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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-19th century art in conservation biology: an untapped potential for connecting
3 with nature
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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-19th century art. However, the examination of European art prior to the
12 19th 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.
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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-19th century art. We believe, however,
28 that pre-19th 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-19th century European paintings.
33

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

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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-19th 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 18th 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 19th 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 20th 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 19th 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.

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-19th 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-19th 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-19th 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-19th 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 19th c. also constitute a cultural and historical heritage that is worthy
296 of promotion through the prism of environmental education.

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-19th 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-19th 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 6th 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 (6th c. - 15th 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 (15th c. to late 18th 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 18th 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 18th 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 19th to late 20th c.), followed by Contemporary art in the 20th 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 18th - late 19th 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-19th 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-19th c. art is the Early
348 Modern period in Europe (15th - 18th 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 17th 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 17th 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 18th 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-19th c. art*

377
378 Pre-19th 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-19th 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-19th 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 19th 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 17th 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-19th 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, 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-19th 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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546

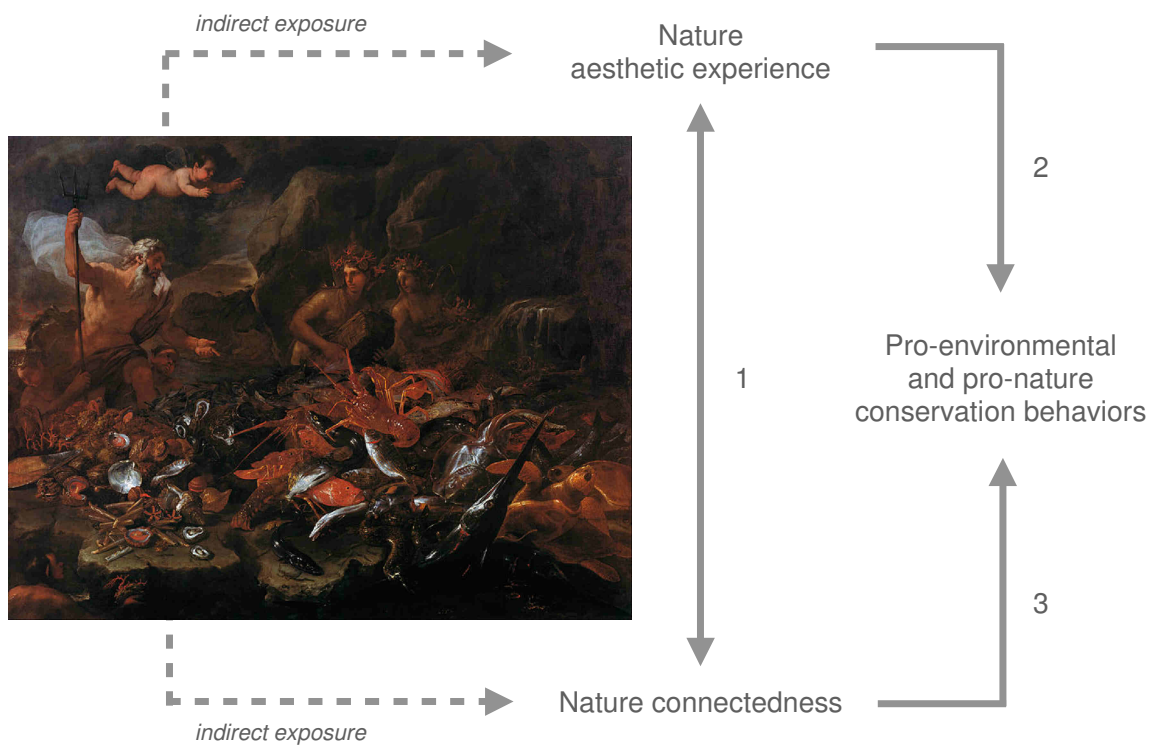
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548
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559
560 Figure 1: Art constitutes a relevant lever for enhancing nature connectedness through nature
561 aesthetic experience. However, further examination of the effect of aesthetic experience as
562 derived from indirect exposure to pre-19th 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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577 **References**

578

579 Ajzen, I., 1991. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50,
580 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)

581 Bancaud, F., 2009. L'esthétique du laid, de Hegel à Rosenkranz. Une « esthétique de la
582 résistance » ou de la résignation aux « arts qui ne sont plus beaux » ? *Études Ger.* 256, 899–
583 917. <https://doi.org/10.3917/eger.256.0899>

584 Barbett, L., Stuppel, E., Sweet, M., Schofield, M., Richardson, M., 2020. Measuring Actions
585 for Nature: Development and Validation of a Pro-Nature Conservation Behaviour Scale.
586 *Sustainability* 12, 4885. <https://doi.org/10.3390/su12124885>

587 Barrable, A., 2019. Refocusing Environmental Education in the Early Years: A Brief
588 Introduction to a Pedagogy for Connection. *Educ. Sci.* 9, 61.
589 <https://doi.org/10.3390/educsci9010061>

590 Barragan-Jason, G., de Mazancourt, C., Parmesan, C., Singer, M.C., Loreau, M., 2022.
591 Human–nature connectedness as a pathway to sustainability: A global meta-analysis.
592 *Conserv. Lett.* 15. <https://doi.org/10.1111/conl.12852>

593 Barrows, P.D., Richardson, M., Hamlin, I., Van Gordon, W., 2022. Nature Connectedness,
594 Nonattachment, and Engagement with Nature's Beauty Predict Pro-Nature Conservation
595 Behavior. *Ecopsychology* 14, 83–91. <https://doi.org/10.1089/eco.2021.0036>

596 Benzi, F., Berliocchi, L. (Eds.), 1999. *L'histoire des plantes en Méditerranée: art et*
597 *botanique.* Actes Sud [u.a.], Arles.

598 Berleant, A., 1992. *The Aesthetics of Environment,* Temple University Press. ed.

599 Boileau, N., 1674. *L'Art poétique.*

600 Bourassa, S.C., 1990. A Paradigm for Landscape Aesthetic. *Environement Behav.* 22, 787–
601 812. <https://doi.org/10.1177/0013916590226004>

602 Brady, E., 2007. Introduction to 'Environmental and Land Art.' *Ethics Place Environ.* 10,
603 257–261. <https://doi.org/10.1080/13668790701573737>

604 Brady, E., Prior, J., 2020. Environmental aesthetics: A synthetic review. *People Nat.* 2, 254–
605 266. <https://doi.org/10.1002/pan3.10089>

606 Brito, C., Vieira, N., Freitas, J.G., 2019. The wonder whale: a commodity, a monster, a show
607 and an icon. *Anthropozoologica* 54, 13. <https://doi.org/10.5252/anthropozoologica2019v54a3>

608 Carlson, A., 2016. Environmental aesthetics, in: *Routledge Encyclopedia of Philosophy.*
609 *Routledge, London.* <https://doi.org/10.4324/9780415249126-M047-1>

610 Carlson, A., 2000. *Aesthetics and the Environment: The Appreciation of Nature, Art and*
611 *Architecture.* Routledge, London.

612 Chatterjee, A., Vartanian, O., 2014. Neuroaesthetics. *Trends Cogn. Sci.* 18, 370–375.
613 <https://doi.org/10.1016/j.tics.2014.03.003>

614 Colléony, A., Clayton, S., Couvet, D., Saint Jalme, M., Prévot, A.-C., 2017. Human
615 preferences for species conservation: Animal charisma trumps endangered status. *Biol.*
616 *Conserv.* 206, 263–269. <https://doi.org/10.1016/j.biocon.2016.11.035>

617 Corbin, A., 2018. *Le territoire du vide,* Champs. Flammarion, Paris.

618 Curtis, D.J., Mainguy, G., Reid, N., Reeve, I., 2014. Towards ecological sustainability:
619 observations on the role of the arts. *S.A.P.I.E.N.S [Online],* 7.1 16.

620 de Leeuw, A., Valois, P., Ajzen, I., Schmidt, P., 2015. Using the theory of planned behavior
621 to identify key beliefs underlying pro-environmental behavior in high-school students:
622 Implications for educational interventions. *J. Environ. Psychol.* 42, 128–138.

623 <https://doi.org/10.1016/j.jenvp.2015.03.005>

624 De Smet, I., Vergauwen, D., 2021. The Collaboration Between Art History and Genetics – An
625 Unlikely Marriage of Disciplines. *Front. Plant Sci.* 12, 757439.
626 <https://doi.org/10.3389/fpls.2021.757439>

627 Descola, P., 2021. *Les formes du visible: une anthropologie de la figuration*, Les livres du
628 nouveau monde. Éditions du Seuil, Paris.

629 Dunlap, R.E., 2008. The New Environmental Paradigm Scale: From Marginality to
630 Worldwide Use. *J. Environ. Educ.* 40, 3–18. <https://doi.org/10.3200/JOEE.40.1.3-18>

631 Dunlap, R.E., Van Liere, K.D., 1978. The “New Environmental Paradigm.” *J. Environ. Educ.*
632 9, 10–19. <https://doi.org/10.1080/00958964.1978.10801875>

633 Esmein, B., 2012. *Beauté et Différenciation: Le Philosophoire n° 38*, 43–76.
634 <https://doi.org/10.3917/phoir.038.0043>

635 Gaston, K.J., Soga, M., Duffy, J.P., Garrett, J.K., Gaston, S., Cox, D.T.C., 2018. Personalised
636 Ecology. *Trends Ecol. Evol.* 33, 916–925. <https://doi.org/10.1016/j.tree.2018.09.012>

637 Gobster, P.H., Nassauer, J.I., Daniel, T.C., Fry, G., 2007. The shared landscape: what does
638 aesthetics have to do with ecology? *Landsc. Ecol.* 22, 959–972.
639 <https://doi.org/10.1007/s10980-007-9110-x>

640 Gombrich, E.H., 2011. *The story of art*, Repr. ed. Phaidon Press, London.

641 Guidetti, P., Micheli, F., 2011. Ancient art serving marine conservation. *Front. Ecol. Environ.*
642 9, 374–375. <https://doi.org/10.1890/11.WB.019>

643 Hager, M., Hagemann, D., Danner, D., Schankin, A., 2012. Assessing aesthetic appreciation
644 of visual artworks—The construction of the Art Reception Survey (ARS). *Psychol. Aesthet.*
645 *Creat. Arts* 6, 320–333. <https://doi.org/10.1037/a0028776>

646 Harrower, J., Parker, J., Merson, M., 2018. Species Loss: Exploring Opportunities with Art–
647 Science. *Integr. Comp. Biol.* 58, 103–112. <https://doi.org/10.1093/icb/icy016>

648 Hatty, M.A., Smith, L.D.G., Goodwin, D., Mavondo, F.T., 2020. The CN-12: A Brief,
649 Multidimensional Connection With Nature Instrument. *Front. Psychol.* 11, 1566.
650 <https://doi.org/10.3389/fpsyg.2020.01566>

651 Heras, M., 2022. Art and Connectedness within Sustainability: Educating Through Aesthetic
652 Pedagogies, in: Vare, P., Lousselet, N., Rieckmann, M. (Eds.), *Competences in Education for*
653 *Sustainable Development*, Sustainable Development Goals Series. Springer International
654 Publishing, Cham, pp. 145–157. https://doi.org/10.1007/978-3-030-91055-6_18

655 Heras, M., Galafassi, D., Oteros-Rozas, E., Ravera, F., Berraquero-Díaz, L., Ruiz-Mallén, I.,
656 2021. Realising potentials for arts-based sustainability science. *Sustain. Sci.* 16, 1875–1889.
657 <https://doi.org/10.1007/s11625-021-01002-0>

658 Heylighen, F., Petrović, K., 2021. Foundations of ArtScience: Formulating the Problem.
659 *Found. Sci.* 26, 225–244. <https://doi.org/10.1007/s10699-020-09660-6>

660 Inwood, H., Taylor, R., 2012. Creative Approaches to Environmental Learning: Two
661 Perspectives on Teaching Environmental Art Education. *Int. Electron. J. Environ. Educ.* 2,
662 65–75.

663 Ives, C.D., Abson, D.J., von Wehrden, H., Dorninger, C., Klanićki, K., Fischer, J., 2018.
664 Reconnecting with nature for sustainability. *Sustain. Sci.* 13, 1389–1397.
665 <https://doi.org/10.1007/s11625-018-0542-9>

666 Januchowski-Hartley, S.R., Bear, C., O’Gorman, E., Januchowski-Hartley, F.A., 2020.
667 “Underwater”, in: *An A to Z of Shadow Places Concepts*.

668 Kant, I., 1790. *The Critique of Judgement*.

669 Kaplan, R., Kaplan, S., 1989. *The experience of Nature, a psychological perspective*.
670 Cambridge University Press, Cambridge.

671 Kazemi-Shahandashti, S.-S., Mann, L., El-nagish, A., Harpke, D., Nemati, Z., Usadel, B.,
672 Heitkam, T., 2022. Ancient Artworks and Crocus Genetics Both Support Saffron’s Origin in
673 Early Greece. *Front. Plant Sci.* 13, 834416. <https://doi.org/10.3389/fpls.2022.834416>

674 Kellert, S.R., Wilson, E.O. (Eds.), 1993. *The Biophilia hypothesis*. Island Press, Washington,
675 D.C.

676 Kjellgren, E. (Ed.), 2007. *Oceania: art of the Pacific Islands in the Metropolitan Museum of*
677 *Art*. Metropolitan Museum of Art ; Yale University Press, New York : New Haven.

678 Langlois, J., Guilhaumon, F., Baletaud, F., Casajus, N., De Almeida Braga, C., Fleuré, V.,
679 Kulbicki, M., Loiseau, N., Mouillot, D., Renoult, J.P., Stahl, A., Stuart Smith, R.D., Tribot,
680 A.-S., Mouquet, N., 2022. The aesthetic value of reef fishes is globally mismatched to their
681 conservation priorities. *PLOS Biol.* 20, e3001640.
682 <https://doi.org/10.1371/journal.pbio.3001640>

683 Leder, H., Belke, B., Oeberst, A., Augustin, D., 2004. A model of aesthetic appreciation and
684 aesthetic judgments. *Br. J. Psychol.* 95, 489–508. <https://doi.org/10.1348/0007126042369811>

685 Lesen, A.E., Rogan, A., Blum, M.J., 2016. Science Communication Through Art: Objectives,
686 Challenges, and Outcomes. *Trends Ecol. Evol.* 31, 657–660.
687 <https://doi.org/10.1016/j.tree.2016.06.004>

688 Li, D., Zhao, L., Ma, S., Shao, S., Zhang, L., 2019. What influences an individual’s pro-
689 environmental behavior? A literature review. *Resour. Conserv. Recycl.* 146, 28–34.
690 <https://doi.org/10.1016/j.resconrec.2019.03.024>

691 Lumber, R., Richardson, M., Sheffield, D., 2017. Beyond knowing nature: Contact, emotion,
692 compassion, meaning, and beauty are pathways to nature connection. *PLOS ONE* 12,
693 e0177186. <https://doi.org/10.1371/journal.pone.0177186>

694 Marks, M., Chandler, L., Baldwin, C., 2017. Environmental art as an innovative medium for
695 environmental education in Biosphere Reserves. *Environ. Educ. Res.* 23, 1307–1321.
696 <https://doi.org/10.1080/13504622.2016.1214864>

697 Mazzoldi, C., Bearzi, G., Brito, C., Carvalho, I., Desiderà, E., Endrizzi, L., Freitas, L.,
698 Giacomello, E., Giovos, I., Guidetti, P., Ressurreição, A., Tull, M., MacDiarmid, A., 2019.
699 From sea monsters to charismatic megafauna: Changes in perception and use of large marine
700 animals. *PLOS ONE* 14, e0226810. <https://doi.org/10.1371/journal.pone.0226810>

701 Menninghaus, W., Wagner, V., Hanich, J., Wassiliwizky, E., Jacobsen, T., Koelsch, S., 2017.
702 The Distancing-Embracing model of the enjoyment of negative emotions in art reception.
703 *Behav. Brain Sci.* 40, e347. <https://doi.org/10.1017/S0140525X17000309>

704 Metzger, A., Tabeaud, M., 2015. Une géoclimatologie culturelle: Comparaison entre les
705 paysages peints des Hollandais et des Espagnols au « Siècle d’or ». *Géographie Cult.* 175–
706 188. <https://doi.org/10.4000/gc.3943>

707 Monroe, R., 1998. Ugliness, in: Kelly, M. (Ed.), *Encyclopedia of Aesthetics in Oxford Art*
708 *Online*. Oxford University Press, New York.

709 Moss, A., Jensen, E., Gusset, M., 2017. Impact of a global biodiversity education campaign
710 on zoo and aquarium visitors. *Front. Ecol. Environ.* 15, 243–247.
711 <https://doi.org/10.1002/fee.1493>

712 Nightingale, A.J., 2012. The Embodiment of Nature: Fishing, Emotion, and the Politics of
713 Environmental Values, in: Brady, E., Phemister, P. (Eds.), *Human-Environment Relations*.
714 Springer Netherlands, Dordrecht, pp. 135–147. https://doi.org/10.1007/978-94-007-2825-7_11

715

716 Onwezen, M.C., Antonides, G., Bartels, J., 2013. The Norm Activation Model: An
717 exploration of the functions of anticipated pride and guilt in pro-environmental behaviour. *J.*
718 *Econ. Psychol.* 39, 141–153. <https://doi.org/10.1016/j.joep.2013.07.005>

719 Oreg, S., Katz-Gerro, T., 2006. Predicting Proenvironmental Behavior Cross-Nationally:
720 Values, the Theory of Planned Behavior, and Value-Belief-Norm Theory. *Environ. Behav.* 38,
721 462–483. <https://doi.org/10.1177/0013916505286012>

722 Paden, R., International Association for Environmental Philosophy, 2013. A Defense of the
723 Picturesque: *Environ. Philos.* 10, 1–21. <https://doi.org/10.5840/envirophil201310212>

724 Pereira, M., Forster, P., 2015. Pereira, M., & Forster, P. (2015). The relationship between
725 connectedness to nature, environmental values, and pro-environmental behaviours.
726 *Reinvention Int. J. Undergrad. Res.* 8.

727 Pritchard, A., Richardson, M., Sheffield, D., McEwan, K., 2020. The Relationship Between
728 Nature Connectedness and Eudaimonic Well-Being: A Meta-analysis. *J. Happiness Stud.* 21,
729 1145–1167. <https://doi.org/10.1007/s10902-019-00118-6>

730 Ramachandran, V.S., Hirstein, W., 1999. The science of art: A neurological theory of
731 aesthetic experience. *J. Conscious. Stud.* 6, 15–51.

732 Rashkow, E.D., 2014. Idealizing Inhabited Wilderness: A Revision to the History of
733 Indigenous Peoples and National Parks: Idealizing Inhabited Wilderness. *Hist. Compass* 12,
734 818–832. <https://doi.org/10.1111/hic3.12190>

735 Reber, R., Schwarz, N.& Winkielman, P., 2004. Processing fluency and aesthetic pleasure: is
736 beauty in the perceiver’s processing experience? *Soc Psychol Rev* 8, 364–382.
737 https://doi.org/10.1207/s15327957pspr0804_3

738 Renowden, C., Beer, T., Mata, L., 2022. Exploring integrated ARTSCIENCE experiences to
739 foster nature connectedness through head, heart and hand. *People Nat.* 4, 519–533.
740 <https://doi.org/10.1002/pan3.10301>

741 Richardson, M., Passmore, H., Barbett, L., Lumber, R., Thomas, R., Hunt, A., 2020. The
742 green care code: How nature connectedness and simple activities help explain pro-nature
743 conservation behaviours. *People Nat.* 2, 821–839. <https://doi.org/10.1002/pan3.10117>

744 Rose, G., 1993. *Feminism and geography: the limits of geographical knowledge*, Repr. ed.
745 Polity Press, Cambridge.

746 Saunders, F.P., 2013. Seeing and Doing Conservation Differently: A Discussion of Landscape
747 Aesthetics, Wilderness, and Biodiversity Conservation. *J. Environ. Dev.* 22, 3–24.
748 <https://doi.org/10.1177/1070496512459960>

749 Schwartz, S.H., 1977. Normative Influences on Altruism, in: *Advances in Experimental*
750 *Social Psychology*. Elsevier, pp. 221–279. [https://doi.org/10.1016/S0065-2601\(08\)60358-5](https://doi.org/10.1016/S0065-2601(08)60358-5)

751 Shimamura, A.P., Palmer, S.E., 2012. *Aesthetic Science: Connecting Minds, Brains, and*
752 *Experience*. Oxford University Press, New York.

753 Soga, M., Gaston, J.K., 2016. Extinction of experience: the loss of human–nature interactions.
754 *Front. Ecol. Environ.* 14, 94–101. <https://doi.org/10.1002/fee.1225>

755 Stern, P.C., Dietz, T., Abel, T.D., Guagnano, G.A., Kalof, L., 1999. A Value-Belief-Norm
756 Theory of Support for Social Movements: The Case of Environmentalism. *Hum. Ecol. Rev.* 6,
757 81–97.

758 Swaffield, S.R., McWilliam, W.J., 2013. Landscape aesthetic experience and ecosystem
759 services., in: Dymond, J.R. (Ed.), *Ecosystem Services in New Zealand – Conditions and*
760 *Trends*. Manaaki Whenua Press, Lincoln, New Zealand, pp. 349–362.

761 Thornes, J.E., 2008. A Rough Guide to Environmental Art. *Annu. Rev. Environ. Resour.* 33,
762 391–411. <https://doi.org/10.1146/annurev.enviro.31.042605.134920>

763 Tinio, P.P.L., 2013. From artistic creation to aesthetic reception: The mirror model of art.
764 *Psychol. Aesthet. Creat. Arts* 7, 265–275. <https://doi.org/10.1037/a0030872>

765 Travaglini, A., Santamaria, F., 2020. Storia dell’arte e della zoologia marina. Un dialogo a
766 due voci per una cultura accessibile al Museo di Capodimonte. *Museol. Sci. Mem.* 165–169.

767 Tribot, A.-S., Deter, J., Mouquet, N., 2018. Integrating the aesthetic value of landscapes and
768 biological diversity. *Proc. R. Soc. B Biol. Sci.* 285, 20180971.
769 <https://doi.org/10.1098/rspb.2018.0971>

770 Tribot, A.-S., Faget, D., Villesseche, H., Richard, T., Changeux, T., 2021. Multi-secular and
771 regional trends of aquatic biodiversity in European Early Modern paintings: toward an
772 ecological and historical significance. *Ecol. Soc.* 26, art26. [https://doi.org/10.5751/ES-12740-](https://doi.org/10.5751/ES-12740-260426)
773 260426

774 Vézilier-Dussart, S., 2016. L'odyssée des animaux: les peintres animaliers flamands du XVIIe
775 siècle [exposition, Cassel, Musée départemental de Flandre, 8 octobre 2016-22 janvier 2017].
776 Snoeck Musée de Flandre, Gand Cassel.
777 Whitburn, J., Linklater, W., Abrahamse, W., 2020. Meta-analysis of human connection to
778 nature and proenvironmental behavior. *Conserv. Biol.* 34, 180–193.
779 <https://doi.org/10.1111/cobi.13381>
780 Zerefos, C.S., Tetsis, P., Kazantzidis, A., Amiridis, V., Zerefos, S.C., Luterbacher, J.,
781 Eleftheratos, K., Gerasopoulos, E., Kazadzis, S., Papayannis, A., 2014. Further evidence of
782 important environmental information content in red-to-green ratios as depicted in paintings by
783 great masters. *Atmospheric Chem. Phys.* 14, 2987–3015. [https://doi.org/10.5194/acp-14-](https://doi.org/10.5194/acp-14-2987-2014)
784 [2987-2014](https://doi.org/10.5194/acp-14-2987-2014)
785 Zhang, J.W., Howell, R.T., Iyer, R., 2014. Engagement with natural beauty moderates the
786 positive relation between connectedness with nature and psychological well-being. *J. Environ.*
787 *Psychol.* 38, 55–63. <https://doi.org/10.1016/j.jenvp.2013.12.013>
788 Zylstra, M.J., Knight, A.T., Esler, K.J., Le Grange, L.L.L., 2014. Connectedness as a Core
789 Conservation Concern: An Interdisciplinary Review of Theory and a Call for Practice.
790 *Springer Sci. Rev.* 2, 119–143. <https://doi.org/10.1007/s40362-014-0021-3>
791