Tracking the social dimension of ongoing fish distributional range shift in marine recreational fishing

Master's in Oceanography and Marine Environmental Management
Master's thesis submitted to the Faculty of Biology of the University of Barcelona by Lucía Espasandín Soneira

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ABSTRACT

One of the most important ecological impacts of climate change on marine ecosystems is the distributional range-shift of species. Understanding the social implications of this phenomenon is crucial for managers and policy makers in order to adapt fisheries management and resource conservation. In this paper we investigate the social dimension of recreational fishing in the context of an ongoing distribution range-shift of a target species. Specifically, we mined data on YouTube about recreational anglers and spearfishers targeting the white grouper (*Epinephelus aeneus*), which is a species expanding northwards in the North-western Mediterranean Sea. We retrieved a total of 453 videos. Results showed that at least in Italy social engagement is higher for spearfishers than anglers. In general, we documented an overall positive polarity of comments in both Italy and Spain, but specific negative emotions such as fear, disgust or anger were more common for angling videos in Italy. Interestingly, we detected a positive correlation between joy and latitude, which means that videos from higher latitude where the white grouper can be still considered a rare species triggered more joy than at lower latitude where this species is more common. Our study demonstrated that social media data can track the social dimension of ongoing distributional range shift and, above all, offer a real time tool for adaptive management.

**KEYWORDS:** Mediterranean Sea; Climate Change; Emotions; Culturomics; Digital data; Species redistributions.
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INTRODUCTION

Social dimensions

One of the most important ecological impacts of climate change on marine ecosystems is the distributional range-shift of species (Molinos et al., 2015; Poloczanska et al., 2013; Poloczanska et al., 2016). Mobile marine organisms are shifting to maintain their optimal environmental windows, which in many cases this means to move towards higher latitudes, looking for suitable habitats to cope with warming (Burrows et al., 2011; Cheung et al., 2009; Fogarty et al., 2017). Similarly, invasive species can be facilitated by the impacts of climate change (Azzurro et al., 2019; Bellard et al., 2013; Walther et al., 2009). Redistribution of species can have important impacts on biodiversity, ecosystem functioning and services (Cheung et al., 2009; Diagne et al., 2021). In particular, human well-being can be directly affected by the changes in species distribution (Pecl et al. 2017). For these reasons, the human dimension of this phenomena must be taken into serious consideration to inform policy makers and managers (Cheung et al., 2010).

Fisheries and recreational fisheries

Fisheries can be considered as complex social-ecological system (SES) where important interactions exist between marine ecosystems, fishing communities and the broader society (Berkes, 2011; Berkes et al., 1998; Ojea et al., 2020). The most direct consequences of distributional range shifts on fisheries comprise the arrival of new potential target species to some locations and disappearance in others, which might lead to a change in species abundance and thus in catch composition (Ojea et al., 2020). Distributional range shift can also affect recreational fisheries (Kerr et al., 2009; Nyboer et al., 2021; Townhill et al., 2019).

Recreational fisheries and real-time monitoring

Recreational fishing can be affected in both positive and negative way (Gledhill et al., 2014). For example, the loss of a species in a place can derive in the colonization of a new habitat, leading to new recreational fishing opportunities (Kennedy et al., 2002). Despite the social, economic and ecological importance of recreational fisheries (Arlinghaus et al., 2019; Hyder et al., 2018), the potential consequences of climate change are understudied (Kerr et al., 2009), especially from a social perspective.

Real-time data mining has been suggested as a necessary approach for scientist for tracking and adapting to distributional range shifts (Pecl et al., 2017). Social media data can provide important complementary information for this real-time approach (Pettorelli et al., 2019;
In this context, recreational fishers can play an important role, because they can be considered a widespread network of observers that tend to share their catches on social media (Sbragaglia et al., 2021). Therefore, mining data about recreational fishing on social media can be an effective way to have a real-time monitoring of distributional range shifts, but above all to track real-time changes among recreational fishers from a social perspective.

**Case study**

Here, we use videos posted on YouTube by recreational fishers in the North-western Mediterranean Sea targeting the white grouper, *Epinephelus aeneus* (Goffroy St. Hilaire, 1817). The Mediterranean Sea is an important marine biodiversity hotspot (Myers et al., 2000), which is warming faster than other areas of the world (Cramer et al., 2020). As such, distributional range shifts represent a widespread problem for biodiversity conservation and fisheries management (Azzurro et al. 2019). Considering the importance of recreational fisheries in the Mediterranean Sea (Hyder et al., 2018), it is essential to analyse the human dimension of the distributional range shifts of species. In this context, the white grouper represents a perfect case study because it is a highly-valued species for both recreational anglers and spearfishers (Pollard et al., 2018). There are also evidences that this species is undergoing a northward distributional range-shift colonizing new areas of the Mediterranean Sea (Bo et al., 2020; Đođo et al., 2016; Dulcic et al., 2006; Glamuzina et al., 2000; Pollard et al., 2018; Riutort, 2012) and even arriving to Galicia through the Atlantic Sea (Bañón et al., 2020). In particular, previous studies showed that social media data can be used to track the ongoing distributional range shift of the white grouper (Sbragaglia, Coco, et al., 2021), but the social aspects of this phenomenon are still not characterized within the recreational fishing context.

**Objective**

Following on the findings of Sbragaglia et al. (2021), the objective of the present study is to characterize the social dimension of recreational anglers and spearfishers related to the ongoing distributional range shift of the white grouper in the North-western Mediterranean Sea (Italy, France and Spain). To do that, we aimed to answer the following research questions:

1) Are there differences in the social engagement of videos posted by recreational anglers and recreational spearfishers?
2) Are there differences in the sentiments and emotions of the comments posted by recreational anglers and spearfishers?
3) Is there a correlation between emotions and sentiments (e.g., joy or surprise) and latitude?
MATERIALS AND METHODS

Ethical aspects
We followed the framework presented by Monkman et al. (2018) on the ethics of using social media in fisheries research. The recent guidelines presented by Di Minin et al. (2021) and Sbragaglia, Correia, et al. (2021) for ensuring data privacy concerns were also fully considered and the European Union's (EU) General Data Protection Regulation (GDPR) was complied with when using social media data. Specifically, we minimized the data by discarding all but the required information and pseudonymised the data by replacing IDs (e.g., channel title, channel ID). Finally, we kept all data related to personal information in one dataset, while the rest of data presented in the paper were stored in a separate dataset.

The case study
We explored the recreational fishing of the white grouper in Italy, France and Spain by systematically mining data on YouTube from 2010 to 2020 by using a methodological approach previously applied in other studies (Correia et al., 2021; Sbragaglia et al., 2020; Sbragaglia et al., 2021). We automatically retrieved the metadata of videos published concerning the species of interest and sorted them into two groups: one related to captures by recreational angling and the other one related to captures by recreational spearfishing, following the process reported in Sbragaglia et al. (2020).

Data mining
We collected the data using the YouTube Data API (v3), following the steps reported in previous studies (Sbragaglia et al. 2020; Sbragaglia et al. 2021). We extracted the data from YouTube's API in January 2021 for each country of interest using the common name of the species in the three different languages (Italian: “cernia bianca”; Spanish: “mero blanco”; French: “mérou blanc”). This approach helped to narrow the results to the study area, but also captured homonyms and other non-relevant content (Correia et al., 2017), and thus data required careful validation (see below). We first compiled a raw dataset with the title and description of videos together with social engagement values (number of views, likes, and comments). Then, we manually cross-checked the data to assign the videos to two different categories such as recreational angling and spearfishing and exclude the videos that were not related to the purpose of the study (e.g., not related to the target species, not showing the catch of the target species, not related to the target countries, or duplicates of previously published videos). We
resolved the location of the catch shown in the video first at a general level (e.g., region within a country such as Balearic Islands or Sardinia), and then when possible at the specific locations together with corresponding geographic coordinates. Data mining was done with R software (https://www.r-project.org/; version 4.0.3) using “jsonlite” (Ooms 2014), “lubridate” (Grolemund & Wickham 2011) and “curl” (https://cran.r-project.org/web/packages/curl/index.html) packages.

**Analysis of comments**

We systematically mined the text of all the public comments associated with the videos previously identified and validated. After downloading the comments, we transformed the text into tokens (i.e., individual word units), and we removed stop words (meaningless words) as well as some signs without implicit meaning. Then, we analysed the frequency of occurrence of tokens in comments of videos by recreational anglers and spearfishers in the different countries.

We applied sentiment analysis to all the comments according to the Saif Mohammad’s NRC Emotion lexicon (http://saifmohammad.com/WebPages/NRC-Emotion_Lexicon.htm), using the available reference dictionaries in the different languages of the countries with some modifications. The NRC emotion lexicon is a list of words and their associations with two sentiments (negative and positive) and eight emotions (anger, fear, anticipation, trust, surprise, sadness, joy, and disgust). In order to be clear, we want to add that “positive polarity” appears when expressing a favourable sentiment, while “negative polarity” appears when expressing an unfavorable sentiment. The output of the sentiment analysis was a dataset with one YouTube comment in each row and ten columns (two sentiments and eight emotions). Some of the most important limitations that the original dictionary has are the following (Mohammad, 2020): (1) some of the most frequent words used by recreational fishers were not listed in the original NRC Emotion Lexicon; (2) in some cases the words used by recreational fishers were not related with the associated emotions originally listed. For example, “grande” (“good boy” in english) is a word that, in this specific context of recreational fishing, is clearly associated with a positive polarity and with emotions like interest and joy; however, it was not listed in the original dictionary. Another example is “fucile” (“rifle” in english) that, in this specific context of recreational fishing, is not associated with a positive nor negative polarity; however, in the original dictionary is associated with a negative polarity. Therefore, we decided to modify the original dictionary using a focus group approach in order create a dictionary that better fitting with our study case and also in order to correct the possible errors in translation, from English to Italian or Spanish. We run all the analyses related to quantitative analysis of comments in R (https://www.r-project.org/);
version 4.0.3) with the additional package “quanteda” (Benoit et al., 2018) and “syuzhet” (Jockers, 2020). In order to analyse the polarity and emotions presented in the comments of the videos posted by spearfishers and anglers in both countries, we sum up the values of the 8 emotions and 2 polarities by group. We also determined the changes of the different emotions and polarities across a latitudinal gradient. To do that, we selected only the comments related to the videos that had an available location and calculated the mean score for sentiments and polarity for all the comments at each specific latitude.

Data analysis
We used Generalized Linear Models (Nelder & Baker, 2006) to estimate differences between recreational angling and recreational spearfishing videos in the social engagement variables (number of views, likes, and comments). We estimated differences in the proportions of polarity and emotions within comments using a two-tailed z-test. We also used that test for estimating the differences between angling and spearfishing regarding the frequency of the most used words. In all the cases we used a 95% confidence interval. We used the Kendall rank correlation coefficient in order to evaluate the degree of similarity between the different sentiments and the latitude. We ran all the analyses in R (https://www.r-project.org/; version 4.0.3).
RESULTS

Framework
The majority of videos that were identified and validated were from Italy (437; 198 related to angling and 239 to spearfishing), while only 16 videos were from Spain (all of them related to spearfishing). We did not identify videos from France (Figure 1).

Figure 1 - Map showing the occurrence of *Epinephelus aeneus* in the Mediterranean Sea. With black dots are represented the occurrences reported by GBIF in Bañón et al., 2020 completed thanks to some bibliographic references (Bo et al., 2020; Đỗđo et al., 2016; Dulcic et al., 2006; Glamuzina et al., 2000). With colourful dots are represented the captures that were used in this study: some are partially available on GBIF (see also Fig. S1 in Sbragaglia et al. (2020) and the rest were retrieved within the analysis of the present study. In this case the dots are showed with different colours according to the year of capture.
Social engagement

Regarding social engagement, the number of views related to videos by Italian recreational fishers were significantly higher in spearfishing videos than in recreational angling ones [Rate Ratio = 2.70 (2.06 – 3.54); $\chi^2 = 49.33; p < 0.001$; Figure 2A]. The same pattern was found in regard to the number of likes [Rate Ratio = 3.18 (2.36 – 4.27); $\chi^2 = 54.98; p < 0.001$; Figure 2B] and comments [Rate Ratio = 4.27 (3.09 – 5.88); $\chi^2 = 72.17; p < 0.001$; Figure 2C]. We were not able to test the same patterns for the videos of Spanish recreational fishers because we only identified spearfishing videos (Figure 2D, 2E and 2F).

![Figure 2 - Barplots of the average social engagement, in Italy and Spain, for both angling and spearfishing together with standard error of the mean: (A) number of views; (B) number of likes; (C) number of comments. The total number of identified videos is 198 for angling and 239 for spearfishing. Significant differences are reported according to the results of the GLM models (***: $p < 0.001$).](image-url)
**Frequency of most used words**

We analysed the frequency of most used words of 3,384 comments (552 for angling and 2,832 for spearfishing) in a total of 282 videos (100 for angling and 182 for spearfishing) from both Italy and Spain. Specifically, in Italy we analysed the content of 3,172 comments (552 for angling and 2,620 for spearfishing) in a total of 270 videos (100 for angling and 170 for spearfishing). In Spain we analysed the content of 210 comments (all of them for spearfishing) in a total of 12 videos. The quantitative analysis, after the tokenization and removal of stop words (meaningless words), identified a total of 8,722 tokens (Italy: 2,354 for angling and 5,434 for spearfishing; Spain: 934 for spearfishing). The frequency analysis indicated that most common tokens in both groups and both countries were “thank you” (“grazie” in Italian; “gracias” in Spanish), “video”, “hello” (“ciao” in Italian; “saludos” in Spanish), and “congratulations” (“complimenti” in Italian; “enhorabuena” in Spanish; **Figure 3**). Interestingly, the token “fishing road” (“canna” in Italian) only appeared in comments of videos by recreational anglers and the word “bel” (“nice”) only appeared in comments of videos by recreational spearfishers. In general, the other Italian tokens showed a significant higher ($p < 0.05$) frequency in comments of spearfishing videos than angling ones (**Figure 3A**).

**Sentiment analysis and correlation with latitude**

Both in Italy and Spain, there was a prevailing “positive polarity”. Sentiment analysis indicated differences in polarity between comments related to videos posted by Italian recreational anglers and spearfishers (**Figure 4A**). In particular, we found that positive polarity was significantly ($p < 0.001$) lower in the comments related to angling videos (84.42%) than in spearfishing ones (91.25%); and that the negative polarity was significantly ($p < 0.001$) higher in the comments related to angling videos (15.57 %) than in spearfishing ones (8.75%). We cannot compare the polarity between groups in Spain, because we only collected spearfishing videos.
Figure 3 - Frequency of the most common tokens used in the comments on videos posted by recreational anglers and spearfishers: (A) Italy (total of words scored by anglers = 2,354; total of words scored by spearfishers = 5,434); (B) Spain (total of words scored by spearfishers = 934). Tokens are reported in Italian and Spanish and their relative translation is reported between parenthesis as follow: grazie/gracias (thank you); complimenti/enhorabuena (congratulations); video (video); grande/crack (good boy); ciao/saludo (hello); bella (wonderful); bravo (bravo); cernia/mero (grouper); blanco (white); canna (fishing road); bel (wonderful); mare (sea); pesca (fishing); cattura (capture); pesce (fish); bellissima (wonderful). Significant differences are reported according to the results of the z-test (*: p < 0.05; **: p < 0.01; ***: p < 0.001).
Figure 4 - Frequency of polarity of emotions computed with sentiment analysis using a modified version of the Saif Mohammad’s NRC Emotion lexicon (http://saifmohammad.com/WebPages/NRC-Emotion-Lexicon.htm) for both comments of videos posted by recreational anglers and spearfishers: (A) Italy (total sentiments scored by anglers = 1117; total sentiment scored by spearfishers = 4867); (B) Spain (total sentiments scored by spearfishers = 328). Significant differences are reported according to the results of the z-test (***: $p < 0.001$).
Regarding the emotions related to comments on videos, in Italy we found that spearfishers indicated a significantly ($p < 0.05$) higher frequency of joy (25.79%) and surprise (14.41%) in comparison to videos posted by anglers (21.64% and 12.80, respectively; Figure 5). In contrast, the emotions related to comments on videos by anglers indicated a significantly ($p < 0.05$) higher frequency of fear (4.57%), disgust (2.41%) and anger (3.74%) in comparison to videos posted by spearfishers (2.43%, 1.25% and 1.28%, respectively; Figure 5). In Spain we also found a high frequency of positive emotions, while negative emotions appeared to be less frequent. Interestingly, in Italy we found that the emotion “joy” showed a significant ($p < 0.05$) positive correlation with latitude, which means that videos triggered more joy when showing the capture of a white grouper at higher latitude. The correlation between latitude and the emotion “surprise” was marginally significant (Figure 6).
Figure 5 - Frequency of emotions computed with sentiment analysis using a modified version of the Saif Mohammad's NRC Emotion lexicon (http://saifmohammad.com/WebPages/NRC-Emotion-Lexicon.htm) for both comments of videos posted by recreational anglers and spearfishers: (A) Italy (total sentiments scored by anglers = 2407; total sentiment scored by spearfishers = 11030); (B) Spain (total sentiments scored by spearfishers = 681). Significant differences are reported according to the results of the z-test (*: $p < 0.05$; ***: $p < 0.001$).
Figure 6 - Scatter plot between the latitude and the different sentiments. Each one of the eight emotions (joy, surprise, trust, anticipation, anger, disgust, sadness and fear) and two polarities (positive and negative) are represented in different colours. The number of observations (N) for each sentiment is represented in the figure. The p-value (\(p\)) and the tau (\(\tau\)) are reported according to the results of Kendall’s rank correlation test.
DISCUSSION
We showed that social media data can inform about the social dimension of ongoing distributional range shift of species by providing real-time quantitative measure of emotions in the context of recreational fishing. There are three major results in this study that we want to highlight. First, we found a higher social engagement for videos published by recreational spearfishers than those published by recreational anglers and we also found differences in the frequency of most used words in comments. Second, we showed that comments associated to spearfishing videos had higher frequency of positive polarity and positive emotions (i.e., joy and surprise) than those associated to recreational angling videos. While, comments associated to angling videos have higher frequency of negative emotions such as fear, sadness and disgust. Third, and most interestingly, we showed a positive relationship between joy and latitude, which means that there was an increase of joy in the comments related to the videos posted in higher latitudes where the white grouper is arriving due to a northward displacement. These results are discussed below together with possible limitations and future direction for this innovative approach.

Videos by Italian recreational spearfishers received more views, likes and comments than those published by Italian recreational anglers. This result is congruent with a previous study that characterized Italian recreational fishing of the common dentex (Dentex dentex) using YouTube data mining (Sbragaglia et al., 2020). We cannot be sure about the public engaged with the videos posted by recreational spearfishers and recreational anglers, but we assume that most of the social engagement with videos was triggered by either recreational spearfishers or recreational anglers, respectively, as also suggested by previous studies (Sbragaglia, Coco, et al., 2021; Sbragaglia et al., 2020). Taking this into account, we suggest two possibilities. The first is that spearfishers have a larger online community that gives a higher social engagement. This is congruent with a previous results that showed spearfishing as the most popular recreational fishing technique on social media (Giovos et al., 2018), suggesting that the community of recreational spearfishers online is larger than that of anglers. The second is that videos posted by recreational spearfishers in fact receive more engagement due to the content of the video. This could be related to the fact that spearfishing videos are more spectacular than angling ones (e.g., the contact with the nature or the use of powerful gears). Moreover, spearfishing requires more skills and personal investment of energy than angling, which could lead to an increase of likes, views and comments due to a high excitement and arousal (Sbragaglia et al., 2020). However, social engagement related to visual media may be linked to
specific attitudes of recreational spearfishers and anglers that vary according to the target species (i.e., spearfishers could be more interested to the white grouper than anglers). The absence of videos posted by recreational anglers in Spain can be very important in the socioeconomic context of this species. We suggest that spearfishers are better for early warning of the arrival of the white grouper, due the underwater nature of the activity. It could be also related to their higher engagement on posting videos, presented previously. This is an interesting aspect to investigate in future study to confirm our interpretation.

The analysis of the most frequent words used in the comments suggested that different themes and social dimensions are expressed when the community interact and engage with the posted videos. Some tokens appear to be present on spearfishing comments but not in angler ones and vice versa. We found that “fishing rod” (“canna” in Italian) is one of the most frequent words and it is only used by anglers. This result is logical due to the fishing rod is a gear only used by anglers. This word appears when asking advice about the type of gears and techniques used in the video in question. We also found that the word “nice” (“bel” in Italian) is really frequent in comments by spearfishers, but it is not frequent at all in comments posted by anglers. This word is usually referred to “video” (e.g.: “thanks for the nice video you edited”). The motivations of practising recreational fishing can be catch or non-catch related (Frijlink & Lyle, 2010). Regarding the catch-related motivations, in our results words as “congratulations”, “bravo” or “good boy” were some of the most frequent tokens used in the comments. Those are words that are mainly related to the appreciation of the fishing performance (e.g., “congratulations for the fishing strategy”). There also appeared to be frequent some words related to the admiration for the attributes of the capture, as for example “beautiful” with references to the captured fish (e.g., “beautiful capture”). Regarding the non catch-related motivations, it is known that the experiencing of nature is very important (Frijlink & Lyle, 2010; Ormsby, 2004; Young et al., 2016), being “sea” one of the most frequent words used by both recreational anglers and spearfishers (e.g., “a wonderful day by the sea” or “admire all the wonders of the sea”). In summary, our interpretation is that the words more frequently used by spearfishers support that they have a higher online engagement with respect to anglers. This interpretation is also reinforced by the previous results related to social engagement.

The sentiment analysis of this study revealed that the polarity of the comments was more frequently positive in both spearfishing and angling videos for Italy as well as Spain. Particularly in Italy we found that comments of spearfishers videos had a more positive polarity than those of angling ones. This was congruent with the frequency of the emotions: positive emotions such as
joy or surprise were more frequent in spearfishing videos, while negative emotions as fear, disgust or anger were more frequent in angling videos. This result is supported by previous studies that showed that spearfishers declare more activity satisfaction than anglers (Gordoa et al., 2019; Pita et al., 2018). However, it is important to consider that positive contents are more likely to be shared on social media (Reinecke & Trepte, 2014; Toivonen et al., 2019), which could in part explain our results. However, some negative comments of anglers in the present study were based on the criticism related to the behaviour of the fisher and the discordance of the person that comment in the video in question, which reinforce similar previous findings (Sbragaglia et al., 2020).

The most important result of our study is the fact that the emotion of joy increased with the increase of the latitude of posted videos. We suggest that with the arrival of the white grouper to northern locations (e.g., “I had never seen or captured it Liguria”), recreationalfishers experience more positive emotions such as joy in catching it, and this can be recorded through social media. The arrival of new species or increased abundance of previously rare species can create new opportunities for fisheries (Ojea et al., 2020), and we demonstrate it for recreational fishing of the white grouper. In particular, we did that by using a methodological approach that exploit public available data without consuming too much time and resources. Such approach can also be extremely valuable for real-time monitoring of distributional range shift and therefore provide essential data for adaptive management.

Limitations
The results of this study provide a novel insight into the social dimensions of recreational fishers regarding the distributional range shift of species. However, there are some limitations that must be considered for interpreting and advancing our research approach.

First of all, the availability and representativeness of digital data is affected by some factors as gender, age, education, and other socioeconomic, cultural, political and geographical factors (Jarić, Roll, et al., 2020). A political constrain was clearly represented in this case study, where there is a banning in some species of grouper, although the specific situation of the white grouper is not clear. This may be the reason of the absence of videos in France. Further research with different data sources must be provided in order to clarify this interpretation. The data gathered may not be representative of the whole population, being biased towards more active users that tend to be the most avid individuals (Ditton et al., 1992). In addition, on social media people often represent themselves in a different way from the reality. In fact, social users
usually share more positive content than negative one (Reinecke & Trepte, 2014), causing a bias on the content. Some ethical limitations must be also taken into account, specially in social media data that usually involves sensitive personal information (Jarić, Roll, et al., 2020).

Moreover, Youtube is a dynamic platform where the data can undergo changes (e.g., data loss and deletion), limiting the replicability of the study. We select some keywords for downloading the data from Youtube’s API. The constrain is that this methodology may return a subsample, limiting the access to valuable information (Sbragaglia, Coco, et al., 2021).

Textual content from social media is rich in information but difficult to analyse. It is characterized by a range of linguistic challenges (e.g., translations, sarcasm or linguistic diversity) (Toivonen et al., 2019). For example, some of the obstacles in analysing the content of the comments of this study was that some words were used with different meaning and, therefore, may be associated to a different emotion (Mohammad, 2020; Toivonen et al., 2019). In general, this is not very problematic because most of the words have a common dominant main sense, but in some specific situations, as in this case study, it is more complicated because the community of recreational fishers has a specific slang and some words are often used with a different meaning. We tried to minimize this challenge by creating the first version - to our best knowledge - of a customized emotion dictionary for a recreational fishing context. However, future aspects should consider to review it according to specific case studies. It must be also taken into account the limitations of the syuzhet package (e.g., the non-properly consideration of negation) (Naldi, 2019). From a technical perspective, we present the first step towards what should be a fully automated process where large volumes of social media contents and associated sentiments are processed using artificial intelligence, as for example image recognition or natural language processing (Roll et al., 2018; Toivonen et al., 2019).

Knowing the previous limitations, it is obvious that the results presented here are not an absolute representation of the entire population of recreational fishers targeting the white grouper. However, they represent a complementary contribution to the existing knowledge.
CONCLUSION AND FUTURE RESEARCH
Our study opens a new avenue for real time monitoring of the social dimension of distributional range shifts of species. Moreover, this is a not overly time-consuming approach that can be implemented with limited resources and that, in combination with other data sources, may provide important information for conservation challenges. The method followed in this stud could also be interesting for the arrival of alien invasive species or increase of abundance of species due to management actions (Kapitza et al., 2019; Shackleton et al., 2019). Understanding human dimension of environmental issues is crucial for managers and policy makers (Bennett et al., 2017). The expansion of iEcology and conservation culturomics (Jarić, Correia, et al., 2020; Jarić, Roll, et al., 2020; Ladle et al., 2016) represent effective approach for responding to the complex interactions between human culture and the natural world. Conservation must adapt and evolve parallel to the digitally mediated societal change that is underway, taking profit of the rich and valuable information present on social media platforms. There is an increased demand of automated processes that improve the analysis of digital data. We demonstrate the potential of this approach within a community of recreational fishing, which is a worldwide important activity with many implications for biodiversity conservation, social and economic dynamics. Recreational fishers can provide a network of observers about detailed spatial and temporal information regarding biodiversity conservation. Collaboration between different disciplines is necessary, specially between social, computer and conservation scientists, in order to improve the analysis of sentiments in this context and take the highest profit of this methodology.
DEVELOPED TASKS
This study was conducted under the supervision of Valerio Sbragaglia and Marta Coll Monton. The first step was downloading the data with the Youtube’s API. Valerio Sbragaglia gave me the instructions, helping me in the process. Once the data was downloaded to the excel file, I filtered the information related to the videos of recreational fishers targeting the white grouper using some keywords. I divided the data in two groups (recreational anglers and recreational spearfishers) using again other keywords, and retrieved the locations that were present in the title or the description of the posted videos. Finally, I manually cross-check the information in order to follow with the next step.

Once the information was validated, I analysed the data in Rstudio in order to obtain the results. While analysing the data, I realised about some methodological limitations related to the syuzhet package and the Saif Mohammad’s NRC Emotion Lexicon. Valerio Sbragaglia and me decided that the best way to proceed was modifying the dictionary, in order to adapt it to our community of recreational fishers. We followed a focus group approach in order to make the decisions about the modifications, following a logic subdivision by themes. I devoted my time to modify the dictionary word by word, knowing the words that were used in the comments. Once the dictionary was modified and with the approval of the director of the study, Valerio Sbragaglia, I continued with the analysis of the data and finished it. I also processed the statistics used in this study with the supervision of Valerio Sbragaglia and his help, in some cases, in order to select the correct technique. I wrote the entire manuscript, with the comments and modifications suggested by Valerio Sbragaglia and Marta Coll Monton.

Summarizing, I am involved directly with all the data used in this study and with all the results obtained after analysing it. However, without the help, comments and supervision of Valerio Sbragalia, Marta Coll and the rest of the colleagues of Marta Coll’s group this study would have been impossible to be conducted successfully.
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