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Bridging sustainability and digital transformation: information technology adoption for eco-literacy

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ABSTRACT

This research was carried out in the context of the urgent global challenges of climate change and biodiversity loss. These ecological challenges have led both society and global institutions to consider environmental education as a key element in the transition toward a more sustainable future. At the same time, the digital transformation of organisations and society offers new opportunities to improve education and communication to promote positive environmental behaviours. This study seeks to contribute to mitigating current ecological challenges by strategically using digital advances to improve education and catalyse positive change. This is done by investigating the interplay between the digital practices of organisations and their impact on education for sustainable development.

Protected natural areas in France were used as a case study, given their dual significance in conservation and education efforts, coupled with their sensitivity to anthropogenic pressures. Thus, the study explores the extent to which these organisations have shifted to digitalisation to support their mission, particularly in raising eco-awareness in the population. The literature review led the researcher to take an interpretative approach to the research based on practitioners' perceptions of digital tools. A two-stage data collection process was carried out involving decision-makers within the French-protected natural areas. The initial stage involves the collection of 26 responses to a questionnaire designed using a combination of closed and open-ended questions. This was followed by a second stage involving 13 semi-structured interviews. Qualitative content analysis and descriptive statistics were used for the data analysis.

The findings significantly enrich the existing body of knowledge in the realms of sustainability, technology adoption, knowledge management, and education. This study, therefore, makes two significant contributions to theory and practice. Firstly, it provides valuable insights into understanding how digitalisation influences organisations' strategic decision-making processes. Secondly, it uncovers effective pathways and tools for harnessing digital tools to enhance individuals' eco-literacy. The research findings and recommendations have been shared with practitioners, enabling the findings to be adopted into practice. Finally, the research has identified areas for further research and investigation.

RESUMEN

La presente investigación se ha llevado a cabo en el contexto de los urgentes retos medioambientales que el cambio climático y la pérdida de biodiversidad están planteando a nivel global. Estos han llevado tanto a la sociedad como a los organismos internacionales a considerar la educación ambiental como un elemento crucial en la transición hacia un futuro más sostenible. Al mismo tiempo, la transformación digital de las organizaciones y la sociedad ofrece nuevas oportunidades para mejorar la educación y la comunicación con el fin de promover comportamientos ambientales positivos. En este contexto, este estudio pretende contribuir a mitigar los retos ecológicos actuales utilizando estratégicamente los avances digitales para mejorar la educación y catalizar cambios positivos. Para ello, se investiga la interacción entre las prácticas digitales de las organizaciones y su impacto en la educación para el desarrollo sostenible. Como estudio de caso se han utilizado los espacios naturales protegidos de Francia, dada su doble importancia en los esfuerzos de conservación y educación, junto con su sensibilidad a las presiones antropogénicas. Específicamente, el estudio explora hasta qué punto estas organizaciones han recurrido a la digitalización para lograr su objetivo, sobre todo en la concienciación ecológica de la población. La revisión bibliográfica ha permitido que se adopte un enfoque interpretativo de la investigación basado en las percepciones de los profesionales sobre las herramientas digitales.

Se ha llevado a cabo un proceso de recopilación de datos en dos etapas, con la participación de los responsables de los espacios naturales protegidos franceses. En una primera etapa, se recogieron 26 respuestas a través de un cuestionario diseñado a partir de una combinación de preguntas cerradas y abiertas. A continuación, se llevó a cabo una segunda fase con 13 entrevistas semiestructuradas. Para el análisis de los datos se utilizó el análisis de contenido cualitativo y la estadística descriptiva. Los resultados enriquecen notablemente el cuerpo de conocimiento existente en los ámbitos de la sostenibilidad, la adopción de tecnología, la gestión del conocimiento y la educación. Así pues, este estudio aporta dos contribuciones significativas a la teoría y la práctica. En primer lugar, los resultados obtenidos son claves para comprender cómo la digitalización influye en los procesos de toma de decisiones estratégicas de las organizaciones. En segundo lugar, se revelan diferentes mecanismos y herramientas eficaces para aprovechar las tecnologías

digitales con el fin de mejorar la ecoalfabetización de la sociedad. Las conclusiones y recomendaciones de la investigación se han compartido con los profesionales, lo que ha permitido ponerlas en práctica. Por último, se han identificado líneas futuras de investigación.

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Ai miei nonni e genitori

À ma famille, Alla mia famiglia

Certificate of Ethical Approval

Applicant:	Laura Di Chiacchio
Project Title:	Digital transition, sustainability and informal learning in protected areas

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Low Risk

Date of approval:	30 Aug 2022
Project Reference Number:	P140727

Certificate of Ethical Approval

Applicant:	Laura Di Chiacchio
Project Title:	The use of social media in protected areas in France to improve eco-literacy and promote the eco-behaviour of their visitors

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

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List of abbreviations

CAQDAS	Computer Assisted Qualitative Analysis Software
COVID-19	Coronavirus COVID-19 pandemic
DIEL	Digital Informal Environmental Learning
ICT	Information Communication Technology
IEL	Informal Environmental Learning
IUCN	International Union for the Conservation of Nature
KPI	Key Performance Indicator
PEB	Pro-Environmental Behaviour
PNA	Protected Natural Area
RBV	Resource Based View
SCODT	Social Construction of Digital Technology
SCOT	Social Construction of Technology
SDG	Sustainable Development Goals
TPAM	Technologies for Pro-environmental Action Model
UGC	User Generated Content
UNESCO	United Nations Educational, Scientific and Cultural Organisation

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Chapter 1 Introduction

Climate change and biodiversity losses are both symptoms of human activity and threats to our livelihoods. Endowed with fragile and exceptional ecosystems, protected natural areas are highly sensitive to anthropogenic pressures. Moreover, they play a key role in raising public awareness of sustainability, putting them at the forefront of educational efforts.

Nowadays, environmental education increasingly occurs in informal settings, notably thanks to information communication technologies. Indeed, digital tools can be seen as a knowledge hub for environmental education of the population and the promotion of their Eco responsible behaviour. This study was carried out to provide PNAs with strategies to use digital tools to fulfil their educational and conservation purpose by efficiently supporting the informal environmental learning of their visitors and promoting their Pro-Environmental Behaviour.

As a starting point of the thesis that reports such work, this introductory chapter presents the contextual background for the research aim and objectives. Furthermore, it highlights the study's contribution and the theoretical gaps it addresses.

1.1 The significance and state of conservation of protected natural areas in Europe

Protected natural areas (hereafter PNAs) are at the core of international and European strategies for biodiversity conservation. At the European level, the European Commission set up its Biodiversity Strategy for 2030: "*Bringing Nature Back Into Our Lives",* which stresses the significance of protected areas to halt biodiversity loss. It sets a goal of 30% of marine area and 30% of land to be protected in Europe by 2030 (European Commission, 2020, 2023). Also, as part of its 2030 Agenda, the United Nations recognise the importance of protecting and extending natural areas in order to achieve its Sustainable Development Goals (hereafter SDGs) (Jones et al., 2020). Indeed, four types of interrelationships between PNAs and SDGs exist:

- The conservation missions of PNAs and their *raison d'être* are directly linked to SDGs 13, 14 and 15.

- Their ecological services can be related to SDGs 1,2, 3, 6, 7 and 8.

- Their educational purpose can be related to SDGs 4 and 9.

- Their management and governance can be related to SDGs 5,10,11, 12, 16 and 17.

The full extent of the PNAs' contributions to each of the SDGs is described in Appendix A.

In 2000, the number of PNAs in Europe encompassed approximately 55,000 sites spanning 715,000 km². By 2017, this number had risen to 103,670 sites covering over 1.5 million km² (European Environment Agency, 2021a). Despite this increased number of protected sites, their average surface area does not exceed 1,000 hectares, demonstrating high pressure on European natural areas (European Environment Agency, 2020). All these natural areas do not benefit from the same level of protection. Indeed, they are divided by the International Union for Conversation of Nature (hereafter IUCN) into seven categories (IUCN, 2021b). Nevertheless, regardless of these different levels of protection, all PNAs share the same educational ambition of raising public awareness of environmental issues. Also there are encounter spaces where humankind and nature intersect.

Table 1 represents the proportion of each category and highlights that few PNAs are free of human presence, habitation, or recreational or commercial activities. Therefore, PNAs are encounter spaces where humankind and nature intersect.

Table 1 Proportion of the different categories of PNAs in Europe in 2017 (European Environment Agency, 2018).

Despite the unquestionable value attributed to PNAs, concerns have emerged regarding the potential compromise to the management and integrity of half of the globe's 252 natural World Heritage sites. This vulnerability arises from various factors, including the lack or weakness of legislative frameworks, site boundaries, relations with local people and the detrimental impact of tourism activities (IUCN, 2020a, p. 30). As Europe is the most visited region in the world, its PNAs are not spared from anthropogenic pressures. As shown in Figure 1, Europe no longer possesses wilderness areas, and 85% of its wetlands areas have been lost (WWF, 2020). In addition, 24% of European sites listed by the IUCN are reported to be damaged by tourism, and 46% are under poor or seriously compromised management (IUCN, 2020a, p. 61).

Figure 1: Proportion of terrestrial biome in the world (WWF, 2020)

To reduce the impact of tourism activities on the environment, new types of sustainable tourism have emerged, such as ecotourism (Xu et al., 2023). The interest in this new form of tourism is increasing, especially in nature-based destinations (Silva et al., 2019) and some of the most ecologically fragile locations on the planet, including National Parks and Nature Reserves (Fei et al., 2023; Williams & Ponsford, 2009). According to a report

prepared in 2019 by the N2K group for the European Commission, nature-based tourism accounts for 20% of international travel worldwide, and its market share is growing six times faster than the conventional tourism market (Silva et al., 2019). Therefore, PNAs are becoming highly attractive destinations, with nearly 8 billion visits per year worldwide (Balmford et al., 2015) and an estimated 9-10 billion visits by 2050 (Leun et al., 2018). This rise in visitation is coupled with higher pressure on ecosystems and a greater need for access and infrastructures (Selcuk et al., 2023; Sharma et al., 2021).

While nature-based destinations and tourism activities rely on the quality of the natural resources (Fei et al., 2023; Selcuk et al., 2023), the non-implementation of regulations and detrimental behaviours to ecosystems and overuse of lands are the main sources of negative impacts on PNAs (Alessa et al., 2003; Goh et al., 2017; Hu et al., 2019; IUCN, 2020a; McGinlay et al., 2020; Sharma & Gupta, 2020). To ensure the economic, environmental, and socio-cultural balance of PNAs, it is critical that they are effectively managed and that the responsible institutions set up strategies considering tourism's fast-changing context (Gale et al., 2019; Selcuk et al., 2023).

Although it has been shown that tourism can support conservation programmes and environmental quality (Pramanik & Ingkadijaya, 2018; Zhao & Li, 2018), it should be noted that even the most careful visitor can damage nature (Alessa et al., 2003). There is no such thing as a non-impacting recreational activity in Nature (Butler, 1991; Higgins-Desbiolles, 2011). Therefore, it is crucial to understand how to promote pro-environmental behaviour from an environmental, social, and economic perspective.

France is a particularly interesting European country for the study of the impact of human activity on PNAs for four key reasons:

1. France is the most visited country in the world, with 90 million visitors in 2019 and ranks third in terms of tourism revenue (Ministere de l'economie des finances et de la relance, 2022). Therefore, PNAs can be subject to strong anthropic pressure due to nature-based tourism.
2. France has the most extensive surface area allocated to PNAs and ranks among the top 10 European countries in the proportion of its territory covered by such areas (see Table 2).

Table 2 Typology and the surface of PNAs in European countries (OECD, 2022)

3. It has a high level of natural capital and benefits from wide-ranging ecological representativeness. Indeed, France's PNAs include four of the nine bioregions found in Europe, making it one of the region's most diverse and ecologically rich (IUCN, 2021a).
4. In 2014, the IUCN created an international standard called *"The Green List of Protected Areas"* to measure and recognise PNAs' efficiency, assessing them against 50 indicators of good governance, sound planning and effective management (IUCN, 2021a). 22 out of 59 sites on the Green List are French, making the French PNAs the most awarded worldwide (IUCN, 2021a).

1.2 The impacts of the coronavirus COVID-19 pandemic on protected natural areas

According to the literature, the coronavirus COVID-19 pandemic (hereafter COVID-19) has had two major consequences on PNAs. Firstly, it may have led to a profound change in outlook on the human/nature relationship (Chen et al., 2023). Secondly, it resulted in changes in the number of visits and typology of visitors (Molteni, 2021; Souza et al., 2021).

Change in perspective

The strict lockdown measures implemented worldwide have significantly decreased human and economic activities, reducing anthropogenic pressure on natural environments (Loh et al., 2021). Consequently, COVID-19 lockdowns have provided a unique opportunity to observe the consequences of human impact on nature, often strikingly and noticeably, such as the drastic reduction of fog in major Chinese cities (ESA, 2020; Khan et al., 2021) and the reduction of contaminants and turbidity in the waters of Venice (Cecchi, 2021; Niroumand-Jadidi et al., 2020).

This realisation has reignited the discussion on how to achieve a harmonious balance between human activities and natural world conservation (Molteni, 2021). It has prompted scrutiny of our sustainable use and carrying capacity of PNAs worldwide (Chen et al., 2023), encompassing sites from the Calanques National Park in Marseille in France (Loumagne, 2021) to the vast Great Smoky Mountains National Park in the USA (Baker, 2021).

Also, in today's context, 75% of the EU population lives in cities or urban areas (World Bank, 2022), leading to a physical detachment of people from Nature. This phenomenon of « extinction of experience » (Pyle, 1993) has a negative impact on people's attitudes towards nature and discourages them from acting in an eco-responsible way (Beery et al., 2021; Gaston & Soga, 2020). Addressing the extinction of experience and disaffection for nature could be critical in considering how to reduce our environmental impact and combat biodiversity loss (Pyle, 2016). However, the COVID-19 may have helped to rekindle people's interest in Nature and their connection to natural areas. For example, 200,000 French citizens signed a petition to demand a right to access Nature in the PNAs during the lockdown.

Change in visitation

During the COVID-19, there was a significant increase in the number of visits to PNAs across Asia, Europe, the United States, and Africa (Molteni, 2021). Indeed, following the COVID-19 lockdowns, restrictions continued to be enforced to limit people's international travel and indoor recreational activities. Consequently, PNAs experienced heightened popularity, especially among local residents (Souza et al., 2021), leading to a substantial increase in visitor numbers in certain PNAs (Derks et al., 2020).

In that context, McGinlay et al.'s (2020) study highlights the difficulties faced by National Parks, such as increased litter, illegal activities, anti-social behaviour, waste, dog waste, off-leash dogs, disregard for designated paths, fires and barbecues. In their interviews, park managers mainly attributed these behaviours to new types of visitors "who were unaware of the main regulations in place and widely accepted behaviour norms in conservation areas" (p.5). Similarly, Beery et al. (2021) argue that PNAs must put efforts into communicating and educating new and inexperienced visitors. Indeed, with increasing environmental threats and pressure on ecosystems, there is a pressing and

timely need to discover effective methods to involve people in pro-environmental behaviours.

1.3 Education and learning for sustainable development and pro-environmental behaviours.

International and European institutions have developed strategies to educate the public to limit these unsustainable and environmentally damaging behaviours. For example, the United Nations Decade of Education for Sustainable Development (2005-2014) aimed at empowering "learners of all ages with the knowledge, skills, values and attitudes to address the interconnected global challenges we are facing". Also, Education for Sustainable Development is recognised as a key enabler of all other SDGs (UNESCO, 2021a). In 2022, the Council of the European Union adopted a recommendation on learning for the green transition and sustainable development for learners of all ages and at all levels of education, particularly to strengthen the European strategy in favour of biodiversity (European Council, 2022). It aims to help European countries take action to tackle climate change by improving environmental literacy and the skills of their populations.

These education programmes stress that we will not reach the SDGs without education and learning for sustainable development (Maurer & Bogner, 2020). Their rationale stems from the recognition that environmental challenges necessitate learning about the environment at all levels of society (Rickinson et al., 2009a) to enable societal transformation toward sustainability (UNESCO, 2021b). In other words, there is a link between education and behaviour.

Behavioural theories, such as the Theory of Reasoned Action and the Theory of Planned Behaviours, validate this view by identifying knowledge as an antecedent of behaviour. According to these theories, an individual's behaviour reflects their environmental knowledge (Zareie & Navimipour, 2016). Therefore, "learning can be seen as a key tool and leverage point for social change towards sustainability, change and transformation of human agency and value" (Bryant & Thomson, 2021). According to Gao et al. (2021), environmental education aims to raise environmental awareness and knowledge to form Pro-environmental behaviour. Applied in the context of PNAs, these theories suggest that

fostering people's environmental learning could be the key to reducing the human environmental impact on ecosystems by promoting pro-environmental behaviour.

1.4 From formal learning to digital informal environmental learning.

Schools and their formal setting were long considered the only source of knowledge and learning process. However, schools can no longer meet the learning needs of society (Falk, 2005). Nowadays, learning settings are considered in their non-formal and informal settings (Singer-Brodowski, 2023). Indeed, a consequent amount of knowledge and experience emerges from our leisure and free time (Robelia et al., 2011) in informal learning settings. According to Falk (2005), most environmental learning occur outside school and in informal settings.

In this context, Falk introduces the term "free-choice environmental learning" to refer to a model of informal environmental learning where the learner is responsible for what to learn about the environment and with whom (Lewis et al., 2010), the location and pace of learning (Falk & Dierking, 2019). Thus, free-choice learning illustrates the evolution from a top-down teacher-centred learning model (Education) to a bottom-up learner-centred environmental learning model (Learning).

This self-directed learning is particularly developing thanks to the emergence of mass media, the internet and Information and Communication Technologies (hereafter ICTs). Learning now is 24/7, continuous and on-demand. Also, COVID-19 is a catalyst for digital transformation (Burlea-Schiopoiu et al., 2023; McKinsey, 2020; Musleh Alsartawi et al., 2022), which was essential to allow the continuity of access to cultural heritage and education during the lockdown (Ruggiero et al., 2021; Samaroudi et al., 2020). Furthermore, new technologies increase learning opportunities due to their flexibility and portability, and tools like social media can be considered a hub for sharing information and knowledge (Chaschatzis et al., 2022; Ninan, 2022; Zareie & Navimipour, 2016). ICTs could be considered sources of environmental information and thus support informal environmental learning (hereafter IEL) (Gössling, 2017; Kidwai & Seema, 2021).

PNAs in France, with their potential unique content to share online, such as pictures of landscapes and animals, their heritage expertise and events, could be among the organisations that benefit the most from digital tools and their ability to generate

interactions (Mergel, 2016). Furthermore, valorising their conservation and education work carried out on the field among the general public and local stakeholders is an integral part of their missions (OFB, 2021, 2023; Parcs Naturels Regionaux de France, 2022). Following the resource-based view (Barney, 1991), ICTs emerge as potential strategic resources for PNAs to leverage in developing capabilities to achieve their conservation education missions. Therefore, PNAs can leverage ICTs as an educational tool and platform to enhance their visitors' pro-environmental behaviours.

Based on the above observations, implementing digital informal environmental learning (hereafter DIEL) strategies can complement the conservation missions of PNAs, allowing the valorisation and transparency of their actions toward the citizens (Mergel, 2016). However, some studies suggest this may not be the case (Hennig et al., 2013; Nahrkhalaji et al., 2019), showing that these institutions may lag in embracing digital tools. In addition, some authors pointed out that new technologies can raise new challenges and have called for not being blindly optimistic about ICTs and their impacts on pro-environmental behaviours (Brereton, 2018; Gössling, 2017). As a result, natural heritage sites may hesitate to adopt or ignore them. Therefore, these studies suggest that ICTs' capability-enabling potential may have remained latent/hidden and not been translated into tangible value by conservation institutions. Therefore, there is a need to explore how PNAs can strategically develop their ICT capacity into organisational capability to achieve their missions.

1.5 Research aim and objectives

This study investigates how PNAs can strategically leverage social media as an ICT resource to develop organisational capabilities that enhance their ability to achieve their educational and conservation missions by effectively supporting informal environmental learning among visitors and promoting their pro-environmental behaviour.

This aim will be achieved through the realisation of the following objectives:

- To review the online communication educational strategy of PNAs and assess if their current strategies support the informal environmental learning of their visitors and promote their pro-environmental behaviours.

- To evaluate the opportunities social media offers to support informal environmental learning and pro-environmental behaviour among visitors to PNAs.
- To determine the main challenges PNAs face in using social media to support informal environmental learning and pro-environmental behaviour among their visitors.
- To determine the impact of the COVID-19 lockdowns on the communication strategies of PNAs on social media for supporting their visitors' informal environmental learning and pro-environmental behaviour.
- To provide PNAs with recommendations to use social media to support their visitors' informal environmental learning and pro-environmental behaviour.

1.6 Research question

This research takes place in the context of climate change, biodiversity loss, and society's digital transformation. It aims to explore how using these new communication tools could represent opportunities or threats for nature conservation and the promotion of pro-environmental actions. The study explores the following research question:

In the context of the digitalisation of society, how do PNAs implement digital informal environmental learning strategies to develop organisational capability that enhance their ability to support the pro-environmental behaviour of individuals?

This research question is further divided into five secondary research questions presented hereafter.

- What is the significance of informal environmental learning and pro-environmental behaviour promotion in protected natural areas' current digital communication strategies?
- What are the challenges protected natural areas face in the technology adoption and utilisation process to support the positive environmental learning of their visitors?
- How do digital tools positively affect visitors' informal environmental learning and pro-environmental behaviours?
- How do digital tools negatively affect visitors' informal environmental learning and pro-environmental behaviours?

- To what extent has the digital strategy of protected natural areas for education evolved during COVID-19?

Given the focus of this research on PNAs and their distinct organisational nature, this study looks specifically at investigating their use of social media to foster environmental learning and promote pro-environmental behaviour (hereafter PEB). The rationale for this emphasis on social media is twofold: first, its growing adoption for education and learning purposes (Barrot, 2022), and second, its pivotal role in facilitating communication between public organisations and their stakeholders during the COVID-19 lockdowns (Ralph et al., 2022).

1.7 Methodological approach to the research

The research was conducted in collaboration with practitioners, particularly decision-makers representing PNAs in France. Adopting a case study approach, the researcher used a two-stage data collection process. The initial stage involved data collection via a questionnaire, and the second stage involved semi-structured interviews. The data collected was analysed using qualitative methods. Finally, the research results were shared with the participants in the research, enabling the findings to be adopted into practice.

1.8 Thesis structure and summary of primary contributions

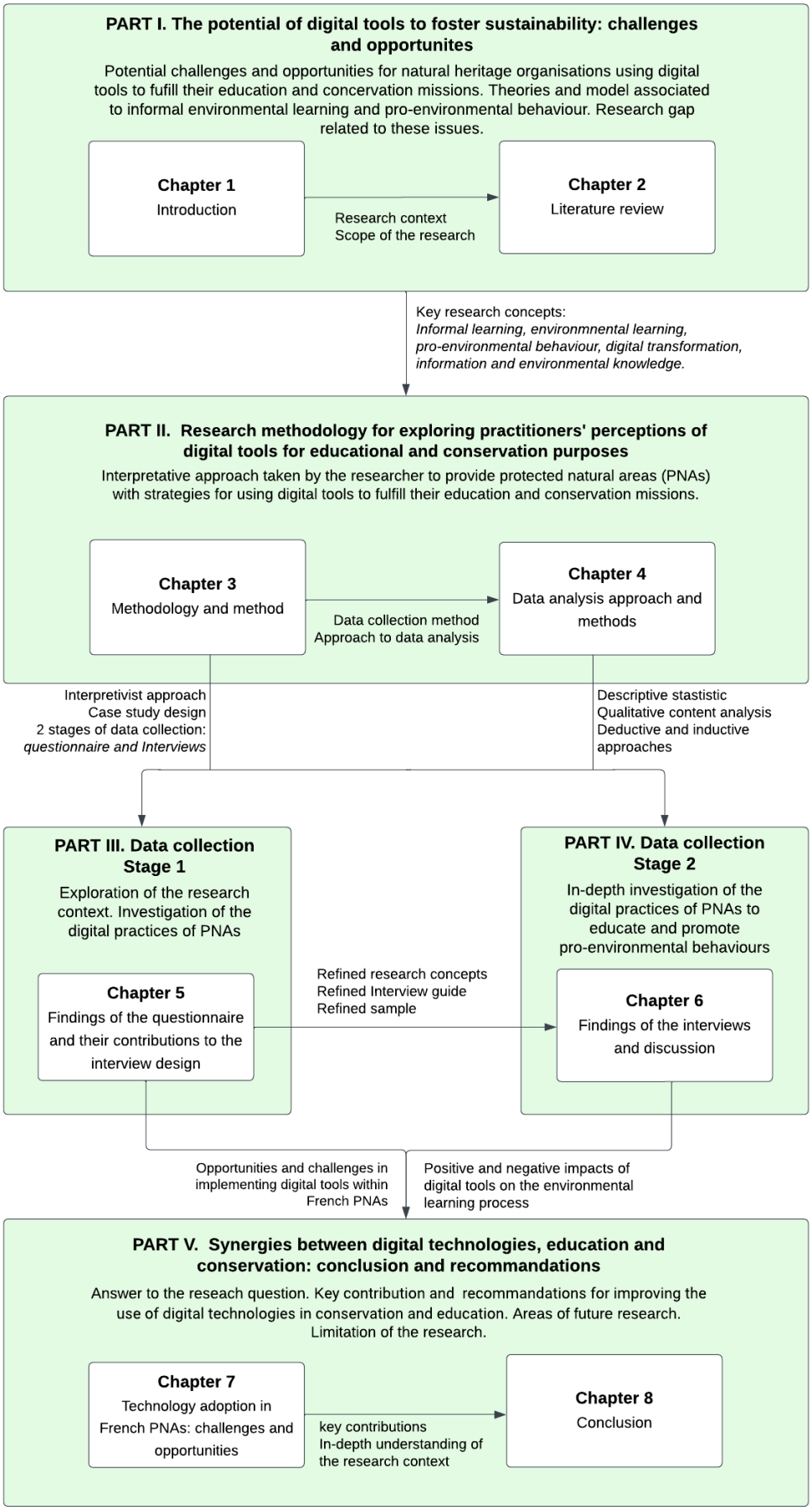
This thesis is structured in five parts, as shown in Figure 2. The first part sets the research context, formulates the research question, aim and objectives (chapter 1) and comprises a review of the literature (chapter 2). Part two focuses on the approach to research taken by the researcher (chapter 3) and presents the methods employed for data collection and subsequent analysis (chapter 4). In accordance with the methodological approach presented in part two, parts three and four describe the results of the two data collection and analysis stages. It describes the findings of the exploratory phase, which was conducted using a questionnaire (chapter 5), and the in-depth investigation into practitioners' perceptions of digital tools for educational and preservation objectives, which was conducted using semi-structured interviews (chapter 6). Finally, the overarching research question is addressed in part five, encapsulating the main findings drawn from the preceding parts (chapter 7). Moreover, it discusses the contribution of the thesis to the understanding of the interplay between digital technologies, education,

and conservation, recommendations for practitioners and avenues for future research (chapter 8).

This thesis represents a significant contribution to multiple domains, enriching the existing body of knowledge in the realms of sustainability, technology adoption, knowledge management, and education. It represents an initial endeavour to establish a connection between learning theories, theories of digital transition, and resources and capabilities theories. In doing so, it adds to the scarce studies regarding the implementation by organisations of digital strategies to disseminate environmental knowledge and promote pro-environmental behaviours. More specifically, while studies regarding social media's impact on nature-based tourism and PNAs are in their infancy (Han et al., 2018), it fills a gap in the literature by exploring how environmental education organisations can take advantage of digital tools to extend their impact on the visitor's awareness of environmental issues in informal settings. The findings show that PNAs are currently underutilising ICTs as a resource for educational purposes and that they could do more in setting up strategies to develop their capability to enhance their DIEL impact and meet the requirements of the digital era. The research also addresses the call for new research from Miller and Freimund (2017) and Gossart (2021) to explore perceptions of PNAs of social media use, their current use, and the potential institutional barriers to their use. Finally, this study provides a unique perspective from PNAs, highlighting the impact of the COVID-19 pandemic on their DIEL strategies.

The significance of the study goes beyond theoretical contributions, as it highlights the social implications of using digital tools to raise environmental awareness and provides managerial recommendations for organisations seeking to use such tools to achieve their environmental education and conservation missions.

Figure 2 Outline of the thesis structure



Chapter 2 Literature Review

This chapter examines the interconnections among the primary research ideas presented in chapter 1, which form the basis of this thesis, including conservation, informal environmental learning, and digital transformation. It reflects how the researcher has been guided by their literature review and has laid the foundation for the research design presented in chapters 3 and 4.

Section 2.1 explores the concepts of environmental learning and pro-environmental behaviour and how they are interconnected. Section 2.2 discusses the impact of digital tools on individuals' learning processes and how the digital transformation of PNAs may support informal environmental learning. Finally, Section 2.3 discusses the impact of digitalisation on organisations' implementation and use of technologies for pedagogical purposes.

2.1 Informal learning as a tool to promote pro-environmental behaviours in PNAs?

As discussed in chapter 1, school is no longer the only source of education, and it is established that most of the knowledge one possesses has been acquired in an informal setting. Therefore, this section thoroughly examines the concept of informal environmental learning and its potential influence on individuals' adoption of pro-environmental behaviours.

First, the concept section of environmental learning and its components are discussed in section 2.2.1, while the concept of pro-environmental behaviours is defined in section 2.2.2. Then, the influence of knowledge on the learning processes (section 2.2.3) and individual behaviours (section 2.2.4) is discussed.

2.1.1 What is informal environmental learning?

To establish a comprehensive definition of IEL, it is necessary to define its components, i.e. environmental learning, environmental knowledge, and informal learning.

What is environmental learning?

Even though environmental education is presented as part of the solution to sustainable development by policy-makers and the international community (see section 1.3), the concept of "*environmental learning"* is not clearly defined. The term is particularly used in education research (Bryant & Thomson, 2021; Duerden & Witt, 2010; Falk & Dierking, 2019; Rickinson et al., 2009b; Robelia et al., 2011; Spiteri, 2023) but also in organisational learning research (Martínez-Martínez et al., 2018), tourism research (Li et al., 2020; Walter, 2013), and economic research (Sechi et al., 2018). The different definitions found in the literature are primarily attributed to a lack of clarity surrounding the definition of its component term "learning".

In education research, the "learning" concept has evolved greatly over time. The early theories, such as the "transmission-absorption" learning model (where learning is seen as "filling" the empty brain), have been abandoned (Falk, 2005). Learning is no longer considered a linear process (cause-effect) where individuals subjected to the same stimulus would respond similarly (Falk, 2005). Instead, most recent studies agree that the learning process is complex and dynamic, takes place throughout individuals' life span (Falk & Dierking, 2019; Mouratoglou & Villalba-Garcia, 2022) and can be accidental (Allaste et al., 2022). Thomashow (2020) define learning as the "interface between structure and change" (p:14). In the same vein, Falk (2005) highlights that all the learning process involves changes in the "brain and "body". This view is shared by Schelly (2018), for whom physicality is integral to the learning process.

The organisation and knowledge management research studies offer another approach that can add to the definition. In this field, learning is mainly facilitated by exploring, acquiring, exploiting and utilising knowledge (Choi & Mcnamara, 2017; Martínez-Martinez et al., 2018). Thus, the learning process is studied as the flow of knowledge within and outside organisations with the perspective of putting it into practice to gain a competitive advantage (i.e. innovation). Based on this knowledge management approach, integrating acquired environmental knowledge into practical actions is essential to environmental learning (Alerasoul et al., 2022; Cegarra-Navarro & Martinez-Martinez, 2010). In addition, In the context of individual environmental learning, the symbolic perspective of knowledge flow acknowledges the diverse sources from which to

acquire environmental knowledge. It recognises that learning can happen through a range of interactions, not limited to formal educational settings. Indeed, studies show that environmental learning can occur via interactions with others (Spiteri, 2023), online platforms and digital tools (Lin & Ardoin, 2023) or direct experiences in nature (Zandvliet & Perera, 2022).

Thus, environmental learning can be considered *a subjective, continuous and complex process allowing for the individual's behaviour transformation toward more sustainability through exploration, acquisition, and utilisation of environmental knowledge*.

What is environmental knowledge?

In the same way as environmental learning, environmental knowledge does not benefit from a universal definition. However, the association between environmental knowledge and the individual's understanding of the relationships between ecosystems (Martinez-Martinez et al., 2018; Zareie & Navimipour, 2016) and environmental issues (Farrukh et al., 2022) is commonly found in the literature. It can also be defined as the outcome of a long life of environmental learning (Geiger et al., 2019).

In some studies, environmental knowledge is defined as how somebody expresses concern about an ecological issue (Cegarra-Navarro & Martinez-Martinez, 2010), thus linking environmental concern to environmental knowledge. Udalov and Welfens (2016) state that environmental concern "requires knowledge and information about the causes and consequences of environmental problems" (p. 7). This view is contested by Schaffrin (2011), who considers that it is not necessary to have accurate knowledge about an issue to express concern about it. Conversely, an individual's knowledge about an ecological issue does not prefigure his environmental concern.

In their study, Schaffrin (2011) bases their argument on a positivist approach to knowledge regarded as objective and defined as a justified-true-belief (Vaughn, 2020) and factual (Barker, 2015). This approach is particularly used in organisational research where knowledge must be veridical, accurate and related to truth (Ichikawa & Steup, 2017; Storey & Larbig, 2018). In the context of organisations, it would refer to explicit knowledge as defined by the model of Nonaka & Takeuchi (1995), expressed through language, symbols and human discourse (Zareie & Navimipour, 2016), what Bratianu &

Bejinaru (2019) refers to as rational knowledge or Frick et al. (2004) as "system knowledge".

Post-constructivists and sophists reject this view, claiming that truth is not accessible and unknowable and that knowledge is relative (Meyers, 2006). Vera & Crossan (2011) acknowledge the change in research that involves a shift from studying "knowledge as a commodity that individuals or organisations can acquire, to studying knowledge as something they do" (p. 3). This alternative definition allows the 'body' to be included alongside the 'mind' in environmental learning, considering that knowledge can not be considered independently of actions (Vera & Crossan, 2011). Thus, according to Martinez-Martinez et al. (2021), "environmental knowledge is one way to apply learned knowledge to address concerns about the environment and collective responsibilities necessary for sustainable development" (p.636). This "corporeal knowledge" (Schelly, 2018) is defined by Bratianu & Bejinaru (2019) as emotional knowledge, which is non-verbal and related to tacit knowledge in the business context (Bratianu & Orzea, 2013). Kuzniar et al. (2021), from the same perspective, define environmental knowledge as the practices that demonstrate knowledge and attitude through action, also called "action knowledge" and “effectiveness knowledge” (Frick et al., 2004).

Finally, Jakučionytė-Skodienė et al. (2020) consider environmental knowledge as a tool that stimulates "a-moral" incentives to behave pro-environmentally, thus opposing knowledge from any form of morality and value. This view is rejected by Bratianu and Bejinaru (2019), who propose to consider "spiritual" knowledge based on shared values and morals or Frick et al. (2004), who consider “effectiveness knowledge” as an individual ability to value and assess the environmental benefits of a specific behaviour among a pool of possible actions.

What is informal environmental learning?

There are three common types of learning settings recognised by the literature, and they can be defined as follows (Brew, 1946):

- **Formal learning**: is provided by the educational or training system or the workplace. The objectives and outcomes of the formal learning process are set in

advance and need to meet the syllabus or a curriculum requirement (Council of Europe, 2021).

- **Non-formal learning**: "takes place outside formal learning environments but within some kind of organisational framework" but "still needs to follow a formal syllabus" (Council of Europe, 2021). In other words, it is formal learning carried out in a non-formal setting.
- **Informal learning**: takes place outside of the school. It is free from restrictions and formalities such as following a curriculum. There are no exams. Informal learning is also often seen as incidental and linked to everyday experiences, encounters and intergenerational transmission of knowledge.

Falk (2005) criticises the model of the three forms of learning for considering that the type of learning depends solely on a change of setting, whereas he considers that the learner's motivation is the main driver. Thus, modern literature offers a new dimension to informal learning with the concept of self-directed and self-motivated learning.

Hase & Kenyon (2000) coined the term heutagogy, which comes from the Greek meaning "self". In creating this concept, Hase & Kenyon (2000) propose to move from Andragogy (the task-oriented but self-motivated learning of the adult) to autonomous learning of the adult (Blaschke, 2012). Heutagogy thus differs from Andragogy in being based on the learner agency (Moore, 2020). It does not require a pedagogical goal; it is centred on the learner's motivation and needs and is based on reflective practice (Holland, 2019). Because it is not time-bonded, it allows for lifelong learning (Moore, 2020). Falk (2005) talks about “free-choice” learning, which takes place in an informal setting but in a deliberate way. Free-choice learning is a bottom-up process where the learner is an active participant rather than a passive recipient of knowledge (Rickinson et al., 2009a).

Thus, informal environmental learning can be defined *as self-motivated environmental learning that occurs voluntarily out of formal and non-formal settings*.

2.1.2 What is pro-environmental behaviour?

The term *“pro-environmental behaviours”* (PEB) does not benefit from a consistent definition in the literature (Esfandiar et al., 2022; Lange, 2022). However, most authors define it by its environmental impact (Steg et al., 2014). On the one hand, authors such

as Lange (2022) consider the positive impact of such behaviours, defining them *"as behaviours that produce environmental benefits relative to alternative behaviours"* (p. 600). On the other hand, Ateş (2020) considers the PEB as the result of altering individual behaviour to decrease the harmful effect on the environment.

To add to these differences in perspective, the term PEB is used interchangeably in the literature with terms such as environmentally sustainable behaviours (Han, 2021), ecological behaviours (Kuzniar et al., 2021), green behaviours. (Han, 2021) and environmentally responsible behaviour (Moghimehfar & Halpenny, 2016). PEB can also be used as an umbrella term that describes all kinds of specific behaviours, such as green consumption, sustainable consumption, reducing energy consumption, recycling, reducing waste, etc. (Esfandiar et al., 2021; Lange & Dewite, 2019; Polonsky & Grau, 2011).

Given the dual nature of PNAs with both conservation and visitation goals and the increase of interest in nature-based tourism (Silva et al., 2019), PNAs must set up visitor programs that promote a wide range of PEBs, such as recycling, waste collection, trail maintenance or sustainable leisure activities (Esfandiar et al., 2021, 2022; Goh et al., 2017). Thus, PNAs offer an opportunity to educate visitors about biodiversity and the interrelationship between humans and the environment, influencing their PEBs (Esfandiar et al., 2022).

The researcher clarifies that, in this study, the term "PEB" is used *as an umbrella term to encompass behaviours carried out or avoided by individuals intending to care for and protect nature or reduce any adverse impacts their actions may have on the environment*.

2.1.3 Prior knowledge as a precedent of environmental learning

In some studies, knowledge is the outcome of learning (Geiger et al., 2019). Nevertheless, other studies consider individual prior knowledge essential to and a precedent of the learning process. In the organisation context, Martínez-Martínez et al. (2018) found that prior environmental knowledge "prepares the ground for organisational learning" and is "necessary for the effort to understand and implement the learning process" (p.671).

In the same line, Brody & Tomkiewic (2002) found that visitors in Yellowstone National Park use cognitive 'anchors' and 'bridges' (p.1121) as knowledge connections, first to prior

knowledge and then to future learning. Their study thus shows that visitors are building on prior knowledge and conception in the learning process. Also, Zambrano et al. (2019) show that prior knowledge benefits the learning outcome. However, in education research, PNAs visitors' values and conceptions were found to act as "a filter for new information" (Poortinga et al., 2004, p. 72).

2.1.4 The contested impact of environmental knowledge on behaviour

Despite easy access to information through new technologies and mass media, individuals' PEBs remain limited and fail to meet the challenges of climate change. In this context, several authors underline the gap between the level of information availability, environmental knowledge and eco-behaviours and actions (Bartiaux, 2008).

Particularly, the literature has been critical of the theory of knowledge leading to the pro-environmental behaviours found in the Theory of Planned Behaviour and the Theory of Reasoned Action (Davies et al., 2002). Indeed, some studies have shown that environmental knowledge has little (Gerdt et al., 2019) or no direct impact on the pro-environmental behaviour of consumers or households (Bartiaux, 2008; Maurer & Bogner, 2020). For example, Polonsky & Grau (2011) found that the more tourists are informed about carbon offset schemes for air travel, the less likely they will pay for them. These results have been found in different contexts, such as energy consumption (Bartiaux, 2008; Jakučionytė-Skodienė et al., 2020; Paço & Lavrador, 2017), recycling (Davies et al., 2002), in different age ranges (Duerden & Witt, 2010; Geiger et al., 2019; Levy et al., 2018) and various parts of the world such as the United States and Australia (Polonsky & Grau, 2011), Lithuania (Jakučionytė-Skodienė et al., 2020) the United Kingdom (Trotta, 2018) or Israel (Levy et al., 2018). These results contrast those of Martinez-Martinez et al. (2021), confirming the relationship between environmental knowledge and pro-environmental behaviour intention in Spanish hotels.

A first explanation for the knowledge-intention gap found in the literature is that households are not subject to stakeholder pressure and scrutiny that influence organisations' environmental behaviours; therefore, their behaviour could be influenced by more than environmental knowledge (Martinez-Martinez et al., 2021). A second point of view is proposed by Bartiaux (2008), who sees a tension between households' intention to act pro-environmentally and the consumption-based model of society, which would

not allow for sustainable development. This gap could also be explained by the trade-off that consumers must operate between environmental intention and the cost of implementing that behaviour. Finally, in the case of green consumption, as in Polonsky & Grau's study (2011) related to the CO_2 offset scheme, the lack of trust and scepticism could be a barrier to pro-environmental behaviour. Thus, some authors have established environmental knowledge as "a behaviour-distal but necessary antecedent of pro-environmental behaviour" (Geiger et al., 2019, p. 1). These studies demonstrated that mere knowledge accumulation or exploration is insufficient for its implementation or exploitation.

As seen in the previous section, the knowledge concept has been defined with multiple sub-components. These categorisations have not helped the literature produce consistent findings on the impact of knowledge on PEB. Indeed, some studies have found that knowledge systems impact behaviour (J.Y. Kim et al., 2016; Levy et al., 2018), while others have found that they do not (Maurer & Bogner, 2020). Also, effectiveness knowledge has been found to be related to PEB by Y. Kim et al. (2016) but not by Levy et al. (2018), while action knowledge has been found to be positively related to PEB (Maurer & Bogner, 2020).

2.2. The impact of digital tools on the learning process

This section discusses learning as a social process of cooperation and collaboration. It examines the mechanisms by which digital tools can support and mediate informal environmental learning through social learning opportunities (section 2.3.1), activation of normative perception (section 2.3.2), collaborative meaning-making (section 2.3.3) and providing learners with additional opportunities to learn (section 2.3.4). Finally, it discusses the potential concerns of using digital tools for educational purposes (section 2.3.5).

2.2.1 New technologies, new ways of learning

As seen in section 2.1.1, informal learning is the capacity to choose what, when and with whom to learn (Lewis et al., 2010). Falk (2005) affirms that dialogue between individuals helps learners to put together the "building blocks of understanding". This idea relates to Aristotle's affirmation in "the metaphysics": "Everyone says something true about the world, and while we contribute little or nothing to the truth by the union of all, a

considerable amount is amassed". In line with that idea and the context of the development of new media, the concept of self-determined informal learning supported by ICTs is emerging (Souza et al., 2021). Authors such as Moore (2020) consider that “technology and heutagogy are intertwined in a symbiotic relationship” (p. 386) and Blaschke (2012) that Web 2.0 is a medium for informal digital learning.

This shift to online learning is due to new digital media giving quick and easy access to a large amount of up-to-date information. Moreover, social media connects people, and "today it is possible to learn from individuals but also from their collective behaviour and interaction" (Anderson & Dron, 2014). Social media facilitates sharing knowledge by supporting users in sharing ideas, developing opinions, collaborating, debating, and disseminating information (Sujata et al., 2019). On the one hand, social media allows individuals to understand others' experiences or what they mean. On the other hand, they allow us to share our perceptions of reality or our own experiences and thus influence what others understand or perceive (Lewis et al., 2010).

In organisational learning research, the flow of knowledge from the individual to the group members is designated as *feedforward* (Martínez-Martínez et al., 2018). Conversely, the flow of knowledge back down to the individual is called *feedback* (Crossan et al., 1999; Jenkin, 2013). These concepts could be transposed to social media, where the learning process can be fed from the individual to the community through feedforward and where the online community impacts the users' learning process through feedback.

Sousa and Rocha (2019) suggest that an organisation's digital transformation requires an understanding and harnessing of the potential of social learning that can be defined as “learning through the experiences or observations of others” (Goldenberg et al., 2018, p. 1). It can take place through observation, imitation, and modelling of others. Indeed, Anderson and Dron (2014) suggest that our human nature leads us to learn by using others as models and sources of information (p. 39). Therefore, the presence of others in the learning process can be considered the cornerstone of social learning.

Three sources of social learning can be identified (Bandura, 1977):

- The live model: The demonstration of a behaviour or action by an individual

- The verbal model: A verbal instruction explains a behaviour or an action.
- The symbolic model: The observation of behaviours performed in books, films, or online by real or fictional people (Reed et al., 2010).

In the current climate change and biodiversity loss context, social learning could be essential to trigger the collective response needed to achieve SDGs (Glasser, 2007; Hollweg et al., 2011; Horsley, 1977). Li & Wu (2020) recently demonstrated that social interactions are significantly associated with PEB behaviour for Chinese tourists. Therefore, new media and ICTs could be a lever for this societal change by expanding the possibilities for social learning through symbolic learning models. This digitalisation of social learning (Deaton, 2015) via the potential for daily social interaction on Web 2.0 led Anderson and Dron (2014) to formulate the term cyber-enhanced form of social learning.

However, while social media is recognised as supporting social learning processes, the literature presents inconsistent findings on their impact on learning outcomes (Bergman et al., 2022; Mehrvarz et al., 2021). For example, Ostrow Michel and Zwickle (2021) demonstrated that the more students use social media, the higher their environmental knowledge. Also, Ai et al. (2021) show that informal sources of learning (e.g. web 2.0) have a stronger impact on an individual's environmental knowledge than traditional and formal ones (television, journals, etc.). However, the same study suggests that internet learning benefits only some social-economic categories and may feed the environmental knowledge gap. Bergman et al. (2022) also demonstrated that social media can negatively impact conservation efforts via misinformation. Despite these conflicting results and the issue's relevance in our knowledge economy, Holland (2019) stresses a lack of research investigating the influence of web-based space on informal learning outcomes and, consequently, informal environmental learning. Moreover, most of the literature exploring the use of technology for learning purposes falls within the field of education research and does not address education outside the school setting (Holland, 2019; Mehrvarz et al., 2021).

2.2.2 Social norms and environmental digital learning

As seen in the previous section, learning is a social process; individuals do not act like "atoms" outside their social context, nor do they adhere blindly to a script written by others (Ishihara & Pascual, 2013). This balance between personal and social context is called social embeddedness (Granovetter, 1985). Therefore, social norms can be defined as the shared understandings within a group that provide guidance and limitations to social behaviour, operating without the enforcement of legal mandates (Han et al., 2018).

They are divided into two sorts of norms: descriptive and injunctive. Descriptive norms refer to what other people do or commonly do, while injunctive norms convey behaviours others approve or disapprove of (Filimonau et al., 2023). They can thus be associated with "peer pressure" (Culiberg & Elgaaied-Gambier, 2016), which can thus influence individuals' behaviours. However, the literature on this issue is inconsistent (Juvan & Dolnicar, 2017). Baca-Motes et al. (2013) found that descriptive norms can motivate hotel guests to reduce their energy consumption, while Schultz et al. (2008) suggest that injunctive norms must accompany descriptive norms to motivate the same behaviour. Also, Schelly (2018) argues that household water consumption can be significantly impacted by shifts in social norms related to bathing. These shifts resulted in an increased frequency of bathing despite the imperative of water conservation.

Nevertheless, Web 2.0 seems to be a favourable environment for activating social norms that promote and motivate behaviour. Indeed, it was found that the public scrutiny exerted through social media improves individuals' eco-awareness and encourages them to act pro-environmentally (Han & Cheng, 2020). This would be partly because social media feeds people's intuition about the consequences of their PEB (Han & Cheng, 2020). Furthermore, Wan & Du (2022) demonstrated that social media with high social norms perception improves public environmental knowledge.

2.2.3 Web 2.0 and environmental knowledge co-construction

Another way in which Web 2.0 and ICT support the environmental learning process is their ability to extend the individual social network and increase social capital (Wan & Du, 2022) through interpersonal communications (Han & Cheng, 2020). The advent of social media and its facilitation of User Generated Content (hereafter UGC) has catalysed a transformative shift from unilateral to multilateral learning where each user can become

a co-creator or prosumer (prosumer in opposition to the consumer) of the information shared with the online community (Romero-Rodriguez & Castillo-Abdul, 2023) (e.g. Wikipedia).

This information exchange function provides an opportunity to engage network members in disseminating environmental knowledge. The more this knowledge is shared, the wider the network and the greater the chance of developing environmental standards within the online community (Han & Cheng, 2020). Holland (2019) suggest that digital platforms support informal learning through knowledge discovery and participation in discourse opportunities. Also, Wan and Du (2022) demonstrated that "environmental knowledge moderates the impact of social capital on environmental behaviour". Therefore, by increasing the social capital of their members, social media increases the chances that they will improve their environmental knowledge and, consequently, implement PEB. A recent study by Wan and Du (2022) validates this hypothesis and adds that social media can also "arouse public environmental emotional resonance and improve environmental awareness" (p. 15).

2.2.4 Environmental learning potential in PNAs: before, during and after the visit

The primary missions and objectives of the French PNAs encompass two vital dimensions: the preservation of ecosystems and species and the integration of education as a crucial component within strategies aimed at fostering a profound societal shift towards sustainability. Ballantyne & Packer (2011) identify three relevant stages when the learning process can occur in the context of PNAs: before, during and after the visit.

Before their visit, the information provided to visitors can raise their awareness of the rules, standards and behaviour expected in the parks (Ardoin et al., 2015; McGinlay et al., 2020).

Regarding the second learning phase, which takes place during the visit, Falk (2005) shows that not identifying the state of knowledge of visitors before they enter the park can be detrimental and create a case of the "wrong message to the wrong audience" (p. 276) and missed opportunities to provide relevant interpretative information in the visitors centre (Tubb & Tubb, 2010) or within the park.

Finally, as our understanding of our impact on the environment continuously evolves, visitors to PNAs must be up to date with new knowledge to inform their behaviour in

these often fragile natural ecosystems (Polonsky & Grau, 2011; Rosário & Dias, 2022). Thus, to reinforce, maintain and update the knowledge obtained before and during the visit, a focus on the post-visit education strategies is a relevant area of research (Ballantyne & Packer, 2011). Although Ballantyne et al. (2018) demonstrated the positive impact of such strategies in the context of zoo visits in the reactivation of environmental knowledge and pro-environmental behaviour, this aspect remains relatively unexplored in the existing literature and in the context of PNAs. Indeed, Gutiérrez-Barroso and Báez-García (2019) found that using social media to spread knowledge by PNAs is still in its infancy.

2.3. Digital informal learning strategy implementation in organisations: a paradigm shift

This section looks at digital transformation from the perspective of organisations willing to implement a DIEL strategy. Section 2.4.1 discusses the emergence of the different schools of thought and technological approaches resulting from the digital transformation of society, which can influence organisations' DIEL strategies. Section 2.4.2 explores pedagogical approaches that PNAs can adopt, taking advantage of the capabilities of new technologies. Section 2.4.3 discussed the potential structural challenges PNAs may face in implementing their DIEL strategy. Finally, section 2.4.4 highlights the strategic paradigm shift that PNAs require to operate due to the digitalisation of society.

2.3.1 The different approaches to technology and their impact on DIEL strategy

The two main perspectives when considering the deep and complex relationship between society and technology development are technical determinism and social construction. Both share the assumption that technology and society are two distinct objects that can impact each other. On the one hand, *technical determinism* considers that technologies influence society. On the other hand, *social construction* considers that technologies are co-constructed by society. A third perspective arises from challenging these two approaches. It proposes a perspective that postulates a mutual influence of the social and technological spheres (Pinch, 2018) and even a 'fusion of technical and social ingredients' (Coron & Gilbert, 2020b, p. 2). It seems important for the researcher to consider these

three approaches that can influence the DIEL strategies of organisations (Anderson & Dron, 2014; Coron & Gilbert, 2020a, 2020c; Orlikowski, 1992).

Technological determinism

Several definitions of technical determinism have led to much debate among researchers about its scope and origins and who can be considered a contributor (Bimber, 1990). Coron and Gilbert (2020a, p. 2) provide a comprehensive view, arguing that technological determinism implies that technology independently shapes societies through widespread production and usage. Hence, they propose two main aspects of technological determinism:

- Technological development is taking place outside of society and is imposed on everyone.
- Technological change causes or determines social change.

The technological determinism approach also yields a more negative view of our interaction with technology, challenging the customary link between technology and social advancement and cautioning against the potential dangers of a "technisation of society" (Ellul, 2012). For example, Foucault (1977), with his notion of a surveillance society, similarly cautions against technological dominance.

This approach is no longer predominant in social scientific and technological research. Still, the idea that "machinery makes history" remains embedded in the individuals' consciousness (Coron & Gilbert, 2020b; Wyatt, 2008). Wyatt (2008) observes this persistent pattern in our inclination to connect areas of human progress with the emergence of significant tools, such as the stone, steam, or computer eras. Also, Wyatt (2008) stresses one of the fundamental flaws of technological determinism, which, by its very nature, makes the course of technological evolution independent of the will of societies, thus allowing individuals and society to deny their responsibility for the production and use of technologies. However, Heilbroner (1994) suggests that technical determinism should not be regarded as a framework for planning or making choices but rather as a heuristic method of investigation. He goes further, proposing to define several levels of determinism depending on the object of study, from soft to hard determinism,

allowing to include the unpredictable and improbable in the deterministic reading of the technology/society relationship.

Social constructivism

This approach is based on the Social Construction of Technology (hereafter SCOT) that derives from approaches such as the Sociology of Scientific Knowledge (Bijker, 2015). It emerged in response to the lack of research on how society might shape technologies (Pinch, 2018). The emergence and rapid development of ICTs in our society have added a new layer of complexity to the technology/society relationship and made it necessary to update the SCOT framework to adapt it to an increasingly digital world (Van Baalen et al., 2016). Hence, the Social Construction of Digital Technologies (hereafter SCODT) framework was created by Van Baalen et al. (2016) and comprises four items:

- Technologies: The authors consider technologies and digital ecosystems.
- Interactions: The authors acknowledge the multiplicity of interactions possible: interpersonal, person-technology, technology-technology and technology-physical environment interactions.
- Social Groups – The authors refine the concept of social groups found in the SCOT framework by adding that social groups can be fragmented, opportunistic and temporary.
- Context – The authors recognise that there are disparities in the capacity of individuals to access information and consequently have a relative power within the socio-digital networks impacting the digital ecosystem.

Coron & Gilbert (2020b) highlight that the social constructivism of technology does not recognise the concept of "impact", as everything depends on how technical objects are used. In other words, technology is always subject to the "verdict of its users, and the logic of negotiation always prevails over instrumental rationality" (p. 15). Consequently, aligning with the constructivist perspective, interpretative flexibility stands as a cornerstone within both SCOT and SCODT (Pinch, 2018). Adopting a radical SCOT approach entails the proposition that the contours and features of technologies are shaped by individuals and their interactions during usage. This, in turn, implies that technology carries an inherently neutral nature and does not wield any direct influence

on society, a proposition that Coron and Gilbert find questionable and "suspicious" (Coron & Gilbert, 2020b, p. 19).

The mutual influence

Authors contributing to the two traditional perspectives discussed in the previous sections have mostly recognised a reciprocal porosity between the social and technological spheres. Thus, new theories have emerged to emancipate from any form of determinism (technological or social) and reconcile and bridge society and technology spheres. Indeed, authors such as Orlikoswski (1992) consider social constructivism and technological determinism as ”incomplete” and propose a structuration model (p. 1), allowing for a more unified and dialectical perspective on society and technology relationships. Along the same line, the translation theory (Akrich et al., 2006) seeks to offer a “balanced vision of the social construction of our artefacts (products of human activity) and the technical construction of our social ties” (Coron & Gilbert, 2020c, p. 21).

2.3.2 The pedagogical approaches to learning in the digital age

The pedagogical approach of organisations wishing to digitalise their educational effort will reveal their perspective on how learning and technology are linked. There are three main types of pedagogical approaches applied to digital informal environmental learning: Behaviourism, social constructivism, and connectivism. This section presents these three approaches and what they mean regarding pedagogical strategies for organisations (Anderson & Dron, 2014).

The pedagogy of instruction

Theories supported by behaviourists view learning as a passive activity and involve stimuli-based learning, resulting in expected behaviour. The behaviour would be a measurement by proxy of the level of knowledge a learner holds (Nagowah & Nagowah, 2009). It is regarded by Anderson & Dron (2014) as a Socratic approach to learning where the teacher instructs the learner who would be taught.

This theory leaves little room for psychology and emotions (O'leary, 2011). In contrast, cognitivists consider that behaviour reflects what is in the individual's mind (Nagowah & Nagowah, 2009). The cognitivist theory is about information processing by the learner. Thus, learning allows for active and creative participation on the part of individuals.

These two theories have in common that they consider learning from the individual's perspective. They also believe that knowledge is 'given' to the learner (Kesler et al., 2022; Nagowah & Nagowah, 2009). This approach translates into a top-down view of learning with the amount of knowledge needed as input to achieve the expected output (behaviour). According to Anderson and Dron (2014), this pedagogy may lead to an instructivist pedagogy. “The notion that a body of knowledge can be represented in written or spoken form and communicated from the learned to the unlearned is powerful but can be limited by the technology, and an instructivist pedagogy is likely to emerge” (p.38).

The pedagogy of construction

As seen in section 2.2.1, constructivists consider learning not from an individual but from a social perspective. Indeed, constructing new meaning, adjusting our mental model, and solving problems necessitate cooperation and collaboration learning (Barnes & Marlatt, 2022). Hence, for constructivists, learning is a social construction process and connection of knowledge. The interaction with others and our environment allows for the confirmation, interpretation, and validation of our knowledge (Anderson & Dron, 2014; Hong & Han, 2023). A constructivist approach to pedagogy would rely on the fact that knowledge creation is a social process that must be supported by collaboration. Therefore, this approach would be more learner-focused.

The pedagogy of connection

In the context of the pedagogy of connection, learning no longer takes place at the level of the individual but takes place at the level of the community. It is based on two main blocks: the community of learners and the tools that support their learning. Connectivism is one of the models supporting a pedagogy of connection. This theory considers that individuals use tools and artefacts to "offload their intellect into external space" (Anderson & Dron, 2014). Implementing such a model should allow learners to create their own learning environment. ICTs have enabled the emergence of these Personal Learning Environments (Dabbagh & Kitsantas, 2012), allowing learners to create, organise, and make meaning from information they find online.

Furthermore, implementing a connectivist pedagogy considers the context of the target learner community within cyberspace. It uses the potential of these networks to promote

interaction and communication between the learners and the tutor(s), the learners and their peers, and the community and its learning resources across online platforms (Conole et al., 2019; Haythornthwaite et al., 2016). Furthermore, it allows self-directed and informal learning by learners. Finally, the organisation's access to the social networks of community members would reveal their learning motivations (Paulin & Gilbert, 2021) and thus shape the strategy for DIEL.

2.3.3 The structural impact of digital transformation on organisations

Technological changes and transformations within organisations used to be part of technical areas of expertise such as research and development. However, digital transformations are pervasive (Coron & Gilbert, 2020a) and require employees to adapt in terms of culture and skills in all dimensions of the organisation. This section discusses the human aspect of adaptation to the digital transformation of organisations and its consequences for DIEL.

Digital mindset and leadership

One of the main barriers to the organisation's digital transformation is not finding and implementing sophisticated IT or digital tools and software but the change in culture and implementing a digital mindset within organisations (Hemerling et al., 2018; Varenne & Godé, 2021).

Booth et al. (2019) have shown that in museums, four types of reactions to the digital transition of their organisation can be found among managers, ranging from scepticism to proactivity. These different approaches could impact the success and how organisations approach, implement and use the technology necessary for their digitalisation. The literature shows that technology acceptance and implementation by employees are positively linked to management support (Schillewaert et al., 2005) and leadership styles (Faiq et al., 2020; Schepers et al., 2005)

New skills

The implementation of new technologies and strategies in an organisation requires new skills of employees to deal with the technical aspect of change. For example, in their case study, Arnaboldi and Diaz Lema. (2021) show that new skills were needed within organisations that wished to implement social media. Digital transformation has created

new types of professions that did not exist before their emergence, such as community managers.

Furthermore, some traditional jobs could also require an adjustment of employees' skills to align the company's strategy with its new digital culture and be resilient to change (Castaldi et al., 2020). For example, the tools available to employees in areas as diverse as communication and human resources are quite different today than they were ten years ago (social networks, photoshop, Adobe, LinkedIn) and require the adaptation of employees and their skills.

This implies that, for organisations, training and the search for new skills must be at the heart of their DIEL strategy. In fact, Arnaboldi & Diaz Lema's (2021) study also shows that areas of the organisation that were thought of separately before digitisation after implementing a digital strategy can meet or even merge. Thus, a siloed design and implementation of the organisation's digital strategy does not seem appropriate; instead, it seems necessary to create bridges between the usually separate fields of competence.

2.3.4 The strategic changes

Kane et al. (2015) found that implementing a new strategy aligned with digital goals and ambitions is the cornerstone of digital transformation. In their digital education strategy, organisations must consider that Web 2.0 has changed how we perceive time and space management in companies and society, profoundly changing how we communicate.

A new approach to time:

The development of ICTs has allowed access to information at any time and in an immediate manner, which has removed the temporal dimension of learning and thereby increased the opportunities for it to occur (Mehrvarz et al., 2021).

More specifically, from a technical point of view, internet-based platforms such as social media allow two types of access to their content. First, they enable chronological and structured access to the information generated by users, for example, in the "wall" for the Facebook platform. Additionally, they allow less structured access to information based on the principle of pop up, notifications, new tweets or Meta posts (Gerlitz, 2012). These features put the concept of immediacy at the heart of our interactions with the world and others. Gehl (2011) highlights this by pointing out that "In Facebook, users are

confronted with a prompt: 'What is on your mind?' Twitter (known as Twitter at the time of the search, now known as "X") asks users, 'What is happening?' and MySpace asks, 'What are you doing right now?' These prompts ask the user of these social media sites to react to present their current 'status'.” Organisations and individuals worldwide share the same 'now', the same *nowness* (Gerlitz, 2012).

A new approach to space:

The emergence of ICTs and Web 2.0 has erased the notion of distance. COVID-19 was a catalyst for mainstreaming tools such as Zoom, Skype, and Teams, making remote communication easy and a daily reality for many. Anyone with Internet access and a computer or mobile phone can communicate with another Internet user regardless of their location at virtually no cost. It thus becomes possible for companies to generate and disseminate knowledge on a global scale (Castaldi et al., 2020) and to be accessed by individuals outside their usual field of attraction.

The emergence of Web 2.0 has also impacted how organisations represent themselves within the new dimension of cyberspace. Before the emergence of the Internet, organisations had physical existence and usually a physical location in our “real” world. Then, the emergence of the Internet allowed for their online presence, an avatar of the physical world into the digital one. Organisations can create websites or blogs to bridge physical entities with online ones.

Valtysson and Holdgaard (2019) propose a second stage of dematerialisation of organisations with what they call the “elsewhere organisation”. The organisation becomes *pixelated* through multiple online networks and communities such as Facebook, Youtube, third-party publishers or Google Maps. The organisation is neither in the real world nor online as a duplicate but deconstructed and reincarnated elsewhere in cyberspace through its embedded network.

By considering this non-physicality of their organisation, PNAs can integrate their new non-physicality into their strategies and implement their education and conservation mission. These missions would be carried out in the field and cyberspace; thus, they could become what Dziekan and Proctor (2019) call a “pervasive” organisation.

A new way of communicating

The organisation in a digital space is expected to be more user-centric and consider its customers' or community members' needs and motivation (Nahrkhalaji et al., 2019). Despite this new context, there is a notable paucity of recent investigations into how PNAs' employees approach the challenges and prospects of engaging new audiences. An earlier study by Hennig et al. (2013) revealed that in 2013, the potential of Web 2.0 in terms of its communicational benefits for PNAs had not been adequately assessed. Surprisingly, ten years later, no research has assessed the progress made by PNAs in their quest to digitalise their educational mission. In Addition, research conducted in museum settings has demonstrated that cultural or natural heritage organisations should be poised to meet the digital communication demands of their visitors (Booth et al., 2019; Dziekan & Proctor, 2019). According to the literature, heritage organisations could benefit from a more interactive relationship with their audience to improve the results of their educational mission and promote their actions. Indeed, an organisation that digitalises its educational missions will have to allow for a two-way conversation with its stakeholders and consider their feedback (Varenne & Godé, 2021). Therefore, a feedback loop seems essential in their DIEL strategy. By extending their reach to potential visitors and the online public, PNAs may appeal to a different audience than they traditionally have on-site.

The development and rapid spread of technologies that allow images and videos to be disseminated on a large scale, such as television and the Internet, have exposed individuals to various kinds of visual data. The 1.4 billion users worldwide of Instagram, a social media dedicated to picture sharing, demonstrates our embrace of visual culture and that images are at the heart of our social interactions. This extensive use of images can be explained in part because, according to Harper (2002), "images evoke deeper elements of human consciousness than do words" and can provoke emotions that words cannot (Davison, 2015). Moreover, this use of media must also be considered in the context of the age of the selfie and trends such as #InstaPlaces and #IWasThere type of tourism (Barry, 2017). Destination organisations, especially PNAs, could benefit from this new era of image culture to communicate with their stakeholders. A report by Hootsuite (2022) on the use of digital media in 2022 by people worldwide shows that over 27% of

social media users use them to find inspiration for things to do or buy. It also shows that the Hashtag #Nature is among the ten most used on Instagram worldwide, with 689,000,000 posts. Moreover, the surge in personal photography, video creation and dissemination has propelled tourism imagery into the heart of social media culture (Barry, 2017; Falk & Hagsten, 2021). Nonetheless, as highlighted by Siyamiyan Gorji (2021), destinations have traditionally centred their efforts on providing textual content.

It must be acknowledged that despite its potential benefits, social media may have adverse implications for the conservation objectives of PNAs. Falk & Hagsten's (2021) study demonstrates this double-edged sword phenomenon with the example of the endangered United Nations Educational, Scientific and Cultural Organisation (hereafter UNESCO) site. The UNESCO heritage label promotes the conservation of sites but simultaneously puts them at risk of over-visiting due to increased popularity. Indeed, it has been shown by Tenkanen et al. (2017) that the flow of posts related to a destination online can be considered a proxy for its frequentation. In other words, the more popular a destination is online, the more likely it is to increase its on-site traffic.

Finally, reaching a new audience is not enough; organisations must find ways to capture their audience's attention. Therefore, organisations aiming to digitalise their educational initiatives should ensure that their online content is culturally relevant, aligns with visitor interests, and addresses their concerns for effective engagement. For this purpose, they may use stakeholders' feedback, tagging, and hashtags and monitor third-party publications (Brennan, 2010; Pierroux, 2019).

2.3.5 The digital panacea for learning?

In the previous sections, it has been discussed how digital tools can support informal environmental learning. However, several authors warn against blind enthusiasm for these technologies and urge us to acknowledge the main challenges and threats they may pose to organisations and individuals. Furthermore, the apparent benefits of democratisation and open access to the knowledge provided by the internet can be a double-edged sword.

At the organisational level

The digitalisation of the educational functions of organisations can lead to an over-complication of their processes. Indeed, as seen in section 2.4.3, a digital transformation requires a change of culture, leading to a need for new skills and a change of leadership and management style. However, what may seem like a relatively simple change can, in fact, profoundly affect all aspects of the organisation (Castaldi et al., 2020).

Also, with the advent of the Internet and Web 2.0, accessing information has never been easier. However, the attention of individuals within cyberspace can be overstretched. It is increasingly challenging to capture it by chance; therefore, a digital strategy must be put in place with the diffusion of specific and relevant content for that purpose (Marcelin et al., 2022; Pierroux, 2019). Failure to implement an appropriate strategy could jeopardise organisations' DIEL objectives' success. This view is shared by Sujata et al. (2019), who suggest that social media have a significant but weak effect on pro-environmental behaviour because of the lack of persuasive content on social media.

At the societal and individual level

Authors such as Facer and Selwyn (2021) and Ritzer et al. (2018) warn against excessive digital optimism and a neo-liberal vision of education that aims to use digital tools to train tomorrow's workers to meet economic needs rather than fulfilling a lifelong learning opportunity for individual self-fulfilment. Therefore, it is necessary to look beyond the “velvet cage” that technology can provide and call for more accountability and democracy in using digital tools and interfaces.

Furthermore, Lewis et al. (2010) emphasised that despite the perception of collective sharing on social media, the individual remains isolated, potentially giving rise to a collective monologue, self-centred behaviours (Abdallah Tani & Alrasheed, 2023), and even adversarial exchanges like "insult wars" (Coron & Gilbert, 2020b, p. 48) within the platform. The act of sharing ideas and knowledge might be treated as a commodity, devoid of engagement in collaborative learning, as viewed in a "confined" context (Lewis et al., 2010). Under these circumstances, social media might not facilitate environmental learning processes.

Openness versus control

As discussed in the previous sections, the advent of Web 2.0 allowed for the rapid, low-

cost, and global dissemination and sharing of environmental knowledge. As King et al. (2016) outlined, the democratisation of knowledge facilitated by the Internet allows the authority and ownership of information to be shared among all segments of society, including experts, professionals, academics, and individuals without formal expertise.

In the context of PNAs, it is common to see information about natural heritage protection organisations disseminated on private websites, social media, and grey or pseudo-official communication channels (Huang, 2023; Mitova et al., 2021). This raises concerns about the credibility and reliability of such information shared by third parties, and PNAs might struggle to adequately supervise and rectify such information due to skill, time, and budget limitations (Brennan, 2010).

2.3.6 Environmental knowledge and ICT as a resource for education and conservation capability building.

The Resource-based View (RBV) has been widely applied in strategic management (Maritan et al., 2017). While extensively applied in the private sector (Kosiol et al., 2023; Szymaniec-Mlicka, 2014), relatively few studies have explored RBV in the public sector (Bryson et al., 2007), with some notable exceptions in the healthcare (Kosiol et al., 2023), education (Araya Guzmán et al., 2007) and e-governance sectors (Zheng et al., 2013). This study contributes to the existing literature by applying RBV to the PNAs' context.

The RBV principles argue that the strategic resources of a private company can provide it with a competitive advantage (Grant, 1991; Barney, 1991; Leiblein, 2011). However, as PNAs operate within the framework of missions focused on conservation and education and not financial profitability; the concept of gaining *a competitive advantage* is not directly relevant to them. Instead, the researcher proposes that their organisational value can be redefined to encompass the ability to fulfil their education and conservation missions effectively and to deliver value to the public.

Applying RBV in the research context also necessitates defining PNAs' strategic resources (tangible or intangible) that are valuable, rare, inimitable, and non-substitutable (Moller & McCaffrey, 2023; Wernerfelt, 1984). Firstly, PNAs' unique and rare environmental knowledge represents a strategic resource, as their core mission centres on creating,

managing and disseminating this knowledge to positively impact visitors' environmental learning and PEB.

Secondly, a resource can be considered strategic when exhibiting a positive differential between the value it provides and the expense of initially securing it (Leiblein, 2011). In other words, as per Rumelt's (1987) conceptualisation, strategic resources' *ex-post* value exceeds their *ex-ante* acquisition and utilisation costs. Thus, the researcher argues that ICTs constitute another valuable intangible resource of PNAs, as access costs to ICT infrastructure and platforms are virtually nil, while it can create high value for the public by amplifying the educational and conservation impact of PNAs. Specifically, ICT integration allows PNAs to extend the scope of their positive impact on public eco-literacy from limited on-site visitors to potentially the whole digitally connected population without geographic boundaries.

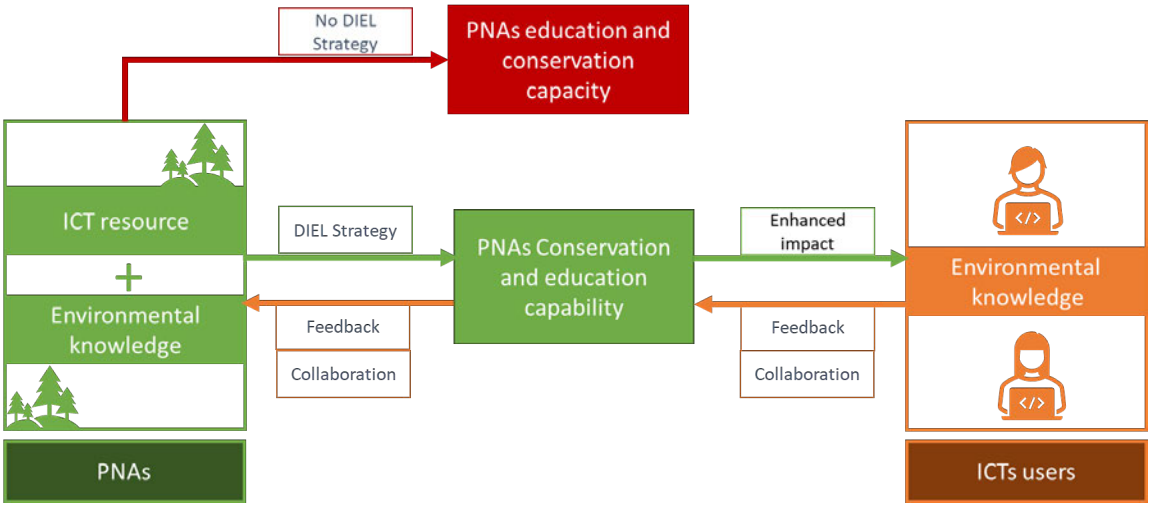
According to Ojiako et al. (2022) the resources of an organisation "*are generally heterogeneous in nature and the strategic nature of these resources can be further enhanced through their distinctive and non-imitable mix"* (p.17). Thereby, the combination of the PNA's rare and inimitable environmental knowledge with the scalability of ICT, holds the potential to significantly amplify their positive impact on IEL and PEB of their visitors (Mehrvarz et al., 2021, Valtysson & Holdgaard (2019).

However, merely implementing ICTs does not guarantee their effectiveness as strategic resources. Indeed, technology alone cannot drive value creation (Lioukas et al., 2016). If not deliberately exploited, the potential of ICT tools will remain an inert, hidden and/or latent opportunity for PNAs to extend their educational impact and achieve their missions. Consequently, the ability of PNAs to strategically translate the opportunities offered by ICTs into organisational capabilities can enhance their ability to achieve their education and conservation missions. Specifically, by implementing DIEL strategies seeking to effectively disseminate environmental knowledge via digital tools, PNAs can support visitors' IEL and promote PEBs.

Figure 3 summarises the arguments above, illustrating that the combination of PNAs' environmental knowledge with the ICTs as a resource can lead to latent ICT capability

when no DIEL strategy is implemented. Conversely, with the implementation of a DIEL strategy, this combination can evolve into education and conservation capability, resulting in an enhanced positive impact on the environmental knowledge of social media users. As discussed in Section 2.2.3, social media users can actively engage in two-way interactions, providing feedback and co-creating environmental knowledge with PNAs. This participation contributes to the dissemination of environmental knowledge and allows PNAs to adapt their ICT capabilities based on user input.

Figure 3: illustration of the strategic potential of the combination of environmental knowledge and ICT as a resource by PNAs to enhance their conservation and education capability.



Key points presented in this chapter

Chapter 2 highlights the inconsistency in defining the research concept within the literature. In response, the researcher undertook a comprehensive literature review to establish a definition of informal environmental learning and pro-environmental behaviour, which serves as the foundational framework for the remainder of the study.

This chapter discusses the arguments for the direct correlation between informal environmental learning and people's pro-environmental behaviour.

The potential of digital tools, particularly web 2.0, to foster environmental learning and pro-environmental behaviour through the co-creation of knowledge and social learning is discussed. This chapter demonstrates that the success of digital informal environmental strategies implemented by organisations for education and conservation hinges on their technological and pedagogical approaches. Specifically, implementing DIEL strategies can allow PNAs to effectively disseminate environmental knowledge via ICTs and support visitors' IEL and promote PEBs. However, caution is raised regarding the potential adverse impacts of digital tools on informal environmental learning processes.

Finally, this chapter paved the way for the researcher's methodological approach, detailed in the next chapters 3 and 4.

Chapter 3 Methodology & Methods

This chapter aims to provide the reader with an understanding of how the researcher intends to provide Protected Natural Areas (PNAs) with strategies to use social media to fulfil their educational and conservation purposes by efficiently supporting the informal environmental learning of their visitors and promoting their Pro-Environmental Behaviour.

Although the literature distinguishes "methodology" and "method", the researcher considers data compilation part of a "continuous back and forth movement between theory and its empirical foundations". Section 3.1 illustrates this strong connection between the two concepts, discussing the researcher's methodological approach and how it influenced their choice of case study as a methodological design.

Then, the two methods used to investigate the case study are discussed. First section 3.2. describes the data collection via questionnaire while section 3.3. discusses the data collection via interviews. Finally, the articulation of the researcher's methodological choices and approach to methods are illustrated and summarised in a research plan in section 3.4.

3.1 Methodological approach

The word "methodology" can take on several dimensions in the literature (Bakker, 2012; Small, 2021). According to Payne & Payne (2011), "methods are the specific techniques used in social research whereas, […] the term, 'methodologies' is usually employed to indicate the sets of conceptual and philosophical assumptions that justify the use of particular methods" (p. 149). The research clarifies that "methodology" is understood here as the methodological approach to conducting research. It represents the onto-epistemological and theoretical choices made by a researcher, reflecting how they conceptualise their research project (Koro-Ljungberg, 2019).

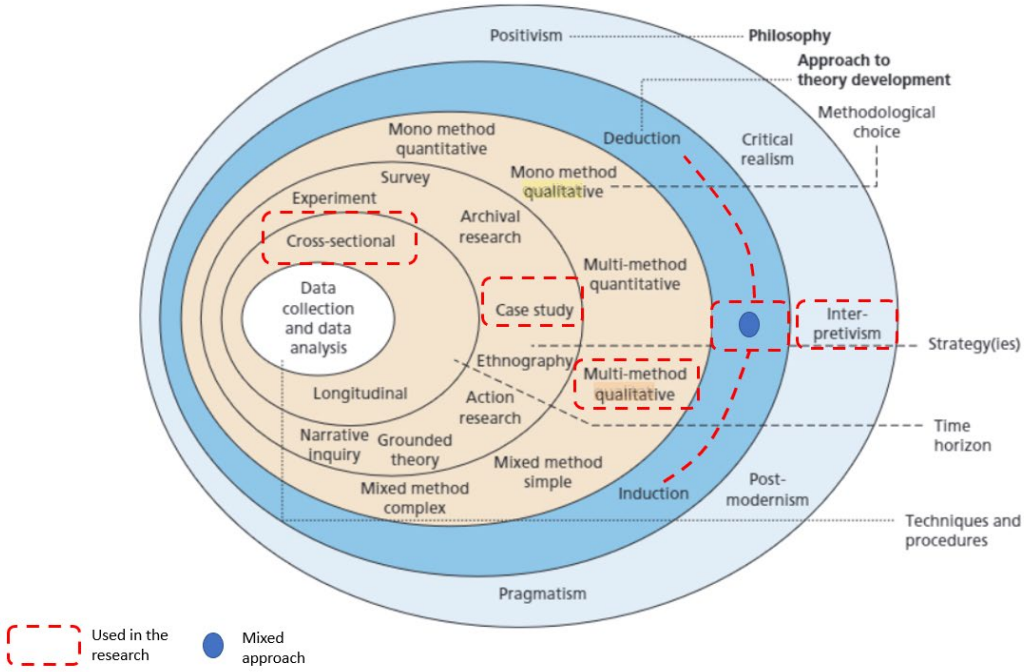
Also, the researcher's approach to research will be reflected in all stages of this study, particularly in the design and conduct of the data collection. Therefore, it is necessary to provide the reader with an understanding of the researcher's methodological choices,

allowing the data to be generated and contextualising this study and its research objectives (Koro-Ljungberg, 2019).

This section provides the reader with a rationale for the choices made by the researcher in terms of data collection and analysis to address the research questions. It discusses the research paradigms that reflect the researcher's beliefs, research approach, foundational research ideas, resulting research concepts, and the theoretical framework guiding the exploration of these concepts through data collection and analysis.

Its structure follows the research onion model developed by Saunders et al. (2009) each sub-sections addressing a layer of the onion (see Figure 4).

Figure 4: Representation of the methodological path taken in the research based on the Saunder et al's research onion model.



Section 3.1.1 describes the research philosophy that underpins all the other layers of the research design of this study (first Layer). Section 3.1.2 outlines the mixed research approach taken in this study (second layer). Section 3.1.3 presents the methodological choices (third layer). Section 3.1.4 presents the rational for the use of case study as a research strategy and section 3.1.5 for a cross-sectional study (fifth and sixth layers). Finally, section 3.1.6 presents a visual summary of the methodological approach.

3.1.1 The research philosophy

This study is primarily concerned with linking informal environmental learning, digital transformation, and conservation within the PNAs' online communication strategies.

In the researcher's view and as discussed in section 2.3, the perception of ICTs and their performance for educational purposes by members of PNAs may impact the strategies they will implement online to support the informal learning of their visitors. This view is also supported by a study by Solberg et al. (2020), which shows that the digital mindset of employees could significantly impact their commitment or disengagement from the digital transformation initiatives of their organisation. The researcher also considers that the understanding and definition by members of PNAs of what environmental knowledge is, how environmental knowledge should be disseminated, to which audience and by which means has an impact on their strategy for promoting eco-responsibility via digital environmental informal online learning. Finally, in line with the studies of Ford (1999) and Gergen & Thatchenkery (2004), it is considered that an organisation is socially constructed around the addition of the realities perceived and shaped by its members.

Based on these previous considerations, the researcher believes that this study's object must be apprehended through the perception of the subject who experiences it (i.e., members of PNAs) (Royer & Zarlowski, 2011), which cannot be reduced to universal laws and be generalised. In other words, to study how digital transformation, informal environmental learning, and conservation of nature can interact in the context of PNAs, an exploration of the understanding of these concepts by members of these organisations is required which provide contextual nuances of the phenomenon. Thus, this study is part of an interpretative work that seeks to understand "how actors construct the meaning they give to social reality" (Girod-Séville & Perret, 2011, p. 17) rather than a positivist inquiry seeking to provide universal laws and validate hypotheses. Indeed, according to Saunders et al. (2009) "The purpose of interpretivist research is to create new, richer understandings and interpretations of social worlds and contexts." (p.140)

3.1.2 The research approach

Four types of approaches to theory are identified by Grbich (2022) that involve different approaches to theory development. The four approaches reflect that theory and

methodology are linked and inform how data will be collected and analysed. However, the strength of this link may vary during the researcher's interpretation process.

1. Pre-chosen theoretical positions: Data are collected to test theories determined at the early stages of the research.
2. Methodological underpinnings: Data collection is constructed based on established theory.

These two approaches were not used in this interpretive study, as they focus on testing or applying existing theories in a deductive manner. These deductive approaches could have restricted the exploration of emerging models or new ideas and not provided the contextual nuances needed to understand the phenomenon under study.

3. Theory minimisation: Data is the focus of the research, and interpretation is minimal.

This inductive approach fits the researcher intention to take an approach allowing new concepts and relationships to emerge directly from the textual data. However, it would have excluded theoretical frameworks and prior research to let the data 'speak for itself', which does not align with the research intention to analyse and interpreting the data through relevant theoretical lenses.

4. Researcher choice: The data is explained in the light of theories that allow for its analysis and interpretation. The researcher can make a more abstract explanation of the data and generate a new model or theoretical proposition (Grbich, 2022).

This fourth approach to theory presents a mix of deductive and inductive reasoning. As Grbich (2022) noted talking about the link between theory and how data will be collected that: "Sometimes this is an almost seamless process where, at one extreme, previously identified theories are applied, while at the other emergent explanation closely linked to a range of theoretical positions occurs. In between these two extremes, light theoretical interpretations of a conceptual nature and the development of models of best practice may occur." (p. 292). Following its interpretative nature, this study follows a "researcher choice approach model" and employs a mix of theory-driven and data-driven approaches,

allowing for the emergence of new models (Green, 2004). Therefore, the use of the researcher choice model allowed the use of relevant theories and frameworks both to guide parts of the research (deductive) as well as allowing for new conceptual relationships to emerge from the data itself (inductive). This choice informed the researcher's thinking about the collection and analysis of the data, which is presented in the next section and chapter 4.

3.1.3 Methodological choice

Following an interpretative philosophy to research this study "*seeks to make sense of subjective and socially constructed meanings"* and therefore fits naturally into a qualitative approach (Saunders et al., 2023, p. 180). While qualitative research is mostly inductive (Saunders et al. 2023), qualitative strategies can incorporate elements of deductive reasoning (Yin, 2018). Thus, the research approach taken mixing deductive and inductive reasoning align with a qualitative approach. This qualitative approach is in line with recent studies exploring the potential impacts of digital transformation in other contexts than PNAs, such as e-health (Gjellebæk et al., 2020), small and medium enterprises (Olsson & Bernhard, 2021), museums (Raimo et al., 2021) or public services (Giulio & Vecchi, 2021). Furthermore, according to Royer & Zarlowski (2011), the limited research and empirical exploration of the subject of this study do not allow for a quantitative or experimental approach.

As seen in chapter 1, the research question: In the context of the digitalisation of society, how do PNAs implement DIEL strategies to support the PEB of individuals via their communication strategy on social media? could be broken down into five sub-research questions, including the following three:

- What is the significance of informal environmental learning and PEB promotion in protected natural areas' current social media communication strategies?
- What are the challenges faced by protected natural areas in the process of technology adoption and utilisation to support the positive environmental learning of their visitors?
- To what extent the digital strategy for education evolved during the COVID-19 crisis?

These three sub-questions require a data collection method seeking to discover "what is going on" (Yin, 2009). This exploratory and descriptive step was necessary for three reasons:

- Very little research has been linking or exploring the concept of informal learning, digital transition, and PEBs. This gap in the literature justifies the present study but represents a challenge for the researcher's theoretical and conceptual work (Streb, 2010). Therefore, it is necessary to collect data to get an overview of "what is going on".
- These descriptive and exploratory approaches make it possible to highlight phenomena not yet recognised by the literature and thus participate in completing the body of knowledge (Hamilton & Corbett-Whittier, 2013a).
- Finally, the data obtained gives the researcher a better understanding of the research context and helps define the research's key concepts (Hamilton & Corbett-Whittier, 2013b).

Once the research context is established and the key research concepts can be refined, and it is possible to proceed to an explanatory investigation of the research phenomenon. The explanatory phase allows the researcher to "remain open to discoveries in the [data collection] process" (Harder, 2010) and to answer the question "why and how"? (Yin, 2009). Hence, the researcher investigated the three previous research questions further and addressed the fourth and fifth research questions:

- How does social media positively affect visitors' informal environmental learning and PEBs?

- How does social media negatively affect visitors' informal environmental learning and PEBs?

The above considerations, i.e., the requirement for aqualitative study allowing for an exploratory and explanatory research were the rationale for the researcher to carry out a multi-methods qualitative research study.

3.1.4 The research Strategies and choices

To answer the research question, this study employs a case study approach. This methodological choice is based on the alignment with the multi-methods qualitative and interpretive approach to research adopted by the researcher (Stewart, 2017). Furthermore, Yin (2003) demonstrated the relevance of case studies in research, seeking to address research questions asking 'how' and 'why,' as is the case in this study. As noted by Stewart (2017), “a nominalist/interpretivist [researcher] would tend to use methods that can capture a range of individual observations and present the complexity of these in their findings” (p. 148). By adopting a case study approach, the researcher aims to provide a detailed understanding of the digital practices and strategies employed by PNAs in the context of environmental education and conservation.

Indeed, case studies are instrumentals as they can be regarded as a tool for better understanding a particular phenomenon within a ‘bounded system’ (Bloor & Wood, 2011, p. 27), i.e., the opportunities and challenges of the uses of ICTs for informal environmental education and promoting PEB in PNAs. The use of case studies allows for finding similarities and differences between cases and singularities, hence confirming constructs and propositions (Santos & Eisenhardt, 2011).

In addition, this research model has also been inspired by recent research using case studies as a methodological approach to explore the impact of digitalisation and social media on cultural heritage organisations (Raimo et al., 2021; Ruggiero et al., 2021).

According to Hamilton & Corbett-Whittier (2013a, p. 8), a case study “uses a variety of data collection tools and different perspectives to provide depth. Employs two or more forms of data collection tool and/or two or more perspectives”. This multiplicity of methods allows data triangulation and reinforces the reliability of the study’s conclusions. Moreover, as seen in section 3.1.2, two different approaches are needed to address the research questions, implying the use of two different methods of investigation. Therefore, the author aligned their interpretative approach with their choice of methods that allowed the collection of the participant’s perspectives on the phenomenon under research.

First, a method for capturing an overview of the research context while gaining insight into the perceptions of PNAs of the research subjects was required. For this purpose, a questionnaire was designed around a mix of closed and open-ended questions and distributed to practitioners, as described in section 3.2.

Secondly, 13 semi-structured interviews, as described in section 3.3, were carried out to collect the participants' perspectives while ensuring that the research questions were covered in-depth (Given, 2012). This choice of method is in line with Girod-Séville and Perret (2011), who explain that in a case study aiming to interpret individual perceptions, the researcher will be drawn toward methods that offer an in-depth exploration and contextualisation, such as interviews.

Moreover, the data collection was carried out via an exploratory questionnaire and semi-structured interviews rather than social media content analysis due to intentional alignment with the specific research goals and constraints. Indeed, by taking a methodological approach focused on PNAs decision-maker perspectives, this research aims to investigate the strategic motivations and barriers shaping their adoption of digital tools for education purposes.

However, using a social media content analysis as a method could not provide the explanatory depth expected nor flexibility to include non-users within the scope of inquiry. Moreover, existing literature had already documented shortcomings in PNAs' online presence and analysed the content of their social media (Abrams et al., 2020; Hennig et al., 2013; Korená & Pártlová, 2023; Marcotte & Stokowski, 2021; Marsat, 2011; Nechita et al., 2014; Podgorski, 2015; Saunders et al., 2019; Watkins et al., 2018) and investigated UGC related to PNAs (Hausmann et al., 2020; Liang et al., 2023; Mangachena & Pickering, 2021; Norman & Pickering, 2023; Pickering & Norman, 2020; Song & Schuett, 2023; Wilkins et al., 2020). Given that these aspects are well documented in the literature, this research focuses on other dimensions by looking at PNAs' strategical and managerial perception and approach of the adoption of digital tools to support eco-literacy of their visitors. Finally, the aim of the study is to investigate the "why" of strategic decision-making in combining environmental knowledge and ICT resources, not describe "how" it is manifested in the social media content itself. Distributing the questionnaire and carrying out the interviews enabled gaining insights from key informants allowing the

research questions to be addressed with the appropriate level of analysis, flexibility and available resources.

The methodology chosen for this research meets the main criteria for case studies defined by Hamilton and Corbett-Whittier (2013a), as discussed in Table 3.

Table 3: Aspects of the research that meet the characteristics of a case study.

Aspects of case studies defined by Hamilton & Corbett-Whittier (2013a)	Aspects of the present study
Bounded unit – a person, a group, an institution, or an organisation located within personal, professional, local and national communities. Involves interactions, communications, relationships and practices between the case and the wider world and vice versa.	The case study for this research concerns delimited units of France's three main types of natural areas. These organisations are part of the larger national framework of educating the population about sustainability and conservation and dealing with various stakeholders.
Focus on collecting rich data – capturing the complexity of the case.	The data collection methods employed in this case study aimed at an in-depth exploration of the research topic.
Data may be collected over extended periods with repeated collections or may be collected during an intensive but short period of time.	The data were collected in a short but intensive period from the 15th of February 2021 to the 29th of March 2021.
Requires spending time within the world of those being researched.	The data collection methods employed in this case study involved interactions with the participants (see chapter 4).
Uses a variety of data collection tools and different perspectives to provide depth. Employs two or more forms of data collection tools and/or two or more perspectives. This helps to triangulate the data and reinforces the legitimacy of the conclusions drawn.	The data collection is based on two methods: a questionnaire and interviews. To allow a more holistic and in-depth view of the research topic, the data was collected from participants with different positions within the natural area's organisation (head of communication, education officer, member of the management) and from various stakeholders of PNAs (elected members of the board of directors, management organisations, federations of organisations) (see chapter 4).

Study sample population

Section 1.1 demonstrates why PNAs in France are particularly relevant cases for this study based on the multiplicity and specificity of their structures but also because of the major stakes they represent in terms of sustainable development and the education of populations. Hence, French PNAs are the population sample for the case study. The geographical areas considered in this study fall into one of the six categories of protected

areas identified by the IUCN. They may be protected areas of a regulatory nature (categories I to IV) or contractual nature (V and VI).

The sample chosen is that of three types of PNAs in France, i.e., the National Parks, Nature Reserves and Regional Nature Parks, for the following reasons:

- They are the largest PNAs in France in terms of surface area.
- They share the same mission of educating and raising awareness among the population about the stakes of nature protection.
- They also shared the need for valorisations of their work to the public (education, conservation, mediation, scientific).
- These three types of PNAs are the types of protected areas best known to the French (French Ministry of ecological transition and territorial cohesion, 2020).
- These three types of PNAs could benefit from ICTs as tools for informal education and for promoting PEBs to achieve their educational and conservation mission.

However, they present specificities that may influence their approach to using ICTs for educational purposes and promoting eco-responsible actions (see Table 4):

- They represent three different levels of protection of natural species, with different levels of frequentation.
- They represent three different types of governance.
- They represent three approaches to the human/nature relationship, from minimising human presence to integrating human activities into sustainable development projects.

Therefore, this sample has both homogenous (same conservation and awareness-raising mission) and heterogeneous (governance, structure) characteristics. By adopting this "criterion sampling", the researcher confirms their ambition to explore the phenomena investigated in this study in-depth and as holistically as possible (Schreier, 2018).

Table 4 Main characteristics of the sample

	National Nature Reserve	National Parks	Regional Nature Parks
Main features	Natural areas unaltered or not significantly altered by human activity are strictly set aside to protect biodiversity. Minimise human disturbance. Low visitation rate	Human activity has little or moderately altered natural areas, allowing for spiritual, scientific, educational, recreational and tourism opportunities compatible with the environment and culture. 810.000 inhabitants 10 million visitors/years	Natural areas are moderately altered by human activity that conserves ecosystems and habitats, associated cultural values and traditional natural resource management systems. 4.1 million inhabitants
Number in mainland France	150	9	56
Land areas covered	180 729km (Reserve Naturelles, 2022)	56 819 km (Parcs Nationaux, 2022),	95 496 km[1] (Approximately)
Access	Regulated	Some areas regulated	Free
Governance	Management organisation/ Regulatory power	National public institution/ Regulatory power	Public establishment of local institutions cooperation/ no regulatory power
IUCN classification	Categories I, III, IV	Category II	Category V

Case study limitations and mitigation strategies

However, the researcher acknowledges the potential limitations and areas of concern relating to the use of case studies.

- Case studies can be regarded as not necessarily generalisable and/or often lacking in reliability and validity (Quintão et al., 2020). However, the investigation of multiple cases is considered more robust than the single case study and reinforces this study's validity and reliability. Furthermore, the choice in the construction of the data collection protocol, presented in sections 3.2 and 3.3, and the technical means deployed (e.g., recording of the interviews) contribute to the reinforcement of the reliability of the study.

- This study relies on the willingness of PNAs to participate in the research. Therefore, the lack of data availability was a potential concern for the researcher (Yin, 2013). To increase the participation rate of the natural areas organisations, the researcher collaborated with the gatekeepers with the objectives of:

[1] The area covered by Regional nature park is based on the following calculation =17,3% (% of French territory covered by Regional Nature Parks) x 552.000km2 (France mainland area) (Lévêque & Feuillet, 2014). The surfaces of PNAs can overlap.

- establishing a relationship of trust,
- engaging PNAs with the subject of the study and,
- encouraging them to promote the study among their colleagues.

In addition, for the purpose of transparency and as part of the information of the participants, the researcher sent them a link to a Microsoft Sway mini-site presenting contact details, a summary of the research context, methodology and objectives (see Appendix B). It is believed that the support of the gatekeepers and the mini-site (viewed 61 times) gave credibility to the researcher's approach among the participants.

Qualitative research, particularly case study research, seeks to explore and collect the participants' interpretation of phenomena, although the researcher will interpret the data collected (Streb, 2010). As such, qualitative research positions the researcher as an interpreter and simultaneously allows for their and the participant's subjectivity (Baumard & Ibert, 2001). Thus, it can be argued that the researcher's point of view can bias the data interpretation, local constructions of meaning, values, theoretical orientations, and experience (Vasilachis De Gialdino, 2012). Moreover, the exploratory case study can be criticised for relying on the researcher's intuition. According to Patton (2002): "The human factor is the great strength and the fundamental weakness of qualitative inquiry and analysis". However, according to Streb (2010), this subjectivity can also represent one of the greatest advantages of case studies when little research has investigated the phenomenon under study. Similarly, Baumard and Ibert (2001) warn that the attempt to maintain strict objectivity may limit the researcher's creativity and prevent the discovery of data or concepts for constructing theories or models. Therefore, the researcher has implemented reflexive efforts in their methods and interpretation process to maintain a balance between objectivity and credibility of the data and their analysis while showing open-mindedness, allowing new ideas and perspectives to emerge.

Thus, following Patton's (2002) advice, the researcher monitored and reported their "analytical procedures and processes as fully and truthfully as possible". For that purpose, the researcher used various strategies to avoid or mitigate the impact of their worldview on their interpretation process and ensure the credibility of the research, such as:

- The researcher did their best to put aside their prior knowledge of the organisations studied regarding their structure, missions and reputation to avoid misunderstanding or bias.
- Also, the researcher carried out reflexivity work throughout the research process, which included maintaining a research logbook and an interview review logbook and systematically revisiting and reviewing the interview recordings to facilitate self-critique and reflection.
- The researcher's methodological choices were presented transparently in chapters 3 and 4, ensuring clarity and openness.
- The search for data saturation and categorisation was sought to comprehensively understand the studied phenomena from multiple perspectives.
- The use of data triangulation to validate and strengthen the findings.

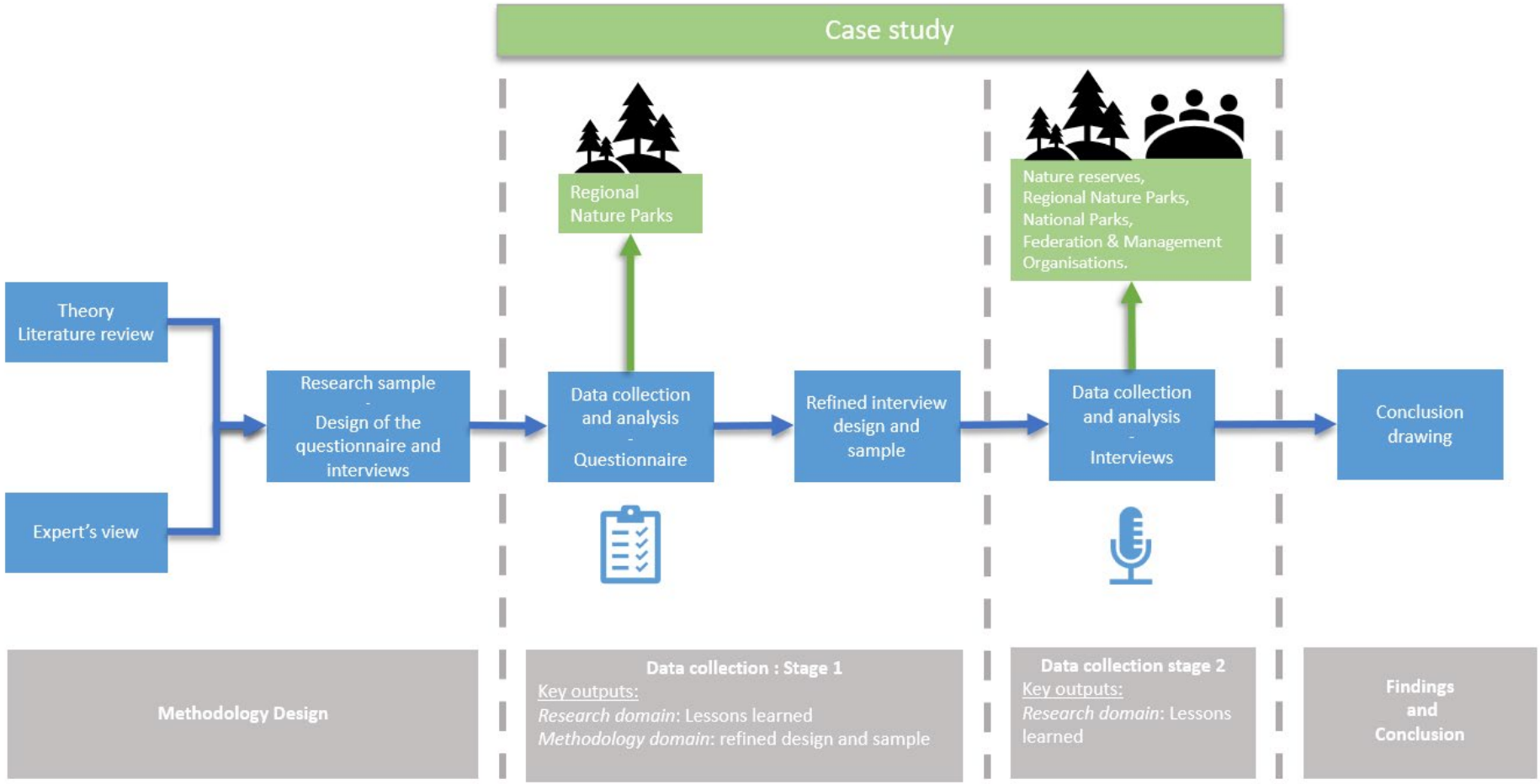
3.1.5 Time horizon

This research seeks to understand the current strategies and practices of practitioners in French PNAs, in other word, to capture a snapshot of the current situation. Therefore, this study uses a cross-sectional time horizon to collect data at a defined point in time to discover “what is going on” (Yin, 2009) and investigate the relationships between education, sustainability and digital transformation in PNAs (Saunders et al., 2019) to address the research questions.

3.1.6. Summary of the methodological approach

A summary of the methodological approach is illustrated in Figure 5

Figure 5 Summary of the researcher's methodological approach



3.2 Stage 1: Exploratory study of digital practices for education

A questionnaire was designed to capture an overview of the research context while gaining insight into the PNA's perceptions of the research subjects in the same way that (King et al., 2016) used a qualitative questionnaire analysis to explore the impact of ICTs on museum practices. This section presents the rationale for the questionnaire sample (section 3.2.1), design (section 3.2.2), and ethical considerations (Section 3.2.3.).

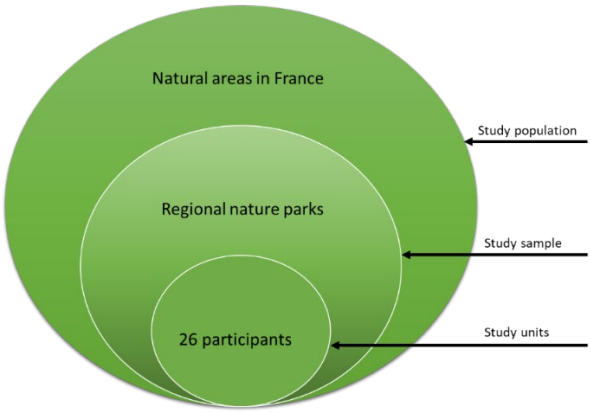
3.2.1. The sample

As seen in section 3.1.3, the sample for the case study is based on three types of PNAs in France: Regional Nature Parks, National Parks, and Nature Reserves. Unfortunately, no gatekeepers were identified in National Parks or Natural Reserves to distribute the questionnaire. Indeed, regarding Nature Reserve, the atomicity of actors in charge of Nature Reserve Management did not allow for the collective questionnaire distribution. Also, the collective solicitation of the National Parks for this study by the researcher was discussed at a board meeting of the Federation of National Parks, which decided not to distribute the questionnaire due to the high workload of their staff. It is worth noting here that COVID-19 put a lot of additional pressure on PNAs in France, which may explain their lack of willingness to be involved in the distribution of the questionnaire, even though several practitioners informally indicated to the researcher their interest in the subject of the present study. Indeed, one National Park and several Nature Reserves have expressed interest in participating independently in the interviews.

However, the participation of a gatekeeper in Regional Nature Parks allowed the creation of a sample of participants among the entire network of 56 Regional Nature Parks in metropolitan France. Their responses were sufficient to provide an overview of the strategies and challenges PNAs face when communicating online for educative purposes and allowed for the refinement of the design of semi-structured interviews (see section 3.3).

The gatekeeper contacted the Regional Nature Parks' communication officers by e-mail to encourage them to participate in the self-administered questionnaire. As a result, 26 of the 56 regional parks (i.e., 46%) responded to the online questionnaire (see Figure 6).

Figure 6 Questionnaire sample



3.2.3. Questionnaire design

The adoption of a questionnaire design mixing open and closed questions is recommended by methodologists to "generate useful data for social research" (Roulston, 2008, p. 2). Hence, a questionnaire, designed around a mix of closed and open-ended questions, was distributed to collect qualitative data, capturing an overview of the research context. Studies such as those by King et al. (2016) or Carvalho & Matos (2018), which explored digital transformation in the context of cultural heritage organisations, inspired the researcher to use a combination of open and closed questions to explore the perspective of PNAs.

The questionnaire design and items are based on six key concepts from the literature review presented in chapter 2. Additionally, before the data collection, informal discussions were held with conservation experts who validated the topicality of the research questions and the relevance of these six items. A copy of the questionnaire is presented in Appendix C Questionnaire question and types of answer.

The six items selected for the design of the questionnaire are the following:

- ***The participant profile:*** A series of questions were designed to profile respondents regarding the year of service, level of responsibility within the organisation, and position held to provide insight into the answers.
- ***The online presence of the parks:*** A series of questions were designed to establish the digital profile of the participating organisations (presence/absence of website and social media accounts).
- ***The digital education strategy:*** The digital education strategy was explored through 5 items:

- *Organisation and resources*: According to Yeow et al. (2018), the success of an organisation's digital strategy is significantly linked to its alignment with the resources it commits to its implementation. Therefore, questions were set to explore the resources available to the park for the digital strategy.
- *Strategy design and target setting:* According to Schimek (2016), successfully promoting environmental knowledge depends on designing a strategy and defining learning objectives and expected outcomes.
- *Digital monitoring:* Strategic online monitoring of what stakeholders say about an organisation is crucial in managing its e-reputation and controlling its discourse and information dissemination (Cherif Ben Miled et al., 2018). This item assesses whether the participants monitor information disseminated by their stakeholders online regarding the Parks and their activities.
- *Temporality:* Ballantyne & Packer (2011) identify three relevant stages of research that could be applied in protected areas about learning processes: before, during and after the visit. This study focuses on using digital tools in protected areas to extend their educational mission before and after their visit. Moreover, learning is no longer considered a linear process (cause-effect) where individuals subjected to the same stimulus would respond similarly (Falk, 2005). Most recent studies agree on the complexity of the dynamic (Sechi et al., 2018) of the learning process. Also, it takes place throughout the life span of individuals (Falk & Dierking, 2019). Therefore, it is a long-term, continuous (Zareie & Navimipour, 2016) and non-instantaneous process (Falk, 2005). This question item assesses whether the park supports this continuous learning through its digital strategy.
- *Knowledge feedback and exchange:* To assess the ability of participants to be visitor-focused in their digital education strategy, their ability to obtain and process feedback from visitors on "why and what people want to learn about the environment" is explored (Rickinson et al., 2009a).

- ***Educational content:*** Based on Frick et al.'s (2004) definition of environmental knowledge, it is assessed whether the organisations participating in the study disseminate the three types of knowledge constituting environmental knowledge. Firstly, system knowledge is considered here as the dissemination of informational

knowledge on the environmental stakes of the protected areas and, more precisely, on the themes of the environmental SDGs (protection of aquatic species, water pollution, sustainable use of natural resources, sustainable use of territories, renewable energies, global warming). Next, action knowledge is considered here as the dissemination of information related to the means of actions of visitors and effectiveness knowledge is related to raising the visitors' awareness of how they can reduce their environmental footprint during their visit and the link between their behaviours and their impact on the park's ecosystems.

- **Participants' perception of digital tools:** The literature indicates that the perception of digital tools by the agents of an organisation or individual can impact their adoption (Rauschnabel et al., 2016; Tomicic-Pupek et al., 2020).

  This item explores park communication managers' perception of digital tools and their potential impact on using social media in education and promoting PEB.
- ***COVID-19 impact:*** Questions were added to assess the extent to which COVID-19 impacted the responses given by the participants in the study and which aspects of the parks' strategies were most affected by it. These questions also explored whether new ways of doing things and new perspectives emerged during COVID-19 and if they persisted after the lockdowns.

The answers to closed-ended questions were multiple-choice, single-choice, or to be placed on a 5-point Likert scale (from completely disagree to completely agree). They were designed to highlight potential emerging trends from the comparative analysis of participants' answers. The open-ended questions aim to allow for an in-depth exploration of the key concepts and generate unanticipated answers that may lead to the emergence of new key concepts relevant to addressing the research questions. Indeed, the questionnaire answers helped design the interview guide (section 3.3.) by validating or invalidating the items selected based on the literature review as relevant to the research and identifying some additional items to be investigated during the interviews.

3.2.4. Ethical consideration

The methodology for the questionnaire received ethical approval from the Coventry University Research Ethics Committee P127893. All participants were informed of their data collection, processing and deletion conditions and consented to participate in the research.

The data have been processed in accordance with the UK General Data Protection Regulation 2016 (UK GDPR) and the Data Protection Act 2018. They have been securely stored on a password-protected computer file on the university server and were only viewed by the researcher and their supervisory team.

3.3. Stage 2: The relevance of digital platforms for education

A second phase of data collection was conducted via semi-structured interviews to gather in-depth participants' perspectives while ensuring the research questions were fully covered (Given, 2012). The use of Semi-structured interviews by the researcher is consistent with the current literature. Indeed, several authors employed the same methodology to explore the impact of digital transformation and tools implementation in organisations in different contexts, such as the public service sector (Giulio & Vecchi, 2021), manufacturing (Tongur & Engwall, 2014) or museums (Raimo et al., 2021) for example.

Section 3.3.1. describes the construction of the interview sample, while section 3.3.2 discusses the interview design based on the literature review findings and the responses to the questionnaire distributed to the regional nature parks. Section 3.3.3 presents the researcher's actions before, during and immediately after the interviews to ensure the quality and credibility of their study. Finally, section 3.3.4 addresses the ethical considerations in realising the interviews.

3.3.1. The sample

As seen in section 3.1.3, the sample population for the case study is based on three types of PNAs in France: Regional nature parks, National Parks, and Nature reserves.

In addition, the data collected from French Regional Nature Parks' communication officers via the questionnaire highlighted the need to extend the sample to stakeholders such as their federation, who can be partners in the communication strategy. It also highlights the heterogeneity of practice in social media use within the PNAs network and a lack of orchestration of knowledge within the organisation of PNAs. Therefore, the education/conservation officers of natural areas and their federations were added to the research sample to enrich the contextual understanding of the research from a network and corporate in addition to the organisational perspective. The process of sample refinement is illustrated in Figure 5.

As a first step, the 26 Regional Nature Parks participants in the questionnaire were re-contacted directly by e-mail with the gatekeeper's permission to confirm their continued participation in this research via interview.

National Reserves and National Parks that maintained a Facebook profile were contacted via Facebook Messenger. Other institutions were approached using a contact form on their respective websites where available.

The researcher included a link to a Microsoft Sway mini-site in the interview proposal email. Microsoft Sway serves as a digital storytelling tool enabling users to craft presentations, reports, and web-based content that are both interactive and visually engaging. The mini-site created by the researcher provided the interview candidates with information about the research and the researcher's background prior to the interview. Openly sharing comprehensive information about the research process, objectives, methods, and the researcher helped create an open and transparent research environment for the participants, fostering their trust and engagement. A copy of the Microsoft Sway mini-site is provided in Appendix B).

The researcher received thirteen positive answers. Thirteen interviews were carried out from 1 March 2022 to 29 April 2022. In two of the interviews, two participants took part jointly. The participants were communication officers, conservation and education officers or directors. A summary of the participant's profiles and the interview duration is described in Table 5.

Table 5 Interviews participant's profiles

Interview number	Number of interviewees	Organisation represented				Role/position				Duration
		National Park	Regional Nature Parks	Reserve Nature Management organisation	Federation	Communication	Education	Conservation	Board/ Direction	
1	1		X			X				1h02
2	1		X			X				1h12
3	1			X		X	X	X		0h54
4	2		X			X				0h53
5	1		X		X		X			1h15
6	1			X		X	X	X		1h03
7	1			X						1h13
8	1		X				X			1h33
9	2			X		X	X	X		1h21
10	1			X		X				0h52
11	1		X						X	1h16
12	1	X				X				1h27
13	1			X		X				1h31
Total	15									15h31

3.3.2 The interview guide

The key concepts included in the interview guide were selected by combining the literature review findings and the questionnaire. Six questionnaire items were confirmed relevant to the research question and required further analysis via the interviews. Moreover, the analysis of the open-ended questions allowed for the emergence of key concepts that were added in the construction of the interview guide, i.e.:

- ***Emotions / Biophilia***: The responses to the questionnaires suggest that Regional Nature Parks are using positive emotions towards nature as a tool to get their educational messages across to visitors online on social media. The answers also indicate that the parks may stimulate the visitors' love for nature to trigger a desire to care for nature, as the biophilia hypothesis predicts (Barbiero, 2021). The researcher, therefore, wished to explore during the interviews whether the parks use the Biophilia hypothesis to motivate the eco-responsible actions of the visitors.
- ***Digital technologies functions:*** The responses to the questionnaires indicated that Regional Nature Parks might not be using all three functions of social media, i.e., the informational, relational and experiential functions for educational purposes to their full potential as defined in Ballew et al.' (2015) technologies for pro-environmental action model (hereafter TPAM).
- ***Negative learning***: The responses to the questionnaires suggest potential negative learning outcomes due to the use of social media. To determine whether negative consequences of environmental learning through social media occur, the author added the concept of negative learning, defined by Meyer et al. (2018), in the interview guide design.
- ***Positive learning:*** The item of positive learning was constructed as the opposite of negative learning, i.e., the learning process leading to positive consequences on the behaviour, knowledge, and beliefs of visitors.
- ***Negative positive learning:*** Having integrated the concepts of positive and negative learning into the design of the interview questions based on the responses given to the questionnaires, the possibility for a park visitor to achieve positive learning through negative learning, as predicted by Oser (2018), is investigated by the researcher.

- ***Digital strategy for environmental education:*** The findings of the questionnaire raised questions about governance, knowledge orchestration, and oversight. Therefore, the interview guide was edited to include these concepts to explore them further. Therefore, a sixth item, called « scope and governance », was added to explore the digital strategy concept for environmental education.
- ***Eco-literacy:*** The findings of the questionnaire show that environmental system knowledge and promotion of environmental skills (action and effectiveness knowledge) and PEB are relevant to this study and the protected natural areas education strategy on social media. However, it is acknowledged that these aspects alone may not fully encompass the complexity of the messages of PNAs, and promoting a positive attitude towards Nature is also deemed valuable for their DIEL strategy. Therefore, in the design of the interview guide, the four items, (1) Environmental knowledge, (2) Skills, (3) PEB, and (4) attitude have been grouped under the umbrella of eco-literacy as defined by Maurer and Bogner (2020).

Table 6 presents the key concepts in the interview guide and the associated questions. The complete list of the questions/concepts included in the interview guide is presented in Appendix *C*.

Table 6 Key Concepts of the Interview Guide

		Questions number																	
Key Concepts	**sub concept**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Online presence		X	X				X				X								X
Digital technologies functions	informational	X				X	X	X	X		X	X				X	X	X	X
	experiential	X				X	X		X		X	X	X				X	X	X
	relational	X				X	X		X		X	X				X	X		X
Digital strategy for environmental education	Audience	X	X		X	X	X	X											X
	Online presence	X	X				X				X								
	Resources						X		X	X									X
	Monitoring						X	X		X					X		X		
	temporality				X		X	X											X
	Scope and governance	X	X	X	X		X	X	X	X	X							X	X
Social Media perception			X				X		X	X	X	X	X		X	X	X	X	X
Negative learning	unwarranted knowledge														X	X	X		X
	non ERB														X	X	X		X
	false belief												X		X	X	X	X	X

Positive learning	warranted knowledge and skill							X			X	X				X			X
	moral behaviour							X			X	X			X	X			X
	ethical belief										X	X	X		X	X		X	X
Environmental literacy	knowledge		X	X		X	X	X	X		X	X							X
	skills		X	X		X	X	X	X		X	X						X	X
	PEB		X	X		X	X	X	X		X							X	X
	attitude		X	X		X	X		X		X		X		X				X
Negative positive learning																X			X
Biophilia		X											X	X					X
COVID-19		X			X	X													X

3.3.3 Conducting the interviews

Before the conduct of the interviews, participants were provided with a list of topics to be discussed for the following reasons:

- To reduce the participants' stress prior to the interview and build trust with them by ensuring transparency regarding the researcher's intentions and the topics to be covered.

- To allow participants to familiarise themselves with the topics beforehand and make notes on relevant points. Also, at the end of the interview, the researcher asked the participants if all their noted points had been addressed. This approach facilitated an in-depth exploration of the topic and allowed unexpected themes to emerge. Several participants referred to their prepared comments and notes during the interviews.

- To set the interview boundaries for all participants. This helped to keep the discussions predominantly focused on the specified topics, with a few exceptions. Overall, the researcher found that the document's distribution effectively guided and maintained the interviews on the topic.

- The provision of the document beforehand enables participants to prepare and gather relevant information from their colleagues regarding the themes to be discussed in the interview. This ensures that participants are well-informed and capable of responding to the researcher's questions. For instance, a participant expert in communication recommended involving a colleague with an educational background to provide additional insights during the interview.

The list of topics sent to the participants before their interview is presented in Appendix D.

Due to the COVID-19 context and the geographical dispersion of participants, the interviews were conducted online, thanks to the software Microsoft Teams and Zoom. All the interviews were audio and video recorded. The transcription was realised in real-time during the interviews with the Teams' live captions tool. The researcher recognises the criticality of transcription accuracy for the quality of research and data analysis (Gubrium & Holstein, 2001). Therefore, even if voice recognition software allows for automatic transcription, the researcher double-checked the transcription's accuracy by replaying the interviews and making the necessary changes in the transcripts. Also, Poland (2011) noted that the software might omit some aspects of the verbal records (accents, for example). That was the case of this study; all transcripts needed a consequent amount of editing work.

The key concepts to be addressed within questions were compiled in the interview guide in advance. However, the order of the questions, the time allocated to them, and the details requested were determined by the researcher in the course of the interviews based on what seemed to be most appropriate for each participant.

The semi-structured interviews were conducted "actively", allowing the interviewer to follow the interview guide with the appropriate flexibility (Hathaway, 2020). As a result, some questions in the interview guide were not asked of participants because they had either already answered them during the interview or because the question was no longer relevant in light of their previous answers. For example, participants would not be asked about their social media strategy if they had already indicated to the interviewer that their organisation did not own a social media account. Similarly, questions not included in the interview guide were asked to some participants when unforeseen topics emerged during the discussion or when the interviewer felt it was necessary or possible to explore a topic further.

This method implies that the interviewer is not passive in the discussions with the participants but is "involved in the meaning-making enterprise" and is engaged in the conversation (Talmage, 2014, p. 2). According to Johnson (2011): "In more traditional standardised interviewing, interviewers are commonly told to stick to the questions on the research protocol, to ask the questions precisely as they are given, […]. This is not a realistic idea for

in-depth interviewing because the nature of the research question usually entails a deeper process of mutual self-disclosure and trust-building. ” (pp. 112–113).

This approach, which is more flexible than structural interviews, was adopted following the recommendations and guidelines of the literature on qualitative interviews:

- Warren (2001) argues that a qualitative interviewer needs to be flexible and attentive to various meanings that may emerge as the interview progresses. According to this author: “this open stance includes being alert to developing meanings that may render previously designed questions irrelevant in light of the changing contexts of meaning” (pp. 5–6).

- Qualitative interviewing is the search for meaning and perspective of participants and is not compatible with standardisation and a strong reliance on literature and theory in conducting interviews (Rubin & Rubin, 2012).

- The active interview model shows the participants that the interviewer is listening, avoiding repeating himself, making the discussion more fluid, and avoiding the interviewee’s disengagement. Active listening allows for a more accurate understanding of the interviewee’s stories and indicates to the interviewee that they have been understood (Talmage, 2014; Warren, 2001).

The criterion for considering the cessation of data collection in qualitative research is “saturation” (Saunders et al., 2018). However, the literature is inconsistent regarding the number of interviews sufficient to reach data saturation (Hennink & Kaiser, 2022). Some suggest seven, others 17 interviews (Hennink & Kaiser, 2019). In their systematic review, Hennink and Kaiser (2022) examined empirical studies on sample sizes for data saturation in qualitative research. Their findings indicated that using small sample sizes, typically 9 to 17 participants, in interviews can effectively achieve data saturation. Also, some authors favour measuring saturation not based on the number of interviews conducted but on the quality and quantity of information obtained. This type of saturation is called saturation in salience and focuses on emerging themes (Weller et al., 2018).

The researcher had to decide if the sample size (13 interviews) was sufficient to develop a solid and valid understanding of the studied phenomenon. In the case of this study, no new

themes or items emerged in interviews 11, 12 and 13. Therefore, the researcher considered that saturation in salience was reached, and that additional interviews were unnecessary.

3.3.4 Ethical considerations

According to Kvale (2011), ethical issues should be considered at seven stages of research involving interviews.

- ***Thematising***. The interviews must be of research value and aim to improve the participants' situation. In preliminary and informal discussions with the regional nature parks' gatekeeper and national parks' members, it was confirmed that the subject of this research was also a pressing concern of the protected areas, which therefore agreed to participate in this study.
- ***Designing*****:** All participants gave written and oral consent before the interview to be recorded and participate in the research.
- ***Interview situation***: The potential consequences of the interviews on the participants should be considered. This study does not aim to investigate aspects of the participants' personal lives; however, their perspective on the research topic has been explored. To put the participants at ease, they could choose the software, date, and time of their interview. Also, they were told before the interview by e-mail and before recording the discussion about the conditions of collecting their data and how the researcher would use their intervention. They were also invited to ask any questions they felt were necessary before and after the interview. Finally, all participants were given a list of items to be discussed before the interview to enable them to prepare for the interview and reduce their stress.
- ***Transcription:*** The confidentiality of the participants was protected. References to participants were made by participant number and not by name, and the researcher has made every effort to ensure that the transcripts are true to their statements. Also, the names of geographical locations that may have been discussed during the interviews that could allow the identification of the participants were anonymised. Finally, the data collected were processed following the UK General Data Protection Regulation 2016 and the Data Protection Act 2018.

- ***Analysis:*** Only the researcher and their supervisor team could access the data collected. All participants gave the researcher their written and oral consent before recording the interview.
- ***Verification*****.** The researcher verified that the information given by the participants was accurate when necessary. For example, the social network accounts of the participants were scanned to verify the consistency of their statements and the reality of the strategies implemented by PNAs online. In some cases, the PNAs declared having a YouTube account, but the researcher's verification revealed that only one video had been uploaded on some accounts over the last few years. These checks and validations allowed the researcher to add to their interpretation of the participant's statements.
- ***Reporting*****:** According to Poland (2011), it may be tempting for researchers to 'clean up' participants' quotes to make them more readable. However, the researcher is aware that doing so may compromise the meaning and veracity of the quotes. Therefore, following Poland's advice, the researcher will note in the text that "some transcription details have been omitted in the interest of readability" for the complete information of the readers and the credibility of this study.

The methodology for completing the interviews received ethical approval from the Coventry University research ethics committee P131092.

3.4. Research plan

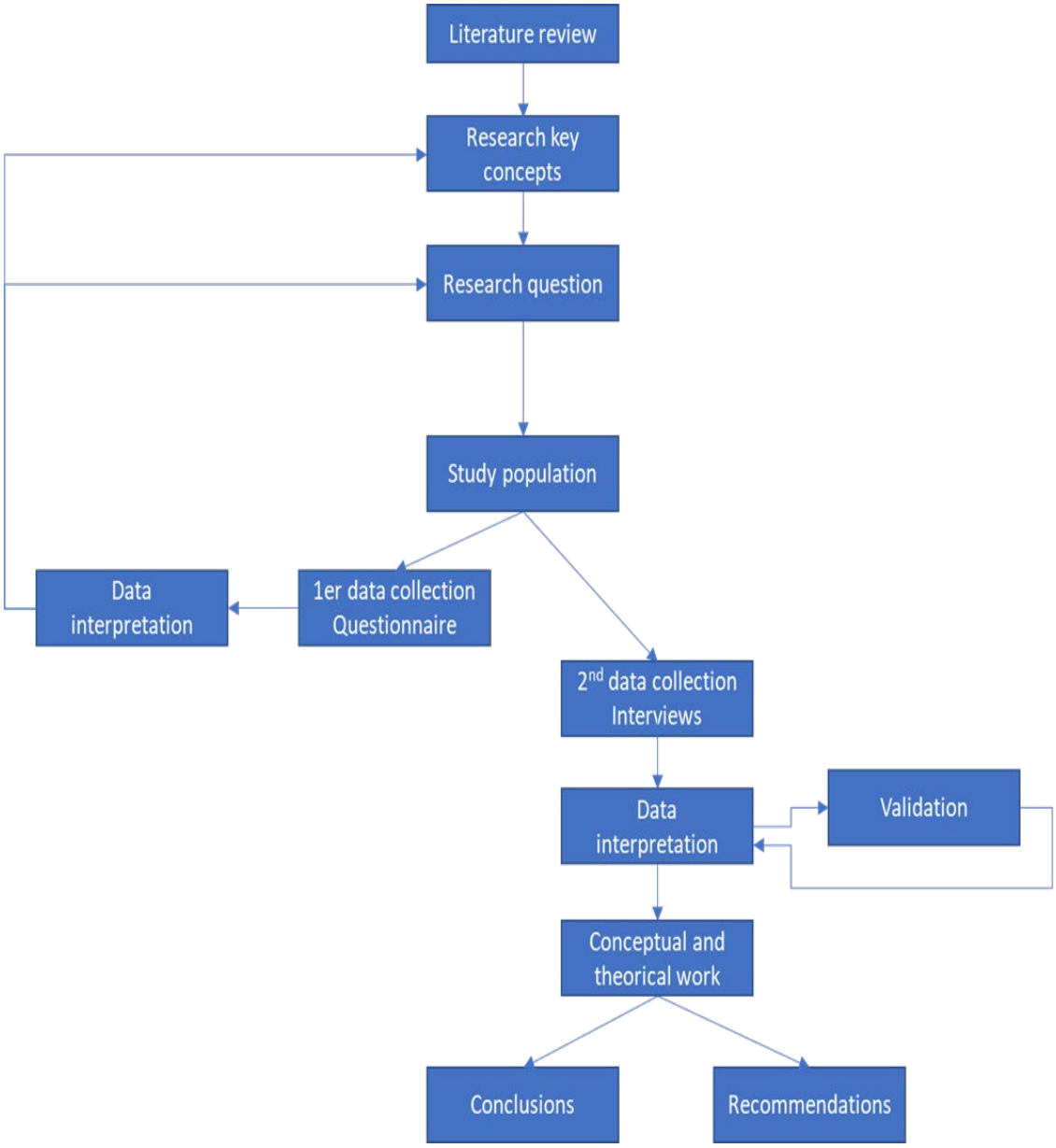
As part of the research management, a research plan has been developed, representing the researcher's roadmap for the conduct of this project. It brings together all the research milestones from the literature review to the study's conclusion. It is the logical extension of the researcher's methodological choices and approach to data collection and research. It allows for the coherence of the research's different elements.

According to Royer & Zarlowski (2011), it *"guides the course of the research and helps avoid at least some of the obstacles that can crop up in later stages of the research".* However, they also add in their study that the contingencies that may arise during the research do not always allow for strict adherence to the research plan. As some stages of the research may be

delayed, postponed, cancelled, or may overlap, the design of the research plan should be flexible and adaptable to the context and circumstances (Royer & Zarlowski, 2011).

In the case of this study, the research plan evolved several times to allow for data collection that will address the research question. Also, the COVID-19 context allowed for rich data but made contact with PNAs more difficult and forced the researcher to adapt their plans to the research's stakeholder availability. The research plan followed at the end-stage of the study is presented in Figure 7.

Figure 7 Research Plan



Key points presented in this chapter

This chapter presented how the researcher's methodological approach was the basis for their rationale for using a case study as a data collection method. It also presented how the two-sate data collection employed aligns with the researcher's interpretative approach to research and the research aim and objectives.

First, a survey instrument was designed to explore the research context and topic and help to refine the research concepts. Next, an explanatory investigation of the case studies was conducted via semi-structured interviews, collecting in-depth participants' perspectives.

The next section presents how the data collected was analysed, reduced, and displayed to draw conclusions and answer the research questions.

Chapter 4 Data Analysis Approach and Methods

The researcher has written this chapter for transparency and reproducibility considerations. It aims to provide the reader with an understanding of the method used by the researcher to analyse the data collected via the questionnaire and the interviews. It demonstrates how the data analysis is embedded in the researcher's methodology approach and discusses how they carried it out.

Section 4.1 discusses the researcher's data analysis approach. Section 4.2. describes the method used to analyse the data collected via the closed questions of the questionnaire sent to the regional parks, while section 4.3 presents the method used to analyse the open-ended questions of the questionnaire and the interviews. Section 4.4 acknowledges the methods' limitations and how the researcher has mitigated them.

4.1 Approach to data analysis

In chapter 3, the researcher discusses their intent to explore ideas and produce data that may allow models, concepts, or theories to emerge. In doing so, they took a qualitative approach to research that impacted their choice of data collection methods and their approach to data analysis.

Data analysis can be defined as the act of making sense of the data (Averill, 2021; Liamputtg, 2009). While quantitative analysis benefits from a "well-established statistical method", mathematical formulae do not apply to the "soft" nature of qualitative data (Walliman, 2014, p. 132). To navigate the various qualitative analysis methods available to the researcher (Campbell et al., 2011), they designed their data analysis approach in the early stage of the research planning in line with their approach to data collection.

According to Namey et al. (2008), "there is no single "right" way to approach analysis" (p. 158). Although there is no standard for qualitative analysis, it requires following certain essential steps as described by Miles and Huberman (1994) :

- The data reduction
- The data display

- The conclusion drawing

The data reduction

The methodology described in the previous chapter allowed for the collection of a large amount of qualitative data via 26 questionnaires and more than 15 hours of interview records. The size and complexity of qualitative data can make it challenging to process and analyse. Therefore, framing the analysis and setting analysis boundaries is necessary (Namey et al., 2008). Hence, researchers must consider the relevant data and which will be used or eliminated from the analysis process. For example, the researcher decided not to include 10 minutes of an interview in their analysis where the participant discussed his PNA carpooling project, which was out of the research topic. As discussed in the next sections, the main tool used by the researcher to reduce and manage the data from the open question to the questionnaire and the interview was coding.

The data display

Even reduced, the amount of information managed in qualitative research may be overwhelming and not readily understandable when presented in bulk. Moreover, *"our minds are not good at processing large amounts of information, preferring to simplify complex information into easily understood patterns and configurations"* (Walliman, 2014, p. 132). Data display is an efficient tool to transform unstructured information into matrices, graphs, and charts that allow for data reduction, simplification, and analysis. Therefore, the researcher used graphs and tables to display the most important research findings.

The conclusion drawing

The conclusion drawing implies identifying and interpreting the relevant data to deduce implications for the research questions. Once the data has been reduced, organised, and presented meaningfully, the researcher's interpretation leads to conclusions. Finally, emergent conclusions were verified through the iterative data analysis process (Bani-Hani et al., 2021) and triangulation (Yin, 2009).

Also, as noted by Smith and Davies (2015), the starting point of the data analysis is hard to pinpoint. In the case of the present study, it is possible to identify two starting points for this analysis. Indeed, the data of the questionnaire were analysed after their collection, whereas

the redaction of notes and memos during the interviews allowed the researcher to begin their analysis during the data collection. (Examples of notes taken by the researcher during the interviews are presented in Appendix E).

4.2 Questionnaire closed questions

The data collected from French Regional Nature Parks via the questionnaire consists of answers to closed and open-ended questions. The researcher retrieved the data of the 26 questionnaires from Jisc Online software in an Excel document. The data was then rearranged into two different Excel files. One for the closed questions and one for the answers to the open-ended questions. This section focuses on the analysis of the answers given via closed-ended questions.

A comparative analysis of the answers was carried out to highlight trends in the parks' strategies, commonalities, and divergences regarding the educational challenges and opportunities that ICTs may represent for education purposes. Indeed, the size of the sample and the exploratory nature of the questionnaire data collection did not aim to make statistical inferences but rather to highlight the characteristics of the respondent PNAs (Fisher & Marshall, 2009). Therefore, the researcher performed descriptive statistics, particularly frequency distribution calculations.

The use of descriptive statistics helped the researcher to summarise and display the numerical data "in a useful way" (Nick, 2007, p. 33) that highlighted patterns and facilitated their understanding (Brown Breslin, 2020). The data retrieved from Jisc Online software was organised in a tabular format and then graphically represented with Microsoft Excel. For example, charts have been created to illustrate data such as the type of knowledge most disseminated by the parks or the type of social media platforms most used by the parks.

4.3 Questionnaire open-ended questions and interviews

Qualitative content analysis was employed as the methodology to analyse the data collected from open-ended questionnaire responses and semi-structured interviews. This approach facilitated a comprehensive exploration of the phenomenon, capturing participants' views, motivations, and experiences while uncovering the meaning they attributed to those experiences, effectively addressing the research questions (Forman & Damschroder, 2007). However, as qualitative content analysis is used in various research areas and analytical

approaches, its terminology is rich and variable. For clarity, section 4.3.1 defines the main terms used by the researcher relevant to the coding process. Section 4.3.2. examines the main characteristics attributed to qualitative content analysis in the literature and how these characteristics also apply to the analysis methodology employed by the researcher. Section 4.3.3. presents the data analysis implementation process, particularly during the coding phase, while section 4.3.4 describes the additional post-coding analysis carried out. Finally, section 4.3.5 describes how the translation of the data from French to English was carried out.

4.3.1 Qualitative content analysis terminology

The qualitative content analysis and the coding process produced rich terminology in the literature, and some confusion can arise from this abundance of terms sometimes used in different ways across research fields. Therefore, the researcher introduces the main terms used in the following sections and their definitions considered in this research:

Codes and units of analysis

In a qualitative analysis, the researcher reviews the documents under investigation, looking for "units of meaning" containing elements relevant to the research. Once these units of meaning have been identified, they are labelled with a code that *must be "understood in relation to the context*" (Bengtsson, 2016, p. 11).

According to Elo et al. (2014), the coding unit can vary in length, ranging from a single word to a sentence or even a portion of a page. For this study, a small unit of analysis was selected to avoid 'unit boundary overlap'. Opting for a small unit of analysis aimed to capture distinct concepts, expressions, or statements with higher coding accuracy. To achieve this, the researcher used sentences or parts of compound sentences that were considered 'meaningful in itself' as suggested by Strijbos et al. (2006, p. 37). This approach ensured that each selected unit of analysis stood independently and conveyed relevant information to facilitate precise coding during the content analysis process.

Categories

Where it is possible to relate codes to each other based on their content or context, they can be combined to create (depending on their number) main categories and sub-categories of meaning (Erlingsson & Brysiewicz, 2017). This implies a hierarchy of main categories, sub-

categories, and codes; however, this hierarchical relationship is functional and not absolute (Schreier, 2019).

Coding frame

According to Schreier (2019), "*The coding frame forms the core of qualitative content analysis",* represented by the list of codes resulting from the qualitative analysis process (Gibbs, 2021).

Codebook

A codebook is a version of the code frame, more than a list of codes; it contains the definition of each code, sub-category, and category. It may also contain examples of how these codes have been applied within the documents under review. It should facilitate the coding process and the replicability of the researcher's analysis (Gibbs, 2021; Huxley, 2020).

Main coding

The main analysis phase consists of coding all the data collected relevant to the research questions. Schreier (2014) noted that the coding framework can no longer be amended at this stage of the analysis process.

4.3.2 Qualitative content analysis

Qualitative content analysis encompasses several approaches and definitions ranging from quantitative analysis of qualitative content to conventional content analysis, leading to research method design confusion (Schreier, 2014). Here, the researcher clarifies that their approach was based on Schreier's (2019, p. 5) definition of qualitative content analysis as being *"concerned with systematically describing and conceptualising textual meaning that is at least partly latent and requires some degree of interpretation".*

Also, the researcher's approach is in line with what the literature has agreed to consider the fundamental characteristics of content analysis (Bengtsson, 2016; Schreier, 2019; Williamson et al., 2018), namely:

- Being primarily interpretative
- And systematic

Indeed, as stated in chapter 3, this study is part of an interpretative work that seeks to understand "how actors construct the meaning they give to social reality" (Girod-Séville &

Perret, 2011, p. 17). Moreover, exploring the research topic via case studies allows for a rich and in-depth examination of the different perspectives of the participants and "stresses not only the uniqueness of each case but also the holistic nature of social reality" Gibbs (2012, p. 5). Consistent with this research approach, the researcher took an idiographic perspective to the data analysis (Schwandt, 2015) that emphasises individual experience, the uniqueness of that experience and the search for meaning in individual experiences (Meadows, 2022). It contrasts with the nomothetic approach that takes an interest in the general dimensions and general law applying to everyone (Schwandt, 2015). However, the data collected by the researcher allowed for revealing differences and variations but also commonalities in participants' experiences that enabled the researcher to place the characteristics of individual cases in a broader context to make nomothetic claims (Gibbs, 2012).

Second, a qualitative content analysis requires a sequence of steps that the researcher must follow systematically and iteratively. In the case of this research project, the entire content of the interview transcripts and answers to the open question in the questionnaire were rigorously examined line by line, several times, to identify any extract that might be relevant to the research questions. However, Campbell et al. (2011) argue that the researcher must be both systematic and creative for qualitative data analysis. Following their advice, the researcher attempted to:

- Be open to the multiple meanings that the data offers. The researcher tried to be aware of their potential bias and analysed the data several times, allowing time between each analysis to permit a fresh perspective on the data.
- View situations from different perspectives by interviewing 16 participants from different organisations (PNAs and federations) in different positions (communication officers, conservation and education officers or directors).
- Think creatively in the analysis and combination of the data.
- Make connections and apply relevant theoretical insights.

4.3.3 Generating the coding frame

As noted by Schreier (2019), qualitative content analysis requires the development of a coding frame where coding may refer to "*the process of attaching a meaningful label to a specific portion of the data*" (Paulus et al., 2015, p. 125).

The content of the responses to the open-ended questions of the questionnaires and the transcripts of the interviews were examined with the help of NVivo 13 software. A Computer Assisted Qualitative Analysis Software (hereafter CAQDAS) presented several advantages; it allowed the researcher to:

- To highlight code units.

- To allow the hierarchical classification of codes under their categories.

- To easily revise the coding, name, rename, split, and merge codes (Allen, 2017).

- To generate and access analytical notes (Williamson et al., 2018) on the use of the codes and memos related to the researcher's thoughts on the data.

- To easily retrieve and manage the data.

Although assisted by a computer, the researcher carried out the coding by hand; no auto-coding tools were used. For that purpose, the researcher has carried out an analysis methodology combining a concept-based (deductive) and data-based (inductive) approach to the data. This combination of inductive/deductive methods is particularly used in qualitative research. For example, in their study, Ligurgo et al. (2018) used a deductive-inductive approach to their interview data to define work-related digital media literacy competencies, while Fereday & Muir-Cochrane (2006) demonstrate how a hybrid process of inductive and deductive analysis can be used to interpret organisational documents and interview data. In both examples and the present study, a concept-driven analysis was completed with a data-driven and interpretative approach to data analysis.

More precisely, the code framing started before the data collection in a deductive manner. This concept-driven approach allowed for creating a priori codes and categories framing without using the data examined.

- ***Regarding the open questionnaire questions***: the code framing was based on the literature review findings. The six main items and sub-items selected for the questionnaire design were translated into categories as sub-categories (see chapter 3).

- ***Regarding the interview transcript:*** the code framing was based on the literature review and findings from the questionnaires, as described in chapter 3. The interview guide's key concepts were translated into categories and sub-items as sub-categories.

Each sentence from the responses to the open-ended questions or interview transcripts relevant to the research question was assigned to one of these categories during the coding process.

At any time during the code framing, when a code unit relevant to the research questions could not be assigned to a pre-defined category or sub-category, an inductive approach was taken to generate a new one, "*allowing the categories and names for categories to flow from the data"* (Hsieh & Shannon, 2005) ensuring that the analysis process reveals how informants make sense of the research topic (Forman & Damschroder, 2007).

This data-driven approach followed subsumption techniques that revealed new sub-categories and categories and added them to the initial code frame. For this purpose, the researcher followed the six steps recommended by Schreier (2014), i.e.:

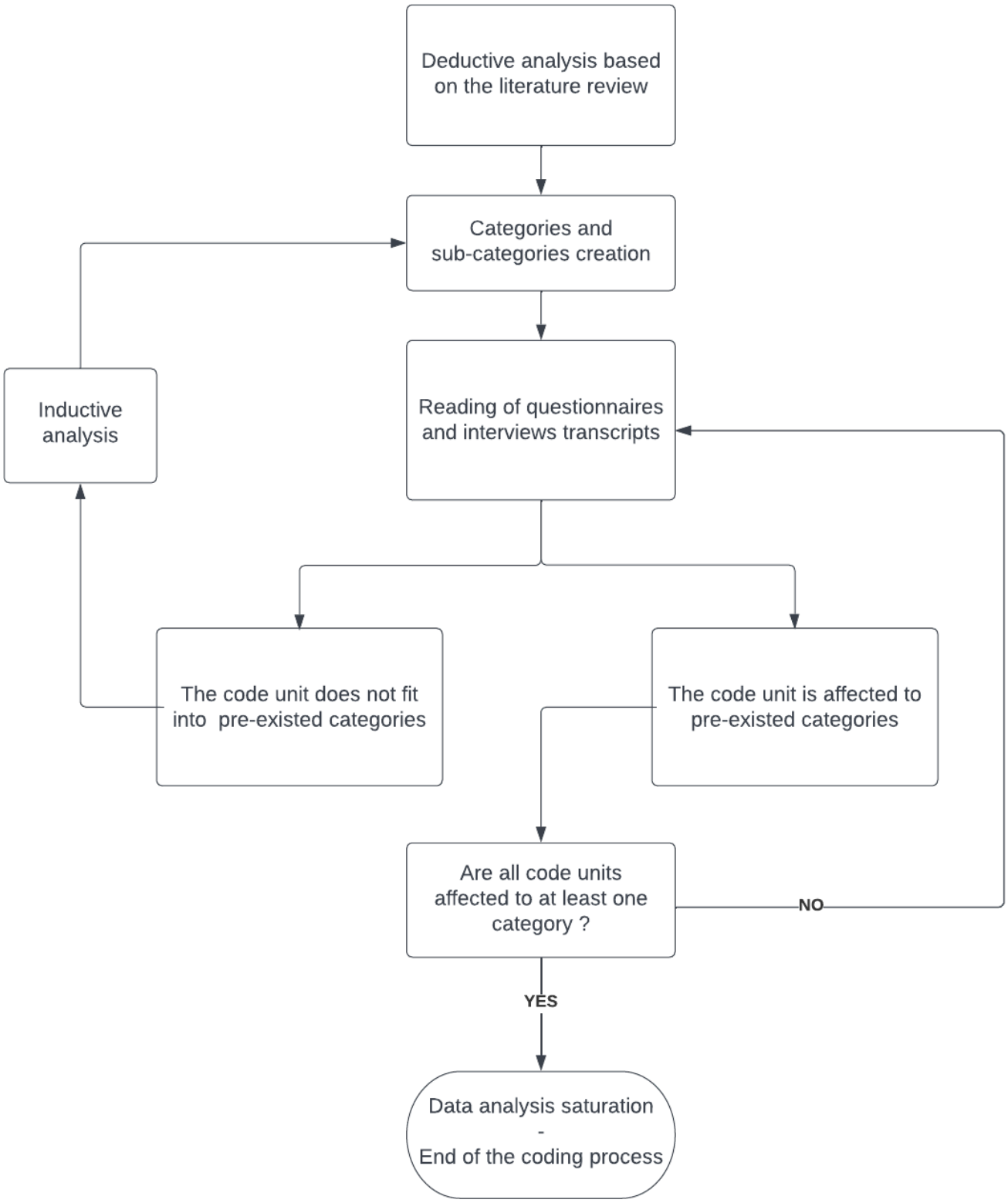
1. Reading the material until a relevant concept is encountered.
2. Checking whether a sub-category that covers this concept has already been created.
3. If so, mentally 'subsuming' this under the respective sub-category.
4. If not, create a new sub-category that covers this concept.
5. Continue to read until the next relevant concept/ passage is encountered.
6. This process is continued until a point of saturation is reached; that is, until no additional new concepts can be found.

As noted by Gibbs (2018) and Forman & Damschroder (2007), it is common in qualitative research to move back and forth between the conceptual and data approaches, seeking not to be too attached to the initial codes. This "dance" of alternating between data immersion and code framing (Check & Schutt, 2017) is continued until a point of saturation is reached. The analysis methodology combining concept-based (deductive) and data-based (inductive) approaches to the data coding adopted by the researcher is illustrated in Figure 8.

Finally, all the codes and sub-categories created in a deductive or inductive manner were designed to be unidimensional, exhaustive, and mutually exclusive (Schreier, 2019).

- Unidimensional: The categories and codes used had to be specific and address only one aspect of meaning at a time. If the code allowed for two dimensions, child codes were created. For example, the category related to the use of the experiential function of social media was divided into three sub-categories related to video, image, and audio.
- Exhaustive: All the data collected defined as relevant to the research question by the researcher have been affected by one code. No relevant data was not coded.
- Mutually Exclusive: The code units were coded to only one subcategory within the same main category. However, code units may have been assigned to several categories.

Figure 8 Flowchart illustrating the analysis methodology combining concept-based (deductive) and data-based (inductive) approaches to the data coding adopted by the researcher.



Once the data saturation is reached, the concept and data-driven categories and sub-categories are compiled to form a codebook.

Table 7 presents an extract of the final Codebook used for the main coding of the data collected by the questionnaires. Table 8 presents an extract of the final Codebook used for the main coding of the data collected during the interviews. The Codebooks were used to realise the main coding of the data collected. (The full codebooks are presented in Appendix F and Appendix G).

Final codebook for questionnaire content analysis

The final codebook used to analyse open-ended answers to the questionnaire contains categories and sub-categories created deductively based on the literature review. However, the data analysis also allowed for the inductive creation of 3 level categories.

- First, the idiographic approach to the research concepts mostly allowed the inductive process. Indeed, each park shared its specific context and perspective on the research topic. This data analysis allowed the creation of level 2 sub-categories that illustrate or exemplify the research concepts. These substantive categories are "primarily descriptive, in a broad sense that includes descriptions of participants' concepts and beliefs; they stay close to the data categorised and do not inherently imply a more abstract theory" (Maxwell & Chmiel, 2014, p. 5).
- Secondly, the data analysis allowed to refine the research concepts by adding level 1 child categories. In contrast with the substantial level 2 subcategories, these organisational categories are more abstractive and cover a broad area of the research concepts (Maxwell & Chmiel, 2014).
- Finally, new research concepts emerged and allowed for the creation of new main categories. These new "theoretical/etic categories" represent the researcher's interpretation and concepts "rather than denoting participants' own concepts" (Maxwell & Chmiel, 2014, p. 5).

As shown in Table 7, the categories in the questionnaire's codebook have been coloured: the codes and categories in blue have been set deductively, and those in orange inductively.

Table 7 Abstract of the final Codebook for the questionnaires analysis

Legend: Deductive categories / Inductive categories

Main categories	*Sub- categories level 1, level 2*	*Sub-categories*	*Definition*	*Example*	*Nb of transcripts /Nb of reference*
COVID impact			Element regarding the impact of COVID on any other codes or child code		
	Digital Informal environmental learning strategies		Statement related to the impact of the COVID-19 pandemic on the Digital Informal environmental learning strategies of PNAs		
		Barriers to the education mission	Statement revealing barriers to the education mission during the COVID-19	*"Lockdowns have prevented some awareness-raising activities."-PQ17*	*1/1*
		Change in culture	Statement related to a change in the organisational culture during the COVID-19	*"We had a little more time to look at social media during the COVID-19 Crisis, which also raised awareness within the park team of the importance of social media."-PQ5*	*2/2*
		Change in content	Statement related to a change of post contents online during the COVID-19	*"Modification of the editorial lines for each account."-PQ20*	*1/5*
		Frequency of post	Statement related to a change in the frequency of posting during the COVID-19	*"The frequency of publications has increased"-PQ2*	*2/4*
		Media use	Statement related to a change in the media used online during the COVId-19	*"We have worked much more with the video medium."-PQ2*	*2/3*
		Online presence	Statement related to a change in online presence during the COVID-19	*"The idea of developing an Instagram page dedicated to nature has gained momentum for implementation in 2022."-PQ3*	*1/1*
	Frequentation		Statement related to a change in frequentation during and after the COVID-19	*"Particularly with regard to natural environments subject to an increase in pressure / increased use of nature sports."-PQ17*	*¾*
	New types of visitors		Statement related to a change in the type of visitors during and after the COVID-19	*"Although this was not really a "strategy", information and knowledge were provided for these new visitors who were unfamiliar with the "codes" necessary to preserve the environment while respecting the uses of each individual."-PQ3*	*2/3*

Codebook for interview content analysis

The codebook for the interviews was built based on the literature review (deductive categories) and the questionnaire data analysis findings (see section 3.4). Moreover, the data analysis of the transcripts of the interviews also allowed for the inductive creation of 3 level categories:

- Level 2, 3 and 4 sub-categories (substantial categories)
- Level 1 sub-categories (organisational categories)
- Main categories (Etic Categories)

As shown in Table 8, the interviews' codebook, the codes and categories in yellow were created based on the analysis of the questionnaires; those in blue were established deductively, and those in orange inductively.

Table 8 Final Codebook for the data analysis of the Interviews

Legend:
- Categories created based on the questionnaire analysis
- Deductive categories
- Inductive categories

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Definition*	*Example*	*Nb of transcripts/Nb of reference*
Digital Informal Environmental Learning strategy	Organisation of resources		Statement related to the technological, financial, and human resources allocated by PNAs for the dissemination of environmental knowledge and the promotion of PEB on social media		
		Lack of resource	Statement of participant related to the lack of financial, human, time, or technological resources	*"And not enough time, not enough staff, that's clear [for the implementation of social media]".-PI7*	12/63
		Lack of skills	Statement of participant related to the lack of skills to use social media	*" Then, the problem is that, for example, the choice was made on Instagram. I have no training in communication. I do not have any notion, apart from knowing how to take pictures, but I do it on top of my job".-PI8*	4/12
	External collaborations		Statements related to collaboration with external stakeholders for the creation and/or the dissemination of content on social media		
		Influencers	Statements related to collaboration with influencers for the creation and/or dissemination of content on social media	*"Yes, because we have tried to find ambassadors who can relay this information via their respective pages". -PI6*	6/13
		local businesses	Statements related to collaboration with local businesses for the creation and/or dissemination of content on social media	*"That is also the strength of the parks, that we are hand in hand with the professionals, the service providers". PI1*	5/13
		Other public institutions	Statements related to collaboration with other public institutions for the creation and/or dissemination of content on social media	*"That's also the strength of the parks; it is that we work hand in hand with service providers, with actors and also with the municipalities because the park is not just a team of technicians or even a political team. It is elected representatives, municipalities and people who work together on projects".-PI1*	5/8

4.3.4 Further analysis and data display

The researcher made analytic notes and memos (Vollstedt & Rezat, 2019), recording their thoughts, ideas and questions that surfaced during the coding and analysis process and compiled them into a Word document. (An example of memos written after an interview is presented in Appendix E). This document was the start of the researcher's progressive focusing process, defined as the researcher's interaction with the data that gradually refined their focus (Check & Schutt, 2017). Moreover, these memos allowed them to analyse the data collected, explore their contiguity and produce the basis for further data analysis. Indeed, once the main coding ended, the researcher examined the relationship between data by exploring "*the actual connections between things, rather than the similarities and differences",* drawing on techniques such as the "axial coding" or "coding paradigm" found in Grounded Theory related analysis methodologies (Maxwell & Chmiel, 2014, p. 22). According to Qureshi & Ünlü (2020, p.8), this axial analysis aims to "put back together [the data] in new ways" to make connections between categories (Vollstedt & Rezat, 2019).

Thus, after the coding process, the researcher has taken a step back from the individual coding units and categories to examine potential inter-category relationships (Schreier, 2014).

Investigating the relationship in the data collected is the main part of the process of interpretation and allows the researcher to move from the description to the explanation of the phenomenon under research (Check & Schutt, 2017, p. 305). Thus, according to Check & Schutt (2017, p. 300): "*Good qualitative data analyses also are distinguished by their focus on the interrelated aspects of the setting or group, or person, under investigation—the case—rather than breaking the whole up into separate parts"*.

For that purpose, two tables were created in Excel, one to describe the positive relationships and the other to the negative relationships between categories and sub-categories of the codebooks. These relationships affected three types of PNAs' outcomes: conservation, education, and management outcomes (sometimes, more than one outcome was affected). An example of these relationships is provided in Table 9.

Table 9 Examples of positive and negative relationships between categories and sub-categories of the codebooks.

Positive relationships	**Information function of social media**	**Digital Mindset**
Eco-literacy	Social media enable disseminating environmental knowledge and raising awareness of the fragility of ecosystems and territories. → **(Impact on education and conservation)**	Having a digital mindset allows the park to move away from a siloed vision of its communication, education, and conservation missions. Thus, the different teams of the park can collaborate to enhance the visibility of their actions through rich and holistic pedagogical messages via new means of communication (social media) → ***(Impact on management and education)***
Negative relationships	**Social Media Affordance**	
Eco-literacy	Social media are mainly considered tools for the promotion of the territory and not as a support for education and conservation missions. This does not allow for the implementation of strategic educational plans nor the use of social media as an aggregator and orchestrator of environmental knowledge by the PNAs. → ***(Impact on education and conservation)***	

Then, the researcher investigated how the analysis of the questionnaire's closed-ended questions may have been supported, contradicted, illustrated, or explained by participants in the interviews and the open-ended questions. For example, the interviews provided valuable insight into why most Regional Nature Parks stated in the questionnaire that they do not use the relational function of social media.

Finally, the researcher also gave particular attention to the participant's use of tropes and metaphors through a close reading of the interview transcript, as they may add a layer of comprehension of the research topic. Trope analysis, such as metaphors, demonstrates the in-depth analysis capabilities of qualitative content in the analysis of text features that are "resistant, if not allergic to quantification" that may give implicit hints and evidence to the researchers (Lewis-Beck et al., 2004, p. 890). According to Brummett (2020), *"Metaphors should be studied for their implications and their extension"*. Indeed, participants' use of a certain figure of speech can reveal their perspective on a subject. This is particularly true with metaphor, metonymy, irony, synecdoche, etc. For example, in the context of the present research study, a participant used the following metaphor:

'We were blown up!' – Participant to the interview 10

[Talking about the reaction of the online community regarding one of the participant's posts on social media]

In the example given above, the participant associating social media with warlike vocabulary lets the researcher appreciate the extent of their experience concerning the research topic.

This type of analysis was used in several studies in education (Miller & Fredericks, 2010), social science (Cassell & Bishop, 2019), psychology (Munday et al., 2020) and health research (Gök & Kara, 2022).

4.3.5 Translation from French to English

The primary data used in this research was gathered in French (the researcher's mother tongue) and translated into English (the language of study for this research) by the researcher. However, the translation process may impact qualitative research's trustworthiness and rigour (Sechrest et al., 1972).

Indeed, data translation can lead to semantic loss (Temple & Young, 2004) and a lack of equivalence in translation (Sutrisno et al., 2014). Therefore, to limit these potential negative impacts, the researcher has interpreted and analysed the data as collected (i.e., in French) and translated only the quotes required for the purposes of chapters 5 and 6 of this thesis.

Given that the resources available to complete this research project did not allow for back-translation, the researcher completed a single translation instead. Nevertheless, according to Sustrisno et al. (2014), bilingual researchers are "in the best position" to conduct cross-language research and related translation due to their experience and expertise in the local culture and language.

4.4 Limitations

This section acknowledges three main limitations to the analysis method presented in this chapter, i.e., decontextualisation (section 4.4.1), subjectivity (section 4.4.2) and coding reliability (section 4.4.3). In the following sections, the researcher discusses how they attempted to mitigate these limitations.

4.4.1 Decontextualisation

The categorisation and coding technique raise concerns about decontextualisation within academic debate. Indeed, the systematic use of categories during the analysis process may “strip” away the concept and move the research away from the data. To keep this connection between data and context, the researcher relies on attention to context check and control (Maxwell & Chmiel, 2014). As advised by Bengtsson (2016), after the first coding round, the researcher operated a further re-reading to ensure that all aspects of the transcript were

considered and that all uncoded transcripts were irrelevant to the research questions. Furthermore, the study is based on a case study that may mitigate decontextualisation risk.

4.4.2. Subjectivity

As discussed in chapter 3, subjectivity can be considered a limitation of qualitative studies. Thus, according to Bengtsson (2016), researchers must conduct a qualitative data analysis from a neutral point of view to avoid confirmation bias and halo affect. In that line, the researcher operated some self-reflective works to consider their objectivity toward the data.

However, the researcher acknowledges that subjectivity is always part of the data interpretation. Also, the researcher's assumptions and a priori toward the data may have been mitigated through the iterative and systematic coding process described in Figure 9 (Maxwell & Chmiel, 2014). Finally, with a frequent re-reading of the transcripts and a replay of the interview recording, the researcher tried to ensure that the data supported their analysis process and coding framing (Gibbs, 2018).

4.4.3. Coding reliability and validity

The reliability of the coding in qualitative analysis is one of the main concerns of academics. One way to improve coding reliability is double coding by two different researchers (Bengtsson, 2016; Schreier, 2014).

In the context of this research, the researcher could not operate a double coding with a second researcher. However, the researcher operated the double coding themselves. Indeed, to further improve reliability, the researcher carried out two main coding within a one-month interval to test the reliability of the study coding frame. The results were satisfactory, with a high rate of similarities in data coding. However, the researcher acknowledges that their personal biases may be found in both coding.

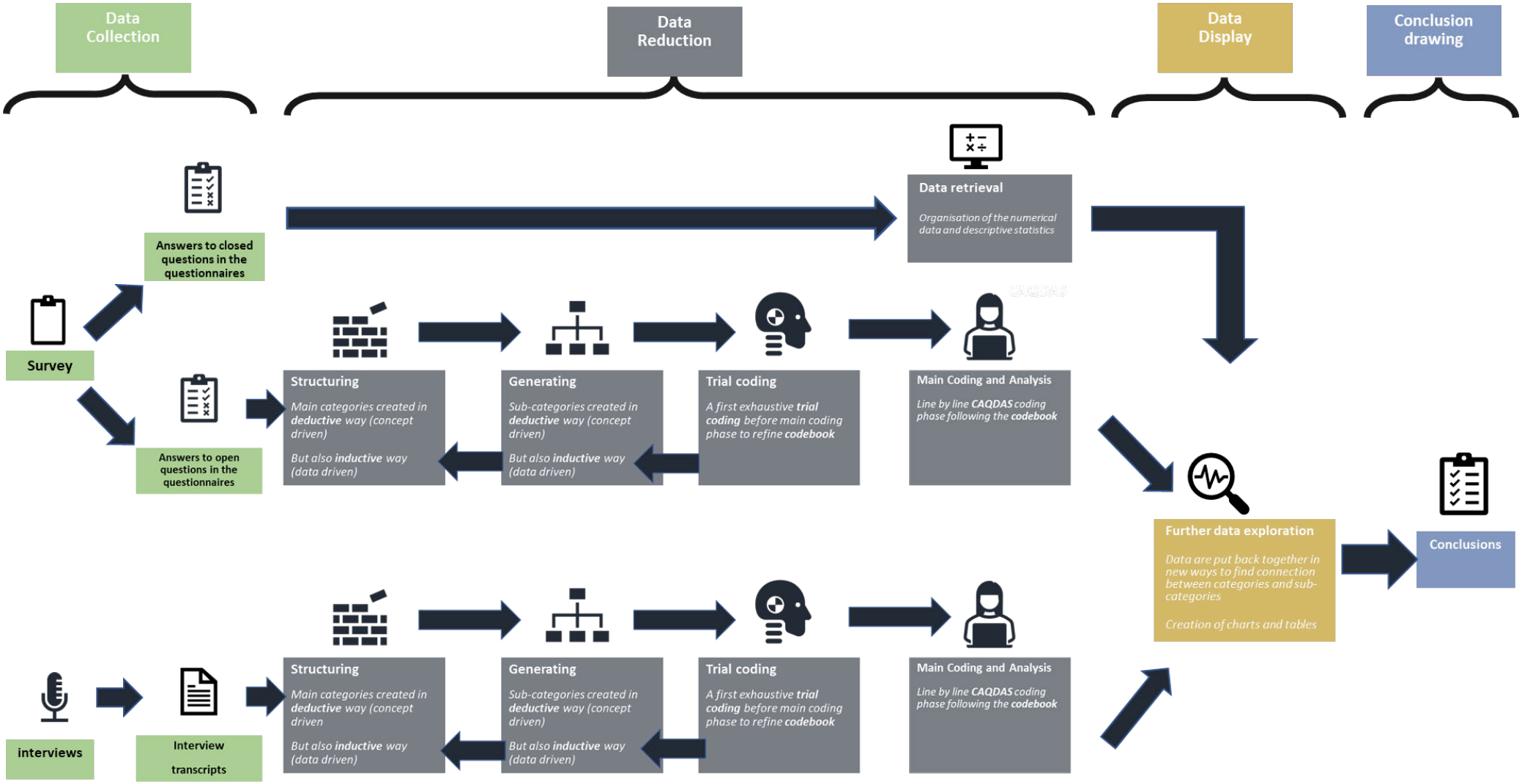
Key points presented in this chapter

This chapter presented how data reduction, display and conclusion drawing were performed while analysing the data collected via the questionnaires and interviews. The researcher followed an analysis sequence presented in Figure 9.

Regarding the answer to the closed-ended question in the questionnaire, descriptive statistics were used. Regarding the open-ended question in the questionnaire and the interview transcript, the researcher conducted the data reduction following four main steps. The first three steps were structuring, generating and trial coding (Schreier, 2019), involving a combination of inductive-deductive analysis to generate categories and sub-categories. They were repeated until satisfactory results. Once the Codebooks were refined enough, the fourth step consisted of the main coding.

Then, a further analysis of all the data analysed was allowed by the data display based on creating tables and charts. Finally, the data analysis allowed for the compilation of findings presented in the next chapters, 5 and 6. Finally, conclusions were drawn that answered the research question in chapters 7 and 8.

Figure 9 Analysis sequence of the answers to an open and closed-ended question in questionnaires and the interview transcript. Adapted from Schreier (2019).



Chapter 5 Findings of the survey and their contributions to the interview design

This chapter presents the researcher's interpretation and analysis of the data collected via a survey instrument designed around a combination of closed and open-ended questions. This analysis provides an overview of the research context and is the basis of the researcher's reflexive work to validate and edit their theoretical framework and interview guide as described in chapter 3. The data analysis presented in this chapter results from two different analytical approaches and includes descriptive statistics and qualitative content analysis, as discussed in chapter 4. The data analysis reveals that the PNAs surveyed face structural, cultural, and environmental challenges that impact their use of social media for educational purposes.

Section 5.1 outlines the respondents' characteristics and their organisations' online presence. Section 5.2 discusses the structural challenges faced by the organisation represented in the questionnaire regarding knowledge orchestration and allocated resources. Section 5.3 describes the findings suggesting that social media features may not be leveraged by the communication officers surveyed, which may limit the content and scope of their external educational communication. Section 5.4 reveals the impact of increased park visitation and shifting visitor demographics following the COVID-19 lockdowns on the respondents' digital practices. Section 5.5 describes how the researcher has drawn on the data analysis findings discussed in the previous sections to edit and refine the interview guide.

5.1. Survey response rate and respondents' digital profile

As discussed in chapter 3, the survey was distributed online to communication officers in the 55 inland French Nature Regional Parks. Section 5.1.1 presents the response rate to the survey and respondents' characteristics. Section 5.2.1 gives an overview of their organisations' online presence and digital profile represented in the survey.

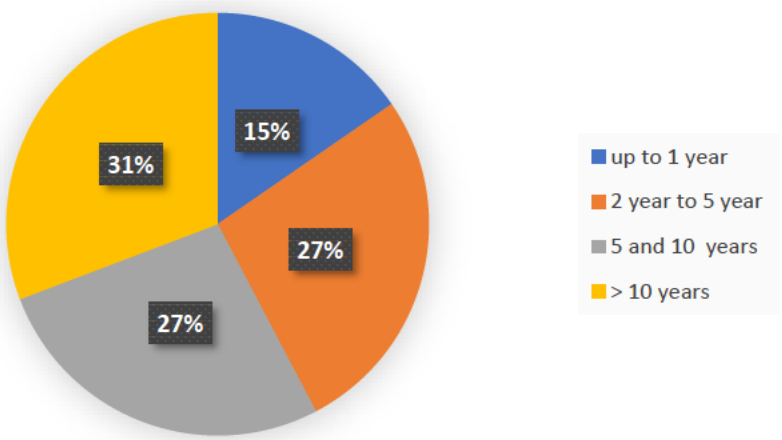
5.1.1 Survey response rate and respondents' characteristics

The researcher received 26 valid answers, i.e., a 48% response rate. The survey was designed around a combination of closed and open-ended questions. The closed questions were compulsory, while the answers to the open questions were voluntary. As noted by Rowley (2014), not all survey respondents are willing to answer open-ended questions. In the case of this study, only one participant (participant 11) did not answer any open-ended questions.

The minimum number of words in the open-ended respondents' statements was two, and the maximum was 258. All open-ended questions received at least two answers, and one up to 17 answers (question 12b). Thus, on average, the open-ended questions received nine answers composed of 34 words. The researcher perceives these results as evidence of the participant's engagement with the questionnaire and the topic.

Regarding the respondents' characteristics, their years of experience varied from less than one year to more than 10. However, most respondents (58%) worked in their park for at least five years (see Graph 1).

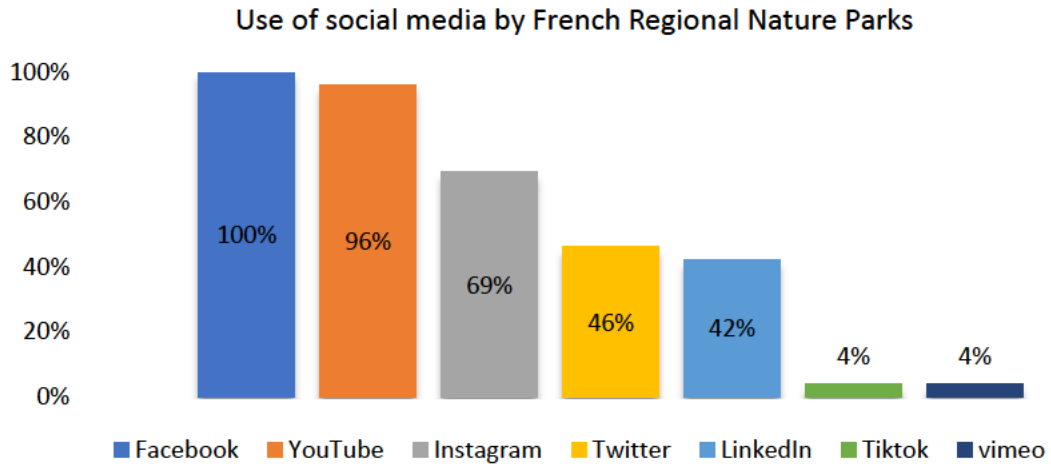
Graph 1 Respondents' years of experience in PNAs.



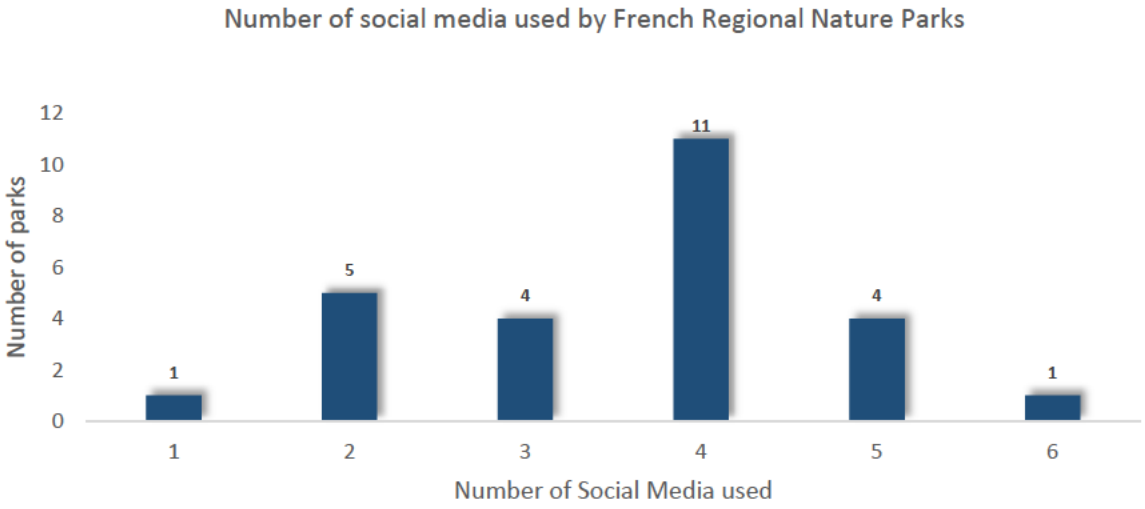
5.1.2 Respondents' digital footprint on social media

The results of the close-ended question 8 show that the parks studied in the survey are well represented online (see Graph 2). Indeed, they all have a website, a Facebook account, and 96% of them are present on YouTube. However, the data suggests their social media use is not homogeneous or standardised. The number of social media platforms used by the respondents spans from 1 up to 6 social media accounts (see Graph 3).

Graph 2 Use of social media by French Regional Nature Parks



Graph 3 Number of social media used by French Regional Nature Parks



Although the results provide a general overview of the online presence of the Regional Nature Parks surveyed, they do not allow for an in-depth understanding of the reasons for heterogeneity in their social media use. Hence, the analysis of these data validated the need to further investigate the online presence of the PNAs during the interview.

5.2 Organisation and resources of communications teams for the use of social media

The results of the data analysis reflect the respondents' practices in organising external communication regarding structure, knowledge orchestration and resources allocated. Section 5.2.1 describes the two structural approaches taken by the respondents' organisation for external communication practices; section 5.2.2 reveals a discrepancy in the approach to

collaboration between the communication team and other project managers in charge of sustainability-related issues. Finally, section 5.2.3 discusses respondents' perceptions of the resources allocated to their mission.

5.2.1. Structural approach to external communication on social media by respondents

The literature shows that an organisation's structural approach impacts its knowledge-sharing practices with external stakeholders (Broom et al., 1991; Cornelissen et al., 2015). A functional organisation implies the concentration of responsibility for external communication activities (knowledge and skills) within a group of specialists. In contrast, in a process organisation, the communication processes are integrated across (non-) specialists (Cornelissen et al., 2015).

In the case of this study, the responses to questions 9 and 10 show that 54% of the respondents adopt a vertical approach to social media, with a concentration on communication skills and ownership in the hands of the communications team (see Table 10 and Graph 4).

"The communication assistant [is in charge of external communication social media]"- Participant to the Questionnaire (hereafter PQ) 3

"I am in charge; others can publish, but after my validation."-PQ6

In contrast, 31% of the respondents adopt a horizontal and functional approach to communication responsibilities, enabling their distribution across various departments within their organisation (see Graph 4).

"Me, the communication assistant, and the tourism/hiking officer" -PQ1

"Some colleagues for Facebook and Insta[gram] according to the themes; the director for Twitter"-PQ23

Finally, four respondents did not give clear enough responses to classify their structural approach to knowledge sharing on social media.

Graph 4 Type of organisational structure adopted by the respondent for their external communication

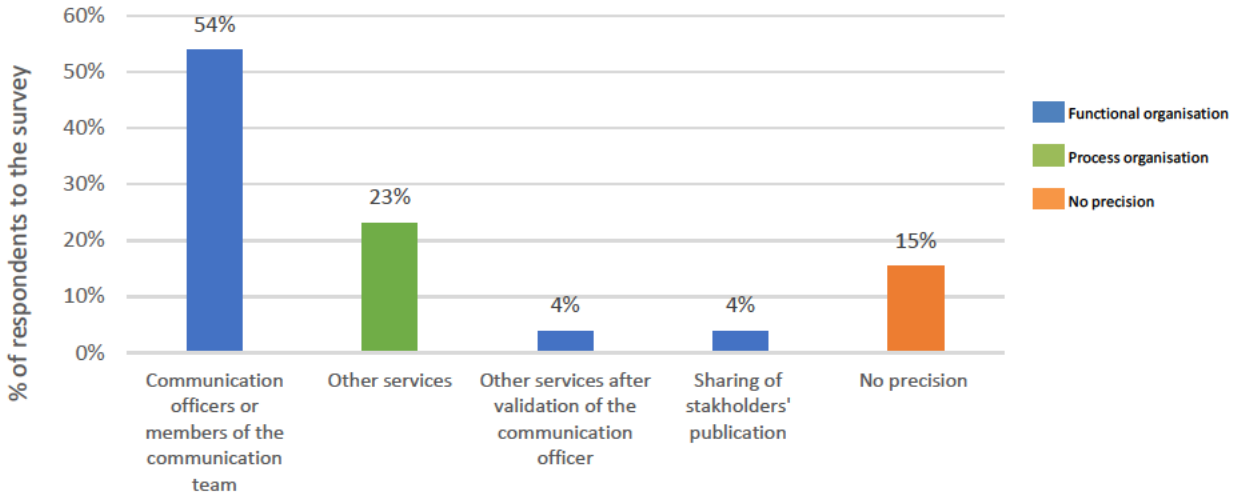


Table 10 Results of the qualitative content analysis of the data collected in the survey related to the respondents' structural organisation of communication on social media

Legend: Deductive categories / Inductive categories

Main categories	Sub-categories level 1	Sub-categories level 2	Nb of references
Digital strategy for environmental education	Strategy implementation	Structural organisation of communication on social media and coordination of knowledge	*31*

These results validate the need to investigate further the structural organisation of external communication adopted by the PNAs and its impact on their DIEL strategy.

5.2.2 Knowledge orchestration supporting knowledge sharing on social media

To convey environmental knowledge to visitors, the parks' communication officers must gather information from specialised agents within their organisation who are knowledgeable about sustainability topics. Thus, coordination of knowledge by respondents within their organisation is necessary to conduct external communication. Indeed, the literature shows that organisations can leverage their collective intelligence, enhance problem-solving capabilities, foster innovation, and improve overall performance by orchestrating knowledge effectively. It enables them to harness the value of knowledge as a strategic asset (Haider & Mariotti, 2016; Rehman et al., 2022; Rohde & Sundaram, 2011; Tian et al., 2021).

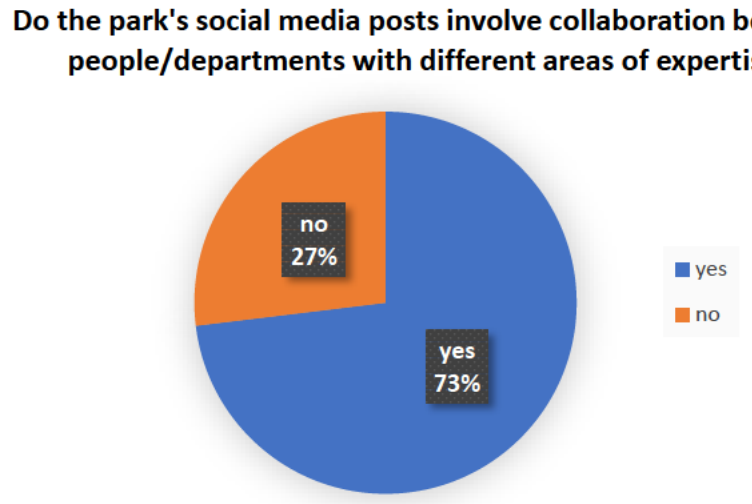
Questions 12 and 12a of the survey investigated the extent of the coordination of environmental knowledge by the respondents via inter-organisational collaboration (see Table 11).

Table 11 Results of the qualitative content analysis of the data collected in the survey related to the orchestration of knowledge

Main categories	Sub- categories level 1	Sub-categories level 2	Nb of references
Digital strategy for environmental education	Strategy implementation	Structural organisation of communication on social media and coordination of knowledge	*31*

As shown in Graph 5, although intra-organisational collaboration seems to be a common practice for more than 70% of the respondents, nearly 1/3 of them do not solicit other services for creating content posted on their social media. In the latter case, communication teams and other departments do not cooperate to create educational posts or strategies.

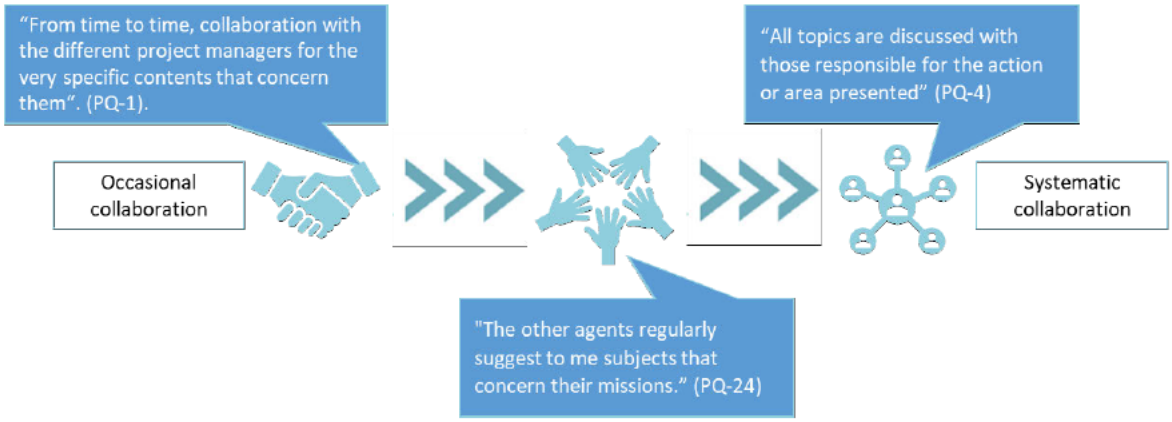
Graph 5 Proportion of the French Nature Park communication officers that engage in collaboration with people/departments with different areas of expertise when posting on social media



This silo organisation raises questions regarding the capacity of PNAs to orchestrate environmental knowledge and address the holistic nature of sustainability in their external communication.

A detailed analysis of the data revealed a variation in the approach to collaboration between the communication team and other project managers in charge of sustainability-related issues. As shown in Figure 10, the extent of this collaboration can range from one-off cooperation to systematic cooperation.

Figure 10 Extent of collaboration with other departments implemented by the respondents



The open-ended question 12a allowed the respondents to specify which departments or project managers they collaborated with. The field of expertise of each department and project manager mentioned by the respondents were listed and then classified into three categories related to the three pillars of sustainability, i.e. the environment, the economy and social issues. This data classification was designed to consider whether knowledge related to all three pillars of sustainability was considered in the respondents' external communication. Table 12 shows the result of this analysis and classification.

Table 12 Areas of collaboration between respondents and other departments within their organisation for external communication

Environmental	Economic	Social
Natural heritage -Biodiversity	Sustainable tourism and tourism	Welcoming new populations
Education to environment	Agriculture	Building heritage
Sea and Coastal sites	Search for economic opportunities	Culture and heritage
Energy	Territorial marketing	
	Urbanism – Architecture	
	Energy	

These results contrast those in section 5.2.1. They suggest the potential for a transversal approach to conservation and environmental education by integrating the holistic nature of sustainability topics in the respondents' DIEL practices. However, they confirm the need for interdepartmental connectedness and collaboration to enhance external knowledge-sharing practices. These results align with Cornelissen et al.'s (2015) study, showing that interdepartmental connectedness supports knowledge sharing within organisations.

"Some posts require the help of a competent project manager on the issue: biodiversity, urbanism, architecture,...on more generic posts, I can do it alone."-PQ25

"Communication on social media is relative to all services, and therefore transversal to all missions."-PQ20

Nevertheless, the predominance of coordination of knowledge related to economic issues may suggest the use of social media for promotional rather than educational purposes.
These results validate the need to further investigate to what extent PNAs engage in interdepartmental connectedness to facilitate knowledge sharing within their organisation to produce holistic environmental external communication.

5.2.3 Resources allocated to the use of social media

Open-ended questions 13b, 19b, 19c, 19d and 20 allowed seven respondents to express their concerns regarding the lack of resources allocated to the communication team, suggesting tensions between the execution of their mission and the resources allocated to them.

"Because if we ask for everything about communication, we do not provide it with sufficient human resources!". -PQ3

"We have no time". -PQ14

"We lack time and technical expertise". -PQ13

The data analysis revealed two main resource-related issues within the respondents' organisation. First, the respondents' statements point out a lack of financial, human, or

technological resources. Second, they highlight a lack of skills and digital capabilities to use social media (see Table 13).

Table 13 Results of the qualitative content analysis of the data collected in the survey related to the organisation of resources for external communication on social media

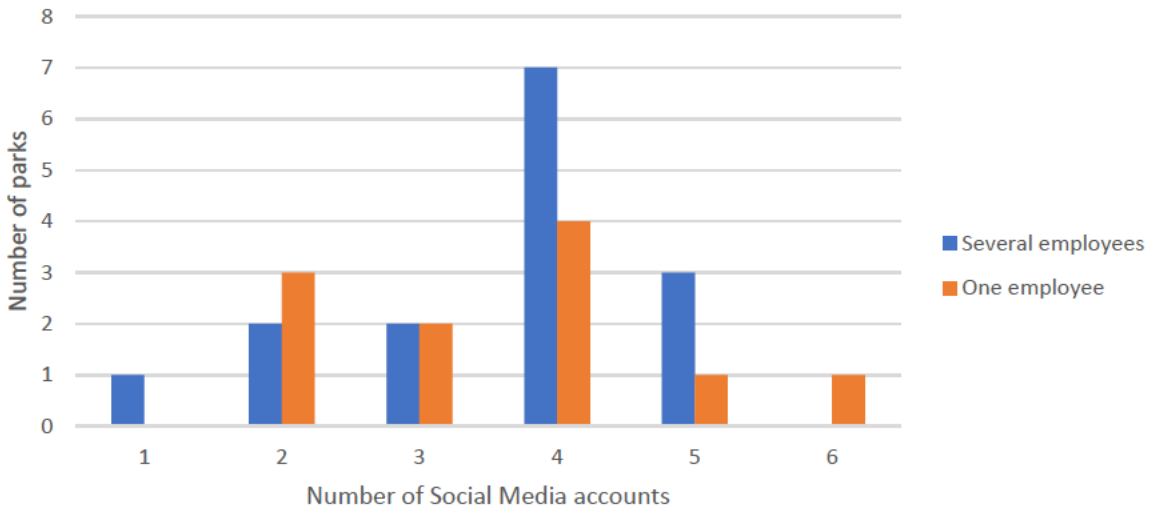
Main categories	Sub- categories level 1	Sub-categories level 2	Nb de references
Digital Strategy for environmental education	Organisation of resources	Lack of resource	*6*
		Lack of skills	*1*

"Not enough human resources."-PQ4

"Lack of time and technical expertise." -PQ13

Finally, the combination of the data collected in questions 8b and 10 allowed to explore the number of employees bearing the responsibility for external communication on social media in relation to the number of social media accounts owned by the respondents' organisation. Graph 6 is the result of this analysis. It shows that the size of the communication team is not directly related to the number of social media platforms a Nature Park uses. For example, one park with six social media accounts has only one employee managing it, whereas one park has several employees in charge of one social media account.

Graph 6 Number of employees in charge of social media in relation to the number of social media accounts used by French Regional Nature Parks



Yeow et al. (2018) showed that the success of an organisation's digital strategy is significantly linked to its alignment with the resources it commits to its implementation. Thus, the results

described in this section validate the need to further explore the potential lack of resources for DIEL in French PNAs.

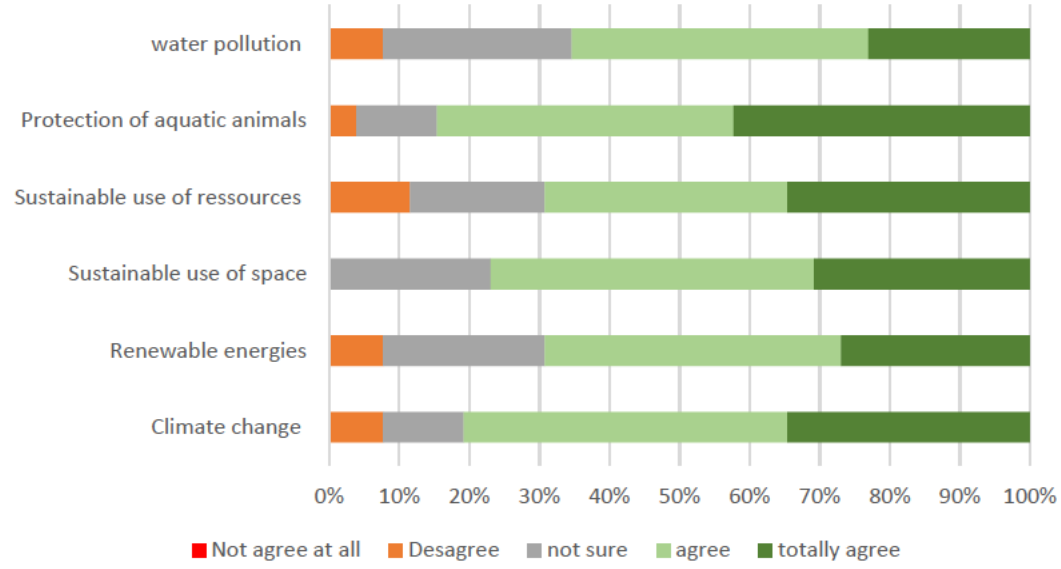
5.3. Use of digital tools for educational purposes

Section 5.3.1 reveals that PNAs surveyed lacked confidence in their ability to provide their visitors with the necessary knowledge action and effectiveness to act eco-responsibly. Section 3.3.2 validates the relevance of exploring the perception of social media by the respondents and reveals a potential adverse impact of DIEL on the visitors' behaviours. Section 5.3.3 highlights the respondents' lack of use of social media relational function to support knowledge exchange and receive feedback from their visitors. Section 5.3.4 reveals a lack of implementation of the DIEL strategy by the respondents and the need to investigate further the governance and oversight of social media practices for educational purposes in PNAs. Finally, section 5.3.5 validates the relevance of online monitoring by PNAs and discusses the potential negative impact of online content on their missions.

5.3.1 Environmental knowledge dissemination by the respondents on social media for education and promotion of pro-environmental behaviour

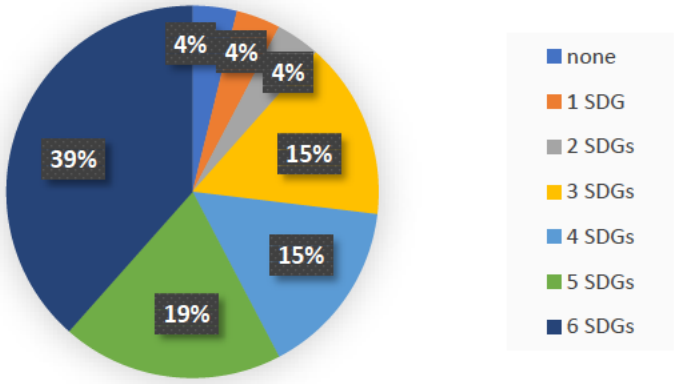
In questions 15.1 to 15.6 of the survey, the respondents were asked if they were addressing issues related to the six environmental SDGs in their external communication on their social media. The responses show that their most discussed topics are the protection of animals, the use of space and climate change. More than a third (34%) of the respondents are unsure or disagree that they address water pollution or sustainable use of resources, and 30% renewable energy (see Graph 7).

Graph 7 Participants' agreement or disagreement on the use by the park of social media for the dissemination of information regarding the environmental SDGs



The same data also shows that 61% of the respondents are unsure or disagree that the knowledge they disseminate on social media covers all environmental SDGs (see Graph 8).

Graph 8 Percentage of respondents distributed according to the number of SDGs they agree are used in their external communication.



These results suggest a lack of a holistic approach to environmental knowledge disseminated on the social media of PNAs represented in the survey. The qualitative content analysis of questions 13.b and 14.a contributed to completing these results (see Table 14 Table 12).

Table 14 Results of the qualitative content analysis of the data collected in the survey related to environmental knowledge and the complexity of environmental learning

Main categories	Sub- categories level 1	Nb of references
Environmental knowledge shared on social media	SDGs addressed in external communication	*12*
	The need for more than knowledge – Learning complexity	*1*

Respondent PQ19 expressed their impression that they were addressing all the subjects in the external communication:

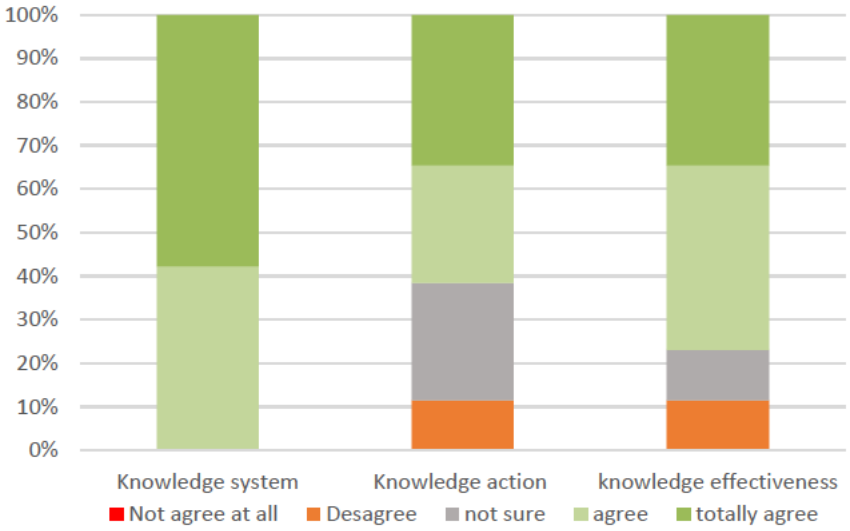
> *"Tendency to talk about all subjects." -PQ19*

Also, participant PQ4 points out that exploring the types of knowledge shared on social media through the sole lens of the environmental SDGs is insufficient to capture the complexity of the messages they address. This argument is in line with the perspective of Maurer and Bogner (2020), who describe affect, behaviour, environmental knowledge, and skills as the "four cornerstones" of environmental learning (p2.). Thus, the researcher worked on refining the interview guide to include concepts such as eco-literacy and to investigate the practitioner's strategy in deciding the scope and content of their DIEL strategy.

> *"Understanding and accepting to let nature take its place is a philosophical process, a voluntary process that takes time and energy, a complex process."-PQ4*

Regarding the type of knowledge disseminated, the analysis of question 16 shows that respondents mainly use social media to convey 'raw' environmental knowledge (knowledge system). In contrast, skills (knowledge action) and knowledge about the benefits of environmentally friendly actions (Knowledge effectiveness) are less discussed in their online communication (see Graph 9).

Graph 9 Type of knowledge provided via social media by the respondents



These findings reveal that despite rising visitor numbers (Derks et al., 2020; Molteni, 2021; Souza et al., 2021) and non-PEB (McGinlay et al., 2020) post-COVID-19, the DIELS strategies of the PNAs surveyed surprisingly lack emphasis on conveying essential visitor behavioural knowledge.

A recent study suggests that knowledge action and effectiveness are as important as knowledge systems to promote PEB (Maurer & Bogner, 2020). Yet, 39% of the PNAs represented in the survey either disagree or are unsure that they provide visitors with information on social media about good behaviours to display in nature. A quarter of them do not share with visitors the key tools required to behave in the best possible way, and 53% have not put in place strategies to prepare visitors for their visit by providing them with information related to PEBs.

The qualitative analysis of the open-ended questions 11.a, 13.b, 16.a, 17.a, 17.b, and 20 gave more insight regarding what type of knowledge the respondents stated sharing with the visitors on social media (see Table 15).

Table 15 Results of the qualitative content analysis of the data collected in the survey related to the different types of environmental knowledge

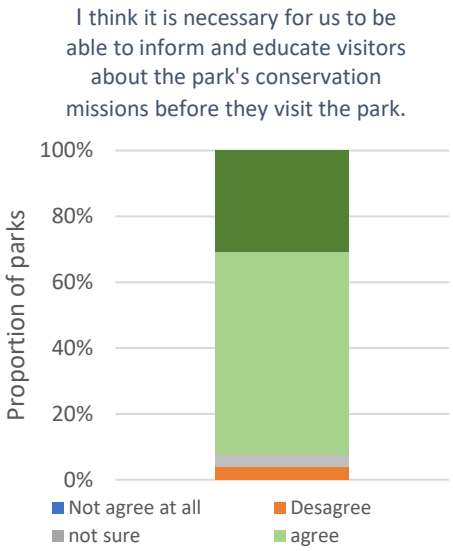
Main categories	Sub- categories level 1	Nb of references
Environmental knowledge shared on social media	Three types of knowledge	*13*

For example, participant PQ16 confirmed that they discuss sustainability issues rather than the available solutions to mitigate our environmental footprint.

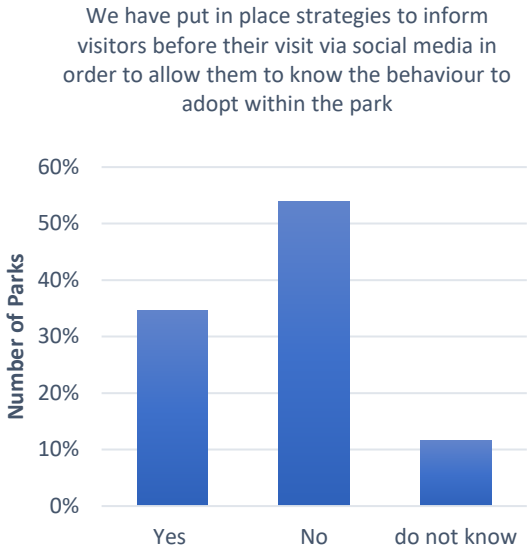
> *"We talk a lot about the issues but do not propose enough actions to address them." -PQ16*

This statement aligns with the answers to questions 14 and 18, which show that while 90% of the park agree that visitors should be informed about the conservation mission of the park before their visits, the majority of them (53%) do not provide visitors with information related to the PEBs expected during their visit (Graph 10 and Graph 11).

Graph 10 The respondents' agreement /disagreement with the statement related to the requirement to inform and educate visitors about the park's conservation missions before their visit



Graph 11 The respondents' agreement /disagreement with the statement related to implementing strategies to inform visitors before their visit via social media to allow them to know the behaviour to adopt within the park.



Overall, the results of the data analysis validate the need to explore further how the dissemination of environmental knowledge is integrated into PNAs' DIEL strategy.

5.3.2 Participant's perception of social media as a tool for education and promotion of pro-environmental behaviours

The content analysis of the opened-ended questions 11.a.b, 14.a, 16.a, 17.b, and 20 allowed 33 respondents to give their perception of social media as a tool for education and promotion of PEB (Table 16).

Table 16 Results of the qualitative content analysis of the data collected in the survey related to the participants' perception of social media as a tool for education and promotion of PEB

Main categories	Sub- categories level 1	Sub- categories level 2	Nb of references
Participants' perception of social media as a tool for education and promotion of PEB	Positive perspective	Promotion of ERB	2
		Knowledge diffusion	8
		promotion of PNAS activities	4
	Negative perspective	lack of impact evaluation and assessment	5
		Superficiality	7
		Social media turbulence	2
		Society polarisation	1
		The superiority of human interaction	4

9 participants stated that social media is a relevant tool for:

- Raising awareness of the PNAs' missions.
- Knowledge dissemination.
- The promotion of PNAS activities.

"At the same time, they [social media] are a useful medium for spreading knowledge."-PQ3

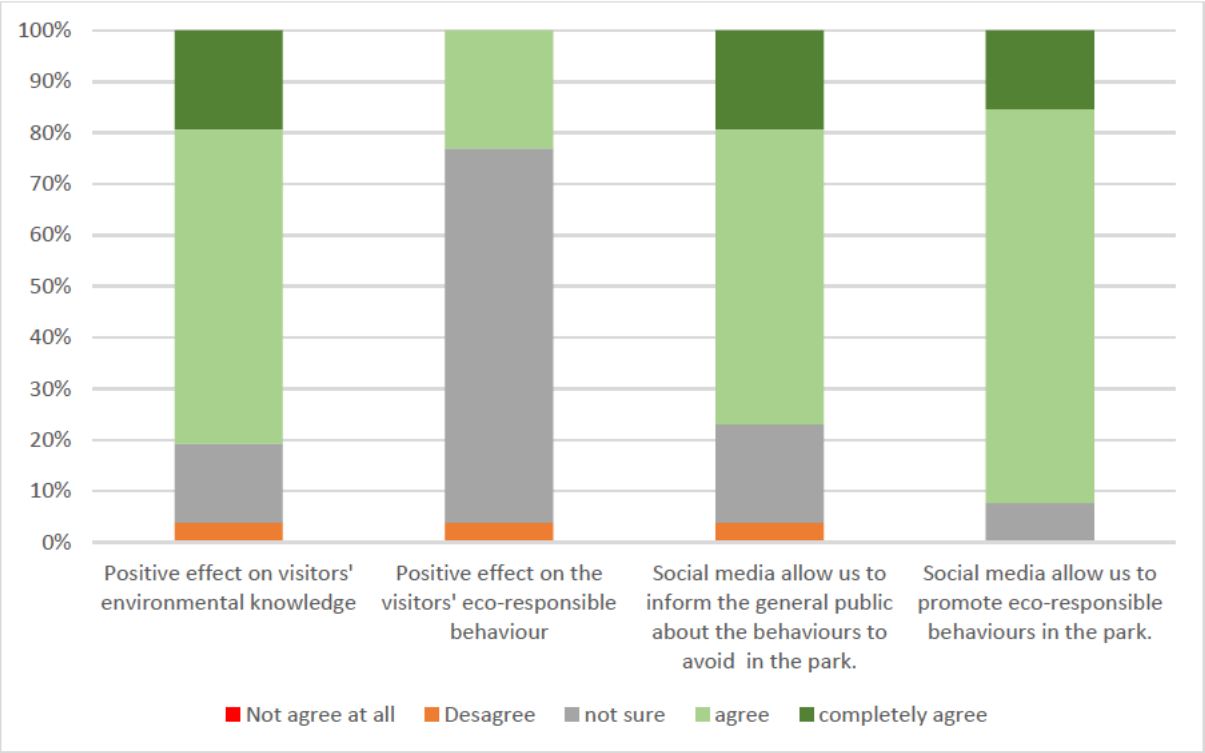
"Used social media well to inform and raise awareness." -PQ7

"All the actions that we carry out or that our partners carry out are relayed on our social media." -PQ23

These results are in line with those of question 14.1. showing that 80% of the respondents totally agree or agree that social media has an overall positive effect on the PNAs' visitors' environmental knowledge (Graph 12).

However, the analysis of the closed questions 14.2 reveals that 77% of the respondents are unsure or question the overall positive effect of social media on visitors' behaviours (Graph 12).

Graph 12 French Regional Nature Park communication officers' perception of social media impact visitors' knowledge and behaviours



The analysis of the data collected in questions 14.a,16.a and 20, reveal five reasons that drive respondents' negative perception of social media as a tool for promoting eco-responsible behaviour, namely (1) the lack of impact assessment, (2) the superficiality of social media, (3) failure of the organisation to cope with the ever-changing environment of social media, (4) polarisation of the debate online, and (5) the superiority of human interaction.

"While social media seems to be a relevant tool for getting a message across, it is impossible to know its impact." -PQ3

"The notions of complexity and balance seem to me essential notions of defending in a world where social media/society simplify and oppose at an incredible speed. "-PQ4

"While I am convinced of the impact of social networks in terms of the "quantity" of the target audience, I remain more sceptical about the real impact on behavioural changes."-PQ14

These results may, therefore, indicate two phenomena:

- ***The non-translation of information and knowledge into PEBs***. As shown in Graph 12, 80% of the respondents declare that social media positively impacts their visitor's knowledge; however, they question the application of this knowledge through PEB. Hence, the participants' answers contrast with behaviour theories such as the Theory of Planned Behaviours (TPB) and Theory of Reasoned Action (TRA), which consider knowledge an antecedent of individuals' behaviour. Also, they contrast with Kidwai et al.'s (2021) study, which demonstrates that social media use can positively impact PEBs. However, the participants' perceptions align with the studies that have shown that environmental knowledge has little (Gerdt et al., 2019) or no direct impact on pro-environmental behaviour (Bartiaux, 2008; Maurer & Bogner, 2020).
- ***The potential negative impact of social media on parks' visitor behaviour.*** The concept of "miseducative" content (Greenhalgh et al., 2021) or the recent concept of negative learning found in the literature could support the argument of an overall negative impact of social media on the learning process and behaviours (Lee & Xenos, 2019; Maurer et al., 2018; Shavelson, 2018; Zlatkin-Troitschanskaia et al., 2018). Indeed, according to Meyer et al. (2018), a negative learning process may imply negative consequences on visitors' behaviour, knowledge, and beliefs.

These results may also highlight an affordance challenge caused by a discrepancy between the actual features and properties of social media and the respondent's digital capabilities and social media perception (Norman, 2013). For example, the participants may regard social media as a way to disseminate information without perceiving (or denying) a potential positive impact of social media on visitor behaviours.

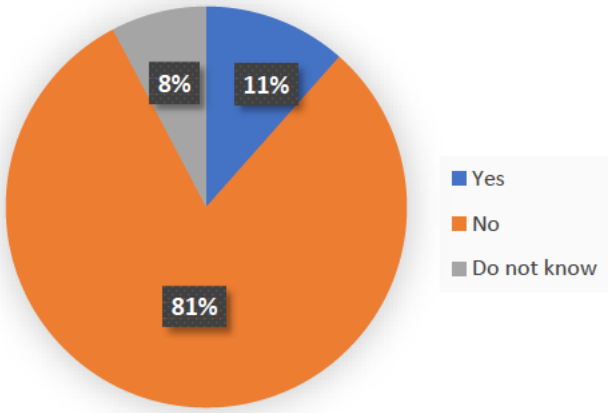
> *"Social media are one of the possible channels for raising awareness, but there is no substitute for a direct exchange of views, such as during a nature outing with a guide or an activity in the classroom aimed at educating the young." -PQ4*

Overall, the responses to the closed and open-ended questions to the survey validate the need to further explore the perception and affordance of social media by the interviewees and the potential negative consequence of DIEL on the visitor's behaviours.

5.3.3 Feedback and knowledge exchange

The data collected in closed-ended question 18 shows that only 3 Parks represented in the survey implemented feedback tools to collect visitors' needs/wishes for environmental education (Graph 13). Thus, the respondents seem to approach DIEL from a top-down perspective and adopt a pedagogy of instruction.

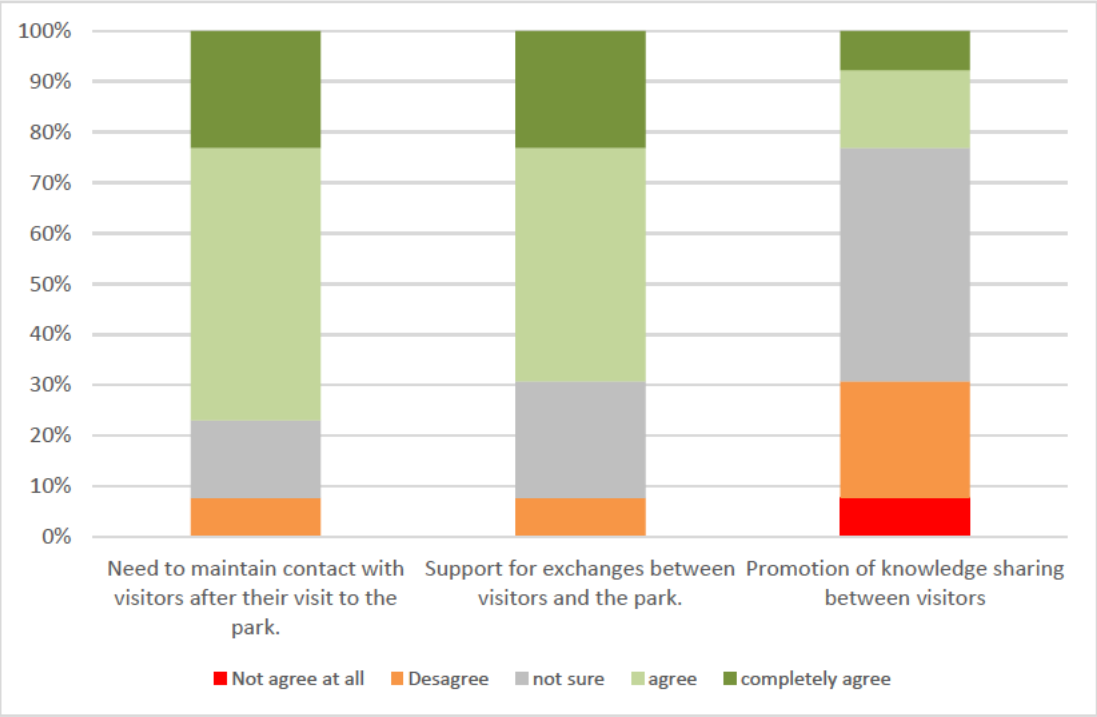
Graph 13 The participants' agreement /disagreement with the statement about the implementation of a specific strategy and tools to ask visitors questions and/or to collect their views on their needs/wishes for environmental education



This approach contrasts with the bottom-up concepts of "self-directed learning" or "free-choice learning" allowed and supported by ICT and Web 2.0 (Falk, 2005; Falk & Dierking, 2019; McKinsey, 2020) that play an important role in the informal environmental learning process (Gössling, 2017; McKinsey, 2020). Also, this top-down approach reveals that the respondents' organisations did take into account the paradigm shift operated due to the emergence of digital tools toward more user-centric content (Nahrkhalaji et al., 2019), two-way and multi-sided communication (Alotaibi et al., 2016).

However, although they do not ask for the visitors' feedback, 77% of the respondents agree that their learning journey may be prolonged after their visit (see Graph 14). Hence, the length and depth of their online relationship with their visitors impact the temporality of the learning process. Therefore, in line with Zareie & Navimipour's (2016) approach to learning, the participants consider education a long-term process requiring the sustainability of the Park/visitor relationship.

Graph 14 Use of the relational function of social media by French Regional Nature Parks



Moreover, according to the responses to questions 14.7 and 14.8, a third of the respondents do not seek to exchange information between their organisation and their visitors, and nearly 80% do not encourage the exchange of environmental knowledge between their visitors on social media. Also, while willing to engage with the visitors online, respondent PQ19 indicates that knowledge exchange with the visitor is limited to specific topics.

"[the respondent creates] Simplified and accessible content, which, where possible, encourages the participation of Internet users."-PQ6

"Concerning the exchange between people, we only do it on certain subjects via Facebook groups: on water saving, soft mobility, the geopark, the revision of the park charter."-PQ19

Therefore, social media seems to be mainly used by the respondents as a one-way and top-down communication tool, disregarding its capacity for facilitating relational functions (Ballew et al., 2015). The respondents do not engage in meaningful two-way interactions or knowledge exchange. They do not seek feedback from their audience, which is a crucial relational aspect of social media.

These results provide further evidence that the parks surveyed predominantly adopt an instructivist pedagogy and do not give significant consideration to implementing a pedagogy of construction or connection allowed by ICTs (Anderson & Dron, 2014).

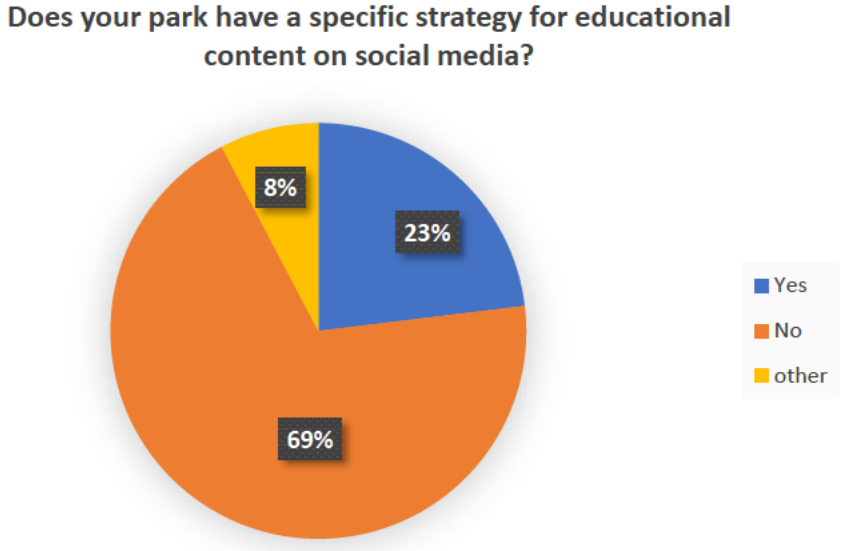
5.3.4 Implementation of digital informal environmental learning strategy

According to the closed-ended question 11 answers, 69% of the respondents did not set up any DIEL strategy, while 23% did (see Graph 15). Two participants chose the "other" response to the question to specify that they have a strategy for their external communication but not specifically a strategy related to environmental knowledge but that it cannot be assimilated as a strategy for DIEL.

"We have a content dissemination strategy but not specifically for environmental education." –PQ19

"Not a written strategy but a practice. When we publish on a species, we add specific content to our website."-PQ4

Graph 15 Percentage of the parks represented in the survey that did implement a DIEL strategy



The analysis of the open-ended questions collected the perspective of 12 respondents regarding their DIEL strategy implementation. It revealed that six respondents have set up a DIEL strategy, two abandoned it, two recently implemented one and eight have not set up any (Table 17).

Table 17 Results of the qualitative content analysis of the data collected in the survey related to the DIEL strategy implementation by the respondents

Main categories	Sub-categories level 1	Sub-categories level 2	Nb of references
Digital strategy for environmental education	Strategy implementation	abandon of strategy	2
		Recent implementation	2
		Strategy implemented	8
		no strategy	11

More specifically, as shown in Figure 11, the data analysis revealed a diversity in the implementation of DIEL strategies, ranging from no strategy to implementing more advanced practices:

Figure 11 The state of implementation of DIEL strategies in the PNAs represented in the questionnaire mentioned by the respondents

This heterogeneity of practices suggests no intent to orchestrate the use of digital technologies for educational purposes within the French Regional Parks network. Moreover, the apparent lack of DIEL strategy in the parks represented in the survey raises questions about governance and oversight. The following statement from participant PQ16 illustrates this lack of organisational vision.

"We hear, "you have to be on social media", but rarely why, considering their real impact." -PQ16

Also, paradoxically, two respondents seem to be holding back on their use of social media due to the lack of a tool to evaluate their "real" impact on knowledge and behaviours. However, implementing a digital strategy could allow them to set their target and expectations and

measure them qualitatively or quantitatively. As a result, the respondents seem to be more focused on what the social media tools may be able to do (or not) for them rather than what they can/want to do with social media.

"These claims are ambitious. Without precise evaluation indicators, it is difficult to answer." -PQ2

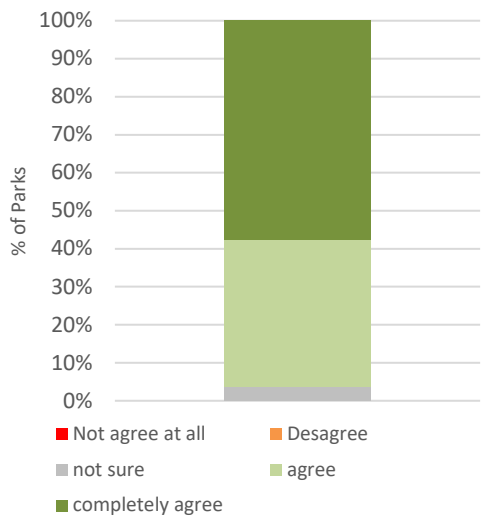
"While social media seem to be a relevant tool for getting messages across, it is impossible to know their impact."-PQ3

These results suggest that the mission of education in Regional Nature Parks represented in the survey is left to the on-site activities (in situ, direct experiences). In contrast, social media platforms (symbolic experiences) are not perceived as a "natural" tool for pedagogical purposes. Also, they enhance the researcher's understanding of the respondents' uncertainties about social media's influence on visitors' behaviours and confirm that the respondents' perception of social media can affect their DIEL strategies.

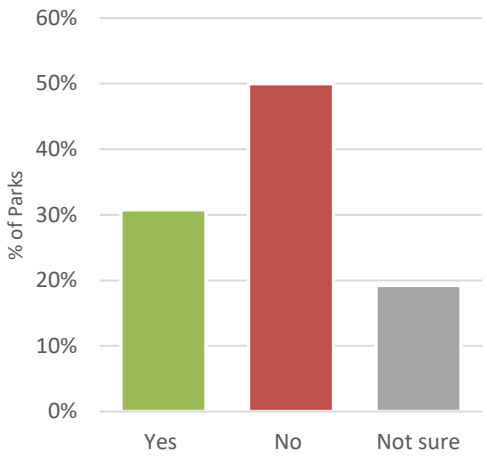
5.3.5 Monitoring of online information

The analysis of the data collected in the close-ended questions 14.9 and 19 shows that more than 95% of the respondents agree that monitoring information about their park online is important. Yet, only a third implemented online monitoring tools (Graph 16 and Graph 17,).

Graph 16 The participants' agreement /disagreement with the statement about the importance of paying attention to the information spread by third parties about their park.



Graph 17 The participants' agreement /disagreement with the statement about the implementation of strategies and tools to be aware of information disseminated by third parties about the park on social media



The responses to the open-ended questions allowed the identification of the park's motivations for monitoring the third-party online content, including (1) assessing the park's online reputation, (2) checking the alignment of the information with regulatory requirements, and (3) better understanding the park's digital ecosystem (see Table 18).

Table 18 Results of the qualitative content analysis of the data collected in the survey related to the implementation of monitoring practices of the respondents

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Nb of references*
Digital strategy for environmental education	Monitoring	digital ecosystem	*9*
		Virtual reputation check	*4*
		Alignment with regulatory requirements	*1*

Regarding the respondents' monitoring of their digital ecosystem, various practices were mentioned, such as:

- Hashtag tracking.
- Monitoring of mention on social media, articles etc.
- Checking for influencers.
- Maintaining the relationship with their stakeholders.

"Monitoring of hashtags, mentions, articles, etc., continuous monitoring of networks." -PQ25

"To detect influence relays (or influencers.)" –PQ2

"It is mutually beneficial for our partners and us." –PQ24

These examples illustrate a passive use of monitoring to assess, check and track content, but participant PQ24 stated using monitoring more actively to react to content.

"It is important to follow the issues that concern us, to be able to react or support. It is a win-win and quite important for our partners too."-PQ24

Furthermore, the data analysis also reveals respondents' difficulties in implementing such monitoring and their motivation not to do so (see Table 19).

Table 19 Results of the qualitative content analysis of the data collected in the survey related to the non-implementation of monitoring practices online by the respondents

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Nb of references*
Digital strategy for environmental education	No monitoring	Auto-regulation of the online discussion	*2*
		Lack of resource	*5*
		No need for it	*2*
		Lack of strategy	*1*

Regarding the challenge faced by the respondents in monitoring practices, the lack of resources and time seems to prevent them from routinely monitoring online content.

"Lack of time and technical expertise. This monitoring is done occasionally"-PQ19

"Lack of means and time"-PQ20

Also, nine participants provided rationales for not implementing monitoring practices on their parks' social media. Two of them let online discussions auto-regulate, leaving social media users to be the main moderators of the discussion.

"It does not seem possible to control everything. Most of the time, the discussions regulate themselves, the Internet users correcting/modifying each other, which I consider a good thing, as the Park is not THE voice for preserving its territory." *-PQ4*

Five respondents mentioned a lack of time, resources, and/or strategic vision.

"lack of time and strategic vision." –PQ13

Two respondents considered that there is no need to monitor.

"On this issue in particular, there is no absolute need for it." -PQ3

Finally, the data analysis highlighted the statements of participants PQ3 and PQ21, who associate the need to closely monitor third-party online content with the level of vulnerability and regulation of a park.

"*The need for monitoring is beginning to be mentioned in the nature reserve XX, which is governed by strict regulations without a strategy and means having yet been determined*." *–PQ3* [quote edited to preserve the respondent's anonymity]

"Not particularly, we do not have any areas that suffer from overcrowding"-PQ21

These statements suggest that the more fragile and under pressure the ecosystem and regulated a park is, the more monitoring would be needed. Thus, information online may be a source of threats to fragile ecosystems, and monitoring is required to protect them.

Overall, the data analysis validates the relevance of online monitoring for the PNAs and may indicate that online content may have a negative impact on park missions. It also reveals different monitoring practices.

5.4 COVID-19 impact on strategies and educational tools

The data analysis highlights the impact of COVID-19 on the respondents' digital practices, mindset, and culture (Section 5.5.1). In addition, it revealed that social media's experiential function may have allowed the visitor to symbolically experience nature during the lockdown and develop positive emotions toward nature. However, with the end of the lockdown, the changes made during COVID-19 have been abandoned (Section 5.5.2).

5.5.1 The impact of COVID-19 on the digital culture and strategy of the PNAs

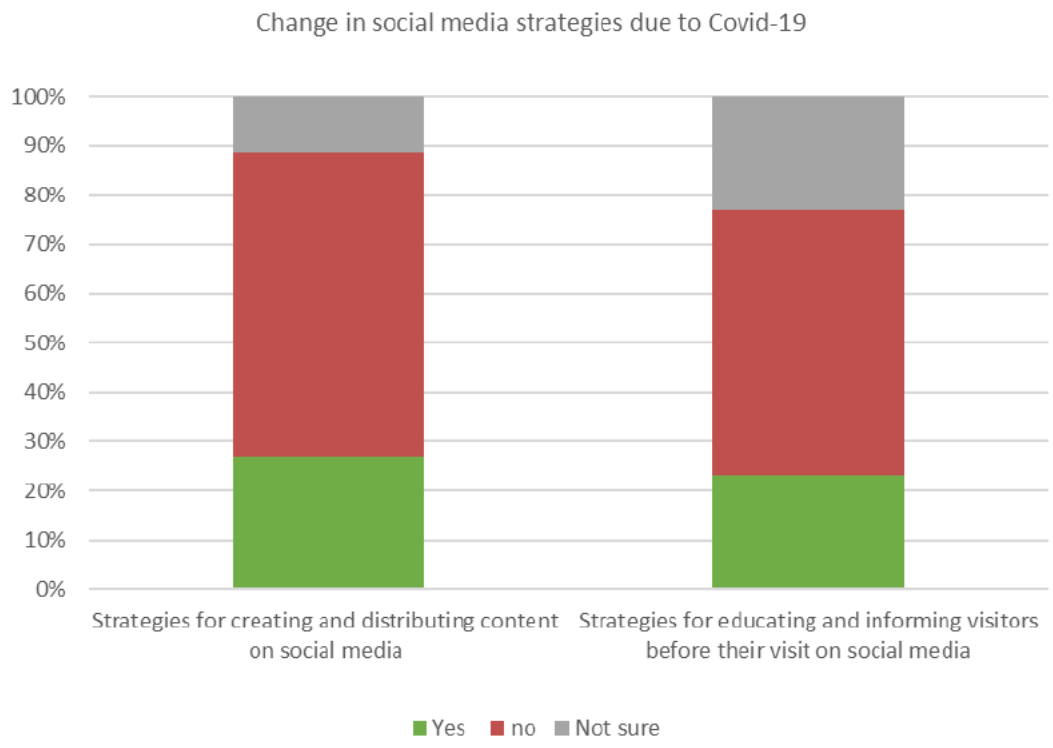
Regarding the global impact of COVID-19 on the Regional Nature Parks represented in the survey, the data collected in questions 17.b, 19.d and 20 highlighted challenges for realising their education mission on site (see Table 20). This supports previous research and feedback from the PNAs about increased park visits after lockdowns and shifts in visitor demographics (McGinlay et al., 2020).

Table 20 Results of the qualitative content analysis of the data collected in the survey related to the COVID-19 impact on the respondents' organisation

Main categories	Sub- categories level 1	Sub-categories level 2	Nb of references
COVID-19 impact on DIEL strategy	COVID-19 impact on DIEL strategy	Barriers to the education mission	1
	Increase in frequentation		4
	New types of visitors		1

Also, as shown in Graph 18, in response to the increase in visitor numbers and non-eco-responsible behaviours, 26% of participants have implemented changes in their publishing practices, and 23% of parks report changing how they provide information to visitors before they come to the parks.

Graph 18 Change in social media communication strategy due to COVID-19 in French Regional Nature Parks



These changes in practices suggest the use of social media by the respondents to reach the new type of visitors who "were unaware of the main regulations in place" (McGinlay et al., 2020, p. 5) to raise their awareness about PEB (Beery et al., 2021).

Analysis of the responses to the open-ended questions provided insight into how respondents modified their practices and how COVID-19 impacted their DIEL strategy (Table 21).

Table 21 Results of the qualitative content analysis of the data collected in the survey related to the COVID-19 impact on the respondents' DIEL strategy

Main categories	Sub- categories level 1	Sub-categories level 2	Nb of references
COVID-19 impact on DIEL strategy	COVID-19 impact on DIEL strategy	change in culture	3
		change in content	5
		frequency of post	6
		media use	2
		online presence	1

The results confirm the need for the respondents to align their external communication content to the new type of visitors and the over-frequentation of the parks to "hammer home good practices" (PQ17). In addition, one participant (PQ4) mentioned that he also varied the communication medium using more videos.

"Information and knowledge were provided for these new visitors who were not familiar with the "codes" necessary to preserve the environment while respecting everyone's uses."-PQ3

"Overcrowding of the park following COVID-19 and especially summer 2020, hence the need to send out messages in summer 2021." -PQ19

"We worked much more with the video medium." -PQ4

Moreover, one participant has noted a shift in the awareness of their organisation's employees regarding the importance of social media. These changes also manifested in the choice to increase their online presence via additional social media accounts and the possibility of allocating more time to digital content creation.

"We had a little more time to look at social networking during the COVID-19 crisis, which also raised awareness within the park team of the importance of social media." "The idea of developing an Instagram page dedicated to nature has gained momentum for implementation in 2022." -PQ4

"We had a little more time to look at social media during the COVID-19 crisis." -PQ4

These results confirm the relevance of investigating the COVID-19 impact on the PNAs' DIEL and their digital practices during the interviews.

5.5.2 The development of the symbolic experience of nature via social media

During the lockdowns, while some participants tried to produce content and activities to keep people at home (e.g., DIY ideas and activities), others offered content that allowed online visitors to 'escape' from their sofas.

> *"We offered daily cultural and nature observation information that allowed Internet users to escape from their sofas in the safety of their homes". -PQ21*

The latter tried to bring the park to people through the symbolic experience of nature by means of different media (e.g., increased use of videos), suggesting that regional nature parks are using positive emotions towards nature (biophilia) as a tool to get their educational messages across to visitors online on social media (see Table 22).

> *"One minute video that invites wonder with the message take 1 minute of your time to stop and just contemplate." –PQ4*

Table 22 Results of the qualitative content analysis of the data collected in the survey related to the use of emotion by respondents to activate their visitors' biophilia

Main Category	Definition	*Nb of references*
Biophilia activation	Statement related to the intent to provoke awe and emotion through the mediated or symbolic experience of nature	*4*

However, with the end of the lockdowns, it seems that the parks returned to normal and did not pursue the change they operated during COVID-19.

> *"Specific plan put in place during lockdown: each day, a theme but since abandoned, not enough time available." -PQ23*

Following these results, the researcher added the research concept of "biophilia activation" to their research framework and edited the interview guide accordingly.

5.5 Contributions of the survey findings to the interview design

As seen in chapter 4, the questionnaire analysis gave the researcher a better understanding of the research context and allowed for the interview guide's refinement. This section identifies all the concepts introduced in the questionnaire that were found relevant to the research question and that have been validated to be introduced in the interview guide, the concepts that needed to be adapted, and the concepts that have been added to the initial interview guide (Table 23).

Table 23 Concepts that were investigated further during the interviews based on the questionnaire findings

Validated concept	Adapted concepts	Concepts added
Online presence	**Eco-literacy**	**Biophilia**
Educational digital strategy	**Knowledge exchange and feedback**	**Digital technologies functions**
Audience	**Educational digital strategy**	**Negative learning**
Resources	Scope and governance	**Positive learning**
Monitoring		**Negative positive learning**
Temporality		
Social media		
Perception/affordance		
Impact of the COVID-19 pandemic		

5.5.1 Concepts explored in the survey validated as relevant to include in the interview guide

Four main concepts explored in the survey were validated as relevant to include in the interview guide:

Online presence: The heterogeneity of the PNAs' DIEL practices requires an overview of their online presence.

Educational digital strategy: The data analysis confirmed the relevance of the sub-themes identified in the literature review and the need to explore them further:

- *The resources allocated to social media use*. The participants' responses suggest a lack of resources and skills within PNAs.
- *The audience targeted*. The heterogeneity of respondents' digital practices can suggest different communication strategies targeting different audiences.

- *The need for monitoring online content*. The participants' concerns about online content shared by third parties suggest a potential negative impact of online content on achieving PNAs' missions.
- *The temporality of the learning process*. The respondents seem to agree on the relevance of reaching out to visitors before their visit and maintaining contact with them after their visit for educational purposes.

Social media perception/affordance: The data analysis results suggest an affordance challenge within PNAs' communication teams represented in the survey caused by a discrepancy between actual features and properties of social media and the PNAs' digital capabilities and social media perception (Norman, 2013). Exploring further the concept of social media affordance, the interview investigated the reasons for the participants' doubts regarding the potential positive impact of social media on visitors' behaviours.

COVID-19 impact: The answers to the questionnaire confirmed the impact of COVID-19 on some respondents' DIEL strategies and digital practices. Further exploration of this impact was integrated into the interview guide.

Table 24 presents how these concepts have been covered in the interview guide.

Table 24 Questions in the interview guide covering concepts validated by the analysis of the questionnaire

Research concepts		Question numbers in the interviews
Online presence		Questions: 1,2,6,10,18
Digital strategy for environmental education	Audience	Questions: 1,2,4,5,6,7,18
	Resources	Questions: 6,8,9,18
	Monitoring	Questions: 6,7,9,14,16,18
	Temporality	Questions: 4,6,7,18
Social media perception/affordance		Questions: 2,6,8,9,10,11,12,14,15,16,17,18
COVID-19 impact		Question: 18

5.5.2 Concepts explored in the survey edited to be introduced in the interview guide

Three main research concepts were edited before being included in the interview guide:

Eco-literacy: The responses to the questionnaires indicated that the environmental SDGs were not enough to grasp the complexity of the messages disseminated by the Parks. Furthermore,

the analysis of close-ended questions validates the relevance of knowledge systems, knowledge related to behaviour, and know-how.

By incorporating the concept of eco-literacy as defined by Maurer and Bogner (2020), the researchers aim to encompass a broader understanding of the participant's knowledge, skills, behaviours, and attitudes towards the environment. Eco-literacy refers to the ability to comprehend ecological concepts, recognise environmental issues, make informed decisions, and take actions to address them. Therefore, all these items have been grouped under the umbrella of eco-literacy as defined by Maurer and Bogner (2020), comprising the following four concepts: Environmental knowledge Skills, PEB, and attitude.

Scope and governance: Some participants expressed a lack of clarity as to “why ?” they were asked to use social media. Moreover, the data analysis suggests a lack of DIEL strategy in the park represented in the survey and raises questions about governance, knowledge orchestration, and oversight. Therefore, the interview guide was edited to include these concepts to explore further.

Digital technologies functions: The responses to the questionnaires indicate that the respondents have different use of social media functions (as defined by Ballew et al. (2015), i.e. informational, relational, and experiential functions). Indeed, the respondents use social media's informational function to disseminate environmental knowledge to their visitors. However, they do not widely employ the social media relational function to encourage knowledge exchange between visitors and parks or to gather feedback on visitors' educational needs and expectations.

The research concepts of “feedback” and “knowledge Exchange” were therefore investigated under the research concept of the relational function of social media during the interviews. Finally, the results of the data analysis suggest that some respondents use the experiential function of social media to support the use of positive emotions toward nature and its symbolic experience. Therefore, the interview investigated how the experiential function of social media impacts PNA’s DIEL strategy.

Table 25 presents how these concepts have been covered in the interview guide.

Table 25 Questions in the interview guide covering concept adapted following the analysis of the questionnaire

research items explored		Question numbers in the interviews
Eco-literacy	knowledge	Questions: 2,3,5,6,7,8,10,11,18
	skills	Questions: 2,3,5,6,7,8,10,11,17,18
	ERB	Questions: 2,3,5,6,7,8,10,17,18
	attitude	Questions: 2,3,5,6,8,10,12,14,18
Scope and governance		Questions: 1,2,3,4,6,7,8,9,10,17,18
Digital technologies functions	informational	Questions: 1,4,5,7,8,10,11,15,16,17,18
	experiential	Questions: 1,4,5,8,10,11,12,16,17,18
	relational	Questions: 1,4,5,8,10,11,15,16,18

5.5.5 Concepts that emerged from the survey findings added to the interview guide

Three main concepts emerged from the survey's data analysis and were added to the interview guide:

Negative/Positive learning: The participants' uncertainties about social media's overall positive impact on visitor knowledge and behaviour raised questions about the potential adverse consequences of environmental learning through these platforms. To further investigate this possibility, the researcher included the notion of negative learning, defined by Meyer et al. (2018), which includes negative consequences on visitors' behaviour, knowledge, and beliefs in the interview design.

The research concept of positive learning was also added as the opposite of negative learning, i.e., the learning process leading to positive consequences on visitors' behaviour, knowledge, and beliefs.

Negative positive learning: Having integrated the concepts of positive and negative learning into the design of the interview guide, the possibility for a park visitor to achieve positive learning through negative learning, as predicted by Oser (2018), was investigated by the researcher.

Emotions / Biophilia: Some of the participants' comments suggested using emotions to stimulate the visitors' love for nature, trigger a desire to care for nature and motivate eco-responsible actions of the visitors. These results align with the Biophilia activation theory, which involves utilizing emotional connections with nature to foster care for the environment

and encourage ecologically responsible behaviours among individuals (Barbiero, 2021; Chang et al., 2020). Moreover, the results suggest that in the same way "direct experiences promote affective growth through the metamorphosis of cognitive learning" (Duerden & Witt, 2010, p. 390), the mediated experience of nature may also affect park visitors' digital informal environmental learning. Therefore, the interview guide incorporated questions related to the potential use of symbolic experience of nature via social media to generate positive emotions toward nature. Table 26 presents how these concepts have been covered in the interview guide.

Table 26 Questions in the interview guide covering concepts added following the analysis of the questionnaire

research items explored		Question numbers in the interviews
Negative learning	unwarranted knowledge	Questions: 14,15,16,18
	non-ERB	Questions: 14,15,16,18
	false belief	Questions: 12,14,15,16,17,18
Positive learning	warranted knowledge and skill	Questions: 7,10,11,15,18
	moral behaviour	Questions: 7,10,11,14,15,18
	ethical belief	Questions: 10,11,12,14,15,17,18
Negative positive learning		Questions: 15,18
Biophilia		Questions: 1,12,13,18

The fully edited interview guide is presented in Appendix H.

Key points presented in this chapter

This chapter has reported the results of the data analysis collected by a survey to explore whether French Regional Nature Parks have shifted to digitalisation to enhance environmental awareness among populations and identify the opportunities and challenges of using ICT for educational purposes and promoting PEB.

The results show that the Regional Nature Parks surveyed do not perceive digital education as a tool and, therefore, do not seek to implement digitally-driven education strategies.

Also, they reveal that the respondents do not seek feedback and contributions from their visitors and, therefore, do not consider the relational function of social media. As a result, they miss the opportunity to extend their outreach and educate a broader audience beyond park visitors, involving them in educational initiatives before, during, and after their park experiences.

The findings show that the PNAs surveyed face structural, cultural, and environmental challenges in implementing their DIEL strategies.

While COVID-19 has led to an increase in the number of "new types of visitors" unfamiliar with the appropriate behaviours in parks, the PNAS surveyed lack confidence in their ability to provide the visitors with the necessary online content to assist them in acting eco-responsibly.

Finally, the findings confirm the questionnaire's relevance as a methodological tool to explore the research context and refine the proposed theoretical framework and interview guide described in the next chapter.

Chapter 6 Interviews: Findings and Discussion

This Chapter is the results of the data analysis of the 13 interviews of communication, conservation, and education officers in French PNAs and Federations, carried out as described in chapter 4. The data analysis of the interview transcripts confirms the questionnaires' findings presented in chapter 5 by showing that PNAs face cultural, structural, and environmental challenges in implementing their DIEL strategy. It also gives additional insights into the challenges and opportunities of using digital tools for education and conservation.

First, an introduction summarises the methodological approach used to collect the data analysed in this chapter. Section 6.1 focuses on DIEL strategy implementation in the participants' organisations, while section 6.2 describes the participants' organisational and cultural challenges to implementing these strategies. Sections 6.3 and 6.4 discuss how the three functions of social media, namely informational, relational, and experiential, influence the DIEL strategies of the participants' organisations and their visitors' IEL outcomes. Section 6.5 describes how the monitoring and moderation of online content can be used to counteract negative social media learning outcomes.

Introduction to the interview transcripts analysis

Chapters 4, section 4.3.2.1 and chapter 5, section 5.5.5, detail how the findings of the literature review and the data analysis of the questionnaire guided the design of the interviews and determined the concepts that were relevant to the research questions and required to be investigated via the interviews.

Thirteen interviews were conducted online (on Microsoft Teams or Zoom) from 1 March 2022 to 29 April 2022. Two interviewees were present for the fourth and ninth interviews, bringing the total number of participants to 15. The semi-structured interviews were conducted following the interview guide presented in Appendix H and in an “active manner” described in chapter 3, section 3.3.3 (Hathaway, 2020).

The participants were communication officers, conservation and education officers or directors in National Parks, Regional Nature Parks, Nature Reserves, Management Organisations and Federations. The total duration of the 13 interviews was 15 hours and 31

minutes, with an average duration of 1 hour and 21 minutes per interview (see chapter 3, section 3.3.1).

6.1 Heterogeneity in DIEL strategy setting

This section focuses on the data analysis relating to the overall use of social media by PNAs and the implementation of their DIEL strategy. Section 6.1.1 reveals that PNAs' social media strategy is not orchestrated within their network. In addition, section 6.1.2 shows that the strategic choices of PNAs regarding audience definition on social media indicate different approaches to their educational mission. Finally, section 6.1.3 shows that social media can support PNAs' flexibility by enabling easy and targeted adjustments to their audience strategy.

6.1.1 Orchestration of digital strategies and social media use

In line with the findings of the questionnaire analysis, the interview transcripts analysis shows that PNAs use a large range of social media (see section 5.1.2). They also highlight the heterogeneity of practices related to the use of social media within the PNAs' network. Therefore, this section examines the online presence of participants' organisations on social media platforms and the associated uses and audiences.

The established but heterogeneous online presence of PNAs

In line with the questionnaire findings presented in chapter 5 and as shown in Graph 19, 11 of the 12 natural areas participating in the interviews[2] are well-represented online and use multiple social media. The data analysis complements the questionnaire results, revealing Facebook and Instagram as the primary platforms for external social media communication. One rationale for this preference is given by Participant 10, who perceives Facebook as a mass media platform, enabling broad audience reach.

> *"Why Facebook? Because it is the first social network on earth. Let's be clear: we are really on a mass media with a very very very impressive strike force." Participant in the Interview (hereafter PI)- 10*

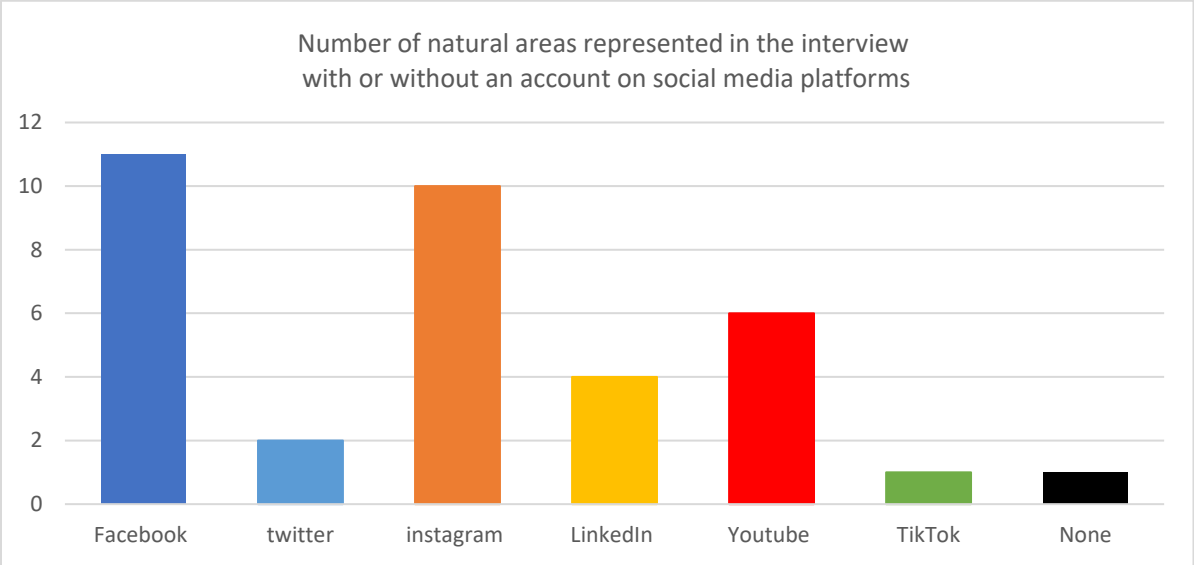
[2]In order to capture the online presence of PNAs, this data analysis considers only the interview transcripts of the Nature Reserve, Regional Nature Parks, and National Parks among the 13 interviews. Therefore, Federation's transcripts were not considered for this analysis.

The PI10's perception regarding the global reach of Facebook and Instagram seems accurate, as Statista reported that in 2020, 3 out of 4 French people had an account on Facebook and more than 1 in 2 on Instagram (Statista, 2022).

The interview findings show that despite being the second-most popular platform worldwide and in France (Hootsuite, 2023; Statista, 2022), YouTube is used less consistently than Facebook by PNAs. These results contrast with the questionnaire's findings that showed that 96% of the Regional Nature Parks represented in the questionnaire used YouTube. The interview data analysis also determines that the interviewees use YouTube as an online storage platform to host and store videos online (video library).

> *"Yes, [we are using Youtube] because that's what is most suited to putting video support online. I do not think there is a real YouTube strategy behind saying once a month, we'll put up a film or two videos."- PI8*

Graph 19 Number of interviewees' organisation with an account on Facebook, Twitter, Instagram, LinkedIn and YouTube



It should be mentioned that a TikTok account was set up by a trainee in PI14's organisation. However, since its creation, only one video has been uploaded. Furthermore, to the best of the researcher's knowledge, the account was not used afterwards.

Finally, interview results revealed that one participant does not use social media.

The absence of digital strategies orchestration

The varied digital usage among interviewees' organisations reaffirms the absence of coordinated digital strategies within their networks, consistent with the questionnaire analysis. Despite the increasing interest of the French Biodiversity Office in advancing online citizen science, no official guidance has been provided for PNAs to create educational digital tools or strategies. Indeed, the analysis of interview data highlights the absence of top-down directives from the federation or the ministry to PNAs regarding digital strategy implementation. As a result, Nature Reserves, National Parks, and Regional Nature Parks are responding to the digital transition on an individual basis.

" [Talking about the use of YouTube and Facebook by Regional Nature Parks] I do not think it is a shared strategy across the parks." –PI1

"Indeed, there is no network-wide reasoning or anything; it is each one in its corner with people who are fully on social media, who throw themselves into it, who have internet pages that are updated almost in real-time 24/7 and others who, like us, update our news section of the website every two months."-PI6

"But then, really, everyone is free to develop their own communication strategy and to implement it as they see fit."-PI10.

"So it is [the digital strategy] more national [than inter-park]. To give you an example, the French Biodiversity Office is currently working on this participatory science aspect. Real reflections are being carried out." – PI13

The findings raise concerns akin to those expressed by authors like Bartiaux (2008), who have warned that the lack of coherence and convergence in the online information disseminated by organisations could confuse or mislead social media users.

The use of social media platforms for different purposes and audiences

The heterogeneity in social media use can be partly explained by the fact that interviewees associate different social media platforms with different purposes and audiences. Indeed, the results of the data analysis highlight that each social media fulfils a different communication objective; therefore, the same topic can be addressed on different social media platforms, but it will be formulated and framed differently.

"In general, my Facebook and Instagram posts are the same subject more or less but framed in a different way."-PI2

Each interviewee's statements related to each social media platform (Facebook, Twitter, Instagram, LinkedIn and YouTube) were analysed using Nvivo's text search tool and analysed to identify how they specifically use different social media platforms and why. Table 27 summarises the different types of audiences and uses associated with the different social media platforms by the interview participants.

Table 27 The different types of audiences and use associated with the different social media platforms used by the interviewees

	Audience	Use	Quote
Facebook	-General public -Local population and stakeholders	- Sensibilisation of individuals - Promotion - Create a community/sense of belonging	*"On Facebook, we're going to have inhabitants, close visitors."*- PI1 *"It is a kind of consolidation of a sense of belonging, a sense of pride". -PI1*
Twitter	-National Institutions -Local stakeholders -Media	- Institutional messages, Messages addressed to organisations	*"On Twitter, we will address elected officials or opinion leaders, journalists, etc."*-PI10
Instagram	-General public -Local stakeholders	- Sensibilisation of individuals - Promotion - Messages addressed to organisations and stakeholders	*"On Instagram, you can really widen the target."* – PI14 *"On Instagram, it is going to be all about tourist places, discovering villages, and so on; it is the beautiful photos that showcase the area more than local themes or practical information."* -PI4
YouTube	-Local stakeholders -Institutions	- Host videos produced by the PNAs - Webtv	*"On YouTube, we post as part of a project that funds small videos. […] The YouTube channel was also the way to host this web TV."* PI9
LinkedIn	-General public -National Institutions -Local stakeholders	- Institutional messages	*"On LinkedIn, we're going to be really professional."* – PI1 *"If we are on LinkedIn, it is because we realise that to reach our professional and institutional partners, it can be a great way to give feedback and to promote the skills we have in the structure, something we do not do in the same way on Facebook" -PI9*

Overall, the data reveal that the participants use social media for multiple purposes, education being one of them (see Table 28). These results are in line with the literature, which shows

that social media has opened new possibilities for communication between organisations and their stakeholders (Floreddu et al., 2014) and that there is a wide range of social media practices in public organisations (Criado & Villodre, 2022). Studies also show that users differentiate their use of social media platforms according to their features and characteristics (Alhabash & Ma, 2017; Roshan et al., 2016), calling for public organisations to consider each social media platform as a different realm (Criado & Villodre, 2022).

Table 28 Results of the qualitative content analysis of the data collected in the interviews related to the purposes for using social media

Main categories	*Subcategories level 1*	*Sub-categories level 2*	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Purpose of use of social media	Answer to an injunction of society	1/4
		Create an online community	9/63
		Disseminate institutional and political messages	12/60
		Promotion and marketing	11/20
		Education and sensibilisation	10/98
		Take advantage of social media as a tool for specific objectives	12/67~~clo~~

6.1.2 Audience setting and PNAs' perspective on DIEL

As seen in the previous section, the results of the interviews seem to indicate that the participants are aware of the different characteristics of social media platforms. This section focuses on how the participant's DIEL strategy impacts the outline of their target audience on social media.

Divergence of participants on the scope of the audience: from sensitised to the non-sensitised audience

The data analysis reveals a dichotomy between the participants who perceive social media as a way to target an audience already sensitised to nature protection and those who perceive it as a way to reach out to the non-sensitised audience (see Table 29).

Table 29 Results of the qualitative content analysis of the data collected in the interviews related to the respondents' audience

Main categories	*Subcategories level 1*	*Sub-categorieslevel 2*	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Audience	Already sensitised	*6/21*
		Non-sensitised	*4/10*

Regarding the formers, 6 participants consider that social media allows them to reach a wider community that shares the same environmental awareness as their traditional community.

"[talking about their social media audience] It is people who are already convinced, for the most part, to protect the environment or rather people who have a naturalist's interest and who are used to coming to natural areas."- PI7

"Those who come and follow us on the networks are already people who are sensitive, concerned, and then there are the very committed sensitive ones, but it is still these people who follow us on social media. I'm not convinced that in any case, on our own networks, we have gained new targets."-PI1

These participants do not perceive social media as a tool to diversify their audience but rather to increase it.

In contrast, 4 participants consider social media a way to reach non-traditional audiences. For example, Participant 14 mentions having created an Instagram account to reach out to new audiences less sensitised to nature conservation or from urban areas with little access to natural areas. Participant 9 mentions seeking to reach out to non-visitors and non-sensitised individuals.

"Yes, clearly, because it is precisely to reach people who are perhaps less aware or less familiar with the biodiversity around them and who are actually more urban."-PI14

"I think it is a good strategy to try to raise awareness among people who won't necessarily come. For me, that's really part of the targets."-PI9

Divergence of participants on the scope of the audience: from local to global audiences

9 participants consider that they should address a local audience composed mainly of the inhabitants of the PNAs or individuals living in the vicinity.

"Well, our main objective is to raise awareness among the people who live closest to us." -PI6

"I have the feeling, rightly or wrongly, I do not know, but that there is an effect, uh, of kilometre 0. I want to say the closer you are to the reserve, the more you have a feeling of belonging, in fact, and the closer it is to your

home, the more you'll want to subscribe to the page and get information." -PI9

In contrast, 7 participants consider that they have the vocation to talk to everyone and individuals that do not reside close to the PNAs (more than 2 hours drive from a PNA). For example, participant 8 acknowledges that locals may be more likely to follow their social media but that they aim to reach beyond this audience.

"For me, it is primarily the locals because, of course, it is their home. It is good that they are aware of what is happening in their territory. But for me, obviously, we have to go beyond that."-PI8

"Well, in fact, our vocation is to address everyone, in fact."-PI12

The participants' diverse approaches to their audience suggest they have different views on their role in disseminating environmental knowledge. If PNAs are seen as vital parts of a worldwide environmental knowledge network promoting sustainability, as endorsed by the Council of the European Union and UNESCO, one may question whether relying solely on a localised approach to public education could adequately lead to global-scale achievements (Gossart, 2021).

Another indication of this restricted global educational outlook for some participants is the lack of awareness about the actions of other conservation organisations regarding DIEL and the lack of homogenisation in the online content and narratives used within PNA networks.

"No, everyone did their own thing."- PI13

"It is true that it would be interesting to see. That's what everyone's practices are on these subjects. Yes, it would be interesting to see."- PI7

"For the moment, even if I have had contact with the other parks, well, some of them, but I do not really know about their own communication strategy and the way they communicate."- PI4

6.1.3 Audience setting in a dynamic environment

The interview data analysis reveals the need for PNAs to address specific audiences at specific times. This section explores how the participants' organisations use social media platforms to increase communication agility in a dynamic environment.

Social media as a tool to target specific audiences

The literature shows that social media allows organisations to target specific audiences at a chosen time to promote specific behaviours (Henderson & Musgrave, 2014; Shawky et al., 2022). As a result, social media enables organisations to set up a dynamic audience strategy. Participant 14 illustrates this potential by mentioning that they adapted their communication strategy during the summer to address canoeists who might disturb a specific bird species during this period.

"We need to raise awareness among canoeists and kayakers that they shouldn't land on the islets; that's what we'll do. Yes, we're going to distribute information at the right time."-PI14

Participant 6 also set up collaborations with athletes who could inform their audience about the vulnerability of the ecosystem in which they practice their sport. These results align with the literature demonstrating that influencers can improve trust and attitude toward a message online (Jin et al., 2019) and promote travellers' sustainable behaviour (Walsh & Dodds, 2022).

"We tried to find "quietness, attitudes" ambassadors [campaign to keep quiet areas in the park] who can relay this information via their respective pages. And that's true; we realise that it works well. For the moment, it has mainly recognised sportsmen and women from the area who have been approached, who have often been sensitised and who are already well aware of the issue. So it can be former mountain bike champions, skiers, and there are also mountain guides." -PI6

These results also align with authors who argue that the concept of "general public" is an "empty concept" (Smith et al., 2020, p. 318) and that audience segmentation is crucial for conservation communication campaigns' success (Detenber & Rosenthal, 2020).

The use of agile and contextual audience management strategies

The interview findings confirm the literature and questionnaire findings (see section 5.5.1), indicating that new types of visitors accessed the PNAs after the COVID-19 lockdowns (McGinlay et al., 2020, p. 5). Therefore, the potential of social media to personalise communication was particularly useful for PNAs after the COVID-19 Lockdowns in France (Table 30).

Table 30 Results of the qualitative content analysis of the data collected in the interviews related to the impact of COVID-19 on their DIEL strategies

Main categories	Subcategories level 1	Sub-categorieslevel 2	Nb of transcripts coded / Nb of references
COVID-19	Impact on digital strategies	Specific content	8/16
		Specific audience	3/5
		New types of visitors	3/13

"Except that there is such an influx of people that in the end, we ended up with a lot of people who are not at all familiar with nature in the mountains and who have taken up camping."- PI6

"We realised after these periods of lockdown that we also had a renewal of visitors who came to the park. There were a lot of new people who had never set foot in the mountains and had absolutely no idea how to behave in the mountains. In terms of safety, they did not know what shoes to wear, how to equip themselves, how to orientate themselves, how to feed themselves, and how to drink. That's how bad it was. So there was a big communication campaign with partners that we were associated with, such as: How do I pack my bag ? How do I feed myself?"- PI13

Indeed, that change in visitor characteristics led 3 participants to change their DIEL strategy by creating specific content for this new target. For example, participant 13 reacted by setting up a DIEL strategy for the next 5 years to promote specific eco-behaviours online.

"We have decided that over the next 4, 5 years we would really continue to have a specific communication on these codes of good conduct for these new visitors." -PI13

These results align with authors such as Shawky et al. (2022), arguing that *"rapid changes in consumers' preferences along with the constantly evolving social media channels require agile content creation that is flexible to cater for platform-specific communication styles."* (p. 298).

Social media as a source of uncertainty

As seen above, social media can assist participants in reacting to environmental change. However, the data analysis shows that it can also be a source of change and uncertainty. Indeed, the digital ecosystem is very dynamic and ever-changing. Thus, the concept of social media agility emerged in the literature as organisations' capacity to detect and respond to the change in user needs in the social media environment (Chuang, 2020; Gligor & Bozkurt, 2021).

6 participants give an example of this dynamic social media environment with the change in Facebook audience. For these 6 interviewees, Facebook used to be a tool to target an audience of young people, which is not the case anymore:

"Today we see that certain targets, particularly younger targets, are no longer on Facebook; it has become an old people's network, I have learned that."- PI1

"A few years ago, I would have told you it is to reach young people, but in fact, I realise now that for young people, it is becoming a has-been to be on Facebook. So I am not going to say that anymore."-PI3

Participants 1, 2 and 8 acknowledge that social media platforms other than Facebook should now be used to connect with the younger generation.

"I think there is Twitch too. I think that could be twitch, yes, if we really want to go towards targets such as younger targets." -PI1

"I do not think young people are on Facebook but rather on Instagram." PI2

"There is Snapchat, there is TikTok, and there are networks that are, I think, used much more by young people". PI8

"I hear that Facebook is for old people. There are no young people of my children's generation who use Facebook. That's what education is all about,

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Participant 14 seeks to reach out to the young audience on social media. However, while acknowledging the need to choose the right platform for that purpose, using social media such as TikTok can be challenging as it requires new skills and adaptation to a new content format. (Anderson, 2020).

"Now we are trying to think; for us young people, it is the target."[…] "We created a TikTok page thanks to an intern, and she made me a first video, but since then, we haven't done anything. I do not despair of moving forward on Tiktok with short videos, but for the moment, it is really anecdotal." -PI14

Additionally, Participant 9 stresses the lack of resources for implementing a new social media account, and Participant 2 stresses the lack of skills to adapt their traditional content to the new platform and users' interests.

"It is true that if we want to reach the practitioners of tomorrow, well, maybe Tiktok would be an investment, but that's a bit of an open question and a reality of means [resources] behind it." PI-9

"There are not many on Facebook [young people], so it would be more like Instagram or even now, it is more like TikTok, and it is not necessarily the people we're going to target. Because, well, I'm not going to lie, I do not see myself dancing on TikTok at the moment to talk about all this [environmental knowledge]".- PI2

These results are in line with Anderson (2020), who considers that "*an important skill in being able to adapt to the changing landscape is to recognise that the current app may not exist in a year or another one is likely to replace it, and the knowledge, skills and tools acquired in using and researching one can be applied to the next"* (p. 7). In addition, according to Iannacci et al. (2021), the degree to which an organisation *"accept and adapt to ongoing social media policy changes in order to cope with and respond to change swiftly"* (p.664) is called adaptive acceptance. Therefore, based on the above, we can conclude that PNAs' management should foster adaptive acceptance of social media to improve their organisations' capability to adapt to their dynamic digital environment.

Key points presented in this section

The set-up of DIEL strategies among PNAs represented in the interviews occurs at the organisation rather than at a network level. This results in diversity in their digital practices, particularly in defining their audience from local to global and from sensitised to non-sensitised to sustainable issues. This lack of strategic alignment could lead to a lack of impact of DIEL strategies on visitors and even confuse them in their understanding of important environmental messages. Finally, the results show that social media enables PNAs to target specific audiences by rapidly and precisely adapting their audience strategy. However, for optimal use of social media and to navigate their dynamic digital landscape, PNAs need to demonstrate skills for agile content creation and social media agility.

6.2 Organisational and cultural challenges for the implementation of DIEL strategies

This section focuses on the challenges of the respondents' organisations in implementing their DIEL strategy. Section 6.2.1 reveals that using social media for educational purposes requires the PNAs to foster a digital culture across their organisations. Indeed, section 6.2.2 highlights that employees' negative perceptions of social media can lead to low social media acceptance. However, section 6.2.3 shows that the lack of leadership related to using social media leaves room for the emergence of intrapreneurs and the development of online experimentation. Also, section 6.2.4 shows that the lack of leadership on how digital tools fit into the PNAs' missions can lead to cognitive dissonance at the individual level and identity tension at the organisational level. Finally, section 6.2.5 reveals that PNAs are subject to resource constraints that may prevent them from implementing DIEL strategies.

6.2.1 DIEL on social media: a side mission?

The interview analysis shows a lack of leadership in the participants' organisation to extend their realisation of their educational and conservation mission online. Therefore, this section focuses on the structural and cultural challenges faced by PNAs in implementing their DIEL strategies.

A lack of intra-organisational collaboration for the implementation of PNAs' DIEL strategies

As shown in Table 31, 4 participants pointed out that their organisation did not set up an organisational structure and/or routine, allowing them to efficiently communicate their work or that of their colleagues working in the field.

Table 31 Results of the qualitative content analysis of the data collected in the interviews related to the lack of collaboration in the implementation of the DIEL strategy

Main categories	Subcategories level 1	Sub-categories level 2	Sub-categories level 3	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Governance	Organisation	Lack of collaboration or need for improvement	*4/7*

These results align with the questionnaire findings, showing that 27% of Regional Nature Parks represented in the survey were not collaborating with their colleagues to create content for their social media (see section 5.2.2).

> *"We go into all kinds of subjects, and we have a lot of interesting things to say, but we do not take the time to promote what we do, so people do not know." -PI2*

The following interview analysis provides a better understanding of this lack of organisational structuration and intra-organisational collaboration.

The cultural challenges for the implementation of DIEL strategies in PNAs

Although valorising their conservation and education work among the general public and local stakeholders is an integral part of their missions (OFB, 2021, 2023; Parcs Naturels Regionaux de France, 2022), interviewees from 2 Regional Nature Parks and 4 Nature Reserves mention that IEL and external communication are not central to their primary mission in their organisation (see Table 32). This could be due to Nature Reserves prioritising conservation and nature protection missions, while National Parks and Nature Parks focus on territorial marketing, cultural heritage, and sustainable tourism, possibly making them more accustomed to external communication. Additionally, Nature Reserves regulation does not allow for the touristic promotion of their sites.

Table 32 Results of the qualitative content analysis of the data collected in the interviews related to the digital mindset and culture of their organisation

Main categories	Sub- categories level 1	Sub-categories level 2	Sub-categories level 3	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Governance	Digital mindset and culture	DIEL as a secondary mission	*6/17*

“And so I do not think it is actually the core of our business to focus on social networks when the core of our work is more conservation on the ground.” -PI6

“So that we are clear from the start, promotion is out of the question for us; it would be contradictory with our regulations.” -PI3

Another possible explanation emerges from the interview data analysis that reveals that the communication missions, specifically social media management and online community management, are not yet considered "traditional and essential work" by PNAs' management and stakeholders.

“Our management team thinks that when you're out in the field, and you're going to take pictures, [they think] you're out on a walk more than we are at work.“-PI8.

“For some people, it is still not necessarily something [social media] that is very, very understandable as a job in its own right.” -PI1

In this context, using social media for education can be challenging as employees across organisations must adapt to the digital transition (Castaldi et al., 2020). Moreover, work habits and routines are not implemented to encourage a digital culture and co-create online pedagogical content.

“We go into all kinds of subjects, and we have a lot of interesting things to say, but we do not take the time to promote what we do, so people do not know” -PI2

“There are no work habits where we systematically say to [name of a colleague], here, I'm going to [name a place in the park], do you need a picture? We do not do that. We do not share enough of our daily life, our timetable so that she can say: [Name of a colleague] is going to go to a school in such and such a sector, well it might be interesting to do a little post on the hedge that the kids are going to plant because they're landscaping a corner of the school.” -PI8 -[quote edited to preserve the anonymity of the participant]

A paradigm shift in education strategy: from on-site- only to online education

Despite the lack of intra-organisational collaboration described above, Participant 9's organisation acknowledges the need for profound structural changes for implementing the DIEL strategy on social media. These changes were formalised by Participant 13's organisation, which incorporates the valorisation of conservation work on social media as an essential part of their employees' missions. These two examples illustrate a paradigm shift in education strategy in PNAs from on-site- education only to extending these missions online.

" In four years, I've already seen a real appropriation of the subjects by the employees, so yes, I think that everyone is becoming very aware of the need to be on these channels and to be more there, and we are in the process of having an increaser online presence." –PI9

"In our internal organisation, we have what we call roadmaps, which means that each year, each agent has very precise objectives, with a certain number of days allocated to him or her to fulfil the missions that are set for him or her, and in the missions that are set for our colleagues in the field, there are a certain number of objectives linked to communication, and there is a line called social media on which we define a number of days allocated to each person to supply us with information for the department."-PI13

To facilitate the integration of social media across their organisation, PNAs might consider introducing unlearning processes (Tsang & Zahra, 2008; Wang et al., 2019), allowing them to replace old habits, beliefs and mental models with new ones and to overcome the temptation to hold with the status quo of conventional communication and education (Appelbaum et al., 1998; Cegarra-Navarro et al., 2021; Schillewaert et al., 2005; Varenne & Godé, 2021).

6.2.2 DIEL: from opposition to digital enthusiasm

The results of the interview data analysis align with previous studies exploring the perception of social media in heritage organisations, in government or public bodies, showing that the perception of social media by PNAs' employees can range from very negative to very positive (Booth et al., 2019; De Graaf & Meijer, 2019; Dekker et al., 2020). Therefore, this section focuses on the causes of the participant's positive and negative perceptions of social media and their impacts on the DIEL strategies of their organisations.

The positive perception of social media for educational purposes

As shown in Table 33, 13 participants mentioned positive aspects of social media. 4 of them consider them critical for achieving their missions. In addition, 5 interviewees give enthusiastic statements regarding the potential opportunities social media offers them and their organisation.

"Yes, for me, yes today, and I do not see how we couldn't finally miss out on some of these supports." –PI13

"But in any case, the tool itself. Facebook is still pretty magical." -PI10

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5 participants consider social media as an essential source of information for specific audiences.

" It is really important, and it is an important source of information for people who are less and less likely to see the news magazines and so on." - PI2

Finally, 8 interviewees consider social media as a useful tool to fulfil their education and conservation missions.

"The feedback is very positive on this; there is a lot of sharing too, for example, [...] That is to say that today, the social network allows, indeed, to inform, allows to exchange." –PI12

Table 33 Results of the qualitative content analysis of the data collected in the interviews related to positive perceptions of social media

Main categories	Sub- categories level 1	Sub-categories level 3	*Nb of transcripts coded / Nb of references*
Participant perception of digital tool	Positive perception	Necessary/critical	*4/9*
		Useful for the realisation of their mission	*8/11*
		New. way of communication/source of information	*5/7*
		Enthusiasm	*5/20*

In the cases described above, the participants share the same characteristics as the 'social media optimists' identified by Booth (2019) in his study among museum leaders, who are social media enthusiasts and see it as a beneficial tool for their organisations.

The negative perception of social media for educational purposes

In contrast with the previous results, 8 participants also mentioned the reasons for their negative perception of social media (see Table 34).

Table 34 Results of the qualitative content analysis of the data collected in the interviews related to negative perceptions of social media

Main categories	Sub- categories level 1	Sub-categories level 3	*Nb of transcripts coded / Nb of references*
Participant perception of digital tool	Negative perception	Lack of efficacity and impact assessment	*4/13*
		Multiplicity and complexity of the platform ecosystem	*2/7*

For example, Participant 9 issues a caution regarding the consequences of employing social media as a novel communication medium. According to them, the indiscriminate adoption of various new digital tools could lead to the depletion of organisational resources and reduce communication effectiveness. In such cases, participants share the same characteristics as the 'resources stressed leaders' identified by Booth (2019) in his study among museum leaders, who may not perceive the benefit of social media for their organisations.

> *"And so the parallel with Don Quixote is not totally wrong, that is to say, by wanting to do so many things and reach everyone, do we manage to be effective and this pragmatic side of rationalising our actions in relation to the means we have. It is not easy to do, and sometimes we get lost, sometimes we cannot refocus."-PI9*

Also, 4 interviewees mention the lack of efficacity and impact assessment of social media. These interviewees deplore that while allocating time and resources to the management of their organisation's social media, they cannot measure its effectiveness in terms of reach and dissemination of their message.

> *" Knowing that we have many other missions, we asked ourselves, is this it? What is the impact? That's really something we do not know." –PI7*

Finally, Participant 7 considers that usual Key Performance Indicators (hereafter KPI) to assess social media strategies may be less relevant for PNAs as they are not in the framework of a commercial relationship with their visitors. Therefore, KPIs such as sales revenue increases or the number of likes are irrelevant to PNAs.

"But seeing that, we're not in a sales goal and profitability. I think the line is there." -PI7

According to Iannacci et al. (2021), the perception of the lack of efficacity of social media can have a negative impact on post-adoption decisions and acceptance by the employees of PNAs and management. Therefore, their management should set up indicators and tools that allow them and their employees to assess the efficacity of their social media practices to increase their continuous acceptance level across the organisation.

The "pressure" to exist on social media

What are the driving forces behind the digital transition of PNAs, despite the negative perceptions mentioned above and the absence of a mandate for the use of social media within their networks and federations? The data analysis of interview transcripts shows that the societal pressure for an organisation to "exist" on social media is strong. These results align with the literature that shows that external stakeholders' pressure may drive the adoption of ICTs in organisations (Nah & Saxton, 2013; Zorn et al., 2011).

For example, participant 4 expresses a social constraint and obligation to use social media.

"So I think that generally speaking, our members, our members, our leaders would not understand that we are not using these tools to make ourselves known. So we considered continuing" -PI14

"Yes, of course, even so, we all become somewhat constrained. It is a social demand; it is a societal obligation" -PI4

Moreover, Participant 12 states that not engaging in the digital transition could be considered professional misconduct.

"I'm saying today that we're almost at professional misconduct [not using social media], um, it is because I do not like it personally in my job, the means of communication have evolved, I have to, um, evolve with them and we feel that there is a delay."-PI12

Finally, participant 9 expresses the potential fluidity of individuals' perceptions from negative to neutral, allowing for more PNA employees' engagement with DIEL online strategies.

> *"There are people, it is better now, but at first, there were people who hated Facebook who did not want to hear about it; well, it is much better now." -PI9*

6.2.3 DIEL on social media: from experimentation to institutionalisation

The analysis of the interview data shows that the participants' organisations reached different stages of digital maturity. This section focuses on exploring the extent of the institutionalisation of DIEL practices in the participants' organisations.

Experimentation on social media and the emergence of intrapreneurs

As seen in Table 35, during the interviews, 4 participants stated that an employee or volunteer had created a social media account on their own initiative for their organisation.

> *"We also have pages on some natural sites, so that is ultimately up to our volunteers. Some volunteers have wanted to create pages they administer themselves." - PI14.*

In this instance, the employees from 5 PNAs represented in the interviews compensate for the lack of resources allocated to DIEL by taking on a social media account in addition to their primary tasks.

Table 35 Results of the qualitative content analysis of the data collected in the interviews related to intrapreneurs in their organisation

Main categories	Sub- categories level 1	Sub-categories level 2	Sub-categories level 3	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Governance	Organisation	Intrapreneurs	*5/20*

For example, participant 8 is not in charge of communication, but his passion for photography led him to create an Instagram account for his organisation.

"Well, [I created an Instagram] first of all because I'm basically a photo enthusiast, so it suits me too to take over a social media where you can mainly post and showcase visuals." – PI8

This experimental, "crafty", and "voluntary" management of the PNAs' social media accounts by their employees and volunteers demonstrates their awareness of the requirement to "exist" online. Furthermore, by taking ownership of the implementation of the social media account, these employees and volunteers become agents of change in their organisation (Hall, 2014b).

These results align with Mergel's (2016) study, which shows that the lack of routinisation and formalisation of social media activities in the US government leaves room for intrapreneurial experimentation on social media. Also, these results align with research that shows that the implementation of social media in the organisation can "clash" with the current communication practices and routines (Picazo-Vela et al., 2016). Finally, these results show that individual willingness for change can trigger organisational changes.

The intrapreneurs described above can be the catalysts for bottom-up initiatives enabling change in routine at the organisational level and can trigger a change in collective routine (Wang et al., 2019). From a resource perspective, It can also support the online presence of PNAs on one or more social media platforms without additional structural cost. From a content creation perspective, it allows for qualitative input from field employees who become producers of the information disseminated on social media.

"If I take the example of the nature reserve pages, it is the local teams that run the pages, in coordination with me, but they take charge of a large part of the animation of the pages because the idea is that being, well, locally present, they can be reactive, take photos, etc." -PI9

These results align with Booth et al.'s findings that show that using social media requires "a managerial receptiveness to experimentation, a capacity to drive change for the long term" (Booth et al., 2019, p. 387). Therefore, the management of PNAs should create an environment allowing their agents to experiment on social media.

The emergence of intrapreneurs and the need for formalisation and guidelines

The results described above confirm the one found in the questionnaire, showing that functional and process organisations are both implemented in PNAS for managing their DIEL strategy (see section 5.2.1 and Table 36).

Table 36 Results of the qualitative content analysis of the data collected in the interviews related to functional and process organisations

Main categories	Sub- categories level 1	Sub-categories level 2	Sub-categories level 3	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Governance	Organisation	Functional organisation	*7/25*
			Process organisation	*5/14*

The analysis of the interview transcripts reveals that the use of process organisation in participants' organisations can occur when employees or volunteers take ownership of their organisation's social media account. However, voluntary participation by employees and volunteers who are not experts in social media or communication does not guarantee the regularity of online posting or the consistency of the editorial line. The data analysis gives empirical evidence that the emergence of intrapreneurs in PNAs represented in the interviews has led them to set up editorial guides and moderation charters to clarify the copyright on photos taken by staff members. In these cases, the adverse effects of the dilution of redactional power in the hands of a multitude of actors are countered by PNAs via the formalisation of the digital external communication processes and the development of "netiquette" and editorial guidelines.

"We have set up a moderation charter." -PI10

"They have the right to use the photos taken during their working time on a personal basis. So, the photos taken during their working hours must be sent to the photo library, but they can keep a certain number of photos for personal use. So that's the deal we've put in place." -PI13

"A small editorial guide, which gives indications on what type of publication, what is shared, what is not shared, how things are done, to help those whose job it is not to carry out the animation of the pages."-PI9

However, Participant 12 stresses that it can be challenging for PNAs' organisations to experiment in the communication domain because of the potential negative impact on their

reputation. Similarly, in their study, Dekker et al. (2020) found that reputational risk is a major barrier to using social media by the Dutch police.

> *"Well, I'm experimenting. But it is true that on social media, it is communication, the image. It is more difficult to let go. To let the unknown happen and to say, "Well, how are you going to react to the unknown and who is allowed to react?" because we're talking about communication, about images, and the elected representatives scrutinise us."-PI12*

6.2.4 DIEL on social media and alignment with individual and organisational values

During the interviews, 11 participants highlighted a potential misalignment between the use of social media and their values or those of their organisation (see Table 37). This section focuses on the sources of these misalignments and their impacts on the DIEL strategy of the participants' organisations.

Table 37 Results of the qualitative content analysis of the data collected in the interviews related to the causes for the misalignment between the use of social media and the values of the PNAs and those of their employees

Main categories	Sub- categories level 1	Sub-categories level 2	Sub-categories level 3	Sub-categories level 4	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Governance	Digital Mindset and culture	Causes for the misalignment of the use of social media with the organisation or interviewee's value	Digital divide	*3/5*
				Lack of digital sobriety and environmental footprint	*8/32*
				Generation divide	*2/4*
				The social footprint of social media	*4/12*

Social media: source of identity and values tensions

To examine the potential impact of values tension on the DIEL strategies of the PNAs represented in the study, the statements of the 11 participants that mention a misalignment between the use of social media and their values or those of their organisation were cross-tabled with the statements coded as a potential challenge to the adoption of DIEL and the visitors' IEL. This crosstabulation was carried out using the matrix crossing queries Nvivo tools. This analysis reveals that 5 participants consider this incompatibility between social media and their value a barrier to implementing an online digital strategy for education (see Table 38).

Table 38 Results of the qualitative content analysis of the data collected during the interviews concerning the challenge of value tensions for the adoption of the DIEL strategies and IEL process

	Number of interview transcripts mentioning a challenge to the adoption of DIEL	Number of interview transcripts mentioning a challenge to the IEL of the visitors
Digital divide	1	0
Lack of digital sobriety and environmental footprint	4	0
Generation divide	1	0
The social footprint of social media	2	1

The first type of misalignment mentioned by the interviewees is related to social media and their social footprint. Indeed, 2 participants considered that social media's social footprint and economic model are incompatible with the missions of PNAs.

"I do not think that the social model of social media is compatible with the very objectives of a regional nature park. If we put forward the ideas of sustainable development, the model of social networks does not correspond to the model of sustainable development both in its treatment of the social and the economic and the environmental."-PI6

"All the while being aware that by developing social media, we're going against this behavioural change. So that's the first paradox. It is the first part of the answer; therefore, we also need to educate people about social media so that we can use them for other educational purposes, eco-citizenship and so on."- PI5

Moreover, Participant PI10 questions the relevance of social media and highlights the latest decision of brands such as "LUSH" to remove themselves from Instagram, Facebook, TikTok and Snapchat until it is safer for their clients' mental health (BBC, 2021). These data show that PNAs are not spared from the questioning related to their responsibilities regarding the consequences of the use of social media by their followers/visitors.

"*Well, that's what I was talking about when I told you that I had taken a step back from all that [social media]. And it is a step back that I'm really starting to take more and more, that many committed brands and structures are also taking. I have the impression that it is clearly a phenomenon that is on the rise [...] I saw that the cosmetics brand Lush had completely abandoned its presence on social media. – PI10 – [some transcription details have been omitted in the interest of readability]*

In addition to the social impact of social media, 4 participants consider its environmental impact as well.

"Yeah, it is a very broad subject because when you say social networks, you say data centres. By definition, well, in a very practical way, using social networks also means keeping in mind that, behind all these mechanisms, there are data centres that consume energy. So, how do you use social media to promote environmental responsibility?" -PI5

The second type of misalignment is related to how the use of social media fits in the current social context of PNAs. Indeed, 3 participants are concerned about the digital divide that the inequality of access to an efficient internet network on the French territory may imply. More specifically, Participant 5 highlights that using digital tools can be divisive for the older part of the population, which can be less digitally literate than the younger people (Eurostat, 2023). These concerns are particularly relevant as PNAs are mostly situated in ageing and remote areas of France.

"To put it another way, the fibre has not arrived everywhere, far from it. Territories that are sometimes ageing. So, the use of social media? Uh, it can also be divisive."-PI5

PNAs' reactions to value and identity tensions

The interview data analysis reveals that the participants' organisations have created various strategies to handle the potential causes of misalignment, such as :

- **Technical adaptation**: Participant 12 mentions that to mitigate the environmental footprint of their social media use, their organisation engaged in a digital sobriety strategy from a technical perspective.

"So we are already integrating that: we are vigilant in the choice of servers. " -PI12

- **Strategy adaptation**: Participant 1 mentions that to mitigate the environmental footprint of their social media use, their organisation engaged in a digital sobriety strategy from a communication strategy perspective.

"We haven't really focused our content production strategy on video, quite simply because in terms of the digital sobriety of ECO designs for our web media, for example, on a website, a video takes up a lot of resources. " – PI1

- **Bargaining:** The organisation of Participant 14 tackles the issue of value misalignment with social media use by weighing their social and environmental footprint against the potential value of using them to promote environmentally responsible behaviour and lifestyle.

"However, I think that today, for a structure like ours which is not very well known, which needs to make itself known, the challenge of making itself known is greater than the problems linked to the image of Facebook. "- PI14

- **Complementarity**: Participant 12 stresses that any means of communication is intrinsically exclusionary. In this context, the use of social media should be regarded as a complement to traditional communication channels, allowing for the inclusion of additional audiences.

"So that's why, in order to be as non-exclusive as possible, knowing that if we are only digital, we will exclude some people because a non-exclusionary solution does not exist." PI12

- **Not engaging:** Participant 14 acknowledges social media's environmental and social impact. However, they did not perceive the ascribed responsibility to engage with the subject on their own. These results reveal that in the case of Participant 14, no reflection on social media impact was carried out at the management level.

"[talking about the use of Facebook] Yeah, well, I asked myself the question, although I would not have decided on my own if we have to continue [to use it] "-PI14

The above findings reveal that implementing a DIEL strategy can be a source of identity tensions for PNAs when their values are contradicted by the requirement to use social media to realise their missions (Smith & Lewis, 2011). They indicate that the misalignment of values with the organisations' mission was considered a barrier to the use of social media. These results align with Dekker et al.'s study (2020) that showed that adopting social media in a Dutch Police led to a conflict with the police values. They also align with the study of Booth et al. (2019), revealing that museum leaders perceive social media as conflicting with museum values. Moreover, Wang et al. (2019) argue that bottom-up changes processes, such as the intrapreneurs' willingness to experiment with social media described in the previous section 6.2.3, can generate tensions between intrapreneurs' beliefs and enthusiasm for social media and the rest of the employees or their organisation's cognition.

Therefore, the researcher concurs with Meijer's (2015) conclusion, contending that the misalignment of value in a public organisation could be remedied by presenting the use of social media as desirable to its employees and emphasising that its adoption is not a goal in and of itself but a means to potentially provide additional public and educational value.

6.2.5 DIEL on social media and lack of resources

This section examines the impact of a lack of available internal and external resources on the strategies of the PNAs represented in the interviews.

A lack of resources hindering the implementation of DIEL strategies

The results of the data analysis of the transcripts align with the questionnaire's findings, revealing resource-related challenges within the participants' organisations (see section 5.2.3). Indeed, 13 out of 15 interviewees reported a challenging increase in communication officers' workload.

"I feel a lot of burnt out at the level of managers, communication officers".

-PI2

The interviewees' coded statements related to a lack of resources or skills in their organisation were cross-tabled with statements related to potential challenges in adopting a DIEL strategy and visitors' IEL process. This crosstabulation was carried out using the matrix crossing queries Nvivo tools (see Table 39).

Table 39 Number of interview transcripts mentioning the lack of resources as a challenge to the adoption of DIEL and the IEL of visitors

	Lack of digital skills *(Nb of transcripts coded / Nb of references*	Lack of resources/time *(Nb of transcripts coded / Nb of references*
Statements mentioning the lack of resources as a challenge to the adoption of DIEL	3/13	8/13
Statements mentioning the lack of resources as a challenge to the IEL of visitors	0/13	2/13

These results reveal that the participants' digital strategy and the visitors' IEL may be hampered by a lack of material, human, or technical resources and social media expertise and capability of their organisations. They align with Yeow's study (2018), highlighting that the lack of resources can jeopardise the digital strategy of organisations.

The data analysis gives insight into the causes of this lack of allocation of resources.

Mission prioritisation

Six respondents stress that financial resources are allocated to missions that are given priority over communication, such as conservation efforts.

"I think that it is really a story of conservation first because the area is immense, and so there are necessary means that are financially committed to it and that the mediation and communication side has really been relegated to second place." -PI7

"And it is true when you have many, many things to manage. Finally, teams in general, communication, I think, is not always the priority." -PI9

Moreover, interviewee 12 points out that communication and culture domains may be the first to be impacted during budget restrictions.

"But we are, in fact, in a domain where the first savings are made on two things: communication and culture. These are two things that everyone says are essential. You cannot touch that. But if there is a time when we have to make savings, it is these two." -PI12

Challenges in raising external funding

Interviewees 2, 9 and 12 point out that the lack of consideration of the communication work is found within the organisation and their stakeholders' ecosystems. Indeed, PNAs can be partly financed by stakeholders via partnerships and donations. However, the flow of funding

is primarily focused on highly innovative projects, like the development of mobile applications or collaborative platforms or traditional forms of communication such as magazines and printed guides.

> *"Often, with funders, we are asked to produce something concrete that can be used to raise awareness among the general public. So it often ends up being a paper guide." -PI2*

> *"It is not necessarily easy to convince them [funders/donators] to support posts which are traditionally associated with the running of a structure. So we would like to strengthen the communication department if we have the means. But in fact, we cannot manage to do it for the moment. We cannot finance it."- PI9*

Therefore, funding the reinforcement of the communication team or facilitating support for essential structural operating expenses through partnerships seems to pose a challenge.

Key points presented in this section

The analysis findings reveal that PNAs encounter both structural and cultural challenges in the process of their digital transition.

To overcome them, fostering a digital mindset across their organisation is critical for PNAs. The results show that it would improve employees' technology acceptance, encourage digital experimentation and avoid organisational identity tensions. Furthermore, a cultural shift is also essential within their broader economic ecosystem as it could better channel internal and external funding toward their DIEL strategy.

6.3 The informational function of social media

This section focuses on the interviewees' practices in using the informational function of social media for educational purposes. Section 6.3.1 provides evidence of the positive outcomes of informal environmental learning of visitors on social media and structural differences between PNAs in their approach to online environmental content dissemination. Section 6.3.2 shows that PNAs employ various communication strategies for their DIEL social media strategy, ranging from institutional messaging to social marketing tactics. Finally, section 6.3.3 reveals that the use of the informational function of social media can be a source of complexity and lead to performing paradoxes.

6.3.1 Eco-literacy and positive learning on social media

As shown in Table 40, the data analysis confirms that PNAs use social media to support the eco-literacy of their visitors and social media users, as hypothesised based on the questionnaire findings and the literature (see section 5.3.1). This section focuses on the positive outcomes of using social media for educational purposes.

Table 40 Results of the qualitative content analysis of the data collected in the interviews related to eco-literacy

Main categories	Sub- categories level 1	*Nb of transcripts coded / Nb of references*
Eco-literacy	Attitude	11/23
	Environmental knowledge	11/47
	PEBs	11/51
	Skills	7/19

Different approaches to eco-literacy: from narrow to broad eco-literacy

Indeed, all PNAs represented in the interviews with social media accounts mentioned having addressed at least two of the four components of eco-literacy on their social media, i.e. Attitude, Environmental knowledge, PEB and skills (see Table 41).

Table 41 Numbers of eco-literacy components addressed in the interviewees' DIEL strategy on social media

Number of eco-literacy components addressed	1 component	2 components	3 components	4 components
Numbers of interviewees	0	3	3	7

In line with the questionnaire findings, the analysis of the interviews shows that the PNAs represented in the interviews focus on disseminating environmental knowledge, reminding visitors of the expected PEBs and anchoring attitude rather than providing the visitors with the skills to exploit their environmental knowledge (see section 5.3.1).

In addition, as shown in Table 42, the in-depth data analysis of the transcripts reveals a differentiation in the scope of the aspects of eco-literacy covered on their social media by the interviewees from "Narrow" to "Broad". During the coding process, the researcher defined the narrow eco-literacy scope as the information about the four components of eco-literacy that are directly related to the completion of the PNAs' missions, their regulation and operations. Whereas the broad scope of eco-literacy has been defined as a holistic approach of IEL covering aspects of eco-literacy that are not directly related to the PNAs, such as promoting eco-behaviours outside the PNAs, carpooling, gardening, recycling, etc.

Table 42 Number of interviewees that cover a narrow or broad scope of eco-literacy in their social media external communications

	*Number of protected areas covering a **Narrow** scope of eco-literacy*	*Number of protected areas covering a **Broad** scope of eco-literacy*
Nature Reserves	6	2
Regional Nature Parks	4	4
National Parks	1	1
Federations	0	2

The data analysis reveals that the 4 Nature Reserves represented in the interviews cover a limited scope of eco-literacy. Participant 9bis explains that the choice of covering a narrow eco-literacy is part of a clear DIEL strategy set by the communication team to delimitate the scope of digital intervention of their organisation to its core missions.

"This is what [the communication team] asked us to do so that our messages come first, that is, biodiversity and climate before anything else." -PI9bis – [quote edited to protect the anonymity of the participant]

These results can be explained by the fact that the missions of Nature Reserves are specifically focused on the conservation and protection of the biodiversity of their site. This expertise is translated into their external communication that tends to focus on biodiversity issues rather than individual behaviours and broader concepts such as climate change.

"Anyway, we deliver a message that is really quite limited in terms of good practices." -PI14

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2 Nature Reserves and all National and Regional Nature Parks mention covering both narrow and broad scopes of eco-literacy on their social media. Participant 13 explains that their organisation's strategy is to diversify the DIEL content on social media to be more attractive to its audience.

"For us, in our policy today to have this panel of posts and that we are not only on the natural heritage, therefore we are going to keep this very strong base on the beautiful and the naturalist that we are going to supplement even more than what we did today."- PI13

These results can also be explained by the fact that National and Regional parks are inhabited areas, and their audience comprises visitors, local communities, and stakeholders. Therefore, these organisations may be motivated to increase their inhabitants' broad eco-literacy to lessen their environmental impact and participate in conservation efforts.

"For example, we have just produced a guide on light pollution to prevent people from consuming electricity at night, turning off visible electricity at night, etc." – PI2

Finally, the two participants, members of Federations of PNAs, mention focusing on broad eco-literacy and not addressing narrow-eco-literacy. These results can be explained by the fact that the federations are not interested in the characteristics of a specific territory but rather in the general concepts that shape the rationale for the existence of the PNAs they represent.

"Territorial education also means accompanying the inhabitants to a re-connection with nature and its environment, with the awareness that we are part of a whole and that what surrounds us is not only a resource."– PI5

The positive impact of DIEL on visitors' eco-literacy and behaviours

Participant 3 reports receiving from the field that the information disseminated on social media by their organisation reached the visitors.

"But we still have relatively frequent exchanges with people who have said yes; I saw that on your Facebook page." – PI3

More precisely, the interview analysis shows evidence that disseminating social media content supporting the eco-literacy of the PNAs' visitors has led to positive learning outcomes. For example, participant 11 perceives social media as a tool allowing for anchoring green consciousness and ethical belief in social media users. Participant 14 states that users absorb the environmental knowledge disseminated on social media. Participant 2 stresses that by being present on social media, PNAs can gain visibility and legitimacy among social media users and become a warranted source of information. Finally, Participant 6 believes their environmental education effort has positively affected visitors' ecological behaviour.

"I think it is that it is a way of passing on information in an educational way, so indirectly, the information also has to get into the minds of people who go through our social media." – PI4

"And it is good that they [the social media users/visitors] think of us [to ask questions]."-PI2

"because people do not know that they live on an exceptional territory or its proximity, there is a lot of work to be done on legitimacy, and, as a result, that is what I am working on." -PI2

"We have succeeded in getting the message across about not leaving waste, not making fires, not driving in protected areas, and not driving in motor vehicles in protected areas. Now, we can go a little further and explain to people why dogs should be kept on a leash, at least. Why avoid night activities, et cetera et cetera?" -PI6

These findings align with the recent studies that demonstrated a positive impact of social media on social media users' environmental awareness and PEBs (Arts et al., 2022; Mallick & Bajpai, 2019; Shah et al., 2021; Xie & Madni, 2023).

6.3.2 DIEL on social media: From institutional messages to social marketing

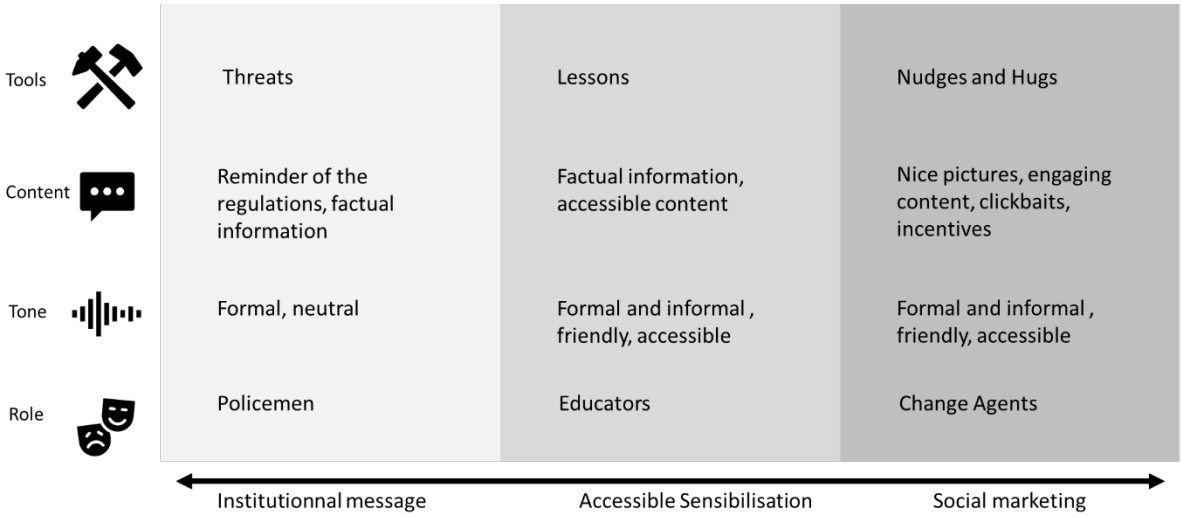
As shown in Table 43, the analysis of the interviews reveals that the participants approach their DIEL strategy in 3 different ways.

Table 43 Results of the qualitative content analysis of the data collected in the interviews related to their communication style on social media

Main categories	*Subcategories level 1*	*Sub-categorieslevel 2*	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Communication style	**Institutional message**	*5/18*
		Accessible sensibilisation	*7/34*
		Social marketing	*5/10*

The data analysis allowed to consider the tools, the type of content and the tone used by the interview participants for each of the 3 strategies. Based on these characteristics, a purpose and role for each strategy have been inferred. (A summary of the analytical work is presented in Figure 12).

Figure 12 Variety and characteristics of communication strategies used by respondents DIEL strategy on social media. (source: the researcher adapted from Hall 2014)



This section describes these strategies that can be positioned on a spectrum from using social media to disseminate institutional and educational messages to visitors to using marketing methods and calls for action.

Institutional messages

The institutional message communication strategy aims to promote the PEB of the visitors by waving the threat of a sanction. It typically relies on disseminating neutral and factual information to the visitor. For example, participant 3 mentions having implemented a communication strategy based on institutional messages reminding visitors of the regulations and potential consequences for any violations. Also, participant 14 stresses the importance of maintaining an institutional tone in their external communication.

"We have already fined mountain guide, and then we communicate about it on our Facebook page; for example, even if we often get negative comments, we do not hesitate to put forward messages when we come across something really abnormal or infringements, of course, without mentioning the people or without going into detail, but often, we highlight the operations that we do and that have led to sanctions on our part. We intervene so that people know that one cannot do what one wants." –PI3.

"So in this respect, we have a discourse that is very polished, that rarely points fingers, that is more descriptive, factual." – PI14

As participants 3 and 14 represent Nature Reserves, they may be inclined to focus on the strict respect of environmental regulations by the visitors. In contrast, participants 9 and 9bis acknowledge that there is a balance to be found between reminders of the law and more positive content in Nature Reserves' DIEL strategy.

"We also try to find a balance between communicating on the regulations, i.e., prohibitions, which are not very trendy in today's communication. So we focus more on positive things, but there is still a balance to find. So here we are, trying to navigate as best we can. "- PI9

Accessible sensibilisation

The institutional tone used online on social media by some PNAs is regarded as ineffective by participant 2. Instead, they consider social media a medium to address users in a friendly and accessible tone. Participant 10 confirms that this approach requires Participant 10 confirms that this approach requires informally addressing their social user.

"It is clear that when I see parks doing very institutional things that say, I do not know, let's meet tomorrow for the union committee at 8.30 pm, it is pointless, and nobody cares, actually. And there are plenty of parks for which you get the feeling that social networks, come on, they're not into it"-PI2

"We will say afterwards on Facebook, depending on the publications that I put online, sometimes I have a little bit of connivance in saying little ideas" –PI10

Participant 13 also notes that they edit the content of the information they provide online to ensure it is accessible to everyone. This simplification of content is achieved through the synthesis of information and the use of iconography.

"We are real scientists; even if we simplify our contents, we tend to always give a lot, a lot, a lot of content, and here we lighten the load by highlighting the iconography."-PI13

Another tactic used by Participant 7 involves looking for a supportive and positive alternative to the disciplinarian and commanding formulations found in institutional content. In that case,

the participant focuses on positive actions and PEBs that the visitors can display. The aim of an accessible communication style in a DIEL strategy online is to avoid the moralistic feels of the educational content to appear more accessible and engaging to social media users.

"The colleague had started to write, she had put: "It is forbidden to walk on the dunes". And I think I reworded it by changing the word, forbidden; I do not know what I put, but in such a way that you do not see the prohibition in a big way, like for example: "We must protect the species by not walking on it". –PI7

"So for the general public, we are more on a tone, on a benevolent tone. We will try not to be. We are not going to play the policeman." -PI10

"But trying, trying to do it in a way that is fairly implicit and not directive or moralistic."-PI4

"For Instagram, it is different, I {je tutoies les gens} [French for addressing the user in an informal way using the informal version of the pronoun "tu" rather than the formal version "vous"], I'm going to engage with them with all the stickers that are available on the stories. I do a lot of stories, in fact, more than on Facebook, with a lot of votes, things that are a little more live, so I am trying to make it a little easier to read. I am trying to put myself in the place of someone who is putting in a story, I do not want to read the boring stuff with a lot of text, etc." -PI2

Social marketing

The use of commercial tools to encourage social and behavioural change is called social marketing (Hall, 2014a). 6 participants mention using practices on social media, such as clickbait, demarketing or the creation of storytelling to promote the PEB of their visitors. In doing so, they act as change agents aiming for their visitors' behaviour to change.

"You need to have a bit of a storytelling axis, tell more about the values, etc. "-PI4.

"I try to do a lot on the first Story; I try to make clickbait that makes you want to go and see the 2nd Story, the 2nd Slide, so I always know a little about my first one to lure you into watching the next one." -PI2

"It is all very well, and I am going to shock you by saying this, but social networks can easily allow a kind of manipulation in the end because we also have something to sell, don't we? We should not lie to ourselves; we claim to know what is good for the planet. We want people to follow what we think is good, and for that, we have to convince them. So are we, are we always honest or not? Are we using communication tools beyond marketing? I think we have to." -PI12

"[talking about over-frequentation of Protected areas and the protection of specific species of animals] Well, we are campaigning and disseminating the information that you really should not go there" -PI14 [quote edited to protect the anonymity of the participant]

"And then I think that there is something that is very important, it is to give the feeling that you can do something in relation to the major crises that we are talking about today, climate change, the biodiversity crisis, we have many people who feel helpless. Showing them that, at their level, they have very simple things that can be put in place and that are effective, but that we do not necessarily see the results immediately, is something important, in my opinion, to try to involve people in something big that is beyond us all." -PI9

Participant 9 gives evidence that using different DIEL strategies in conjunction with each other may be required to achieve different objectives simultaneously, such as engaging the public and disseminating institutional information.

"We also try to find a balance between communicating on the regulations, i.e., prohibitions, which is not very trendy in today's communication. We tend to focus on positive things, but there is still a delicate balance to be found."-PI9

The positioning of PNAs within the spectrum of the DIEL strategy (see Figure 12) underscores the nuances in their interpretation of the societal role assigned to them and their governing regulations. PNAs face the challenge of delineating their scope of intervention and identity as they formulate their DIEL strategy, spanning from being mere conveyors of information to actively propelling transformative shifts. However, this decision-making process can be intricate, as evidenced by the participant in questionnaire PQ6, who calls for greater clarity regarding the mission entrusted to regional nature parks by the regulations.

"The various missions given by the law to regional nature parks should be examined in greater depth" –PQ6

6.3.3 The paradox of environmental awareness versus environmental protection

The interview analysis reveals that the implementation of a DIEL strategy in PNAs can be a source of complexity and lead to performing paradoxes when the members of the organisation have to perform contradictory roles and activities (Jarzabkowski et al., 2013; Smith & Lewis, 2011). Therefore, this section focuses on describing the paradoxical challenges the participants face and their impact on their organisations' DIEL strategies.

Performing paradoxes due to the use of social media

As seen in section 6.3.1, the PNAs' DIEL strategy implies communicating about the park and reserves' environmental characteristics and valorising the conservation/protection. It also entails highlighting the environmental heritage of the PNAs and what makes them unique. However, raising awareness about fragile ecosystems can lead to a surge in the public interest, which, paradoxically, puts these ecosystems at risk due to increased visitation. Indeed, it has been shown that the rise in interest in natural features or species generated by social media messages can have negative effects for them, often due to a significant increase in visitation posing a potential threat to ecosystems and their sustainability. Figure 13 show an example of a press article related to National Park overfrequentation due to an Instagram-related interest by visitors in Utha (USA) in 2019. Another example is provided by Figure 14 which depicts individuals in the south of France trampling through a sunflower field to take photos partaking in a social media trend related to sunflowers on Instagram in 2023.

Figure 13: Press article related National Park overfrequentation due to an Instagram-related interest by visitors in Utha (Hegyi, 2019)

Figure 14: Individuals trampling through a sunflower field to participate to an Instagram trend. (Picture from: De Mathieu, 2023)

The data analysis demonstrates that 13 participants mention facing performing paradoxes as they need to communicate to enhance visitor eco-literacy and awareness while safeguarding the ecosystem from potential over-interest or excessive visitation. This delicate balance requires careful management to maintain sustainable tourism and conservation efforts.

"So effectively, we're getting into this issue of: "come and see us but do not have too many"."-PI10

"We also have real questions about the use of our sites. We are in natural areas which are extremely sensitive and which can be attraction and point of interest. In the department, many people want to go there for the beauty of the landscapes, for the places, and so on. And today, social media can also be a big source of disturbance, so we are very careful not to launch photo contests. And you, what is your most beautiful picture of such and such a place so as not to feed that in fact*"-PI9*

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illustrating Sharma & Bansal's (2017) argument that "juxtaposing opposing elements of a paradox can create anxiety and elicit defensiveness" (p. 343), participant 11 mentions their difficulty balancing the two elements of the paradox.

"[talking about their reaction to the tensions perceived between the promotion of heritage and its protection] It is hard, it is hard, it is hard, there is nothing harder than that." -PI1

Strategies implemented to mitigate paradoxical tensions

To mitigate these paradoxical tensions, the participants adopt various strategies to maintain the "appearance of order" (Lewis, 2000). Indeed, the analysis results show that the participants overcome the anxiety of contradictions by engaging in paradoxes.

"At first, it seemed to me.
It seemed a bit of a dichotomy to me to act on the 2 sides [talking about their reaction to the tensions perceived between the promotion of heritage and its protection]. But given the type of tourism promotion that we advocate in the park; it is not tourism; it is sustainable tourism with itinerancy, with cycle tourism, with the development of local actors. So that does not seem to me to be opposed, but rather complementary."-PI4

However, the interviews reveal that while engaging with the paradoxes, 4 participants used avoidance strategies such as rationalised hiding of environmental knowledge. For example, these participants deliberately downplayed or obscured the existence of certain animal or plant species within their designated PNA. Such actions aimed to mitigate the impact of heightened public interest on sensitive ecosystems, as they sought to limit the potential pressure on these delicate ecological environments. In these cases, the negative interdependence between communication and conservation (Strik et al., 2021) perceived by the participants led to their intentional withholding of environmental knowledge (Anand et al., 2021).

"We really have objectives in certain sites, to reduce the number of visitors, almost to make people forget the existence of these sites in order to meet the conservation objectives that we have."-PI6

"There are often constraints that we impose on ourselves. When we show beautiful species, we do not mention the places; that is to say, we do not necessarily say on which site it can be found; it can be picked, but depending on the sensitivity of the species, we do not specify too much so as not to increase the risk of photographers or pickers, etc."-PI14

In the case of Participant 14, this perception of negative interdependences is reinforced by the external stakeholders:

"I put a publication on the subject of {species of plants}, which are very pretty protected species and which are subject to collection. And when I put this publication, it provoked an immediate outcry by 2 or 3 people saying, "You have to be careful not to talk about it at all; it will encourage people to pick it - you should not talk about it at all.". And it was the first time I had deleted a message from the Facebook page." -PI14 [quote edited to protect the anonymity of the interviewee]

Other participants fully embrace the paradoxical tensions. For example, participant 2 integrates paradoxical elements (Sharma & Bansal, 2017) by considering online educational content and conservation efforts as complementary rather than mutually exclusive or contradictory:

"Our slogan is: "Another life is invented here", so the idea is to reconcile the preservation of the territory and the environment, the natural heritages, the built heritage while developing a human activity and a local economy." PI2

Participant 7 mentions being aware of the potential paradoxical tension regarding the conservation and DIEL missions; however, they did not engage with it at the communication team level. Sharma and Bansal (2017) predict that "when paralysed by the opposing characteristics [of a paradox], actors are either stuck in one or ignore the relative positions of the opposing elements and simply choose one of the two opposing elements" (p. 343). However, the analysis suggests that Participant 7's PNA deals with the paradox by assigning the two components of the paradox (conservation and environmental promotion) to different organisational units. In this particular case, the communication mission seems to be executed separately from the conservation mission and the DIEL strategy may not include conservation objectives. This siloed organisation enables the clarification and acknowledgement of the value and singularity of each paradoxical component (Sharma & Bansal, 2017) while avoiding paradoxical tensions.

"For the moment, in fact, the question has not really been asked concretely yet... I know that we said to ourselves that we have to do it and that we would think about it in the next few years. It is true that for the moment, it is a subject that we have put aside, to be honest."-PI7

The strategies for addressing performance paradoxes outlined in this section mirror the various approaches PNAs adopt in their human-nature relationship, spanning from protection to the conservation of nature. The conservationist approach taken by the nature reserves aims to create nature sanctuaries, which implies avoiding the presence of visitors in nature and/or reducing and controlling the number of visitors. In contrast, the Regional Parks represent a protectionist approach, allowing for the co-existence of nature and humans. National Parks combine these two approaches; their core area is protected, while the rest of the parks is accessible without restrictions.

"I will always try to bring people to nature." -PI2

"Because it is actually forbidden [to enter the reserve], you cannot walk or drive or anything." -PI7

Therefore, Nature Reserves, which are the most regulated PNAs, may find it more challenging to engage in the paradoxical tension between communication and conservation than Regional and National Parks.

Key points presented in this section

The results presented in this section give evidence of the positive impact of IEL via social media on the visitors of PNAs' environmental learning outcomes, thus aligning with the principles of theories such as the theory of planned behaviour.

The results enable the researchers to identify two profiles of PNAs illustrating the scope of their educational mission, ranging from building local and narrow eco-literacy among visitors to fostering a broader and holistic eco-literacy.

Finally, the results show that while setting up their DIEL strategies, PNAs face the challenge of delineating their scope of intervention and identity. The researcher proposes to position these communication strategies on a spectrum from using social media to disseminate institutional messages to using marketing methods and calls for action.

6.4 Relational and Experiential functions of social media to extend the visitors' learning journey?

This section shows that PNAs could extend the visitor's environmental learning journey from on-site to online using social media's relational and experiential functions. However, section 6.4.1 shows that PNAs do not exploit the social media relational function to its full potential, preferring information "push" strategies rather than information "pull" or multi-sided conversation with their visitors. Section 6.4.2 explores a potential explanation for this lack of use of this relational function, i.e., the stakeholders' scrutiny and fear of backlashes. Finally, section 6.4.3 reveals that 12 of the 13 organisations represented in the interviews use social media's experiential function to engage with their audience. Moreover, the results presented in this section reveal "Techno-Biophilia" as a tool for PNAs to recreate a symbiotic relationship between social media users and Nature within cyberspace.

6.4.1 Relational function of social media and community building

After cross-tabulating the interviewees' statements coded as related to the relational function of social media and their statements related to the opportunities for their DIEL strategy, the data analysis shows that 7 participants mention the relational function of social media as an opportunity for their DIEL strategy. Therefore, this section focuses on the participants' use of the relational function of social media for educational purposes.

Use of relational function of social media to personalise educational content

Participant 4 highlights that the social media relational function allows for personalising their online content to meet their visitors' needs. These results suggest that direct and personalised communication with the visitors positively impacts learning outcomes and engagement.

"So when there is a specific request, but no, it is mainly an advantage, and we see the subjects that interest people, and there is really a personalisation of the response." -PI4

"Well, we can respond to the request directly, and this personalisation can have a higher impact because we talk directly with the person who is going to come to the territory." -PI14

Also, the personalisation of communication meets the new expectations of online users in a digitalised society (Pfiffelmann, 2020). Furthermore, participants 2 and 7 suggest that the more an organisation uses social media as a space for dialogue with their visitors, the more the users will consider this organisation a primary and credible source of information. This can be crucial in providing visitors with warranted and accurate information and avoiding negative learning opportunities associated with external and unofficial sources of information.

"It is good that he thinks of us [to ask questions]". -PI2

"Some people have asked questions about scientific data relating to what we had put on a share, and, as a result, it is quite interesting to me and to see that people can be interested in having precise information on the scientific surveys that are carried out in the reserve." -PI7

The use of the relational function of social media for two-way and multi-sided conversations

3 participants indicate social media can be a relevant tool, not only to "push" information to the visitors but also to "pull" information from them.

"It could be a good starting point on Facebook and our existing pages to ask our members and our members on social networks. Are you interested in our content? Give us your opinion. We could also question our strategies more qualitatively; that would be an interesting starting point." -PI14

Thus, users can become producers of information and knowledge to share with other online community members. In this scenario, both users and PNAs gain from these online interactions. PNAs receive field information they would not otherwise have acquired (e.g. photos of rare animals for census purposes). Additionally, users are recognised and empowered by sharing knowledge and generating valuable data. Therefore, social media users can become "e-citizens" or "e-naturalists" (Giardullo, 2022).

"There is also the naturalist side of taking pictures of species that sometimes and there is just an individual that is rare, and that we have not seen but that a visitor has seen, so I would find that interesting." -PI7

"Ah yes, yes, yes, I do it often [tagging people and organisations] because I find it nice that people think of us, they want to tag us and then, especially from an opportunistic point of view, they share and share again. It allows to grow the Community and to give also to the others desires to share their story."-PI2

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5 participants mention that they seek interaction among social media users and support online discussions about sustainable development.

"Yeah, it is when you get that kind of reaction; it is great. When you see that the conversation feeds on itself and you almost do not have to do anything, to see that It is great when the conversation is stimulated in a good way." -PI10

These results align with Oral et al. (2022), arguing that digital tools can be part of the solution to tackle climate change, enabling users to increase their literacy levels and foster civic engagement.

The use of relational function in the COVID-19 context

5 participants generate two-way and multi-sided conversations, allowing them to build an online community on their social media. Developing online communities allows PNAs such as participants 1, 2, and 14 to stimulate local residents' interest in the significance of PNA heritage, validate their conservation efforts, and foster a sense of pride and belonging within this community.

“The feeling of belonging, of knowing one's territory, of knowing what one is doing, that is very important because people do not know that they live in an exceptional territory or nearby. There is a lot of work to be done on this, on legitimacy, and that's what I'm working on.” -PI2

“That's actually one of our objectives too. That's what our networks are for. It is a kind of consolidation of the [socle d’appartenance]. In fact, I think that the networks really have this role, in any case on our profile of inhabitants, they really have this role there, which I feel is often pride.“-PI1

By using the metaphor of the *"socle d’appartenance"*, Participant 1 illustrates the use of social media to boost local residents' pride and sense of belonging via their online community. The term "socle" can be translated into English as "bedrock", i.e. the fundamental principles on which something is built, while the term "appartenance" can be translated as "belonging". Using this metaphor, Participant 1 suggests that social media can be a powerful vehicle for the eco-literacy of their audience by allowing them to provide the foundation for a community based on common beliefs and positive attitudes towards natural areas and their conservation.

The results of the analysis also reveal that the participants particularly used the relational function of social media during the COVID-19 lockdowns. Indeed, during the lockdowns, some participants encouraged social media users to share pictures or to ask questions, stimulating their curiosity and involving them in remote naturalist observation projects.

"It can strengthen the bonds between people; people talk to each other, and people will exchange photos of their village. So that is a good point, and the fact that it allows interaction it is pretty cool. I think it is a good way of creating relationships, and we saw that during the COVID-19 crisis, we set up recurring publications with little games with interactions like that. Finally, some publications supported the interaction with people who sent us photos so that we could republish. We asked them to take pictures from their window to show us what they saw." -PI1

The results align with the results of Art et al. (2022), who found that conservation NGOs in Scotland used social media during the COVID-19 lockdowns to connect people and create a conservation community online.

The use of the relational function of social media to extend the visitors' educational journey

The literature highlights that effective learning is not an instantaneous process but, on the contrary, must be considered a long-term process (Zareie & Navimipour, 2016). Creating a sustainable online community may be the basis for PNAs to build a long-term digital informal learning journey for their visitors. Along the same line, the interview analysis shows that the use of social media relational function can be a relevant tool to reach visitors before, during and after their visit.

"I see it, in fact, and I get very positive feedback; I was telling you things about creating a loyal community. It allows me to get feedback that is really encouraging, and I get a lot of messages from people who say: "Ah well, I did not know that, I did not know that, but it is crazy, I did not know it was next to my house". "-PI2

"The use of social media before an operation to make it known, during, and why not after, to keep the link? Yes, I find that it can be very useful." -PI6

Based on the findings above, a classification of the use of social media by the participants was carried out. This classification reveals that social media can extend visitors' learning journey from on-site to online. The main temporal uses of social media in terms of user education and information expressed during the interviews are presented in Table 44.

Table 44 The main temporal uses of social media in terms of user education and information expressed during the interviews

Before the visit	During the visit	After the visit
- Institutional information (regulations, access, rules, advice). - Call for participants for on-site educational activities ad promotion of activities.	- Promotion of on-site conservation activities or educational events. -Citizen science (user-generated environmental content).	- Reinforce local pride and sense of belonging. -Anchor a message through repetition. -Maintain an online relationship with the visitor after their visit on-site. -feedback from educational events. -Citizen science (user-generated environmental content).

One-sided and top-down approaches to educational communication

The data analysis reveals that only half of the participants mention the relational function of social media as an opportunity for their DIEL strategy, suggesting that PNAs represented in the interviews use social media as a one-way and top-down communication tool.

> [Talking about keeping touch with tourists] "So I do not know if it was a mission, like a Facebook objective. I see that it has its interest, but I'm not sure that was really the objective ". [...] *"I see that it has its interest [in generating engagement between users], but I'm not sure that was really the point for us." -PI7*

These results are in line with studies related to the implementation of social media by government and public institutions that found that social media was primarily used to «push » information to the citizens and less to promote their engagement and participation (Falco & Kleinhans, 2018; Picazo-Vela et al., 2016). The fact that participants in the interviews and questionnaires do not systematically engage in symmetrical (two-way) communication on social media can be interpreted as their entrenchment in a traditional *'we communicate, you read'* approach of communication and in an instructivist pedagogy (Rovenţa-Frumuşani & Farcaș, 2020).

6.4.2 Relational function of social media, stakeholders scrutiny and censorship

10 participants highlight that the anonymity prevalent online can lead to the disruption of online conversations and communities. This sentiment is particularly resonant for participants

1, 3, 5, and 7, who find that social media is not conducive to fostering peaceful and constructive discussions.

"The risk of social networks in themselves is that they are a kind of vent for some people who will be able to confront and attack in a somewhat direct way but still hidden behind a screen."-PI1

"We are not in a comfortable space [on social media] for dialogue."-PI5

Thus, this section focuses on the challenges faced by the participants when using the relational function of social media for educational purposes.

Social media backlashes and knowledge-hiding

The analysis of the interview transcripts reveals that 9 participants were exposed to backlashes or hostile comments on their social media (see Table 45).

Table 45 Results of the qualitative content analysis of the data collected in the interviews related to the respondents' use of the relational function of social media

Main categories	*Subcategories level 1*	*Sub-categorieslevel 2*	*Nb of transcripts coded / Nb of references*
Social media digital functions	Relational function	Negative experiences on social media	*9/50*
		Controversial topic	*8/44*

In response to these negative online experiences, participants adopted avoidance strategies, intentionally refraining from addressing certain controversial topics to prevent debates, backlash, or misunderstandings.

"It is not that we do not want to give the information, but it is that it is better to give it in another context, that is to say, on social media, it can be distorted, transmitted to people who could use it to put us at fault." -PI7

"At times, you have to be a bit cynical and negative and say to yourself, well, rather than communicate and then risk it being misinterpreted, maybe there are certain subjects.... It is better not to tackle them or to take other angles or simply not to communicate and do nothing but regulatory or not communicate at all." -PI3

The interview analysis shows that 8 participants mentioned avoiding discussing specific topics on their social media. (see Table 46). These topics are perceived as controversial as they can

be divisive and involve stakeholders with opposite perspectives, such as pro and anti-wind turbine or pro and anti-hunting.

Table 46 Examples of controversial topics that PNAs will avoid discussing on their social media

Controversial topic	Participants quotations
Renewable energies	*"There are some subjects that we are wary of. Like wind power." -PI4*
Hunting	*"Because already internally, we have people who are very, very anti-hunting, others who do not care, others who are hunters, so it is not a subject that I address very, very often." -PI14*
Conservation of species: wolfs, bats and bears	*"For example, a wolf attacked in the last two years in a nature reserve, or the wolf's presence. These are highly controversial subjects because between the farmers, the state and us, as a protected area, it is, it was complicated, and it is an example of something that we avoid communicating about." -PI9*
Resources management	*"In fact, it is more a question of the positioning of the reserve; in any case, in our region, there is really a climate here... it is tense in relation to the management decisions that the reserve takes for protection measures." – PI7*

These results stress that the PNAs' actions can have higher visibility due to social media use and increase reputational risks. This is in line with Dekker et al.' (2020) study that shows that the management of reputational risks can be a barrier to the use of social media by public institutions such as the Dutch Police.

Social media and reputational risks and political uses

The data analysis reveals that the avoidance strategies of PNAs may also be due to their political nature. Indeed, PNAs are mainly governed by public and political institutions (local governments, city councils, ministry…); therefore, they have to fit their discourse within their "official" purpose and regulations while addressing opposing stakeholders' expectations and viewpoints. These findings align with Sanders' (2019) study, which argues that a public organisation's communication strategy can not be divorced from its political context and environment.

"So we are, in fact, more controlled than perhaps a lambda association that does its own thing and says whatever it wants." -PI7

"The installation of a wind farm on the park's territory is a big political issue; there are elected representatives who are for, there are elected

representatives who are against, a president of the region who does not want to hear about it. We have the ADEME { the French ecological transition agency} and so on, lots of partners who tell us that clean, renewable energies are going to develop, so we have to go for it....”-PI8

Moreover, stakeholders' scrutiny can be another form of pressure exerted on the editorial policy of PNAs.

“The elected representatives and the press can easily pick up on what is published on social media. [...] There are some publications where I allow myself a little levity, but there are some subjects where the impact [and stake] is far greater”-PI1

The fact that participants in the interviews and questionnaires do not systematically engage in symmetrical and two-way communication on social media can be interpreted as their reluctance to bear reputational risks. These findings align with Rovenţa-Frumuşani & Farcaș' (2020) study that shows that public institutions may avoid using two-way conversations online to avoid risks.

6.4.3 The experiential function of social media and positive emotion and biophilia activation

As shown in the above sections, social media encourages interaction and connectivity. Therefore, this section focuses on the participants' use of the experiential function of social media (as defined in Ballew et al.'s (2015) TPAM), enabled by interactive tools and media.

PNA's use of the experiential function of social media to engage with visitors

In the case of this study, 12 out of the 13 organisations represented in the interviews mention using images, sounds, video or games and gamification strategies to create content on their social media (Table 47).

Table 47 Results of the qualitative content analysis of the data collected in the interviews related to the use of the experiential function of social media

Main categories	*Subcategories level 1*	*Sub-categorieslevel 2*	*Nb of transcripts coded / Nb of references*
Social media digital function	The experiential function of social media	Images	12/36
		Sounds	2/2
		Videos	10/29
		Playful experiences/game	5/12

Compared to conventional media, participant 12 perceives social media as a communication tool with almost unlimited potential in terms of media and online experiences.

"Completely, in terms of content, there is no limit. You have the image, the video, and the sound. All the words, the text, actually everything."-PI12

Moreover, participant 10 states that the experiential function of social media can increase online engagement through emotion.

"And especially on social networks, you have to play the emotion card to the hilt if you want to get any kind of engagement and reaction." -PI10

For 3 Participants, COVID-19 lockdowns were the drivers to engage with the experiential function of their social media. They developed games and quizzes or immersive experiences that reinforced their interactions with their online community and consolidated or even increased their number of followers.

"We have an inclination to connect with people in novel ways, and it has been necessary to find ways to maintain that connection despite challenges. During the lockdowns, we have multiplied our social media publications, which has led to increased interaction with small games, small quizzes, photo contests, and other tools, and we have seen a spike and growth of all of our networks and all of our web platforms."-PI1

"The animators made a lot of tutorials, quizzes, and so on, really trying to propose to people who were confined, animations and things to do."-PI9

These results align with the literature that demonstrated that the power of social media lies in their ability to engage their users and trigger emotions (Duncombe, 2019; Schreiner et al., 2021).

The use of the experiential function of social media to generate emotions

Images, videos and sounds can be powerful tools for transcribing emotions. Indeed, according to Barthes (1980), images are not code-free; rather, they enable to grab the reader's attention (Hrasky, 2012), anchor storytelling (Dhanesh & Rahman, 2021), or even depict concepts that

no words can describe (Jones et al., 2017; Kress & Leeuwen, 2006). Therefore, as stressed by Participant 12, images, sounds, and videos can help PNAs to express values and generate emotions online, which text alone cannot do (Li & Xie, 2020; Nikolinakou & King, 2018; Okubo et al., 2021).

"I do not know about other languages, but in French, words force us to think of things in a certain way and not in another. And I really have the impression that sometimes we are missing words." -PI12

The data analysis also reveals that 5 participants perceive positive emotions as a trigger to activate the visitor's empathy toward Nature and thus encourage them to act pro-environmentally.

"When we explain in a 1+1=2 register, we achieve nothing, but if we explain with our heart, stomach, and feelings, maybe it will reach people much more strongly than this purely scientific side. And so it is this same approach that I have by telling myself; if people feel this emotion, they will probably be more inclined to preserve nature." -PI13

"I do not like the word educate at all, in any case: to make people love it [Nature], I think that is really the objective and at least when I write something, I tell myself that when you love something, you want to protect it. You want to respect it; you want to preserve it."-PI1

These results are supported by studies showing that emotions can interact with individuals' cognition and lead them to take action (Déchaux, 2014) or that emotions can promote sustainable behaviours (Brosch, 2021). Also, Oe et *al.* (2022) hypothesise that experiencing Nature in cyberspace can be an attempt to recreate a symbiotic relationship between social media users and Nature. The findings of the interviews align with this argument, showing that PNAs try to activate their visitors' biophilia (love for Nature) online via digital tools. For example, during the COVID-19 lockdowns, Participant 7 increased their online diffusion of images of natural landscapes to address their visitors' desire to connect with nature while confined to their homes.

"Well, I think it is true that people wanted to escape, to see landscapes and sceneries, because they could not go there. It is a guess, but I think there is some of that. Especially the fact that the reserve was inaccessible, there was a sense of: "we cannot go there", therefore the images are even more valuable and precious."-PI7

These results align with the finding of Art et al. (2022), showing that during the COVID-19 lockdowns, conservation NGOs in Scotland used social media to disseminate pictures of natural landscapes to provide people with images of "*places that bring them peace*" (p. 1300). They also confirm the results from the questionnaire (see section 5.5.2) by demonstrating that PNAs can use social media to support the symbolic experience of nature online and that symbolic experience may activate the social media users' biophilic inclination (Oe et al., 2022). In doing so, this study contributes to the scarce literature on techno-biophilia that examines the relationship between Individuals and Nature in cyberspace and how it can potentially support PEBs in the "real world" (Oe et al., 2022; Thomas, 2013).

However, despite using the experiential function of social media, Participant 12 stresses the importance of the direct experience over the symbolic experience of Nature. Indeed, studies show that visiting Nature once a week has a positive impact on health and pro-environmental behaviours (Martin et al., 2020), or on the contrary that the lack of contact with nature in time, such as the COVID-19 lockdowns can be detrimental to mental health (Martin et al., 2020).

"Today, finally, we can learn everything behind our screens. Except that we do not experience these things. Thus, learning is not the same. Things are missing." -PI12

The data analysis also shows that 2 participants use positive emotions not toward Nature but toward "human beings". Participant 4 stresses the importance of considering "People" as Regional Nature Parks are inhabited territories. Participant 14 highlights the added value of personifying their Regional Nature Park to foster user engagement and a sense of ownership over the content.

"I would say that, in general, we remain on the positive emotion, inevitably and more than emotions about the scenery, a landscape, etc., it is rather on the human aspect that we will focus. It is really on the human aspect. Because the specificity of a regional nature park is that we are a rural territory inhabited with its inhabitants who constitute the territory." -PI4

[quote edited to protect the participant's anonymity]

"Yeah, the human side of it has totally allowed for personification and incarnation. It works well, so it is also something to build on." -PI14

Key points presented in this section

This section highlights how PNAs can enhance visitors' IEL journey by extending it from on-site experiences to online learning before and after their visit using social media's relational and experiential features.

However, the findings presented in this section confirm the questionnaire results indicating that PNAs are hesitant to fully leverage social media's relational function, favouring one-way information sharing over two-way conversation discussions with visitors. The findings show that these PNAs' digital practices and content strategies are driven by factors such as their political structure, stakeholder scrutiny, and efforts to mitigate reputational risks.

Additionally, the study confirms that PNAs use the experiential function of social media to evoke positive emotions and attitudes towards Nature, activate visitors' biophilic characteristics, and foster nature protection and a sense of community. Consequently, the result suggests that digital tools can contribute to addressing sustainability challenges by promoting civic engagement via techno-biophilia as a means for PNAs to establish a symbiotic relationship between social media users and Nature in the digital realm.

6.5 Monitoring and moderating online content to counteract negative learning outcomes on social media

Social media can be regarded as a hub of knowledge (Zareie & Navimipour, 2016). Still, the data analysis highlights that they can also be the source of outdated, unwarranted or inaccurate information. Section 6.5.1 reveals direct and indirect negative learning outcomes due to visitor exposure to misinformation. Section 6.5.2 explores the sources of these opportunities for negative learning in cyberspace and how monitoring can help PNAs counter

their negative impacts. Finally, section 6.5.3 shows that PNAs developed moderating strategies to mitigate the negative learning outcomes caused by the dissemination of unwarranted messages by third parties.

6.5.1 Negative learning outcomes on social media

The empirical findings (see Table 48) align with the literature, confirming that adverse outcomes can arise during IEL through social media, resulting in three types of negative consequences: unwarranted knowledge, non-PEBs, and false beliefs, as previously suggested by Meyer et al. (2018).

Table 48 Results of the qualitative content analysis of the data collected in the interviews related to negative learning

Main categories	*Sub- categories level 1*	*Nb of transcripts coded / Nb of references*
Negative learning	False belief	*2/4*
	Non-PEB	*7/26*
	Unwarranted knowledge	*7/24*

This section focuses on the causes of these negative learning outcomes and how they impact the visitors' eco-literacy.

Direct negative learning outcomes due to the use of social media

The abundance of information on social media brings the possibility of PNAs' visitors encountering inaccurate content, which could lead them to learn out-of-date or incorrect information. Participant 13 gives an example of unwarranted knowledge disseminated on purpose by local communities online in an attempt to misguide the visitors and officials to their benefit.

> *"You know this [animal] attracts tourists. But the worst thing is for the residents. Some try to make people believe that there are no more because they [the animals] are annoying to them. Because of the quiet areas [areas set up to protect animals to which no one has access, including residents], they try to convey that it is an extinct species. There are no more of them. It is all nonsense because there are still some." -PI3 [quote edited to protect the anonymity of the participant]*

The transcripts highlight negative learning outcomes due to the visitors accessing inaccurate information on social media, leading to non-PEB. This is often linked to UGC offering

inaccurate peer-to-peer advice, which can lead to environmentally damaging behaviour and infringements. This is exemplified in Figure 15 where a visitor in a National Park in Iceland is captured taking a photo that distinctly demonstrates dangerous behaviour and a disregard for regulations.

Figure 15 xample of a visitor breaching a park guideline (The Guardian, 2019)

"Itineraries, activity or practice advice on platforms that leads to offences. And that is, I would say, in total impunity." –PI3

Also, the analysis of the data reveals that unwarranted information is not only disseminated through textual messages but also through images. Indeed, images are an effective communication tool that can anchor storytelling (Dhanesh & Rahman, 2021). Participant 6 illustrates this with a case where negative learning happens due to normative pressure, shaping visitors' perceptions of what is considered "trendy" and "acceptable" in nature, including activities like trails, survival practices, and using cameras and drones to capture their outdoor experiences.

"People are bombarded with images that tell them: you need a GoPro and then enjoy great outdoors. And even if you do not have the wide open spaces at hand, just act like it, so everyone does what they want [in Nature]." -PI6

Moreover, Participant 14 illustrates the power of the virality of a message without fact-checking on social media and the potential negative impact on people's knowledge.

"[...] last year, I published a photo of [a popular animal but not present in the participant's protected area]. And there, for the moment, I saw that it could overwhelm us. So it was a big deal. We did not make a national buzz, but it is one of our most widely-read publications. Well, it was a joke, but we can see that we can generate a lot of interest with extraordinary things. [...] So there you have it. It was also a lesson for me. Um okay. So that was a joke. But if ever that was something real, something a bit sensitive, sensational, it could actually arouse more interest." – PI14 [quote edited to protect the anonymity of the participant]

These results confirm the hypothesis drawn from the questionnaire results regarding the potential negative impact of social media on the behaviour of visitors (see section 5.3.5). Indeed, they reveal three negative outcomes for the visitors that can occur during the informal environmental learning process on social media, such as unwarranted knowledge, non-PEBs, and false beliefs. They thus align with the concept of "miseducative" content (Greenhalgh et al., 2021) or the recent concept of negative learning found in the literature (Lee & Xenos, 2019; Maurer et al., 2018; Meyer et al., 2018; Shavelson, 2018; Zlatkin-Troitschanskaia et al., 2018).

Indirect negative learning outcomes due to the use of social media

The data analysis reveals that the exposition to social media also indirectly impacts the visitors' behaviours. Indeed, social media can support social learning via mimicking for social proof conformity (Schnuerch & Gibbons, 2015) or the Doppelganger mimicry effect (Ruvio et al., 2013).

For example, specific outdoor activities via influencers can be promoted on social media or become popular due to the virality of publications. While these activities might initially appear to have a minimal environmental impact, their adoption by a significant number of visitors can collectively exert pressure on the environment. Participant 9 illustrates this with the instance

of paddleboarding in a lake, which could potentially jeopardise fragile ecosystems. Also, participants 1 and 10 statements highlight that the virality of some content online can impose high anthropogenic pressure on the ecosystem in PNAs.

"On the other hand, there are other things that worry us much more. I can give you an example: today, more and more people want to go stand-up paddling in high-altitude lakes with more than a 1,000-metre vertical drop. To reach them, these are ecosystems that are ultra fragile, so it is a contribution of microplastics in an ecosystem that is very sensitive and fragile."-PI9

"So we had a big social media challenge because they actually have a beautiful place with turquoise lakes on their territory. In short, it is beautiful, and in fact, it was photographed by a fairly well-known influencer on Instagram. They were swamped with visitors, so much so that the park did not know how to manage their flow. They had a rather important degradation of the environment because of this episode, because of the trampling."-PI10

"In fact, the message conveyed by these photos takes no account of the environment and the surroundings in which they are taken, so they just focus on the beauty of the place. And what nature parks generally see is that there is a risk in these places of over-frequentation and a risk of the real cost to the environment, biodiversity and so on." -PI1

Also, the interview data analysis highlights that the process of creating online content itself can sometimes inadvertently contribute to negative learning opportunities for visitors. For instance, five participants express concerns over the use of drones to produce UGC. For example, participant 9 emphasises that drones can greatly disturb animals, locals, and visitors. In addition, the widespread dissemination of images and videos captured by drone PNAs can cause visitors to disregard the fact that using drones may be considered an offence in some protected areas.

"And then, often, the people who do this want to immortalise the moment and come with a drone to try to film themselves, et cetera et cetera. And that, well, one of them does it. And then there are 25 people who want to

do the same thing in the same month, and depending on the accessibility of the site, we sometimes find ourselves with real difficulties." –PI9

The multiplicity of sources of unwarranted information in the post-tourist context

As a next step of the data analysis, the interviewees' statements coded as related to negative learning outcomes were cross-tabulated with their statements related to the stakeholders of PNAs. The results of this crosstabulation show the different organisations or individuals mentioned as the source of unwarranted information and false beliefs or displaying non-PEB online (see Table 49).

Table 49 Number of interviewees that mentioned different organisations or individuals as the source of unwarranted information, false beliefs or displaying non-PEB online

	False belief	Non-PEB	Unwarranted knowledge
Political institutions and public bodies	-	1	1
Local community	1	1	2
Opposant to PNAs	-	-	1
Visitors	-	2	1

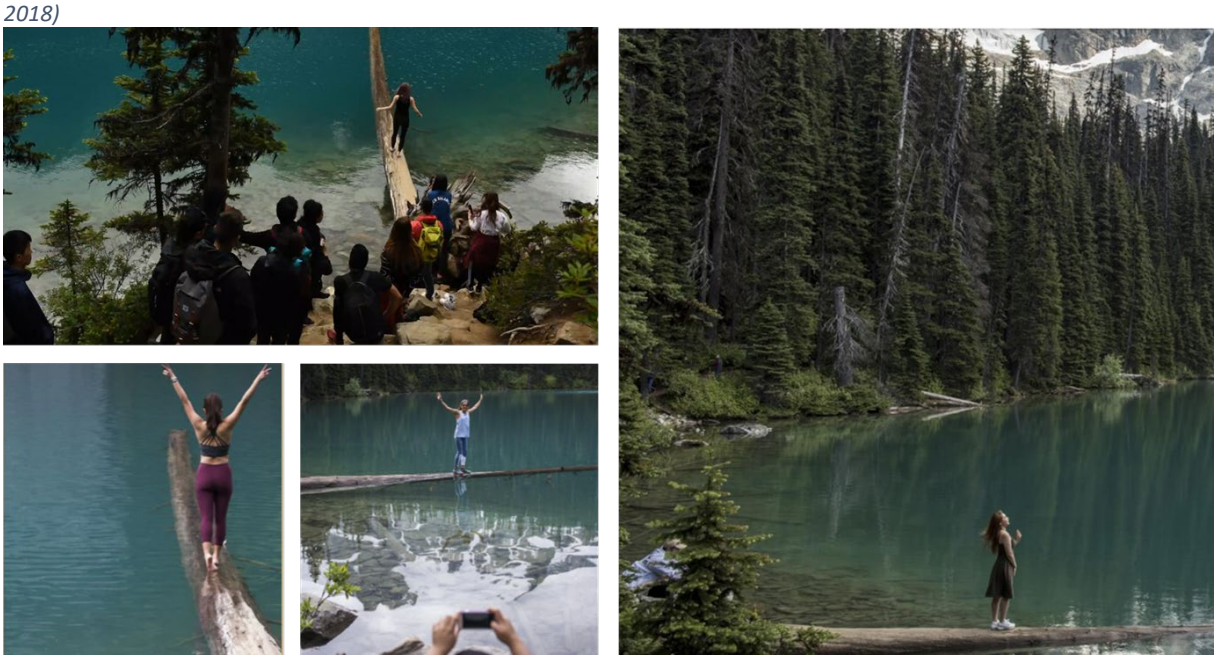
The data presented in this section above highlights that disseminating unwarranted knowledge related to protected areas on social media is current, takes multiple forms, and is generated from multiple sources.

"We have a lot of people commenting, and it is often the same people who comment on publications, and if you read what they say, you could believe they are more familiar with our regulations than we are. When in fact they do not."-PI3

The data analysis also highlights the development of a post-tourist or tech-tourist culture and beliefs that have turned nature into a commodity and a spectacle (Ng, 2020; Tribe & Mkono, 2017). Figures 16 and 17 exemplify this commodification derived from trends such as #InstaPlaces taking place in natural areas, leading considerable number of social media users to reproduce photos in specific locations, promoting a uniform and often superficial visual narrative also called Insta-Repeat.

The top-left image in Figure 16 captures visitors at British Columbia's Joffre Lakes queuing to photograph what has become an Instagram-famous spot, known as the "instalog." This “instalog”, is a fallen tree trunk by the shore, wide enough to stand on, which has gained celebrity status on Instagram among visitors. The other images of Figure 16 are pictures shared on social media of the same location, giving the impression of an isolated, wild and solitary place, contrasting with the reality of crowds lining up to take the same iconic photo.

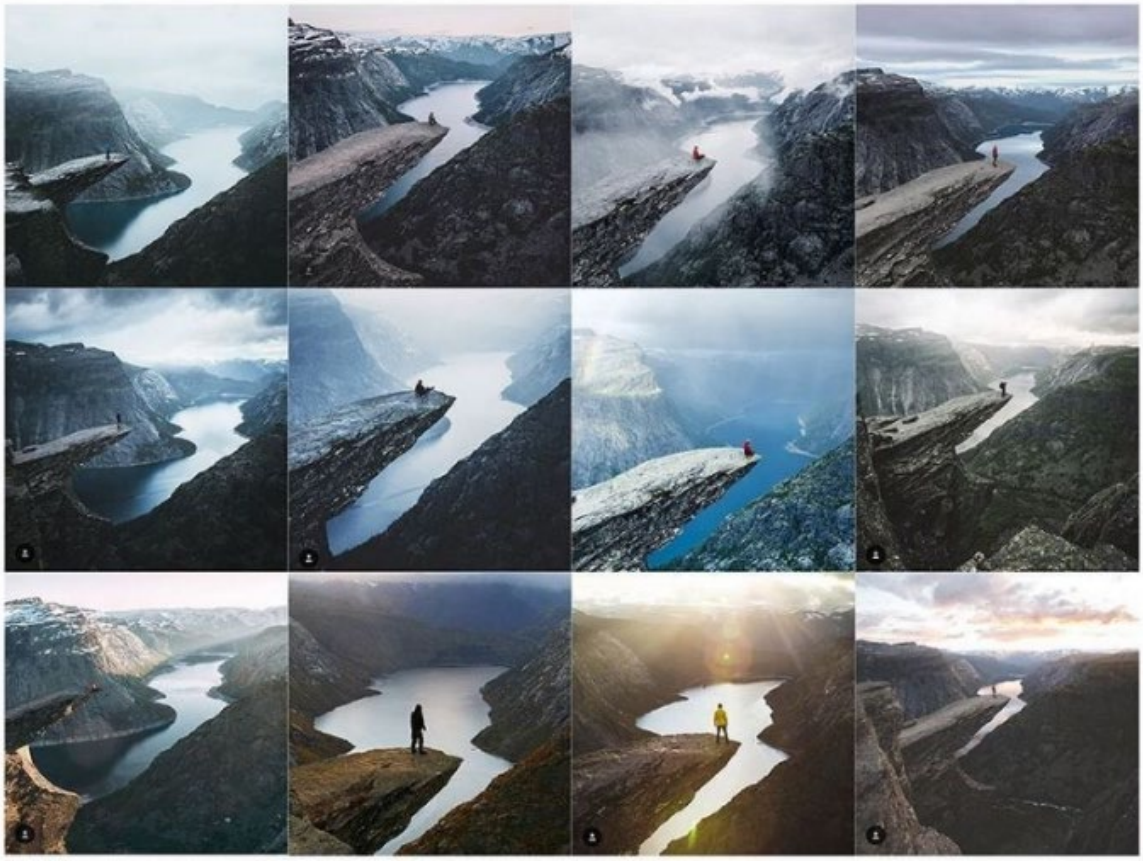
Figure 16 Collage of pictures of Joffre Lakes visitors queuing for a picture with “Instalog”. (Collected from De l’eglise et al., 2018)



Also, UGC does not consistently provide visitors with the essential context and can contribute to tourists' limited awareness of destinations they select based on aesthetics, leading to the tourists' perception of invulnerability and exaggerated control, heightening the risk of accidents.

Figure 17 is a collage of pictures shared on Instagram by users, all showing the identical landscape of Trolltunga in Norway and demonstrating the same perilous behaviour (Insta Repeat, 2023).

Figure 17 Example of Insta Repeat in Norway's Trolltunga.



Also, the misconception that PNAs resemble amusement parks rather than untamed lands deflects responsibility from tourists for their security and places it on the PNAs (John, 2022). This situation poses a risk to both visitors and ecosystems.

> *"We have got some really attractive locations. Nevertheless, there is also the forbidden side. It is beautiful, but it's forbidden because it's dangerous. It's 40 metres deep. So it's fun to go diving from the top of the cliff. Except that some people don't come back up. There's an accident every year." PI-8*

6.5.2 Monitoring the content produced by third parties online and stakeholders' management

As shown in the above Section 6.5.1, the data analysis of the interviews reveals that unwarranted information and pictures/videos of non-responsible behaviours in protected

areas can be disseminated by various sources of information online. Therefore, this section focuses on the monitoring practices of the online content by the participants.

The importance of monitoring online information

The online negative learning opportunities led 10 interviewees to monitor information related to their organisation produced by individuals and organisations. Also, participant 7 states they do not carry out this monitoring but recognise its value.

> *"Oh yes, that is clear; it is really something we do not follow at all. But we would indeed have to; I would have to keep an eye on it. Once I had seen [...] a blog, in fact, of someone who said: I went to that place, but in fact, he was not allowed to go there, and therefore, it is true that it would be necessary to inform people at least that they have the right to do so." -PI7*

These results align with the questionnaire's findings presented in section 5.3.5, which shows that 95% of the respondents agreed that monitoring information related to their park online is important.

Monitoring of online platform content and its compliance with protected area regulations

The interview analysis validates and augments the findings from the questionnaire (see section 5.3.5) concerning passive monitoring practices employed by PNAs for evaluating, verifying, and monitoring online content. Interview participants elaborate on how online content monitoring assists them in ensuring UGC and other third-party online content adhere to PNAs' regulations, thereby reducing the potential for negative learning outcomes across multiple platforms (see Table 50), such as:

- **Forum/Blogs and online communities:** 4 participants monitor UGC posted online related to nature-based tourism and outdoor activities by online communities that may not consider regulations or promote unsafe and non-pro environmental behaviours.
- **Phone applications:** 3 participants highlight the particular challenges of mobile apps that encourage peer-to-peer itinerary suggestions for outdoor activities, some of which may direct individuals off established hiking trails.
- **Public bodies' website and social media**: 2 participants monitor the content disseminated by local authority members of their PNA to identify the inconsistencies

and potential lack of coherence in the messages conveyed by the various actors in the same territory.

- **Stakeholders and local partners' social media:** 2 participants monitor the content disseminated by their stakeholders and local partners, such as tourism offices, to identify the inconsistencies and potential lack of coherence in the messages conveyed by the various actors in the same territory.

Table 50 Results of the qualitative content analysis of the data collected in the interviews related to the monitoring of the digital ecosystem

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	Monitoring of the digital ecosystem	forum/blogs/ other online community	4/6
		Itinerary phone applications and websites	3/5
		institutional stakeholders	2/2
		local economic stakeholders	2/3

The data also reveals that it may be challenging for PNAs to trace the source of information disseminated online and remove it.

> *"Because sometimes it is really hard to track down the source of a website, application or to find the person who put it [the misinformation] online and find out who can change it. So we spend a lot of time inventorying all this, contacting the people who manage it, and ensuring it is edited. And sometimes, there are big obstacles, but in general, we manage to remove them by threatening the regulatory side of the offence. We always manage to get things moving so far." PI3*

The need for harmonisation of the narrative with PNAs' stakeholders

The result reveals that the emergence of Web 2.0 led PNAs to extend their stakeholder management strategies online. Indeed, PNAs aim to align the online environmental discourse of local stakeholders, who may pursue different objectives and goals, to ensure the accuracy and consistency of the content provided to online visitors. For example, tourism offices may want to increase the frequentation and promote activities that could go against PNAs' conservation missions.

"There are also the mountains committees, which add a layer with which we had real coherence problems for several years. It was obvious. On the one hand, we were trying to pass on the principle of the "quietude attitude" [quiet zones] programme, while they had an almost outrageous communication saying: Come to the great outdoors, have fun, do what you want. That was really it." -PI6

A range of reactions to misinformation: from online to field actions

The data analysis gives a better understanding of how the participants react when encountering unwarranted content online related to their PNA (see Table 51). More specifically, four reactions to the content monitored online were found in the analysis of the transcripts.

Table 51 Results of the qualitative content analysis of the data collected in the interviews related to reactions to the content monitored online

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Sub-categories level 3*	*Nb of transcripts coded / Nb of references*
Digital informal environmental learning strategy	Monitoring	Reaction to content monitored	Hammer home	1/1
			Contact privately	1/2
			Remember the law/threat	4/17
			On-site surveillance	1/1

- **Reiterate and hammer home the warranted information**: Participant 11 mentions hammering home warranted information as a practice for responding to content monitored on social media and the internet by respondents or their organisations.

"We reiterate through campaign accounts the good practices and the good information we want to pass on" -PI1

- **Addressing the information disseminator directly and publicly:** Participant 12 directly and publicly engages in a conversation that establishes the park or reserve's perspective or reminds the public of the regulations.

"Finally, I try to re-explain behind and take the time to re-explain because these are people who can be detrimental to us" -PI2

- **Answer indirectly and remind the general public of the regulations**. Participant 3 uses the dissemination of information online related to police action carried out in their reserve to "warn" future visitors of potential offences.

> *"Without mentioning people or going into detail, but often highlight the operations we do that have led to sanctions on our part" -PI3*

- **Action on the field:** In the case of Participant 6, monitoring online content displaying illegal or non-PEBs can lead to monitoring in the field. However, it can be challenging to anticipate a change in behaviour in the field based on the content monitored online.

> *"So, in concrete terms, this means surveillance in the field where, effectively, we try to identify all of these prohibited activities, and so this involves a surveillance and possibly prevention mission."-PI6*

> *"I think we are still a step behind in trying to anticipate, raise awareness and so on"-PI6*

The data analysis shows that the main reasons given by the participants for not implementing this monitoring are the same as the ones found with the questionnaire, i.e. the lack of strategy and the lack of need for it (see Table 52).

Table 52 Results of the qualitative content analysis of the data collected in the interviews related to the respondents' reason for not monitoring the digital ecosystem

Main categories	*Subcategories level 1*	*Sub-categorieslevel 2*	*Nb of transcripts coded / Nb of references*
Digital strategy for environmental education	No Monitoring	No particular reason	*1*
		No need for it	*1*
		Lack of strategy	*1*

The monitoring of online content: an overwhelming and costly task

Furthermore, the data analysis indicates that monitoring proves to be time-consuming and overwhelming for Participants 3 and 6. The advent of Web 2.0 extends the educational responsibilities of Nature Reserves and National Parks from physical locations to the online realm, presenting challenges related to resource and skill shortages.

"We spend an enormous amount of time each year scrutinising everything that is communicated."-PI3

"This is something we could almost spend our time doing. In fact, it is absolutely crazy. All you have to do is a quick search on the internet, and you come up with the words nature reserve + bushcraft. And usually, you have a whole list of results, and you think, Oh my, where do I start? "-PI6

Regarding Regional Nature Parks, Participant 5 stresses that because of their limited enforcement authority, they have to invest time and resources in mediation and explanations to ensure the accuracy of the content found online by the visitors.

"We do not have any enforcement authority, unlike national parks, for example. Then, they have sworn agents; if there is an offence that is noted, the sworn agent can issue a report. We are in mediation in the regional nature parks, so I think it is important to provide explanations and denials."-PI5

6.5.3 Moderation of comments on social media and positive negative learning

In addition to monitoring third parties' online publications, PNAs may allow their visitors and stakeholders to comment on their social media, raising a common social media issue - the need to moderate content. According to the 7 interviewees, moderation enables them to comment on content, mitigate negative emotions associated with environmental issues, and rectify inaccurate information (see Table 53).

Table 53 Results of the qualitative content analysis of the data collected in the interviews related to moderation and reaction to online content on social media

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Nb of interviewees*
Digital strategy for environmental education	Moderation and reaction to online content on social media	Commenting	*4/10*
		Defusing	*3/5*
		Deletion	2/3

Therefore, this section focuses on the participants' organisations' moderation practices and impacts on the visitors' IEL.

The positive outcomes of moderation practices

4 participants mentioned examples where they replied to a comment on their social media to uphold user relationships, share their organisation's standpoint and ensure accurate information within the user community. Moreover, Participant 10 highlights that moderating practices on social media can create opportunities for positive learning outcomes for users who may learn from the mistakes of others.

"But yes, it is always better to answer to provide educational support, if not for the person who made the first comment, then for the person who follows." -P10

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2 Participants also stress that answering inflammatory comments can be a way to defuse a conflicting situation.

"By spinning things to bring down the emotions a little. In fact, we are an association that acts on the technical side; we are not militant, and so we always try to put forward a technical and professional angle." -PI9

Finally, 3 participants provide examples of where they find it necessary to delete comments made on their social media accounts. The decision to delete UGC was driven by the offensive or commercial nature of the comments.

"I'll delete any adverts that have nothing to do with the subject. I don't have any qualms about that."-PI14

"We were attacked [on social media]. Yeah, 'We were blown up at that event by abusive, insulting comments. I'd never seen anything like it. It was quite, quite complicated to deal with. So, in fact, as far as moderation is concerned, anything that was insulting was rude. Yes, I delete it, that's all."-P10

Participant 10's choice of words: "We were attacked" and "we were blown up ", vividly illustrate the intensity of the backslashes that can occur on social media and the profound

impact of offensive UGC on PNAs' employees. This situation may contribute to the reluctance of PNAs to use the relational function of social media, as seen in sections 5.3.3 and 6.4.2.

The need for clarification and transparency of the PNAs' moderation practices

As seen above, offensive UGC on social media leads PNAs represented in the study to moderate online content. Participant 10 formalised the deletion process of online content by creating the moderation charter that harmonised the moderation processes within their organisation for transparency purposes toward their social media users.

"I have made it [the moderation charter] available to the users, also so that they could understand why their posts had been deleted." -PI10

In contrast, 3 Participants express difficulty defining clear moderation practices within their organisation, leading to internal debate. Indeed, as the literature indicates, moderating social media involves intricate decision-making regarding time allocation, technical skills, and the implementation of formal processes (Veglis, 2014).

"So moderation is very, very hard because there is a communication officer, but they do not speak on her behalf; they speak on behalf of a community. So the tone to use is complicated to choose. Would the elected representative have validated it? In addition, you have to be very reactive. It is in the moment, not three days later." -PI12

The non-moderation of online content: the challenges of the costs and the dynamic social media environment

3 participants mention that they do not respond to online comments to avoid involving themselves in time-consuming and non-ending debates with users that could express militant narratives.

"It was too big a conflict that was not necessarily worth discussing with the person in question." -PI7

Additionally, three participants believe that conversations on their social media platforms self-regulate with the assistance of their community members.

"In the end, the people moderated themselves; there was one who was in favour and one who was against [talking about an action carried out by a PNA], and then someone came along and said: well, we still need to support the local economy to continue doing this kind of thing, etc. So it fed itself a bit and balanced itself out."-PI10

Finally, the nature of the PNAs' chain of command can be very rigid and complex (composed of multiple elected representatives and/or city councils). As a result, their administrative structure and culture can be a source of inertia that cannot match the dynamism and fast-paced communication of social media (Ashok et al., 2021; Husain et al., 2014) needed for content creation and moderation.

"We are kind of missing out. Yeah, it is clear that we are a little bit missing out; I think we are suffering from a little bit of inertia in the parks and at the federation"-PI10

"I think that, in fact, the problem, but this is perhaps a problem that is more linked to the administration and the civil service, is that there is always a slowness in getting things done"-PI8

Key points presented in this section

The data analysis in this section highlights that social media can lead to three types of negative learning outcomes, including learning inaccurate knowledge, false belief anchoring, and non-PEB among visitors. It also reveals the primary pathways contributing to these negative outcomes, such as mimicry and normalisation of non-PEB or inaccurate peer-to-peer advice. The results also highlight that the content leading to negative IEL can be supported by various media types, such as text, images, and videos.

Moreover, the results show that interview participants respond to these negative learning opportunities by implementing diverse monitoring and moderation practices. These practices allow PNAs to shape and guide discussions about environmental topics online and help establish them as authoritative sources of information. However, these practices often demand resources and skills that PNAs might lack.

Key points presented in this chapter

This chapter presents the analysis and discussion of the data collected during 13 interviews carried out online with communication officers, Conservation and Education officers or directors in French PNAs and Federations. The data analysis of the interview transcripts confirms the findings of the questionnaires presented in chapter 5 by showing that protected areas face cultural, structural, and environmental challenges in implementing their DIEL strategies. It also expands on the concept relevant to the research question that emerged from the questionnaire analysis and provides new insights into the challenges and opportunities of using social media as educational tools in PNAs.

Section 6.1 highlights that there is no homogeneity in the setup and implementation of the DIEL strategy among PNAs. On the contrary, their use of social media reveals their different approaches regarding the scope of their educational objectives. Section 6.2. reveals reasons for the participants' negative and positive perceptions of social media and gives insights into how PNAs' employees overcome their negative perceptions and accept to engage with the digital transition of their organisations positively. In addition, it highlights that a lack of leadership for the institutionalisation of the use of social media in PNAs can lower the level of acceptance of these new means of communication by their employees. Moreover, additional structural challenges, such as a lack of resources, can worsen these cultural challenges.

Despite evidence of challenges for their implementation, section 6.3 shows that social media is a relevant tool for PNAs that can lead to positive environmental learning outcomes for visitors. However, PNAs must align their social media strategies with their educational goal and characteristics (regulations, missions, administrative structure, etc.) to avoid performance paradoxes.

Although Web 2.0 is recognised for its relational and experiential functions, the findings in section 6.4 indicate that PNAs have yet to capitalise on the potential of these two functions in their DIEL approach. Finally, section 6.5 discusses how unwarranted information disseminated on social media may constitute a direct and indirect source of negative environmental learning for visitors and how monitoring and moderating online content practices can assist PNAs in addressing erroneous UGC.

Chapter 7 Technology adoption in French PNAs: perceived challenges and opportunities

This chapter aims to answer the five research questions presented in chapter 1 based on the combination of data analysis and findings of the questionnaire discussed in chapter 5 and the data analysis of interview transcripts presented in chapter 6.

Section 7.1 describes the significance of informal environmental learning and PEB promotion in protected natural areas' current social media communication strategies. Section 7.2. presents the challenges faced by protected natural areas in the technology adoption and utilisation process to support the positive environmental learning of their visitors. Section 7.3 summarises how social media positively affects visitors' informal environmental learning and PEBs, while section 7.4 presents their negative impacts. Finally, Section 7.5 focuses on the impact of the COVID-19 pandemic on the PNAs' DIEL strategies.

7.1 The significance of DIEL and PEB promotion in PNAs' current social media communication strategies

The extent of PNAs' use of social media

The PNAs represented in the research do not live in a vacuum, sheltered from the digital age (Hemerling et al., 2018). This observation is rather well acknowledged by the participants who mentioned a "necessity" (PI12), a "societal pressure" (PI4) or a "professional obligation" (PI12) for their organisation to be on social media. It is also reflected in the findings of the questionnaire and interviews that reveal a strong presence of the PNAs represented in the research on social networks. Indeed, all participants have at least one social media account and up to 6 accounts (except for Participant 9's organisation in the interview, which is not present on any social media). These results align with the findings on cultural heritage organisations that reveal the necessity for education organisations to exist online to extend their cultural mission online (Carvalho & Matos, 2018). However, PNAs have been implementing and designing their DIEL strategies at different paces, following the government social media technology model. Indeed, the results of this study

found that they are following the three-stage adoption process as described by Mergel and Bretschneider (2013);

Stage 1: Intrapreneurs and experimentation: The experimentation on social media is led by a few agents of change or intrapreneurs within PNAs. These intrapreneurs voluntarily and in addition to their normal activities will invest time in implementing and operating their organisation's social media and/or participating in creating and disseminating online content. This is particularly the case in PNAs, where financial resources are limited.

Stage 2: Coordinated chaos: This stage implies increased awareness of social media activities throughout an organisation and the use of informal standards and best practices resulting from online experimentation (Mergel & Bretschneider, 2013). Most PNAs represented in the questionnaire and interviews reached this second stage. Indeed, the finding of this study shows that most participants deal with digital tools not as engineers, designing and implementing digital strategies or guidelines and rationalising their practices, but as "bricoleurs", deftly combining the resources and skills available locally. These findings may be reminiscent of the DIY digital practices found in the study by Batist et al. (2021) when investigating the digitisation process of archaeological sites. They are most likely the results of the need to upskill and the lack of resources allocated for implementing social media mentioned by the Participants in the questionnaires and the interviews.

Stage 3: Institutionalisation: In the organisations that reached the third stage of social media adoption, guidelines for their implementation have been adopted, and online practices have been normalised (Mergel & Bretschneider, 2013). According to Mergel (2016), at that stage, *"[…] social media becomes embedded in the organisation structure, and the organisation agrees on a common understanding […] and needs to recognise the potential of social media for its own mission."* (p. 145).

In this research, few participants mentioned having an editorial committee or setting a DIEL strategy. Indeed, 77% of the participants in the questionnaire did not set up such strategies, and only 3 participants in the interviews have editorial guidelines. Also, only Interviewee 13's organisation formally acknowledged the value of social media as a crucial component of their education and conservation strategy by mainstreaming their use across the entire organisation. Although the formalisation of practices may seem counterproductive given the ever-changing nature of the digital realm, the PNAs' institutionalisation efforts demonstrate

their recognition of the plurality of communication needs driven by their education and conservation missions (Mergel, 2016).

However, even though institutionalisation is the outcome of a process of experimentation that is desirable, it should not be regarded as an end, especially in the context of social media. Maintaining a pool of intrapreneurs and supporting their capacity to experiment within the organisation may be a way to cope with the dynamism of the digital environment. Moreover, some participants considered experimentation part of their organisation's DNA and core values. This is particularly evident in Regional Nature Parks, which were established to pioneer new economic models and cultivate innovative approaches to the interplay between humanity and the natural world (Missonnier & Laruelle, 2021). In this study, PNAs with a decentralised organisational system (such as Regional Nature Parks and Nature Reserves) experienced intrapreneurship as a result of employees' awareness of the need to be online. This occurred in a resource-constrained environment infused with a culture of experimentation. In contrast, organisations with a more centralised organisational system, such as National Parks, tend to favour and foster institutionalisation and standardisation practices.

[Talking about the coordination of the use of social media within the Regional Nature Parks' network] "So I have the impression that everyone does things in their corner, everyone does a bit as they like and that there is no real coordination. However, there are subjects on which, yes, there is coordination. Also, we have this mission, as parks, which is to experiment. So when we do not know how to justify it [a test or trial], we take shelter behind that mission: "Well, we have a mission of experimentation". Perhaps it did not work well, but we experimented, tried, and did our job. Fortunately, we have this possibility." -PI8

"So we, the parks [Regional Nature Parks], we have a vocation, which is to experiment."-PI1

The set up of strategies for IEL on social media and promotion of PEBs

Regarding the use of social media to educate their visitors and enhance their eco-literacy, the findings from the data analysis align with studies that have identified the underutilisation of digital tools in enhancing the eco-literacy of the general public (Gossart, 2021; John, 2022). Less than a ¼ of the respondents to the questionnaire have set up a DIEL strategy. Also, the

interview data analysis emphasised the lack of a top-down directive from the federation or the ministry regarding implementing digital strategies. This places the responsibility of managing the digital transition on a case-by-case basis for Nature Reserves, National Parks, and Regional Nature Parks.

Furthermore, the empirical evidence drawn from both the questionnaire responses and the interviews demonstrates that the participants' organisations predominantly employ social media to push information to users without significantly enhancing their engagement or actively seeking feedback. The PNAs tend to overlook or underutilise the potential of social media's relational capabilities as an educational tool. This potential includes extending visitors' educational journey temporally (before, during, and after their visit) and spatially (within cyberspace). These findings align with studies highlighting a lack of two-way communication in government external communication online (Mergel, 2016; Picazo-Vela et al., 2016) and raise the question of whether PNAs have grasped the fundamental shift in communication brought on by the digital era. They also show that PNAs miss the opportunity to ensure their online content is relevant to their audience.

Finally, the findings show that the PNAs may have different approaches to their educational missions (see Figure 18). More particularly, this study found that with their strong focus on conservation missions, Nature Reserves are more likely to cover a narrow scope of eco-literacy in their online external communication, i.e., directly related to completing their missions, regulation and operation. In contrast, National and Regional Nature Parks cover a broader scope of eco-literacy that may extend to a holistic approach to sustainability and sustainable development. The PNAs represented in the interviews also show a divergence in their approach to the scope of their DIEL strategies addressing local or global audiences. These various approaches to their audiences indicate that they have different perspectives on their role in disseminating environmental knowledge, in turn impacting their DIEL strategies.

This categorisation provides a framework to analyse the alignment between natural heritage organisations' profiles, online practices, and environmental objectives. It also opens avenues for further research into the implications of these profiles on the effectiveness of the digital communication strategies of PNAs and their impact on individuals’ eco-literacy.

Figure 18 Different PNAs' approaches to DIEL in terms of audience and eco-literacy scope (source: the researcher)

Global expert
The PNA addresses a global audience of residents and non-residents and focuses on conservation missions and local environmental knowledge and issues.

Local expert
The PNA addresses an audience of residents or local communities and focuses on conservation missions and local environmental knowledge and issues.

Local agent of change
The PNA addresses an audience of residents or local communities with the aim to increase their broad eco literacy and give them tools and lessen their daily environmental impact.

Sustainability Advocate
The PNA addresses a global audience to improve their eco-literacy while discussing the global implications of sustainability and sustainable development.

7.2 The challenges faced by PNAs in the process of technology adoption and utilisation to support the IEL of their visitors

Digital transition in PNAs may seem like a straightforward change, affecting only its IT or communication department, but this study reveals that it profoundly impacts various aspects of its organisation (Castaldi et al., 2020). The empirical evidence from the questionnaire and the interview shows that following technological determinism assumptions, implementing DIEL strategies implies organisational changes leading to managerial and structural challenges. In addition, following the social determinism perspective of technology, this study reveals that the implementation of new digital tools is the result of the "shared understanding of the purpose" of their implementation (Picazo-Vela et al., 2016, p. 695) by PNAs' agents, which exposes PNAs to cultural and political challenges. Indeed, one of the main barriers to the digital transformation of companies is not to find and implement sophisticated IT or digital tools and software but the change in culture and the implementation of a digital mindset within organisations (Hemerling et al., 2018; Varenne & Godé, 2021). Also, the literature shows that employee technology acceptance and implementation are positively linked to management support (Schillewaert et al., 2005) and leadership styles (Faiq et al., 2020; Schepers et al., 2005).

Therefore, this study details how structural, managerial, political and cultural challenges can hinder the efforts of PNAs to advance digital transition for educational purposes. In addition, this study addresses the gap in the literature identified by Medaglia and Zheng's (2017) study,

highlighting that: “the properties of social media platforms are under-investigated” (p. 502). Table 54 summarises the challenges in using social media in PNAs, considering both the overall social media usage and its specific functions: informational, relational, and experiential, as defined in Ballew et al.'s TPAM (2015).

Table 54 Summary of the four types of challenges in the implementation of social media in PNAs found in the questionnaire and interviews related to the general use of social media perspective and from the three functions of social media perspective

Main challenges faced by PNA	Managerial	Structural	Cultural	Political
The overall use of social media	- **Key Performance Indicators**: Lack of KPI related to the use of social media and educational missions relevant to PNAs' characteristics. - **DIEL strategy**: Lack of clarity on the scope of eco-literacy disseminated and the audience targeted. - **Leadership**: DIEL strategies can be considered secondary and not as important as "real and traditional work" by team managers.	**- Dynamic environment**: Need to adapt quickly to new social media platforms, content types, technologies, culture, and environmental changes such as COVID-19. - **New technologies associated with social media use**: Most PNAs are not equipped to feed social media content (photographs, editing software, computers, etc.). **-Complexity**: The complexity of the French conservation landscape may not allow visitors to "find" the PNAs online.	- **Identity and performing tensions**: The use of social media in PNAs can lead to a misalignment of the use of social media with PNAs or its employees' values and missions. -**Digital mindset**: Challenge to find a financial sponsor willing to fund IT, a job position for communication, or software when traditionally sponsorship has been for on-site activities or tangible outputs such as books and guides.	-**Human/nature relationship perspective**: Tension between promoting the PNAs and potentially detrimental frequentation to the natural ecosystems. **- Leadership**: DIEL strategies can be considered secondary and not as important as "real and traditional work" by the Elected officials who may refuse to allocate additional resources to them. Also, there is no top-down directive from the federation or the ministry to implement DIEL strategies. **- Collaboration**: No inter-PNA collaboration or formal orchestration of practices for the DIEL strategies implementation.
Informational function	- **Knowledge orchestration**: Difficulties for communication officers to retrieve information from agents specialised in sustainability-related topics within their organisation. - **Editorial line and oversight**: Lack of coherence in the online narrative due to the emergence of intrapreneurs and the heterogeneity of online practices within PNAs' network.	- **Human Resources**: Need to upskill employees and allocate time and resources to content generation and dissemination. - **Complexity**: The complexity of the French conservation landscape may blur the message and complicate the understanding of the PNAs' missions. **- Inertia**: The administrative and management structures of PNAs make the posting review process too long and/or complicated.	- **Technology acceptance and cognitive dissonance**: Some employees "do not like "social media and hesitate to engage in DIEL strategy and thus do not participate in the knowledge orchestration. - **Unlearning**: Technological change can clash with organisational routines that need to be updated.	- **Institutional positioning**: PNAs have to fit their online narrative within their official purposes and regulations. **- Inertia**: Elected officials and political entities may burden the chain of command by participating in the validation of certain online contents.
Relational function	-**Institutionalisation of practices and oversight**: The relational function of social media can lead to the need for the formalisation of practices such as moderation charters.	-**Moderation**: The need for moderation and monitoring of stakeholders and User Generated Content can be overwhelming and resource-consuming for PNAs.	-**Choice of tone**: Some PNAs are highly regulated; thus, because of their structure, they may use a formal and regulatory tone online that would not be attractive to their audience.	**-Stakeholders scrutiny**: The PNAs' officers may hide information to avoid stakeholders' backlashes.

	-**Reputation risk management**: The relational function of social media increases reputational risks for PNAs related to their stakeholders' scrutiny.	- **Monitoring**: Lack of resources to counter negative learning opportunities and track new behaviours and potential "hot spots" and "Instagrammable Places". -**Human resources**: Lack of human resources to spend time and resources, maintain relationships with social media users, and answer their comments.		- **Political instrumentalisation/exploitation**: Use by elected officials and political entities of PNA social media platforms to convey political messages.
Experiential Function	- **Institutionalisation of practices and oversight**: Using different media, pictures, videos, and sounds raises concerns regarding their copyright and ownership.	-**Digital skills**: Lack of technical skills to generate engaging and experiential content online. -**Technology and software**: Lack of resources and technological adaptation to generate engaging and experiential content online.	-**Digital culture**: Lack of digital culture and the capacity to translate traditional content to new types of content and medium. - **Social media social and environmental footprint**: Lack of technology acceptance due to the misalignment between the use of the technology and the agent's values or those of their organisation. -**Technophobia and "Fear"**: Fear that social media and digital ecosystem will replace physical interactions between visitors and Nature. Fear of "all-digital".	

7.3 DIEL positive impact on visitors' eco-literacy

Scholars such as Ballew et al. (2015) and Ng (2020) demonstrated that the three social media functions (i.e. informational, relational and experiential as defined in Ballew et al.'s (2015) TPAM) can have a positive effect on the PEB of social media users. This study substantiates these findings in the context of PNAs. It highlights the significance of Web 2.0 as a pertinent instrument that positively impacts the IEL of social media users and promotes PEBs among their visitors.

More specifically, the data analysis of the interviews shows how social media functions can be used by PNAs to positively impact aspects of their social media audience's eco-literacy, such as their attitude toward the environment, green skills, behaviours and environmental knowledge. Indeed, the findings show that each of the three social media functions can support specific objectives of the DIEL strategies of PNAs via different tools and practices that contribute to positive outcomes of visitors' IEL. In addition, the data analysis reveals that different objectives of DIEL strategies can be fulfilled on different social media platforms. For example, Twitter is preferred for the diffusion of institutional messages, while Instagram is preferred for disseminating pictures.

As discussed in chapters 5 and 6, all the respondents to the survey or the interview using social media are taking advantage of its informational function to disseminate institutional or educational content online. However, the questionnaires show that nearly a third (30.8%) of the respondents do not support the online exchange between the park and their visitors.

Also, only 5 of the 14 interviewees mentioned taking into consideration feedback from social media users, such as expressions of support or approval; none had established intentional practices or tools for proactively collecting and analysing social media user feedback.

"What [Name] brings up to me is that, uh, there are encouragements, often from the same people saying: "Bravo, you did the right thing on this action", etc."-PI13 [quote edited to protect the anonymity of the interviewee]

Finally, the questionnaire did not provide insight into the respondents' use of the experiential function of their social media for DIEL purposes. However, cross-tabulating the data collected

in the interview allowed to determine that 6/14 of the participants are using pictures, videos, sounds or gamification to elicit positive emotion toward Nature or to create an immersive experience of Nature in cyberspace for their audience online. Therefore, most of the PNAs represented in this study are missing out on the potential paths to positive outcomes for their visitors.

The summary of the above discussion related to the extent of the use by PNAs of the three functions of social media, how they support the implementation of PNAs' DIEL strategies and their positive impacts on the eco-literacy of visitors is presented in Table 55.

Table 55 Summary of the extent of the use by PNAs of the three social media functions, how they support the implementation of PNAs' DIEL strategies and their positive impact on the eco-literacy of visitors

	Implementation of DIEL strategy by PNAs on social media		Positive Outcomes on Visitors' Eco-literacy					
	Objectives of DIEL strategies	**Tools and practices**	**Attitude**	**Environmental knowledge**	**Eco-Responsible Behaviours (ERB)**	**Green Skills**	**Preferred social media**	**Respondent's use of the function**
Informational	Disseminate information related to environmental regulation. Disseminate local environmental knowledge and allow actions of PNAs to be valued. Disseminate holistic environmental knowledge related to sustainability.	Institutional messages, accessible sensitisation and/or Social Marketing.	Develop a sense of pride for locals and create communities that share environmental values. Develop a preference for sustainable tourism and activities. Change in perception of natural space. Stimulate interest and love of Nature. Creation of a human/Nature synergy in cyberspace.	Development of Narrow environmental knowledge. Development of Broad environmental knowledge. Development of Implicit environmental knowledge.	Compliance with regulations ***Narrow ERB*** How to behave in the park to respect the ecosystem. How to respect others and local communities when visiting the PNAs. ***Broad ERB*** How to reduce the environmental footprint in daily life.	***Narrow green skills:*** Skills necessary to come into the park and use relevant equipment. Skills to act appropriately when encountering wildlife in PNAs. ***Broad green skills:*** Transferable green Skills for daily life. To know where to find warranted information.	**Twitter** **LinkedIn** **Facebook**	Interviewees using the informational function of SM **13/14** Participants in the Questionnaires using the informational function of SM **100%**
Relational	Targeting a specific audience. Broadening the audience. Harmonise and clarify the discourses of the different PNAs' stakeholders. Create a long-term relationship with the online community. Create a long-term educational journey for the visitor before and after their visit.	Responsiveness and personalised communication. Support of two-way and multi-sided conversations on PNAs' social media. Collaboration with influencers and PNAs' stakeholders. Cross-posting, tagging, and sharing functions and hashtags. Auto-regulation of content by visitors. Generate a sense of					**Facebook** **Instagram**	Interviewees using feedback tools and practices **0/14** Interviewees supporting multi-sided conversation **5/14** Participants in the Questionnaires supporting two-way communication **69,2%**

	Extend the visitors' learning journey from on-site to online.	belonging. Participative activities: e.g. quizzes, MOOC. Promotion of citizen science and e-naturalist. Social learning.						Participants in the Questionnaires supporting multi-sided communication **23%**
Experiential	Disseminate Implicit knowledge. Activate visitors' biophilia. Create a human/nature relationship in cyberspace by bringing Nature to the visitor in cyberspace. Promote PNAs' values.	Use of audio-visual and immersive content. Generate positive emotion toward Nature. Embodying communication and highlighting the local cultural heritage. Foster collaboration with stakeholders who share the values of the PNAs.					**Instagram YouTube Facebook**	Interviewees using engaging publications **5/14** Interviewees using biophilia activation **5/14** Questionnaires **N/A**

7.4 DIEL negative impact on visitors' eco-literacy

The data analysis of the questionnaire and the interviews confirm that social media can negatively impact visitors' IEL outcomes. More specifically, the findings allow to determine that each of the three social media functions is responsible for different potential negative impacts on visitors' eco-literacy.

The analysis of interviews reveals three main pathways that create opportunities for these negative outcomes. The first pathway involves misinformation present in UGC. The second pathway encompasses the practices of PNAs to avoid certain environmental topics, either by not addressing them or by downplaying them, due to reasons outlined in chapter 6, section 6.4.2. The third pathway relates to the overall use of social media, which can inadvertently normalise behaviours that are not eco-responsible (non-PEB) and unwarranted knowledge and beliefs.

Table 56 highlights how the three social media functions can enable the emergence of opportunities for negative outcomes for visitors' IEL, based on the results presented in chapters 5 and 6.

Table 56 Summary of the pathway for negative impact allowed by the three functions of social media and their impact on DIEL and IEL

	Negative Outcomes on Visitors' Eco-literacy	Processes/paths/sources	Evidence	Mitigation measures for PNAs using social media
Informational function	**Acquisition of irrelevant knowledge** **Learning of non-PEBs**	***Access to third-party content:*** Decontextualised information	*"Itineraries, activity or practice advice on platforms that leads to offences. And that is, I would say, in total impunity." – PI3*	-Launch educational online campaigns that highlight the importance of responsible outdoor activities and environmental stewardship.
		Unwarranted knowledge/ "Fake news"	*"Last year, I published a photo of a seal on the beaches {of the NAP concerned where no seal ever came). And there, I saw that it could go beyond us a little bit [...] it is one of our most read publications [...], and it led to discussions between the locals. It was a joke, but you can still see that you can stir up some extraordinary things. [...] It also taught me a lesson. "-PI14*	-Counter negative learning opportunities by providing social media users with trustworthy environmental knowledge.
		Out-of-date information/ Misinformation	*"We spend an enormous amount of time each year scrutinising everything that is communicated, particularly on outdoor activities, on dedicated applications, forums and websites, and so on, because there are always mistakes, [...] to get in touch with the people who run it, to get it changed. And sometimes, there are big obstacles, but in general, we manage to raise it by threatening the side. Well, that is a regulatory offence.."-PI3*	-Take advantage of open-sources and inter-modalities of online platforms and applications to provide PNA's stakeholders with build up-to-date, easy-to-access eco-knowledge hub (section 8.3).

Relational function	**The normalisation of non-PEBs** **Disruption to online learning**	***Access to User Generated Content leading to:*** Non-PEB mirroring Implementation of what is regarded as common practices found online The virality of unwarranted information online Disruptive, offensive, and abusive online content and behaviour	*"On the other hand, there are other things that worry us much more. I can give you an example: today, more and more people want to go stand-up paddling in high-altitude lakes with more than a 1,000-metre vertical drop. To reach them, these are ecosystems that are ultra fragile, so it is a contribution of microplastics in an ecosystem that is very sensitive and fragile. "-PI9* *"And then, often, the people who do this want to immortalise the moment and come with a drone to try to film themselves, et cetera et cetera. And that, well, one of them does it. And then there are 25 people who want to do the same thing in the same month, and depending on the accessibility of the site, we sometimes find ourselves with real difficulties." –PI9* *"We can, for example, detect the video with relay potential. Yes, but to manage it in anticipation, no. [...] For the moment, we feel rather helpless; we are trying things out, but we are in the realm of the uncontrollable. [...] It is a real challenge." -PI9* *We are not in a comfortable space for dialogue [on social media]". -PI5*	- Provide visitors with example of know-how and examples of behaviours expected in PNAs (Tutorials, podcast, collaboration with green influencer etc) on social media. - Use social media to create a long-term relationship with online communities and visitors to extend they learning journey before and after their visit in PNAs. - Monitor and anticipate potential new trends and viral content online that could represent a risk for PNAs. - Moderation of UGC. - Explore the use of artificial intelligence (AI) algorithms to identify and filter out potentially harmful or false content.
	Fragmented knowledge acquisition	***PNAs' avoidance practices:*** Due to stakeholders' scrutiny Due to the fear of backlashes	*"I put a publication on the subject of {species of plants}, which are very pretty protected species, and which are subject to collection. And when I put this publication, it provoked an immediate outcry by 2 or 3 people saying, "You have to be careful not to talk about it at all; it will encourage people to pick it - you should not talk about it at all." And it was the first time I've deleted a message from the Facebook page." -PI14 [quote edited to protect the anonymity of the interviewee]*	- Elaborate a clear digital strategy and editorial line. - Create a moderation charter allowing to define the limit of what are the expected behaviour online.

			"But I know that today there are even subjects; we will finally forbid ourselves to put it forward for fear of the hostile reactions that it will generate from 3% of the population." -P12	- Train employees on emotional intelligence and emotional risks for effective social media moderation.
Experiential function	**Acquisition of implicit knowledge leading to non-PEB**	***Access to third-party content:***		
		The normalisation of practices through pictures and trends	*"In our magazine, we published a photo of a dog in a place where dogs were not allowed; we did not pay attention. [...] I'll give you 3 guesses; all season, we had this famous question, "We were told that the dog was not allowed, but there in the picture, there is a dog. Can we bring it?". So really, whether it is the networks or something else, you really have to be careful how you communicate because the moment people see it (the dog), it becomes real and authorised." -P11*	- Leverage the potential of technobiophilia by promotion "positive emotion" toward nature. - Counter negative learning opportunities by providing social media users with trustworthy environmental knowledge and skills. - Recontextualise UGC by highlighting potential dangers to both visitors and the ecosystem caused by specific behaviours. For example, employ IoT and push messages to inform visitors entering PNAs about expected behaviours and associated safety risks. - Lead by example by engaging in digital sobriety practices and support digital sustainability practices. - Define their digital carrying capacity
		Spectacularisation of nature		
			"People are bombarded with images that tell them: you need a GoPro and then enjoy great outdoors. And even if you do not have the wide-open spaces at hand, just act like it, so everyone does what they want [in Nature]." -PI6	
		Overall use of social media		
		Unstainable use of digital tools	*"We also need to educate people about social media so that they can use them for other educational, eco-citizenship and other purposes." -PI5*	
		Dependency on digital tools	*"I ask myself the question, I find it both timely [digital tools] [...] and at the same time, I'm against it because I say to myself that when you're in the middle of nature, you have to let yourself go, be, be in the grip of nature, of noise, of nature, of smells, of nature, of the emotions you receive, and that once again being hooked on your mobile phone and not being able to make that break really questions me." -P13*	

Also, the data analysis of the survey and interviews reveals that PNAs are monitoring and moderating the online content to address erroneous UGC and thus reduce opportunities for negative outcomes for the IEL and ERB of the visitors. More specifically, four main approaches to the content were found in the questionnaire and the transcripts: Preventive, Reactive, Proactive, and Passive. These approaches are not mutually exclusive as they can be used in combination with each other. Table 57 presents a summary of the reactions of PNAs to misinformation online:

Table 57 Type of approach and action taken by PNAs represented in the interview and the questionnaire to misinformation online

Actions taken / Type of approach	Actions taken	Evidence
Preventives approach	**-Reiterate and harmer home** the warranted information. - **"Infiltration" strategies** *(being a member of other social media groups or being an administrator of satellite groups).*	*"Need to 'hammer home' good practice. "-PQ17* *"I am undercover in a way, and I can see what is said and intervene if necessary." –PI2*
Reactive approach	**-Addressing the information disseminator publicly.** **-Answer indirectly** reminding the general public of the regulations and the possible fines. **-Contacting directly and privately** the source of information. **-Action on the field.**	*"Finally, I try to re-explain and take the time to re-re-explain because these are people who can be detrimental to us."-PI2* *"Without mentioning people or going into detail, but often highlight the operations we do that have led to sanctions on our part."-PI3* *[we spot] itineraries, activity or practice tips that lead to infringements [...] so we spend a lot of time making an inventory of all this, getting in touch with the people who manage it, making sure it is changed."-PI3* *"So, in concrete terms, this means surveillance in the field where, effectively, we try to identify all of these prohibited activities, and so this involves a surveillance and possibly prevention mission."-PI6*
Pro-active approach	**Harmonisation of the discourse and collaboration with** stakeholders. **Raise stakeholders' awareness.**	*"Well, then there are joint communications (speaking of joint communications made between the tourist office and the PNA)." -PI1* *"There is a synergy, so it is going well at the level of the municipalities, [...] that are sharing our information, that are sharing the posts [...] on their wall, and so on."-PI2* *"[...] we also train many people, social and economic partners to preach the good word"-PI3*
Passive approach	**Do not answer** or wait for autoregulation. **Hashtag tracking.**	*"We see them [the UGC], but we do not act on them; they regulate themselves"-PQ7* *"Monitoring of hashtags, mentions, articles, etc., continuous monitoring of networks" -PQ25*

7.5 Evolution of DIEL strategies during the COVID-19

The analysis of the questionnaire and interview data reveals that the impacts of COVID-19 were experienced by participants over two distinct periods: The French COVID-19 lockdown periods and the post-lockdown period.

When COVID-19 hit France in 2020, the French government answered, like most countries, by implementing a strict lockdown that stopped the visitation of PNAs for weeks. This consequently made digital transformation mandatory for PNAs wishing to maintain contact with their stakeholders and the external world (Fletcher & Griffiths, 2020). In this context, the PNAs examined in this study have undergone cultural and structural transformations within their organisations and updated their DIEL strategy.

First, the lockdown periods have allowed the resources otherwise allocated to fieldwork to be shifted to external communication on social media, allowing for experimentation (PI1), the increase in the number of posts (PQ4), testing of new media types such as podcasts and video (PQ13, PI12), the creation of new social media accounts (PQ4, PI1) and adaptation of the content disseminated to the pandemic context with publications related to DIY activities, gardening or Nature observations from home activities (PQ25, PQ21, PI14).

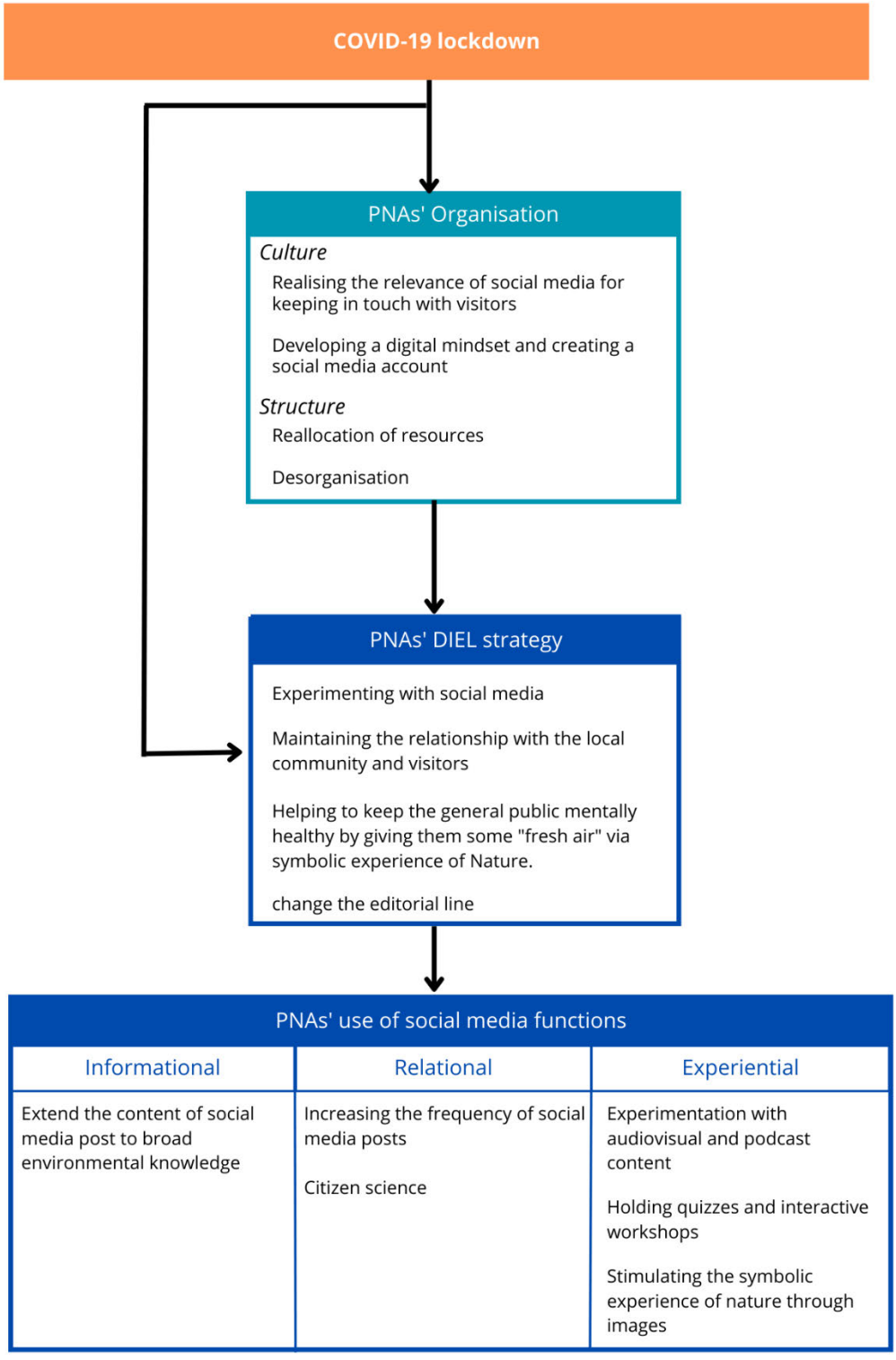
"In short, we really tried to make different types of publications."-PI14

"It was necessary to refocus the posts on content that did not require travelling, hiking; we made posts on DIY ideas, reports etc."-PQ25

"We worked much more with the video medium, the frequency of publications increased, and the idea of developing an Instagram page dedicated to nature made its way for implementation in 2022."-PQ4

Second, the lockdowns have increased the need to provide online social connections, intensifying the use of the relational function of social media by PNAs. These results align with Arts et al.' (2022) study showing that NGOs used social media during the COVID-19 lockdowns to connect people and create an online conservation community. Finally, the COVID-19 lockdowns drove PNAs to engage with the experiential function of their social media as they increased their use of images and pictures to counter the lack of exposure to Nature experienced by the French population. The summary of the impacts of the COVID-19 lockdown period, discussed above, on the DIEL strategies of PNAs are described in Figure 19.

Figure 19 Summary of the impacts of the COVID-19 lockdown periods on PNAs' organisation, DIEL strategies and use of social media functions



The data analysis of the questionnaire and interview confirm the literature findings, showing that after the COVID-19 lockdowns were lifted, PNAs experienced an increase in frequentation and a change in the type of visitors (Geng et al., 2023; McGinlay et al., 2020;

Miller-Rushing et al., 2021). However, the PNAs represented in the study used two different approaches in the post-COVID-19 lockdown context. Despite these changes in frequentation and visitations, the first group of PNAs returned to the pre-COVID-19 organisation and DIEL strategy. This return to normal is exemplified by Participant 17 response to question 13b of the questionnaire :

"During the COVID-19 crisis (now back to normal), with 2 daily posts on Facebook and regular DIY meetings (e.g. nature crafts for children, participatory science observation protocol...), to keep busy + keep the link."-PQ17

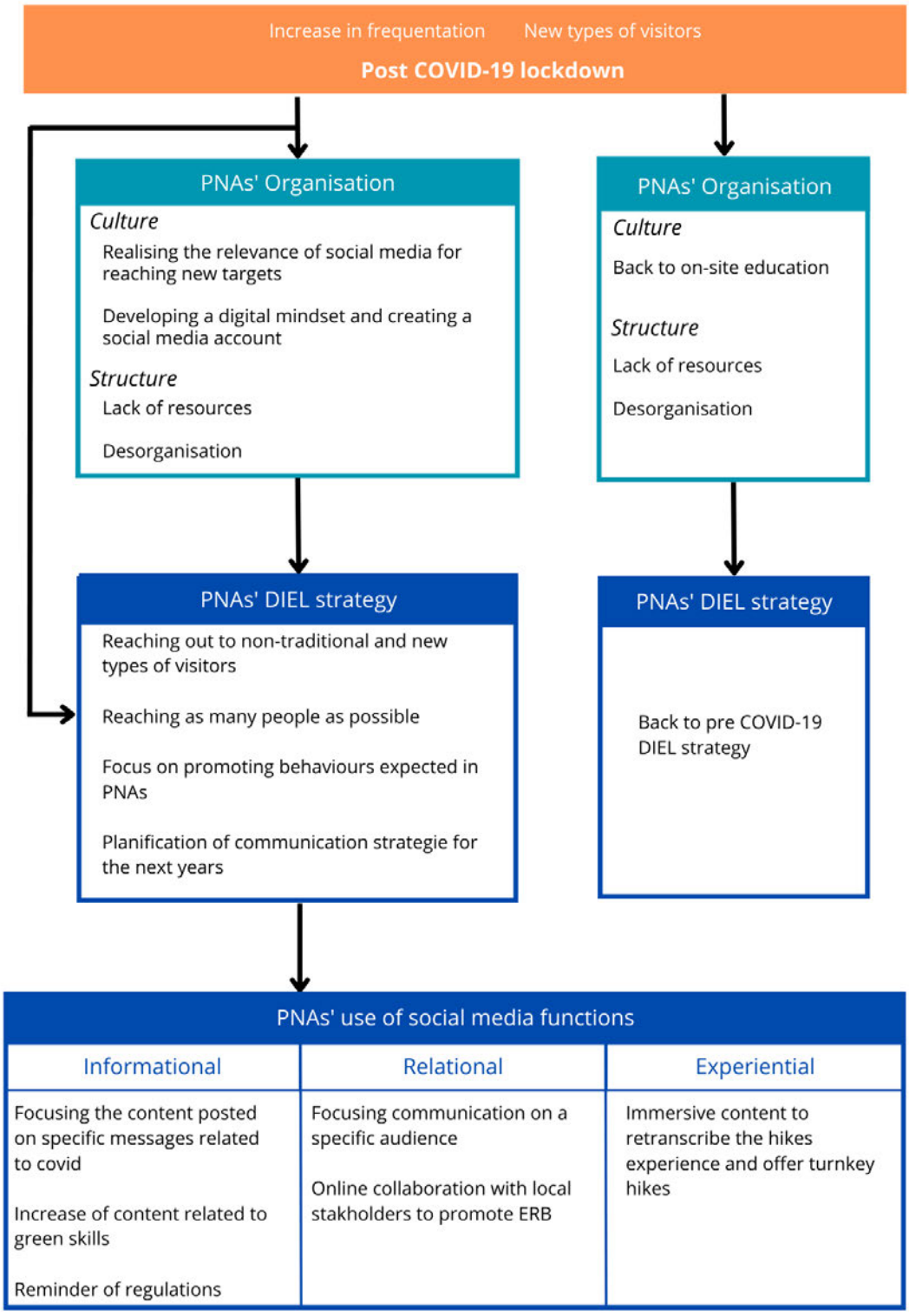
In contrast, the second group of PNAs have operated long-term and profound changes in their organisation and DIEL strategies. For example, the change in type visitor characteristics led the participant in interview 13 to set up a DIEL strategy for the next 5 years to promote specific eco-behaviours online among new visitors who were not used to nature-based leisure and were not accustomed to the behaviours expected in the park. Also, 27% of the participants in the questionnaire stated having changed their strategies for creating and distributing content on social media in the post-COVID-19 lockdown context.

The study results reveal that social media has proven to be a relevant and successful tool for PNAs in responding to the new constraints they face after the end of the lockdown. By utilising and engaging with the three functions of social media in new ways, PNAs were able to reach and engage new and non-traditional audiences (PI14, PI13), adapt and personalise their communication to the post-lockdown context (PQ4), collaborate with their partners in joint communication campaigns (PI6), and meet the changing expectations of their stakeholders (PI1, PI2). The results show that for some participants, the legacy of COVID-19 on their DIEL strategy is little, while for others, it generated a mindset shift toward more digitalisation.

"We had a little more time to look at social networking during the COVID-19 crisis, which also raised awareness within the Park team of the importance of social media."-PQ4

Figure 20 summarises the impact of the post-COVID-19 lockdown period on PNAs' organisation, DIEL strategies and use of social media functions.

Figure 20 Summary of the impacts of the post-COVID-19 lockdown periods on PNAs' organisation, DIEL strategies and use of social media functions



Key points presented in this chapter

Following a two-stage data collection involving practitioners from French PNAs, the data analysis presented in chapters 5, 6 and the discussion in chapter 7 addressed the research question outlined in Chapter 1.

The results give an in-depth understanding of PNAs' DIEL strategies. First, they show that the digital tools for education by PNAs often lack a strategic compass and well-defined objectives. This deficiency results in the under-exploitation of social media's main features, particularly its relational and experiential functions. Second, the findings allowed the researcher to categorise PNAs into four profiles reflecting how the diversity of their approaches to their educational mission and their digital culture impact their DIEL strategies. Third, they contribute to the understanding of PNAs' digital transformation by revealing its continuous and non-linear nature. Fourth, they reveal the main challenges PNAs face in their digital transformation and highlight the interplay between organisational challenges and the strategic utilisation of social media functions.

The findings give insights into the impact of DIEL on the visitors' learning eco-literacy. Firstly, they show the positive effects of DIEL strategies that fully leverage the diverse functionalities of social media platforms on the visitors' learning outcomes. Secondly, the study unveils the mechanisms and pathways through which social media can lead to negative learning outcomes for visitors, highlighting the need for vigilant moderation and content monitoring by PNAs.

Finally, this chapter provides valuable insights into the short-term and long-term effects of COVID-19 on the digital transformation of French natural heritage institutions, contributing to our understanding of how external crises shape organisational adaptations in the digital realm.

Chapter 8 Conclusion

This chapter summarises the research outcomes produced as part of this PhD project. First, a description of the steps taken to complete the thesis is given in section 8.1, followed by a summary of its key contributions in section 8.2. Next, section 8.3 highlights the research limitations and the opportunities for future research. Then, the academic and non-academic outputs obtained while carrying out this research project are discussed in section 8.4. Finally, section 8.5 concludes with the researcher's closing remarks.

8.2 Summary of the key contributions

In addition to addressing the research questions presented in chapter 1, this thesis provides additional contributions to the body of knowledge discussed in Section 8.2.1. It also offers managerial contributions and recommendations (see section 8.2.2) and highlights several societal implications (see section 8.2.3.).

8.1 Summary of the path followed for the conduct of the Research

The urgency of addressing climate change and biodiversity loss has required global institutions to focus on mitigating anthropogenic pressure on natural environments and on the sustainable development of society. Thus, global commitment to sustainability goes beyond reducing CO2 emissions; it also includes efforts to restore and conserve natural ecosystems and to increase public awareness about environmental issues. At the same time, rapid advances in disruptive technologies have initiated an age of digital transformation permeating every aspect of organisations and society. In this context, the quest to harness technology's potential for the protection of the environment is becoming paramount. Therefore, this study was carried out to contribute to meeting this imperative by investigating the interplay between the digital practices of organisations and education for sustainable development. This study was motivated by gaps in the literature and conversations with conservation and communication experts. More specifically, informal consultations with French Regional Nature Park gatekeepers validated the topicality of this research and the relevance of equipping PNAs with DIEL strategies to foster visitor eco-literacy while concurrently meeting new societal expectations.

As described in chapter 4 and Figure 7, the researcher based the design of their methodology on the expert's view and the literature review. To capture an overview of the research context while gaining insight into the PNA's perceptions of the research subjects, a first data collection via an online questionnaire was carried out with the help of the French Regional Nature Parks' gatekeepers. Subsequently, an interview guide for employees of PNAs was developed, informed by the results found in the questionnaire.

However, the interviews were conducted in the spring and after the COVID-19 lockdowns in France. As a result, PNAs were under pressure as the number of visitors increased. This context made it difficult for nature reserves and national parks to devote time to participating in this research project. However, as they acknowledged the research topic's relevance for their organisations, one National Park and six Nature Reserves accepted to participate in the study.

Concurrent with the conduct of the interviews, the researcher started the redaction of recommendations presented and circulated to the French Regional Nature Parks network in the form of a report and an online seminar held on 10/03/2023. The seminar gathered 32 communication managers and Regional Nature Parks Federation members and consisted of a 35-minute presentation followed by a 45-minute question-and-answer session. An anonymised copy of the comments made in the chat by the participants during and after the seminars can be found in Appendix I. In addition, the gatekeeper circulated a feedback form to the participants following the seminar. The two answers received are presented in Appendix J. The seminar and the feedback forms allowed the researcher to validate and refine the findings and recommendations presented in the thesis.

Overall, the path taken in this research has been driven by four main factors:

- Consider the perspective of the PNAs before the data collection on the research project design.
- Establish a relationship of trust with the protected natural areas to ensure their involvement in the data collection in a challenging post-COVID-19 and high visitation context.
- Ensure the validity and credibility of the research findings and their interpretation via participants' feedback.

- Ensure the research impact of this study by contributing to the literature, society and the PNAs with relevant and actionable recommendations.

8.2.1 Theoretical contributions

This study has several theoretical contributions. Firstly, it contributes in several ways to the resource and capability theory and knowledge management body of knowledge. It expands the set of capabilities considered in the resource-based view literature by identifying ICTs as valuable resources with strategic capability-building potential. It also investigates these capabilities in the specific strategic context of education and conservation objectives. The findings reveal how the combination of environmental knowledge and ICTs as a resource can support organisational capabilities that allow them to achieve their specific objectives. More specifically, in the context of PNAs, implementing DIEL (e.g. editorial and managerial strategies) can enable the mobilisation of ICTs to achieve their educational and conservation mission by supporting the eco-literacy of their visitors. This research defines specific pathways and conditions for PNAs to transform their ICT capacity into a capability that enhances visitors' eco-literacy. Therefore, by providing a detailed understanding of the specific contexts in which the use of ICT as a resource translates into increased value for stakeholders, this research extends the applicability of the resource and capability theory.

Moreover, by exploring the paths and processes allowing for a positive and negative impact of digital tools on the PNAs visitors' eco-literacy and providing managerial recommendations to set up their DIEL (see section 8.2.2), this study answers the call of He et al. (2022) for "more studies [..] not only to understand better the influence of digital tools on visitors' pro-environmental behaviour but also to identify how their efficacy can be improved". Therefore, by uncovering the pathways and tools that can be harnessed to elevate individuals' eco-literacy, this study identifies avenues through which digital tools, such as web 2.0, interactive applications, and immersive virtual experiences, can be leveraged to support society's transition toward sustainability. By revealing these pathways and tools, the research offers a roadmap for organisations, educators, and policymakers to leverage digital tools and resources effectively. By investigating the negative impacts of DIEL on visitors' eco-literacy, this study aims to contribute to a critical discussion related to the impact of digitalisation and avoid "naïve" technological optimism. In doing so, the researcher intends to address calls to produce interpretative and critical research regarding digital technology implementation in

governmental or public organisations (McBride et al., 2022; Meijer & Bekkers, 2015). Finally, this study addresses Medaglia, and Zheng's (2017) call to examine the impact of social media properties and features on public organisations' digital strategy by exploring how PNAs can leverage the three functions of social media to support and extend the educational journey of visitors and the wider social media user community, while also considering the potential risks of negative learning outcomes and behavioural impacts associated with these functions.

Secondly, this study addresses calls for exploring the activation of positive emotions towards Nature to promote PEB (Barbiero & Berto, 2018). Indeed, the results show that the experiential function of Web 2.0 can support the eco-literacy of users via explicit and implicit environmental knowledge and the activation of positive attitudes and emotions towards Nature. In doing so, this study contributes to the emerging literature on Technobiophilia and argues in favour of a positive synergy between humans and Nature in cyberspace. Conversely, it also alerts to the risks of normalising non-PEBs through individuals, public institutions and businesses disseminating pictures and videos online. Indeed, this study emphasises the potential significance of the images and videos posted embedded narrative online, contributing to a commodification, decontextualisation of outdoor activities and spectacularisation of Nature, which in turn can lead to unsafe behaviours and non-PEB of individuals in Nature. These insights contribute to a nuanced understanding of the complexities surrounding the symbolic experience of Nature in digital spaces and its implications for individuals' IEL and eco-literacy.

Thirdly, the findings of the study align with theories such as the Theory of Planned Behaviour, reaffirming the connection between knowledge and behaviour while stressing the crucial roles of emotions and tacit knowledge in the learning process. Specifically, results reveal that virtual content found on social media can create normative perceptions influencing users' conservation behaviours. Indeed, the findings show that UGC can encourage both PEB and mimetic behaviours that can have harmful effects on the conservation of ecosystems. Furthermore, the findings describe how digital tools can activate the users' technobiophilia and positive attitudes toward conservation and nature. Therefore, by describing the specific processes of subjective norm shaping and attitude formation toward nature enabled by digital tools, this research contributes to our theoretical understanding of two key drivers of

environmental behaviours. Also, the study uncovers four distinct approaches of PNAs in disseminating environmental knowledge and targeting local or global audiences. The classification introduced by the study can serve as a theoretical framework for analysing the alignment between organisations' profiles, DIEL strategies, and DIEL outcomes.

Fourthly, by aiming to make sense of the "figured world" and the perceptions of participants, this study contrasts with research that considers the implementation of digital transformation in public organisations and government from a positivist perspective. In doing so, it addresses the call of Meijer and Bekkers (2015) for studies to examine the values and beliefs of individual actors. It also confirms the relevance of such studies, showing that cultural challenges, identity and performing tensions were the most significant challenges to overcome for using Web 2.0 for educational purposes in PNAs. Analysis of the data revealed that the varying ability of participants' organisations to meet these challenges was reflected in their different levels of digital adoption maturity. Thus, by revealing the factors hindering the adoption of digital tools in conservation organisations and identifying strategies to overcome these barriers, this study contributes to the theory of technology adoption.

Fifthly, the results of this study challenge linear and staged innovation models (Buijs, 2003; Tohidi & Jabbari, 2012) by showing that the digital transformation of PNAs is supported simultaneously by innovation exploration and exploitation tactics. Indeed, while some PNAs set up exploitation strategies by institutionalising the use of social media via guidelines, editorial committees, or moderation charters, they also allow change agents (intrapreneurs) to experiment, test and explore social media. This flexibility allows PNAs to overcome the structural and cultural challenges associated with implementing a DIEL strategy (e.g. lack of resources, identity and performing tensions). These findings align with those of Dekker et al. (2020), who found that the Dutch and UK police approach the implementation of social media from a *'perpetual beta'* perspective defined as an "iterative process of innovation adoption", implying a development stage extending over an indefinite period of time (p. 101441). This perpetual beta innovation mode, also found in PNAs, illustrates these organisations' requirements to continuously adapt to socio-technical and environmental changes.

In the literature, the public organisations' digital innovation process is described as emergent and fluid due to the relational functions of social media (Dekker et al., 2020; Picazo-Vela et al., 2016). For example, in Dekker's (2020) study, the Dutch and UK police continuously modify

their social media content as "users are treated as co-developers from which the organisation learns and can adjust" (p. 101441). Picazo-Vela et al.'s (2016) case study showed that "technology, instead of a tool, constitutes activities and identities making the material and the social inseparable in "socio-material assemblages" (p. 695). However, as shown in chapter 6, the emergence of intrapreneur and digital experimentation in the context of PNAs seems to be driven by a lack of resources and leadership related to DIEL strategy rather than the exploitation of the relational function of social media and users' feedback. These results raise questions related to the capacity of small and less-resourced organisations to meet the digital expectations of society and their stakeholders. These organisations may thus perceive the implementation of digital tools not only as beneficial but also as a source of stress (Booth et al., 2019). In turn, this may fuel their resistance to making the organisational, cultural, political, and managerial adjustments necessary for their implementation.

Finally, the research findings depict a dichotomous landscape of digital governance among the studied organisations divided into two groups. The first group comprises organisations with pre-digital managerial norms, pedagogy approaches, mindsets, and practices. For example, some organisations in the study do not recognise the value of digital tools in educational contexts and see digital communication as secondary to 'real work'. These participants perceive digital transformation as counter-productive and contradictory to their educational and conservation logic. In contrast, the second group of organisations is willing to embrace change and digital transformation, implement a pedagogy of construction and connection and demonstrate a higher level of maturity in digital adoption. These organisations consider the use of digital tools beneficial for the realisation of their missions and a professional imperative.

This contrasting picture revealed in this study suggests the de-institutionalisation or de-normalisation of pre-digital logic to the benefits of a new institutional logic centred around digitalisation. This study provides evidence of ongoing transformations reshaping institutions and demonstrates the adaptability of heritage organisations in an era of digital transformation. Therefore, this study adds to the existing body of knowledge, providing valuable empirical evidence to support the newly emerging concept in the literature known as the “institutional logic of digitisation” (Schildt, 2022). This study also enriches our understanding of how digitalisation influences institutional dynamics and strategic decision-

making processes; its findings are relevant and generalisable to all organisations undergoing digital transformation.

8.2.2 Managerial contributions and recommendations for PNAs

To ensure the validity and credibility of the research findings and their interpretation, a white report was circulated with initial managerial recommendations to PNAs participating in the study. They were also invited to a seminar with Q&A was held on March 10, 2023 by the researcher to discuss the white report recommendations. This allowed to:

- Control the validity of the findings and enabled the researcher to refine the recommendations to ensure the research made relevant contributions and actionable recommendations to PNAs.
- Add rigor to the research methodology by seeking participants' feedback to confirm the results resonated with their on-the-ground experiences and perspectives. This participant validation reinforced the credibility of the data analysis carried out.

Seminar contributions

The seminar confirmed that the findings aligned with the participants' real-world experiences and that the recommendations were relevant to them. Two ideas were found to be particularly useful: First, the research revealed the potential for social media to extend visitors' learning experience before and after their visits representing a "temporal" opportunity that parks had not previously identified. Digitally enhanced education capability could allow parks to better prepare visitors prior to their trip and nurture meaningful, long-term relationships post-visit to continue eco-education. As this temporal potential was a new insight from the research, the researcher has included recommendation no. 9 on exploiting ICTs to extend the visitor's learning journey before and after the visit to the managerial recommendation of this thesis. (see managerial recommendation section below).

Second, the findings highlighted the siloed organisation of French PNAs. This study and the its findings provided an opportunity for participants to reflect on the need to bridge the gap between conservation and communication experts within and across PNAs. Specifically, the seminar represented the opportunity for conservation and communication officers at federation level to gather and to discuss online communication strategies for promoting park activities and eco-literacy among visitors. Following the seminar, the French Regional Park

Federation decided to organise a workshop during its annual congress, focused on discussing social media as an education tool, gathering both conservation and education officers from across the entire park network. This workshop will facilitate continued cross-departmental and cross-organisational dialogue to further develop strategies leveraging digital channels for eco-literacy initiatives. The seminar marked a first step toward integrating such collaboration into PNAs' communication and education strategies. The importance of intra-organisational and inter-organisational collaboration was therefore stressed by the researcher in their recommendation no 5 (see managerial recommendations section below). Finally, the recommendation proposed in the white reports and this study and discussed during the seminar raised the awareness of PNAs of the importance of knowledge management to turn their ICTs resource from mere DIEL capacity into capability to enhance their positive impact of their visitor eco-literacy.

Manageial recommendations

In the context of the digitalisation of society, this study shows that an effective DIEL strategy can allow PNAs to extend their visitors' learning journey in time (before and after the visit) and space (from direct to the symbolic experience of Nature) and enhance their eco-literacy. Also, in the context of the increase of interest in Nature-based tourism PNAs' DIEL strategy can equip visitors with the necessary knowledge and skills to engage in PEB in Nature. Therefore, this study aims to provide PNAs with recommendations to enhance their DIEL strategies, ultimately assisting them in achieving their educational and conservation missions.

To do so, this study uses an idiographic framing and an empirical, methodological approach to research to analyse how PNAs' employees and management can use digital tools to reach their educational objectives and promote PEBs among their visitors. As noted by Giulio and Vecchi (2021), it is common in the literature to focus on the impact of technology on organisations, yet this impact is also constantly mediated by human agency. Thus, with the intention of encouraging reflexive work, which considers the agency and intentionality of PNAs' employees in the implementation of DIEL strategies and based on the research findings, several recommendations are made:

1. **The need for a digital strategy:** To optimise resources through the use of online platforms for educational purposes, it is imperative that parks implement a digital strategy based on a definition of key elements such as their educational objectives,

target audiences, messages to be transmitted, behaviours to promote or avoid etc. Indeed, as shown by Picazo-Vela (2016) and Dekker et al. (2020), successful use of social media relies on the strategy adopted, the format and content of the messages disseminated online and the definition of the community with which one chooses to communicate. Furthermore, to implement a successful DIEL strategy, PNAs must be able to establish “a line of sight" for their employees. This means ensuring they understand organisational objectives and how to contribute to them (Boswell & Boudreau, 2001, p. 851). Yet, the results of the questionnaire and interview show that no clear line of sight was provided to employees in terms of social media implementation for educational purposes:

“We are told "You have to be on social networks", but rarely why, in terms of their real impact.”-PQ16

In addition, individual PNAs and their federation could revisit and re-assess their social media presence, their underlying goals and effective ways of communicating them to their internal and external stakeholders, drawing from the lessons learned and advancements achieved during the COVID-19 pandemic.

2. **The importance of leadership and digital mindset:** Leaders need to recognise that digital transformation is a strategic paradigm shift that requires an environment conducive to change and fostering the digital mindset of their employees (Hemerling et al., 2018). In addition, to overcome identity and performing tensions within PNAs willing to implement digital tools, management should present ICTs as desirable and not necessarily as providing better educational contexts than face-to-face and on-site activities, but different contexts and opportunities for learning (Meijer, 2015; Selwyn et al., 2002). Also, social media can be presented as a tool for practitioners to value and promote their missions and activities to the public.

   As stated in Tribe and Mkono's (2017) study, "We are so lucky to live in a time with all this amazing technology. It is what we choose to do with it individually and as a community, nation and planet that counts" (p. 113). Therefore, it is crucial for managers to address how the implementation and utilisation of digital tools may be

carried out within an ethical framework and aligned with their organisations' missions and values.

3. **The need for goals and metrics:** Clearly defined goals and objectives are fundamental to implementing a successful DIEL strategy. The lack of evaluation of the impact of social media mentioned by some participants could be compensated by the implementation of a digital strategy defining specific quantitative and qualitative objectives which could be measured. For example:

   - ***Online:*** engagement with publications, ability to reach a specific audience in terms of age or geographic location, number of publications related to the exploration of activities carried out in the field, online assessment of visitors' perceptions and understanding of conservation missions and stakes, etc.

   -***In the field:*** number of participants in park activities who have known them through social media, observation of behaviour changes, field study, assessment of the visitors' understanding of conservation missions and stakes. Qualitative assessment of the ability of the organisations to anticipate and understand new trends (new sports, new fashionable places, etc.) and/or to confirm and inform the perceptions and practices of the teams on the field, etc.

4. **The need for resource alignment:** The success of an organisation's digital strategy is closely linked to its alignment with the resources it devotes to its implementation (Yeow et al., 2018). In addition, the dynamic and evolving context of social media requires a regular reassessment of digital strategies and practices, as well as technology and skills needs.

   Based on the findings of this study and the literature, we can argue that implementing a DIEL strategy requires simultaneous changes across multiple components of PNAs, not only at the strategic level but also at the technical, financial and human resources level (Yeow et al., 2018).

5. **The importance of intra-organisational and inter-organisational collaboration:** Concerning parks that have effectively implemented a communication strategy using digital platforms, it is important to maintain a high level of intra-organisational collaboration and connectivity between agents within the park, as this would allow a holistic approach to environmental communication that promotes the field agents' work and raises public awareness of the challenges faced by parks in achieving their

mission. Indeed, according to Yeow et al. (2018), "a digital strategy is inherently trans-functional".

PNAs' federations and networks should foster inter-organisational collaborations and experience sharing to provide PNAs with best practice guidelines and to pool and rationalise PNAs' resources allocated to digital innovation.

6. **The significance of an editorial line:** Concerning parks that have set up a mechanism for their online communication, the responsibility for creating and sharing knowledge in their online platforms is diluted across the organisation. It is thus important to ensure that an editorial line is established and followed to ensure consistency of the messages broadcast on social networks.
7. **The opportunity for connectivity and feedback:** While interactivity is the main characteristic of social media, PNAs do not seem to exploit it. PNAs' social media is mainly used as a one-way, vertical communication (like a website). Yet, according to academic studies, Web 2.0 seems to be an environment favourable to the activation of social norms to stimulate the ecological awareness of individuals and encourage them to act in an eco-responsible way (Han & Cheng, 2020; Ostrow Michel & Zwickle, 2021; Wan & Du, 2022). The implementation of two-way communication with visitors would allow parks to update their digital strategies to remain relevant and effective.
8. **The importance of the promotion of know-how:** The creation of content on social media relating to the skills gaps and the behaviours expected from visitors, in addition to ‘raw’ environmental information, could make it possible to better promote eco-responsible behaviours and to report certain behaviours.

   In the aftermath of COVID-19, the PNAs' description and communication of the expected PEBs from their visitors become increasingly crucial, as they play an essential role in educating and guiding new types and primo-visitors who might not be accustomed to activities within protected areas.
9. **The opportunity to extend the visitors' learning journey:** Digital tools could be considered an additional tool for PNAs to extend their learning before and after their visit. It may prepare the visitors for the expected behaviours and provide them with the required institutional information. In addition, it may allow for answering the visitors’ questions following their visit, getting their feedback and creating a long-term

relationship, allowing them to get deeper into the educational journey and improve their global eco-literacy.

10. **The importance of Openmindedness:** Managers should allow agents of change to experiment with social media. Indeed, this will assist their organisation in coping with the rapid changes in the digital ecosystem while also updating their employees' cognitive frame and perception of social media, reducing potential paradoxical tensions at both the individual and organisational levels (Sharma & Bansal, 2017).

In providing PNAs with managerial recommendations to improve their use of social media for educational purposes, this study answers the call of Teubner and Stockhinger (2020) for academics to discuss the managerial challenges imposed by digitalisation and how to address them. Therefore, this study contributes to understanding how digitalisation impacts strategic decision-making processes. As such, the study's findings and recommendations are generalisable to all organisations considering implementing a DIEL strategy.

Finally, the findings of this study consider the impact of the post-COVID-19 lockdowns on PNAs' DIEL strategies, answering the call "for improved planning, strategic communication, and online/digital communication and engagement with visitors" due to the increased use of natural areas during the pandemic (He et al., 2022; Miller-Rushing et al., 2021).

8.2.3 Societal implications

This study has several social implications.

First, Soga & Gaston's (2016) study demonstrates the ongoing loss of interaction of humans with Nature and argues that individuals are increasingly less likely to have direct contact with Nature mainly due to urbanisation. This context results in "*the extinction of experience*", defined by Pyle (1993, as cited in Soga & Gaston, 2016) as: "*not just about losing the personal benefits of the natural high. It also implies a cycle of disaffection that can have disastrous consequences ".* The results of this study show that Technobiophilia and the symbolic experience of Nature in cyberspace can represent an opportunity for conservation organisations to act against this "extinction of experience" by reaching out to urban and non-traditional visitors (Klein & Hilbig, 2018; Oe et al., 2022; Thomas, 2013). Also, it shows that the experiential function of Web 2.0 can generate positive emotions toward Nature. Therefore, harnessing the potential of Technobiophila could have important positive impacts

on the conservation of natural ecosystems. In addition, as contact with Nature was proven to have a positive impact on individuals' cognitive functioning, emotional well-being, and mental health (Bratman et al., 2019), the concept of Technobiophilia holds the possibility for immersive virtual Nature to contribute to strategies design in public health and well-being (Oe et al., 2022, p. 6).

Moreover, more than half of the world's population directly depends on natural resources and biodiversity for their livelihood (IUCN, 2021a), even though natural capital per capita has declined by 40% since 1990 (WWF, 2020). *"Together, this evidence shows that biodiversity conservation is more than an ethical commitment for humanity: it is a non-negotiable and strategic investment to preserve our health, wealth and security"* (WWF, 2020, p. 7). Therefore, Technobiophilia and DIEL can play a pivotal role in attaining the health and well-being targets outlined in SDG 3 (good health), 14 (life below water) and 15 (life on land) and ensuring a sustainable approach to nature-based tourism.

Second, the results of this study show that digital tools can be regarded as a hub for environmental knowledge. In the same way that the literature has regarded the museums as a cultural network (Russo et al., 2009; Zareie & Navimipour, 2016), the researcher proposes to consider PNAs as a trusted online educational hub extending their pedagogical practices online to involve as many people as possible in IEL to develop their eco-literacy. This knowledge hub could help counteract the negative effects of digital tools on global conservation efforts and the eco-literacy of the population, as revealed by the results of this study. This aligns with Šmelhausová et al.'s study (2022), which found that when encountering a photo depicting harmful behaviour towards nature for the first time, 80% of Instagram users initially have a positive sentiment toward the picture. However, their opinions shift after being informed about the detrimental effects of the behaviours depicted in the picture on the environment. In fact, after this re-contextualisation of the picture, only 20% still expressed liking the photo, and 80% said they would unfollow the creator if they posted the same picture as they no longer found it inspiring. These results suggest that by correcting, commenting, moderating UGC and adding context to the conservation discussion online, conservation organisations can positively impact web users' eco-literacy.

In addition, as highlighted by Jaric et al. (2022), the *extinction of experience* can lead to "*societal extinction of species*", defined as the reduction of "societal salience of species to a

point where they are collectively forgotten" (p1), which may lead to a depletion of support for the conservation effort. Therefore, by acting as an environmental knowledge hub, conservation organisations could increase species salience, reverse species' societal extinction, and support global conservation efforts.

Finally, as described in section 7.1, the findings show that PNAs may have different approaches to their educational missions. Indeed, when communicating with their visitors, Nature Reserves prioritise addressing a narrow scope of eco-literacy strictly related to their missions, while National and Regional Nature Parks extend the content of their communication to the broader concept of sustainability. Therefore, participants' strategies for reaching audiences differ, reflecting their distinct perspectives on disseminating environmental knowledge. Therefore, as stated by Participant 5 in the questionnaire, PNAs' missions may need to be clarified:

"The various missions given by the law to regional nature parks should be examined and defined in greater depth." – PQ5

Based on these findings, this study encourages reflection on what society expects from conservation organisations as part of the global framework of environmental education and, as a result, clarification of their missions and the resources provided to them. This is especially true if PNAs are considered components of a global environmental knowledge hub that supports the sustainable transition of the entire society (European Council, 2022; Zareie & Navimipour, 2016).

8.3 Limitations and areas for future research

In chapter 4, the researcher discussed the study's methodological limitations and how they were mitigated where possible. Also, this section presents limitations related to the research context that may impact the generalisation of the study's findings while revealing new research opportunities.

First, this research was carried out in France, where access to Nature and PNAs is, in principle, open to all and free (Les parcs nationaux de France, n.d.), with few exceptions. Therefore, the results of the study can not be generalised to other PNAs with restricted and or fee-based

access, such as in the USA, Poland, Costa Rica, South Africa or Tanzania (Jolivet, 2019). Indeed, it can be argued that whether or not a park is financially dependent on the number of visitors it receives can affect its perception and use of social media as a promotion and educational tool. In addition, PNAs in France are under the supervision of the French Office for Biodiversity and are generally managed by a mix of public institutions, associations, and elected representatives. As shown in chapter 6, this specific mode of governance impacts the implementation of DIEL strategies of French PNAs. Therefore, the research findings can not be generalised to PNAs under complete private governance, such as in Brazil's Private Natural Heritage Reserves (IUCN, 2018). Future research could be carried out to investigate how culture and/or governance can impact and challenge the implementation of DIEL strategies in PNAS in cross-country and cross-regional comparative studies.

Nonetheless, given that a majority of PNAs in Europe provide free access (National Parks of Europe, 2023) and are under a public governance regime (Petrić & Mandić, 2021), the insights and recommendations derived from this study hold value for European PNAs that share the common traits of free accessibility and a blend of public governance.

Second, the resources allocated to this research did not allow the researcher to include the perspective of all PNAs stakeholders, such as the visitors, the social media users, the French Office for Biodiversity or the local businesses and organisations. Future research could fill these gaps and investigate if individuals are increasingly engaged with digital tools for experiencing natural heritages and how ICTs could add value to their online and on-site experience. In addition, this study revealed a lack of coherence in terms of discourse, tone, and content disseminated by PNAs and their stakeholders. Therefore, future research could investigate what narrative related to human/nature relationship and sustainability is desirable for PNAs and their stakeholders and how its coherence can be orchestrated by governmental bodies and PNAs' network management.

Finally, this study was carried out in the post-COVID-19 context in France. However, the lockdown's duration and consequences differed from country to country. In addition, the literature has shown contrasting impacts of COVID-19 lockdowns on PNAs in different parts of the world (Souza et al., 2021). Therefore, future research could investigate if other COVID-19 legacies may be found in other parts of the world, especially in areas where COVID-19 led

to the diminution of the visitors' frequentation in PNAs and what lessons can be drawn from it.

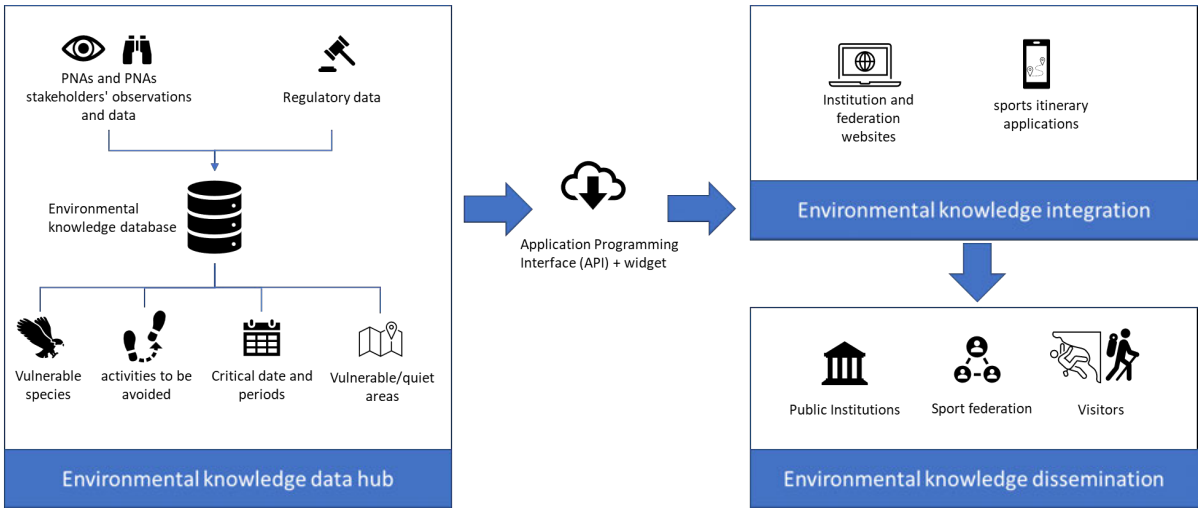
In line with the findings presented in Chapters 5 and 6, scholars and practitioners are encouraged to collaborate on addressing several challenges identified by this study.

Firstly, in accordance with Gossart's study (2021), this research reveals the need to devise indicators that can effectively evaluate the efficacy of DIEL strategies of PNAs. It highlights the limitation of conventional marketing indicators (such as the number of likes and followers) that may not aptly capture the unique attributes of conservation organisations and their underlying missions. Consequently, future investigations are warranted to establish Key Performance Indicators (KPIs) tailored to the specific characteristics of conservation organisations. These KPIs need to be aligned with their educational mission, which involves disseminating knowledge to enhance visitors' eco-literacy while considering safeguarding the integrity of ecosystems and mitigating the environmental footprint of visitors and their potential consequences for the PNAs' conservation objectives.

Secondly, this study shows that moderation and monitoring of online content are essential for PNAs to limit their visitors' opportunities for negative learning online. However, these practices were described by participants as "overwhelming" or "time-consuming". Therefore, a first avenue of research could explore how artificial intelligence and new technological advances can support PNAs in policing misconduct and unwarranted information on social media. A second potential line of research is to explore how PNAs could use digital tools to solidify their position as an environmental knowledge hub aiming at the diffusion of warranted information online, allowing for the visitors' PEB. For example, interview Participant 9 mentioned the "Biodiv-Sport" application, a participatory system responsible for defining areas with wild fauna/flora sensitive to disturbance. Once defined, these zones are shared with partner platforms such as "Visiorando" (mobile application downloaded more than a million times on Google Plays Store) via a data flow (API), whose users will receive alert and awareness messages when they are in these sensitive zones (BiodivSports - LPO France, 2023). Following the same logic, as shown in Figure 21, conservation organisations could combine regulatory information and field observations to create an open-access environmental knowledge database that could then be integrated into mainstream phone applications and websites, providing a large audience of visitors, public institutions and sports

federations with real-time information on the presence of vulnerable species within their areas and warning them of activities to be avoided or prohibited. Therefore, future research could investigate how conservation organisations could take advantage of open-source information and inter-modalities of online platforms and applications to build an up-to-date, easy-to-access eco-knowledge hub. Research would then be needed to look at the technical requirement of such inter-modalities and reflect on how the government could support conservation organisations in the mainstream dissemination of open-source information to counteract the visitors' access to unwarranted sources of information.

Figure 21 Example of an open-access digital environmental knowledge hub based on the BiodivSport project. (source: the researcher, adapted from LPO, 2023)



Thirdly, the boundaries between reality and the virtual realm become fuzzier in a context where one can be connected to anything and everywhere, thanks to ICTs (Oe et al., 2022). Thus, concerns are raised regarding the potential desirability of such ubiquitous connectivity (Radtke et al., 2022). These concerns are translated in the fear of some participants in this study of degradation and a reduction of the direct experience of Nature by visitors due to using ICTs. That led Nicolinia and Fraticelli (2020) to coin the term *digital carrying capacity*, defined as "the possible degree of "reduction" of the human-nature connection due to the introduction of new IT visiting experience in a protected area" (p. 7). However, studies show that ICTs have become essential to visitors' experiences of their environment and that practices such as taking photography in PNAs to feed social media can be regarded as a complex combination of technology, discourse and materiality (Müller-Roux, 2021). In addition, this study found that digital tools, especially the experiential function of Web 2.0, can be used to induce positive emotions toward Nature. Therefore, in agreement with Oe et

al. (2022), the researcher argues that research should address the issue of whether "it is appropriate to view the real world and the virtual world as opposites and to analyse them in the context of a trade-off relationship" (p. 6). Studies could also investigate how ICTs such as social media mediate the individual relationship with Nature while visiting PNAs. They could also investigate what is gained and lost in the mediated experience of Nature in cyberspace and give a critical perspective on how it affects both individual and collective conservation efforts and eco-literacy. Finally, future research is needed in Technobiophilia that investigates the immediate and long-term impacts of nature experience in cyberspace on individuals' well-being and biophilic characteristics.

8.4 Academic and non-academic outputs related to the research

During the completion of this PhD research, the researcher took opportunities to present the research project design and findings to academic and non-academic audiences via seminars, conferences, and publications. In addition, research projects indirectly linked to the completion of the present thesis were carried out that allowed the researcher to expand their academic network and improve their research and writing skills.

8.4.1 Conferences and seminar presentations:

- **Faculty of Business and Law PGR presentation series** (CBIs) 7th December 2020
  Research project presentation: *COVID-19: An Opportunity to reinvent the Tourism Industry?*

- **Association of Economics and Business Management Conference** (ACEDE) 30th June 2021
  Presentation of a paper: *A critical assessment of the evolution of companies' engagement in CSR by analysing the evolution of the rhetorical and visual language in their nonfinancial reports: examples from China, Germany and the United Kingdom*

- **22nd European Conference on Knowledge Management** (ECKM) 2-3 September 2021
  Presentation of a poster: *Are the policies implemented in protected natural areas in Europe in line with SDGs and allow for pro-environmental behaviour of stakeholders?*

- **Centre for Business in Society seminar in Coventry University** (CBiS) 16th February 2022
  Seminar presentation: *Technology as a tool to promote pro-environmental behaviours*

- **17th International Forum on Knowledge Asset Dynamic** (IFKAD) 20-22 June 2022
  Presentation of a paper: *Data privacy practices and Organisational reputation: the mediating role of eco-innovation and green Skills.*

- **Seminar** for MSc master students at Coventry University 3rd October 2022
  Seminar presentation: *Law and Governance in Protected Naturals Areas in the World*
- **Conference** ECKM 2023 September 2023
  Seminar presentation: Ecotourism Capital as an Enabler of Positive Change in Tourism Sustainability
- **Conference** IEEE -ICTE 2023 October 2023
  Seminar presentation: Setting a strategy for the use of digital technologies to promote eco-responsible Behaviours: the case study of Nature Parks in France

8.4.2 Publications

Di Chiacchio, L. (2021), Do the Policies Implemented in Protected Natural Areas in Europe Allow for Pro-Environmental Behaviour of Their Stakeholders? In A. Garcia-Perez & L. Simkin (Eds.), *Proceedings of the 22nd European Conference on Knowledge. Management, ECKM 2021*, Academic Conferences International Limited, pp. 983-987, 22nd European Conference on Knowledge Management, Coventry, United Kingdom, 2/09/21. https://www.proquest.com/docview/2581072090

Di Chiacchio, L., Martínez-Caro, E., Cegarra-Navarro, J.G. and Garcia-Perez, A. (2023), "Eco-innovation in the textile industry: the strategic importance of data privacy and environmental knowledge management", Kybernetes, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/K-02-2023-0222

8.4.3 Professional outcomes

- White report: *The Use of social media in French Natural Areas for educational purposes*. *Di Chiacchio, L. (2023). Use of social networks in natural areas of France for environmental education purposes.*

- **Report restitution seminar** for the French regional Nature Parks (online) 3rd October 2023
  Seminar presentation: *Research report restitution: Use of social media in French Natural Areas for educational purposes.*

8.5 Concluding remarks

This research project had several positive outcomes.

First, as demonstrated in the previous section, it added to the body of knowledge and provided future avenues for research. Second, from a personal perspective, this research project allowed the researcher to explore new methodological approaches and strengthen their writing and presentation skills by providing opportunities to address academic and non-academic audiences. As the researcher moves forward in their academic career, the lessons learned, and the knowledge acquired over the course of this three-year study will serve as a

valuable foundation, guiding their future research and allowing them to make meaningful contributions to the research field.

Finally, this research project's findings allow for addressing a topical issue and producing an impactful contribution to research with real-world implications. Indeed, as described in section 8.1, the research findings and managerial recommendations were presented and circulated to the French Regional Nature Parks network in the form of a white report and an online seminar with Q&A on 10/03/2023 leading to the following impact of my research on practice:

- Several participants stated that the findings encouraged reflection and that the report's recommendations were relevant to their organisation.
- Team leaders acknowledge the report recommendations and are planning, for the first time, joint workshops between the communication and education/conservation teams to discuss the use of social media and online educational content.
- The French Regional Nature Parks Federation forwarded the white report to a biodiversity specialist in charge of drawing up an educational guide for the Europe and International Delegation of the Conservatoire du Littoral.

This research project paves the way for discussions and reflections about the place of PNAs in the digital age and how the synergies between technology, environmental learning and conservation can occur. Therefore, by adding to the body of knowledge on the interplay between digital practices and environmental awareness, this study holds relevance as it looks at two major issues facing modern organisations and society: digital transformation and societal transformation toward sustainability.

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Appendices

Appendix A The contribution of PNAs to each SDGs based on IUCN (2020b)

SDG	PNAS' CONTRIBUTION TO SDGS
	Worldwide, 1.1 billion people are estimated to depend on PNAs for their livelihoods, including through secure access to the resources they provide (IUCN, 2020b). They also enable resilience against global warming (Ma et al., 2020).
	In most protected natural areas, resource extraction is prohibited. However, category V and VI natural areas are key players in promoting sustainable agriculture (Wiseman & Hopkins, 2000). Moreover, all categories of PNAs contribute at least indirectly to food security by providing water supply, soil production, preserving genetic diversity and buffering against the effects of climate change (IUCN, 2020b).
	PNAs contribute to the health of their visitors by providing access to outdoor leisure activities, enabling a connection with nature and playing a therapeutic function for mental health and cognitive development functions (IUCN, 2020b; Jones et al., 2020).
	Protected areas have an educational role in raising public awareness of conservation importance. This mission is aimed at all categories of individuals, schools, organisations and institutions (IUCN, 2020b).
	"Like any professional organisation, institutions in charge of managing protected areas are required to respect the principle of parity and to fight against any gender discrimination within their staff"(IUCN, 2020b, p. 14).
	Catchments, forests, and wetlands are essential for flood control, especially for drinking water supply. Indeed, a WWF report indicates that 105 major cities worldwide depend on PNAs for their drinking water (WWF, 2003). This leads some of them, such as New York City, to sustainably manage these wetlands to meet their drinking water needs (NYC Parks et al., 2021).
	Renewable energy development is essential for achieving the SDGs, and sometimes protected areas can be considered for their implementation site. The objective, then, is to make these installations compatible with the conservation objectives of the PNAs (IUCN, 2020b).

	PNAs generate income in their territory by being an employer and tourist attractions. Some communities, especially rural and local ones, may depend on this income. However, the commercial exploitation of these areas must be sustainable and aligned with their conservation mission (IUCN, 2020b, p. 14).
	PNAs are areas for scientific research in geology, biology, sustainable development, etc... When they are inhabited, they can also be an area for experimenting with new, more local and sustainable economic models. To this end, they are central actors in their territories (IUCN, 2020b).
	PNAs support the economy of rural areas through tourism, employment, and the development of a sustainable economy (IUCN, 2020b).
	Some PNAs are located on the outskirts of large cities and provide ecological (freshwater, cooling), social (recreation), and economic (tourism) services (IUCN, 2020b; WWF, 2003).
	PNAs represent models and experimental sites for sustainable resource management (IUCN, 2020b).
	They constitute areas for preserving species and ecosystems, allowing biodiversity protection. They contribute to mitigating the causes and effects of global warming, particularly by acting as a CO2 sink. Finally, they are sites for observing the effects of climate change, allowing us to understand its impacts better.
	Marine-protected areas allow for the protection of nurseries, refuge areas, and breeding grounds. They also support sustainable fisheries, coastal protection and carbon storage (IUCN, 2020b).
	Terrestrial protected areas enable the protection and restoration of natural areas and promote sustainable use of resources to control ecosystem biodiversity. They allow the fight against desertification, soil stabilisation in arid areas and poaching. (IUCN, 2020b).

To fulfil their missions, PNAs must be able to communicate with their stakeholders and be actors in territorial collaboration. Also, transnational PNAs allow for cooperation between populations and international institutions on the issues of sustainable development and conservation (Europarc, 2021).

Protected natural sites can no longer be considered "isolated units" (European Environment Agency, 2021b). At the scale of national parks, ecological coherence sometimes requires "both spatial and functional connectivity within countries and across borders" (European Environment Agency, 2021b), which is why Europe has the most developed network of protected areas in the world (Jones et al., 2020). This awareness stems from the Natura 2000, Emerald or Ramsar sites and other programmes. These ecological corridor projects should be implemented under equitable governance among stakeholders.

Appendix B Copy of the Microsoft Sway mini-site created by the researcher as part of the information of the participants to the survey

In black and blue, the original Microsoft Sway mini-site created by the researcher in French (link to the online version: https://sway.office.com/XKNRugzeHPronUyu?ref=Link). In red is the translation made in English for the purpose of the redaction of this thesis.

These Doctorale [Phd Thesis]

Co-tutelle [co-tutelle]

Laura Di Chiacchio, Doctorante en deuxième année à Coventry University (UK) en co-tutelle avec L'Université Polytechnique de Cartagène (Espagne)

Cette recherche est réalisée dans le cadre de l'obtention d'un double diplôme de Doctorat de Philosophie relatif à la gestion des connaissances, la gestion des données et le développement durable.

[Laura Di Chiacchio, a second-year doctoral student at Coventry University (UK) in joint supervision with the Polytechnic University of Cartagena (Spain)

This research is being carried out as part of a double Ph.D. in Philosophy on knowledge management, data management and sustainable development.]

Contexte recherche

L'importance des zones naturelles protégées en Europe et état de conservation

- 24% Des sites européens endommagés par le tourisme (IUCN,2020).
- 6x Le tourisme axé sur la nature croit six fois plus rapidement que le tourisme conventionnel.

L'éducation et l'apprentissage comme réponse au développement durable

«La connaissance est considérée comme un élément de levier pour le changement social vers la durabilité, et la transformation des valeurs »

(Bryant & Thomson, 2021)

De l'éducation à l'apprentissage environnemental informel en ligne

- Les expériences personnelles ou les échanges en ligne sont reconnus comme ***les premières sources d'apprentissage.***
- La recherche montre que les réseaux sociaux **peuvent être** des outils pertinents d'***apprentissage*** et de ***changement des comportements***.

Potentiel d'apprentissage environnemental

- ***Avant*** et ***Apres*** la visite.
- Nouvelles technologies **(TICs).**
- **Nouveaux types de visiteurs.**

[The importance of protected natural areas in Europe and their state of conservation

- 24% of European sites are damaged by tourism (IUCN,2020).

- 6x Nature-based tourism is growing six times faster than conventional tourism.

Education and learning as a response to sustainable development

- "Knowledge is seen as a lever for social change towards sustainability and the transformation of values". (Bryant & Thomson, 2021)

From education to informal online environmental learning

- Personal experiences or online exchanges are the primary learning sources.

- Research shows that social networks can be relevant tools for learning and changing behaviour.

Environmental learning potential

- Before and after the visit.

- New technologies (ICTs).

- New types of visitor.**]**

Objectifs et Finalites **[Aim and objectives]**

- *L'exploration du potentiel pour les parcs d'utiliser particulièrement les réseaux sociaux, pour soutenir leur objectif* ***d'éducation environnementale.***

- ***Fournir aux zones protégées des stratégies pour utiliser les médias sociaux afin de remplir leur objectif d'éducation et de conservation en soutenant efficacement l'alphabétisation écologique de leurs visiteurs et en promouvant leur comportement pro-environnemental.***

[- Exploring the potential for parks to make particular use of social media to support their environmental education objectives.

- Providing protected areas with strategies for using social media to fulfil their education and conservation objectives by effectively supporting the ecological literacy of their visitors and promoting their pro-environmental behaviour.]

Methodologies

Phase 1: Achevée

Questionnaire à destination des parcs concernant leurs stratégies d'apprentissage environnemental sur les réseaux sociaux.

--> Etat des lieux

- Equipe de communication des PNR (48% taux de réponse).
- Analyse comparative des résultats observés dans les différents parcs.
- Analyse thématique.

Phase 2: Achevée

Interviews à destination des parties prenantes des zones naturelles protégées concernant leurs stratégies d'apprentissage environnemental, en particulier sur les réseaux sociaux.

Analyse thématique et comparative des différentes perspectives et enjeux afin de d'établir :

- Une définition du «**savoir environnemental** » et « **apprentissage environnemental**».
- Une définition du **comportement Pro-Environnemental** dans le contexte des parcs.
- **Les risques associés** à l'apprentissage en ligne, leur potentiel impact sur les comportements.
- **Stratégies** à établir pour surmonter ces risques.

[Phase 1: Completed

Questionnaire for parks on their environmental learning strategies on social networks.

--> Inventory

- communication team (48% response rate).
- Comparative analysis of the results observed in the various parks.
- Thematic analysis.

Phase 2: Completed

Interviews with stakeholders in protected natural areas about their environmental learning strategies, particularly on social networks.

Thematic and comparative analysis of the different perspectives and issues in order to establish :

- A definition of "environmental knowledge" and "environmental learning".

- A definition of Pro-Environmental behaviour in the context of parks.

- The risks associated with e-learning and its potential impact on behaviour.

- Strategies to overcome these risks.]

Contact

Si vous acceptez de participer ou si vous voulez en savoir plus sur mon projet, vous pouvez me joindre par e-mail : dichiacl@uni.coventry.ac.uk

Si vous souhaitez en savoir plus sur mon profil professionnel et académique :

LinkedIn

Orcid

PurePortal

[If you agree to take part or if you would like to know more about my project, you can contact me by e-mail: dichiacl@uni.coventry.ac.uk

If you would like to know more about my professional and academic profile:

LinkedIn , Orcid , PurePortal]

Appendix C Questionnaire question and types of answer

	N°	*Questions*	*Type of answer*
Consent	1	I have read and understood the above information	yes/no
	2	I confirm that I am 18 years of age or older	yes/no
	3	I agree to participate in this questionnaire survey	yes/no

Research items	*N°*	*Questions*	*Type of answer*
The participant profile	4	For/with which park do you work?	open answer
	5	For how long	open answer
	6	What position do you hold?	open answer
The park's online presence	7	Does your park have a website?	Yes/no/I do not know/other
	8a	Is it represented by an official page on social networks?	Yes/no/I do not know/other
	8b	If so, which ones?	Multiple answer tick boxes: Facebook, Twitter, Instagram, YouTube, Snapchat, TikTok, LinkedIn, Pinterest, Flickr, and other
The digital education strategy	9	Are you in charge of the content, or do you have access to the content creation and diffusion on the park's social networks?	Yes/no/I do not know/other.
	10	Who is allowed to add content to the park's social networks?	I am solely responsible for the content of the park's social networks / Several people are authorised to produce content for the park's social networks / other
	11	Has the park implemented a specific strategy and defined objectives in terms of educational content related to environmental issues and eco-responsible behaviour on social networks?	Yes/no/I do not know/other
	11a	Please specify	open answer

	12	Are the publications on the park's social media the subject of collaboration between different people/core services of expertise (for example, tourism, sustainable development, guides, etc..).	Yes/no/I do not know/other
	12a	Please specify	open answer
	13	Have strategies for creating and distributing content on social networks changed as a result of COVID-19?	Yes/no/I do not know/other
	13a	Please specify	open answer
Participant perception of digital tools and The digital education strategy:	14.1	Overall, social networks have a positive effect on the environmental knowledge of park visitors.	Likert scale 5 point from completely disagree to completely agree
	14.2	Overall, social networks have a positive effect on the PEB of park visitors.	
	14.3	I think that social networks can be used to warn people about what to avoid doing in the park	
	14.4	I think that social networks allow us to promote eco-responsible actions in the park.	
	14.5	I think it is necessary for the park to be able to inform and educate visitors about the park's conservation missions before they visit the park.	
	14.6	I think it is necessary to maintain contact with visitors after their visit to the park.	
	14.7	The park supports the exchange of environmental questions and information between visitors and the park on its social networks.	
	14.8	The park encourages visitors to share their environmental knowledge with other visitors on our social networks.	
	14.9	I think it is important to pay attention to the information spread by third parties about the park on social networks.	
	14.10	I think that social networks are an effective way for the park to convey ecological messages to visitors.	
	14b	Please enter here your comments on the questions asked in the table above	Open answer

Educational Content	15.1	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as climate change.	Likert scale 5 point from completely disagree to completely agree
	15.2	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as renewable energy.	
	15.3	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as sustainable use of the territory.	
	15.4	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as sustainable use of resources.	
	15.5	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as water pollution.	
	15.6	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as the conservation of ecosystems.	
	16.1	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as the biodiversity stakes of the park.	Likert scale 5 point from completely disagree to completely agree
	16.2	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as means for the visitor to reduce his/her carbon footprint.	
	16.3	The park's social networks are used to enable residents and visitors to understand the park's environmental issues in a global context, such as a link between behaviour and their impacts on ecosystems.	
	16b	Please enter here your comments on the questions asked in the table above:	Open answer
	17	The park has put in place strategies to inform visitors before their visit via social networks so that they are aware of the behaviour to adopt in the parks.	Yes/no/I do not know/other

Educational Content	17a	Comments	Open answer
COVID-19 impact	17b	Have these strategies for educating and informing visitors prior to their visit on social networks evolved following COVID-19?	Yes/no/I do not know/other
	17i	Why? How?	Open answer
The digital education strategy:	18	**Is there a specific strategy and tools to ask visitors questions and/or to collect their opinions on their needs/wishes for environmental education?**	Yes/no/I do not know/other
	18a	If yes, which ones	Open answer
The digital education strategy:	19	The park has put in place a strategy and tools in order to be aware of information disseminated about the park by third parties (outside the official park page) on social networks.	Yes/no/I do not know/other
	19a	Why?	Open answer
COVID-19 impact	19b	Have these strategies evolved following COVID-19?	Yes/no/I do not know/other
	19i	How? Why?	Open answer
The digital education strategy:	20	Is there anything you would like to add or clarify to the researcher before completing this questionnaire?	Open answer

Appendix D Pre-Interview documentation

Topics to be discussed in the interviews

Environmental learning and pro-environmental behaviour in protected natural areas and nature parks through social networks.

You are invited to participate in a research project exploring the potential, opportunities, and threats of using social networks for educational purposes and for promoting PEB in natural protected areas and natural parks.

The interviews will be conducted on TEAMS or ZOOM in a guided discussion format to gather your perspective on the above research topic. For your information, you will find below the list of topics that will be addressed during this discussion.

1. Questions relating to your knowledge or lack of knowledge of the use of social networks by your organisation:

Example of themes to be discussed:

   a. Main uses of social networks
   b. The targets of communications
   c. The impact of COVID-19 on the previous points.

2. Your knowledge or not of the educational mission of the XXX Park and its implementation:

Example of themes to be discussed:

   a. Existence of educational objectives?
   b. Collaboration to combine conservation and promotion of the territory?
   c. Strategies to engage tourists and visitors in PEB?

3. Your perception of the type of content and information that should/should be disseminated through social networks to people and visitors for educational purposes and to promote their PEB.

4. Your perception of the resources and skills available to the XXX Park to implement its digital strategies.

5. Your perception of the relevance of social networks and digital tools for the XXX Park (benefits, threats, opportunities etc.). Example of themes to be discussed:

   a. The benefits, threats, and opportunities of the existence of Facebook groups, mobile applications, blogs, and influencers.
   b. The possible impact of digital tools to raise the interest of people and visitors towards nature and its protection.
   c. The use of social networks to communicate to a large audience, especially regarding the skills needed to adopt a more sustainable behaviour in the park.
   d. The plurality of social networks and their audience.
   e. Existence of incorrect or incomplete information on the internet about your organisation or the behaviour of people or visitors.

6. Comments you would like to add

Thank you for your participation in this research; your help is much appreciated.

Appendix E Example of notes taken during the interviews

Interview Date	What went well	What can be improved	Action to be taken	Themes and topics discussed
Interview 1	- The participant was very engaging and spoke easily on her own from topic to topic. - The automatic caption worked. - New items emerged from the discussion.	- Technical problem, very bad connection. - Cannot see the person while talking all the time. - I could not go through everything in depth because of the connection problems.	- Have a plan B if the internet does not work – try WhatsApp or a phone call, for example.	New items: 1. Digital Sobriety 2. Sens of Belonging 3. Community 4. Make people love – value nature 5. Communication "apostrophe" 6. Sensitive topics and censorship 7. Collaboration 8. Moderation of speech 9. Culture of change 10. Awareness raising within the framework of the charter and regulations

Appendix F Final codebook for the data analysis of the questionnaire

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Definition*	*Example*	*Nb of transcripts /Nb of reference*
Digital strategy for environmental education			**Aspects of PNA educational strategy to disseminate environmental information and promote PEB**		
	organisation and resources		Statements on the resources allocated by PNAs for the dissemination of environmental knowledge and the promotion of PEB on social networks		
		Lack of resource	Statements of participants related to the lack of financial, human, or technological resources	*"Because if we ask for everything about communication, we do not provide it with sufficient human resources!"-PQ3*	*4/13*
		Lack of skills	Statements of participants related to the lack of skills to use social media	*"Lack of time and technical expertise" -PQ19*	*1/1*
	Strategy implementation		Statements related to the implementation of DIEL by the participant		
		Abandon of strategy	Statements related to the abandonment of strategies and actions taken during the COVID-19 Statement related to the abandonment of action of strategy for DIEL	*"During the COVID-19 crisis (since returned to normal)"-PQ18*	*1/3*
		New implementation	Statements related to the implementation of new strategies or actions following the COVID-19	*"Started in the summer of 2021 with a sponsored campaign on Facebook, Instagram, and Waze."-PQ19*	*1/1*
		No strategy	Statements related to the absence of a DIEL strategy	*"No strategy is in place yet"-PQ4*	*7/21*
		Operationality	Statements related to how the DIEL is operated within the organisation (a collaboration between colleagues, for example)	*"From time to time, collaboration with the different project managers for the very specific content that concern them"-PQ1*	*1/14*
	Monitoring		Declarations related to the need to monitor online information		
		Autoregulation	Statement related to the capacity of the online community to auto-regulate third-party posts or unwarranted information	*"Most of the time, speech regulates itself, with users correcting/modifying each other"-PQ4*	*1/3*
		Digital ecosystem understanding	Statement related to the need to monitor third-party posting to understand their digital ecosystem better	*"We monitor the relay of the Park's actions by third parties (municipalities, media)"-PQ16*	*2/8*
		Virtual reputation check	Statement related to the need to monitor third-party posting to check their virtual reputation	*"To check what is said about the Park (virtual reputation)"-PQ6*	*1/1*
		Alignment with regulation check	Statement related to the need to monitor third-party posting to see if the information disseminated is aligned with the regulation and PNA best practices	*"On the other hand, the need for monitoring is beginning to be mentioned in relation to the xxxx National Nature Reserve, which is governed by strict regulations without any strategy or means having yet been determined"-PQ2 – [quote edited to preserve the anonymity of the participant]*	*1/1*
Environmental content of social media posts					
	SDGs		Statement related to the creation of content dealing with SDGs	*"Tendency to talk about all subjects"-PQ18*	*3/5*
	Three types of knowledge		Statement related to the creation of content supporting the three types of knowledge (system, effectiveness, and action)	*"We talk a lot about the issues but do not propose enough actions to address them"-PQ16*	*5/12*
	More than knowledge		Statement related to the idea that disseminating knowledge is not enough to tackle sustainability in society; more is needed.	*"Understanding and accepting to let nature take its place is a philosophical process, a voluntary process that takes time and energy, and a complex process."-PQ4*	*4/5*
Participant perception of digital tool			**The interviewee's perception of social media as an educational tool for PNAs. Evidence and declaration of the interviewee regarding social media affordance**		
	positive perspective		Statement revealing a positive perspective on social media by the participant		
		Promotion of ERB	Positive perspective on social media due to its capacity to promote ERB	*"You have to try to build loyalty to have subscribers who regularly receive complex messages and eventually integrate more responsible behaviour." -PQ3*	*3/3*
		Knowledge diffusion	Positive perspective on social media due to its capacity to share and disseminate knowledge	*"At the same time, they are a good medium for spreading knowledge."-PQ25*	*4/9*
		Promotion of PNAS activities	Positive perspective on social media due to its capacity to promote PNA activities	*"All the actions that we carry out or that our partners carry out are relayed on our networks."-PQ21*	*2/2*
	negative perspective - scepticism		Statement revealing a negative perspective on social media by the participant		
		Lack of impact evaluation and assessment	Negative perspective of social media by the participant due to a lack of KPI and assessment tools measuring social media impact on visitors	*"While social networks seem to be a relevant tool for getting messages across, it is impossible to know their impact."-PQ3*	*2/5*
		Superficiality	Negative perspective of social media by the participant due to the superficiality of social media	*"Social media allow people to understand environmental issues in a superficial way."-PQ3*	*3/10*

		Social media turbulence	Negative perspective of social media by the participant due to the social media turbulence environment	*"It is up to us to use them in this way, but everything is going very fast on social networks."-PQ3*	*2/3*
		Society polarisation	Negative perspective of social media by the participant due to societal polarisation that does not allow for serene debate or the impact of social media on societal polarization	*"The notion of complexity and balance seems to me an essential notion to defend in a world where social networks/society simplify and oppose at an incredible speed."-PQ3*	*2/2*
		The superiority of human interaction	Negative perspective of social media by the participants due to the perception that social media can not replace face-to-face education or outdoor education	*"Social media are one of the possible channels for raising awareness, but there is no substitute for a direct exchange of views, such as during a nature outing with a guide or an activity in the classroom aimed at educating the youngest."-PQ3*	*2/2*
COVID impact			Element regarding the impact of COVID on any other codes or child code		
			Statement related to the impact of COVID-19 on the Digital Informal environmental learning strategies of PNAs		
	Digital Informal environmental learning strategies	Barriers to the education mission	Statement revealing barriers to the education mission during the COVID-19	*"Lockdowns have prevented some awareness-raising activities."-PQ17*	*1/1*
		Change in culture	Statement related to a change in the organisational culture during the COVID-19	*"We had a little more time to look at social media during the COVID-19, which also raised awareness within the park team of the importance of social media."-PQ5*	*2/2*
		Change in content	Statement related to a change of post contents online during the COVID-19	*"Modification of the editorial lines for each account."-PQ20*	*1/5*
		Frequency of post	Statement related to a change in the frequency of posting during the COVID-19	*"The frequency of publications has increased"-PQ2*	*2/4*
		Media use	Statement related to a change in the media used online during the COVID-19	*"We have worked much more with the video medium."-PQ2*	*2/3*
		Online presence	Statement related to a change in online presence during the COVID-19	*"The idea of developing an Instagram page dedicated to nature has gained momentum for implementation in 2022."-PQ3*	*1/1*
	Frequentation		Statement related to a change in frequentation during and after the COVID-19	*"Particularly with regard to natural environments subject to an increase in pressure / increased use of nature sports."-PQ17*	*¾*
	New types of visitors		Statement related to a change in the type of visitors during and after the COVID-19	*"Although this was not really a "strategy", information and knowledge were provided for these new visitors who were unfamiliar with the "codes" necessary to preserve the environment while respecting the uses of each individual."-PQ3*	*2/3*
Knowledge feedback and exchange			**Statement related to the PNA's willingness to engage with visitors online through conversation, feedback seeking or Knowledge exchange**	*"Concerning the exchange between people, we only do it on certain subjects via Facebook groups: on water saving, soft mobility, the geopark, the revision of the park charter."-PQ22*	*3/3*
Biophilia activation			Statement related to the intent to provoke awe and emotion through the mediated or symbolic experience of nature	*"A one-minute video that invites wonder with the message that says take 1 minute of your time to stop and simply contemplate."-PQ5*	*1/1*

Appendix G Final codebook for the data analysis of the interviews

Main categories	*Sub- categories level 1*	*Sub-categories level 2*	*Sub-categories level 3*	*Sub-categories level 4*	Definition	*Respondents' quotes*	*Nb of transcripts/Nb of statements*
Digital Informal environmental Learning strategy					Statements related to the respondent's organisation's educational strategy to disseminate environmental information and promote PEBs through social media		
	Social media use				Statements regarding the PNAs' online presence on social media (what platforms?)		
		online presence			Statements about the social media account on which the respondent's organisation is not present	*"We don't have Twitter tik tok,."-PI2*	*7/37*
		No presence			Statements about the social media account on which the respondent's organisation is present	*"If we take the example of TikTok, we have, I think in our structures, a little difficulty in projecting ourselves on this because the very use of TikTok, which is rather an access to the base, on the dance, the small real and so on".-PI9*	*6/22*
	Temporality				Statement related to the use of social networks by the respondent's organisation for educational purposes and to promote PEB in advance of a visit, during a visit or after the public visit	*"We're going to take a long-term approach with small, subtle messages, which will be passed on overtime.".-PI1*	*8/14*
	Purpose of use of social media				Statements related to the purposes of social media use by the respondent's organisation		
		Answer to an injunction of society			Statements mentioning the use of social media for answering to societal pressure as the purpose of the social media use by the respondent's organisation	*"In any case, the federation does not have the position of forcing anyone. I think that if there is an injunction, it is rather from the outside. The injunction or the pressure, I think, comes from the outside. To be in the game, you need to have a Facebook page."-PI5*	1/4
		Create an online community			Statements mentioning the creation of an online community as the purpose of the social media use by the respondent's organisation	*"That's actually one of our objectives too. That's what our networks are for. It is, it is a kind of consolidation of the [socle d'appartenance]. In fact, I think that the networks really have this role, in any case on our profile of inhabitants, they really have this role there, which I feel is often pride."-PI1*	9/63
		Disseminate institutional and political messages			Statements mentioning the dissemination of institutional and political messages as the purposes of the social media use by the respondent's organisation	*"Yeah I think so, yeah. I think that in my use of social networks, I find it interesting to have practical tools to know the opening hours, the events that are going on in one place. "-PI7*	12/60

		Promotion and marketing	Statements mentioning the marketing and commercial promotion as the purposes of the social media use by the respondent's organisation	*"It is a means of promotion, for sure, and that's what it is used for the most."-P12.*	10/20
		Education and sensibilisation	Statements mentioning the education and sensitisation to the environmental causes as the purposes of the social media use by the respondent's organisation	*"So the aim is really to promote the actions of the reserve and to make people more aware of what we do internally. " -PI7*	10/98
		Take advantage of social media as a tool for specific objectives	Statements mentioning the taking advantage of social media as a tool for specific objectives as the purposes of the social media use by the respondent's organisation	*"We need to raise awareness among canoeists and kayakers that they shouldn't land on the islets; that's what we'll do. Yes, we're going to distribute information at the right time."-PI14*	12/67
		Reach a broader audience	Statements mentioning reaching a broader or larger audience as the purpose of the social media use by the respondent's organisation	*"Why Facebook? Because it is the first social network on earth. Let's be clear, we are really on a mass media with a very very very impressive strike force." -PI10*	10/28
	Audience		Statements related to the type of audience the respondent's perception of their organisation's audience on its social media		
		Already sensitised	Statements related to an already environmentally sensitised audience	*"[talking about their social media audience] It is people who are already convinced, for the most part, to protect the environment or rather people who have a naturalist's interest and who are used to coming to natural areas."- PI7*	6/21
		Non-sensitised	Statements related to a non-environmentally sensitised audience	*"Yes, clearly, because it is precisely to reach people who are perhaps less aware or less familiar with the biodiversity around them and who are actually more urban."-PI14*	4/10
		Local audience	Statements related to a local audience	*Well, our main objective is to raise awareness among the people who live closest to us. PI6*	9/40
		Global audience	Statements related to a global audience	*"Well, in fact, our vocation is to address everyone, in fact."- PI12*	7/9
	Governance		Statements related to the governance type in the respondent's organisation regarding the digital tool and digital education.		
			Statements related to the organisation related to the implementation of the respondent's organisation DIEL strategy		

		Organisation	Lack of collaboration or need for improvement		Statement related to the lack of collaboration between the respondent's organisation and the need for improvement in that region	*"We go into all kinds of subjects, and we have a lot of interesting things to say, but we do not take the time to promote what we do, so people do not know". -PI2*	4/7
			Intrapreneurs		Statements related to the emergence of intrapreneurs that take the lead for the implementation of social media or the creation of social media content in the respondent's organisation	*"We also have pages on some natural sites, so that depends on our volunteers. Some volunteers have wanted to create pages that they administer themselves. ".-PI14*	5/20
			Functional organisation		Statements mentioning a functional organisation of the communication mission within the respondent's organisation	*"So it is a colleague who is currently on maternity leave who is responsible for updating and maintaining this website".– PI6*	7/25
			Process organisation		Statement mentioning an organisation by process of the communication missions within the respondent's organisation	*"It depends a little bit on the reserves because, as they are people who do not come from communication, who animate the pages of the nature reserves, they do it in addition to the main actions they have to carry out, so they do not necessarily have a lot of time to spend on animation". -PI9*	5/14
			Inertia		Statements mentioning the inertia in the implementation of social media, creation of online content and validation of online content due to the respondent's organisation structure	*"We're kind of missing out. Yeah, it is clear that we're a little bit missing out; I think we are suffering from a little bit of inertia in the parks and at the federation"-PI10*	6/16
		Digital mindset and culture			Statements related to the Digital mindset and culture of the respondent's organisation		
			DIEL is perceived as a secondary mission		Statements mentioning DIEL as a secondary mission of the respondent's organisation	*"Our management team thinks that when you're out in the field, and you're going to take pictures, [they think] you're out on a walk more than we are at work "-PI8.*	6/17
			Causes for the misalignment of the use of social media with the organisation or respondent's value		Statements mentioning the causes for the misalignment of the use of social media with the organisation or respondent's value		
				Digital divide	Statements mentioning the digital divide as a cause for the misalignment of the use of social media with the organisation or respondent's value	*"So I ll say it again, but we're in a rural environment, in the countryside, with population densities that are sometimes very, very low."PI5*	3/5
				Lack of digital sobriety and environmental footprint	Statements mentioning the lack of digital sobriety and the environmental footprint of social media as a cause for the misalignment of the use of social media with the organisation or respondent's value	*"We haven t really focused our content production strategy on video, quite simply because in terms of the digital sobriety of the ECO design of our web media, for example, on one of our websites, well, a video takes up a lot of space."- PI1*	8/32
				Generation divide	Statements mentioning the generational divide as a cause for the misalignment of the use of social media with the organisation or respondent's value	*"Territories that are sometimes ageing."-PI5*	2/4

				The social footprint of social media	Statements mentioning the social media social footprint as a cause for the misalignment of the use of social media with the organisation or respondent's value	*So, the use of social networks? Uh, it can also be divisive."- PI5*	4/12
			Willingness to implement social media		Statements mentioning the willingness to implement social media in the respondent's organisation	*"It is clear that there is a real awareness [of the need to use social media], but we do not have the means".- PI14*	5/13
		lack of leadership			Statements related to the lack of leadership related to the implementation of social media in the respondent's organisation		
			Lack of direction		Statements related to the lack of strategy and direction related to the implementation of social media in the respondent's organisation	*"So today, on video, we are at a low ebb, especially when it comes to language elements, content duration, tone; we are not good".-PI12*	3/18
			Lack of willingness		Statements related to the lack of willingness to implement social media in the respondent's organisation	*"It is a question of resources, time and willingness too. It is true that I'm deeply resistant to Facebook and so on".- PI6*	2/8
		Online Stakeholders management			Statements related to the respondent's organisation's online stakeholders management		
			Local community and businesses		Statement mentioning local communities and businesses as online stakeholders	*"Yes, well, an inhabitant may be looking for, um, information on his territory or also to promote his territory because we realise that there are often inhabitants who follow us on social media".-PI1*	10/31
			Opponent		Statement mentioning opponents to PNAs as online stakeholders	*"It is just a matter of wording, but I think it is important that some people who are a bit resistant to the fact that the reserve is quite restrictive can understand it in a different way, even if it comes down to the same thing."- PI7*	4/12
			Visitors		Statement mentioning visitors as online stakeholders	*"So I'm more into wildlife, so obviously it is more my sensitivity, but we try not to communicate too much about species or to be very careful in the messages so that we do not make the hordes of naturalists or observers want to come and see a species".-PI3*	4/7
			Political institution		Statement mentioning political institutions as online stakeholders	*"In my nature reserve, for example, between the nature reserve and the National Forestry Office, who clearly compete with each other, we are trying to find our respective places, so it is certain that there is work to be done in order to agree on the approach and the narrative, it is not easy". -PI6*	9/24
			Funder/financer		Statement mentioning respondent's organisation funders as online stakeholders	*"In fact, it is part of the deal, often with the funders, or in fact the funders, our request to produce something*	5/10

					concrete that can be used to raise awareness among the general public".-PI2	
			Media	Statement mentioning the media as online stakeholders	*"These publications have received a lot of attention, and even the press has issued a small press release".-PI9*	5/10
	Social media Perception			Positive and negative statements related to the use of social media in the respondent's organisation		
		Positive		Positive statements related to the use of social media in the respondent's organisation		
			Necessary/critical	Statements mentioning social media as necessary or critical to engaging with	*"I'm saying today that we're almost at professional misconduct [not using social media], um, it is because I do not like it personally in my job, the means of communication have evolved, I have to, um, evolve with them and we feel that there is a delay."-PI12*	5/11
			Useful for the realisation of their mission	Statement mentioning social media as useful to the realisation of the respondent's mission	*"Ah, well, when I see this, I do not ask myself if social networks are good for anything. Well, yes, it does serve a purpose" – PI2*	8/11
			Newway of communication/source of information	Statement mentioning social media as a new way of communication or source of information for visitors	*"So we wanted to have an additional way to communicate". – PI3*	5/7
			Enthusiasm	Enthusiastic statement related to the use of social media in the respondent's organisation	*"But in any case, the tool itself. Facebook is still pretty magical" -PI10*	5/20
		Negative perception		Negative statements related to the use of social media in the respondent's organisation		
			Lack of efficacity and impact assessment	Statements mentioning a negative perception of the use of social media in the respondent's organisation due to their lack of efficacy and tools to assess their impact	*"That's where we said to ourselves, is this really necessary? And is this really adequate because it requires a lot of time to convince people who are already convinced?". -PI7*	4/13
			Multiplicity and complexity of the platform ecosystem	Statements mentioning a negative perception of the use of social media in the respondent's organisation due to the complexity of the digital ecosystem.	*"If today we want to reach hikers in general, there are so many platforms. No one is going to look for information in the same way that we won't be able to be exhaustive". -PI9*	2/6
	Communication style			Statements related to the communication style used by the respondent's organisations on their social media		
		Institutional message		Statements related to the use of institutional messages as a communication style	*"We have already fined mountain guide, and then we communicate about it on our Facebook page; for example, even if we often get negative comments, we do not hesitate to put forward messages when we come across something really abnormal or infringements, of course, without mentioning the people or without going into*	5/18

					detail, but often, we highlight the operations that we do and that have led to sanctions on our part. We intervene so that people know that one can't do what one wants." – PI3	
		Accessible sensibilisation		Statements related to the use of accessible sensitisation as a communication style	*"We are real scientists; even if we simplify our contents, we tend to always give a lot, a lot, a lot of content, and here we lighten the load by highlighting the iconography."- PI13*	7/34
		Social marketing		Statements related to the use of social marketing as a communication style	*"It is all very well, and I'm going to shock you by saying this, but social networks can easily allow a kind of manipulation in the end because we also have something to sell, don't we? We're not going to lie to ourselves; we claim to know what is good for the planet. We would like people to follow what we think is good, so we have to convince them. So are we, are we always honest or not? Are we using communication tools beyond marketing? I think we have to." PI12*	5/10
	Monitoring			Statements related to the need to monitor content posted by third parties on social media (other than the respondent organisation's Facebook page) and the internet		
		Content monitored		Statements mentioning what content is monitored by respondents or their organisations		
			Forum/blogs/ other online community	Statements mentioning the monitoring of content found on forums, blogs, and other community-based platforms	*"But then, there is all the coordination, we ll say of yeah, the monitoring on the various forums or others".-PI6*	4/6
			Itinerary phone applications and websites	Statements mentioning the monitoring of content found on itinerary phone applications and websites	*"My colleague who deals with environmentally friendly itineraries inevitably will have an eye on the mobile applications that reveal tracks and uncontrolled GPS routes".-PI1*	3/5
			Institutional stakeholders	Statement mentioning the monitoring of content found on institutional stakeholders' social media and website	*"Another structure that communicates a lot about this and that we have to correct very often is the Intercommunal Tourist Office".-PI3*	2/2
			Local economic stakeholders	Statement mentioning the monitoring of content found on local economic stakeholders' social media and websites	*It happens to us regularly from quotation marks to remind the order to repeat to partners: "Attention, complete the information you convey because bah no, [...] we can not do this or that" -PI13.*	2/3

		No Monitoring		Statements giving reasons why respondents' organisation would not engage in online content monitoring		
			No need for it	Statements mentioning that no monitoring is operated because there is no need for it	*"[Talking about implementing monitoring practices] Honestly, it is a question we've never asked ourselves".-PI8*	1/1
			Lack of strategy	Statement mentioning the lack of strategy for the implementation of the monitoring of third parties/ online content	*"Oh yes, that's clear; it is really something you do not follow at all. But it is true that I'd have to keep an eye on this."- PI7*	2/6
		Reaction to content monitored		Statements related to the reaction to the content monitored on social media and the internet by the respondents or their organisation		
			Direct contact	Statements mentioning direct contact with a third party as a practice for responding to content monitored on social media and the internet by respondents or their organisation.	*"So we spend a lot of time making an inventory of all this [information posted online by third parties], and getting in touch with the people who manage it, to make sure that it is changed".-PI3*	1/2
			Hammer home	Statements mentioning hammering home information as a practice for responding to contents monitored on social media and the internet by respondents or their organisation.	*"We reiterate through campaign accounts the good practices and the good information we want to pass on" - PI1*	1/1
			Contact privately	Statements mentioning contacting a content generator or disseminator privately as a practice for responding to content monitored on social media and the internet by respondents or their organisation.	*"They are aware [the tourist offices] but still do not include them in their communication because it is not a selling point. So every year we held awareness-raising days for the staff, precisely to make them aware of the regulations in particular, and therefore to go and find out about the richness of natural heritage."-PI13*	1/2
			Remember the law/threat	Statements mentioning legal threats and institutional messages as a practice for responding to content monitored on social media and the internet by respondents or their organisation.	*"It happens to us regularly to remind the rules and regulations to partners by saying: "Be careful, you have to complete the information you convey because [...] one is not allowed to do this or that." -PI13*	4/17
			On-site surveillance	Statements mention on-site surveillance as a response to contents monitored on social media and the internet by respondents or their organisations.	*"So, in concrete terms, this is what happens. Monitoring in the field, where, effectively, we try to identify all of these prohibited activities, and so this involves monitoring and possibly a prevention mission".-PI6*	1/1
	Moderation			Statements related to the type of moderation practices used by the respondent's organisation on its social media account		
		Moderation and reaction to online		Statements to the moderation practices of the respondent's organisation		

		content on social media	Commenting/correcting	Statements about mentioning comments and corrections as moderation practices on the respondent organisation's social media	*"Well, as soon as there are messages like that, we intervene to say no, no, you can't say that like that."-PI3*	4/12
			Defusing	Statements about mentioning practices aiming at defusing conflicting comments as moderation practices on the respondent organisation's social media	*"And by turning things around to bring the emotions down a bit".-PI9*	2/3
			Deletion	Statements about mentioning deletion of content as a moderation practice on the respondent organisation's social media	*" So in fact, I, in terms of moderation, everything that was insulting and rude, yes, I delete it, that's it. Because it wasn't necessary".-PI10*	2/2
		No moderation		Statements about why the respondent's organisation does not moderate or react to the comments found/posted on its social media		
			Auto-regulation	Statements mentioning that the respondent's organisation does not moderate or react to the comments found/posted on its social media because of auto-regulation of their users	*"We have absolutely no need to intervene, [...] well, it is the others [social media users] who answer; we do not even have to answer". -P13*	3/6
			Avoid conflict	Statements mentioning that the respondent's organisation does not moderate or react to the comments found/posted on its social media to avoid conflicts	*"That was too much of a conflict and not necessarily worth getting into with the person in question".-PI7*	3/7
			Lack of resource	Statements mentioning that the respondent's organisation does not moderate or react to the comments found/posted on its social media because of the lack of resources	*"So we do not have, we do not have a team of 20 people who are ready to draw on the slightest comment on the networks".-PI9*	1/1
			No proactivity or willingness	Statements mentioning that the respondent's organisation does not moderate or react to the comments found/posted on its social media because of a lack of willingness or proactivity	*"Well, I do not react very much because I do not see the notifications, so I realise 6 months later, but okay, there is a bit of stuff, there is a bit of everything".-PI14*	1/1
		Perception of Moderation		Statements related to the respondent's perception of moderation		
			Necessary	Statements mentioning moderation as necessary or useful activities	*"But on our networks, yes, we try to answer as systematically as possible, but it can happen that we miss it".-PI9*	3/5
			complicated/ Overwhelming/time-consuming	Statements mentioning moderation as complicated, overwhelming or time-consuming	*"Yes, it is not just that, it is that, it takes energy, it can quickly take a lot of energy, and it feels like it is never-ending".-PI12*	3/7

	Organisation of resources		Statement related to the technological, financial, and human resources allocated by PNAs for the dissemination of environmental knowledge and the promotion of PEB on social media		
		Lack of resource	Statement of participant related to the lack of financial, human, time, or technological resources	*"And not enough time, not enough staff, that's clear [for the implementation of social media]".-PI7*	12/63
		Lack of skills	Statement of participant related to the lack of skills to use social media	*" Then, the problem is that, for example, the choice was made on Instagram. I have no training in communication. I do not have any notion, apart from knowing how to take pictures, but I do it on top of my job".-PI8*	4/12
	External collaborations		Statements related to collaboration with external stakeholders for the creation and/or the dissemination of content on social media		
		Influencers	Statements related to collaboration with influencers for the creation and/or dissemination of content on social media	*"Yes, because we have tried to find ambassadors who can relay this information via their respective pages". -PI6*	6/13
		local businesses	Statements related to collaboration with local businesses for the creation and/or dissemination of content on social media	*"That's also the strength of the parks, that we are hand in hand with the professionals, the service providers". PI1*	5/13
		Other public institutions	Statements related to collaboration with other public institutions for the creation and/or dissemination of content on social media	*"That's also the strength of the parks; it is that we work hand in hand with service providers, with actors and also with the municipalities because the park is not just a team of technicians or even a political team. It is elected representatives, municipalities and people who work together on projects".-PI1*	5/8
Eco-literacy			Statements related to the type of educational content disseminated on PNA's social media		
	Eco-literacy four components		Statements related to the four components of eco-literacy disseminated in the PNA's social media content		
		Attitude	Statements related to the dissemination of content aimed at impacting visitors' attitudes toward nature	*in respect of the territory that welcomes you and in the respect also of the people who are other users or people who live there - PI1*	11/23

		Environmental knowledge	Statements related to the dissemination of environmental knowledge (defined as system knowledge)	*It is even education because I've posted photos, and we put the name of the species, and it is characteristics, or the habitat and the interest of the habitat. So it is always, even if it is very short, there are always three sentences: What is it? Why is it important in the ecosystem? So that's a limited education. But it is still education.. -PI7*	11/47
		PEBs	Statements related to the dissemination of content aimed at improving the PEB of the visitor	*We did a good practice campaign both on our social networks - PI 1*	11/51
		Skills	Statements related to the dissemination of content aimed at improving the green skills of the visitors	*" But in any case, if there are people who are not used to it and want to have information before setting off, we often communicate on how to equip ourselves. What are the safety rules to follow?" - PI3*	7/19
	Type of eco-literacy		Statements related to the dissemination on social media of content aiming at improving social media users' eco-literacy		
		Broad eco-literacy	Statements related to the dissemination on social media of holistic content covering aspects of eco-literacy that are not directly related to the protected areas, such as promoting eco-behaviours outside the protected areas, carpooling, gardening, etc.	*"For example, we have just produced a guide on light pollution to prevent people from consuming electricity at night, turning off visible electricity at night, etc." –PI2*	9/22
		Narrow eco-literacy	Statements related to the dissemination on social media of content covering the four components of eco-literacy that are directly related to the completion of the protected areas' missions, their regulation and operation	*"This is what [the communication team] asked us to do so that our messages come first, that is, biodiversity and climate before anything else." -PI9 [quote edited to protect the anonymity of the participant]*	10/38
Social media digital functions			Different types of functions of social media used by PNAs		
	Informational function		Use of social media informational function that allows the public to experience nature through posting on social media		
		Use of information function	Statements related to the use by the respondents' organisation of the information function of social media	*"In fact, it is also to get feedback that is really encouraging, and I get a lot of messages from people who say "Oh, I did not know that I did not know that, but it is crazy".-PI2*	14/100
		knowledge hiding	Respondent's statements about not discussing certain topics online or restricting discussion on certain topics on social media for conservation purposes		

			Activities	Respondent's statements about not discussing certain topics online or restricting discussion on certain topics related to outdoor activities on social media	*"Then, there are other activities where, on the contrary, we'll try not to publicise it, i.e., the news, the hyper-creative idea of someone who has a lot of influence. It will be relayed enough without us giving it extra publicity". - PI9*	3/4
			vulnerable fauna and flora	Respondent's statements about not discussing certain topics online or restricting discussion on certain topics related to vulnerable fauna and flora on social media	*"But we try not to communicate too much on species or to be very careful in the messages so that we do not give the desire to come to hordes of naturalists or observers, sometimes of Sunday, who just want to come to see a species or to enjoy it"-PI3*	4/28
	Relational function			Use social media Relational functions to create a relationship and maintain contact between members of the public and PNAs		
		PNAs to visitors		Statements related to the use of the relational function of social media for one-way communication with social media users	*"It is not the case on our page actually, Facebook it is not possible actually for people to add content".- PI7*	11/58
		Visitor to PNA		Statements related to the use of the relational function of social media for two-way communication with social media users. Statements related to the will to get the visitors' feedback.	*"Ask our members: "So, we're on social networks, are you on them? Are you interested? Give us your opinion. We could also look at our strategies in a more qualitative way; that would be an interesting starting point.".-PI14*	5/9
		Visitor to visitors		Statements related to the use of the relational function of social media for a multi-sided conversation with social media users	*"It can strengthen the bond between people; people talk to each other, people will talk about their village photo".- PI1*	5/8
		Sense of belonging		Statements on the use of the relational function of social media to generate a sense of community among social media users	*"It is a kind of consolidation of the base of belonging. In fact, I think that social networks, on the inhabitants' profile, they really have this role, and there is often a sense of pride". -PI1*	8/27
		Negative experiences on social media		Statements related to backslashes and other negative outcomes experienced by the respondents due to the use of the relational function of social media	*"I received an inflammatory message on Facebook from a gentleman who lives in a village in the park which is crossed by a road with traffic on it".-PI1*	9/50
		Controversial topics		Statements related to the topics that were described by the respondents as controversial due to the stakeholder's scrutiny and comments on the social media of their organisation	*"The communication around the bear and the wolf which could be very conflict-producing today,"- PI13*	7/22
	The experiential function of social media			Use Social media Experiential function that allows PNAs to inform the public and disseminate environmental knowledge		
		Images		Statements related to the use of images and pictures	*"Well, yes, putting lots and lots of pictures". - PI13*	12/36

		Sounds	Statements related to the creation of podcasts and the use of sounds	*"In terms of content. There is no limit. You've got the image, the sound, uh. Everything the word, the text, the finally everything".- PI12*	2/2
		Videos	Statements related to the creation and use of video	*"So we have slowed down a bit on the video content".-PI1*	10/29
		Playful experiences/game	Statements related to the use of games and the intent to create a playful experience for the social media user	*"There, she really programmed publications with events announcements, plus quizzes sides and highlighting species. That's it, it is paying off". -PI12*	5/12
		Biophilia	Statements related to the intent to provoke awe and emotion through the mediated or symbolic experience of nature	*"When we explain in a 1+1 register, we achieve nothing, but if we explain with our heart, with our stomach, with our feelings, maybe it will reach people much more strongly than this purely scientific side. And so it is this same approach that I have by saying to myself, if people feel this emotion, they will probably be more inclined to preserve nature." PI 13*	5/11
Positive learning			Statements related to a positive outcome of the use of social media in the learning process		
	PEB		Statements related to positive outcomes of the use of social media on the learning process of visitors leading to non-ERB	*"I think that the messages are actually getting through. People understand them, people take them on"- PI6*	10/28
	Ethical belief		Statements related to positive outcomes of the use of social media on the learning process of visitors leading to or based on a false belief	*"So the only thing we can do is to try to educate as well as possible, to make people understand as well as possible, to make them like it. I'm good at this because making people understand". -PI1*	6/8
	warrarrentd knowledge		Statements related to positive outcomes of the use of social media on the learning process of visitors due to unwarranted knowledge	*"In fact, it is also to get feedback that is really encouraging, and I get a lot of messages from people who say "Oh, I did not know that I did not know that, but it is crazy".-PI2*	9/25
Negative learning			Statements related to a negative outcome of the use of social media in the learning process		
	False belief		Statements related to negative outcomes of the use of social media on the learning process of visitors leading to or based on a false belief	*" In fact, the message conveyed by these photos takes no account of the environment and the surroundings in which they are taken, so they just focus on the beauty of the place. And what nature parks generally see is that there is a risk in these places of over-frequentation and a risk of the real cost to the environment, biodiversity and so on."- PI1*	2/4
	Non-PEB		Statements related	*"There are platforms that can take people to places that are not safe, et cetera".-PI5*	½

	Unwarranted knowledge		Statements related to negative outcomes of the use of social media on the learning process of visitors leading to or based on a false belief	*"And then, if something [online content] is not true, the slightest misinformation, the slightest. So not only do we reiterate a little bit through campaign accounts the good practices and the good information that we want to pass on". -PI1*	7/24
Positive Negative learning			Statements related to building on the negative learning of others result in positive learning outcomes.	*"Because in fact, in moderation, there are, there are these two aspects. There is responding to the person, but in fact, there is also being read by the next person.".-P10*	2/3
COVID-19			Statements regarding the impact of COVID on any other codes or child code		
	Impact on digital strategies		Statements related to the impact of the COVID-19 pandemic and lockdowns on the respondents' DIEL strategy		
		Specific content	Statements regarding changes in participants' social media content following the COVID-19 crisis	*"This summer, depending on the practices that are going to be repeated, I think that we will still have to do some small reminders". -PI7*	8/16
		Specific audience	Statements about changes in participants' social media audiences following the COVID-19 crisis	*"We have decided that over the next 4, 5 years we would really continue to have a specific communication on these codes of good conduct for these new visitors." -PI13*	3/5
		New types of visitors	Statements on changes in the type of visitors in the participants' organisations following the COVID-19 crisis	*"Except that there is such an influx of people that in the end, we ended up with a lot of people who are not at all familiar with nature in the mountains and who have taken up camping"- PI6*	3/13
		No changes	Statements by participants that they did not change their DIEL strategy as a result of the COVID-19 crisis	*"There were no major disruptions.". PI4*	1/1
		online presence/posting	Statements by participants mentioning changes in the frequency of posts and online presence due to the COVID-19 crisis	*"[During COVID lockdowns] We have been very active on social media because we are used to being on the field". -PI7*	3/6
Opportunity			Statements that may reveal a potential or real opportunity for the implementation of the DIEL in PNA or the IEL process		
	for DIEL		Statements that may reveal a potential or real opportunity for the implementation of the DIEL in PNA	*"It is part of the constraints; it is that we do not have much time to deal with this [social media] in the natural areas structures". -PI7*	10/25
	for IEL		Statements that may reveal a potential or real opportunity for the IEL process online	*"If I take the example of Facebook, I would tend to say that if there is a discussion, I'm not sure that's the best space for dialogue."-PI5*	10/44
Challenge			Statements that may reveal a potential or real challenge for the implementation of the DIEL in PNA or the IEL process		

	for DIEL	Statements that may reveal a potential or real challenge for the implementation of the DIEL in PNA	*"So yes, I find that when I started, it was a reflection that I made to myself that they are really aware of the importance of communication. And in particular, the importance of social media, even if some people do not use them in their personal lives, they know that it is also important to make their actions understood and known" - PI4*	12/82
	for IEL	Statements that may reveal a potential or real challenge for the IEL process online	*"And as a result, it is quite interesting to me to see that it can actually interest people to have precise information on the scientific surveys done in the reserve". -PI7*	13/60

Appendix H Question guide for the face-to-face interview

1	What is your primary use of social media?
2	How would you define the mission of the park in environmental education? (scope, purpose, goals, expected outcomes) How is this mission carried out? (In the field, guides, online, communication, collaboration, etc.)?
3	Is there an official/formal framework for the parks' educational missions at the local or national level? Do you think that other additional objectives could be pursued?
4	In terms of the parks' environmental education mission, who do you think is the target of this mission? How can the park reach its audiences? What about those who do not visit the park?
5	What is the motivation of your visitors online?
6	Has the scope of these missions changed with the advent of new technologies? Especially social media?
7	Do you think visitors or the public should be provided with certain information or skills before their visit to the park to behave in a safer and more environmentally friendly way?
8	Do you have a strategy for using social media? Is this strategy specifically developed as part of the mission to educate the population? If yes, what does it consist of? If not, why?
9	Do you think the park is able to fulfil its mission of environmental education in the field and online (resources, skills, strategies, etc.)? Why or why not? Do you have management issues of promotion on one side and conservation on the other? Do you know of any examples? How are the trade-offs made?
10	Do you think it is relevant for the park to develop its environmental education mission online, especially on social media? Why?
11	Do you think it is possible to replicate the results of environmental education missions carried out on the ground, online, through communication and engagement in social media?
12	Do you think it is possible to trigger the positive emotions of virtual visitors towards nature through social media? In the same way that a field experience in the park could do? Why?
13	Do you think you can create admiration or interest in natural areas through social networks?
14	In your opinion, does the use of social media by virtual visitors facilitate or threaten their connection to nature? Why?
15	Do you think that the possibility for virtual visitors to communicate online with other visitors about their personal experience of the park represents an opportunity for the park's educational missions? Why or why not?

16	Do you think that inappropriate, dangerous, or unauthorised behaviour In the park may result from accessing information sources other than those provided by the park on the Internet (e.g., Facebook groups, mobile applications, blogs, influencers...)?
17	Do you think the use of social media by the park could result in equipping visitors with the necessary skills to behave more sustainably in the park? In their daily life in general?
18	The impact of COVID-19 on the previous points.

Appendix I Comments made by members of the French Regional Nature Parks network during the webinar presenting the white report (anonymised and translated from French into English)

[feedback on the presentation and recommendations]

14:31:42 Participant 1: It's a great feedback! I can relate to it well:-p

14:32:03 Participant 2: Bravo ! Very interesting!

14:32:37 Participant 3: Despite my short 6 months of seniority at Parc XX, I can relate too!

14:33:20 Participant 4: What is the share of parks with territories with difficult access to the internet?

[Comments answering the author's question related to the time dedicated per week to social media by the participants]

14:59:33 Participant 5: 4h-5 hours per week is my average, too

14:59:54 Participant 2: 10h/12h here Facebook/insta/linkedin/YouTube

15:00:56 Participant 6: All networks combined (FB, Insta, Linkedin, YouTube), minimum 10 hours per week.

15:01:52 Participant 7: It also takes time to synthesise and popularise the information provided by the project leaders and to put it in Insta or Facebook mode

15:01:57 Participant 8: I have to be at 10 am too, it depends on the culture/park news too.

15:03:38 Participant 1: I must be at 2h/week... but indeed I should spend more time to be more visible :-/

[feedback on the presentation and recommendations]

15:04:52 Participant 9: Thank you for this very interesting please share

15:05:40 Participant 10: Thank you for this very interesting presentation.

15:05:41 Participant 11: Thanks for the feedback... We still have a long way to go :)

15:05:46 Participant 12: Thank you for everything. See you soon.

15:05:50 Participant 6: Thank you very much!

15:06:03 Participant 2: Thank you very much 👏

15:06:19 Participant 13: Thank you!

15:06:38 Participant 14: Thank you, very interesting feedback. See you soon.

15:06:42 Participant 15: thank you very much for the feedback and the interest in PNAs ;-);-

15:06:54 Participant 4: Very good work, great, thank you very much!

15:06:55 Participant 7: Thanks, it was very interesting to take a step back

Appendix J Feedback form circulated to the webinar participant presenting the white report to the Regional Nature Park network.

Question 1: Do the results and recommendations of the research report on using social networks in PNAs for educational purposes and the promotion of pro-environmental behaviour reflect the reality of your digital practices on social networks?

Answers	Participant number
Yes, I could relate to the practices presented, especially the dichotomy between the values of the social network and the values defended by Parks	1026646-1026628-107525567
Yes, absolutely.	1026646-1026628-107746904

Question 2 Have the results and recommendations of the research report on using social networks in PNAs for educational purposes and the promotion of pro-environmental behaviour led you to reflect on your practices regarding the use of social networks?

Answers	Participant number
Yes, these elements force us to reflect and question ourselves. Among the recommendations, the one on the promotion of know-how will be particularly important to work on	1026646-1026628-107525567
Yes, there is a need for reflection on these subjects.	1026646-1026628-107746904

Question 3 Have the results and recommendations of the research report on using social networks in PNAs for educational purposes and promoting pro-environmental behaviour enabled you to confirm or question your practices regarding using social networks?

Answers	Participant number
See question 5	1026646-1026628-107525567
It was very interesting to gain perspective	1026646-1026628-107746904

Question 4: Having read the results and recommendations of the research report on using social networks in PNAs for educational purposes and promoting pro-environmental behaviour, do you plan to implement all or part of the recommendations made in the report?

Answers	Participant number
Six recommendations are already being worked on, although we still have work that will be needed. The 7th recommendation, "promote know-how", is very new, so it is on this one that there is room for improvement.	1026646-1026628-107525567
Yes, it is to be discussed with the teams	1026646-1026628-107746904

Question 5 Do you have any comments or follow-up questions regarding the findings and recommendations of the research report on the use of social networks in PNAs for educational purposes and the promotion of pro-environmental behaviour?

Answers	Participant number
Thank you	1026646-1026628-107746904