, as the use of video abstracts is still a very recent tool, it still lacks clear and definitive guidelines that sometimes leads to improper use of the type of content considered. Such a lack of theoretical framework inevitably leads to subjectivity not only in the type of content but also in the evaluation process. To fill these gaps, a separate study on creating a validation model for video-abstracts in these scientific areas is under development. We hope that this future instrument of research will allow us to validate some of our coding categories and contribute to establishing a stronger model of an effective video abstract in Ecology and Environmental Sciences.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

MF and JL designed the study. MF conducted the main analysis of the videos. JL performed the statistical analyses. All authors participated in scientific discussion and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2021.596248/full#supplementary-material.

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