Integrering av landskapsøkologi i landskapsplanlegging

– Kan «Emerald Necklace» brukes som et verktøy for å overvinne kommunikasjonsgapet?

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Gesine Jimenez-Martinez et al.: Integrating landscape ecology into landscape planning – Can the Emerald Necklace be used as a tool to overcome the communication gap?

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As the human population grows and its influence on the environment continually increases, sustainability is again on the policy agenda. At the same time there is increasing awareness of the need for more environmentally attuned landscape planning. Nevertheless, researchers have recognized that many research findings are not applied in real life management or practice. We argue that the lack of incorporating ecological knowledge into landscape planning is partly caused by a communication gap between ecologists and planners and designers. In this article we suggest one approach of how this communication gap could be minimized. We link landscape ecological concepts relevant for land use planning to a well-known planning and design concept, the Emerald Necklace. We argue that applying the Emerald Necklace concept in a planning process can have several possible positive contributions. First, it will necessitate thinking on a landscape scale, i.e., putting the focus not only on individual planning project areas, but also on the ways in which these are linked to the surrounding landscape. Further, it will help identify priority areas from an ecological perspective. Finally, it will emphasize the importance of heterogeneity of habitats and connectivity of the blue-green infrastructure during the planning process. In addition, and equally important, the concept provides abundant opportunities for creative design. We hope using the Emerald Necklace will contribute to improved dialogue and understanding between the professions involved in planning processes.

Keywords: planning principles, sustainable planning, sustainability, interdisciplinary collaboration

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Introduction

Population growth, urbanization, increased food production, extraction of resources for industrial use, and also recreational activities are examples of development that has led to increasing pressure on land area and natural resources (Williams and Shaw 2009, UNEP 2012). As available land area is a finite resource, there is a pronounced need to carefully manage and plan for these areas in a more sustainable way (Seto et al. 2011, Bio by Deloitte 2014). Accordingly, much research has been carried out to gain insight into sustainable management and planning, how it could be achieved and how potential progress could be measured. Key contributions include studies on spatial patterns (e.g. Turner 1989, Forman 1995, With and Crist 1995, Dramstad et al. 1996, Forman and Collinge 1996, Turner 2005, Ellis et al. 2012, Gutzwiller 2013) and on measurement, spatial indices and use of these (e.g. Leitão and Ahern 2002, McGarigal et al. 2002, Li and Wu 2004, Corry and Nassauer 2005, Kim and Pauleit 2005, Dramstad 2009, Uuemaa et al. 2009, Kupfer 2012, Uuemaa et al.

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2013). Much research has also been carried out more directly on integration of landscape ecology[3] in planning (Selman and Doar 1992, Hersperger 1994, Opdam et al. 2001, Forman 2002, Leitão and Ahern 2002, Theobald et al. 2005, Potschin and Haines-Young 2006, Ignatieva et al. 2011, Ahern 2013). In Norway, landscape ecological principles have been incorporated in planning guidelines for some time, in particular regarding planning of green infrastructure in urban areas (e.g. Nyhuus 1991, Direktoratet for naturforvaltning 1994, 2003, Miljødirektoratet 2014). Biological biodiversity, for example, as a contributor to environmental quality, has come into focus in planning and managing recreational areas close to cities (Direktoratet for naturforvaltning 2003).

Despite this effort we argue that there is still a need to improve the consideration of ecological principles in landscape planning and design to achieve a more ecologically sustainable management of land areas. Globally, urban areas will experience continued growth with resulting pressures on agricultural land, clean water, vegetation, and other resources (Forman and Wu 2015). Reducing the total area of agricultural land creates challenge for future food production (Dramstad and Fjellstad 2011) and is recognized as a growing problem, also in Norway. Despite numerous initiatives to halt this trend, statistics show a 19,9% increase in the rate of loss of agricultural land from 2014 to 2015 (Statistisk sentralbyrå 2016). In addition, green structures in cities are continuously being lost (Forman and Wu 2015) despite numerous studies documenting the high value of such areas (e.g. Uy and Nakagoshi 2008, Sullivan and Chang 2011, Scott et al. 2016). In Norway, Halvorsen-Thorén and Saglie (2015) have documented the loss of green structures and described the challenges involved in integrating blue-green infrastructure in urban planning.

Reasons for these ongoing trends can be diverse. One issue is conflicting aims. Peri-urban agricultural area is to be protected due to its environmental qualities, an increasingly urban population is to be accommodated, and easy access to public transport must be improved. All of these worthy aims often end up competing for the same land. Another reason for the trends described above may be the way priorities are set. Planners tend to be requested to prioritize «creating jobs, housing, transport and economic growth» rather than protecting agricultural land and biodiversity, as Forman and Wu (2015, p. 608) point out. Ultimately, this is a consequence of the assignment from an employer or customer.

An additional factor is persistent gaps between science and policy and between science and practitioners (e.g. Lenz and Peters 2006, McNie 2007, Beunen and Opdam 2011). Opdam et al. (2001, p. 767) question «Why so much knowledge on ecological processes is not applied in spatial planning.» They answer it by pointing out a lack of transference, for example, from knowledge about single species distribution and behavior to knowledge *applicable to* spatial planning. In our experience, even though a large amount of ecological information is available, this information tends to be generalized. As a result, considerable effort is needed to make the information easily applicable to local conditions.

Many of the already existing guidelines and recommendations on how to include ecological knowledge into planning and design are either too extensive and/or are not presented in a form that is easily comprehensible for non-ecologists. This may lead to a high application threshold for practitioners. Further, as concluded in a review by the Environmental Law Institute (2003, p. 25), «…science offers very little consensus opinion to land use planners on how to determine

3. Landscape ecology is a branch of ecology that focuses on spatial patterns in landscapes and related ecological processes, such as species presence or absence, movement of individuals and success of populations. In addition, landscape ecology considers human presence, housing, infrastructure, etc. to be an integral part of the landscape. Humans can contribute positively to the strengthening of the ecological functioning in a landscape through careful planning and design. Thus, it has recently been suggested to incorporate the process of design in the landscape ecology paradigm which links landscape spatial patterns to ecological processes (Nassauer and Opdam 2008). Similarly, Wu (2013, p. 191) describes «landscape optimization» as a key research area for landscape ecology and asks whether there are ways to optimally «spatially meshing nature and culture» to promote landscape sustainability.

which habitat patches to conserve and where; the amount of habitat to protect in a region or conversely the maximum amount of impervious surface to allow; the ways in which to mitigate against the negative consequences of habitat edges; or how best to design and plan for corridors.» The Institute (2003, p. 25) also writes: «To better inform decision making, the scientific community needs to provide more specific information to land use practitioners on how to implement ecologically conscious growth.» Thus, there appears to be a missing link in the communication and transfer of knowledge between many of those involved in sustainability science and landscape design, planning and management (see Halvorsen-Thorén and Saglie 2015, and Dramstad and Fjellstad 2016).

Our experience from teaching future landscape architects and planners, and from cross-disciplinary work, indicates that communication between landscape ecologists and planners and designers is challenged by their different educational and professional backgrounds (Opdam et al. 2001, Halvorsen-Thorén in prep.). For example, many ecologists focus on capturing data on species distributions, long-term changes and – landscape ecologists in particular – on processes at larger spatial scales. Planners and designers, on the other hand, are often in a situation where a more pragmatic approach is needed. Their focus is a clearly delineated area which is the subject of a planning process. With limited time and resources available to meet a deadline, knowledge needs to be easily applicable. In practice, the amount of ecological information planners can be expected to deal with in any one project will be limited, whether it be input on species occurrences or other ecological data. These differences in «cultural background» may result in a lack of understanding. Which data do planners and designers need? How can the provided data be incorporated in planning processes? The Environmental Law Institute (2003, p. 26) recommends that «Land use practitioners should be encouraged to better communicate with scientists about the type of information that they need and in what format it would be most useful.» As Dramstad and Fjellstad (2011) point out, to achieve sustainable landscapes the focus needs to be on establishing a dialogue between researchers and planners – rather than on developing new tools.

One way to overcome the communication gap between landscape ecologists and planners and designers is through curriculum development and stimulation of interdisciplinary learning in study programs. Another option could be to ensure that ecologists are included and integrated in planning teams. Besides these long-term approaches, we think measures are needed that can promote dialogue and a practice of collaboration between these fields of knowledge and skill sets. The purpose should be to promote easily comprehensible and applicable landscape ecological knowledge for landscape plans and designs. In this article we aim to show one example of how some landscape ecological knowledge which is relevant in the context of landscape planning could be made more easily accessible and comprehensible for planners and designers.

Many central concepts of landscape ecology, for example «barriers and connectivity» and «edge and core habitat», are rather abstract and difficult to directly transfer into practical planning. As an attempt to facilitate communication and dialogue we looked for 1) planning and design concepts that can be used to communicate landscape ecological concepts and 2) landscape ecological concepts that can be linked to this/these planning and design concept(s). Discussions were held with colleagues and students and a literature study was conducted covering 17 IALE proceedings between the years 1992 and 2011 (Jiménez-Martinez, Dramstad and Loupa Ramos, in prep.). Eventually, we identified the design concept of the «Emerald Necklace,» developed by the famous landscape architect Frederick Law Olmsted in 1837, and four key concepts in landscape ecology – habitat, edge zone, fragmentation and heterogeneity as most the relevant concepts for our purpose.

Landscape ecological principles for landscape planning

The Emerald Necklace Concept

The Emerald Necklace is a well-known concept among most landscape architects. It is taught in numerous design programs, has a long history of persistence under urban development pressure and is well studied and documented. It was first applied in the city of Boston around 1878. The concept describes the arrangement of green spaces of different size, shape, composition, content and quality (i.e. the emeralds). These are linked together by various landscape elements to make a structure that resembles an emerald necklace laid out over the city map (Figure 1). This approach seems to be applicable to different spatial scales and can be adapted, designed and developed according to local conditions and needs. The resulting design has the potential to fulfill multiple functions for both people and urban wildlife.

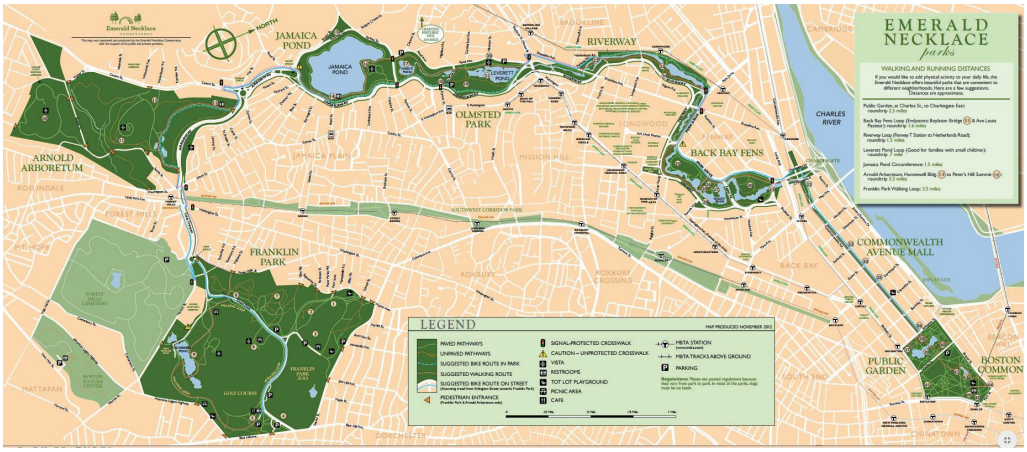

Figure 1: A map showing the Emerald Necklace of Boston. (Source: Courtesy of the Emerald Necklace Conservancy; http://www.emeraldnecklace.org)

The components of the Emerald Necklace not only offer an opportunity for recreation in a vegetated environment, but are also ecologically important urban wilds which provide the city with other benefits. For example, in the Qunli Stormwater Park in China, an award-winning project by Kongjian Yu and Turenscape, «The completely transformed site performs many functions, including collecting, cleansing, and storing stormwater, and recharging underground aquifers. The pre-existing wetland habitat has been restored and native biodiversity preserved. Potentially flooding stormwater now contributes to an environmental amenity in the city. The storm water park has not only become a popular urban amenity but has also been upgraded to a National Urban Wetland Park because of its improvement to ecological and biological conditions» (Saunders 2013, p. 153).

Importantly, for our purpose, the Emerald Necklace also embraces several concepts recognized as important in landscape ecology (Forman 2008). The concepts of habitat, edge zone, fragmentation and heterogeneity can be directly related to the concept of an Emerald Necklace. Connectivity and the shape and size of habitats can also be discussed using this concept. While the grey structures of urbanized areas can function as habitats for some species, e.g. lichens, pigeons etc., many species depend on green or blue spaces of a certain size. We argue that the emeralds of the necklace can function as habitats for species which would commonly not be found within urbanized areas. Thus, the emeralds mitigate the negative impact of urbanization on surrounding wildlife habitats. The size and shape of the emeralds/ habitats will have an impact on the size of the edge zones, which in turn influences the interaction be-

tween the emeralds and their surroundings. The linkages between the emeralds are of key importance for species movement. Fragmentation of habitats, on the other hand, is recognized as a severe threat to biodiversity, and should be avoided (Lindenmayer and Fischer 2013) (Figure 2). In the following, the four selected key landscape ecological concepts will be presented in more detail before returning to the Emerald Necklace.

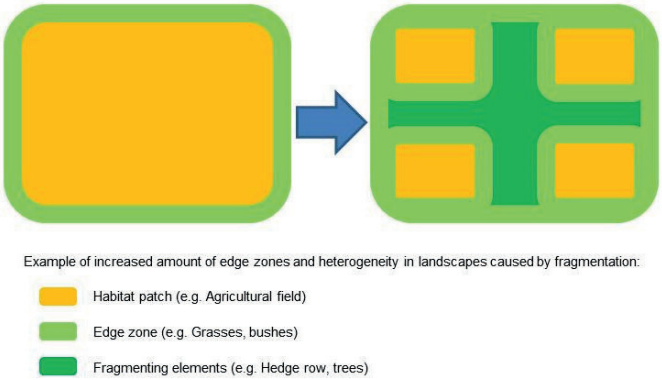

Figure 2. Relationships between habitat, edge zone, fragmentation and heterogeneity.

Definitions:

«Habitat» is defined as living space for a species. In order to consider a (range of) species during planning processes, it is necessary to look at the demands the different species have on landscapes, which may consist of different landscape elements that may not be found in close proximity. To complicate matters further, certain species need different habitats during different stages of their lifecycles.

«Edge zone» is defined as the location where one habitat type meets another, creating an environment that is different from both the adjoining ones.

«Fragmentation» is defined as splitting habitat into smaller pieces, which also generates more edge zones. One typical cause of fragmentation is development of infrastructure, such as roads. Fragmentation is often accompanied by habitat loss.

«Heterogeneity» is defined as the variation in habitat over space. Heterogeneity can be present at different spatial scales, and it is thus very important to include scale in the assessment of heterogeneity. While an increase in heterogeneity tends to increase the number of species in an area, there are species that need larger tracts of continuous habitats to survive.

Habitat: Considering the individual emeralds

Habitat is a basic concept when aiming to increase the focus on biodiversity in landscape planning. A habitat may be a continuous tract of land, or as is the case for many mobile species, it may consist of different areas that are used at different times of the year or for different purposes. For example, migratory bird species spend the winter in a warmer climate and return to Norwegian habitats to breed in the summer. When discussing habitat, it is important to acknowledge that habitat requirements differ between species. The spatial scale involved may also vary from a few square centimeters (e.g. tree-dwelling lichens) up to several square kilometers (e.g. wolves, birds of prey). Some species have very specific habitat requirements, e.g. a butterfly larva which can only survive and develop into

a mature individual on the leaves of one particular plant species. Other species are more flexible and can thrive under very diverse conditions, such as the Norway rat (*Rattus norvegicus*) or humans (*Homo sapiens*). Thus, in terms of an Emerald Necklace, the individual emeralds may provide different habitat qualities and benefit different species.

Edge zones: Getting into contact with areas outside the emeralds

Edge zones exist alongside or within habitats. New edge zones are created through land use changes. Typically, neighboring areas will be subject to a range of «edge effects» (e.g. Ries et al. 2004, Perlman and Milder 2005, Laurance et al. 2006). Since edges represent a combination of habitats, they may be species rich. However, certain species are more sensitive to the presence of edges than others (Ries and Sisk 2010, Newmark and Stanley 2011). To these species, edges represent less attractive habitat. Species that avoid edges are often rare or threatened species, while species thriving along edges are often more common (Yahner 1988). Thus in addition to considering the number of species present in edge zones, it is important to take into account the type of species. The number of species may be high, but rare or threated species may be replaced by invasive or very common species. If a species of interest avoids edges, the total habitat area may be much smaller than what it appears to be on a map. Edge effects related to each individual emerald will influence the quality of the entire necklace. Knowingly integrating edges as a design element may counteract some undesirable aspects, while at the same time promoting positive functions of edges such as increased species diversity and creation of additional ecological niches or buffer zones to adjoining areas. A more heterogeneous landscape will be the result.

Fragmentation: Avoiding breaks in the necklace

The concept of fragmentation is closely related to the concept of edges since fragmentation – the process of cutting a larger whole into smaller pieces – results in more edge. Fragmentation is a widely studied threat to a range of species (EEA 2011), in particular species requiring large habitats with few disturbances. The Northern spotted owl (*Strix occidentalis*) is an early and much studied example (Lamberson et al. 1992). The negative effects of fragmentation, such as decreased connectivity, isolation of populations, etc., can be counteracted or minimized by maintaining or establishing linkages between the single emeralds in a necklace through greenways or blue-green infrastructure (Smith and Hellmund 1993, Angold et al. 2006, Jorgensen and Gobster 2010).

Heterogeneity: Including other gems

Heterogeneity describes the variation of habitat and resources. A landscape with high variation in landform, land use or land cover configuration, fauna and flora would be considered heterogeneous compared to a landscape with little variation, which would be considered a monotonous (homogeneous) landscape. However, scale is important when considering the heterogeneity of an area. A city may appear as totally dominated by built up land and hard surfaces when studied on a satellite image. Zooming in, however, variation becomes apparent as parks, trees and gardens become visible. Zooming in further, additional variation can be discerned, for example, parks consisting of lawns, woodlots, ponds and footpaths. For the Emerald Necklace concept this implies that the design should include different types of habitats and resources since species may have different habitat and resources requirement throughout their life cycle. Amphibians are one example of a species requiring different habitats during the season. Another is ducks commonly found in park ponds and waterways. Many of them will need to move their young from the nesting habitat to the pond. A well-designed necklace will offer a variety of habitats – on a designated planning scale.

How to apply the Emerald Necklace as part of a planning process?

We argue that it could be useful to think in terms of an Emerald Necklace in different planning situations. The reason for initiating a planning process is often a need to

change landscape functioning. The objective of a plan defines what human-related functions the area to be planned should provide: housing, infrastructure, industrial development, etc. Similarly important, ecological functions need to be identified and one should also assess which particular functions should be given priority.

To begin the process of incorporating thinking in terms of an Emerald Necklace in a planning process we suggest identifying priority areas that are essential to sustain. Similarly, are there areas that can probably be removed without causing too many negative consequences for ecological functions? Landscape change is likely to affect species differently. Thus, a first step is to get an overview of existing habitats and blue-green spaces, potential habitats, and linkages between them. These habitats will differ in size and shape. When identifying priority areas, it is important to assess the different habitat types (i.e. their characteristics, quality and uniqueness) and the species present. Thus, knowledge about species and their habitats is vital. This comprises for example an understanding of the type of vegetation used, the demands species have on their habitat, and the probability of colonization and population persistence. These considerations will implicitly necessitate considering the entire necklace, not only the individual gems.

After mapping and ranking blue-green spaces according to their importance, options for habitat improvement should be considered. Is there potential for adding more gems or more linkages to the necklace? In some areas there may be potential for improving the habitat quality of already existing gems. By adding additional resources the gems could become suitable habitat for additional species or better habitats for species already present. Through the process described here, the Emerald Necklace can become a basis for dialog to help analyse existing blue-green spaces, sustain important ecological functions and improve existing blue-green spaces.

From Emerald Necklaces to Emerald Networks

Currently, most plans and designs involving landscape change focus on, and are even limited to, a specific area subject to the planned change. However, even if a current plan is relevant to only one of the «emeralds» of a necklace, one needs to consider the potential impacts on the entire necklace. This also allows one to take heterogeneity into account on both spatial and temporal scale, i.e., that different species are in need of different resources during different seasons. Using this approach, the Emerald Necklace in question can even be situated into a network of surrounding blue/green structures, which may in turn have implications for its function, design and management (for an Emerald Necklace on a European scale see EEA 2012).

Regardless of the spatial scale of the actual project being planned, a wider spatial perspective and consideration of surrounding areas is considered crucial to successful landscape planning (Perlman and Milder 2005). Ideally, in densely populated areas, several Emerald Necklaces can form in and around neighboring cities and create a connected network of blue/green spaces.

Concluding remarks

When planning larger areas, the sheer variety of environmental factors that have to be considered, e.g. red-listed species, differences in soil, climate or landform configuration etc. may appear overwhelming. Many stakeholders fronting conflicting interests may also be involved. We propose to use a concept that provides «familiar ground» for landscape planners and designers, such as the Emerald Necklace, as a starting point to ease communication between landscape ecologists and planners and designers, and thus help integrate concepts and ideas from landscape ecology into landscape planning and design.

For the future, we envision close collaboration between landscape designers and planners and ecologists in planning projects as the norm rather than the exception. In this context, the importance of a dialogue must be emphasized. Feedback from planners and designers is needed: Could the Emerald Necklace be used as a tool to close the communication gap between ecologists, planners and designers? What adjustments and which

types of data are needed? We are well aware that this is a proposed first step, and look forward to continued discussion on the topic.

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