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Environmental restoration, an ecological approach to enhance ecosystem services and biodiversity in urban areas, Magnuson Park, Seattle/Washington

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Abstract

People's life has been always determined by the importance of their basic needs. From time to time, the world has made significant progress in terms of infrastructure and technology, pathways to good living conditions. Urban areas house high concentrations of people. They are also reservoirs of extremely important ecological niches for biodiversity. Nowadays, there has been a surge interest to study these ecological components within cities. Built-up places have always been seen as concrete jungles for human settlement with very few units of green spaces where nonnative taxa are dominant and homogenous. In a near future, it is predicted that up to 85 percent of the population of the world will inhabit urban spaces, still seeking to meet primary needs and opportunities offered in cities. This settlement in urban areas creates rapid urbanization which in return has harmful impacts on the environment. Urban sprawl is the main cause of ecosystem degradation, destruction, and ecological discontinuity. This anthropic phenomenon raises awareness considering how significantly it contributes to biodiversity depletion. Increasing conurbations lead to drastic environmental changes. Urban areas can also be healthy natural environments when mixed with blue and green infrastructures, which functionalities are beneficial to the environment. Services provided by these ecological communities are known as ecosystem services. They include but are not limited to pollution reduction, soil protection, carbon sequestration, cooling effect, and air purification. Sustainable urban development can be driven from healthy ecosystems, which are substantial for human well-being and important economic growth. To better understand the growing concerns and find key actions to be able to fight against them, this study uses different scenarios to evaluate the restoration effects on biodiversity and ecosystem services through a typology with two main categories. One part describes the structure of different ecosystems, which are the compound of blue and green infrastructures along with their respective biodiversity. On the other hand, it outlines the substantial function of these ecosystems that are beneficial to the environment. The dominant idea of ecological restoration is to make cities resilient and sustainable through a process divided into phases that lead to a holistic approach to reconstructing, rehabilitating, and enhancing the healing of damaged, degraded, and destroyed ecosystems. The research process of this study was more of a theoretical approach using qualitative data to assess ecosystem services provided by blue and green infrastructures in cities. The objectives were summed up in the anticipated answers that are the hypotheses that presumably expect that environmental restoration through the Best Ecosystem Management Practices (BEMP): a) Enhance internal and external ecosystem services and improve biodiversity, and b) Further ameliorate the states of urban ecosystems as to make cities livable and resilient.

Keywords:
Ecosystem conservation, Magnuson Park, Seattle, Urban ecosystem services

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INTRODUCTION

The natural essence is often understood as the surrounding environment and its components. It refers to all the phenomena that happen in the physical world, along with all the organisms and their organization within their natural habitats. Human is at the center of the natural environment but the impacts of anthropic activities are by far understood as a separate category from other natural phenomena. (Ducarme and Couvet, 2020). From an environmental perspective, the conceptual definition of nature also refers to ecology with a very broad approach on the fauna and the flora. Through the organizational standards of the biotic and abiotic factors, their function, and their nonstop interaction, these ecological communities are beneficial for living conditions on earth and are considered key factors in sustaining life. (Danley and Widmark, 2016). Dynamic modification can happen in case of any variation or drastic changes of any of these factors.

Today, urbanization and its infrastructure are flourishing at an exponential level. The latest data from the World Bank show that in a near future, nearly all cities around the world will be inhabited by close to 90 percent of the world's population, resulting in the maximization of the urbanization process and the worsening of its impacts on the environment (World Bank Group, 2011). Considering how fast the widening of urban areas are growing, the Impacts of those settlements on biodiversity is evident. Anthropic activities and demographic trends are known to contribute to depleting biodiversity at a very large spectrum (Moll and Petit, 1994). Urban development is the result of the movement of an exponential number of people from rural areas and abroad. This increase of population in cities is on average 2 times the level of the United States population growth (Dow, 2000). Urban infrastructure development enhances the shrinking of household sizes and pushes city limits over the suburb areas (Alberti et al., 2003; Heimlich and Anderson, 2001; Radeloff et al., 2005). The intensification of these infrastructures creates a major disconnection between people and nature, ecological disturbances and enhances the pollution level.

Climate change has a significant impact on the level of environmental hazards and weakening the level of resilience within urban environments (UN Environment Program, 2019). The global warming intensely impacts ecosystems in cities and the consequences are altered soil conditions, rapidly shifting and warmer microclimates, very limited living conditions for native species, and the wild spread of nonnative species (Heneghan et al., 2004). Moreover, the exacerbated effect of the heat island phenomenon has led to significantly warmer metropolitan areas than the surrounding Periurban and Rural areas (McDonnell et al., 1997). This shift of temperature is usually more significant at night than during the day. ''Novel ecosystem'' is the concept of reshaping the environment when people decide to make changes in the hydrological and the soil processes as to reassemble species (Hobbs et al., 2006). Anthropic activities can have considerable impacts and on the long term weaken the resiliency of cities. Numerous animal and plant species are moving towards a dangerous minimum to the point of threat, disappearance, and extinction, and the degradation of land and water resources has drastic impacts on ecosystem structures and functions (Pimm and Raven, 2000).

Given the important role that nature plays in climate regulation and the various services it provides for the benefit of both humans and the environment, it is important to study the factors that characterize the structures and functions of natural infrastructures (Boyd and Banzhaf, 2007; Dana and Fairfax, 1980). Environmental restoration, being a young science, propose a wide range of measures to be considered and the actions to be taken following an integrated ecological approach to better cure the environment by trying to restore nature's historical face (Alamgir et al., 2016; Society for Ecological Restoration, 1993). The environmental restoration principles propose considerable ecological approaches from the development of projects to the maintenance of the sites (Alexander et al., 2016). The Society of American Foresters defines the restoration and maintenance of ecosystem health as the backbone of ecosystem management (Holling, 1973; Moser, 1994). Restoration of ecosystem health is in fact, an international theme as per the consideration of the United Nations in 1992 that recognized ecosystem restoration as a central concern during the Rio Declaration on Environment and Development in Principle Seven, which declares (Costanza et al., 1997): ''Sates shall cooperate in a spirit of global partnership to conserve, protect, and restore the health and integrity of the Earth's ecosystems (Moseman et al., 2014; Mumby et al., 2014)." The same idea is supported by Berger, which he proposed in one of his reviews, from a perspective to restore and manage ecosystems. (United Nations, 1992; Berger, 1997).

THEORETICAL APPROACHES

Based on the on the garden city movement initiated by Ebenezer Howard in 1898, urban agriculture stems from the idea to foster the greening and cleaning of cities through the creation of green places (Maes et al., 2016). Along with the ecosystem services provided by nature, vegetation plays substantial roles such as: micro-climate creation, new habitat, noise barriers, shade, lowering temperature, sequestration of CO2 (Rebele, 1994; Svensson and Eliasson, 1997).

Green spaces in and around cities, bring about to improving climate conditions the physical climate by rising humidity level, overcasting temperatures, providing better air quality, breaking wind, intercepting solar radiation, and providing shadow (Alberti et al., 2011; Dobrovolny, 2013).

The value of less tangible ecosystem services, such as climate control, water filtration, soil fertility, and other types of services have become more apparent (Costanza et al., 1997). Every living organism depends on natural processes and their lifespan can be shortening if their environment undergoes critical disturbances. Ecosystem services assessment is widely encompassed within the ecological restoration framework across various temporal and spatial scales (Tallis et al., 2012). The current situation of the urban environment requires a questioning of sustainability and resilience given the level of damage and the tangible facts of the global warming (Calfapietra et al., 2015). Research on ways to mitigate impacts and consider solutions is substantial, hence the interest of this study, which shows the extent and importance of nature in cities in terms of the ecosystem services it provides and its inclusive openings on biodiversity. Once identified, the problems give rise to possible solutions to create a better situation and degraded environments also represent opportunities for environmental restoration.

Environmental restoration is built upon the fundamental ecological and conservation principles along with management actions that enhance the recovery of a natural ecosystem (Clark and Sampson, 1995; Arno et al., 1995; Williams et al., 1993). The simultaneous conservation of animals and

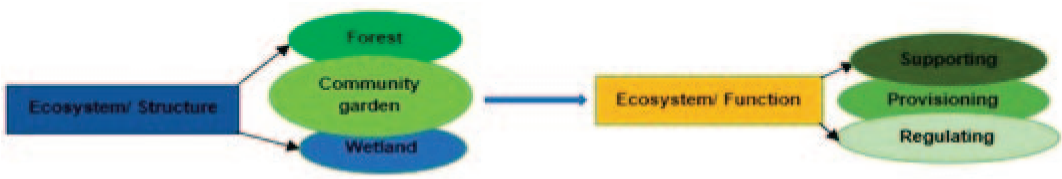

Figure 1. Typology of Urban Ecosystems and the Services They Provide

plants within a given ecosystem prevents further degradation as the central premise of ecological restoration focuses on natural ecosystem restoration to conditions related to their evolutionary environments (Society for Ecological Restoration, 1993). Restoration ecologists put emphasis on the interaction of people with restored systems is substantial and a failure to do so can affect long-term sustainability (Cinner et al., 2015; Mumby et al., 2014; Carpenter et al., 2012; Mooney et al., 2009). As seen in Figure 1, ongoing management is expected to compensate unnatural conditions in scenarios where novel conditions prevent natural system functions. For instance, without a large surface area, an ecosystem may not be able to support natural dynamics or to take in natural disturbances regimes (Adger, 2006). Although the more ambitious goals of ecological restoration, the common practices are healing, rehabilitation, reclamation, and bioremediation (MacMahon, 1997).

Ecosystem: A broad diversity of animal, plants, and microorganisms and the abiotic elements in constant interaction are the main components of an ecosystem. Organized into dynamic communities, these systems work as a functional unit (Millenium for Ecosystem Assessment, 2005). The singularity of each environmental factor such as soil type, the landscape position, the atmospheric conditions, and water availability determine the characteristic of the ecosystems and the services they provide (Convention on Biological Diversity Press Brief, 2015; Costanza et al., 1997; Kumar, 2010). The tradeoff among services is a view as a whole understanding of the potential role of nature, given the management action plans and the level of intervention (Bastian et al., 2012; FAO, 2012).

Biodiversity: Researchers often established relationship between biodiversity and ecosystem functions through experimental confirmations stating that the two entities are indeed linked to one another. Such assumptions clearly prove that environmental changes have predictable effects on ecosystem function (Kaiser, 2000; Naeem, 2009) However, the experimental design and the interpretation of the results have raised much debates (Schulze and Mooney, 2012). Despite the controversies raised by the biotic feedback within a functional ecosystem, the concept dates to Darwin who hypothesized in 1985 that diversity evolves, fills habitats and ecological niches, and lead to biodiversity proliferation at some levels (Hooper et al., 2002). Biodiversity is a very broad concept from which derived a plethora of variations of nature within a given ecosystem; both in number and frequency (Zacharias and Roff, 2001). Scientists believe that there are about 13 million species (Mora et al., 2011). It is critical to address the fact that conventional approaches to ecology neglect the necessary integration to compel the critical roles of biodiversity to the natural environment and the wellbeing of the human population around (Egoh et al., 2014). Traditional ecology textbooks (Naeem, 2009), for instance, generally starts with the adaptation of communities to local environmental conditions and then move on to the next category such the population biology of single species, the dynamics of those populations living in symbiotic relations (the trophic chain, mutualism, hosts, parasites, competitors, etc...). The Ecosystem Best Management Practices (EBMP) considers not only the sustainability of the exploited resources but the sustainability of other indirectly affected ecosystem components, the ecosystem functions and services themselves, and the inclusion of ecological restoration within the institutional and sociopolitical regulations as to adopt and implement the management systems as well (Pavlikakis and Tsihrintzis, 2000). The EBMP stems from the definition of the management of natural systems through the integration of scientific understanding of ecology and the sustainable values of the economic, institutional, and geopolitical dimensions of natural resources management (Steenberg et al., 2019).

ECOSYSTEM STRUCTURE

Located at the south boundary of Magnuson Park, the tree canopy of the study area covers at least 6000 square feet or an equivalent with a mixture of different strata. (Sheldon and Associates, 2001). The zone is covered by upland forest covering the ridges in broad bands of slopes radiating from the center of the Park (Green Seattle Partnership, 2014). This forest is somewhat fragmented and invasive species are encroaching from the mostly forested property boundary. English ivy and Himalayan blackberry encroach at almost every side of the peripheral area. Because of the development of rapid urbanization on all sides, construction and trampling disturb, damage, and even threaten the integrity of native species within the park (Seattle Park and Recreation, 2001). The lack of native trees regeneration indicates that as the existing deciduous tree canopy matures, action needs to be taken to maintain the forest health condition. To better asses the forest condition, the covered area is divided into three main layers that are the overstory, the understory, and the groundcover.

Established on a four-acre of land, Magnuson Community Garden is a multipurpose garden designed to welcome the entire community. The garden is divided into four plots: the children's garden, the native plant demonstration area, the pollinator garden, and the demonstration orchard. Seattle Park and Recreation oversees the management of the garden with the department of neighborhood P-patch program and the Magnuson Community Garden, a non-profit formed of a community of volunteers (Green Seattle Partnership, 2014).

Wetlands are a set of environments that support water. These wet ecosystems can be bogs, floodplains, marshes, swamps, tidal wetlands, and wet meadows. These wet environments can be marshes, bogs, swamps, wet meadows, tidal wetlands, floodplains, and the common characteristic between these types of wetlands is their location in the vicinity of either surface water or near-surface water (Keddy, 2010). Magnuson Park Lays on the bay of Lake Washington on a portion of 30 acres of land and bathes by five distinct man-made wetland ecosystems: Northern Marsh, Entry Marsh, Marsh Ponds, Promontory Ponds, and Linked Marsh Ponds (Washington Department of Ecology, 1997). It is a grid of ponds aligned with the geometries of the former runways and shaped to maximize shoreline emergent vegetation. Located in the vicinity of Lake Washington, these wetlands are transition zones between aquatic and terrestrial environments, they are true ecosystems, holding very peculiar attributes.

The area around the wetlands is surrounded by trails and there is growing vegetation at the boundary of the pond. The tree cover around the wetlands are predominantly scattered stands of black cottonwood closing down depression areas on the eastern side of the habitat zone (Seattle Park and Recreation, 2001). The herbaceous stratum around the wetlands is lacking with some sparse coverage of Spike rush. Native willows, alders, and some hardhack (spirea) constitute the understory and much of the Park's east cost is covered with Oregon ash (older trees with many saplings), and black cottonwood. This forested section constitutes the riparian zone marking the transition between the wet area and the dry land. The water bodies are extremely rich of different aquatic plants.

ECOSYSTEM SERVICES

Green spaces are the main identifying points for the extents of nature in both number and frequency. Magnuson Park, a functional man-made green space offers a wide variety of flora and fauna, genes, microorganisms, and the habitats therein (Green Seattle Partnership, 2014). The constant functioning of ecosystems naturally generates the recycling of energy and materials through living organisms which is continually evolves in response to any disturbances. The overall composition of each of these ecological structures, under the Pacific North West climate conditions provide services by which the environment produces resources that are often taken for granted. Following the classification of the Millenium Ecosystem Assessment in 2005, four types of ecosystem services are distinguished by three of them are being emphasized in this paper. The services provided by blue and green infrastructures, within Magnuson Park, are categorized into provisioning services, regulatory services, and supporting services. Provisioning services are obvious, tangible, and are directly extracted from forested areas. Those provisions are woods, logs, fibers, fuels, as well as food and water. (Boyd and Banzhaf, 2007).

Forests: Apart from the other services, forest ecosystem provides many essential life sustaining services (Franklin et al., 1981; Harmon et al., 1986; Ruggiero et al., 1991). The tree spatial patterns within a forested, their size and species create very complexe and diverse micro climate conditions in which climatic conditions such as solar radiation, temperature, moisture, and wind speed can vary greatly over a wide range of distances (Jansson and Nohrstedt, 2001).

Some species inside the forest convert solar energy into edible plants for birds, salamanders, small mammals, and even people since the area is open to the public. Within forest ecosystems, trees play numerous roles. Because of their size of some species and their physiological characteristics, they can store up an important quantity of water. Therefore, they are specialized in the hydrological regulation process especially in groundwater hydrology, local evaporation, and precipitation pattern (Franklin et al., 1981; Hansen et al., 1991). The massive duff of fallen leaves from deciduous can form a storehouse for rainwater (Nowak et al., 2007).

Supporting ecosystem services are largely the outcomes of the environment in terms of biomass production, atmospheric oxygen production, soil formation and its retention capacity, water and nutrient cycle, and the diversification of numerous ecological habitats (Millenium Ecosystem Assessment, 2005). Nutrient cycle within a forest ecosystem involves all forms of life, as well as mineral components of soil made of dead leaves, wood, and water from precipitation (Alamgir et al., 2016; Quintas-Soriano et al., 2016). The vegetated sections use the mineral and non-mineral from the soil through their roots (Blitzer et al., 2012). The leaves, flowers, and other parts of the plants are the storage system and there keep them even when they fall from the plants. These nutrients are either transferred to animals that eat the parts of the plants or transferred back into the soil (Conradin K., 2009).

Under the temperate climate condition in Seattle and the presence of deciduous and pine trees inside the forest, the level of acid is high due to the presence of the pines in the soil which most of the is sandy and less suitable to growing crops (Soil Science of America, 2018). Forests are very important ecosystems because they can store a great amount of carbon with their leaves, their barks, and in the soil (Lal and Lorenz, 2012). Once the plant material such as woods, leaves, and flowers or when an animal dies within the forest ecosystem, the presence of various forms of life in the soil involve in grinding up and decaying the material which they mix with the soil. The result is a refined soil with a more suitable environment for earthworms and arthropods. Conifers, when associated with deciduous trees provide habitats for species which also play a key role in enhancing biodiversity (Franklin, 1988; Lindenmayer et al., 2012). Tree diversity, age are key drivers in forest change and the supporting role of any forest ecosystem (Daily and Ehrlich, 1995). In Magnuson Park, the forested areas contribute to important biological features such as habitats for flora and fauna along with a diverse successional tree species, woody debris, and more diverse stand structures (American Forest, 1998). These woodlands support habitats for numerous birds, salamanders, frogs, snakes, insects, and bugs.

Regulating services are a wide range of benefits provided by forest ecosystems, these services encompass but are not limited to climate regulation, flood mitigation, and water purification. In the carbon cycle, forest involve in removing carbon dioxide (CO2) from the atmosphere by filtering the air and converting it biofuels such as wood as they grow (Beer et al., 2010). Forest ecosystems play a substantial in carbon regulation that is two folds: first they can be a source of carbon by sequestering carbon and reduce net CO2 emissions, they can be a sink of carbon by storing it in the soil or in other parts of the plants (Pan et al., 2011). After fossil fuel combustion, massive deforestation is weighed as the second-voluminous source of annual CO2 emissions and imparts to ten percent of global greenhouse gas emissions (Union of Concerned Scientists, 2013; Blanco et al., 2014). Healthy forest ecosystems involve in water regulation and provision, play a key role in water filtration, stream flow regulation, recharge aquifers, improve water infiltration, and absorb flooding (Kreye et al., 2014; Danley and Widmark, 2016). Forests act like sponges in water absorption, storing water and provide moisture during drought seasons. The world relies on the role of forest ecosystems on the growing freshwater scarcity (Maser and Trappe, 1984; Harmon et al., 1986). It is expected that the world could face severe water scarcity by 2025 and two-third of the population can experience water stress conditions worldwide (Blumenfeld et al., 2009).

Urban agriculture: Industrialized agricultural systems have very few environmental functions apart from food production and can obviously produce ecosystem disservices (The Department for Environment, Food and Rural Affairs, 2005). Other agricultural production systems that use environmental conservative techniques such as permaculture, agroecology, biodynamics, and other sustainable growing systems contribute to the provision of a wide range of ecosystem services (Sandhu et al., 2013). These environmental tendencies are often put to practices by urban farmers due to the uniquely small scales of the plots in cultivation and the urban context. It is obvious that these systems produce less food than conventional agriculture but the ecosystem services they provide make them worthwhile to be considered. The potential benefits of urban agriculture encompass but are not limited to food production, water management, climate mitigation, biodiversity enhancement, and soil health improvement (Galluzzi et al., 2010).

Most of the agricultural systems primarily provide food and fiber which are considered extremely important ecosystem services (McClintock et al., 2013). Urban farms mostly provide vegetables, some fruits, aromatics, poultry, honey bees, and some domestic livestock (Breuste and Artman, 2015). Intensive management practices can lead to urban farm productivity improvement and can also contribute to improving the total food production. Along with the provisioning services it provides, urban agriculture practices help reduce stormwater runoff, resulting in reduced peak flows and higher base flow in streams (Pataki et al., 2011). Urban agriculture facilitates the increase of soil nutrient content and due to moderate cultural practices, urban agriculture helps reducing soil bulk density (Pugh et al., 2012). The soil food web at the urban scale carries out beneficial biocontrol interaction (Verbruggen et al., 2011). Urban gardens support insects, birds, and microbes, provides habitats for some mammals, and contribute to improving connectivity of the larger matrix of green spaces within the urban system. (Matteson and Langellotto, 2010). In addition to all the supporting ecosystem services provided by urban farming, seed spreading, pollinators habitat, decomposers, and integrated pest management are part of tremendous contribution of green infrastructures in cities (Gardiner et al., 2013; Matteson and Langellotto, 2010). After the restoration of formerly impervious surfaces such as rooftops and parking lots, urban farm activities can follow up and greatly contribute to slow down stormwater and reduce runoff (The Freshwater Society, 2013). Using vacant lots within the urban tissue for farming purposes, can have help improve rainwater infiltration even in the scenario of disturb soil, the process will establish as the environmental conservation practices are carried out.

Wetlands: Wetlands are the unique ecosystems direct transition between aquatic and terrestrial habitats, they involve in the maintenance of many natural cycles and house numerous forms of life, and tremendously are productive ecosystems that provide a plethora of services to society worldwide (Millenium Ecosystem Assessment, 2005; Richardson et al., 2001). Many of the challenges of the future such as food insecurity, clean water scarcity, environmental disaster, and climate change in general can be mitigated through conserving and sustainably using wetlands (Richardson et al., 2001). Considered true ecosystems, wetlands hold distinctive attributes such as water purification and the replenishment of water sources is one of the critical roles that wetland ecosystems play, and they provide food such as fish and rice that feed not only human but also other animals depending on them (Ramsar, 2009c). The regulation contributions of wetlands involve groundwater recharge, flood regulation, water quality and quantity, erosion control and sediment transport (Campbell and Jackson, 2004). Wetland areas are conditioned as they create micro-environment resilient to storms (Convention on Biological Diversity Press Brief, 2015).

In comparison to other ecosystems, wetlands contribute to providing habitats to nearly all types of life in the world. Involving in nutrient recycling, greater species diversity, and niche specialization, wetlands ecosystems stand out as one of the most productive habitats on earth (Timoshkin et al., 2001; Ramsar, 2009b). Wetlands can also be vegetated area where microscopic and aquatic plant evolve within a symbiotic relationship. The vegetated area between the land and the water is called riparian habitat and house a plethora of living creatures from bugs to mammals. Wetlands also involve in organic material decomposition through the presence of the aquatic macrophytes and especially their associate microbial communities, which is also appealing in nutrient cycling (Moseman et al., 2011). Exploding with range of tree and animal diversity, wetlands play a substantial role in carbon sequestration and today there is strong argument regarding the blue carbon project initiated by the Smithsonian Environmental Research Center that implies that wetland can store carbon 10 times faster than any terrestrial ecosystems (Chesapeake Research Consortium, 2018). Wetlands are very specific ecosystems and are considered the kidney of the environment because of their contribution to water quality improvement, carbon sequestration, and flood attenuation (Ramsar, 2009c). Through their storing of nutrients and pollutants in soils and aquatic vegetation, wetlands offer a very diversified services from which the world greatly benefit (Ramsar,2009a). Wetlands invaluably support climate change mitigation by storing CO2 and by refreshing the air and cooling down the atmosphere. Plant within the wetland environment can absorb harmful toxicants from pesticides and fertilizers as well as heavy metals and other industrial toxins (U.S. Environmental Protection Agency, 2009). These ecosystems are specialized in flood control, drought mitigation, coastline protection, and climate change mitigation. They prevent weather hazards and provide physical barriers to lower the speed of floods (Chmura, 2003).

ENVIRONMENTAL RESTORATION

Being an intentional activity, environmental restoration, based on ecological approaches, boosts and accelerates the healing of natural habitats with respect to their integrity and their sustainable recovery (Society for Ecological Restoration, 2004; Elliott et al. 2007). The level of environmental disturbance varies according to the historical factors that involved and can lead to degradation, damage, transformation or even destruction of a natural milieu (Christensen et al., 1996). Disturbance can be the result of natural events or anthropogenic activities such as logging and the developing of infrastructures (urbanization) and Other interposing factors that have harmful impacts on the environment (Lubchenco et al., 2015). The system-based approach of restoration is the implementation of projects to return ecosystems to their historic trajectory which is most of the time arguable due to the complexity related to the natural evolution of species and their dimensions (Bradshaw, 1984). The restored environment will not necessarily recover its historical state as per the contemporary restrictions and conditions that can involve in the development of the given area through modified courses of healing (Society for Ecological Restoration 2004). Ecological restoration demands managerial actions unavoidable to accelerating the recovery of disturbed ecosystems by strengthening natural procedure. Ecological restoration is considered a highly prescribed natural medication to healing disturbed ecosystem with a well-structured management plan, fundamental in the natural recovery process (Millenium Ecosystem Assessment, 2005).

Restoration ecology is a biological discipline bracing up ecological. Research, experimental activities, and management are the master pieces of ecological restoration (Society for Ecological Restoration, 2004). And they are also crucial They are crucial operations that oversee the recovery of disturbed ecosystems through cautious ways to restore degraded ecosystems to more nearly natural conditions (Young et al., 2005).

1- Appropriate genetic materials (native species): Localization is substantial in the reference ecosystem identification process since environmental issues can be specific from place to place (Hedrick, 2005). The project must target the obvious, direct, and susceptible factors that involve during the degradation of the natural area to facilitate a basis for monitoring and assessing outcomes (McKay et al., 2005). The framework of the project must include native plants, animals, and biota preceding the ecosystem disturbance (Hobbs and Norton, 1996). It is very substantial to gather information as to have an idea of the reference ecosystem, which can be an actual site or a conceptual model close to the historical reality and a predictive record of the site to be restored (McKay et al., 2005; Liu et al., 2016). Species from the vicinity of the reference ecosystem can be used as per the consideration of migratory indicators that are naturally involved (Hedrick, 2005; Young, 2000). A site survey which helps to be in touch with indigenous people and regional information can help defining a so-close site history of the refence ecosystem. The identification process of a reference ecosystem involves species analysis and composition, distribution which can be complex, and the historical function of the site to be restored (Bakker, et al., 2003; Trowbridge, 2007).

2- Inputs: The level of damage and the state of resilience of an affected site require an assiduous intervention (Society for Ecological Restoration, 2013). The obvious interaction among the species can potentially be maintained even after the disturbance. As such, two scenarios can be highlighted:

a) where there are remnants and the external stressors are natural, all species possess an evolved but variable level seen as their ability to recover naturally from shocks if those species are used to those external factors in the process of their evolution. Recovery can occur without assistance

(Chase, 2003; Holling, 1973; Westman, 1978).

b) In the scenario where the impacts are considerably higher, for instance in the case of anthropogenic activities, intervention is needed to initiate recovery and inputs are likely to be needed. The restoration process may include an advanced remedial of the physical and chemical properties of the ecosystem along with a natural supplement of population and the reintroduction of missing species (Young, 2000). Intransigent barriers can occur on extremely damaged sites, to mitigate these issues, adaptive environmental management, and active research to not only identify specific solution but also to anticipate any issues that can affect the environmental remediation process (Millennium Ecosystem Assessment, 2005). Assessment methods are mandatory and need to take place prior the conclusion of the type of intervention whether to regenerate or totally reconstitute the ecosystem.

3- Recovery of ecosystem attributes: The main point of an ecological restoration project is to target the components of the ecosystem to be restored as to model the ''reference ecosystem'' (Liu et al., 2016). This is related to the description of specific composition, structure, and function to reinstate the ecosystem attributes before proposing the final action plan to achieve the pre-defined goals (Puget Sound action Team, 2007). Being on secure trajectory, ecosystem attributes enter the restored state process, and approximately resemble to the characteristic of those of the reference ecosystem (McKay et al., 2005; Clark and Sampson, 1995).

4- Total recovery: The restoration project duration is not enough to determine whether the goals are attainable or not, but the intent and the management plan provide a better idea of the expected results (Society for Ecological Restoration, 2013). The main objective is to identify key factors that will lead to the complete recovery in relation to a reference ecosystem into a desired ecosystem. Depending on the level of damage, the expected results may be achievable in relatively short courses of time, whereas in other cases they may take longer but still they are attainable.

These four principles are embedded within the Best Environmental Management Practices which generally involves four Phases: invasive removal, planting, maintenance, and stewardship. Key management priorities involve:

- Ongoing maintenance of active restoration in targeted sites
- Targeted control of priority invasive species
- Site restoration efforts along low-gradient portion of wetland habitat
- Comprehensive evergreen planting to maintain the native vegetation diversity
- Comprehensive efforts to reduce cover of predominant invasive species
- Trail to avoid social path creation within the site

Some management practices can affect ecosystems and have detrimental impact on biodiversity.

Link to ecosystem services

It is obvious that important portions of the world's ecosystems are being influenced by anthropic activities, which resulted in the damage or the removal of these natural environments, despite their vital contribution to sustainability. The rehabilitation of reference ecosystems aims for sustainable trajectory to the recovery of biodiversity on a long-term basis. The main idea of ecological restoration is to attempt to return reference ecosystems to their initial or historical trajectory (Society for Ecological Restoration, 2004). Humans involve in reshaping the urban environment into novel ecosystem and what was one-time forest, wetlands, rivers, and lake become street trees, parks, ponds, urban forest, and cultivated lands (Bolund and Hunhammar, 1999). Ecosystem services are the weapon to tackle climate change. Therefore, the environmental restoration principles mainly address the factors that play key roles ecosystem reinstatement and undertake climate change mitigation action plans. Reinstating nature within the urban space help regulating climate. Through their evaporative function, green infrastructures contribute to lower the impact heat island, facilitate infiltration, and intercept chemical particles (Alexander et al., 2016). Although they can be man-made ecosystems, natural remnants such as forests, grasslands, lakes, and parks also involve in climate change regulation and adaptation in cities (True and Dolan, 2003).

Link to biodiversity

Within this dynamic system, biodiversity plays a fundamental role in ecosystem functions, as per the distribution of the species along with their genetic diversity, their specificity, and their arrangement into communities that assemble into ecosystems (Hooper et al., 2005; Schulze and Mooney, 2012). Biodiversity is the main stem of numerous services such as food and fiber provision. Each community of organisms plays very substantial roles in air and water filtration, energy and material cycles (Millenium Ecosystem Assessment, 2005). Disturbances and changes can directly lower the capacity of an ecosystem to thrive and respond to global pressures (Colding et al., 2006; Goddard et al., 2010)

This is more of a theoretical approach, based on the general extents of the services provided by nature, the study area is most likely to benefit from a broad-spectrum of ecosystem services resulted from the diversity of ecological infrastructures. All three ecosystems within the study area are vegetated areas (Green Seattle Partnership, 2014). However, due to the individual components of each system, the context disparity is used not to compare the quality services they provide but to put emphasis on the uniqueness of the taxonomic diversity above the species level. The Service Providing Unit (SPU) defines a population in terms of the services it generates at a scale instead of geographic boundaries or genetic lines (Luck et al., 2003). For instance, a very specific tree population with the same ecosystem at Magnuson Park might involve in the provision of carbon sequestration service, whereas the exact same tree population is specified in water filtration service provision if located in the vicinity of the wetland. Another example is urban agriculture, as a way to bring nature in cities, depending on the purpose the project can be focused on production, pollination, remediation, and so forth (Taylor and Lovell, 2012; Lanarc-Golder, 2013). The outcomes of biodiversity in terms of provisioning, supporting, and regulating services they provide may vary from place to place. Using environmental restoration as a remedy makes it possible to define genetic and species diversity, but the quantitative assessment approach of diversity within a given ecosystem can be very difficult. Ecosystems taxonomic assessment is possible at a regional scale because from a realistic point of view, ecosystems are explicitly composed of abiotic factors that differ from region to region which makes it difficult in practice to assess the level of diversity (Steenberg et al., 2019).

CONCLUSION

Once perceived as a domain to be dominated, nature is increasingly regarded as a life maintaining element. Ecological restoration is one the major anthropic strategies to help ecosystems recover from disturbances as to reverse biodiversity decrement in urban areas. The attempt of healing ecosystems and return their natural trajectory for unassisted recovery and adaptation can be very difficult to attain. Ecological restoration practices are specific to site localization context such as topography, climate, precipitation, species, and numerous factors. After an environmental disturbance has occurred, there is a high fluctuation in species number which makes it challenging to address in the scope of restoration projects since all the species cannot be restored to their original state. In that case, it is critical to put a strong planning into application to approach the issues and propose appropriate restoration and management action plans. In fact, due to the genetic diversity vegetation needs to go first to reinstate ecosystem functions. Finally, it is good to know that many ecosystem services are generated according to a process that can relatively be in suddenly or on a long-term basis.

Given the obvious impacts of climate change, natural environments need to be restored from their impairment because urban environments are very dependent on the remnants of those degraded ecosystems. Thus, environmental restoration, based on the integrated ecological approach is critical to successful ecosystem management since it:

- Enhances ecosystem services
- Improve biodiversity
- Conserve biodiversity

Biodiversity and ecosystems are interconnected and are regulated by a dynamic process in which none of them can exist without the other. This complexity is assessed to explore the possibility of revealing non-identical typologies of ties between the two concepts. The more species diversity within a given ecosystem, the better the exchange will be because species abundance is important in many extents such as pest regulation, pollination, timber production, and freshwater. Natural assets support ecosystem trends that make ecosystems to be functional and in turn to provide provisioning, supporting, and regulating services beneficial to human and nature and benefits to humans. Likewise, the sustainability of service provision, ecological integrity, and societal resilience is strengthened through ecological restoration.

This study carried out at Magnuson Park in Seattle, after careful review of numerous documents addressing the environmental restoration process, the best management practices, and the level of intervention, clearly proves that blue and green infrastructures in cities effectively provide ecosystem services and support biodiversity when restored and well managed. This approach implies the confirmation of the two hypothesizes of the study stating: that presumably expect that environmental restoration through the Ecosystem Best Management Practices (BEMP):

a) Enhance internal and external ecosystem services and improve biodiversity, and

b) Further ameliorate the states of urban ecosystems as to make cities livable and resilient.

Ecological restoration enhances the healing of nature and offers opportunity for dynamic communities of plants, animals, and microorganisms to increase and interact with their physical environment as a functional unit. Based on scientific and technical ecological investigation, are there other values or functions of environmental restoration, and should city planners stop urbanization?

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