



# Best practices in European wetland restoration: a review of manuals and guidelines

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**Abstract** A significant portion of wetlands is currently degraded and scaling up restoration efforts is necessary for both biodiversity and climate targets. However, many barriers to ecological restoration have been identified. To overcome them, capacity building and effective exchange of best practices are vital. Restoration experts have reported shortcomings in the availability, usability, scope, and quality of restoration guidance and manuals. This study reviews wetland restoration guidance across Europe (and beyond), assesses the state-of-the-art and potential gaps, and discusses how well it addresses restoration impediments. The reviewed resources performed generally well in providing technical guidance for restoration, regardless of the wetland type addressed.

The manuals also covered various aspects of restoration project planning generally well, but a striking shortcoming was that monitoring and post-restoration evaluation were rarely mentioned. Regarding stakeholder engagement, again many resources hardly addressed this aspect of restoration, but the most recent resources performed better. In the review, general restoration manuals, not specific to any wetland type, were ranked highest across the various aspects of restoration. At the same time, we want to highlight that manuals with a narrower scope serve their purpose well in their context. A key limiting factor for capacity building and cross-border knowledge exchange is language—many of the good restoration manuals were in national languages only. We recommend reserving resources in projects for making restoration guidance better accessible (e.g. English translation) and drawing on multidisciplinary

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expertise for upscaling the socio-ecological approach to restoration.

**Keywords** Capacity building · Knowledge transfer · Monitoring; peatlands · Restoration manuals · Socio-ecological approach

## Introduction

In response to continuing ecosystem degradation, climate change, and biodiversity loss, the UN declared 2021–2030 as the Decade on Ecosystem Restoration. Previous policies and practices have been insufficient to stop the negative trend in ecosystem conditions. It is now widely acknowledged in research and policy that in addition to habitat conservation, ecological restoration is needed to put biodiversity on the path to recovery. In Europe, the EU Biodiversity Strategy for 2030 emphasizes restoration, and the Nature Restoration Law adopted by the European Council in June 2024 is expected to speed up wetland restoration. Thus far, progress on restoration has been slow and insufficient to meet international or national aims (Cortina-Segarra et al. 2021). Therefore, the UN has highlighted capacity building for restoration (FAO 2021). Restoration is especially relevant for wetlands as they are among the most degraded habitats (e.g. Convention on Wetlands 2021c).

Cortina-Segarra et al. (2021) studied European restoration experts' perceptions of barriers to restoration in Europe. The study revealed that the experts hold a multi-dimensional understanding of ecological restoration: it is not perceived narrowly as the recovery of historical reference ecosystems but rather as a comprehensive approach with diverse, highly valued components. Already in the seminal work on "restoration ecology" by Jordan et al. (1988), the focus was not only on aiding nature, but restoration was seen as crucial in mending the problematic relationship between humans and the natural world (also see Higgs 1994; Furness 2021), advocating for a paradigm of caring stewardship. Similarly, Fischer et al. (2021) support a pluralist approach encompassing species composition and ecosystem functions and services. They also emphasize the idea of making ecological restoration a socio-ecological endeavour (see also, e.g., Martin 2017): in addition to ecological criteria, restoration goals should consider the various social impacts of

restoration and the social drivers of degradation. This socio-ecological systems perspective on restoration requires (and supports) collaboration between ecologists, social scientists, and practitioners (Fischer et al. 2021). This foundational approach is shared by the EU Horizon consortium WaterLANDS, which investigates such practices in ecological restoration that meet both biodiversity and social objectives and that would foster upscaling wetland restoration in Europe through its network of 32 partners across 14 countries ([waterlands.eu](http://waterlands.eu)).

In the paper by Cortina-Segarra et al. (2021), a significant number of barriers to the advancement of ecological restoration in Europe were identified. Worth highlighting is that the major barriers identified pertain to the socio-economic, not environmental, domain. The three main barriers to ecological restoration were insufficient funding, conflicting interests among different stakeholders, and low political priority given to restoration. This was also indicated in a European survey on wetland restoration that focused on major barriers to upscaling such initiatives, conducted by WaterLANDS with the Society for Ecological Restoration—Europe (Klimkowska 2023). In the survey, respondents reported shortcomings regarding the availability, usability, and quality of restoration manuals and guidelines. The answers also highlighted the limited scope of the guidance, largely failing to integrate wider policy, governance, social or financial concerns and drivers. There is already several decades of knowledge on how to restore ecosystems physically, but much of this expertise is localized.

In this short communication, we address knowledge exchange concerning best practices in wetland restoration. We report the results of a review of wetland restoration manuals and guidelines across Europe that was carried out within the WaterLANDS consortium in 2023. The rationale behind the review was to capitalize and coalesce existing knowledge regarding wetland restoration and bring relevant experience to inform future wetland restoration. Our aim in this paper is to take stock of the existing wetland restoration guidance, assess the state-of-the-art and potential gaps, discuss to what extent the guidelines respond to the identified barriers in restoration, and contribute to capacity building for restoration. Specifically, we evaluated how well the manuals addressed (1) the technical aspects of wetland restoration, (2)

project planning, implementation, and monitoring, and (3) stakeholder engagement.

## Material and methods

A holistic, socio-ecological approach to ecological restoration calls for multidisciplinary collaboration and combining various expertise and knowledge in a co-creative process. To carry out the review, a multidisciplinary, international team consisting of 12 WaterLANDS experts with diverse knowledge and expertise in wetland restoration and with different disciplinary backgrounds in both natural and social sciences was put together. The experts represented geographically different parts of Europe and were familiar with diverse regional restoration practices. The command of several European languages was crucial, as we did not want to limit the review to English-language manuals alone, and many of the restoration guidelines are written in other European languages.

The review covered only wetland restoration manuals that are openly available online, and thus broadly accessible to restoration practitioners. The participating experts scoped the available guidelines in their region and languages. Initially, 81 restoration guidelines from different European countries were listed. As there were overlaps and some resources seemed dated or limited in scope (e.g., addressing only a particular aspect of restoration, such as financing), and we aimed for a balance in the regions and wetland types covered, we ended up reviewing 39 manuals and reports, including 3 with international (global) scope. Only manuals from the last 20 years were included; the majority of the reviewed guidelines were published in the last decade. While we acknowledge the value of earlier restoration guidance, according to our initial review the more recent guidelines incorporate the insights of earlier robust guidance with more recent understanding, concerns, conceptualizations, and methodologies (e.g., climate change, nature-based solutions, co-creative processes).

The body of reviewed resources contained diverse reports, handbooks, manuals, and guidelines; we use the terms here synonymously. The guidelines were produced by diverse authors and organizations, from international and national conservation and management agencies to EU-funded projects, and civil

society organizations. The reviewed guidelines covered the main geographic regions in Europe (Atlantic, Boreal, Continental, Mediterranean), and were written for all main wetland types (peatlands in general (11), bogs (4), fens (3), coastal wetlands (8), and wetlands in general (11)), with 2 manuals addressing restoration in general. The guidelines were written in the following languages: English (15), Dutch (9), Finnish (6), Polish (4), Swedish (3), Spanish (1), and French (1).

An evaluation sheet covering key aspects of wetland restoration was developed in a collaborative process in autumn 2022, to ensure the review covered all aspects of best practices in wetland restoration and to ensure consistency in the review process between experts (see Supplementary material). In addition to general questions (4) regarding the scope of the manual (region, wetland type, and use of evidence-based knowledge), the evaluation sheet comprised multiple questions on 1) technical aspects of wetland restoration (7 questions), 2) project planning and implementation (8 questions), and 3) stakeholder engagement (6 questions). The reviewers' assessment was measured on a scale from 3 (component addressed completely, with widely applicable guidance), 2 (complete, but local in scope or relevant for a specific wetland type only), 1 (at least mentioned), to 0 (component not addressed at all). Mean average scores for the technical, planning and implementation, and stakeholder engagement sections were calculated for each resource.

The review questions related to 1) technical aspects of wetland restoration focused primarily on hydrological restoration, as drainage for agriculture and forestry is a significant driver of wetland degradation. Drainage changes the hydrological and biochemical processes of wetlands, which affect the restoration potential and methods required. Thus, we assessed how well the resources explained the connection of wetland processes with the wider landscape, the main principles for interventions, the restoration techniques used, and any risks or pitfalls associated with them. The 2) project planning and implementation questions aimed to understand how well the resources addressed aspects of the project cycle, from formulating restoration goals and developing criteria for success to adaptive management of the project, considering ecosystem services and the economic potential of wetland use. The 3) stakeholder engagement section

of the review focused on understanding whether wetland restoration manuals provide guidance on stakeholder mapping, participatory processes, interacting with different actors, and facilitating stakeholder support. We also wanted to know whether elements of co-creation (see e.g. Langemeyer and Baró, 2021) could be identified in the resources, which would suggest a high level of engagement with communities, inhabitants, and local land users, beyond one-directional informing the local stakeholders about the project. Finally, we asked whether issues of governance and legal constraints related to restoration projects were addressed.

Furthermore, we reviewed whether guidance was provided concerning follow-up management and post-intervention monitoring of success using hydrological, biological, and social measures and indicators. The reviewers were asked via Yes/No questions whether specific, listed data components concerning 4) the planning and 5) monitoring and evaluation of wetland restoration were addressed in each resource. Regarding the planning phase, we reviewed whether specific methods and data concerning the topography and hydrology of a site were included and whether the choice of a reference ecosystem was specified in the manual (10 questions). Furthermore, the evaluation sheet listed 30 specific indicators to be considered in monitoring, regarding the hydrology, soil and water properties, vegetation and fauna, microbes, and ongoing ecological processes such as greenhouse gas emissions (see Supplementary material). A sum of the addressed indicators was calculated for each resource, providing an overall idea of the “completeness” of the resource (i.e. its ability to present a holistic, socio-ecological approach for forwarding restoration), and the sum was scaled to the 0–3 scale. Finally, the evaluation sheet contained two open-ended questions regarding the resource’s overall completeness and strengths and weaknesses. The free-text answers were analysed in parallel to the scores to form a well-rounded understanding of the manual’s overall completeness and strengths.

The manuals were divided between the WATERLANDS experts according to region and language, and experts were given a few months to carry out the review. The results were collected, analysed, and discussed in spring 2023. The resources were ranked, considering the top-ranking resources to be most broadly useful in wetland restoration overall. The

scores were cross-referenced and validated through a second internal round of review. The review results should be treated as indicative only: the objective of the scoring was not to discard certain reviewed guidelines in favour of the high-scoring ones. The study explored what is currently available, where gaps exist in relevant information, and where useful input (regarding different sets of questions) can be found. The review was comprehensive enough to create an overall understanding of the state-of-the-art, identify components of well-rounded restoration guidelines, and suggest some points for development.

## Results and Discussion

The results of the review are presented in Table 1, listing the 39 resources reviewed in detail and providing links to the original material, available online. The manuals are listed in the order of highest overall score. In addition to the title, author(s), publication year, language, and the type of wetland targeted, the table provides the overall score of the review for each manual, as well as the scores on 1) technical aspects of wetland restoration, 2) project planning and implementation, and 3) stakeholder engagement. The last two columns report the scores of the more detailed restoration planning methods and data discussed, and the scores on different monitoring aspects to be considered. Below, we discuss the strengths, weaknesses, and emerging themes in the reviewed guidelines.

### Strengths

Many of the recent restoration guidelines provide a broad framework that lays out the different stages of a restoration project, with an emphasis on planning. The reviewed restoration guidelines generally described the targeted wetlands well, indicated their characteristics, and performed well in highlighting the importance of formulating restoration goals. The regional differences of wetlands were well identified and many of the guidelines are therefore quite generic and useful in various contexts, even though many manuals focused on specific types of wetlands. Most of the reviewed resources provided case examples of restored wetlands, illustrated with pictures and descriptions of the applied interventions, which help apply the methods and guidance in practice. The

**Table 1** Scoring of the reviewed restoration guidelines and manuals, on a scale of 0–3. A higher score indicates the restoration aspect was well included in the guideline

	Title (with link)	Author	Year	Language	Wetland type	Overall score	Tech.	Plann.	Engagement	Plann. knowl.	Monit.
1	Podręcznik dobrych praktyk renaturation wód powierzchniowych	Pawlaczyk (ed.)	2020	Polish	Wetlands	2,9	2,9	2,9	3	1,5	0,8
2	Vesistö- ja valuma-aluekunnostukset Natura 2000 -alueilla: suunnittelun toimitamalli	Härkönen et al	2022	Finnish	Wetlands	2,8	2,9	2,8	2,7	2,7	2
3	Global peatland restoration manual	Schumann & Joosten	2008	English	Peatlands	2,7	2,9	2,8	2,5	1,8	0,9
4	Saltmarsh restoration handbook UK & Ireland	Hudson et al	2021	English	Coastal	2,5	2,5	2,3	2,7	1,5	1,2
5	Fysisk restaurering av akvatiska miljöer	Degerman & Näslund	2021	Swedish	Wetlands	2,3	2,6	1,9	2,3	0,6	0,2
6	Ojittuitten soiden emallistamisopas	Aapala et al. (eds.)	2013	Finnish	Peatlands	2,2	2,9	2,3	1,5	2,4	2
7	Best practice book for peatland restoration and climate change mitigation. Experiences from LIFE Peat restore project	Pakalne et al	2021	English	Peatlands	2,1	2,7	2,5	1	2,1	1,8
8	Natuurherstel in de Westerschelde: De mogelijkheden nader verkend	Nolte et al	2011	Dutch	Coastal	2,1	2,7	1,8	1,7	0	0
9	Handboek voor beheerders: Europese natuurdoelstellingen op het terrein: deel I: habitats	van Uytvanek & de Blust(ed.)	2012	Dutch	Wetlands	2,1	3	2,5	0,7	0,3	0
10	Best practice in raised bog restoration in Ireland	Mackin et al	2017	English	Bogs	2,0	2,7	1,8	1,5	2,1	0,7
11	Kosteikko-opas	Alhainen et al	2015	Finnish	Wetlands	2,0	2,4	1,4	2,2	1,5	0,3
12	Onderzoek ten behoeve van het herstel en beheer van Nederlandse laagveenwateren	Lamers et al	2006	Dutch	Peatlands	1,9	2,9	2,6	0,3	1,2	1,6
13	Restoration of mire habitats: experiences from the project 'Conservation and restoration of mire habitats'	Salm et al	2021	English	Mires	1,9	1,9	1,8	2	1,5	0,7
14	Best practices in the restoration and management of wetlands at six Life sites in Finland – Results of the Life CO-OP Project	Mikkola-Roos & Niikkonen (eds.)	2005	Finnish	Peatlands	1,9	2,3	1,7	1,7	0,3	0,2
15	Podręcznik najlepszych praktyk ochrony mokradel	Maktes et al	2014	Polish	Wetlands	1,9	2,6	1,8	1,2	0	0
16	A guidebook on good practices of alkaline fen conservation	Staňko et al. (eds.)	2022	Polish	Fens	1,8	2,4	1,3	1,7	1,8	0,2
17	Ecological restoration in drained peatlands—best practices from Finland	Similä et al. (eds.)	2014	English	Peatlands	1,7	2,6	2	0,5	1,5	1,7

Table 1 (continued)

	Title (with link)	Author	Year	Language	Wetland type	Overall score	Tech.	Plann.	Engagement	Plann. knowl.	Monit.
18	Guidelines for the environmental management of the Mediterranean and Black sea saltworks (management model)	Costa et al	2016	English	Coastal	1,7	2,3	2	0,8	0	0
19	Verjonging van half-natuurlijkewkelders en schorren	Wesenbeek et al	2014	Dutch	Coastal	1,7	2,6	1,4	1	0	0
20	Conserving bogs: the management handbook	Thom et al	2019	English	Bogs	1,6	2,7	2	0,2	2,1	1,8
21	Restoring Mediterranean wetlands	Wetland-Based Solutions	2020	English	Coastal	1,6	1,1	2,4	1,3	0	0
22	Global guidelines for peatland rewetting and restoration. Ramsar Technical Report 11	Convention on Wetlands	2021	English	Peatlands	1,5	2,3	1,9	0,3	1,8	0,6
23	The road to restoration: a guide to identifying priorities and indicators for monitoring forest and landscape restoration	Buckingham et al	2019	English	General	1,5	0,3	2,1	2	0	0
24	Nature-based solutions for disaster risk reduction	Waddington (ed.)	2021	English	Wetlands	1,4	1,3	1,4	1,5	0	0
25	Opas soiden ennalistamiseen käsityöniä	Aalto & Aalto	2018	Finnish	Peatlands	1,4	1,4	1,4	1,3	1,2	0,1
26	Åtgärdsprogram för bevarande av rikkärr	Sundberg	2006	Swedish	Fens	1,3	2	0,8	1,2	0,6	0,2
27	Manual de restauración de humedales mediterráneos	Montes del Olmo et al	2007	Spanish	Coastal	1,3	2	1,4	0,5	0	0
28	Verkenning van duurzame beheerstrategieën voor de natte duinvalleien op Terschelling	VBNE	2021	Dutch	Coastal	1,3	2,3	1,6	0	2,4	0
29	Instructions for monitoring restored forests and mires	Päivinen & Aapala (eds.)	2007	Finnish	Peatlands	1,3	2,1	1,4	0,3	0,9	1
30	Perspectieven voor hoogveenherstel in Nederland. Samenvatting onder zoek en handleiding hoogveenherstel 1998-2010	van Duinen et al	2011	Dutch	Bogs	1,2	2,4	1,3	0	1,2	0
31	Wetlands buffer zones: the solutions we need!	Kotowski et al	2020	English/Polish	Wetlands	1,2	2	1,3	0,3	0	0
32	Handboek voor beheerders Europese natuurdoelstellingen op het terrein	van Uytvanek & Goethals	2014	Dutch	Wetlands	1,2	2,6	1	0	0	0
33	Guide technique d'aménagement et de gestion des zones humides du Finistère	Thulliez & Maguer	2018	French	Peatlands	1,1	2,4	0,6	0,3	0	0

**Table 1** (continued)

	Title (with link)	Author	Year	Language	Wetland type	Overall score	Tech.	Plann.	Engagement	Plann. knowl.	Monit.
34	<a href="#">Strefy buforowej biotechnologie ekohydrologiczne</a>	Izydorczyk et al	2015	Polish	Wetlands	1,0	2,1	0,8	0,2	0	0
35	<a href="#">Praktisk handbook för vårmarksbyggare</a>	Feuerbach	2014	Swedish	Wetlands	1,0	1,7	0,6	0,8	0,9	0,2
36	<a href="#">De nutriëntenkringloop tijdens herstel van basenrijke, vochtige bossen</a>	Brouwer et al	2022	Dutch	Fens	0,9	2,3	0,5	0	1,2	0
37	<a href="#">Peatland restoration. Report to IUCN UK Peatland Programme</a>	Lunt et al	2010	English	Bogs	0,9	1,3	1,3	0	0,3	0,3
38	<a href="#">Effectiviteit van herstelbeheer in vennen en duinplassen op de middellange termijn</a>	Brouwer et al	2009	Dutch	Coastal	0,7	1,4	0,6	0	0	0
39	<a href="#">MoorFutures: Integration of additional ecosystem services (including biodiversity) into carbon credits</a>	Joosten et al	2016	English	General	0,6	0,1	0,8	0,8	0,9	1,3

manuals also list restoration pitfalls (e.g. Convention on Wetlands 2021) or lessons learned (Montes del Olmo et al. 2007). Most manuals refer to at least some research articles or reports and can be considered research-based.

The reviewed resources scored generally high in providing technical guidance for restoration (overall mean = 2.2; median 3), regardless of the wetland type addressed. This is perhaps unsurprising, as the technical aspects of wetland restoration have long been established (for instance see Kusler & Kentula 1989) and further developed over many decades. The more generic resources (not specific to any wetland type) showcased a comprehensive understanding of catchment thinking and scored better in covering the planning, implementation, and stakeholder engagement aspects of restoration. Generally, the most recent manuals scored highest in our review, except for the Manual de restauración de humedales mediterráneos by Montes del Olmo et al. (2007), which is already 18 years old. That manual focuses especially on the restoration of Mediterranean wetlands, but it establishes concepts related to wetland ecology and restoration and discusses in detail the design of a restoration project as well as applicable techniques.

The planning phase of a restoration project typically includes various measurements and assessments, such as hydromorphological analysis, water quality measurements, and studying the flora and fauna of the site. For the planning and implementation aspects of restoration, the reviewed resources were generally awarded moderate scores (mean = 1.6), but there were some manuals especially strong in guiding planning. An authoritative report is the Global guidelines for peatland rewetting and restoration, issued by the Ramsar Convention on Wetlands (2021a), with a global scope. The more general restoration guidelines provide a similar 4- or 5-step framework for restoration, including at least the following phases: 1) problem identification and site assessment, 2) planning, 3) goal setting, 4) physical restoration measures, and 5) evaluation and monitoring.

Wetland restoration projects always have to be adapted to the local conditions. For this reason, different restoration guidelines with varying scopes have merit, and good manuals pay sufficient attention to the importance of context. The more general manuals can be used for inspiration in compiling geographically or ecologically more specific guidelines and as

checklists of the aspects to be taken into account in restoration projects, whereas the more focused manuals serve their purpose well in their intended context. As an example of a reviewed manual with a narrower scope, the Finnish Association for Nature Conservation has produced a small 15-page leaflet on restoring peatlands manually (Aalto & Aalto 2018). The leaflet guides volunteer conservationists in carrying out small-scale restoration projects, thus making restoration potentially accessible to the broader publics.

As an example of restoration guidance with a broad scope, the global guidelines for peatland rewetting and restoration by the Ramsar Convention on Wetlands (2021a) provide a comprehensive approach to wetland, especially peatland, restoration, in a concise format on 51 pages. The report is complemented by several annexes expanding on e.g. public engagement, and briefing notes providing more detailed guidance. For instance, the Ramsar briefing note 11 “Practical peatland restoration” (Convention on Wetlands 2021b) provides detailed guidance on various peatland restoration techniques and additionally lists further useful guidelines, including several of the ones reviewed here. The Ramsar approach (see Alexander & McInnes 2012, Annex 1) is to offer a multi-layered knowledge and guidance infrastructure, starting from compact general guidelines and going deeper into specific information according to user needs. Both general guidelines for project planning and specific technical guidance for various wetland types are already well-established, thus a contextually compiled synthesis of existing guidance saves resources.

### Weaknesses

In our review, the generic, all-encompassing restoration manuals ranked highest. However, such manuals with a reader-friendly layout and images may easily become hundreds of pages in length; for instance, the Swedish manual by Degerman and Näslund (2021) is 381 pages, and the Polish manual by Pawlaczyk et al. (2020) is 364 pages long. As such, the extensive manuals may lose some of their appeal, and the layered knowledge infrastructure of the Ramsar approach discussed above could be more useful in future guidance.

One key hindrance to broader usability of existing restoration guidance is language. This was not assessed in the review questionnaire but is a more

generic appraisal we arrived at. Many of the reviewed manuals were written in local European languages, without providing even an English summary for broader accessibility. The diversity of restoration guidance should be reflected in the diversity of languages in which they are written. Guidance available in various local languages facilitates public engagement in restoration and makes guidance accessible to various stakeholders. Thus, projects producing restoration guidance should reserve resources for translating guidelines into local languages, and, vice versa, projects funded for instance by the EU LIFE program should reserve resources for translating guidance into English, at least, or even all official EU languages, to facilitate knowledge transfer and enable capacity building for socio-ecological restoration.

For stakeholder engagement in wetland restoration, the review scores were variable, with many resources hardly addressing this aspect of restoration. Public participation has been perceived as an essential part of good European governance since the beginning of the century and the importance of a socio-ecological approach is increasingly understood (e.g. Martin 2017). The most recent, generic restoration manuals all included some consideration of public participation, but broader potential socio-ecological impacts of restoration were rarely discussed. Thus, despite the increasing understanding and guidance on the importance of public involvement in the last decades, the adoption of a socio-ecological approach to restoration seems still rather limited. While the ecological benefits of restoration are rightfully prioritized, the potential socio-ecological benefits (e.g. economic, health, and well-being; see e.g. Scholte et al. 2016) of restoration remain at best vague if addressed at all in the manuals.

What was striking in our review was the overall lack of guidance on monitoring the restored wetlands (see Kentula 2000 for different success criteria). The manuals generally covered other aspects of project planning well, but monitoring and post-restoration evaluation were rarely mentioned (mean = 1.7). An exception was the joint report by FAO and WRI (2019), authored by Buckingham et al., that focuses especially on identifying priorities and indicators for monitoring forest and landscape restoration; the guide does not, however, provide indicators specifically for monitoring the restoration of different types of wetlands. The number of monitoring indicators covered

in the reviewed resources varied from 0 to 20 (out of 30), with the most recent manuals performing best. Scaled to the 0–3 scale, the manuals scored between 0 and 2, with a mean of only 0.8. There is a growing demand for monitoring for continuous improvement and adaptive management, both from the public and from the EU (e.g. EASAC 2024), and this should become the state of the art in restoration literature. Currently, much of the restoration is carried out on intermittent project-based funding (e.g. Canning et al. 2021), which could incorporate longer-term engagement with a restored site and should allow for monitoring and adaptive management.

### Emerging themes

While a more comprehensive socio-ecological approach to wetland restoration is present only in a few top-ranking guidelines in our review, in the most recent guidelines public participation is generally included. Public participation per se is not an emerging theme, as it was introduced already e.g. in the Ramsar Convention Resolution over 20 years ago; rather, the issue is the absence of comprehensive guidance on how to integrate public engagement within wetland restoration planning and implementation. Among the reviewed resources, stakeholder involvement and public participation aspects of restoration were covered extensively in the Finnish framework for planning restoration by Härkönen et al. (2022), discussing different means of contacting stakeholders and methods for organizing public participation, as well as in the Polish handbook of good practices in surface water restoration by Pawlaczyk (2020). There are, however, differing views as to what public engagement encompasses, what are its aims, and who are the desired participants. The issue of public engagement is also closely tied to questions of expertise and goal setting in restoration projects. Public engagement is thus a strongly emerging theme in the restoration guidelines, but at the same time in need of clarification and further development.

Recent studies report strong public support for wetland restoration (e.g., Giergiczyński et al. 2022). Many of the reviewed guidelines mention public acceptance as the main motivation for involving the public and local stakeholders. Participation is seen as a means for knowledge transfer and it is emphasized that participation should take place in all stages

of restoration, from planning and setting goals to the actual restoration work and monitoring. Through public participation, stakeholders have the opportunity to be actively involved in governance processes, influencing major and minor decisions. Successful implementation of a restoration project often depends on public support and stakeholder acceptance, especially when concerns about restoration are likely (Convention on Wetlands 2021a, 28; Phalen 2009). It is acknowledged that public support is not achieved only by providing factual information on restoration: the annex to Ramsar guidelines (Convention on Wetlands 2021a), for one, very pragmatically encourages to “create a community atmosphere” by, for instance, offering refreshments, tea, and biscuits in participatory events.

While in the technically-oriented restoration guidance the overall goal of wetland restoration is to restore natural hydrological conditions, the manuals emphasize the importance of mindful goal setting. The site assessment should include consideration of whether the site is “worth” restoring—could it become naturally restored without intensive intervention, or is it so degraded that the restoration effort may be better spent somewhere else? The most recent manuals reflect the emphasis on climate change mitigation and carbon capture in environmental policies and remind that restoration goals may sometimes be contradictory and even conflicting. For public support, it is necessary to carefully consider and communicate in each context, whether the primary aims of restoration are enhancing biodiversity, maximizing carbon capture, or, for instance, facilitating some type of paludiculture, to avoid misguided expectations and disappointments. Many of the reviewed, generic restoration manuals emphasize the need for a theoretical understanding of the functioning of wetlands and, subsequently, suitable measures. Thus, restoration guidance must balance between broad public engagement and expert-driven methodology. The potential conflict is made explicit in the Swedish wetland restoration guidelines by Degerman and Näslund (2021, 9), as they make a distinction “between evidence-based methods and such that are only considered ‘best practice’, i.e. are generally not scientifically evaluated”. While we agree with the necessity to use evidence-based methods, we wish to point out that the best available restoration knowledge is not necessarily tied to professional degrees or institutional

status. Local restoration practitioners may have the best available knowledge on local conditions, stakeholders to be included, even funding opportunities, and regulations that apply. Long-term volunteer conservationists, practitioners, landowners or other locally embedded stakeholders often develop an in-depth understanding of the social-ecological dynamics of a particular site, and may possess valuable practical knowledge that builds into broader systemic understanding resembling theoretical knowledge even before it is evaluated by scientific research.

While a sound scientific basis is vital, emphasizing solely technoscientific expertise in wetland restoration has been problematized by social scientists (e.g., Ruuskanen 2016), as it may exclude many people’s experiences and values related to wetlands and may obscure restoration aims for the lay public. One of the main challenges associated with socio-ecological governance is rooted in the disconnection between those who culturally value ecosystems and those who have authority in an environmental governance domain (Hirons et al. 2016). The most recent restoration manuals reviewed mention stakeholder mapping as a step in public involvement, but often the mentioned stakeholder groups are the “usual suspects” such as landowners, fishermen, local entrepreneurs, conservationists, and local authorities. For instance, Härkönen et al. (2022) encourage to consider also people indirectly affected by restoration, and the Ramsar guidelines (Convention on Wetlands 2021a) remind us to pay attention to cultural awareness, anti-racism, and equal opportunity. The Road to Restoration manual by FAO and WRI (2019) explicitly brings forth the viewpoints of gender, age, and ethnic background, drawing on case examples from Malawi, Ethiopia, Kenya, and El Salvador. Also in the European context paying attention to the engagement opportunities of especially women, young people, and different ethnic groups could offer new opportunities for restoration, new communication channels, and invested participants.

For upscaling the restoration efforts to achieve the targets set for instance in the Paris Agreement on climate change (2015), the EU Biodiversity Strategy (2020), the Target 2 of the Kunming-Montreal Global Biodiversity Framework (CBD 2022), and the EU Nature Restoration Law (European Union 2024), ecosystems have to be restored over large areas and all types of wetlands must be considered. Upscaling may be interpreted as both increasing the size of restoration

projects in terms of wetland area, as well as increasing the number of restoration efforts on diverse scales. Also locally led restoration initiatives are needed, as national conservation authorities alone do not have the necessary resources. Small-scale restoration projects may be run by conservation associations or landowners and carried out on a voluntary basis, which creates opportunities for public engagement and emphasizes the need for pragmatic, small-scale guidance such as the Finnish example (Aalto & Aalto 2018). Also conscious municipalities are undertaking bottom-up initiatives in restoration, e.g., by implementing their climate change adaptation strategies. For strengthening the socio-ecological approach to restoration, multidisciplinary expertise and collaboration is necessary. Beyond public acceptance, public engagement is increasingly seen as essential for the overall success of upscaling wetland restoration (Perring et al. 2018). Restoration guidance can facilitate local agency and initiatives, provide novel ideas for building social support and engagement around restoration projects, develop stable funding, and showcase different means of balancing stakeholder interests. Providing means to engage new publics will facilitate making wetland restoration a socio-ecological endeavor and help to scale up restoration efforts.

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**Declarations**

**Conflict of interest** The authors have no relevant financial or non-financial interests to disclose.

**Data availability** A list of the dataset analysed during the current study is available on the WaterLANDS consortium website (<https://cdn.sanity.io/files/34jdpbeg/production/b527f5f7206d15b5483efb6a527639b07d77bd07.pdf>), as an appendix to Deliverable 5.2. The resources analysed are freely available online.

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## References

- Aalto M, Aalto A (2018) Opas soiden ennalistamiseen käsityönä. Suomen luonnonsuojeluliitto. <https://www.sll.fi/app/uploads/2018/10/Opas-soiden-ennallistamiseen-kasityona.pdf>. Accessed 11 March 2024
- Alexander S, McInnes R (2012) The benefits of wetland restoration. Ramsar Scientific and Technical Briefing Note no. 4. Gland, Switzerland: Ramsar Convention Secretariat.
- Canning A, Jarvis D, Costanza R, Hasan S, Smart J, Finisdore J, Lovelock E, Greenhalgh S, Marr H, Beck M, Gillies C, Waltham N (2021) Financial incentives for large-scale wetland restoration: beyond markets to common asset trusts. *One Earth* 4(7):937–950. <https://doi.org/10.1016/j.oneear.2021.06.006>
- CBD (2022) Decision adopted by the Conference of the Parties to the convention on biological diversity 15/4. Kunming-Montreal Global Biodiversity Framework. <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf>. Accessed 31 October 2024
- Convention on Wetlands (2021a) Global guidelines for peatland rewetting and restoration. Ramsar Technical Report No. 11. Gland, Switzerland, Secretariat of the Convention on Wetlands. Authors: H. Joosten & and Duene e.V. [https://www.ramsar.org/sites/default/files/documents/library/rtr11\\_peatland\\_rewetting\\_restoration\\_e.pdf](https://www.ramsar.org/sites/default/files/documents/library/rtr11_peatland_rewetting_restoration_e.pdf) Accessed 11 March 2024
- Convention on Wetlands (2021b) Practical peatland restoration. Briefing Note No. 11. Gland, Switzerland: Secretariat of the Convention on Wetlands. [https://www.ramsar.org/sites/default/files/documents/library/bn11\\_practical\\_peatland\\_restoration\\_e.pdf](https://www.ramsar.org/sites/default/files/documents/library/bn11_practical_peatland_restoration_e.pdf) Accessed 26 July 2024

- Convention on Wetlands (2021c) Global Wetland Outlook: Special Edition 2021. Gland, Switzerland: Secretariat of the Convention on Wetlands.
- Cortina-Segarra J, García-Sánchez I, Grace M, Andrés P, Baker S, Bullock C, Declerck K, Dicks LV, Fisher JL, Frouz J, Klimkowska A, Kyriazopoulos AP, Moreno-Mateos D, Rodríguez-González PM, Sarkki S, Ventocilla JL (2021) Barriers to ecological restoration in Europe: expert perspectives. *Restor Ecol* 29:e13346. <https://doi.org/10.1111/rec.13346>
- Degerman E, Näslund I (2021) Fysisk restaurering av akvatiska miljöer. Vattendrag och sjöar med kantzon och våtmarker. GRIP on LIFE:s rapportserie 2021.03. Havs- och vattenmyndigheten, Sweden.
- EASAC (2024) Monitoring Nature Restoration. European Academies Science Advisory Council. <https://easac.eu/news/details/monitoring-nature-restoration>. 11. July 2024
- European Union (2020) Biodiversity Strategy for 2030. [https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030\\_en](https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en). Accessed 11 March 2024
- European Union (2024) Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869. <http://data.europa.eu/eli/reg/2024/1991/oj>. Accessed 5 August 2024
- FAO and WRI (2019) The Road to Restoration: A Guide to Identifying Priorities and Indicators for Monitoring Forest and Landscape Restoration. Rome, Washington, DC. <https://files.wri.org/d8/s3fs-public/road-to-restoration.pdf>. Accessed 26 July 2024
- FAO (2021) Global capacity needs assessment: key gaps and capacity priorities for restoration to support the United Nations Decade on Ecosystem Restoration 2021–2030. Food and Agriculture Organization of the United Nations. <https://www.decadeonrestoration.org/publications/global-capacity-needs-assessment>. Accessed 11 March 2024
- Fischer J, Riechers M, Loos J, Martin-Lopez B, Temperton VM (2021) Making the UN decade on ecosystem restoration a social-ecological endeavour. *Trends Ecol Evol* 36(1):20–28. <https://doi.org/10.1016/j.tree.2020.08.018>
- Furness E (2021) How participation in ecological restoration can foster a connection to nature. *Restor Ecol* 29:e13430. <https://doi.org/10.1111/rec.13430>
- Giergiczny M, Valasiuk S, Kotowski W, Galera H, Jacobsen JB, Sagebiel J, Wichtmann W, Jabłońska E (2022) Re-meander, rewet, rewild! Overwhelming public support for restoration of small rivers in the three Baltic Sea basin countries. *Restor Ecol* 30:e13575. <https://doi.org/10.1111/rec.13575>
- Härkönen LH, Ilmonen J, Tolonen KT, Vuorio K, Ahola M, Vaso A, Käki T, Lehtovaara V, Haapalehto S, Koljonen S, Hautamäki J, Olli P, Leinonen K, Tiusanen M, Leinonen A, Myllykangas N, Hellsten S (2022) Vesistö- ja valuma-aluekunnostukset Natura 2000 -alueilla: suunnittelun toimintamalli. [Restoration and water protection of aquatic ecosystems at Natura 2000 sites: framework for planning.] Suomen ympäristökeskuksen raportteja 37. <http://urn.fi/URN:ISBN:978-952-11-5514-7>. Accessed 11 March 2024
- Higgs E (1994) Expanding the scope of restoration ecology. *Restor Ecol* 2:137–146. <https://doi.org/10.1111/j.1526-100X.1994.tb00060.x>
- Hirons M, Combetti C, Dunford R (2016) Valuing cultural ecosystem services. *Annu Rev Environ Resour* 41:545–574
- Jordan WR, Peters RL, Allen EB (1988) Ecological restoration as a strategy for conserving biological diversity. *Environ Manage* 12:55–72
- Kentula ME (2000) Perspectives on setting success criteria for wetland restoration. *Ecol Eng* 15(3–4):199–209. [https://doi.org/10.1016/S0925-8574\(00\)00076-8](https://doi.org/10.1016/S0925-8574(00)00076-8)
- Klimkowska A (2023) 5.2.3 European Survey of Practitioners. In: D5.2: Upscaling wetland restoration: barriers and elements of best practice. WaterLANDS. <https://waterlands.eu/results-and-resources/deliverable-5-2-upscaling-wetland-restoration-barriers-and-best-practice/>. Accessed 11 March 2024
- Kusler JA & Kentula ME (1989, eds.) Wetlands creation and restoration: The status of science. United States Environmental Protection Agency, Report No. 600/3–89/038a.
- Langemeyer J, Baró F (2021) Nature-based solutions as nodes of green-blue infrastructure networks: a cross-scale, co-creation approach. *Nature-Based Solutions* 1:100006. <https://doi.org/10.1016/j.nbsj.2021.100006>
- Martin DM (2017) Ecological restoration should be redefined for the twenty-first century. *Restor Ecol* 25:668–673. <https://doi.org/10.1111/rec.12554>
- Montes del Olmo C, Rendón-Martos M, Varela L, Cappa MJ (2007) Manual de restauración de humedales mediterráneos. Consejería de Medio Ambiente. Sevilla. [https://www.juntadeandalucia.es/medioambiente/portal/documentos/20151/0/manual\\_humedales\\_medi\\_2007.pdf/7e18d302-9f75-fc63-6320-24395511d96?t=1602148201185](https://www.juntadeandalucia.es/medioambiente/portal/documentos/20151/0/manual_humedales_medi_2007.pdf/7e18d302-9f75-fc63-6320-24395511d96?t=1602148201185). Accessed 11 March 2024
- Pawlaczyk P (2020, ed.) Podręcznik dobrych praktyk renaturyzacji wód powierzchniowych. Oprac. w ramach przedsięwzięcia „Opracowanie krajowego programu renaturyzacji wód powierzchniowych”. Państwowe Gospodarstwo Wodne Wody Polskie, Krajowy Zarząd Gospodarki Wodnej, Warszawa. [https://www.wody.gov.pl/images/Aktualnosci/foto/renaturyzacjaKPRWP/Podrecznik\\_renaturyzacji.pdf](https://www.wody.gov.pl/images/Aktualnosci/foto/renaturyzacjaKPRWP/Podrecznik_renaturyzacji.pdf). Accessed 13 March 2024
- Perring MP, Erickson TE, Brancalion PHS (2018) Rocketing restoration: enabling the upscaling of ecological restoration in the Anthropocene. *Restor Ecol* 26:1017–1023. <https://doi.org/10.1111/rec.12871>
- Phalen KB (2009) An invitation for public participation in ecological restoration: the reasonable person model. *Ecol Restor* 178:43441267
- Ruuskanen E (2016) Valuing Wetlands and Peatlands: Mires in the Natural Resource and Land Use Policies in the Nordic Countries From the Late Eighteenth Century to the Present Day. In: G. M. Winder & A. Dix (eds) Trading Environments. Frontiers, Commercial Knowledge, and Environmental Transformation, 1970–1990. Routledge, New York, pp 118–137
- Scholte SSK, Todorova M, van Teeffelen AJA et al (2016) Public support for wetland restoration: what is the link with ecosystem service values? *Wetlands* 36:467–481. <https://doi.org/10.1007/s13157-016-0755-6>

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