

# Evidence Brief: Social Impact Framework for NbS Supplementary Information

NBS services promoting local biodiversity, wellbeing and scalable solutions project (NBSPLUS) Deliverable 15

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*April 2026*



# Introduction



- This supplementary information slide-deck provides further details and references related to the following evidence brief:
  - Tuhkanen, H., and Tamm, K. (2026). Social Impact Framework for Nature-Based Solutions: Evidence Brief. NBS services promoting local biodiversity, wellbeing and scalable solutions project deliverable 15. NBSPLUS project.
  - <https://zenodo.org/communities/nbsplus/about>



# Main concepts

- **Nature-based Solutions (NbS):** „Actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits“ (UNEA, 2022).
  - Includes parks, wetlands, waterways and other blue-green and green spaces
- **Societal wellbeing:** the combined physical, mental, social, and economic conditions that enable individuals and communities to thrive within just and resilient social–ecological systems (EEA, 2021).
- **Social impact:** the effects of NbS on people’s health and wellbeing, social relations, participation and governance, knowledge and capacities, and equity and justice at individual and community levels (EC, 2021; EEA, 2021; OECD, 2023).
- **Biodiversity\*:** Biodiversity, in turn, refers to the variability of life on Earth, including the diversity of genes, species, and ecosystems, and the interactions among them (Romanelli et al., 2015; IPBES, 2019; WWF, 2024).
- **Perceived biodiversity:** peoples’ subjective experience of biodiversity (Rozario et al. 2025).
- \*See slide 24 for definitions used in the literature reviewed



# Key references

- **UN Environment Assembly (UNEA). (2022).** *Resolution 5/5: Nature-based solutions for supporting sustainable development.* United Nations Environment Programme, Nairobi. <https://wedocs.unep.org/handle/20.500.11822/39864>
- **European Commission: Directorate-General for Research and Innovation (2021).** *Evaluating the impact of nature-based solutions – A handbook for practitioners*, Publications Office of the European Union, <https://data.europa.eu/doi/10.2777/244577>
- **European Environment Agency (EEA). (2021).** *Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation.* EEA.
- **OECD (2023).** *Promoting nature-based solutions in municipalities in Hungary*, OECD Environment Policy Papers, No. 39, OECD Publishing, Paris. <https://doi.org/10.1787/d81fb09f-en>.
- **IPBES (2019).** *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. <https://doi.org/10.5281/zenodo.3831673>
- **Rozario, et al. (2025).** *Perceived biodiversity: Is what we measure also what we see and hear?* People and Nature, 7(8), 2019–2037. <https://doi.org/10.1002/pan3.70087>



# Methodology

- European Commission evaluation framework within the *Evaluating the Impact of Nature-based Solutions* report explores literature prior to 2020
- We review literature published after 2020 to examine recent evidence on the social impacts of NbS and biodiversity
  - close look at the impacts on human well-being and justice
  - 2 separate searches – boolean search
  - Various searches on SciHub/Google scholar/snowballing search (fall 2025 + spring 2025)
  - mainly review articles, but also empirical articles and grey literature
  - 165 publications total
- Thematic analysis of social impacts
- Themes organised according to the societal challenges (SC) related to People and Prosperity\* pillars of the European Commission evaluation framework within the *Evaluating the Impact of Nature-based Solutions* report which is explores literature prior to 2020.

\* We excluded the Natural and Climate Hazards category of the Prosperity pillar due to their focus on ecological impacts



# Societal challenges related to impacts

- The NBSPLUS Social impact framework is based on the societal challenges identified in the *Evaluating the Impact of Nature-Based Solutions: A Handbook for Practitioners* (EC 2021).
- We focus on the People and Prosperity categories of societal challenges reflected in this diagram („pie” part).
- Societal challenges related to Planet categories and Natural and climate hazards category of societal challenges were not applied due to the focus on ecological impacts rather than social impacts.
- Figure 1 is simplified in the Evidence Brief.

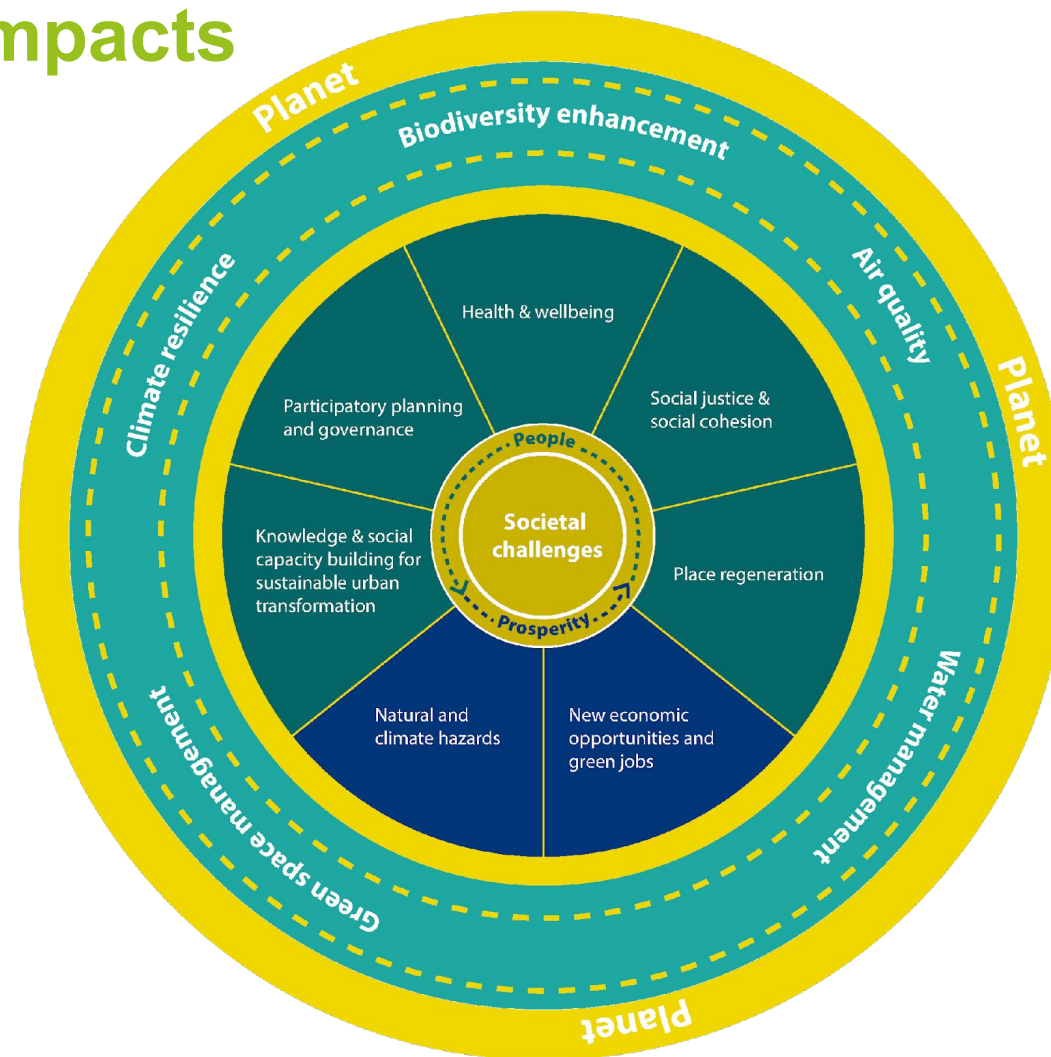
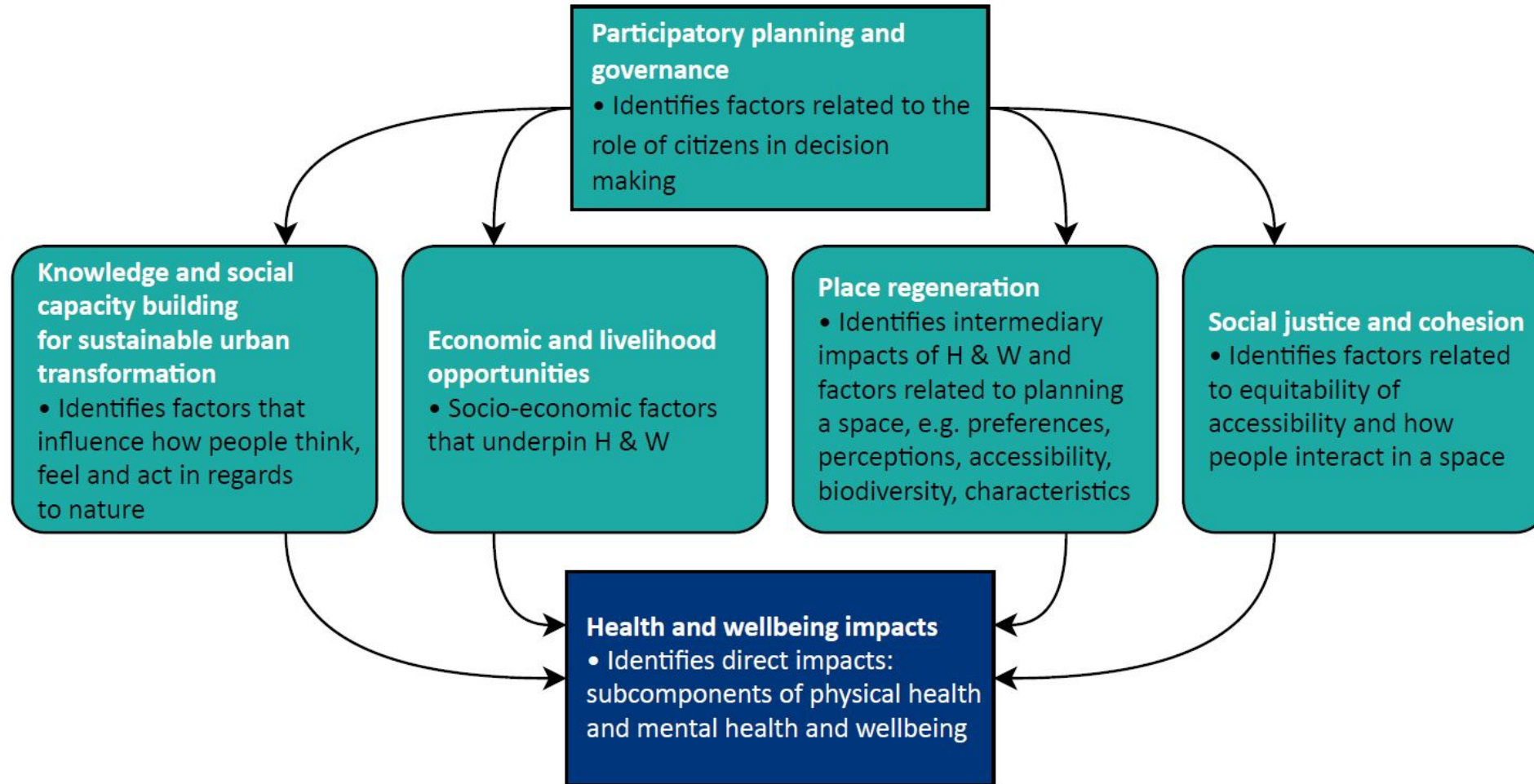
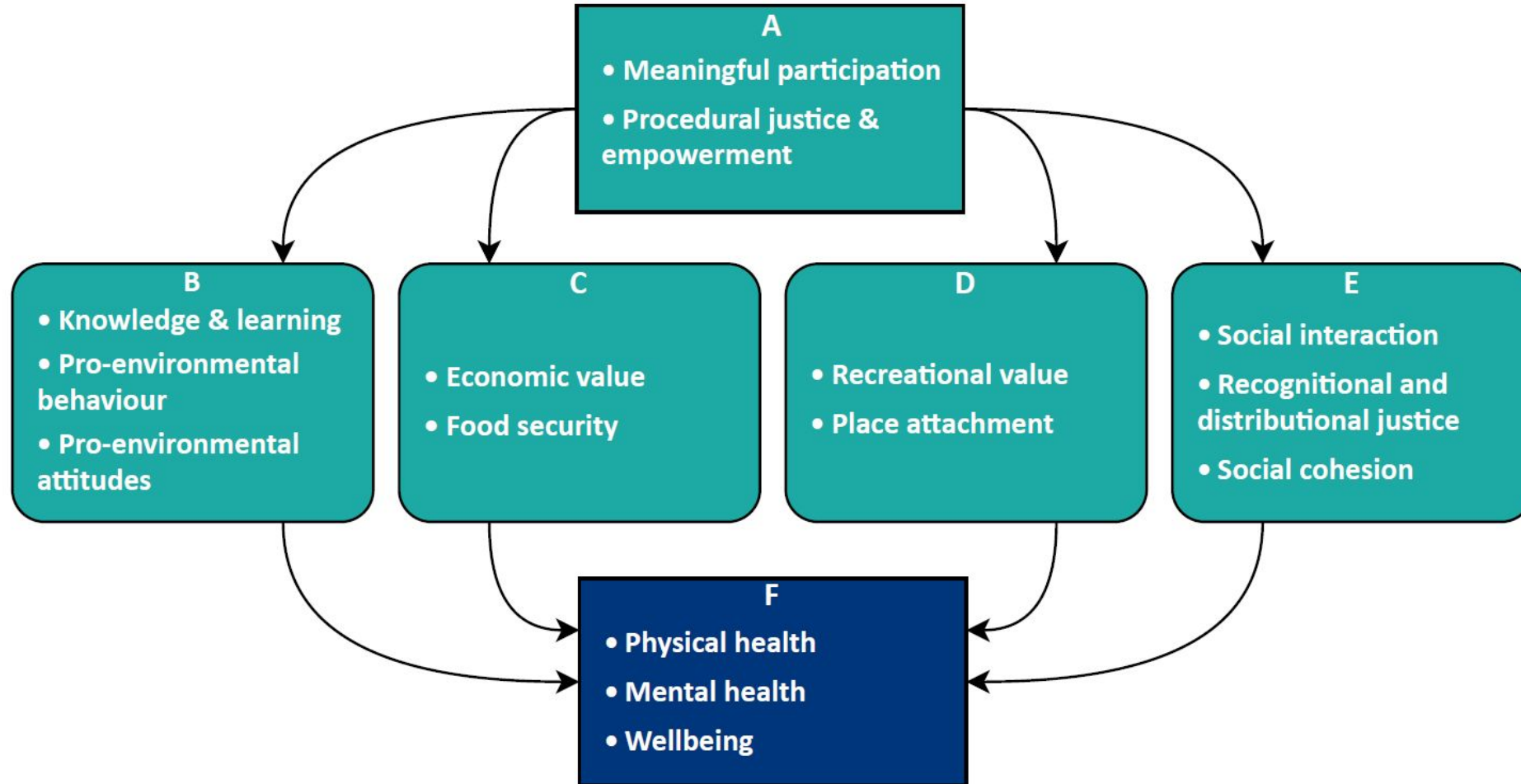


Figure 1: Societal challenges that can be addressed through NbS. Figure adapted by authors from EC, 2021 to reflect the dependence of the societal and economic sustainability (people and prosperity) on ecological sustainability (planet) .









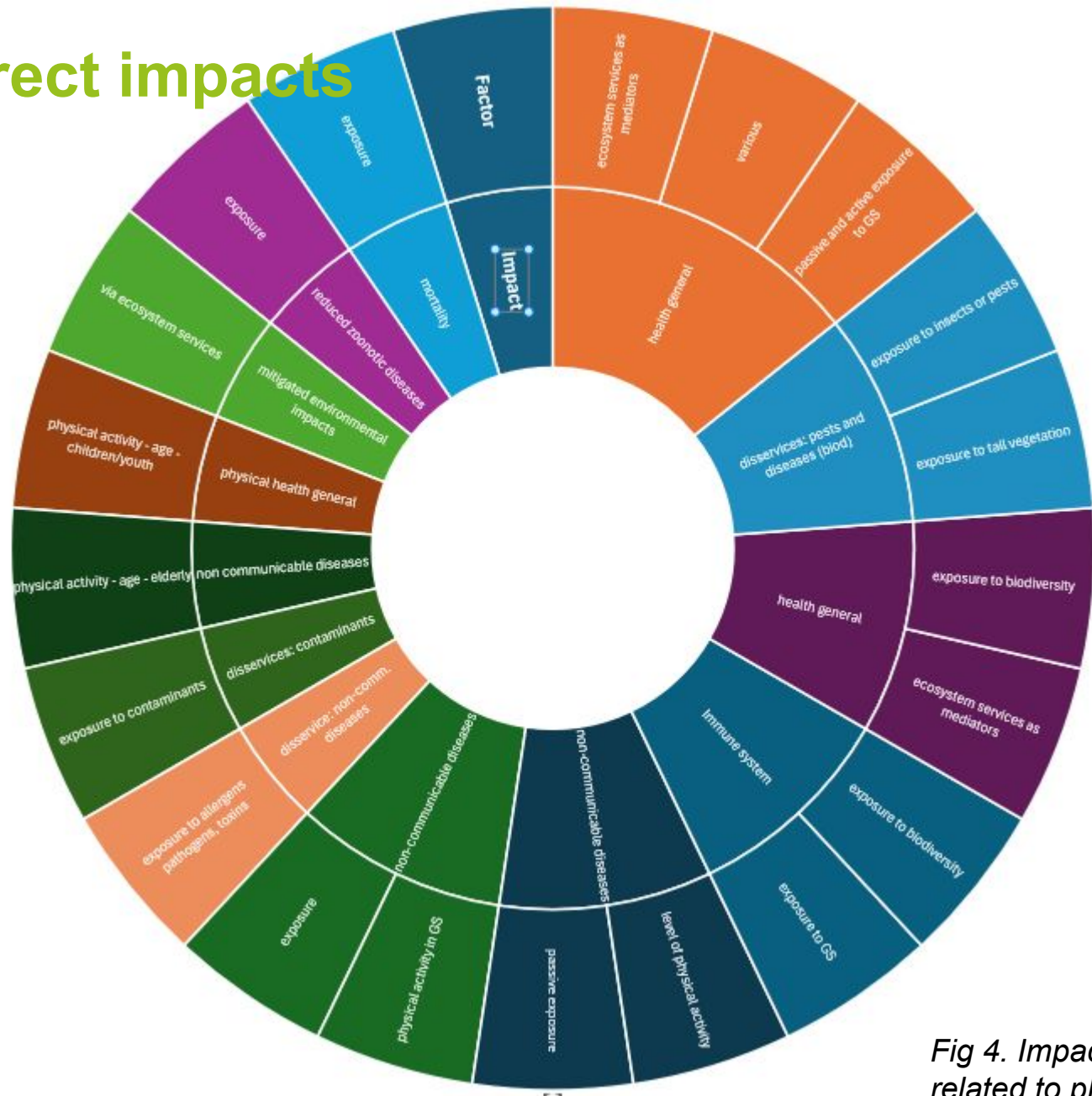


## Health and wellbeing: direct impacts



## Areas of physical health:

Health (general),  
non-communicable diseases,  
mortality, reduced zoonotic  
diseases, mitigated  
environmental impacts,  
weight management,  
cardiovascular and general  
physical health, improved  
mobility, immune system  
functioning, infectious disease  
transmission, as well as  
disservices related to  
contaminants,  
non-communicable diseases,  
and pests and diseases.



**Fig 4. Impacts and factors related to physical health and wellbeing**



# Health and wellbeing: direct impacts

**Areas of mental health:** mental health and wellbeing (general), restoration promoting physical health, restorative benefits, improved mood, reduced stress and anxiety, alleviation of depression, resilience against mental disorders, cognitive benefits and attention restoration, perceived cognitive restorativeness, happiness and quality of life, disservices/negative impacts.

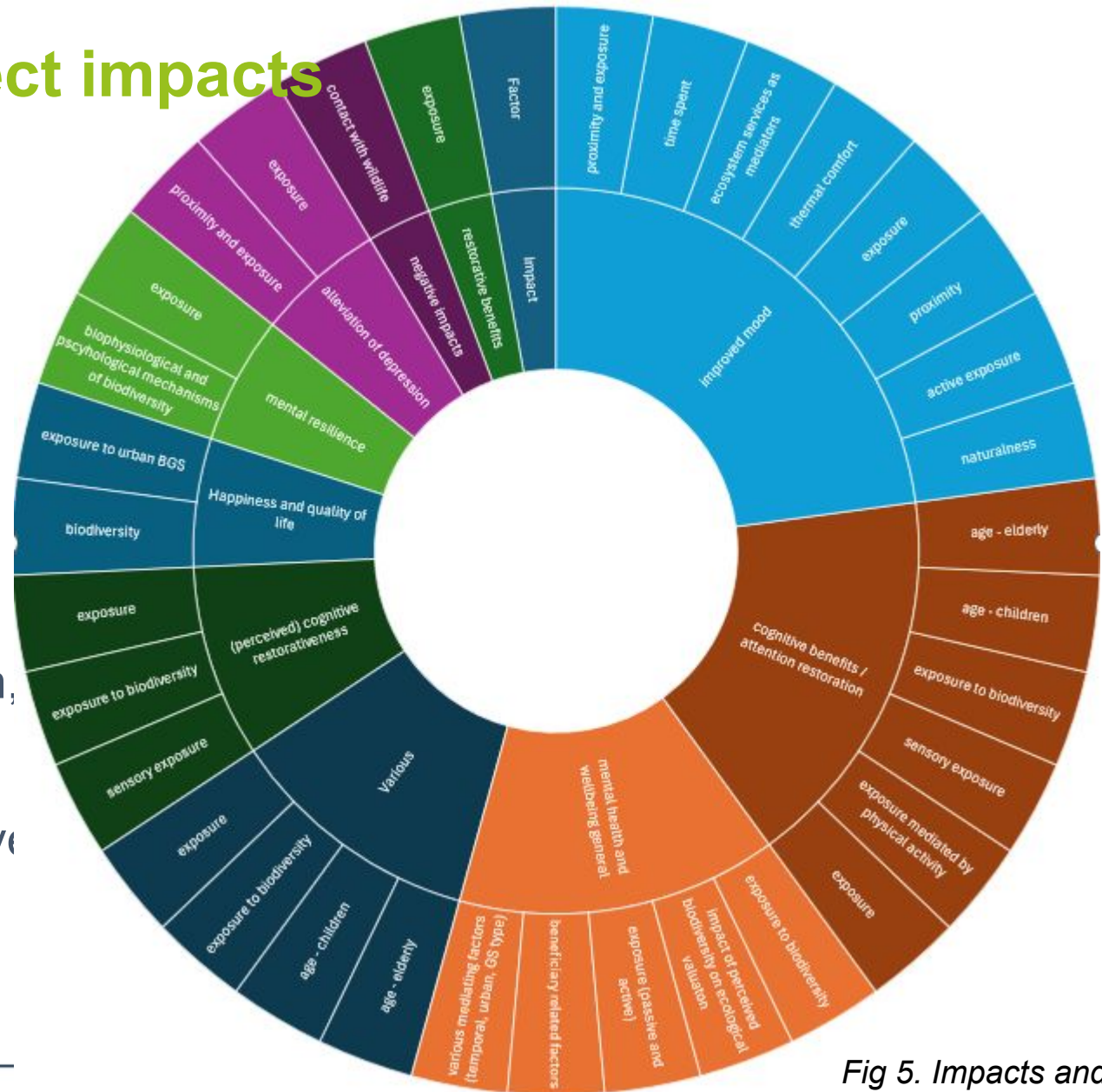


Fig 5. Impacts and factors related to mental health and wellbeing



# Health and wellbeing: direct impacts

**Integrated physical and mental impacts:**  
health and wellbeing (general), therapeutic mental and physical health benefits.

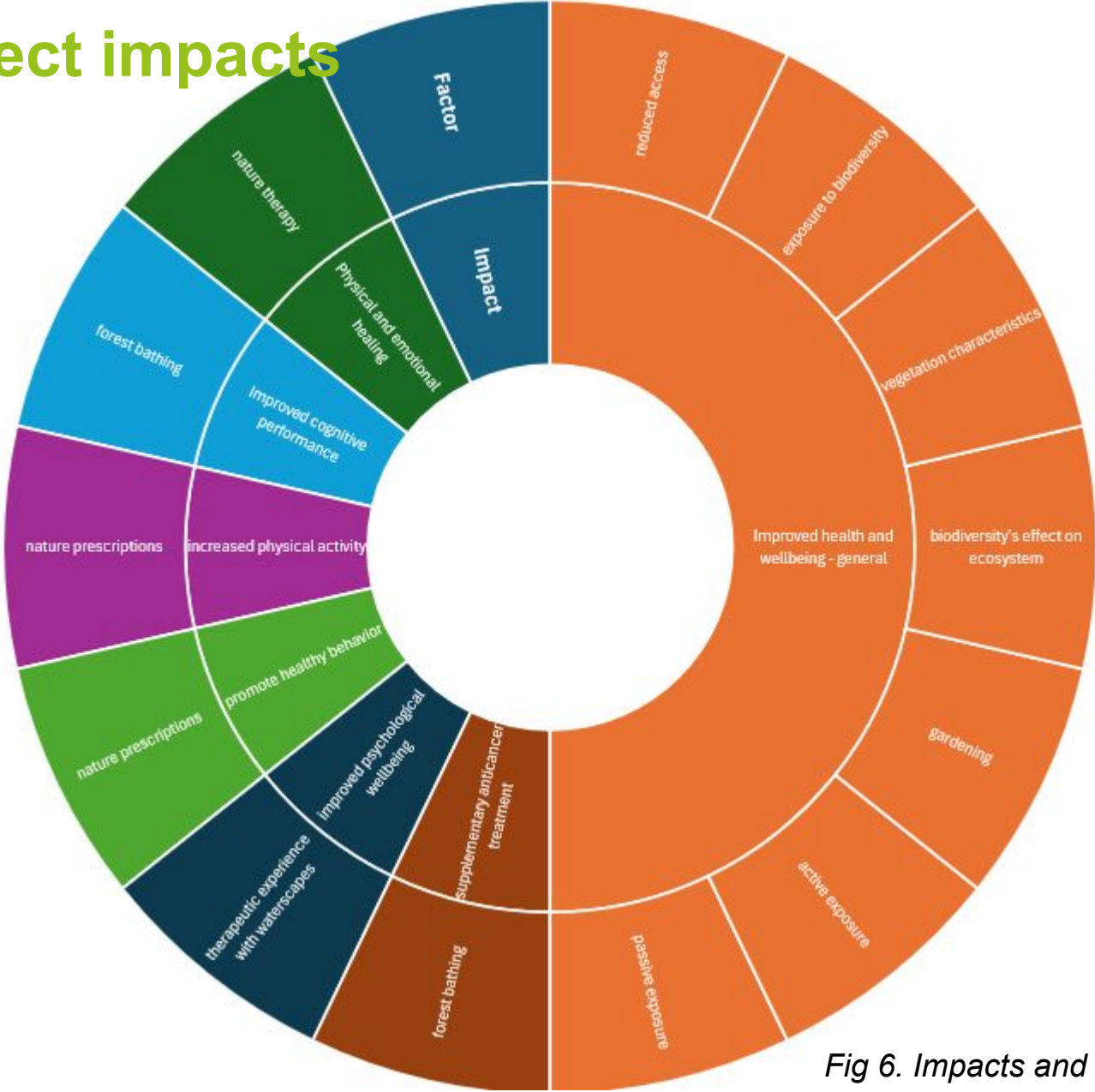


Fig 6. Impacts and factors related to integrated health and wellbeing



# Health and wellbeing – role of biodiversity

- Biodiversity linked to impacts on: **general physical health\*** (through increasing level of physical activity), improved immune system\*, decreased non-communicable diseases\* and disservices: infections diseases, pests and non-communicable diseases\*, **general mental health and wellbeing\***, improved mood, resilience against mental disorders, cognitive benefits, perceived cognitive restorativeness, happiness and quality of life, **improved health and wellbeing (integrated)**.

\* mixed results found by at least one study.



# Health and wellbeing references



NBSPLUS

Impact category	References
Physical health impacts	Almenar et al. (2021); Amorim et al. (2021); Andersson et al. (2022); Babí Almenar et al. (2021a); Barbiero & Berto (2021); Bele & Chakradeo (2021); Borca et al. (2023); Bruno et al. (2024); Bryer et al. (2025); Cardinali et al. (2023); Castañeda et al. (2024); Davis et al. (2025); de Sousa Silva et al. (2025); Díaz-Martínez et al. (2023); Finnerty et al. (2025); Geneshka et al. (2021); Georgiou et al. (2021); Hall et al. (2021); Javadi & Nasrollahi (2021); Khalaji et al. (2024); Marselle et al. (2021); Martín Muñoz et al. (2024); Murray et al. (2022); Nieuwenhuijsen (2021); Pandey & Ghosh (2023); Paudel & States (2023); Pereira et al. (2023); Pinto et al. (2023); Priya & Senthil (2024); Reyes-Riveros et al. (2021); Remme et al. (2021); Robinson et al. (2024); Sari & Bayraktar (2023); Schell et al. (2020); Seastedt et al. (2025); Serra & Feio (2024); Song et al. (2022); Wang, K. et al. (2022); Wang, X. et al. (2025); White et al. (2023); Wilkie & Davinson (2021); Williams et al. (2021); Wu et al. (2024); Yang et al. (2023); Yuan & Chen (2025); Zhang, H. et al. (2022); Zhang, K. et al. (2024); Zhang, S. et al. (2022); Zhang, X. et al. (2021); WHO & IUCN (2023); WHO & IUCN (2024).
Mental health impacts	Alikhani et al. (2021); Amorim et al. (2021); Atiqul Haq et al. (2021); Barbiero & Berto (2021); Batterham et al. (2022); Bele & Chakradeo (2021); Beute et al. (2023); Bolanis et al. (2024); Bolouki (2023); Borca et al. (2023); Bray et al. (2022); Bryer et al. (2024); Bryer et al. (2025); Callaghan et al. (2021); Cameron et al. (2020); Castañeda et al. (2024); Christensen et al. (2025); Coman et al. (2022); Cooley et al. (2020); Davis et al. (2021); Davis et al. (2025); de Sousa Silva et al. (2025); Díaz-Martínez et al. (2023); Felappi et al. (2020); Finnerty et al. (2025); Frost et al. (2022); Gonzales-Inca et al. (2022); Gonçalves et al. (2021); Grilli & Sacchelli (2020); Hall et al. (2021); Han et al. (2025); Javadi & Nasrollahi (2021); K. Wang et al. (2022); Li & Lange (2023); Li, L. & Lange (2023); Luque-García et al. (2022); Martín Muñoz et al. (2024); McInturff et al. (2025); Nghiem et al. (2021); O'Brien et al. (2022); Pandey & Ghosh (2023); Patuano (2020); Paudel & States (2023); Pereira et al. (2023); Pinto et al. (2023); Priya & Senthil (2024); Reece et al. (2021); Remme et al. (2021); Reyes-Riveros et al. (2021); Ribeiro et al. (2024); Robinson et al. (2024); Rowley et al. (2022); Schell et al. (2020); Seastedt et al. (2025); Semeraro et al. (2021); Serra & Feio (2024); Silva Luz et al. (2024); Smith & Turner (2023); Soga & Gaston (2025); Song et al. (2022); Syamili et al. (2023); Tharrey & Darmon (2021); Wang, X. et al. (2025); White et al. (2023); Wilkie & Davinson (2021); Williams et al. (2021); Wong & Osborne (2022); Wu et al. (2024); Yang et al. (2023); Yuan & Chen (2025); Zhang, H. et al. (2022); Zhang, R. et al. (2021); Zhang, S. et al. (2022); Zhang, X. et al. (2021); Zhang, Y. et al. (2025); WHO-IUCN (2023); WHO-IUCN (2024).
Integrated health impacts	Ayatollahi & Morello (2025); Bryer et al. (2024); Cooley et al. (2020); Grilli & Sacchelli (2020); Hall et al. (2021); Harrison et al. (2023); Houlden et al. (2021); Marselle et al. (2020); Marselle et al. (2021); Paudel & States (2023); Reyes-Riveros et al. (2021); Robinson et al. (2024); Tharrey & Darmon (2021); Thomas et al. (2022); Ulrich et al. (2023); White et al. (2023); Williams et al. (2021); Wu et al. (2024); X. Zhang et al. (2021); Yuille et al. (2024); WHO-IUCN (2024).



# Place regeneration

- Identifies impacts, e.g. perceived safety; nature connectedness\*, place attachment\*, recreational value\*, happiness\*, restorativeness\*
- Identifies factors related to „planning a space“, e.g. perceptions, preferences, space characteristics\*, accessibility.

\* *biodiversity shown to play a role in these categories.*



Fig 7. Impacts and factors related to health and wellbeing related to the societal challenge of place regeneration



# Place regeneration references



Impact category	References
All	<p>Alikhani et al. (2021), Allegretto et al. (2022), Amorim et al. (2021), Andersson et al. (2022), Atiqul Haq et al. (2021), Babí Almenar et al. (2021a), Babí Almenar et al. (2021b), Barbiero &amp; Berto (2021), Bele &amp; Chakradeo (2021), Cameron et al. (2020), Castañeda et al. (2024), Davis et al. (2025), de Sousa Silva et al. (2025), Dushkova et al. (2021), Felappi et al. (2020), Finnerty et al. (2025), Fischer et al. (2020b), Gonçalves et al. (2021), Javadi &amp; Nasrollahi (2021), Juntti &amp; Ozsezer-Kurnuc (2023), Li &amp; Lange (2023), Mahmoud et al. (2021), Martín Muñoz et al. (2024), McPhearson et al. (2022), Methorst et al. (2021), Ndayambaje et al. (2024), Ode Sang et al. (2022), Paudel &amp; States (2023), Patuano (2020), Priya &amp; Senthil (2024), Reece et al. (2021), Revich (2023), Reyes-Riveros et al. (2021), Robinson et al. (2024), Seastedt et al. (2025), Serra &amp; Feio (2024), Smith &amp; Turner (2023), Teerlinck et al. (2024), Viti et al. (2022), Wallace &amp; Clarkson (2019), Wilkie &amp; Davinson (2021), Xu et al. (2025), Zhang, X. et al. (2021).</p>



# Social justice & cohesion

- Identifies intermediate impacts, e.g. social cohesion\*, social Interactions\*, social capital, justice, ecological grief\*, etc.
- Identifies factors related equitability of access\*, and how people interact in a space, e.g. NbS development processes, social activities/events, quality of NbS, locally specific contexts.

\* *biodiversity shown to play a role in these categories.*



Fig 8 Impacts and factors related to health and wellbeing related to the societal challenge of social justice and cohesion



# Social justice and cohesion references

Impact category	References
Health and mental health	Allegretto et al. (2022); Babí Almenar et al. (2021); Benham and Hoerst (2024); Blaschke et al. (2024); Castañeda et al. (2024); Hall et al. (2021); Han et al. (2025); Javadi and Nasrollahi (2021); Marselle et al. (2021); McDonald et al. (2023); McInturff et al. (2025); Murray et al. (2022); Pandey and Ghosh (2023); Patuano (2020); Reyes-Riveros et al. (2021); Revich (2023); Robinson et al. (2024); Schell et al. (2020); Seastedt et al. (2025); Smith and Turner (2023); Spotswood et al. (2025); Tharrey and Darmon (2021); WHO and IUCN (2023); Williams et al. (2022); and Wu et al. (2024).
Social capital	Astell-Burt et al. (2022); Castañeda et al. (2024); Cooley et al. (2020); Han et al. (2025); Pandey and Ghosh (2023); Pereira et al. (2023); Patuano (2020); Smith and Turner (2023); and Zhang et al. (2022).
Social cohesion	Atiqul Haq et al. (2021); Buijs et al. (2024); Castañeda et al. (2024); Khalaji et al. (2024); NATURVATION (n.d.); Pandey and Ghosh (2023); Paudel and States (2023); Pinto et al. (2023); Priya and Senthil (2024); Semeraro et al. (2021); and Silva Luz et al. (2024).
Social interaction	Atiqul Haq et al. (2021); Hall et al. (2021); Haase et al. (2017); Khalaji et al. (2024); Luque-García et al. (2022); Mahmoud et al. (2021); Marselle et al. (2021); McPhearson et al. (2022); Tharrey and Darmon (2021); and Wallace and Clarkson (2019).
Accessibility and justice	Allegretto et al. (2022); Castañeda et al. (2024); Davis et al. (2025); European Environment Agency (2024); Gantioler et al. (2023); Khalaji et al. (2024); Methorst et al. (2021); Pandey and Ghosh (2023); Robinson et al. (2024); Sarı and Bayraktar (2023); Schell et al. (2020); Van Lierop and Fakirova (2022); Wu et al. (2024); and Zuniga-Teran et al. (2021).
Others	Allegretto et al. (2022); Angradi et al. (2019); Bundesamt für Naturschutz (2024); Dushkova et al. (2021); Khalaji et al. (2024); Kronenberg et al. (2023); Kubiszewski et al. (2024); McInturff et al. (2025); Murray et al. (2022); Pandey and Ghosh (2023); Reyes-Riveros et al. (2021); Robinson et al. (2024); Schell et al. (2020); and Serra and Feio (2024).



# Knowledge and social capacity building

- Identifies intermediate impacts, e.g. pro-environmental behavior, positive attitudes towards nature\*, awareness about nature\*, nature connection\*,
- Identifies factors that influence how people think, feel and act in regards to nature, e.g. direct contact with nature, activities in nature\*, user characteristics\*, previous experiences\*, affiliation with nature\*, etc.

*\* biodiversity shown to play a role in these categories.*



Fig 9. Impacts and factors related to health and wellbeing related to the societal challenge of knowledge and social capacity building



# Knowledge and social capacity building references



Impact category	References
All	Andersson et al. (2022); Barbiero and Berto (2021); Battisti et al. (2023); Bele and Chakradeo (2021); Bertoletti et al. (2025); Cooley et al. (2020); Coman et al. (2022); Finnerty et al. (2025); Fischer et al. (2020a); Hall et al. (2021); Khalaji et al. (2024); Pandey and Ghosh (2023); Paudel and States (2023); Patuano (2020); Perry et al. (2008); Robinson et al. (2024); Stagg and Dillon (2022); Straka et al. (2025); Williams et al. (2021); X. Zhang et al. (2021); Zandersen (2024); and Zedda (2023).



# Prosperity

- Focuses on factors related to „influencing people“, e.g. ecosystem services, social policies, types of plants and management practices.
- Identifies intermediate impacts, e.g. profit, food security, increased property value, savings, poverty alleviation, etc. environmental behavior, positive attitudes towards nature, awareness about nature.



*Fig 10 Impacts and factors related to health and wellbeing related to the prosperity*



# Prosperity references



Impact category	References
All	Artmann and Sartison (2018); Bertoleti et al. (2025); Chester et al. (2022); Dushkova et al. (2021); Hardberger et al. (2025); Murray et al. (2022); Ndayambaje et al. (2024); O'Brien et al. (2022); Paudel and States (2023); Schell et al. (2020); Shackleton (2021); and Tharrey and Darmon (2021).



# Participatory planning and governance

- Impacts include: justice, multifunctional landscapes, social acceptability, local stewardship, empowerment, and sustained and innovative NbS.
- Identifies factors related to „the role of citizens in decision making“, e.g. local engagement (especially of marginalised groups), governance innovations, etc.



Fig 11 Impacts and factors related to health and wellbeing related to the societal challenge of participatory planning and governance



# Participatory planning and governance references



Impact category	References
All	Andersson et al. (2022); Angradi et al. (2019); Battisti et al. (2023); Buijs et al. (2024); Celletti et al. (2025); Chester et al. (2022); C. S. S. Ferreira et al. (2023); European Environment Agency (2024); Gantioler et al. (2023); Haase et al. (2017); Hall et al. (2021); Hölscher et al. (2023); Hölscher et al. (2024); Khalaji et al. (2024); Lam et al. (2024); McInturff et al. (2025); Mesa-Vieira et al. (2023); Mohtat and Khirfan (2021); Moxon et al. (2025); Murray et al. (2022); NATURVATION (n.d.); Pandey and Ghosh (2023); Pinto et al. (2023); Pörtner et al. (2023); Potgieter et al. (2024); Razzaghi Asl and Pearsall (2022a); Razzaghi Asl and Pearsall (2022b); Schell et al. (2020); Suich and Dawson (2023); Van Lierop and Fakirova (2022); Vinczeová and Tóth (2025); WHO and IUCN (2023); WHO and IUCN (2024); and Zuniga-Teran et al. (2021).



# Further insights related to biodiversity

- Underlying research uses various concepts and definitions of biodiversity when analyzing the impacts of NbS (see slide 24).
- Biodiversity was associated with factors related to social impact across all societal challenge areas except Participatory planning and governance.
- Impacts of biodiversity is an area that needs further research due to mixed results and variety of definitions and in some cases, lack of clear definition.
- A majority of articles that describe a social impact of biodiversity, contain an explicit definition of biodiversity (56%). While many articles state a general biodiversity definition, often following the Convention on Biodiversity, some focus only on one aspect of biodiversity, usually inter-species diversity.
- In measuring impacts, research includes explicit measures of biodiversity sometimes relating to only one group of species or measures of perceived biodiversity.
- Studies examine perceptions of biodiversity both in controlled settings, e.g. by studying reactions to photographs or videos of nature and in real world settings by surveying visitors to urban nature sites.
- In some studies, biodiversity heuristics are employed by researchers, for example, when equating more colorful or more wild-looking natural areas to higher biodiversity.



Definitions/characteristics of biodiversity	Literature references applying the definitions
Multiples scales, including microbial	Bruno et al. 2024;
Diversity in/variability of genes and traits/functional traits of species (e.g. Colors)	Robinson et al. 2024; Marselle et al. 2021; Gonçalves et al., 2021; Seddon et al., 2020; Smith and Turner 2023;
Variety or abundance in life/living organisms/plant and animal diversity	Robinson et al. 2024; Seastedt et al. 2025; Borca et al. 2023; Davis et al. 2025.; Felappi et al. 2020; Ayatollahi & Morello, 2025; Houlden et al. 2021
Species richness/abundance/number/composition and configuration and diversity	Wu et al. 2024; Marselle et al. 2021; Methorst et al. 2021; Coman et al. 2022; Reyes-Riveros et al. 2021; Gonçalves et al., 2021; Seddon et al. 2020
Variety/abundance in ecosystems/habitats/landscapes	Seastedt et al. 2025; Marselle et al. 2021; Borca et al. 2023; Cameron et al. 2020; Seddon et al. 2020
Genetic variation/composition/identity of particular species	Marselle et al. 2021; Cameron et al. 2020
Biophysical patterns occurring in a certain area	Bele and Chakradeo 2021
Species richness for specific species (e.g. bird)	Cameron et al. 2020; Ayatollahi & Morello, 2025; Blaschke et al. 2024
Perception of biodiversity/bird abundance	Cameron et al. 2020; Yuille et al., 2024
Origin of species	Reyes-Riveros et al. 2021
Tree canopy cover	Ayatollahi & Morello, 2025
No definition	Numerous



**Cite as: Tuhkanen, H., and Tamm, K. (2026).** Social Impact Framework for Nature-Based Solutions: Evidence Brief. NBS services promoting local biodiversity, wellbeing and scalable solutions project deliverable 15. NBSPLUS project.

**Citation for evidence brief: Tuhkanen, H., and Tamm, K. (2026).** Social Impact Framework for Nature-Based Solutions: Evidence Brief. NBS services promoting local biodiversity, wellbeing and scalable solutions project deliverable 15. NBSPLUS project.

This research was funded by **Biodiversa+**, the European Biodiversity Partnership, in the context of the **NBSPLUS project** under the 2023-2024 **BiodivNBS** joint call. It was co-funded by the **European Commission (GA No. 101052342)** and the following funding organisations: The Swedish Research Council for Environment, Agricultural, Sciences, and Spatial Planning (Formas), Fundação para a Ciência e a Tecnologia, I.P., Research Council of Norway, Agencia Estatal de Investigación; Fundación Biodiversidad, Estonian Research Council (ETAG), Fonds de Recherche du Québec (FRQ). IBN, partner and subcontractor, has been co-financed by FORMAS, Agencia Estatal de Investigación; Fundación Biodiversidad, and FRQ.

#### Social Media:

NBSPLUS project - webpage



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