



# A comparison of the concepts: *Ecosystem services* and *forest functions* to improve interdisciplinary exchange



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## ABSTRACT

Ecosystems, such as forests and their associated processes, provide numerous goods and services to human societies. These so called *ecosystem services*, have recently gained a lot of scientific interest, also in the field of forest science. This approach is not new to the forest sector, as forest ecosystems have been used in the past for many different purposes besides wood production and even their non-consumptive benefits have been well known for more than one hundred years. Central European forest scientists summarized these diverse services under the term *forest functions*, a widely accepted approach in the region.

Since both concepts have developed separately this paper aims at creating a base to enable interdisciplinary scientific exchange among forest scientists and other disciplines by reviewing and comparing the concepts of *ecosystem services* and *forest functions* systematically. This review uses scientific publications (generally in English) to encompass the ecosystem service concept and textbooks as well as legislation and forest management guidelines (predominantly German), for the forest functions concept. Additionally a meta-analysis was conducted to examine their publication patterns.

The review shows that despite their different backgrounds, both concepts developed similar definitions and classification schemes. Both consider the valuation of services or functions using similar methods, although their motivations for valuation differ. Interactions of functions and services are more intensely investigated within the *ecosystem service* concept, whereas *forest functions* have been more management orientated and consider aspects of sustainability – two points that have been criticized to be insufficiently considered within the *ecosystem service* concept. Merging the ideas of *ecosystem services* and *forest functions* can therefore contribute to science in general, forest policy as well as forest management.

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## 1. Introduction

Ecosystems, such as forests and their associated processes, provide numerous goods and services to human societies. These benefits were recently heavily debated by scientists and politicians under the broad headline of *ecosystem services*, which also became an important field for forest science.

On the other hand forest scientists and managers are familiar with the idea of different forest goods and services. They have been trying to balance different needs of society and to sustain ecosystems at the same time for generations. Within the Central European forest sector the benefits provided by forests are also described by a traditional concept that is known under the German term *Waldfunktionen* (*forest functions*), which resembles the idea of ecosystem services (Bürger-Arndt, 2013).

Examining both concepts quickly leads to the questions: what are the differences between the concepts and do they offer different approaches and solutions regarding the handling of ecosystems and

their services? This paper first introduces the two concepts in respect to the applied definitions and classification schemes, their backgrounds and their role in the international and German scientific discourse. Subsequently ecosystem services and forest functions are compared regarding their approach towards valuation, how they address the complexity of service interactions, and their role in sustainable forest management as well as operational level management.

Since forest management and ecosystem service research are dealing – so far without systematic exchange – with similar issues, comparing and, if necessary, translating their ideas can enable interdisciplinary exchange and contribute to science, policy and forest management.

## 2. Methods and materials

Within this paper the two concepts: *forest functions* (FF) and *ecosystem services* (ES) are compared considering six different aspects: 1. Definitions, classification schemes and considered benefits, 2. Backgrounds and concepts behind them, 3. Publication Patterns, 4. Valuation of services and functions, 5. Dependency and interactions, 6. Functions and services in the management context. While the first three aspects are essential to understand the concepts and their range of application,

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the remaining aspects present areas with particular importance to forest practitioners.

Apart from the third aspect “Publication Patterns”, the comparison of the two concepts was conducted through a literature review. Since the phrase *ecosystem service* is a term from the end of the 20th century, with ongoing scientific discussion, it has primarily been investigated using publications in scientific journals (in English). The *forest function* concept, on the other hand, is a traditional German concept used mainly in the Central European forestry sector. It was introduced by Victor Dieterich in the 1950s in Germany and was discussed by practitioners and politicians, and manifested in forest acts. Therefore, the considered literature is dominated by older textbooks and legislation relating to forests and forest management guidelines, most of which are in German.

“Publication patterns” on the other hand were analyzed using meta-analysis to identify the application of the terms *forest functions* and *ecosystem services* of forests (FES) within scientific literature. Relevant listed publications (accessed November, 4th 2014) were investigated, using the two different electronic platforms *CAB direct* and *Web of Science*, since they offer different criteria to refine the results. *CAB direct* is a platform that consists of literature across applied life sciences, and was used to refine papers according to their year of publication and geographic location as identified by the search service. To specify the numerous publications on FES, the platform was searched for titles including both the exact full phrase (so-called “unstemmed”) “ecosystem service” (singular and plural) and the term “forest”. The platform’s publication titles were also filtered for “forest function(s)”, but here the 89 unstemmed results also included titles that described a certain forest to *function* in a specific way. Therefore the publications’ titles were checked manually and papers not using the FF concept were excluded.

To allow a thematic differentiation of papers dealing with FES and FF a second platform was used, as the categories offered by *CAB direct* were too specific on forestry (e.g. differentiating between categories like “silviculture”, “forest economics” or “forest recreation”). Therefore the electronic platform *Web of Science* was used to classify the results thematically. This platform offers broader categories, called *research areas*, such as “forestry” and “environmental science ecology”. Likewise to the former approach, publications that used the words “forest” and “ecosystem service(s)”, as well as “forest function(s)” in their titles were selected (accessed November 8th 2014). The FF titles were also checked manually and both results were compared according to the number of titles listed in the most common categories “forestry” and “environmental science ecology”.

In Germany today both terms *forest functions* (“Waldfunktionen”) and *ecosystem services* (“Ökosystem(dienst)leistungen”) are applied. To investigate their use in forest science German forest journals were searched for the translated terms. Therefore the subject indices of the scientific journals “Forstarchiv”, “Forst und Holz” (formerly „Der Forst- und Holzwirt” until 1987, journal discontinued in 2011) and „Allgemeine Forst- und Jagdzeitschrift” were reviewed for terms beginning with “Waldfunktionen” (FF) and the translations of ES for the time period from 1954 to 2013.

Additionally, publications regarding the two concepts were analyzed considering their relation to *sustainable forest management* (chapter 3.6). *CAB direct* was used to identify the number of papers that name “sustainable forest management” as well as “forest” and “ecosystem service(s)” or “forest function(s)” in “all fields”.

### 3. Forest functions and ecosystem services

#### 3.1. Definition, classification schemes and considered benefits

Both concepts consider similar benefits (service/function), and classification schemes.

The term FF is rarely defined but often explained using a common classification scheme. Brandenburg’s ministry of agriculture provides one of these rare definitions of FF, stating: “*They are effects of forests that secure livelihoods of the community.*” (Groß and Müller, 2007). The German Federal Forest Act differentiates between the economic use of a forest, the environmental role it plays, “*especially regarding the persistent, natural performance of the ecosystem, climate, water balance, air purification, soil fertility, landscape scenery, agrarian- and infrastructure as well as its importance for the population’s recreation*” (§1 German Federal Forest Act). This approach, considering the three function categories: *use-, protection- and recreation* is widely used in German literature presenting an open definition. Further functions can be easily added if required: Lemerding (1967) for example, interpreted the conservation of the natural flora and fauna associated with a landscape – an aspect that would be paraphrased today as protection of biodiversity – to be covered by the *protection function*. Other aspects were added by some federal states within their forest legislation.

Contrary to this, numerous articles discuss appropriate definitions for ES (Boyd and Banzhaf, 2007; Fisher et al., 2009; Nahlik et al., 2012). A very broad and common definition originates from the international research initiative “Millennium Ecosystem Assessment” (MEA) stating: “*ecosystem services are the benefits people obtain from ecosystems*” (Alcamo and Bennett, 2003). Many other authors follow a less personal approach and define “humankind” (Jenkins et al., 2010), “human life” (Daily, 1997) or “human well-being” as beneficiary (Boyd and Banzhaf, 2007; Fisher et al., 2009; Nelson et al., 2009; in: Nahlik et al., 2012). Of similar diversity are the applied classification schemes, differentiating the services according to service type, derived products or applied scales. Often cited, for example, are the MEA classification, which consider provisioning -, regulating -, cultural - and supporting services (Alcamo and Bennett, 2003), or the “Common International Classification of Ecosystem Services” (CICES) scheme. Shvidenko et al. (2005) focuses on forest services within the MEA and differentiates five service classes: “biospheric”, “amenities”, “social”, “ecological” and “resource”.

A comparison presented in Table 1 shows that the respective benefits, different authors identified, within the two concepts resemble. The table lists services or functions that were recognized by at least two of the presented sources using two well-known ES classifications by Costanza et al. (1997) and the MEA (Alcamo and Bennett, 2003), one scheme that is particularly focused on FES by Stenger et al. (2009) and two traditional interpretations of FF.

Table 1 emphasizes the utilitarian perspective that both concepts follow when identifying services according to their use to humans. Thereby the ES concept is quite detailed, considering single ecological processes, especially within the supporting services, like pollination. These details are all covered by the protection function in the FF concept that includes the “*preservation of the persistent, natural performance of the forest ecosystem*” (§1 German Federal Forest Act). Furthermore, this definition recognizes a healthy and resilient ecosystem as important for future functions and therefore links the concept of sustainability to the FF concept.

Within in the older FF concept a shift in understanding of relevant functions over time can be observed, already described by Hasel in 1971. Comparing Dieterich’s functions from the 1950s to younger function portfolios reveals such changes. For example, Dieterich (1953) lists a military function named “securing external or strategic affairs” and an “area-reserve function” that were not taken up by other FF authors. Hasel (1971) on the other hand added the recreation function and the regulating functions considering sound - and air pollution that were not relevant at Dieterich’s time, twenty years earlier. Pistorius et al. (2012) furthermore alludes to the often neglected historical FF of the pre-industrialized age, such as litter raking or woodland pasture. In the younger discourse on ES such changes within the service portfolios are rather rare to observe, however the phenomenon is known (Dick et al., 2011; Alcamo and Bennett, 2003).

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