Environmental themes and ecosystem services in picture books about forests for sustainability education

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Abstract

This study is based on the perspective that picture books about forests can facilitate children's knowledge and emotions about the forests, functioning as a triggering source to make children act sustainably toward forests. This study used content analysis to explore the presence and association between environmental themes and forest ecosystem services (FES) categories in 169 picture books about forests. The analysis revealed that behavioral themes (e.g. daily environmentally friendly behaviors) and the regulating services (e.g. local climate and air quality control) were less frequently presented in the picture books than other environmental themes and FES. Furthermore, several associations were identified between environmental themes and FES categories. We discuss some implications of the findings for research and practice in using picture books about forests for sustainability education.

Keywords

Young children, forest ecosystem services, picture books, content analysis, education for sustainability

Introduction

Education for Sustainable Development (ESD) is now widely recognized as an essential element in early childhood education because childhood is a fundamental phase for developing individuals' attitudes, values, skills, and behavioral patterns (Ewert et al. 2005; Samuelsson and Kaga 2008; Hahn and Garrett 2017; Borg et al. 2019; Otto et al. 2019). At the same time, there is surging interest among researchers and policymakers in using the natural environment, such as forests, as a place to implement ESD for young children (Barratt et al. 2014; Chawla and Rivkin 2014). This is encouraging news, given that the forest is a space where various economic, social/cultural, and environmental factors are interlinked and dealt with in a complex manner.

At the same time, storytelling has been suggested as a practical educational approach for implementing ESD (Wason-Ellam 2010; Spearman and Eckhoff 2012; UNESCO 2017; Ebersbach and Brandenburger 2020). In this study, we focused on picture books as a form of educational material.

Picture books include all children's stories in which illustrations (images) and text interact to create a new meaning (Shulevitz 1997; Lynch-Brown et al. 2014). They contain stories and narratives about humans, society, and nature with the potential for educational use. The use of narratives involves presenting a chain of events in cause-effect relationships, which resonates with how children make sense of the world based on events and causal relationships. Narratives in picture books can help children understand the natural world and develop explanations about the material world, which is the core aim of science and environmental education (Avraamidou and Osborne 2009).

Picture books about forests contain elements related to the "forest." Major institutions such as the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Framework Convention on Climate Change (UNFCCC) generally refer to forests as the land in which trees grow collectively. This study was developed based on the perspective that picture books about forests can facilitate children's knowledge, positive emotions, and behaviors toward forests. Such a belief highlights the necessity of investigating what kind of and how much of the necessary contents (in this case, environmental themes and forest ecosystem services) are present in current picture books about forests. Thus, we aimed to investigate to what extent the picture books about forests depict contents that may stimulate children to view, think, and sustainably treat the forest.

Use of picture books about forests as a tool for ESD

Prior studies have shown that children can accumulate new knowledge, become interested in things they are not familiar with, and develop new attitudes toward a specific topic through reading picture books (Justice et al. 2005; Hassinger-Das et al. 2015; Ostrosky et al. 2015). Ultimately, some children also experienced behavioral changes: their sharing behavior and vegetable intake increased after reading picture books (Larsen et al. 2018; Appleton et al. 2019). If children are properly motivated and scaffolded, they can actively "learn" through observation in any context (Bandura 1986, 2001). In addition, with the presence of adults' help (i.e. through discussions about the book) during picture book reading, children can understand and become more attentive to seemingly complex contents and messages that may seem to be beyond their level (Zevenbergen and Whitehurst 2003; Fountas and Pinnell 2012).

Picture books about forests that portray how nature may, or may not, have changed, reflecting the society in which they are created (Babb et al. 2018), can reinforce children to reflect on their sustainable living. Through reading, children may experience and learn to identify, investigate, evaluate and practice appropriate actions (Bradbery 2013). Thus, forests can function as space with an essential meaning for children's ESD (Knight 2013; Barratt et al. 2014; Chawla and Rivkin 2014; Knight and Luff 2017). Likewise, educational programs using environmental picture books enhanced children's respect for nature, pro-environmental attitudes, prosocial behaviors, and sensitivity to the natural environment (Park and Choi 2014; Hsiao and Shih 2015; Kim and Lee 2016). Although these studies provide empirical evidence that utilizing picture books in ESD for early childhood could be effective and meaningful, up to date, there has been no research to explore the content of picture books about forests. Furthermore, the lack of information is presented on what kinds and how much critical information for environmental and sustainable education is contained in published picture books.

Specific contents

For past years, the criticality of implementing culturally-responsive environmental education has been emphasized (Blanchet-Cohen and Reilly 2013). Since an individual's interests, concerns, and contributions towards a solution for environmental issues may vary depending on individual's

characteristics, interests, knowledge, experience, and feeling towards the environment (Dunlap and Jones 2002), it may be essential to expose young children to a broad concept of environmental themes and benefits of nature which may heighten their environmental awareness and concern for forests. In this view, we analyzed picture books about forests to grasp the extent to which environmental themes and forest ecosystem services (FES) are presented.

Environmental themes

Children's literature, in general, is acknowledged to enhance people's awareness and understanding of culturally defined meanings, attitudes, and values of nature, environment, and place by providing a visual portrayal of the environment both familiar and not familiar to them (Squire 1996; Korteweg et al. 2010). Thus, the environmental themes embedded in picture books can be valuable sources for developing children's values, attitudes, and behavior towards the environment. Prior studies which analyzed ecological and environmental elements in children's books have attempted to identify or evaluate the presence of environmental themes (Rule and Atkinson 1994; Babb et al. 2018; Martín et al. 2019). For instance, Babb et al. (2018) tracked the environment in Australian children's literature and gained information that recent children's literature presented a growing ecological or environmental awareness and diversification of environmental themes.

The environmental themes investigated can trigger children's cognitive/environmental knowledge (i.e. knowledge of biology and ecology), affective/motivational factors (i.e. connection to nature), and actual behavior (i.e. participation, problem-solving) (Clayton and Myers 2010; UNESCO 2017) toward forests. Therefore, the study explored how much each environmental theme is presented in the picture books about forests we examined.

Forest ecosystem services

The forests consist of various ecosystem services (ES) and are recognized as the source of the most commonly encountered ES around humans (Mengist and Soromessa 2019). ES refers to nature's direct or indirect benefits to humans (De Groot et al. 2002). The term ES, instead of nature's contributions to people (Pascual et al. 2017; Díaz et al. 2018), was used in this study because we followed the definition of the Millennium Ecosystem Assessment (MEA (Millennium ecosystem assessment) 2005). In this paper, FES are grouped into four categories: Provisioning services category (PSC), regulating services category (RSC), cultural services category (CSC), and supporting services category (SSC) (MEA 2005; TEEB 2011).

Sustainable management of forests is to maintain and promote the various functions of forests in better condition than they are now. Prior studies on the sustainable management of forests have attempted to quantify the FES (Boerema et al. 2017), measure people's evaluation (Anaya-Romero et al. 2016; Müller et al. 2020), knowledge (Parrotta et al. 2016; Torkar and Krašovec 2019), and attitudes towards FES (Baur et al. 2016). Accordingly, increasing people's awareness of FES could foster positive forest management (Schwaiger et al. 2019; Mann et al. 2021), and one of many effective ways of managing forests was found to be acknowledging and implementing a policy that supports a balance between the FES preferences of diverse stakeholders (i.e. local authorities, governments, citizens) (Zoderer et al. 2019).

We believe that learning about the concept of FES from early childhood years will help future generations to grow with an ability to value and manage forests that are currently deteriorating globally. Guiding children to understand the facts, reasons, and ways to maintain the forest in their lives sustainably is an important issue. Although still scant, studies assessing the perception of FES among youth have found that Slovenian children in primary school were already capable of placing preference on FES (Torkar 2016; Torkar and Krašovec 2019). This evidence directly points to the vital role of introducing FES to younger children in balanced ways to strengthen their ability to

understand all four categories of FES equally well and improve their ecological knowledge to raise environmental awareness. In the meantime, little is known as to how much of this information is included in picture books about forests, and this study aimed to fill in this gap.

Present study

The main goal of this study was to investigate to what extent the environmental themes and FES contents are presented in picture books about forests published in South Korea. Furthermore, we also explored the associations between the two contents. The depiction of environmental themes and the importance of their presence in children's literature have been recognized (e.g. Rule and Atkinson 1994; Babb et al. 2018; Martín et al. 2019). However, the concept of FES in picture books about forests has rarely been examined. Thus, the study attempted to explore the possibility of introducing FES to children in a friendlier way, embedding the concept of FES in environmental themes. To do this, we explored the consistency in the presentation of the environmental themes and FES categories together in picture books about forests and provided the reasonability of any explored associations between two contents based on the definition of FES.

The following research questions were posed:

Research question 1: To what extent do children's picture books about forests present environmental themes?

Research question 2: To what extent do children's picture books about forests present the concept of forest ecosystem services?

Research question 3: Is there associations between the depiction of a specific environmental theme and forest ecosystem services categories?

Materials and methods

The present study conducted content analysis to examine picture books about forests. This method was chosen because it allows the researcher to investigate "quantitatively oriented questions" qualitatively to detect patterns and reveal common thematic elements across large bodies of work (Wagner 2013). Content analysis has been used to analyze children's literature (Johnson et al. 2016) and sometimes specifically on how nature and the environment are depicted in children's books (e.g. Rule and Atkinson 1994; Babb et al. 2018).

Materials

This study was conducted in the context of South Korea, and we included both original Korean picture books and translations of books written by non-Korean authors. Furthermore, we utilized the search engine of the Kyobo Book Center (http://www.kyobobook.co.kr), the largest and most popular bookseller in the country.

The key terms used to search for the picture books about forests were "forest (swupt)", "mountain (san)", "tree (na-mwu)", "ecology (sayng-thay)", "nature (ca-yen)", "leaf (iph)", "seed (ssi-as)", and "berry, fruit, nut (yel-may)". The total number of picture books that appeared for the initial search with the key terms was 3,092. The information available online (e.g. the year of the publication, age appropriateness, picture book type, title, summary, and preview) was reviewed, and only the printed narrative picture books (published between 2000 and 2020) with illustrations, text, and plot were

included (for details, supplementary material 1). Excluding those books that do not meet the criteria, the researchers purchased 248 picture books and precisely reviewed them. As a result, 79 books were excluded from the final selection process, and 169 books formed the final list.

Among the selected picture books, 26 picture books (15.38%) were published in 2000–2005, 33(19.53%) in 2006–2010, 39 (23.08%) in 2011–2015, and 71 (42.01%) in 2015–2020. Writers from outside of Korea wrote more than 60% of picture books. Apart from Korea writers, 28.99% of the writers were from Europe (France, UK, Spain, Italy, Belgium, Netherland, Norway, Germany, Czech Republic, and Switzerland). Furthermore, 25 writers (14.79%) were from North and South America (USA, Canada, and Brazil) and 21 writers (12.43%) were from South and Asia-Pacific regions (Japan, Taiwan, China, Iran, Turkey, and Australia). More than half (57.88%) were fantasy picture books,[1] followed by realistic[2] (26.63%), informative[3] (13.02%), and traditional[4] (2.37%).

Coding

Environmental themes

We modified and utilized the environmental themes coding schemes used in the previous studies (Rule and Atkinson 1994; UNESCO 2017; Babb et al. 2018; Martín et al. 2019). Forty-four picture books were initially selected to make necessary amendments to the initial coding scheme extracted from the prior studies. Specifically, two researchers sat together and coded the selected 44 picture books together based on the original coding scheme. When discrepancies arose, the coders discussed the illustrations and texts together to agree and clarify the coding criteria. Any repeated environmental themes in the draft version were eliminated or merged. For example, “human dependence” was eliminated because all elements coded as FES reflected “human dependence.” We also divided the “environmentally friendly behaviors” theme into four categories to clearly distinguish the type of human behaviors which can be done to the environment.

The coding framework consisting of 15 themes (Table 1) was used in this study. The unit of analysis was a page. For each page, the texts and the illustrations (images) were coded into one or more of the themes (present = 1; absent = 0). In case the contents of the text and illustration (image) differed on a page, all contents were counted.

Table 1. Environmental themes descriptions (Table view)

Environmental Themes	Explanation
Endangered living things	· Introduce endangered living things. Specified in the text that introduced living thing (animal/insect/plant) is “endangered” (very few left, no longer living, etc.)
Realistic species behavior	· Wild animals display natural behaviors (not simply ornamentally present in the image)
Interrelatedness of ecosystems	· The interrelatedness of nature and natural processes (the connection between different ecosystems and natural processes such as rainfall and plant growth, food chains, seasons, etc.)
Portrayal of pests	· The negative depiction of pest species

Environmental Themes	Explanation
Slow regeneration	· Slow regeneration of forest: Provide the message that it takes a long time to replenish itself
Human impacts	· Direct and indirect human impacts on the environment/nature such as litter, pollution, harm to animals, forest living things' habitat loss, deforestation, fragmentation, overexploitation, and invasive species · The negative portrayal of industrialized societies (dark/muted colors and undertones associated with cities and mass production/consumption/waste etc.). · The negative portrayal of destructive environmental practices that cause biodiversity loss
Aesthetic appreciation	· Appreciation of beauty/wonder/harmony of the natural world
Vocalizing nature	· Gives voice to usually non-vocal aspects of nature (trees, sky, earth, etc.). Story from the viewpoint of animals or nature
Empathy	· Evokes or depicts empathy towards animals and other living beings (protecting endangered species, caring for wildlife, etc.)
Realization of human beings as part of nature	· Question the dualism of human/nature and realize that they are part of nature and not apart from nature · Creation of a vision of human life in harmony with nature · Depict the life of natives in the forest
Realistic plant growth	· Detailed characteristics, realistic change, and growth of plants
Daily environmentally friendly behaviors	· Display environmentally friendly behaviors which can be practiced in our everyday lives (e.g. recycling, collecting garbage)
Saving/helping wild animals	· Action to save/help an individual wild animal(s) in the forest (e.g. building a birdhouse)
Conservation effort	· Display conservation effort by participating in campaigns or volunteering
Direct Forest caring behavior	· Display direct forest caring behaviors such as planting trees, picking garbage in forests, etc.

Notes. Revised version based on previous studies (Rule and Atkinson 1994; UNESCO 2017; Babb et al. 2018; Martín et al. 2019).

Forest Ecosystem Services

For every page with an image, a coding procedure recorded the presence or absence of each specific FES category (MEA (Millennium ecosystem assessment) 2005; TEEB 2011) (Table 2). Both the text and illustration (image) were coded: each FES was coded for each page (present = 1; absent = 0).**Table 2**. Forest ecosystem services categories descriptions and coding scheme (Table view)

Forest ecosystem services		Description	Coding scheme (coded by page)
Provisioning services (PSC)	1. Food	Provide food such as forest products and fruits	The appearance of fruits or forest products edible by humans (e.g. acorns)
	2. Raw materials	Provide a variety of materials for construction and fuel, including wood, biofuels, and vegetable oils	The appearance of the use of forest raw materials in people's daily life (e.g. furniture production)
	3. Freshwater	Provide water to mankind and ensure the storage, flow, and storage of water resources	Provide information that forests provide water for human use in the forest
	4. Medicinal resources	Provide raw materials for the pharmaceutical industry and plants used in traditional medicines	The scene features plants that can be used as raw materials for medicine
Regulating services (RSC)	1. Local climate and air quality control	Control air quality by lowering the city's temperature and removing pollutants	The portrayal of any information related to forests regulating air quality and water quantity
	2. Carbon sequestration and storage	Regulate the earth's climate by absorbing and storing greenhouse gases	The portrayal of any information that forests regulate earth's climate
	3. Moderation of extreme events	Create buffers against natural disasters and control damage from extreme weather events or natural disasters (floods, storms, tsunamis, avalanches, landslides, etc.)	The portrayal of any information that forests reduce damage from extreme climatic events and natural disasters
	4. Waste-water treatment	Control waste decomposition activity through the activity of microorganisms in the soil	Provide information and explain the principle that forest soil decomposes waste
	5. Erosion prevention and maintenance of soil fertility	Take a role in decelerating the land degradation and desertification process essential for plant growth and agriculture. Properly functioning ecosystems provide the soil with nutrients needed for plant growth	The portrayal of any information related to the fact that trees in the forest help to fertilize the soil and to prevent soil erosion caused by rain and wind

Forest ecosystem services		Description	Coding scheme (coded by page)
	6. Pollination	Insects and wind control the pollination of plants, which are essential for fruit, vegetable, and seed fruiting and growth	Depict, describe or explain (how) insects, wind, and animals pollinate
	7. Biological control	Control pests and diseases through the action of predators and parasites	The portrayal of any information that the activities of specific individuals in the forests are regulated through the structure of the food chain, such as primary consumers and secondary consumers in an ecosystem
Cultural services (CSC)	1. Recreation and mental and physical health	Provide an environment that helps people maintain mental and physical health	The portrayal of enjoying a walk in the forest for no specific purpose, playing games, or exercising
	2. Tourism	Ecosystems and biodiversity play an important role in the tourism sector. Tourism brings economic benefits, serves as an important source of income for many countries, and teaches people about the importance of biodiversity	Portray a feeling of pleasure and learning new things in the process of sightseeing in the forest
	3. Aesthetic appreciation and inspiration for culture, art, and design	Provide a source of inspiration for much of human art and culture	The portrayal of a character receiving artistic inspiration from the forest (e.g. a character drawing forest scenery)
	4. Spiritual experience and sense of place	Certain areas such as forests or mountains are considered to have sacred or religious significance. As a common element constituting religion and traditional knowledge, interest in nature plays an important role in forming a sense of belonging	The portrayal of how sacred power resides in the forest to protect humans, animals, and plants or to punish people for harming the forest
Supporting services (SSC)	1. Habitats for species	Provide everything an individual plant or animal needs (food, water, habitat) to survive	Coded when specifically mentioned “00’s home” or “00’s place of residence” and when everything (food, water, habitat) needed for animals to live appear

Forest ecosystem services		Description	Coding scheme (coded by page)
			in one scene. In addition, any information or explanation related to the nutrient cycle, soil formation, photosynthesis, and water cycle were also coded.
	2. Maintenance of genetic diversity (Biodiversity)	The genetic diversity of organisms distinguishes between different breeds and races and provides the basis for regionally appropriate breeds and gene groups for further improvement of commercial crops and livestock	Portrayal of biodiversity ※ coded if three or more species appear on one page. In the case where a new species appeared on each page, a score of "1" was given after the third species appeared.

Notes. Revised version based on previouse studies (MEA (Millennium ecosystem assessment) 2005; TEEB 2011)

Inter-rater agreement

Two of the authors of this paper coded every page of 44 picture books individually and conducted interrater reliability using the intra-class correlation coefficient. Interrater reliability reflects the variation between two or more raters who measure the same group of subjects (Koo and Li, 2015). The percent agreement for "carbon sequestration and storage" and "realization of the human being as part of nature", "slow regeneration" and "direct forest caring behavior" were between 60% and 80%, and for the rest of the themes, the agreement exceeded 80%. Generally, the inter-rater agreement of 50%-75% indicates moderate reliability, 74%-90% good, and 90% and above is excellent (Koo and Li 2016).

Analysis

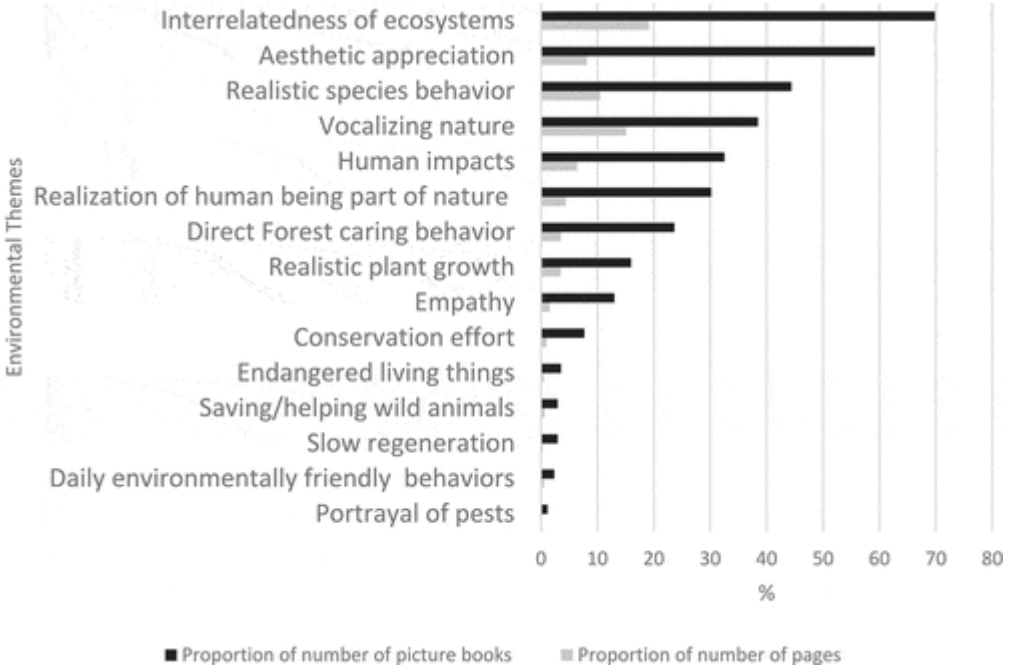
To measure the extent of children's picture books presenting the environmental themes and FES concept, the number of books and pages that a book devotes to providing information about each Environmental theme and FES was counted, and the percentages were compared (Wagner 2013). Then associations between the depiction of a specific environmental theme and the FES category was investigated through correlation coefficient analysis. Finally, the reasonability of the association found in the study was discussed in detail based on the FES's definition of reasonability (MEA (Millennium ecosystem assessment) 2005; TEEB 2011).

Environmental themes

Figure 1 presents the proportion of number of picture books and images that contained information related to each environmental theme. For example, 118 out of 169 picture books (69.82%) and 916 pages out of 4,792 pages (19.12%) contained information related to the "interrelatedness of ecosystems." The results indicated that all the environmental themes were present in picture books about forests. However, texts or images related to the behavioral domain were less frequently presented than themes that could elicit children's knowledge (i.e. the interrelatedness of ecosystems) and socio-emotional responses (i.e. vocalizing nature). Among the themes related to

the behavioral domain, daily environmentally friendly behaviors such as recycling, not wasting food, and collecting garbages that could also help to sustain forests, were least emphasized. Moreover, the themes related to the possible destruction of forests ("endangered living things", "slow regeneration", "portrayal of pests") were rarely covered in the picture books.

Figure 1. The proportion of the number of picture books and number of pages (images) for each environmental theme.

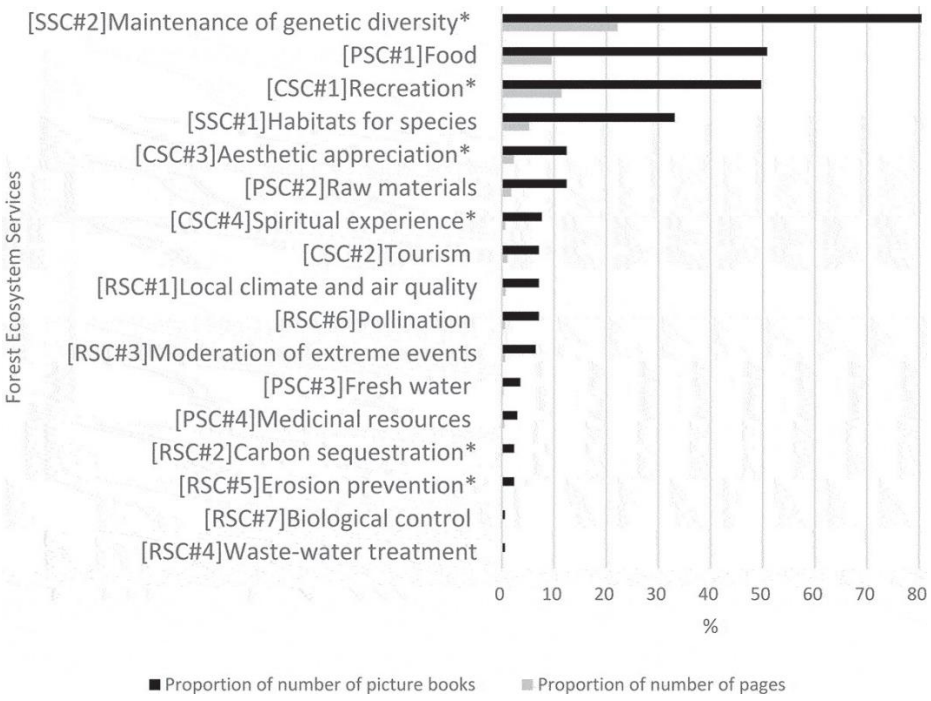


Forest ecosystem services

Figure 2 presents the proportion of number of picture books and images containing FES information. For example, 136 books out of 169 picture books (80.47%) and 1,061 pages out of 4,792 pages (22.14%) depicted a "maintenance of genetic diversity (biodiversity)", which is under SSC. The two FES ("maintenance of genetic diversity (biodiversity)" and "habitats for species") under the SSC were in the top five, suggesting that the forest's role in providing habitat for diverse species is emphasized in picture books. Meanwhile, all FES under RSC appeared to be less than 1% in the overall collection. When grouped into four FES categories (Figure 3), the SSC (1,313 images; 27.40%) and the RSC (118

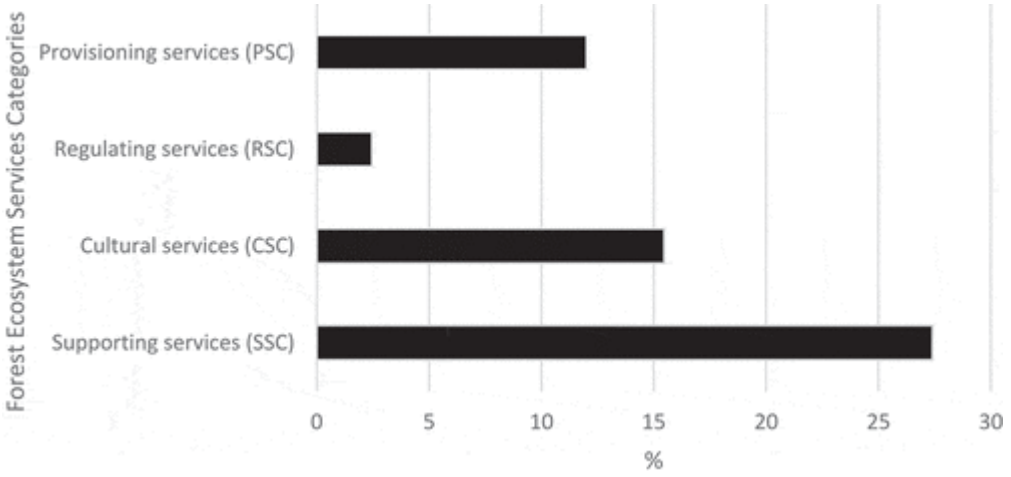
images; 2.46%) comprised the most and the least significant proportions, respectively.

Figure 2. The proportion of the number of picture books and number of pages (images) for each forest ecosystem services.



PSC: Provisioning services category; RSC: Regulating services category; CSC: Cultural services category; SSC: Supporting services category [SSC#2] Maintenance of genetic diversity (Biodiversity); [SCS#1] Recreation and mental and physical health; [CSC#3] Aesthetic appreciation and inspiration for culture, art, and design; [CSC#4] Spiritual experience and sense of place; [RSC#2] Carbon sequestration and storage; [RSC#5] Erosion prevention and maintenance of soil fertility

Figure 3. The proportion of the number of pages (images) for each forest ecosystem services category.



Associations between environmental themes and forest ecosystem service categories

The results of the correlation analysis (Table 3) revealed that the appearance proportion of contents related to the RSC was positively associated with the proportion of “portrayal of pests

(r = .36, p < .001)", "slow regeneration (r = .20, p < .001)", and "empathy (r = .26, p < .001)" in picture books. However, while nine picture books portrayed both the RSC and "empathy", only two and one picture book(s) depicted the "portrayal of pest" and "slow regeneration" together with the RSC, respectively. The CSC was positively related to "aesthetic appreciation (r = .24, p < .001)", and "realization of the human beings as part of nature (r = .25, p < .001)", and negatively related to "vocalizing nature (r = −.25, p < .001)". The "aesthetic appreciation", the "realization of human beings as part of nature", and the "vocalizing nature" theme were presented with CSC in 62, 43, and 29 picture books. In 75 and 44 picture books, the SSC was positively associated with "realistic species behavior (r= .28, p< .001)" and negatively associated with the "realization of the human beings as part of (r= −.17, p< .05)" .

Table 3. Correlations between environmental themes and FES categories n = 169 (Table view)

Environmental Themes	Forest Ecosystem Service Categories			
	Provisioning	Regulating	Cultural	Supporting
Endangered living things	−0.09	0.05	−0.02	0.01
Realistic species behavior	0.07	−0.10	−0.08	.28***
Interrelatedness of ecosystems	−0.04	−0.05	−0.15	0.03
Portrayal of pests	−0.06	.36***	−0.04	−0.01
Slow regeneration	−0.08	.20***	−0.06	−0.04
Human impacts	−0.10	0.13	−0.10	−0.07
Aesthetic appreciation	−0.13	−0.09	.24***	0.04
Vocalizing nature	0.01	−0.03	−.25***	−0.02
Empathy	0.01	.26***	−0.05	−0.03
Realization of human being part of nature	−0.04	−0.06	.25***	−.17*
Realistic plant growth	−0.07	0.01	−0.10	−0.01
Daily environmentally friendly behavior	−0.05	−0.01	−0.06	0.05
Saving/helping wild animals	−0.05	0.12	0.00	−0.03
Conservation effort	−0.02	−0.01	−0.05	−0.08
Direct Forest caring behavior	−0.04	0.06	0.12	−0.05

p* <.05, p** <.01, p ***<.001

Discussion

This paper examined the presence and association between environmental themes and FES categories in children's picture books about forests. While all environmental themes and FES categories were covered at least once in the picture books, not all environmental themes and FES were presented to the same extent. Moreover, some particular environmental themes were more associated with a specific FES category. In the following, we discuss several trends that emerged from the analysis and their implications for research and practice.

First, among the 15 environmental themes, comparably, the themes associated with the behavioral domain (e.g. "environmentally friendly behaviors") appeared to be less present than the cognitive (e.g. "interrelatedness of ecosystems") and socio-emotional domain (e.g. "aesthetic appreciation") (Figure 1). The majority of the sustainable behaviors portrayed in picture books were the types of behaviors (e.g. planting trees, giving water to plants, and making voices to stop adults from cutting down trees) that can be done at the children's level. The importance of encouraging individual participation, problem-solving, critical thinking, and making a difference (Summers and Childs 2007; Davis 2015; Inoue et al. 2016) has been emphasized to construct sustainable societies. Thus, portraying behaviors that children could easily practice in their daily lives should be valuable and helpful.

Interestingly, most of the behaviors portrayed in the picture books were focused on "what people could do to help forest" rather than "what people could *avoid* doing to help the forest" – for example, picking up berries and stepping on the grass for shortcuts are some of the behaviors which one could avoid doing to help forests from deteriorating. However, the picture books we reviewed depicted only a few "do not do" behaviors (mostly not cutting down trees). In the meantime, young children's intention to practice pro-environmental behavior could be enhanced by the presence of role models practicing sustainable behavior (Djuwita and Benyamin 2019; Ebersbach and Brandenburger 2020). Thus, including a more diverse range of direct and indirect sustainable behaviors in picture books could help.

Furthermore, few books in our study contained environmental themes of "endangered living things", "slow regeneration", and "portrayal of pests". This result is coherent with the findings of Babb et al. (2018) that the "portrayal of pests" was not present in Australian children's literature until the 1990s and appeared only in a tiny portion even in the 2010s. These three themes share a message on deforestation that forests may not exist longer than expected. For longer than a decade, the size of forests has undergone fast shrinkage worldwide (UNEP 2013), and deforestation has led to the emergence of many environmental problems (UNEP 2013; WWF 2014). Nevertheless, prior studies targeting preschool children have found that children had minimal knowledge about the concepts of forest and deforestation (Palmer 1994; Ahi and Balcı 2018), suggesting that issues related to deforestation have been presented less to young children. Given that children's acquisition of ecology-related concepts can be challenging (Özkan et al. 2004), picture books on such topics can be valuable for educators.

Second, the SSC appeared relatively more frequently than other FES categories (Figure 2), suggesting that the forest's role in providing habitat for diverse species has been emphasized in the picture books about forests. Meanwhile, the RSC appeared less than 1% in the overall collection, revealing that not much information associated with the RSC was presented (Figure 2, Figure 3). While we hoped to find more depictions of regulating FES within the picture books about forests, one possible reason for the failure could be because the writers may have thought that the topic was too complex for children to understand or too rigid (too much information) to depict the concept in picture books. For instance, forming attitudes toward regulating FES was a more complex process (Sodhi et al. 2010; Torkar and Krašovec 2019).

However, we want to emphasize the importance of presenting a balanced amount of information related to four FES categories to children. This is because the definition and classification of FES are

not universally applicable but instead are made during a specific decision-making process (Fisher et al. 2009). Furthermore, various FES can interact together in a complex manner to create trade-offs and synergy effects (Briner et al. 2013), and FES should be handled appropriately depending on the situation (Shi et al. 2021). Therefore, education on FES should be balanced without emphasizing the significance of a specific category. In this way, children will form a strong foundation for understanding the trade-offs between protection and developing a holistic understanding of the forest.

Third, the study revealed some positive and negative associations between environmental themes and FES categories, which we found reasonable (Table 3). For example, the positive associations between RSC and "portrayal of pests," "slow regeneration," are plausible as "controlling the pests" is under "biological control", and the regeneration is the result of "pollination", which are the two functions of RSC (MEA (Millennium ecosystem assessment) 2005; TEEB 2011). The positive association between the RSC and "empathy" is interesting. Although the precise reasons for this association will need further investigation, it may be that the RSC involving extreme events such as climate catastrophes, floods, droughts, and wildfires (MEA (Millennium ecosystem assessment) 2005; TEEB 2011), was often presented in a way that provokes the reader's empathy. For example, the depiction of land cracking and the site destruction due to uncontrolled erosion can provoke the reader's empathetic feelings.

The CSC was positively associated with "aesthetic appreciation" and "the realization of the human beings as part of nature" and negatively associated with "vocalizing nature." "Aesthetic appreciation", "recreation", "relaxation", and "spiritual experience" are part of CSC (MEA (Millennium ecosystem assessment) 2005; TEEB 2011), which makes the results theoretically appropriate. The negative association is also expectable because the CSC includes the benefits people can directly obtain while physically being in forests (Wolff et al. 2015). Picture books containing contents related to the CSC may have been written in a human-centered perspective, depicting more of humans' voices and less of animals' and plants.

The "realistic species behavior" and "realization of human beings as part of nature" were positively and negatively associated with SSC. The positive association is possible because the "maintenance of genetic diversity (biodiversity)" in this study was coded based on the number of forest living things that appeared simultaneously on a page. On the other hand, the negative association is also sensible as the SSC focuses on forests' practical functions for maintaining the biodiversity of diverse species. Meanwhile, the "realizing humans as being part of nature" theme is part of a CSC and is based on a human-centered perspective that concentrates on humans' inner state towards the forests. Overall, the reasonable associations found in this study suggest the possibility of introducing FES concept to children in a friendlier manner: associating FES categories to environmental themes.

As we highlight our conclusion, it is essential to note that this study investigated the picture books about forests published in South Korea between 2000 and 2020. Although the list of key terms was selected based on the definition of forests (FAO 2018) and writers' judgment, other experts from different cultures might suggest other key terms which should have been included in the searching process. Thus, every detail of our findings may not apply to define the current status of other countries with different publications and forests-related keywords. In addition, within the RSC, only one picture book depicted the "portrayal of pest" theme, and two depicted "slow regeneration." Thus, the positive associations found among them should be interpreted with caution.

Despite these limitations, the findings of our content analysis will provide a valuable guide for researchers, educators, guardians, and publishers in the production, selection, and use of picture books for ESD. Specifically, we would like to highlight the possibility of utilizing currently published picture books about forests to introduce FES concept and environmental themes to young children. This study's findings are coherent with other prior studies that assert that picture books about the

environment will foster children's knowledge, awareness, and attitudes towards the environment (Wason-Ellam 2010; Babb et al. 2018), which will eventually change their behavior towards it (Meinhold and Malkus 2005; Duerden and Witt 2010). Raising children to become ecological citizens with more knowledge of environmental themes and positive environmental attitudes is an essential issue because they are future policymakers and consumers who are responsible for active and high-quality governance for environmental policies. In the meantime, our examination of the content areas addressed in the picture books revealed gaps that call for stakeholders' attention for comprehensive and holistic education about forests from an early age. It is advisable to portray more diverse types of sustainable behaviors and a balanced amount of information related to FES in picture books about forests.

Notes

1. Fantasy: Deliver an imaginary world through fictionalization.
2. Realistic: Fictional stories in nature but can happen in our everyday lives.
3. Informative: Contain realistic illustrations (images) and descriptions of accurate information to communicate knowledge and concepts about a particular topic.
4. Traditional: Folk tales and reflect the unique culture in which the story emerged

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Supplementary material

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