Biodiversity impact assessment (IA) in Modified Habitats: lessons learnt from artificial wetlands

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ABSTRACT

Europe hosts a stunning diversity of wild animals, plants and habitats protected under Habitat Directive 92/43 EEC and Birds Directive 409/2009 EC, including species of conservation concern frequently associated with strongly anthropic sites, identified as “modified habitats” according to IFC PS6. In the present case study, for public health reasons it was necessary to carry out sediment remediation of a series of wastewater basins located in an industrial area, that over time had become a breeding habitat for several bird species, potentially triggering critical habitat thresholds; planned activities were potentially going to lead to the loss of these important modified habitats. The following tasks were conducted to meet the goals outlined in European directives and IFC PS6: (i) habitat mapping through remote sensing to identify main vegetation/land-use types and classify natural/modified habitats (ii) desktop data collection (iii) rapid field survey focused on bird species, to identify the most relevant breeding areas (iv) development of mitigation measures, in line with the Mitigation Hierarchy framework. This paper aims to explore a set of lesson-learnt arisen from the case study: (1) bird species are indicators that support the identification of critical modified habitats (2) desktop analysis (including GIS tools) needs to be supported by field surveys to spot significant modified habitat; (3) mitigation and offset measures should take into account the ‘human’ use of modified areas, therefore it’s essential to build a good relationship with stakeholders.

1 INTRODUCTION

Biodiversity Impact Assessment (IA) in modified habitats has become increasingly relevant as development projects expand into anthropogenic environments. International guidelines regulatory frameworks, such as the International Finance Corporation’s Performance Standard 6 (IFC PS6), the European Bank for Reconstruction and Development Performance Requirement 6 (EBRD PR6), and the European Union’s Habitats Directive (92/43/EC) and Birds Directive (2009/147/EC), recognize that even heavily modified habitats can host significant biodiversity values.

According to IFC PS6, modified habitats are defined as areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area’s primary ecological functions and species composition [6].

Among the most important Modified Habitats for biodiversity are artificial wetlands. Artificial wetlands, such as salines, wastewater treatment areas, and aquaculture ponds, became a crucial habitat since many natural wetlands have been drained; more than half of the planet's natural wetlands have been lost since the 18th century [2]. The relative importance of these areas for wildlife, regardless of their primary purpose, has increased as a result of the loss of natural wetlands, and they are now a significant habitat for biodiversity, especially waterbirds, with an unanticipated role in conservation [9].

Despite their potential importance, conducting Biodiversity IA in modified habitats can present distinct challenges. First, baseline ecological data on modified sites are often scarce; many modified habitats lack comprehensive ecological assessments, making it challenging to evaluate their biodiversity significance and inform conservation strategies and management plans. Second, modified ecosystems can be misclassified or undervalued in desktop studies; for example, an artificial wetland might not be recognized as a priority habitat without field evidence of species usage. Finally, stakeholders might have a say in which management measures can be applied, and their engagement is crucial in determining feasible mitigation or offset measures.

This paper presents a case study of a Biodiversity Impact Assessment (IA) conducted at an industrial complex (i.e., the Project); hosting artificial wetlands that needed to be drained for sediment remediation due to environmental concerns. A biodiversity assessment was required as the bibliographic & desktop analysis highlighted that the artificial wetlands are an important habitat for several bird species. The assessment was carried out to meet international standards (IFC PS6, EBRD PR6, EU Directives) and provides an opportunity to derive broader lessons. (1) the value of birds as indicators of important biodiversity values even in artificial habitats; (2) the need to complement GIS analysis with field surveys; and (3) the influence of human use and stakeholder engagement on designing mitigation and offset measures.

2 METHODOLOGY

2.1 DESKTOP DATA COLLECTION AND GIS ANALYSIS

A desktop study gathered existing information on biodiversity and land use in the study area and in the wider area (50 km) to characterize the habitats and species potentially present around the artificial wetlands. Data sources, among others, included GIS data purchased from the Integrated Biodiversity Assessment Tool (IBAT), Birdlife International, Ramsar sites, Key Biodiversity Areas, and Convention on Biological Diversity National Report(s), as well as scientific papers and reports available online.

2.2 REMOTE SENSING FOR HABITAT MAPPING

Remote sensing techniques, aided by low altitude picture taken via drone on site, were employed to map and classify habitats across the surrounding Project Area to i) identify possible wetlands in the wider area which could be restored / enhanced as bird habitat and ii) characterize the wider area. The most recent high-resolution satellite imagery (e.g., Sentinel-2 Imagery, normalized difference vegetation index (NDVI) imagery) was analyzed to delineate land cover/land use types, with a focus on identifying water bodies, vegetation, and other habitat features associated with the artificial wetlands. Information on vegetation and habitats was supplemented by a detailed bibliographic research of the area. The habitat mapping followed international classification standards to differentiate natural (e.g. remnant native vegetation) and modified habitats (e.g. artificial water bodies, drained lands) in the landscape.

2.3 STAKEHOLDERS INTERVIEWS

To gather specific information regarding local biodiversity around the Project area, interviews were conducted with environmental NGOs, public authorities, local inhabitants, and Project representatives to verify the presence or sightings of fauna or flora species, as they are the most likely to possess specific information on the area.

2.4 RAPID BIODIVERSITY SURVEY

As the desktop analysis highlighted the importance of artificial wetlands for avifauna, a Rapid Biodiversity Survey with emphasis on birds was conducted during two 4-days surveys, at the beginning of the spring migration season and breeding season (April and June). To assess the state of the local fauna, counts of its species and quantitative composition methods were followed.

3 RESULTS AND DISCUSSION

3.1 BIRDS AS INDICATORS OF IMPORTANT MODIFIED HABITATS

Previous information on the study area reported that the basins provide limited habitat to various avifauna and other fauna, and few resident animals. Furthermore, it was indicated that the area is not a key reproduction area. However, desktop analysis highlighted that the Project area is located along a migratory flyway; furthermore, some Protected Areas hosting natural wetlands resulted to be located within 30 km from analyzed artificial wetlands, suggesting the potential presence of rare or protected bird species in the Project area as well.

Rapid field surveys documented a high diversity of avifauna, with over 100 bird species recorded in and around the artificial wetlands, including several species of conservation concern according to the IUCN Red List and EU Bird Directive; the site was found to host a significant population of an endangered bird species, which potentially triggered Critical Habitat, as well as large congregations of migratory birds such as ducks, geese and shorebirds. The presence of these species indicates that the artificial wetlands had become a habitat of significant biodiversity value, which aligns with broader research [5][7] showing that while natural wetlands typically support more species, artificial wetlands can support bird communities nearly as diverse as natural ones.

Birds, including species of conservation concern, have a remarkable ability to adapt to heavily anthropized and disturbed environments such as urban areas, industrial zones [8], and artificial wetlands [9]. This adaptability and ease of observation make birds reliable bioindicators of ecological conditions in modified habitats, including the identification of Critical Habitat thresholds under international standards. Moreover, they can support site selection for protected areas under the EU Natura 2000 framework, which include core breeding, resting and wintering sites for endangered bird species [3].

Some of the interviews confirmed the findings as the artificial wetlands have been regularly visited by local ornithologists which observed up to 150 species of birds, with many species have also been recorded during migration and breeding seasons. However, various stakeholders were not aware of the important role of the artificial wetland ecosystem, highlighting that a wider range of stakeholders should be consulted for more reliable results.

3.2 GEOSPATIAL ANALYSIS MUST BE COMPLEMENTED BY FIELD SURVEYS

A second key lesson is that geospatial analysis must be ground-truthed and complemented by field surveys to produce an accurate and reliable biodiversity assessment. In this study, remote sensing and desktop GIS analysis were used for mapping habitats and understanding the landscape context, identifying the extent of the artificial wetlands and their general characteristics (size, vegetation cover). However, the ecological condition and micro-scale usage of the habitat by species could only be assessed after on-site investigation, underlining the limitations of relying solely on remotely sensed data.

By combining GIS with field data, the assessment achieved a much more robust picture: the remote sensing provided scale and mapping accuracy, while the field surveys provided ecological validity. For future impact assessments in similarly modified habitats, it is recommended to i) begin with a thorough desktop analysis and stakeholder consultations to identify any potential, unexpected biodiversity values; and ii) allocate sufficient field effort to validate desktop and remote sensing findings and to document key biodiversity elements. This integrated approach improves confidence in the assessment findings and leads to more appropriate mitigation measures.

3.3 HUMAN USAGE AND STAKEHOLDER RELATIONSHIPS SHAPE MITIGATION & OFFSETS

The third lesson highlights the critical role of human usage and stakeholder relationships in shaping effective mitigation and offset strategies for biodiversity in modified habitats.

In modified habitats it's necessary to take into account the presence of human activities, even in Critical Habitats; in this case remediation of the wetlands was necessary due to environmental concerns , which potentially posed a long-term risk to the local population as well as avifauna species. In this case, as in other similar cases in highly anthropized environments, it was necessary to find a compromise between the need to carry out remediation activities within a Critical Habitat and the imperative to avoid completely disrupting the habitat of avifauna species.

In addition to specific mitigation measures in the Project area, such as limiting scheduling works outside breeding periods, the Project develop a biodiversity offset strategy focused on wetland creation in case NNL and NG thresholds were not met. However, these measures are notoriously expensive and can have high social impacts [10].

During the biodiversity IA, an artificial wetland under construction was identified in the broader project area (<5km) and evaluated as potentially playing a key role in the project's mitigation strategy by helping to limit fauna displacement and disruption of behavioral patterns, providing an alternative suitable niche in relative proximity. Considering the known difficulty of shareholder/stakeholder interactions, initially this area was designated for monitoring NNL and NG targets. However, if these targets were not met within the expected timeframe, additional environmental measures at the artificial site (after dedicated stakeholder engagement activity) may be activated as part of the offset strategy, potentially limiting costs compared to wetland creation.

4 CONCLUSION

This case study illustrates how modified habitats, such as artificial wetlands, can accumulate significant biodiversity value over time; birds are powerful indicators of biodiversity value in modified habitats, particularly artificial wetlands. Their ability to adapt to anthropized and disturbed environments make them suitable to identify critical habitats under international standards and EU directives To avoid overlooking these critical values, robust biodiversity assessments must begin with thorough desktop analyses and local stakeholder consultations. These early steps help identify potential biodiversity concerns to be validated through field surveys to accurately assess project impacts. Collaborating with stakeholders is also vital for designing and implementing effective mitigation measures, which are key to achieving biodiversity targets and avoiding unnecessary project costs. Recognizing and integrating these practices is essential for delivering meaningful conservation outcomes in increasingly human-modified landscapes.

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