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# The role of pre-19th century art in conservation biology: An untapped potential for connecting with nature

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1 **Title**

2 The role of pre-19<sup>th</sup> century art in conservation biology: an untapped potential for connecting  
3 with nature  
4

5  
6 **Highlights**  
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- 8
- There is an urgent need to (i) better integrate the methods and outcomes of nature  
9 connectedness research in conservation biology, and (ii) to further study the effect of  
10 aesthetic experience on nature connectedness and pro-environmental behaviors.
  - The integration of art in conservation biology and environmental education has mainly  
11 concerned post-19<sup>th</sup> century art. However, the examination of European art prior to the  
12 19<sup>th</sup> century presents an opportunity to participate in nature connectedness through  
13 aesthetic experience, while promoting an important cultural and historical heritage.
  - This approach is particularly suitable for the promotion and conservation of remote  
14 ecosystems, such as aquatic ones, to which people are generally only indirectly  
15 exposed.  
16  
17  
18

19 **Abstract**  
20

21 Research exploring nature connectedness has shown that these relationships influence  
22 worldviews, values, attitudes and behaviors toward nature. In this context, natural areas that  
23 are difficult to access, such as aquatic ecosystems, lead to questions concerning the need for  
24 mediation tools capable of modulating human behavior through indirect exposure. Art has  
25 been recognized as an efficient lever in this objective, as it triggers emotional, cognitive and  
26 experiential interactions. Despite a growing interest in integrating art into environmental  
27 education, prior research has mainly focused on post-19<sup>th</sup> century art. We believe, however,  
28 that pre-19<sup>th</sup> century European art presents an opportunity to connect with nature while  
29 enhancing historical and cultural heritage. We thus propose a research framework dedicated to  
30 the quantifiable study of the interrelations between aesthetic experience, behaviors, and nature  
31 connectedness (especially relating to aquatic ecosystems) using a case study approach to  
32 examine aquatic nature as represented in pre-19<sup>th</sup> century European paintings.  
33

34 **Keywords:** nature connectedness, human-nature interactions, art, mediation tools, aquatic  
35 biodiversity  
36

37 Word count: 8151 (including main text, references, and one figure)  
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## 1. The need to integrate nature connectedness into conservation biology

In recent decades, nature connectedness (NC) has been recognized as a key factor in addressing and meeting sustainability challenges (Ives et al., 2018). As one of the main levers for the adoption of pro-environmental behaviors (PEBs), NC has been shown to be a relevant tool for promoting the conservation of biodiversity (Richardson et al., 2020). An increasing number of studies suggest that NC contributes significantly to the adoption of PEBs, *i.e.* engaging in acts that benefit the natural environment and avoiding acts that harm it (Whitburn et al., 2020). In addition, NC actively participates in human happiness and well-being (Pritchard et al., 2020), and therefore concerns both ecology and human health, in line with the sustainable development goals of the United Nations.

Nature connectedness can be defined as the individual's subjective feeling of a deep and continuous awareness of the link between self and the rest of nature (Zylstra et al., 2014), and is based on multiple cognitive, sensorial, emotional and experiential dimensions (Ives et al., 2018). The evidence linking NC and PEB is mainly based on psychological theories such as the Norm-Activation-Model (Schwartz, 1977), the New Environmental Paradigm (Dunlap and Van Liere, 1978), the Theory of Planned Behavior (Ajzen, 1991), the Biophilia Hypothesis (Kellert and Wilson, 1993) and the Value-Belief-Norm Theory (Stern et al., 1999). All these theories highlight that PEBs are sequentially influenced by worldviews, attitudes, values, beliefs and personal norms (Oreg and Katz-Gerro, 2006; Dunlap, 2008; Onwezen et al., 2013; de Leeuw et al., 2015). Following these theoretical baselines, much research has been dedicated to identifying how the combination of these various factors are associated to PEBs (Li et al., 2019) and to NC (Pereira and Forster, 2015; Whitburn et al., 2020). NC and PEBs are interdisciplinary and multidimensional, so multiple self-assessment scales have been devised for their measurement (Hatty et al., 2020), based on different factors defined according to the psychological theory chosen by the authors (Barragan-Jason et al., 2022). Measuring NC and PEBs presents certain limitations: these factors are generally considered socially desirable, and participants may thus overestimate the extent to which they perform these behaviors, or the degree to which they feel connected to nature (de Leeuw et al., 2015). Moreover, if psychometric tools do allow to highlight direct correlations between NC and PEB, they do not inform causality links (Whitburn et al., 2020). The development of accurate observational tools and quantitative approaches would constitute a considerable advance in this field (Richardson et al., 2020).

In this perspective, the outcomes of previous studies linking NC and PEBs deserve to be operationally integrated and applied to the field of sustainability science, particularly in conservation biology. To make these generalist tools efficient and informative, they must be tested and adapted to specific contexts and ecosystems for which experts acknowledge the particular socio-ecological issues that need to be taken into account. Moreover, the definition of PEB deserves to be reconsidered in the light of ecological objectives as defined by conservation biology, beyond the prism of environmental psychology. The need to examine pro-nature conservation behaviors (PCBs) more precisely has recently been addressed, as prior research mainly focused on behaviors relating to climate change and resource use, at the expense of behaviors that directly support conservation of habitats and biodiversity (Barbett et al., 2020; Richardson et al., 2020; Barrows et al., 2022). It thus seems necessary to directly involve conservation biology both in response to this need and in the development of psychometric tools dedicated to PCBs.

In this context, this perspective paper aims to incite researchers in conservation biology to take part in projects carried out at the crossroads of arts and sciences. We first develop the

101 ways in which aesthetic experience and the beauty of nature contribute to nature  
102 connectedness. After defining nature aesthetic experience across different disciplines, we then  
103 discuss the need to integrate conservation biology into interdisciplinary research that  
104 examines the link between nature aesthetic experience and connectedness. In this context, we  
105 present Western art (in particular environmental art and Art-Sciences) as a means to promote  
106 nature connectedness and conservation. Finally, we draw attention to the lack of research  
107 exploring European historical art (pre-19<sup>th</sup> c.) in this perspective, and demonstrate through  
108 different examples the interest these artworks represent for interdisciplinary projects linking  
109 art, biological sciences, environmental education and nature connectedness.

110

## 111 **2. Engaging with nature through aesthetic experience**

112

### 113 *2.1 Nature connectedness and engagement with the beauty of nature*

114

115 Facing the current biodiversity crisis and the need to engage people with nature, research in  
116 environmental psychology has examined ways to modulate NC. A number of studies have  
117 shown that activities involving physical, emotional and sensory engagement with nature seem  
118 to have more effect on NC than do knowledge and theoretical education (Zylstra et al., 2014;  
119 Lumber et al., 2017; Ives et al., 2018; Pritchard et al., 2020; Barragan□Jason et al., 2022). In  
120 this perspective, aesthetic and experiential approaches are promising tools to improve NC  
121 through nature experiences. The beauty of nature is a fundamental aspect of the human  
122 relationship with the natural world and has been extensively studied under the prism of  
123 engagement with nature's beauty, *i.e.* experiencing positive emotional reactions in response to  
124 the perceived beauty of nature (Zhang et al., 2014). This particular aspect of human-nature  
125 interactions plays a significant role in well-being, NC, and in the adoption of pro-  
126 environmental and pro-nature conservation behaviors (Zhang et al., 2014; Barrows et al.,  
127 2022).

128 In a similar way, a large part of the science of environmental education has been dedicated to  
129 the mediation of biodiversity conservation through simple activities that enhance aesthetic  
130 experiences and promote engagement with nature's beauty (Barrable, 2019). Such activities  
131 include, for instance, simple exposure to nature (Barragan□Jason et al., 2022), spending some  
132 time each day noticing beautiful things in the nearby natural environment (Richardson et al.,  
133 2020), engaging with nature's beauty through artistic creation inspired by nature-based  
134 sources (Renowden et al., 2022), or viewing visual arts and performances intended to create  
135 empathy towards nature and improve knowledge about environmental concerns (Curtis et al.,  
136 2014). Facing the current general tendency of disconnection with nature (Soga and Gaston,  
137 2016; Ives et al., 2018), several mediation tools based on indirect exposure have also been  
138 examined, revealing a positive effect on NC (Barragan□Jason et al., 2022). Regarding the low  
139 impact of theoretical education on NC, this could be linked to the method of transmitting  
140 scientific knowledge that includes neither affective nor emotional dimensions, two essential  
141 facets of NC (Barragan□Jason et al., 2022). The integration of an approach based on  
142 aesthetics and engagement with nature's beauty is thus particularly relevant in environmental  
143 education.

144

### 145 *2.2 Nature and aesthetic experience: a multidisciplinary overview*

146

147 Nature has long been a topic in aesthetic studies, and defining what is beautiful and  
148 pleasurable in nature is a knotty question that cuts across fields as diverse as philosophy,  
149 neuroscience, environmental psychology, environmental aesthetics, landscape architecture  
150 and human geography. Aesthetics relates to the human ability to judge an object from various

151 perspectives such as emotions, practical use, or experience (Shimamura and Palmer, 2012). At  
152 its origin, Aesthetics was a philosophical field that explored beauty through the study of  
153 sensations and emotions involving human perception, particularly by way of Art (Brady and  
154 Prior, 2020). Beauty is defined in this context as a set of perceptual qualities that generate  
155 pleasure or admiration through an aesthetic experience (Chatterjee and Vartanian, 2014).  
156 However, objects of aesthetic appreciation are not limited to works of art; indeed, aesthetic  
157 experiences triggered by nature have long aroused the interest of philosophers (Carlson,  
158 2016). Kant, for instance, considered nature to be an object of aesthetic appreciation in itself,  
159 and introduced the notions of the Beautiful and the Sublime in nature (Kant, 1790). Beauty is  
160 associated with harmony, symmetry and order, and is therefore defined by the intrinsic  
161 characteristics of the object (Boileau, 1674), while the Sublime arouses admiration and  
162 vulnerability, such as may be experienced, for example, when confronting a beautiful  
163 landscape beyond the control of the observer (Carlson, 2000). During the 18<sup>th</sup> century, a third  
164 dimension of nature aesthetic judgement was defined: the Picturesque, which connects nature  
165 with art to treat nature and landscapes as objects of scenic pleasure (Paden, 2013). This notion  
166 greatly inspired 19<sup>th</sup> century Dutch painters, especially in their representation of landscapes  
167 (Paden, 2013).

168 These philosophical foundations in Aesthetics formed the background for a set of theories in  
169 environmental aesthetics beginning in the 20<sup>th</sup> century (Brady and Prior, 2020).

170 Environmental aesthetics places the aesthetic experience of everyday environments as subject  
171 matter, in response to the field of Aesthetics that has long favored art over nature (Carlson,  
172 2016). Environmental aesthetics particularly emphasizes the importance of the multisensory  
173 immersion of such aesthetic experiences (contrary to the visual and scenic approaches of  
174 classical Aesthetics, Berleant, 1992) and questions whether knowledge is a significant factor  
175 of aesthetic valuing (Carlson, 2000).

176 Research in philosophical Aesthetics has also shaped the theoretical frameworks of landscape  
177 aesthetics and environmental psychology that use an integrative approach in the attempt to  
178 identify the biological, psychological, cognitive and socio-cultural origins of the aesthetic  
179 experience of nature (see Bourassa, 1990; Kaplan, 1989; Gobster et al., 2007). Regarding the  
180 biological and cognitive underpinnings of aesthetic experience, neuro-aesthetics has also  
181 provided important insights, even though this field is mainly devoted to the aesthetic  
182 judgment of art. Ramachandran and Hirstein (1999) proposed the ‘laws of artistic experience’:  
183 a list of aesthetic perceptual qualities related to neurophysiological mechanisms. In the same  
184 vein, the processing fluency theory of aesthetic pleasure (Reber, 2004) integrated these  
185 properties into a common framework and linked pleasure to the fluency with which  
186 information flows through the cognitive system. As in neuroscience, evolutionary psychology  
187 suggests that aesthetic judgement has played a role in human survival (Kaplan, 1989). It has  
188 been hypothesized that humans have been selected throughout evolutionary history for their  
189 extreme proficiency at gathering and processing information from their environment, and that  
190 the evaluation of landscape aesthetics is the expression of a selection for simple and reliable  
191 information concerning environmental quality (Gobster et al., 2007; Kaplan, 1989).

192 Regarding the interdisciplinary literature in aesthetics, a historical dichotomy appears to exist  
193 between the aesthetics of art on the one hand and the aesthetics of nature on the other  
194 (Carlson, 2016; Barrows et al., 2022). However, we feel that these approaches should be  
195 considered together, because aesthetic experience is a phenomenon that concerns both art and  
196 nature. In this sense, integrating the fields of sustainability and biodiversity conservation  
197 would constitute a suitable transversal approach for the study of art, nature and aesthetic  
198 experience in a more pragmatic and operational way, which could thus be considered as a  
199 conservation lever.

200

### 2.3 *The need to integrate nature aesthetics into biodiversity conservation*

The interest of integrating the topic of aesthetic experience into conservation biology stems from a simple observation: affective and emotional factors play a fundamental role in the conservation of biodiversity, for we tend to protect and to invest in the conservation of what we love and find beautiful in our environment (Gobster et al., 2007; Saunders, 2013; Swaffield and McWilliam, 2013). A telling example dates from the 19<sup>th</sup> century, when landscape beauty motivated the creation of the first national parks in the United States: this initiative was greatly influenced by the painters of that time who depicted the wonders of nature (Rashkow, 2014). The beauty of nature can therefore be considered as a powerful argument for conservation, provided that the perceived aesthetic value is convergent with the ecological objectives of conservation (Gobster et al., 2007). Ecosystems with high biodiversity are generally perceived as being the most aesthetic (Tribot et al., 2018). However, this convergence is not always consistent, in particular regarding human preferences for the conservation of charismatic species (Colléony et al., 2017). Consequently, over the recent decades ecologists have examined how perceived biodiversity affects the aesthetic evaluation of species and ecosystems in an attempt to better understand how the ecology of species influences human interactions with nature and the willingness for conservation (Gaston et al., 2018). These assessments are generally based on visual and digital observations of nature (usually photographs) and very few have explored the potential for engaged and engaging nature aesthetic experiences. However, we believe that conservation biology has a role to play when investigating how different facets of nature aesthetic experience affect NC. In this perspective, there is a need to implement into conservation biology the findings of the several disciplines interested in nature aesthetic and NC. In particular, conservation biology would help formalize in this context the notions of ‘nature’ and biodiversity based on formal metrics, since these concepts remain fuzzy in the human sciences. It is important that the biological sciences take part in research and reflection on the relationships between aesthetic experience, NC, and conservation in order to provide an approach specifically tailored to the conservation of biodiversity. Thus, the development of interdisciplinary research at the crossroads of conservation biology, art and humanities is both urgent and pertinent.

### **3. Fostering nature connectedness through environmental art**

Connecting people with nature through aesthetic experience could act as a lever for biodiversity conservation, revealing the need to explore experiences that trigger significant affective and emotional responses. Art is a suitable pathway in this context, because it allows to transcend the cognitive dimension of environmental concerns and also influences people's worldviews and life goals (Heras et al., 2021). Among recent successful programs connecting art with ecological mediation, many involve environmental art and exhibit a broad range of artistic practices and artworks in any format, including the use of nature as a medium. Since its appearance in the late 1960s, this artistic movement has often been characterized by a political and ethical stance towards nature (Brady, 2007; Thornes, 2008) and has aimed overall to raise awareness of environmental issues by fostering an appreciation and interest for nature. Studies in environmental education have examined the potential of such artworks and practices to foster nature connectedness through ‘aesthetic learning’ (arts-based educational experiences, Heras, 2022). For example, Marks et al. (2017) explored responses to environmental art initiatives in two Biosphere Reserves (Noosa, Australia and North Devon, UK) and revealed that such programs can be used both to enhance understanding of environmental issues and to generate concern. Another way to link art to environmental

251 education, known as Art-Science, involves using scientific data, processes or knowledge as  
252 supports for artistic projects (Lesen et al., 2016). Aesthetic learning and Art-Science  
253 initiatives are often based on participatory practices (see for example Curtis et al., 2014;  
254 Harrower et al., 2018; Renowden et al., 2022). A number of Art-Science artworks intended  
255 for large audiences have resulted from collaborations between artists, stakeholders and  
256 scientists. One such example is the Cucusonic project, that brought scientists, musicians,  
257 farmers, city dwellers and indigenous peoples together to create musical compositions based  
258 on bioacoustic recordings in Columbia (see cucusonic.net).  
259 Obviously, artistic creation and aesthetic reception do not involve the same amount of  
260 physical commitment, but these two facets of art should be considered as complementary and  
261 reciprocal (Tinio, 2013). Although participatory approaches allow for a great degree of  
262 engagement (Lesen et al., 2016) they nevertheless have drawbacks: setting up such projects  
263 may be more costly in terms of time and resources, and their success may also be highly  
264 dependent on the motivation of the participants. Ensuing problems may include sampling bias  
265 in the recruitment of participants, or artistic practices that are not always suitable for all  
266 participants. For example, Renowden et al. (2022) reported that some participants felt  
267 'infantilized' during a workshop where they were asked to recreate frog songs using everyday  
268 objects. Initiatives based on the aesthetic reception of artwork may be experienced by large  
269 audiences, where individuals can engage in an aesthetic experience in keeping with their own  
270 disposition and sensibilities. Regarding research into art reception (the field of Aesthetics  
271 science analyzing the factor structure of aesthetic experiences, Leder et al., 2004; Hager et al.,  
272 2012), few studies have focused on nature aesthetics, as this field mainly concerns classical  
273 art (Carlson, 2016). Further investigations at the intersection of the psychology of aesthetics,  
274 neuro-aesthetics, environmental education and sustainability sciences are therefore required.  
275

#### 276 **4. Beyond environmental art: connecting with nature through pre-19th century art** 277 **and cultural heritage**

278  
279 Art as a tool of mediation for ecological purposes has engaged the interest of artists and  
280 researchers since the late 1960s (Brady, 2007). This growing interest in art as a lever for  
281 sustainability has mainly focused on post-19<sup>th</sup> century art (Heras et al., 2021). For instance,  
282 Lesen et al. (2016) reviewed 200 Art-Science projects in the US, and found that all were  
283 based on recent artistic projects. Yet focusing only on the post-19<sup>th</sup> century period to the  
284 detriment of most of our artistic and cultural heritage seems inadequate because these earlier  
285 artworks have the potential to elicit a multitude of aesthetic responses and powerful  
286 experiences. In addition, pre-19<sup>th</sup> c. art provides an opportunity to explore the imagination of  
287 our predecessors: examining their art is a way to connect with the intimacy, daily life, and  
288 beliefs of their time. In this way, these artworks allow to confront our current relationship to  
289 nature in the face of the history of humanity and its rapport with the environment over time.  
290 Indeed, ever since humans began producing works of art (50,000 years ago), nature has been a  
291 constant source of inspiration through its intrinsic or symbolic value. There is therefore no  
292 obvious reason to concentrate research efforts on recent art only: even if a pre-19<sup>th</sup> c. artist's  
293 direct intention was not to alert to an environmental crisis, their ability to generate a strong  
294 aesthetic experience in connection with the representation of nature remains undeniable.  
295 Works of art prior to the 19<sup>th</sup> c. also constitute a cultural and historical heritage that is worthy  
296 of promotion through the prism of environmental education.  
297

##### 298 *4.1 A short timeline of European art history until the 19th century*

299

300 In order to provide relevant perspectives when studying pre-19<sup>th</sup> c. art in relation to nature  
301 connectedness, nature aesthetics, and conservation biology we will focus on pictorial art,  
302 particularly painting, in Western countries. Indeed, these particular artworks (among others)  
303 include many representations of nature that have survived throughout time, and they have  
304 been thoroughly studied by art historians. To explain our conviction that pre-19<sup>th</sup> c. Western  
305 art is deserving of more scientific attention, a brief timeline of European pictorial art history  
306 may be helpful.

307 Prehistoric art (50,000 BCE to 3,000 BCE) represents the iconographic depiction of humans  
308 and animals, whose possible symbolic and linguistic meaning is still under debate. The  
309 parietal paintings of this period testify to the fascination and the great interest of humans for  
310 the animals that surrounded them.

311 Ancient art (3,000 BC to 6<sup>th</sup> c. CE) is defined as the wide variety of artistic and cultural styles  
312 developed by ancient societies living during this period. The Romans, for example,  
313 represented nature and its wonders with realism, through frescoes and mosaics. Fish and  
314 aquatic animals occupy an important place in this iconography, as evidenced by the famous  
315 *Mosaic of marine life* from Pompeii (early 1st century BC).

316 Art of the Medieval period (6<sup>th</sup> c. - 15<sup>th</sup> c.) used symbolism to serve God. The animal was a  
317 symbolic figure to which feelings, thoughts, emotions, vices and virtues could be attributed in  
318 order to convey the teachings and morality of Christianity (Vézilier-Dussart, 2016).

319 The Early Modern period (15<sup>th</sup> c. to late 18<sup>th</sup> c.) includes the Renaissance, Mannerism,  
320 Baroque art, Rococo and Classicism. The art of this period is mainly figurative. Under the  
321 impetus of technical and scientific discoveries, the representation of nature and the  
322 understanding of natural phenomena became subject matter. The 18<sup>th</sup> c. Enlightenment was  
323 marked by the industrial revolution, reflecting a desire to understand the laws of nature in  
324 order to better control them. In parallel, the rise of natural theology in the early 18<sup>th</sup> c.  
325 translated the spectacle of nature into the expression of the Sublime and perfect divine  
326 creation, inspiring, for example, an admiration of the seas and oceans which had hitherto  
327 aroused fear and aversion since Antiquity (Corbin, 2018).

328 The Modern period (late 19<sup>th</sup> to late 20<sup>th</sup> c.), followed by Contemporary art in the 20<sup>th</sup> c., is  
329 marked by the appearance of photography and Impressionism, leading to the rethinking of the  
330 function of art: the goal is no longer to faithfully represent reality, but rather to question and  
331 criticize it, and also to reveal reality and its contradictions in a different way. During  
332 Romanticism (late 18<sup>th</sup> - late 19<sup>th</sup> c.) artists depicted pristine wilderness in landscapes charged  
333 with emotions to denounce the impact of industrialization and the desire to dominate nature.  
334 For example, Caspar David Friedrich's famous *Wanderer Above the Sea of Fog* (1818) evokes  
335 the insignificance of the human being faced with the landscape, blending admiration and  
336 incomprehension through an aesthetic of the Sublime. William Turner (1775 - 1861) painted  
337 landscapes evoking impressive natural phenomena (fire, storms, sunsets or sunrises) inspired  
338 by travels, scientific questioning and the industrial revolution. Conversely, Thomas  
339 Gainsborough's *Mr. and Mrs. Andrews* (1750) can be interpreted as an expression of land  
340 ownership and capitalist domination over nature and laborers (Rose, 1993).

341 In summary, pre-19<sup>th</sup> c. art figuratively depicted the history and lifestyles of civilizations in  
342 their diversity, whereas modern and contemporary art take a more reflective and abstract  
343 approach with a universal ambition.

#### 344 345 *4.2 Focus on the Early Modern period*

346  
347 A noteworthy example of representations of nature's beauty in pre-19<sup>th</sup> c. art is the Early  
348 Modern period in Europe (15<sup>th</sup> - 18<sup>th</sup> c.), in which artists represented the visible world with  
349 realism and fidelity (Gombrich, 2011). This period is characterized by changes in



350 representations of the world, by religious reforms, great discoveries and by an economic  
351 dynamism resulting from numerous innovations. During the Renaissance, arts and sciences  
352 operated harmoniously. Driven by their own curiosity, artists and scientists were often one  
353 and the same (e.g. Leonardo da Vinci, Albrecht Dürer, Bernard Palissy, etc.), seeking to  
354 understand nature and the world from the perspective of the wonders of nature. For this they  
355 combined scientific techniques (including the natural sciences) with beautiful and creative  
356 representations of their ideas. The discovery of the microscope in the 17<sup>th</sup> c. allowed a better  
357 understanding of nature and contributed to the appearance of naturalist painters. Among them  
358 was Anna Maria Sibylla Merian who traveled to Suriname in 1699 and brought back drawings  
359 of plants and insects integrated into their ecosystem, illustrating that a plant is not just an  
360 isolated organism, but is part of an ecosystem whose elements interact. During this period,  
361 naturalist explorations developed, and artists traveled to report their observations. Travel and  
362 discovery thus became recurring themes in 17<sup>th</sup> c. artworks.

363 In this way, artists and scientists used exploration and experimentation to further improve a  
364 theory, performance or work. The clear separation between the arts (related to creation and  
365 passion) and the sciences (associated with rationality) began during the 18<sup>th</sup> c. and is still  
366 ongoing today (Heylighen and Petrović, 2021). The Early Modern period is thus of particular  
367 interest when considering a reunification of the arts and sciences in the service of  
368 environmental education and NC. First, the degree of realism and the observable desire to  
369 represent reality permit a relatively reliable biological interpretation of these artworks.  
370 Secondly, the living world was treated as a subject in its own right through the emergence of  
371 animal representations in painting and the naturalistic approach, offering visions arousing  
372 wonder, curiosity, or even terror or pity (Vézilier-Dussart, 2016). This multiplicity of  
373 aesthetic responses fits perfectly within the framework of environmental education through  
374 the aesthetic experience of nature.

#### 375 376 *4.3 Science based on pre-19<sup>th</sup> c. art*

377  
378 Pre-19<sup>th</sup> art is generally characterized as being a testimony to past civilizations (Gombrich,  
379 2011); it thus seems logical that scientists today are interested in these artworks in the attempt  
380 to better understand our historical connections with nature and the environmental history of  
381 living organisms. Researchers have, for example, investigated representations of fruits,  
382 flowers, vegetables or cereals in historical art in order to trace evolutionary history regarding  
383 selections over time (see for example Benzi and Berliocchi, 1999; De Smet and Vergauwen,  
384 2021; Kazemi-Shahandashti et al., 2022). This kind of initiative, that examines botanical  
385 material from art historical sources, requires the close collaboration of biologists and art  
386 historians. The former identify the specimens represented; the latter differentiate symbolic  
387 and allegorical iconography from reliable representations that were intended to be realistic  
388 (De Smet and Vergauwen, 2021). Other research has shown the interest of historical art in  
389 understanding the environmental history of marine mammals (see for example Brito et al.,  
390 2019; Mazzoldi et al., 2019) and aquatic biodiversity (Guidetti and Micheli, 2011; Tribot et  
391 al., 2021). Finally, researchers have reflected on how painting could inform the European  
392 history of climate (Metzger and Tabeaud, 2015) and air pollution (Zerefos et al., 2014). This  
393 research has shown the importance of integrating pre-19<sup>th</sup> c. works of art as material in  
394 various disciplines in order to improve understanding of variations of the environment and  
395 living organisms over time. However, they have not explored their aesthetic reception by  
396 contemporaries as a tool for connecting with nature. Here again, we see the need for  
397 additional research at the intersection of environmental history and the psychology of  
398 aesthetics for the benefit of environmental education. Aesthetic reception could be  
399 investigated by estimating quantitatively the visibility of such works in current museums,

400 exhibitions and art reviews, or by conducting quantitative surveys based on psychometric  
401 questionnaires dedicated to aesthetic reception.

402

#### 403 *4.4 Connecting with nature inside and outside art museums*

404

405 In this perspective, museums have a role to play in putting as many people as possible into  
406 direct contact with artworks. To achieve this, scientific mediation efforts can be proposed  
407 around cross-cutting themes such as biodiversity, allowing the public to apprehend works of  
408 art using different approaches. For example, the Anton Dohrn Zoological Station and the  
409 Capodimonte Museum of Naples recently proposed an exhibition dedicated to zoology and art  
410 history through a collection of Neapolitan Baroque still life paintings of fish and seafood  
411 (Travaglini and Santamaria, 2020). The authors reported that the paintings were effective  
412 levers of involvement regarding gastronomy and fishing, themes whose current issues of  
413 biodiversity conservation are of particular interest. The authors also stated that the use of a  
414 double narrative discourse (natural sciences and art history) as a promotional language  
415 reduced the disparities between visitors from different cultural backgrounds, and made the  
416 museum more attractive and welcoming for all. This kind of collaboration between scientists  
417 and museums is of particular interest in environmental education, since the emotional impact  
418 of the art gains strength when paired with a scientific discourse (Harrower et al., 2018).  
419 Several other initiatives based on guided tours in museums have been proposed in order to  
420 develop engaging learning activities for students by crossing art education and environmental  
421 education (see for example Inwood and Taylor, 2012). However, apart from school programs,  
422 museum exhibitions may still remain unattractive or inaccessible to the general public. Faced  
423 with this problem, it is thus important that researchers work alongside museums to develop  
424 initiatives that bring physically tangible works into general audience mediation events (such  
425 as for instance the European Researcher's Night) in order to substitute for *in situ* aesthetic  
426 experiences (Inwood and Taylor, 2012). To this end, some initiatives such as interactive  
427 shows and performances (for examples see Lesen et al., 2016) can also be exhibited outside  
428 the museums.

429

### 430 **5. From aesthetic experience to nature connectedness: an interdisciplinary** 431 **perspective to promote aquatic biodiversity conservation**

432

433 Aquatic ecosystems (oceans, rivers, lakes and wetlands) represent a very pertinent concern in  
434 the context of NC through nature aesthetic experience. They aggregate strong human and  
435 ecological issues, and as such are included in the 17 Sustainable Development Goals, yet the  
436 relationships that humans have with these ecosystems are mostly derived from indirect  
437 exposure (typically through food or cultural objects). This may partly explain why perception  
438 of these ecosystems gives rise to many beliefs and misconceptions that are often disconnected  
439 from ecological realities (Langlois et al., 2022; Tribot et al., 2018).

440 To remediate this, there is an urgent need to find new ways to connect people with underwater  
441 worlds, which are otherwise inaccessible due to remoteness, mobility issues, lack of specific  
442 skills such as swimming, or to financial constraints (Januchowski-Hartley et al., 2020). With  
443 the exception of divers or small-scale fishermen who develop expertise and close  
444 relationships with aquatic environments (Nightingale, 2012), underwater aquatic life does not  
445 enter into most people's everyday experiences of nature. The resulting separation between  
446 human perception and ecological goals may indeed constitute an obstacle in the acceptance of  
447 conservation or restoration programs, and therefore needs to be scientifically addressed.  
448 Paradoxically however, these organisms are actually better known and viewed today than they  
449 were historically, thanks to technical advances in scuba diving and underwater cameras. We

450 acknowledge that the success of aquariums with the general public (Moss et al., 2017), and  
451 exhibitions about the deep ocean (e.g., the title *Wildlife Photographer of the Year 2021* was  
452 awarded to underwater photographer Laurent Ballesta) participate significantly in people's  
453 commitment to the conservation of aquatic environments. Pre-19<sup>th</sup> c. art is underestimated as  
454 an agent for connecting people with the aquatic world: here we propose indirect exposure to  
455 these works as a tool for promoting aquatic biodiversity conservation. Art may be seen in this  
456 way as an effective means of engaging with these environments and their species by indirect  
457 exposure and through aesthetic experience (Fig. 1). While we fully recognize that this  
458 aesthetic experience does not replace the true experience of nature, it does, however, enable  
459 people to interact and engage with hitherto inaccessible species and environments such as  
460 aquatic ecosystems.

461 In the Early Modern period, aquatic species were generally portrayed as bountiful sources of  
462 food, diversity and wonder, and were figurations of a boundless might and indomitable  
463 nature. Artworks from this period are likely to arouse multiple feelings ranging from  
464 curiosity, wonder, or appetite, to pity, disgust or unease (Vézilier-Dussart, 2016). Repulsion  
465 or disgust are generally aroused by perceptual characteristics defined as ugliness (Monroe,  
466 1998). Although ugliness was formalized in Aesthetics during the 19<sup>th</sup> c. under the impulse of  
467 Hegel (Bancaud, 2009), the Early Modern painters had long depicted ugliness in order to  
468 sublimate reality (see for example the figures depicted by Vincenzo Campi (1536 - 1591) or  
469 Joachim Beuckelaer (1533 - 1574)). The paintings of Giuseppe Recco (1634 - 1695) for  
470 example, show kitchens and market stalls with fish and marine organisms that are ugly and  
471 perhaps even frightening due to their viscous and rough aspect (see for example *The riches of*  
472 *the sea with Neptune, tritons and two nereids*, 1684, by Luca Giordano and Giuseppe Recco,  
473 Fig. 1). Fishes as subjects were not considered beautiful during the 17<sup>th</sup> c., nor were they seen  
474 to be particularly interesting. The painters sublimated this *a priori* ugliness through a high  
475 degree of realism and by creating effects of light and texture: obtaining the wet reflections on  
476 the fish was a technical and technological feat. Ugliness may also be embellished by  
477 originality and curiosity: we take pleasure in seeing curious monstrosities, which are here  
478 assembled, ordered, and balanced. Finally, ugliness is sublimated by diversity, which is a  
479 principle of beauty (Esmein, 2012): in this way, painters play on the similarities and  
480 dissimilarities within the diversity of life. It is noteworthy that shellfish and crustaceans tend  
481 to be associated with travel and discovery, and figure as ornaments (see for example Pierre  
482 Mignard's *The Marquise de Seignelay and two of her sons*, 1691).

483 Whether positive or negative, these aesthetic responses elicit pleasure or interest and convey  
484 strong emotional, attentional and memorial implications (Menninghaus et al., 2017). Among  
485 the multitude of possible aesthetic responses, observation of these artworks today is thought-  
486 provoking and helps decipher the evolution of our perception of the environment and its  
487 resources over the long term. This increases understanding not only of the linearity of causes  
488 and consequences of human impact on nature, but also the changes of human perceptions of  
489 nature, and even prompts questions about the variation of human-nature relationships. A  
490 simple way to collect the quantitative data necessary for the in-depth examination of  
491 reciprocal relations between pre-19<sup>th</sup> c. art and NC would be to constitute a database of  
492 artworks specifically representing aquatic biodiversity (through participative science  
493 programs, such as [www.biodivaquart.fr](http://www.biodivaquart.fr), Tribot et al., 2021). A set of analyses of the  
494 perceived effect of aquatic NC and PEB on aesthetic responses could then be applied to this  
495 corpus, using environmental psychology tools adapted to the specific case of aquatic  
496 biodiversity. More broadly, an interdisciplinary study framework based on the links between  
497 aesthetic reception (Hager et al., 2012), environmental psychology (NC and PEB) and  
498 ecology (formal identification and biological interpretation of represented organisms) would  
499 be particularly informative. To go further, partnerships between research teams and museums

500 would enable to test the effect of aesthetic experiences on future NC and PEBs in relation to  
501 aquatic environments through workshops consisting of guided aesthetic paths. At the same  
502 time, mediation activities outside museums involving physical media would be beneficial  
503 during events dedicated to the general public.

504 Note that although this article has focused on European art as a case study, art from other  
505 regions of the world also deserves to be explored through this type of approach, such as the  
506 arts of Africa, Oceania or the Americas. For instance, nature and animals occupy a central  
507 place in the iconography of the arts and crafts of Pacific Islands (Kjellgren, 2007). Its  
508 aesthetic properties are generally expressed as the receptacle of the sacred and immaterial  
509 dimensions of the living world, used as both material and source of inspiration, and thus  
510 testifying to particular spiritual connections between humans and nature (Descola, 2021). It  
511 would be of great interest to carry out cross-cultural surveys on the aesthetic reception of the  
512 arts from different regions of the world, in order to learn more about the transversality of the  
513 aesthetic experience of nature in different cultural contexts.

514 The development of such interdisciplinary programs represents a potentially rewarding  
515 opportunity to bring together scientists from the human and environmental sciences with  
516 actors within cultural organizations, while also involving citizens through participatory  
517 sciences. We believe this to be of great interest to conservation biology, as it is only by  
518 integrating different layers of society into research processes that the goals of improved  
519 understanding and concrete application of the links between art, human-nature relationships  
520 and behaviors in favor of biodiversity will be achieved.

521

## 522 **6. Conclusions**

523

524 Experts, managers, policy makers and ecological scientists should fully consider the arts as a  
525 viable lever for sustainable development and biodiversity conservation, and thus as a means  
526 of initiating changes in belief systems and environmental behaviors. To do this, scientific  
527 advances into the relationships between aesthetic experience, nature connectedness and pro-  
528 environmental behavior are necessary, and should not be limited to recent and contemporary  
529 artworks. We have an opportunity to better understand and quantify the interrelations between  
530 aesthetic experience, nature connectedness and behaviors, in particular with regard to  
531 environments such as aquatic ecosystems that are less accessible, and for which people's  
532 connection depends for the most part on indirect exposure. To conclude this commented  
533 review, we believe that these needs can be achieved through the promotion of research and  
534 management projects involving very broad disciplines, ranging from social and environmental  
535 psychology through the cognitive neurosciences, to art history and the environmental  
536 sciences. Finally, we recommend that pre-19<sup>th</sup> c. art deserves to be further investigated,  
537 because this is an opportunity to better understand historical nature connectedness and to  
538 foster stronger relationships with nature.

539

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541

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546

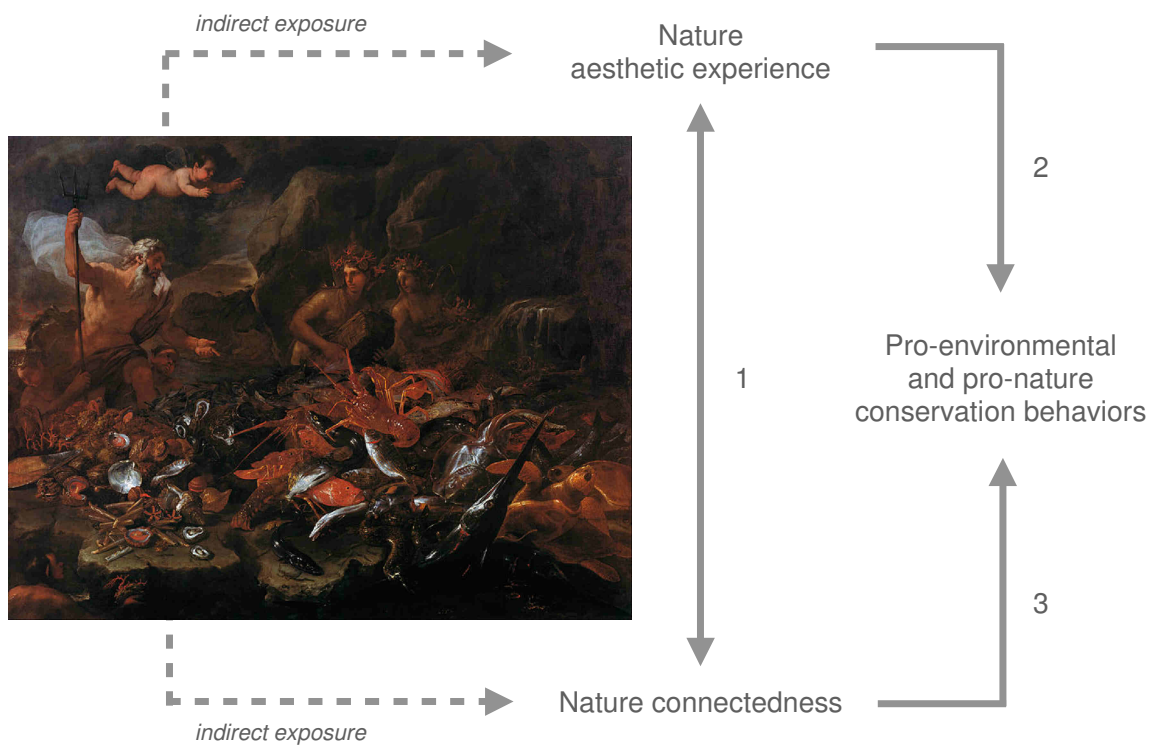
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548  
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559  
560 Figure 1: Art constitutes a relevant lever for enhancing nature connectedness through nature  
561 aesthetic experience. However, further examination of the effect of aesthetic experience as  
562 derived from indirect exposure to pre-19<sup>th</sup> c. art is necessary for the improved understanding  
563 of nature connectedness and pro-environmental behaviors.

564 Solid arrows illustrate relationships that have been well established in the literature: 1 =  
565 Barrows et al., 2022; Lumber et al., 2017; 2 = Barrows et al., 2022; Curtis et al., 2014; Lesen  
566 et al., 2016 ; 3 = Barbett et al., 2020; Richardson et al., 2020; Whitburn et al., 2020.

567 Dotted arrows represent hypothesized relationships requiring further investigation: the effect  
568 of such paintings on NC, PEB and PCB could for instance be examined through  
569 questionnaires using the Art Reception Survey (e.g., Hager et al., 2012), NC scales (e.g.,  
570 Hatty et al., 2020) and PEB/PCB scales (e.g., Barbett et al., 2020). Through a quantitative  
571 approach, statistical relationships between these factors could be modeled.

572 Painting: Luca Giordano, Giuseppe Recco, 1684, *The riches of the sea with Neptune, tritons*  
573 *and two nereids*, Naples, oil on canvas, 296 x 234 cm, Art Gallery of South Australia.

574 Source: Google Arts & Culture, US Public Domain Mark 1.0 - CC0, Mary Overton Gift Fund  
575 1997, Art Gallery of South Australia.

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