



The effect of enclosure on cultural services of semi-arid shrublands of Kerman province, Iran

Azam Khosravi Mashizi^{1*}, Mohsen Sharafatmandrad² 

¹ Associate Professor, Department of Ecological Engineering, Faculty of Natural Resources, University of Jiroft, Jiroft, Iran.

E-mail: Azam.khosravi@ujiroft.ac.ir

² Associate Professor, Department of Ecological Engineering, Faculty of Natural Resources, University of Jiroft, Jiroft, Iran.

Email: mohsen.sharafatmandrad@ujiroft.ac.ir

Article Info

Abstract

Article type:

Research Article

Article history:

Received: 2 April 2022

Accepted: 26 July 2022

Corresponding author:

azam.khosravi@ujiroft.ac.ir

Keywords:

Flowering species

Species diversity

Shrublands

Enclosure

Biodiversity conservation and ecosystem services provision are of the main ecosystem management objectives. Despite the enormous importance of cultural services, they are often ignored in ecosystem management plans due to the difficulty in quantifying. This study was done to investigate the impact of enclosure on cultural services in semi-arid shrublands. Flowering plants were considered as a proxy for cultural services. The canopy cover and the number of plant species inside and outside the enclosure were recorded in two vegetation types *Artemisia aucheri* and *Artemisia aucheri-Zygophyllum eurypterum*. The results showed that enclosure significantly increased diversity, abundance and richness of plant species. The enclosure also significantly increased the diversity, richness and abundance of flowering species in both vegetation types. A positive relationship was found between diversity indices and flowering species diversity. The results also showed that perennial forbs had a greater role in providing cultural services. It can be concluded that enclosure can promote both plant species diversity and cultural services in semi-arid shrublands.

Cite this article: Azam Khosravi Mashizi & Mohsen Sharafatmandrad. 2022. The effect of enclosure on cultural services of semi-arid shrublands of Kerman province, Iran. *Environmental Resources Research*, 10 (1), 143-152. DOI: 10.22069/ijerr.2022.6058



© The Author(s).

DOI: 10.22069/ijerr.2022.6058

Publisher: Gorgan University of Agricultural Sciences and Natural Resources

Introduction

Natural ecosystems support human life through providing multiple ecosystem services (Brück et al., 2022). These ecosystem services can be maintained by sustainable management of ecosystems (Schröter et al., 2017). One of the greatest challenges that ecosystem management faces to is the loss of biodiversity and ecosystem services (Sun et al., 2022). Conservation plans should be focused on biodiversity and ecosystem services protection (Graves et al., 2017). Plant species diversity contributes in supplying ecosystem services (Bagella et al., 2020).

Therefore, biodiversity conservation is essential to supply ecosystem services (Souza et al., 2021).

There are numerous studies dealing with conservation of provisioning and regulating ecosystem services under management changes to ensure food and water security (Rosenfield et al., 2022; MA, 2005). However, cultural services are rarely included in such studies. Cultural ecosystem services defined as “the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience” (MA,

2005). These services sometime are called informational services and are comprised esthetic, spiritual and religious, historic (heritage value), scientific and educational information (Kosanic and Petzold, 2020). Chan et al. (2016) believed that cultural services are services that are everywhere and yet nowhere. Cultural services are composed both art and human (Church et al., 2014) and they are essential for cultural identity and even survival (Kosanic and Petzold, 2020). Demand for cultural ecosystem services is expected to increase due to world population growth (Hegetschweiler et al., 2017).

Ecosystem services are defined mainly based on the natural science paradigms that are difficult to apply for cultural services (Tengberg et al., 2012). Understanding of the cultural services is difficult for their intangible essence (Nahuelhual et al., 2014). Hence, cultural services are rarely quantified in ecological studies (Zhao et al., 2022). As cultural services are related to condition and shape of ecosystems, a number of proxies are commonly used for their quantifying such as the amount of green space (Barthel et al., 2005), the pathways for recreation activities (Lovell and Taylor 2013), or some land covers (van Berkel and Verburg, 2014). Abundance of flowers can be a proper indicator to study cultural services through their aesthetic appreciation (Graves et al., 2016, 2017). Variation of flora plays an important role in ecosystem management (Sakurai et al., 2011).

Studies evaluating the relationship between biodiversity conservation and the protection of cultural ecosystem services are limited (Junge et al., 2009). Biodiversity is related to cultural services such as recreation, aesthetic, nature conservation (Mace et al., 2012). Aesthetic is one of the cultural services which is often assumed to be positively correlated with biodiversity (Wallace, 2007). Flowering plant species can be used to relate biodiversity to cultural services (Graves et al., 2017).

Cultural services are of enormous importance in the human well-being and their assessment and acknowledgement lead to more sustainable ecosystem management

(Raymond et al., 2013). However, there is a paucity of information on cultural services in shrublands which are the predominant land cover of arid and semi-arid regions. Therefore, it is necessary to know whether management practices can improve both the environmental quality and cultural services (e.g., recreation, aesthetic, sense of place) and subsequently can benefit to human well-being (Krasny et al., 2014). Hence, impact of exclosure on cultural services was assessed in semi-arid shrubland in this study.

Materials and Methods

Study area

The study area is located in Khabr National Park (28°47' to 29°1' N and 56°18' to 56°33' E) in Kerman province. Exclosure area is surrounded by fences and ditches excluding grazing livestock for more than 25 years. The region is characterized by 340 mm mean annual precipitation, which mostly occurs in winter. *Artemisia aucheri* is dominant species in the studied region.

Collect data

After preliminary studies and visiting the area, two vegetation types *Artemisia aucheri* and *Artemisia aucheri-Zygophyllum eurypterum* were identified by physiognomic methods. Random-systematic sampling was performed to collect data in each vegetation type. Hence, five 100-m transects with 100 m intervals were laid out in the region and six quadrats were randomly placed along each transect. The canopy cover and number of plant species were recorded in each quadrat.

Diversity indices

Simpson's Diversity Index (D) was determined by calculating the relative cover of each plant species as following:

$$D = 1 - \sum P_i^2$$

where p_i = relative cover of species i in each plot.

Margalef's richness index (R) was calculated for species richness as following:

$$R = \frac{S - 1}{\ln n}$$

where S is number of taxa and n is number of individuals.

Data analysis

The data were checked for normality by Kolmogorov-Smirnov test which was performed by SPSS 20.0. Student t-test was used to compare two vegetation types in terms of diversity indices and life forms. The relationship between diversity indices and flowering species was assessed using Pearson's correlation coefficient.

Results

In the vegetation types *Artemisia aucheri* and *Artemisia aucheri* - *Zygophyllum eurypterum*, species richness increased significantly from 1.5 ± 0.77 and 1.02 ± 0.21 outside the enclosure to 2.22 ± 0.73 and 1.85 ± 0.43 inside the enclosure respectively (Figure 1). The species abundance, in the vegetation type *Artemisia aucheri*, increased significantly from 4.1 ± 1.2 outside the enclosure to 8.7 ± 1.9 inside the enclosure (Figure 1c). The species abundance, in the vegetation type *Artemisia aucheri* - *Zygophyllum eurypterum*, increased significantly from 1.6 ± 3.6 outside the enclosure to 7 ± 1.9 inside the enclosure (Figure 1d). Species diversity increased significantly from 0.35 ± 0.19 outside the enclosure to 0.74 ± 0.08 inside the enclosure in the vegetation type *Artemisia aucheri* (Figure 1e). For the vegetation type *Artemisia aucheri* - *Zygophyllum eurypterum*, species diversity increased significantly from 0.41 ± 0.21 outside the enclosure to 0.64 ± 0.21 inside the enclosure (Figure 1f).

The results showed that the flowering species richness in the vegetation type *Artemisia aucheri* increased significantly from 1.4 ± 0.34 outside the enclosure to 1.81 ± 0.49 inside the enclosure (Figure 2a)

and in the vegetation type *Artemisia aucheri* - *Zygophyllum eurypterum* increased significantly from 0.90 ± 0.20 outside the enclosure to 1.57 ± 0.21 inside the enclosure (Figure 2b). The flowering species diversity in the vegetation type *Artemisia aucheri* increased significantly from 0.31 ± 0.12 outside the enclosure to 0.61 ± 0.19 inside the enclosure (Figure 2c). The flowering species diversity in the vegetation type *Artemisia aucheri* - *Zygophyllum eurypterum* increased significantly from 0.30 ± 0.25 outside the enclosure to 0.57 ± 0.19 inside the enclosure (Figure 2d). The flowering species abundance in the vegetation type *Artemisia aucheri* increased significantly from the average of 3.9 ± 1.1 outside the enclosure to 7.1 ± 1.9 inside the enclosure (Figure 2e). The flowering species abundance in the vegetation type *Artemisia aucheri* - *Zygophyllum eurypterum* increased significantly from the average of 2.3 ± 1.8 outside the enclosure to 5.8 ± 1.6 inside the enclosure (Figure 2f).

Pearson's correlation analysis showed that diversity indices for flowering plant species is significantly correlated to species indices (Table 1). There was a positive significant relationship between the flowering species diversity and richness ($R^2=0.985$, $p<0.01$). A positive significant relationship was observed between flowering species diversity and species richness ($R^2=0.923$, $p<0.01$). There was a positive significant correlation between flowering species diversity and species diversity ($R^2=0.627$, $p<0.01$). A positive significant relationship was observed between flowering species richness and species richness ($R^2=0.902$, $p<0.01$). There was a positive significant relationship between flowering species richness and species diversity ($R^2=0.951$, $p<0.01$).

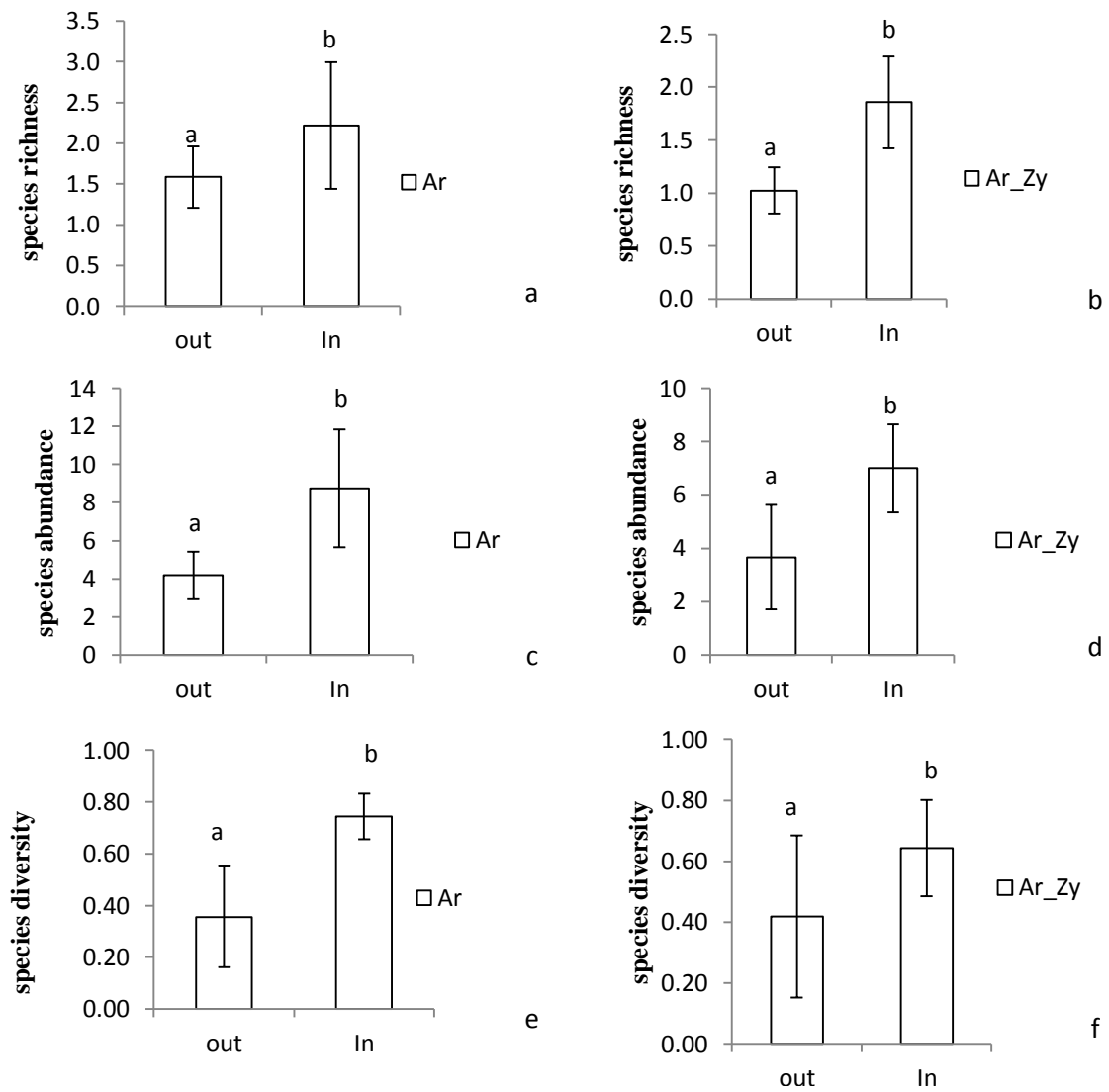
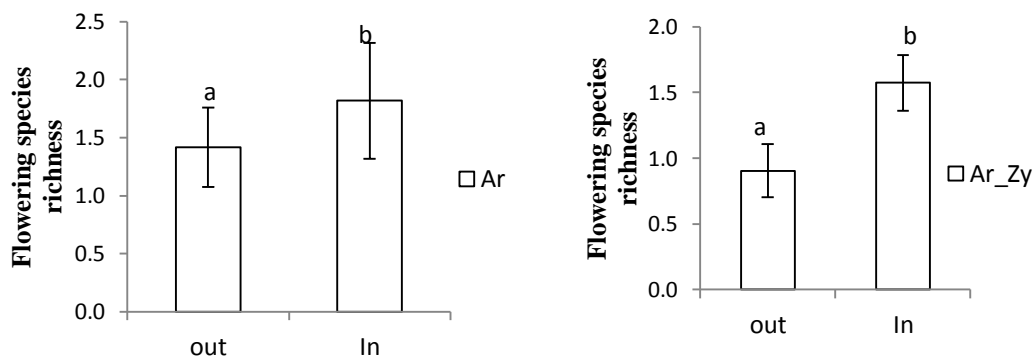


Figure 1. The differences between outside and inside of enclosure based on species diversity indices. Values are mean \pm SD. Significant differences are showed by the superscripts a and b the same letter indicates no significant difference.



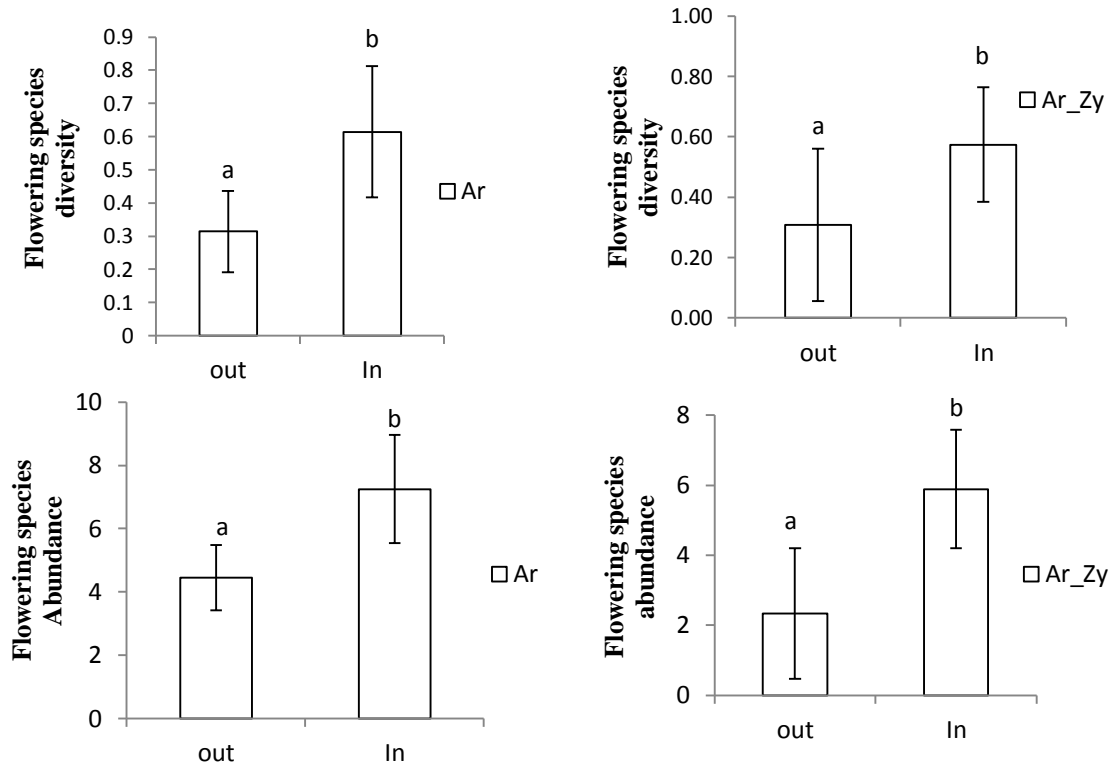


Figure 2. The differences between outside and inside of enclosure based on flowering species diversity indices. Values are mean ± SD. Significant differences are showed by the superscripts a and b the same letter indicates no significant difference.

Table 1. Pearson’s correlation coefficient between flowering species diversity indices and species diversity indices. Significant correlation are shown by: **p = 0.01

	Flowering species diversity	Flowering species richness	Species richness	Species diversity
Flowering species diversity	1	0.985**	0.923**	0.627**
Flowering species richness		1	0.902**	0.951**
species richness			1	0.758**
Species diversity				1

Table 2. The differences between outside and inside of enclosure based on life form of flowering species. Values are mean ± SD. Significant differences are showed by the superscripts a and b the same letter indicates no significant difference.

	Ar		Ar-Zy	
	In	Out	In	Out
Annual flowering forbs	4.23±0.56a	2.53±0.35b	3.12±0.98a	1.2±0.89b
Perennial flowering forbs	6.08±1.23a	1.89±0.68b	4.23±1.23a	1.31±0.74b
Flowering semi-shrub	15.14±4.32a	9.21±1.23b	10.23±2.32a	8.23±1.32a
Flowering shrub	2±2.1a	1.15±0.68a	6.12±1.2a	5.23±1.32a

The results also showed that the enclosure significantly affects different life forms of flowering species (Table 2). In the vegetation type *Artemisia aucheri*, annual flowering forbs were significantly increased

from 2.53±0.35 outside the enclosure to 4.23± 0.56 inside the enclosure (p<0.05). Perennial flowering forbs were significantly increased from 1.89±0.68 outside the enclosure to 6.08±1.23 inside the enclosure

($p < 0.05$). Flowering semi-shrubs were significantly increased from 9.21 ± 1.23 outside the enclosure to 15.14 ± 4.32 inside the enclosure ($p < 0.05$). There was no significant difference between inside and outside the enclosure in terms of flowering shrubs, but they were increased from 9.21 ± 1.23 outside the enclosure to 15.14 ± 4.32 inside the enclosure ($p > 0.05$). In the vegetation type *Artemisia aucheri* - *Zygophyllum eurypterum*, annual flowering forbs were significantly increased from 1.2 ± 0.89 outside the enclosure to 3.12 ± 0.98 inside the enclosure ($p < 0.05$). Perennial flowering forbs were significantly increased from 1.31 ± 0.74 outside the enclosure to 4.23 ± 1.23 inside the enclosure ($p < 0.05$). There was no significant difference between inside and outside the enclosure in terms of flowering semi-shrubs, but they were increased from 8.23 ± 1.32 outside the enclosure to 10.23 ± 2.32 inside the enclosure ($p < 0.05$). Flowering shrubs were significantly increased from 5.23 ± 1.32 outside the enclosure to 6.12 ± 1.2 inside the enclosure ($p < 0.05$).

Discussion

The results of this study showed that enclosure has increased species diversity and richness in two vegetation types of the region, indicating the positive effects of enclosure on diversity conservation. This is in accord with the results of Fikadu and Argaw (2021) stating that reducing the intensity of livestock grazing provided suitable conditions for species growth and biodiversity increase. However, a number of studies have shown that livestock grazing is necessary to maintain species diversity (e.g. Karamiet al., 2021). Mahmoudi et al. (2011) also showed that the species diversity and richness had increased in the protected area and concluded that proper management practices can cause ecosystem stability and increase biodiversity by reducing or eliminating livestock from the ecosystem. Kiani Sadr et al. (2016) concluded that enclosure had a significant effect on species density, diversity and richness.

The results also showed that the enclosure improved the diversity of

flowering plants in the studied region. The promotion of flowering plant diversity was different in different vegetation types. Forrest et al. (2010) also showed that plant communities that are different in terms of plant composition, are different in providing flowering plants and cultural services. *Artemisia aucheri* vegetation type, which includes more flowering forb plants, is more successful in providing cultural services. Hence, flowering forbs are valuable species for providing cultural services in semi-arid shrublands which should be given more attention in protection plans.

The diversity of flowering plants as an indicator of cultural services had a positive significant relationship with species diversity. Marshall and Moonen (2002) also showed that rich ecosystems in plant species usually provide beautiful landscapes. Color diversity in flowering plant can enhance the value of cultural services in the natural ecosystems (Lindemann-Matthies et al., 2010). People are very interested in seeing wild flowering plants (Satz et al., 2013). The results Cordell (2012) showed that flowering plants photography is one of the dominant activities of tourists. Flowering plants as a component of biodiversity are important to promote cultural services (Kremen et al., 2007). People's motivation to conserve biodiversity and native species is also increasing by promoting flowering plants and thus increasing the value of cultural services such as tourism and aesthetic value (Schirpke et al., 2016; De Lacy and Shackleton, 2017). Enhancing flowering plants also has a significant effect on promoting pollinator activity and pollination service (Kremen et al., 2007; Williams and Winfree, 2013). The flowering plant conservation program and cultural services pursue other ecosystem conservation goals and are a good way to prevent biodiversity loss (MA, 2005).

Knowing of flowering plants diversity and cultural services is very low (Daniel et al., 2012). In addition to anthropogenic activities, flowering species diversity is influenced by environmental factors such as soil and landscape and topography (Gornish

and Tylianakis, 2013). Hence, it is necessary to study the spatial variations of flowering plants in different landscapes under new studies. In this study, flowering plants have been studied just in spring. Examining the temporal changes of flowering plants and the potential of ecosystems in providing cultural services

throughout the year can provide proper information for management planners. In general, exclosure as one of the best methods of rangeland improvement in arid and semi-arid regions (Wang et al., 2019) is able to improve both biodiversity and cultural services in semi-arid shrublands.

References

- Bagella, S., Caria, M.C., Seddaiu, G., Leites, L., and Roggero, P.P. 2020. Patchy landscapes support more plant diversity and ecosystem services than wood grasslands in Mediterranean silvopastoral agroforestry systems. *Agricultural Systems*. 185, 102945.
- Barthel, S., Colding, J., Elmqvist, T., and Folke, C. 2005. History and local management of a biodiversity-rich, urban cultural landscape. *Ecology and Society*. 10(2), 10.
- Berkes, F., Colding, J., Folke, C., 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications*. 10, 1251–1262.
- Brück, M., Abson, D.J., Fischer, J., and Schultner, J. 2022. Broadening the scope of ecosystem services research: Disaggregation as a powerful concept for sustainable natural resource management. *Ecosystem Services*. 53, 101399.
- Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G.W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., and Turner, N. 2016. Opinion: Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences of the United States of America*. 113, 1462–1465
- Church, A., Fish, R., Haines-Young, R., Mourato, S., Tratalos, J., Stapleton, L., Willis, C., Coates, P., Gibbons, S., Leyshon, C., Potschin, M., Ravenscroft, N., Sanchis-Guarner, R., Winter, M., and Kenter, J. 2014. UK National Ecosystem Assessment Follow-on. Work Package Report5: Cultural ecosystem services and indicators. UNEP-WCMC, LWEC, UK
- Cordell, H.K. 2012. Outdoor recreation trends and futures: A technical document supporting the Forest Service 2010 RPA assessment. General Technical Report SRS-150 (US Department of Agriculture Forest Service, Asheville, NC).
- Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J.W., Chan, K.M.A., Costanza, R., Elmqvist, T., Flint, C.G., Gobster, P.H., Gret-Regamey, A., Lave, R., Muhar, S., Penker, M., Ribe, R.G., Schauppenlehner, T., Sikor, T., Soloviy, I., Spierenburg, M., Taczanowska, K., Tam, J., and von der Dunk, A. 2012. Contributions of cultural services to the ecosystem services agenda. *Proceeding of the National Academy of Science USA*. 109, 8812–8819.
- De Lacy, P., and Shackleton, Ch., 2017. Aesthetic and Spiritual Ecosystem Services Provided by Urban Sacred Sites. *Sustainability*. 9, 1628.
- Fikadu, A., and Argaw, M. 2021. Impact of exclosures on woody species diversity in degraded lands: the case of Lemo in Southwestern Ethiopia. *Heliyon*. 7, e06898.
- Forrest, J.R.K., and Thomson, J.D. 2011. An examination of synchrony between insect emergence and flowering in Rocky Mountain meadows. *Ecological Monographs*. 81, 469–491.
- Gornish, E.S., and Tylianakis, J.M. 2013. Community shifts under climate change: Mechanisms at multiple scales. *American Journal of Botany*. 100(7), 1422-1444
- Graves, R.A., Pearson, S.M., and Turner, M.G. 2016. Landscape dynamics of floral resources affect the supply of a biodiversity-dependent cultural ecosystem service. *Landscape Ecology*. 32, 415–428.
- Graves, R.A., Pearson, S.M., Turner, M.G., 2017. Species richness alone does not predict culturalecosystem service value. *Proceeding of the National Academy of Science USA*. 114, 3774–3779.

- Hegetschweiler, K.T., Vries, S., Arnberger, A., Bell, S., Brennan, M., Siter, N., Olafsson, A.S., Voigt, A., and Hunziker, M. 2017. Linking demand and supply factors in identifying cultural ecosystem services of urban green infrastructures: A review of European studies. *Urban Forestry and Urban Greening*. 21, 48-59.
- Junge, X., Jacot, K.A., Bossharda, A., and Lindemann-Matthies, P. 2009. Swiss people's attitudes towards field margins for biodiversity conservation. *Journal for Nature Conservation*. 17. 150–159.
- Karami, P., Bandak, I., GorginKaraji, M., and Dragovich, D. 2021. Effects of seasonal grazing and annual mowing on floristic composition and plant diversity in the Saral rangeland, Kurdistan, Iran. *Global Ecology and Conservation*. 27, e01515.
- Kiani Sadr, M., Imani Buzhani, F., Melhosseini Darani, K., and Arefian, A. 2020. Assessing effect of exclusion on the quality of Gonbad rangelands using with density and species richness indices. *Journal of Environmental Sciences studies*. 5, 2268-2274
- Kosanic, A., and Petzold, J., 2020. A systematic review of cultural ecosystem services and human wellbeing. *Ecosystem Services*. 45, 101168.
- Krasny, M.E., Russ, A., Tidball, K.G., and Elmqvist, T. 2014. Civic ecology practices: participatory approaches to generating and measuring ecosystem services in cities. *Ecosystem Services*, 7:177-186.
- Kremen, C., Williams, N.M., Aizen, M.A., Gemmill-Herren, B., LeBuhn, G., Minckley, R., Packer, L., Potts, S.G., Roulston, T., Steffan-Dewenter, I., Vazquez, D.P., Winfree, R., Adams, L., Crone, E.E., Greenleaf, S.S., Keitt, T.H., Klein, A.M., Regetz, J., and Ricketts, T.H. 2007. Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. *Ecology Letters*. 10, 299–314.
- Lindemann-Matthies, P., Junge, X., and Matthies, D. 2010. The influence of plant diversity on people's perception and aesthetic appreciation of grassland vegetation. *Biological Conservation*. 143, 195-202.
- Lovell, S.T., and Taylor, J.R. 2013. Supplying urban ecosystem services through multifunctional green infrastructure in the United States. *Landscape Ecol.* 28,1447–1463.
- Mace, G.M., Norris, K., and Fitter, A.H., 2012. Biodiversity and ecosystem services: a multilayered relationship. *Trends in Ecology Evolution*. 27, 19–26.
- Mahmoudi, J., Choopani, H.V., and Akbarlo, M. 2011. The impact of exclusion on the steppe rangeland biodiversity (Case study: Bozdaghi catchment In Northern Khorasan). *Natural Ecosystems of Iran*. 1,136-144
- Marshall, E.J., and Mooney, A.C. 2002. Field margins in northern Europe: Their functions and interactions with agriculture. *Agriculture Ecosystems & Environment*, 89: 5-21.
- Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Multiscale Assessments*. (Island, Washington, DC)
- Nahuelhua, L., Carmona, A., Latorra, P., Barrena, J., and Aguayo, M. 2014. A mapping approach to assess intangible cultural ecosystem services: The case of agriculture heritage in Southern Chile. *Ecological Indicators*. 40, 90-101.
- Raymond, C.M., Singh, G.G., Benessaiah, K., Bernhardt, J.R., Levine, J., Nelson, H., Turner, N.J., Norton, B., Tam, J., and Chan, K.M.A. 2013. Ecosystem services and beyond: using multiple metaphors to understand human–environment relationships. *Bioscience*. 63, 536-546.
- Rosenfield, M.F., Brown, L.M., and Anand, M. 2022. Increasing cover of natural areas at smaller scales can improve the provision of biodiversity and ecosystem services in agroecological mosaic landscapes. *Journal of Environmental Management*. 303, 114248.
- Sakurai, R., Jacobson, S.K., Kobori, H., Primack, R., Oka, K., Komatsu, N., and Machida, R. 2011. Culture and climate change: Japanese cherry blossom festivals and stakeholders' knowledge and attitudes about global climate change. *Biological Conservation*. 144,654–658.
- Satz, D., Gould, R.K., Chan, K.M.A., Guerry, A., Norton, B., Satterfield, T., and Halpern, B.S., et al. 2013. The challenges of incorporating cultural ecosystem services into environmental assessment. *Ambio*, 42, 675-684.

- Schirpke, U., Timmermann, F., Tappeiner, U., and Tasser, E. 2016. Cultural ecosystem services of mountain regions: Modelling the aesthetic value. *Ecological Indicators*. 69,78-90.
- Schröter, M., Stumpf, K.H., Loos, J., van Oudenhoven, A.P., Böhnke-Henrichs, A., and Abson, D.J. 2017. Refocusing ecosystem services towards sustainability. *Ecosystem Services*. 25, 35-43.
- Souza, B.A., Rosa, J.C.S., Siqueira-Gay, J., and Sánchez, L.E. 2021. Mitigating impacts on ecosystem services requires more than biodiversity offsets. *Land Use Policy*. 105: 105393.
- Sun, Zh., Behrens, P., Tukker, A., Bruckner, M., and Scherer, L. 2022. Shared and environmentally just responsibility for global biodiversity loss. *Ecological Economics*. 194, 107339.
- Tengberg, A., Fredholm, S., Eliasson, I., Knez, I., Saltzman, K., and Wetterberg, O. 2012. Cultural ecosystem services provided by landscapes: Assessment of heritage values and identity. *Ecosystem Services*. 2,14-26.
- Van Berkel, D.B., and Verburg, P.H. 2012. Spatial quantification and valuation of cultural ecosystem services in an agricultural landscape. *Ecological Indicators*. 37, 163-174.
- Wallace, K.J. 2007. Classification of ecosystem services: Problems and solutions. *Biological Conservation*. 139,235–246.
- Wang, S., Fan, J., Yuzhe, L., and Huang, L. 2019. Effects of grazing exclusion on biomass growth and species diversity among various grassland types of the Tibetan plateau. *Sustainability*. 11,1705.
- Williams, N.M., and Winfree, R. 2013. Local habitat characteristics but not landscape urbanization drive pollinator visitation and native plant pollination in forest remnants. *Biological Conservation*. 160, 10-18.
- Zhao, Y., Wang, N., Luo, Y., He, H., Wu, L., Wang, H., Wang, Q., and Wu, J. 2022. Quantification of ecosystem services supply-demand and the impact of demographic change on cultural services in Shenzhen, China. *Journal of Environmental Management*. 304, 114280.

