



# **Biodiversity education: resources and sources used by school teachers and rangers in Mendoza (Argentina)**

*Educación sobre biodiversidad: recursos y fuentes utilizadas por los maestros de escuelas primarias y guardaparques de Mendoza (Argentina)*

**ALEXANDRA BARAHONA<sup>1\*</sup>, CARINA LLANO<sup>2</sup>, GABRIELA DIAZ ISEN RATH<sup>3</sup>,  
LORENA ROJAS<sup>4</sup>, CRISTINA PAMPILLÓN<sup>5,6</sup>, LAURA NUDELMAN<sup>6</sup>  
AND CLAUDIA CAMPOS<sup>1</sup>**

<sup>1</sup>IADIZA (UNCuyo- Gobierno de Mendoza- CONICET)

<sup>2</sup>CONICET- Facultad de Ciencias Aplicadas a la Industria (UNCuyo, San Rafael)

<sup>3</sup>Facultad de Ciencias Exactas y Naturales (UNCuyo, Malargüe)

<sup>4</sup>Instituto San Pedro Nolasco- Universidad del Aconcagua

<sup>5</sup>Instituto de Ciencias Ambientales (UNCuyo, Mendoza)

<sup>6</sup>Tecnicatura Superior en Conservación de la Naturaleza,  
Instituto de Educación Física Dr. Jorge E. Coll (Malargüe)

\*<abarahona@mendoza-conicet.gov.ar>

## **ABSTRACT**

This research had the aim of studying how biodiversity education is practiced in formal and non-formal settings by primary school teachers and rangers. We explored 1) type of resources used by practitioners to prepare a biodiversity lesson plan, 2) sources of materials available at the school and in protected areas, 3) teaching methods and resources used by teachers in a biodiversity lesson plan. For preparing a class, the teacher mainly uses print and digital resources, whereas rangers prefer to rely on print material and other resources, such as consulting with researchers, and learning through interaction with local people. While schools receive resources from government education and environmental agencies, protected areas receive them from academic institutions and environmental agencies. It is necessary to create spaces for them to share educational experiences, join forces and make visiting protected areas a significant part of the longer-term teaching process at school.

## **RESUMEN**

*En este artículo se analiza la forma en que los maestros de escuelas primarias y guardaparques enseñan sobre la biodiversidad en entornos formales y no formales. Exploramos: 1) el tipo de recursos utilizados por los educadores para preparar un plan de clases, 2) las fuentes de materiales disponibles en la escuela y en las áreas protegidas, 3) los métodos de enseñanza y los recursos utilizados en las clases. Para preparar una clase sobre biodiversidad, los maestros*



utilizan principalmente recursos impresos y digitales, mientras que los guardaparques prefieren material impreso y otros recursos, como la consulta a investigadores y el aprendizaje mediante la interacción con la población local. Mientras que las escuelas reciben recursos de los organismos gubernamentales de educación y medio ambiente, las áreas protegidas los reciben de instituciones académicas y organismos ambientales. Tanto maestros como guardaparques manifiestan la escasez de recursos para enseñar sobre la biodiversidad local, lo cual evidencia la necesidad de que los investigadores produzcan materiales educativos para contextos formales y no formales. Resulta importante además crear espacios de intercambio de experiencias educativas para maestros y guardaparques; por ejemplo, a través de programas de capacitación compartidos, ya que ambos profesionales coinciden en el escenario educativo cuando las escuelas visitan las áreas protegidas.

---

**Key words:** Biodiversity conservation, educational settings, experiential learning, protected areas

---

---

**Palabras clave:** Conservación de la biodiversidad, entornos educativos, aprendizaje por la experiencia, áreas protegidas

---

## INTRODUCTION

### Biodiversity conservation

Over the past 50 years, the prevailing view of biodiversity conservation has changed, from a conservation thinking focused on “nature for itself”, going through paradigms of “nature despite people”, and “nature for people”, until the most recent “people and nature” approach (Mace, 2014). The last view guided the assessments of the Intergovernmental Science Policy Platform for Biodiversity and Ecosystem Services (IPBES), focused on the concept of “nature’s contributions to people” (Díaz et al., 2018; Mastrángelo et al., 2019), which embraces a variety of worldviews on human-nature relations and knowledge systems (Pascual et al., 2017).

The last assessments of the IPBES (Brondizio et al., 2019) highlight that the rate of global biodiversity change during the past 50 years is unprecedented in human history (Díaz et al., 2019). But even in this alarming scenario, nature can be conserved and used sustainably while simultaneously meeting other global so-

cial goals. Since the Convention on Biological Diversity (CBD, United Nations, 1992), until the most recent Sustainable Development Goals and the 2050 Vision for Biodiversity, the need has been emphasized for urgent and concerted efforts, such as the promotion of education and knowledge generation and sharing, including scientific, indigenous and local knowledge about nature and its conservation and sustainable use (Díaz et al., 2019).

### Biodiversity education

Since the adoption of the CBD, the need was recognized to promote and encourage understanding of the importance of biological diversity conservation through the media, and inclusion of this topic in educational programs. It becomes important to have an education with biodiversity as a pedagogical goal, that is to say, biodiversity education (González Gaudiano, 2002). At a local level, Mendoza’s Provincial Education Law (2002) maintains that the education system should provide development of skills to preserve nature.

This paper studied some aspects of how biodiversity education is practiced in formal and non-formal settings in the province of Mendoza (Argentina). Our study was focused on two key practitioners of biodiversity education: primary school teachers and rangers. Rangers were included because they teach local biodiversity and conservation when they guide schools and people who visit protected areas. Teachers and rangers have to prepare their classes on biodiversity and can use different print and digital resources coming from different sources. We explored 1) type of resources (print, digital, and others) used by practitioners to prepare a lesson plan on biodiversity; 2) sources of materials available at the school and in protected areas (government and non-government agencies, institutions, etc.); 3) teaching methods and resources used by teachers in a lesson plan on biodiversity. We also asked key informants (teachers working on the training of primary school teachers and rangers) about resources used for biodiversity education.

## MATERIAL AND METHOD

We applied a combined methodological approach based on a quantitative mail survey and interviews with key informants. During 2017 and 2018, 106 primary school teachers (from a total of 870 in Mendoza) and 64 rangers (from 200 ones working in protected areas) answered the survey through a form available on the Internet. In the first section of the survey, they entered personal and professional information.

In the second section, they were asked about the resources used to prepare a lesson plan on biodiversity (the options were: print resources—books, maga-

zines, brochures, pictures, and newspapers—, digital resources—websites, videos—and other resources—consulting with specialists, teacher training materials, and classes by other colleagues), the sources of resources available at schools and in protected areas (the categories were: government education agencies—National Ministry of Education, Provincial General School Agency—, academic institutions—National University of Cuyo, National Council of Scientific and Technological Research—, government environmental agencies—National Secretariat of Environment, Agency of Renewable Natural Resources, National Institute of Agricultural Technology, Institute of Health and Quality of Agriculture of Mendoza, General Department of Irrigation—, non-government environmental organizations), and the activities and materials used to develop the class on biodiversity. In order to know the teaching methods and resources used in the classroom, we particularly asked school teachers how often (once a week, once a month, once a year) they include: 1) activities involving analysis of texts, brochures, posters and magazines, using print material, 2) activities related to analysis of educational and documentary videos, use of information and communications technology (*ICT*), classes by invited specialists using digital resources, 3) experiential learning activities such as making school trips (to visit protected areas, interpretation trails, zoo, museums, etc.), working with laboratory material, working with interviews and other social techniques, building school biological collections, participating in science fairs, etc. Particularly for rangers, an open question of the survey asked them about the difficulties they encoun-

ter in pursuing biodiversity education in protected areas.

Data were analyzed using a sample test for equality of proportions in R version 3.6.1 (R Core Team, 2016).

In order to deepen the study on biodiversity education, five teachers who work at institutes for training primary school teachers were interviewed. They were asked about the materials and resources teachers count on for preparing their lesson plan on Mendoza's biodiversity. The qualitative data from the interviews were analyzed by extracting common and heterogeneous meanings from the different opinions (Hernández Sampieri et al., 2010).

## RESULTS

Teachers who responded to our survey are between 25-45 years old, and they were 94% women. Currently, 72% of them are teaching in urban schools and the rest in rural schools. Almost 80% of them have a primary education teaching degree obtained in non-university teacher training institutes of Mendoza.

Rangers are between 25-45 years old, and 75% of them were men. They have been working in protected areas for 2 to 28 years, developing environmental education activities directed to schools and general public visiting the reserves.

### Type of resources on biodiversity used by practitioners to prepare a class lesson plan

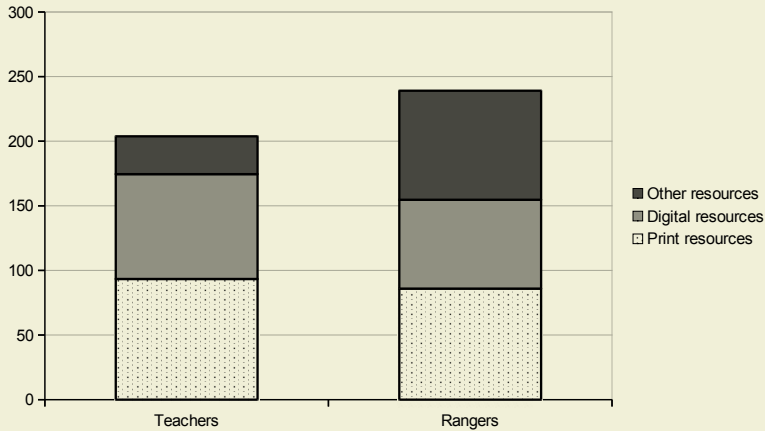
The teachers mentioned print resources more often than digital ones and, to a lesser extent, they named "other resources" (X-squared = 112.84, df = 2, p-value < 0.0001; **Table 1; Figure 1**). Rangers mentioned that they use print and "other resources" more than digital resources to prepare a lesson plan on biodiversity (X-squared = 7.14, df = 2, p-value = 0.03; **Table 1, Figure 1**).

Comparisons between practitioners regarding the resources used yielded differences only in the mention of the category "other resources", which was more often named by rangers (X-squared = 48.51, df = 1, p-value < 0.0001; **Table 1, Figure 1**). This category included mate-

**Table 1.** Percentages of responses about types of resources used by practitioners to plan a biodiversity class (several answers possible). Letters indicate significant differences among types of resources used by each actor; p-value indicates differences between teachers and rangers in the use of each type of resource. Source Authors 2017-2018.

*Tabla 1. Porcentajes de respuestas sobre los tipos de recursos utilizados por los educadores para planificar una clase sobre biodiversidad (varias respuestas son posibles). Las letras indican diferencias significativas entre los tipos de recursos utilizados por cada actor; el valor p indica diferencias entre los maestros y los guardaparques en el uso de cada tipo de recurso. Fuente Autores 2017-2018.*

| Type of resources | Teachers | Rangers | p- value |
|-------------------|----------|---------|----------|
| Print             | 93 A     | 86 a    | 0.11     |
| Digital           | 81 B     | 69 b    | 0.06     |
| Others            | 29 C     | 84 a    | 0.0001   |



**Figure 1.** Percentages of responses about types of resources used by practitioners to plan a biodiversity class (several answers possible).

*Figura 1. Porcentajes de respuestas sobre los tipos de recursos utilizados por los educadores para planificar una clase sobre biodiversidad (varias respuestas son posibles).*

rial obtained from training courses, consulting with scientific researchers and technicians, and learning through interaction with local people.

### Sources of print resources available at schools and in protected areas

According to the teachers, resources available at schools were produced mainly by government education and environmental agencies, whereas a lower number came from academic institutions (research institutions, university), and from environmental NGOs (X-squared = 13.32, df = 3, p-value = 0.004; **Table 2**). Rangers mentioned government environmental agencies, academic institutions, and private environmental organizations as the main sources of resources currently available in protected areas. They had less resources produced by government educa-

tion agencies (X-squared = 35.12, df = 3, p-value < 0.0001, **Table 2**).

When the mentions of sources of resources available at schools and in protected areas were compared between practitioners, rangers mentioned more government environmental agencies, organizations dedicated to scientific research and knowledge production, and private environmental organizations than teachers did (**Table 2**).

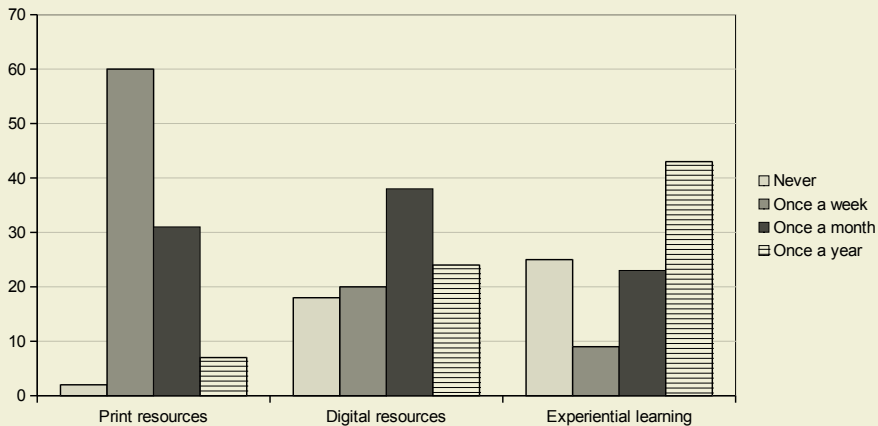
### Teaching methods and resources used in the classroom

There was a significant difference in the frequency of use of different teaching methods and resources in the classroom. Teachers indicated that teaching methods involving activities with print resources are the ones most frequently used “once a week” (X-squared = 112.75, df = 3, p-value < 0.0001, **Figure 2**). These

**Table 2.** Percentages of responses about the sources of resources on biodiversity available at schools and in protected areas (several answers possible). Letters indicate significant differences among sources mentioned by each actor; p-value indicates differences between teachers and rangers in the mention of each source. Source Authors 2017-2018.

*Tabla 2. Porcentajes de respuestas acerca de las fuentes de recursos sobre biodiversidad disponibles en las escuelas y en las áreas protegidas (varias respuestas son posibles). Las letras indican diferencias significativas entre las fuentes mencionadas por cada actor; el valor p indica diferencias entre los maestros y los guardaparques en la mención de cada fuente. Fuente Autores 2017-2018*

| Sources of resources              | Teachers | Rangers | p- value |
|-----------------------------------|----------|---------|----------|
| Government education agencies     | 32 A     | 28 b    | 0.6      |
| Academic organizations            | 14 B     | 70 a    | 0.0001   |
| Government environmental agencies | 29 A     | 75 a    | 0.0001   |
| Nongovernment organizations       | 18 B     | 60 a    | 0.0001   |



**Figure 2.** Percentage of responses about the frequency at which different teaching methods and resources are used in the classroom.

*Figura 2. Porcentaje de respuestas sobre la frecuencia con que se utilizan diferentes métodos y recursos de enseñanza en el aula.*

activities included analysis of printed information. Teaching methods involving activities with digital resources are the ones most frequently used “once a month” (X-squared = 13.01, df = 3, p-value = 0.005, **Figure 2**).

Experiential learning involving a diversity of resources is practiced “once a year” (X-squared = 31.15, df = 3, p-value < 0.0001, **Figure 2**). It includes, among other activities, school trips to protected areas, where students will come in con-

tact with rangers in their role as biodiversity educators.

### **Opinions of teachers working on the training of primary school teachers, and rangers**

Teachers working on training primary school teachers highlighted the scarcity of educational resources on Mendoza's biodiversity. They said that "for the specific study of biodiversity of Argentina and Mendoza, publications are fragmented" and continued explaining "except for a few examples, schools have no teaching materials for the topic of biodiversity, especially Mendoza's biodiversity. It is the teachers themselves who usually produce these materials, at best; or they use examples of the diversity of other places".

When asked about the difficulties they found in pursuing biodiversity education, most of the rangers mentioned the lack of educational resources in the protected areas. One of them said "we lack materials, we lack institutional support, and above all we lack coordination with formal education institutions". Other rangers mentioned "the need for training in didactic tools and the lack of support from the Agency of Renewable Natural Resources of Mendoza to develop educational activities".

## **DISCUSSION**

Our study showed some aspects related to the practice of biodiversity education by primary school teachers and rangers in Mendoza. Both practitioners use a variety of resources to prepare a lesson plan for a biodiversity class, including printed, digital and "other resources", such as material obtained from train-

ing courses, consulting with scientific researchers and technicians, and learning through interaction with local people. The difference among practitioners was that rangers mentioned using fewer digital resources and more of "other resources" than teachers. There are different sources of resources on biodiversity available at schools and in protected areas. In schools, resources mainly come from government education and environmental agencies, whereas protected areas receive resources from academic institutions, and government and non-government environmental organizations. Nevertheless, both practitioners pointed out the lack of educational resources, such as books, posters, videos, etc. about local biodiversity. In the classroom, learning about biodiversity is still limited to learning from textbooks and digital materials, whereas experiential activities such as visiting protected areas, museums, and interpretive trails are infrequently proposed by teachers. Activities outside the classroom enhance spontaneity, knowledge related to daily life and traditional knowledge that can then be adopted and deepened in the classroom (Diaz Isenrath & Morant, 2017).

Teachers and rangers are two key practitioners in biodiversity education. With different professional training, both have an understanding of nature and biodiversity. On the one hand, primary school teachers have knowledge of the conceptual barriers that students face in learning, and knowledge of strategies for working with students, but many of them have the belief that teaching biodiversity applying experiential methods based on nature requires a more specialist knowledge than what they have (Gayford, 2000; Lindemann-Matthies, 2006).

As a consequence, many teachers do not encourage students to experience nature first-hand and are teaching biodiversity mainly through print and digital media (Barker, 2002). On the other hand, rangers have theoretical knowledge about biodiversity and conservation, and a wide practical knowledge about nature, but they recognize their lack of teaching tools (Slattery & Lugg, 2002).

During preparation of a lesson plan for a biodiversity class and application of teaching methods in the classroom, teachers rely on print and digital resources, although print resources, such as textbooks, appear to be the most important resource. School textbooks provide a valid conception of the knowledge to be taught (Cobo Merino & Batanero, 2004). However, some problems have been described regarding textbooks' treatment of different topics, such as the concept of biodiversity (Bermúdez et al., 2014), far from the new "people and nature" framework proposed by IPBES (Díaz et al., 2019). It could be expected that the resources produced by academic institutions would contain more up-to-date contents on biodiversity. It has been emphasized that scientific researchers need to be much more strongly proactive in their approach to communicating science, in formal and non-formal educational settings (Bickford et al., 2012). When local scientists are not committed to engaging in the production of resources to assist educators, practitioners rely on traditional resources, which show a strong bias toward exotic biodiversity and toward people and nature relationships taking place in other parts of the world, with far-reaching implications for biodiver-

sity education in a regional and local context (Campos, 2012; Campos et al., 2012, 2013; Celis-Diez et al., 2016).

The digital age has inevitably driven the transformation of a classic learning and teaching paradigm based on traditional resources into a new paradigm shaped by digital media technology (Cvetković & Stanojević, 2018). Information and communication technology allows building, testing, and critically evaluating new knowledge, while promoting reflection on controversial ethical and social issues (Diaz Isenrath, 2015).

When rangers prepare the class on biodiversity, they have access to flora and fauna guides, scientific journals, technical reports, material from training courses, etc. coming from academic institutions, and from environmental organizations because of their close contact with scientific researchers and technicians working in protected areas. It is likely that rangers use less digital resources to plan a class because of the lack of internet connection in many protected areas, but they have the valuable opportunity to exchange knowledge with local people and learn about their relationships with nature.

When teaching methods in formal settings were explored, a "once-a-year" frequency was reported for projects involving experiential learning, for example building biological school collections, and participating in a science fair, which involves months of preparation. Teachers also organize a school trip once a year, as low a frequency as that recorded for schools around the world (Lindemann-Matthies, 2006). Several barriers were identified to a successful school trip, such as transportation, teacher's training and experience, time issues such



as school schedule, lack of school administrator support, curriculum inflexibility, poor student behavior and attitudes, and lack of venue options (Michie, 1998). However, students on school trips are motivated to develop connections between the theoretical concepts learned in the classroom and what they have experienced in nature (Falk & Dierking, 2000).

The roles in biodiversity education fulfilled by teachers and rangers, the two studied practitioners, converge in protected areas. This space should encourage them to communicate and develop a partnership in the sharing of teaching experiences in formal and informal settings, with the aim to enrich biodiversity education.

### ACKNOWLEDGEMENTS

We thank all primary school teachers and rangers for their effort in participating in the study. This work was supported by the UNCuyo (SECTYP 2016-06/M096 and SIIP 2019-06/M108), the CONICET (PUE IADIZA), the Agencia Nacional de Promoción Científica y Tecnológica (PICT 2017-2154), and a graduate fellowship from CONICET to AB. N. Horak assisted us in drafting the English version.

### REFERENCES

BARKER, S., 2002. More than a nature table and mobiles: living ecology in the primary classroom. *Environmental Education* 71: 13-15.

BERMUDEZ, G., A. DE LONGHI, S. DÍAZ & V. GAVIDIA, 2014. La transposición del concepto de diversidad biológica. Un estudio sobre los libros de texto de la educación secundaria española. *Enseñanza de las Ciencias* 32: 285-302.

BICKFORD, D., M.R.C. POSA, L. QIE, A. CAMPOS-ARCEIZ & E.P. KUDAVIDANAGE, 2012. Science communication for biodiversity conservation. *Biological Conservation* 151: 74-76.

BRONDIZIO, E.S., J. SETTELE, S. DÍAZ & H.T. NGO, 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat.

CAMPOS, C.M., 2012. Los niños y la biodiversidad. ¿Qué especies conocen y cuáles son las fuentes de conocimiento sobre la biodiversidad que utilizan los estudiantes? Un aporte para definir estrategias educativas. *Boletín Biológica* 24: 4-9.

CAMPOS, C.M., S. GRECO, J.J. CIARLANTE, M. BALANGIONE, J.B. BENDER, J. NATES & P. LINDEMANN-MATTHIES, 2012. Students' familiarity and initial contact with species in the Monte desert (Mendoza, Argentina). *Journal of Arid Environments* 82: 98-105.

CAMPOS, C.M., J. NATES & P. LINDEMANN-MATTHIES, 2013. Percepción y conocimiento de la biodiversidad por estudiantes urbanos y rurales de las tierras áridas del centro-oeste de Argentina. *Ecología Austral* 23: 174-183.

CELIS-DIEZ, J.L., J. DÍAZ-FORESTIER, M. MÁRQUEZ-GARCIA, S. LAZZARINO, R. ROZZI & J.J. ARMESTO, 2016. Biodiversity knowledge loss in children's books and textbooks. *Frontiers in Ecology and the Environment* 14: 408-410.

COBO MERINO, B. & C. BATANERO, 2004. Significado de la media en los libros de texto de secundaria. *Enseñanza de las Ciencias* 22: 5-18.

CVETKOVIC, B. N. & D. STANOJEVIC, 2018. Integrating digital technologies into teaching process. *Teme* 42: 1219-1233.

DIAZ ISENATH, G.B., 2015. Biodiversidad y TIC: experiencia de capacitación virtual para profesores de secundaria en la provincia de Mendoza, Argentina. In: *Bio-grafía. Escritos sobre la Biología y su*

- Enseñanza. Memorias del VIII Encuentro Nacional de Experiencias en Enseñanza de la Biología y la Educación Ambiental. III Congreso Nacional de Investigación en Enseñanza de la Biología. 1250-1262.
- DÍAZ ISENATH, G.B. & A. MORANT, 2017. Conocimientos sobre biodiversidad en una escuela primaria rural en el sur de Mendoza (Argentina) ¿Diálogo entre educación científica y ambiental? In: L.M. Dubini et al. (Eds.). Educación científica e inclusión socio-digital. Actas del IX Congreso Iberoamericano de Educación Científica y del I Seminario de Inclusión Educativa y Socio-digital (CIEDUC 2017). Servicio de Publicaciones, Buenos Aires: 537-544.
- DÍAZ, S., U. PASCUAL, M. STENSEKE, B. MARTÍN-LÓPEZ, R. T. WATSON, Z. MOLNÁR, R. HILL, K. M. A. CHAN, I.A. BASTE, K. A. BRAUMAN, S. POLASKY, A. CHURCH, M. LONSDALE, A. LARIGAUDERIE, P.W. LEADLEY, A.P.E. VAN OUDENHOVEN, F. VAN DER PLAAT, M. SCHROTER, S. LAVOREL, Y. AUMEERUDDY-THOMAS, E. BUKVAREVA, K. DAVIES, S. DEMISSEW, G. ERPUL, P. FAILLER, C.A. GUERRA, C.L. HEWITT, H. KEUNE, S. LINDLEY & Y. SHIRAYAMA, 2018. Assessing nature's contributions to people. *Science* 359 (6373): 270-272.
- DÍAZ, S., J. SETTELE, E.S. BRONDIZIO, H.T. NGO, J. AGARD, A. ARNETH, P. BALVANERA, K.A. BRAUMAN, S.H.M. BUTCHART, K.M.A. CHAN, L.A. GARIBALDI, K. ICHII, J. LIU, S.M. SUBRAMANIAN, G.F. MIDGLEY, P. MILOSLAVICH, Z. MOLNÁR, D. OBURA, A. PFAFF, S. POLASKY, A. PURVIS, J. RAZZAQUE, B. REYERS, R.R. CHOWDHURY, Y.J. SHIN, I. VISSEREN-HAMAKERS, K.J. WILLIS & C.N. ZAYAS, 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science* 366: 1327-1337.
- FALK, J.H. & L.D. DIERKING, 2000. Learning from museums: visitor experiences and the making of meaning. New York: Altamira Press.
- GAYFORD, C. 2000. Biodiversity education: A teacher's perspective. *Environmental Education Research* 6: 347-361.
- GONZÁLEZ GAUDIANO, E., 2002. Educación Ambiental para la Biodiversidad: reflexiones sobre conceptos y prácticas. *Tópicos en Educación Ambiental* 4: 76-85.
- HERNÁNDEZ SAMPIERI, R., C. FERNÁNDEZ COLLADO & P. BAPTISTA LUCIO, 2010. Metodología de la investigación. MsGraw-Hill Interamericana, México.
- LINDEMANN-MATTHIES, P., 2006. Investigating nature on the way to school: responses to an educational programme by teachers and their pupils. *International Journal of Science Education* 28: 895-918.
- MACE, G.M., 2014. Whose conservation? *Science* 345(6204): 1558-1560.
- MASTRÁNGELO, M.E., N. PÉREZ-HARGUINDEGUY, L. ENRICO, E. BENNETT, S. LAVOREL, G.S. CUMMING, D. ABEYGUNAWARDANE, L.D. AMARILLA, B. BURKHARD, B. N. EGOH, L. FRISHKOFF, L. GALETTO, S. HUBER, D.S. KARP, A. KE, E. KOWALJOW, A. KRONENBURG-GARCÍA, B. LOCATELLI, B. MARTÍN-LÓPEZ, P. MEYFROIDT, T.H. MWAMPAMBA, J. NEL, K.A. NICHOLAS, C. NICHOLSON, E. OTEROS-ROZAS, S.J. RAHLAO, C. RAUDSEPP-HEARNE, T. RICKETTS, U.B. SHRESTHA, C. TORRES, K.J. WINKLER & K. ZOELLER, 2019. Key knowledge gaps to achieve global sustainability goals. *Nature Sustainability* 2: 1115-1121.
- MICHIE, M., 1998. Factors influencing secondary science teachers to organise and conduct field trips. *Australian Science Teacher's Journal* 44: 43-50.
- PASCUAL, U., P. BALVANERA, S. DÍAZ, G. PATAKI, E. ROTH, M. STENSEKE, R.T. WATSON, E.B. DESSANE, M. ISLAR, E. KELEMEN, V. MARIS, M. QUAAS, S.M. SUBRAMANIAN, H. WITTMER, A. ADLAN, S. AHN, Y.S. AL-HAFEDH,

- E. AMANKWAH, S.T. ASAH, P. BERRY, A. BILGIN, S.J. BRESLOW, C. BULLOCK, D. CÁCERES, H. DALY-HASSEN, E. FIGUEROA, C.D. GOLDEN, E. GÓMEZ-BAGGETHUN, D. GONZÁLEZ-JIMÉNEZ, J. HOUDET, H. KEUNE, R. KUMAR, K. MA, P.H. MAY, A. MEAD, P. O'FARRELL, R. PANDIT, W. PENGUE, R. PICHIS-MADRUGA, F. POPA, S. PRESTON, D. PACHECO-BALANZA, H. SAARIKOSKI, B.B. STRASSBURG, M. VAN DEN BELT, M. VERMA, F. WICKSON & N. YAGI, 2017. Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability* 26-27: 7-16.
- R CORE TEAM, 2016. R: A language and environment for statistical computing, version 3.6.1. Vienna, Austria: R Foundation for Statistical Computing.
- SLATTERY, D. & A. LUGG, 2002. If they treated the whole world like a national park: environmental education by teachers and rangers. *Australian Journal of Environmental Education* 18: 47-55.

Recibido: 12/2020  
Aceptado: 03/2021