Wetland Assessment: Overview

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Abstract

Wetland assessment is an important part of the wetland policy process and is defined as the identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities. The overall aim of assessment is to answer the question: "what are the values that this wetland provides and how can humans benefit from them?" There is thus a close relationship between wetland assessment and wetland monitoring, with assessment sometimes relying on the results of monitoring, and monitoring being triggered by the results of an assessment. A range of assessment types have been developed, each with its own focus and applicability, ranging from hydrological, biological, functional and integrated assessments to vulnerability assessment. Determining and describing the status, characteristics, and worth of a particular wetland is often done by measuring the current condition of a wetland area within the context of a reference condition. Assessments can make use of existing data or collect up-to-date site data, provided by a combination of desk

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and field-based investigation, often with a combination of expert opinion and scientific knowledge. Depending on its focus, the scale of assessments can range from a broad overview of many functions and services on a regional or watershed scale to very specific investigations into a single wetland site. Future challenges of assessment include developments in assessment technology (e.g., using satellite sensors to assess large areas) and the involvement of the general public in collecting useful scientific information (so-called citizen science).

Keywords

Wetland assessment · Wetland monitoring · Hydrological assessment · Biological assessment · Functional assessment · Integrated assessment

Introduction

Wetland assessment has been carried out by humans for hundreds, possibly thousands, of years. Initially, in an informal and unstructured way, to identify the values or hazards that might benefit or endanger those living nearby. The move to a more structured assessment approach has coincided both with greater awareness of the value of wetland habitats and recognition of the widespread damage that is being done to the natural world. Developing over the last 30–40 years, current assessment methods seek both to provide a greater understanding of the functions and value of wetland habitats and also to meet an ever-increasing need to demonstrate and defend the needs of sensitive areas of habitat in the face of human-induced pressures.

Wetland assessment is now engrained in the laws of many nations through various pieces of legislation and is a necessary preliminary part of much development activity (e.g., Town and Country Planning (Environmental Impact Assessment) Regulations; UK Government 2011). Inventory, assessment and monitoring of wetlands are fundamental tools that provide the basis for successful implementation of the Ramsar Convention on Wetlands (Ramsar Convention Secretariat 2010). There is an increasing onus on countries to provide information on the quantity and quality of their wetland habitats and to take steps to mitigate degradation. Assessment provides the mechanism for doing this (e.g., the EU Habitats Directive; European Commission 1992). Wetland assessment is a rapidly developing area.

This section provides an overview of wetland assessment, including the evolution of the process, the range of processes currently in use, some of the methods employed, and the future challenges facing effective assessment. A more detailed exploration of each method is provided in the subsequent sections.

Relationship Between Assessment and Monitoring

The Ramsar Convention defines wetland inventory, wetland assessment, and wetland monitoring as follows (Ramsar Convention Secretariat 2010):

- Wetland Inventory: the collection and/or collation of core information for wetland management, including the provision of an information base for specific assessment and monitoring activities.
- Wetland Assessment: the identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities.
- Wetland Monitoring: the collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. The collection of time-series information that is not hypothesis-driven from wetland assessment is here termed surveillance rather than monitoring.

There is a close relationship between wetland assessment and wetland monitoring, with assessment sometimes relying on the results of monitoring, and monitoring being triggered by the results of an assessment. The two often work together in order to achieve the ultimate goal of establishing current condition, providing the factual underpinning for action, and observing to see whether an action is achieving its objective. When assessments are repeated over time, an established replicable monitoring programme is required in order to provide suitable data. Another important aspect of wetland assessment is understanding vulnerability and the magnitude and duration of impact that may result from a certain pressure. For example, a wetland may respond differently to an acute incident such as a one-off chemical spillage compared to a chronic condition such as sediment input from run-off in the upstream catchment. On-going monitoring can provide the information required to assess various aspects of a wetland.

The Evolution of Assessment Methods

There is evidence of human interaction with wetland areas from much of the world dating back many years. Archaeological discoveries often provide evidence of very early assessment methods, where early settlers chose to live close to wetlands, realising these habitats offered various benefits. Excavations in Japan revealed organic remains of fish traps, ground-level dwellings, and trackways with ages estimated to be around 5,000 years BP. Sites across Europe such as Corlea bog in Ireland, Noyen-sur-Seine in France, and Usvyaty in Russia all show evidence of human settlement. Remains of baskets and harpoon points have been found on the northwest coast of North America, estimated to be between 4,500 and 3,000 years old (Coles 1992).

As sites rich in food, fiber, fuel, and water, living close to a wetland had many advantages. Resources invested in constructing homes near to a wetland and/or putting in the infrastructure necessary to improve access to different parts of the wetland were justified by the material gains that they facilitated. It is likely that this early decision making also considered the possible disadvantages of living near a wetland, such as potentially increased numbers of disease-carrying insects.

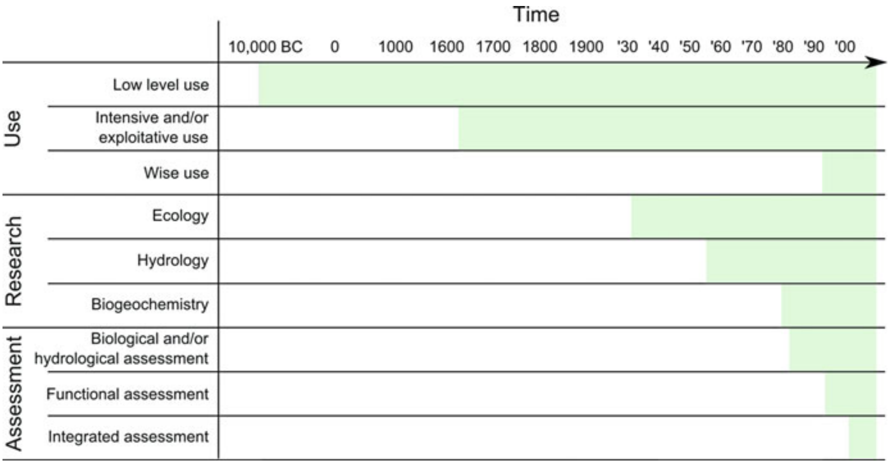

Fig. 1 The evolution of wetland assessment. Time (note nonlinear axis) is shown along the horizontal axis and different aspects of wetland use, research, and assessment are shown on the vertical axis

Although modern methods are more structured and tend to apply a more rigorous set of tests in arriving at an assessment, the overall aim of assessment is in some ways unchanged, i.e., to answer the question: "what are the values that this wetland provides and how can humans benefit from them?" Such a broad question quickly becomes a veritable "can of worms" when challenged, giving rise to subquestions (and a multitude of other, similar questions) such as:

- Can value only be judged from the perspective of "what is the value to humans?"
- Is one value more important that another?
- Is it ok to exploit one value to the detriment of another?

As a result of this complexity a whole range of assessment types has been developed, each with its own focus and applicability. The evolution of wetland assessment reflects the increasing intensity with which humans manipulate landscapes, the growing interest in natural sciences, and most recently a desire to reduce the damage that is being done to habitats of all kinds (Fig. 1).

Early use of wetlands most likely had a minimal impact on the wetlands themselves as the intensity of activity was low. However, as societies and countries "developed," the use of wetlands became more exploitative. Wetlands were modified and in many countries large areas of wetland, too wet for habitation or agriculture, were drained (Biebighauser 2007). Drainage of the Fenland area of the UK became more widespread during the 1600s and with the industrial revolution came the ability to drain much larger areas more effectively (Godwin 1978). The resulting fertile, workable agricultural land was viewed by many as a step forward, meeting the growing need for food supply and reducing flood risk (Baldock et al. 1984). Similarly throughout Europe, large areas of wetland were drained in order to facilitate agriculture. It is estimated that Spain has lost 60% of its inland freshwater wetlands since 1970, Lithuania has lost 70% of its wetlands in the last 30 years, and 67% of France's wetlands have disappeared in the last 100 years (Silva et al. 2007). It is only recently that the idea of "sustainable benefit" has become more prominent through promotion of ideas such as the "wise use" concept (Finlayson 2012).

Types of Assessment

Assessment methods have developed both as society's desire to "use" wetlands for its benefit has increased and as scientific understanding of wetland functioning has improved. The different assessment methods are described here and are summarized in Table 1. Specific assessment frameworks, such as Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), are described in detail in other sections of this volume.

Assessments can be tightly focused, concentrating on just one aspect of the wetland. Hydrological assessment, for example, seeks to understand and ideally quantify the role of a wetland system in influencing the hydrological regime of the surrounding area. This might be particularly relevant if a wetland is thought to ameliorate or contribute to flood risk. A biological assessment would most likely give an indication of the ecological "health" of the ecosystem or might be applicable if a rare habitat or species is present within the wetland.

Table 1 Examples of different types of wetland assessment

Wetland assessment methods	
Type of assessment	Purpose
Hydrological assessment	To develop a conceptual understanding of hydrological inputs and outputs to and from a wetland system (Acreman and Miller 2007)
Biological assessment	"*To evaluate the health of a waterbody by directly measuring the condition of one or more of its taxonomic assemblages and supporting chemical and physical attributes*" (USEPA 2002)
Functional assessment	*"Wetland functional assessments were developed for the specific purpose of quantifying the levels of function of an existing wetland (impacted site) or the levels of function of a compensatory, mitigation site based on predicted future conditions"* (USDA 2008)
Integrated assessment	*"A set of methods that can be used to investigate the links between biodiversity, economics, and livelihoods in wetlands and to identify and address potential conflicts of interest between conservation and development objectives"* (Springate-Baginski et al. 2009)
Vulnerability assessment	The following example is focused largely on climate change – "*an approach that can provide information and guidance for maintaining the ecological character of wetlands which are subject to adverse change as a consequence of climate change (including sea level rise), while recognizing that climate change will interact with the many other anthropocentric pressures on wetlands"* (Gitay et al. 2011)

A more human-centric view, which seeks to establish what “functions” or “services” a wetland provides either to humans, wildlife, or the environment, is achieved through functional assessment (Maltby 2009). The Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005) provides a full list of services and examples include carbon sequestration, provision of food and fuel, water storage, and areas of natural beauty. Functional assessment considers the direct and/or indirect benefits provided by wetlands at a range of scales. For example, Acreman et al. (2003) carried out a modeling exercise on the River Cherwell, Oxfordshire, UK, to quantify the impact of embankment removal on downstream river flows. With the floodplain in hydrological connection with the river and therefore able to readily receive flood water, the model results showed a 30% reduction in peak flood flow downstream.

With wetlands increasingly viewed as integral parts of larger systems, not only in terms of biology and hydrology but also in their interaction with humans, a broader integrated assessment approach often makes more sense. Integrated assessment seeks to assess three main aspects of the wetland’s interaction with human society and bring these together in order to assess the interlinkages and connectivity between wetland condition and economic/livelihood status or to express this information in a form and with a focus that can inform and influence real-world conservation and development planning (Springate-Baginski et al. 2009). The three aspects of integrated assessment are:

- The ecosystem and the physical conditions that support it
- The value of the ecosystem services that wetlands provide
- The role of the wetland in supporting the well-being of local people

With increasing focus now on protecting wetland areas, a further assessment method has been developed with the aim of identifying wetlands at risk from one or more threats: wetland vulnerability assessment takes into account the relationship between exposure to a particular risk event, the impacts of that event on a wetland, and the ability of the wetland to cope with the impacts or the efforts needed to minimize the impacts. The resilience and sensitivity of the study area is included in the assessment (Gitay et al. 2011).

An Overview of the Assessment Process

Wetland assessment is the process of determining and describing the status, characteristics, or worth of a particular wetland (Springate-Baginski et al. 2009). This is often done by measuring the current condition of a wetland area and presenting this within the context of a reference condition (Fig. 2). It is then possible to report whether the wetland is in good condition or not. The result will lead to recommendations for activities that either maintain the current condition or seek to mitigate the factors causing the current poor condition. The assessment process therefore

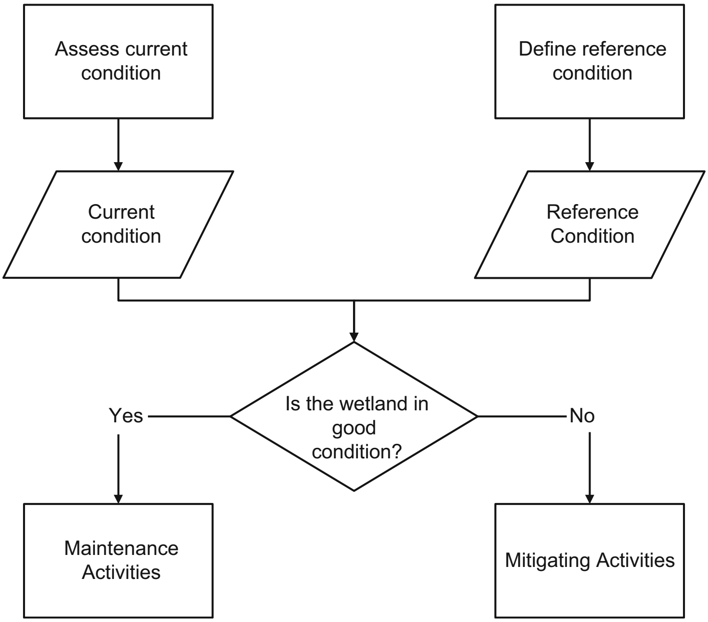

Fig. 2 Basic assessment process and potential outcomes

typically consists of establishing two pieces of information: the current condition of the focus area and the reference condition of the focus area.

Assessing the current condition of a site is likely to make use of existing data as well as require additional up-to-date site data, and this is provided by a combination of desk and field-based investigation. The scope of the data required for this will depend upon the type of assessment being carried out. The definition of a reference condition aims to establish the state a site would be in, in the absence of all or some of the pressures under investigation. A combination of expert opinion, scientific knowledge, and, where possible, identification of an unimpacted comparable site will provide much of the information required. This should take into account the setting (e.g., hydrogeomorphic and eco-regional) and the overall wetland landscape profile, representing the abundance, by class, of wetlands in that occur in the geographical area (USEPA 2006).

Selection of appropriate indicators of condition will be guided by the assessment focus with close reference to existing scientific information. The indicators should be tested at a range of relevant sites and across the range of conditions to be assessed so that their appropriateness and usefulness can be confirmed. For this purpose, it can be useful to establish a network of sites that help establish both the reference conditions and range of assessment conditions; however, this may not always be possible and even when possible could prove to be expensive.

An assessment can take many forms depending on its focus. It could for instance be a broad overview of many functions and services, a continental-scale review of all

Table 2 Three types of wetland assessment method that can be developed to support program objectives (Compiled from data in USEPA 2006)

	Products/applications
Level 1 – Landscape assessment These assessments rely almost entirely on Geographic Information Systems and remote sensing data to obtain information about watershed conditions and the distribution and abundance of wetland types in the watershed. Typical assessment indicators include wetland coverage, land use, and land cover Wetland landscape profiles and landscape development indices (LDI) are used to characterize the lands that surround the assessed wetland. Metrics used in the LDI approach, such as road density, percent forest cover, land use category, and presence of drainage ditches, can provide preliminary information on wetland condition within a watershed This level of assessment can help to target areas for level 2 and level 3 assessments	• Targeting restoration and monitoring • Landscape condition assessment • Status and trends • Example – Wetland extent trends analysis that is conducted by the US Fish and Wildlife Service's National Wetland Inventory is a Level 1 type of assessment (US Fish and Wildlife Service 2014)
Level 2 – Rapid wetland assessment The Convention on Biological Diversity and Ramsar Convention define rapid assessment as a synoptic assessment, which is often undertaken as a matter of urgency, in the shortest timeframe possible to produce reliable and applicable results for its designed purpose (CBD-Ramsar 2006) Rapid assessments use relatively simple metrics for collecting data at specific wetland sites. Their methods should provide a single rating or score that shows where a wetland falls on the continuum ranging from full ecological integrity (or least impacted condition) to highly degraded (poor conditions). Assessment is often based on the characterization of stressors known to limit wetland functions (e.g., road crossings, tile drainage, ditching.). A "rapid" method should take two people no more than four hours of field time, and one half day of office preparation and data analysis to reach a condition score	• Integrated reporting • Watershed planning • Implementation of monitoring of restoration projects • Example – Kotze et al. (2012) carried out rapid assessment of ecological condition in South Africa
Level 3 – Intensive site assessment This is a more rigorous, field-based method that provides higher resolution information on the condition of wetlands within an assessment area, often employing wetland bioassessment procedures or hydrogeomorphic functional assessment methods. It produces quantitative data with known certainty of wetland condition within an assessment area and is used to refine rapid wetland assessment methods and diagnose the causes of wetland degradation. Assessment is typically accomplished using indices of biological integrity or hydrogeomorphic function	• Support the development of water quality standards that are protective of wetlands • Develop design and performance standards for wetland restoration • Verify and refine levels 1 and 2 methods • Integrated reporting • Example – intensive assessment of the Upper Juniata Watershed, Pennsylvania (Hychka et al. 2007)

wetland habitat types, or a very specific investigation into a single wetland site. Table 2 gives examples of three types of assessment ranging from landscape scale to site scale.

Future Challenges

The pressure on the natural environment is likely to increase in the future as population growth and societal development continue. The need for resources of all kinds is going to continue to put pressure on wetland habitats. Safeguarding wetlands will depend more and more on our ability to assess their condition, function, societal importance, and vulnerability. Technological advances have led to improvements in the efficiency and effectiveness with which assessments can be carried out. For example, the modern sensors fitted to some satellites are capable of collecting data from which a wide range of wetland information can be derived. Hydrological parameters such as salinity and soil moisture, topography, and the type and extent of different types of vegetation can be collected for very large areas using these remote sensing techniques (Klemas 2011). There have also been advances in defining the metrics to use in assessments, and target water table regimes and nutrient status now exist for many wetland plant species (e.g., Wheeler et al. 2004; Davy et al. 2010).

Citizen science, which aims to engage the public in collecting useful scientific information, is an emerging area with the potential to provide great benefit to wetland habitats. Not only can the information collected cover a wider scope than would be economically viable through traditional scientific methods, but facilitating public engagement can also promote interest and awareness of the environment. The Watsonville Wetlands Watch is a good example of a citizen science program in operation (http://www.watsonvillewetlandswatch.org).

So although the pressures on wetlands are unlikely to reduce, advances in technology, understanding, and integration will continue to address these pressures in the most effective manner.

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