PROVIDING ECOSYSTEM SERVICES AT BUSINESSES

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ABSTRACT

In Oklahoma, few projects exist that incorporate ecosystem services into business sustainability plans. A literature review was completed to analyze how ecosystem services have been incorporated into businesses. Methods include a quantitative approach with 2 case studies using primary and secondary data from literature searches as well as using the Ecosystem Services Identification Tool (ESII). Results showed varying ways businesses incorporate ecosystem services. This research provides businesses with the option to incorporate ecosystem services into their business plans and utilize a model of pre and post ecosystem services.

INTRODUCTION

The objective of this study is to demonstrate how ecosystem services can be incorporated into land management decisions for the benefit of people and nature. How can the Ecosystem Services Identification Tool (ESII) be utilized to create baseline and future scenarios for land management decisions that will benefit ecosystem services? This study is directed by the following research question: 1) Do businesses choose to implement ecosystem services projects based on an existing environmental sustainability plan? The hypothesis for this research is: Businesses chose to invest in ecosystem services based on an environmental sustainability plan. Finding the answer to this research question is guided by a quantitative approach. The quantitative component involved using the Ecosystem Service Identification and Inventory Tool (ESII). This research provides businesses with options to improve ecosystem services for water quality and quantity.

Ecosystem services (ES) are the benefits that nature provides humans. These services include water filtration, carbon sequestration, flood protection, pollination, and cultural places of significance. It is projected that by 2050, 66% of the population will be living in urban centers (United Nations, 2014). This makes ES provisions crucial in urban centers. Many cities have been degraded due to roads, buildings, large concentrations of people in one area, automobiles, and pollution. This has caused many habitats to be lost, and ES to be degraded (United Nations, 2014). The conversion of Earth's land surface to urban uses is one of the most irreversible human impacts on the global biosphere (Seto et al., 2011). It hastens the loss of highly productive farmland, affects energy demand, alters the climate, modifies hydrologic and biogeochemical cycles, fragments habitat, and reduces biodiversity (Seto et al., 2011). Forest degradation has been occurring at a fast rate which has impacted ES (Seto et al., 2011). This research highlights how the Ecosystem Services Identification Tool (ESII)

can be utilized to create land management decisions that will benefit nature. This research is important because it will provide opportunities for local and state governments to get involved in implementing ES. This study is directed by the following research question: **1) Do businesses choose to implement ecosystem services projects based on their leadership and financial resources?** The hypothesis for this research is: Businesses chose to invest in ecosystem services if there is an environmental sustainability plan as part of their strategic planning.

Around half of the world's forests have disappeared according to the World Wildlife Federation (World Wildlife Fund, 2018). This is enough cause for concern to protect the remaining habitat and create new habitat. Highlighting the importance of ES that different habitats provide will allow for greater protections to be put in place. Foley et al., (2005) examined how land use activities degrade the global environment which undermines ES, human welfare, and long-term sustainability of human societies. Quality of life is affected by ES in urban environments as Bolund et al., (1999) found. Quality of life is directly tied to human health which includes access to clean water and sanitation and responsible consumption and production.

Human health has been impacted by poor air quality, degraded drinking water, and lost interactions with the natural world. The World Health Organization (WHO) revealed that there is a correlation between ecosystem services in preventing disease and sustaining good health (Millennium Ecosystem Assessment, 2005). The World Health Organization reports that forest clearance and climate induced changes have led to impacts on ticks, midges, and mosquitoes which alters transmission of lyme disease and malaria (Millennium Ecosystem Assessment, 2005). Ecosystem services have a much larger impact on ecosystem health, human health, and the economy than many people realize.

Kearns, 1998 demonstrated that ES life support services provided

$33 trillion American dollars on all 40 known ES. Voluntary incentives can be offered rather than regulation when incorporating ES into projects as Goldman, 2007 revealed. Many cities are more inclined to provide ES when incentives are involved rather than state or federal regulations. The current Trump administration is relaxing federal environmental regulations and putting environmental regulations back in the hands of state government (National Public Radio, 2019). Deregulation of 45 environmental regulations since 2017 have occurred and another 46 environmental regulations will be removed in the next few months (National Public Radio, 2019).

In this paper, one case study will be presented from one city in Oklahoma, Norman. Norman is the third largest city in Oklahoma. This case study highlights ES provided by Hitachi Vantara Computer Products America, Inc. on 66 acres that their building resides on. Hitachi Vantara is looking at what ES exists and what they can do to maintain the habitat and increase habitat for wildlife that exists year-round or migrates through their property. This study will analyze the ES provided at one site and provide policy implications for ES. This research will contribute to the implementation of urban conservation policy utilizing ecosystem services. In the coming section we begin by undertaking a review of relevant literature. Next we present a brief profile of the study area. Next is a discussion on methods and the associated statistical techniques employed in the study. Discussion of findings and water policy implications will be discussed at the end of this research paper. The research question states: **Do businesses choose to implement ecosystem services projects based on their leadership and financial resources?** It is important to incorporate ecosystem services into land management decisions for businesses because 60% of the land in the United States is owned by private individuals and corporations. This research paper justifies the case for implementing new policy at the local and state levels so that property owners can implement ecosystem service projects on their property. It provides justification for the

importance of maintaining and enhancing ecosystem services.

LITERATURE REVIEW

Ecosystem services is the benefits nature provides to humans and defines human well-being. Some ecosystem services are carbon sequestration, reducing carbon dioxide levels, water filtration, flood reduction, and pollination. The Millennium Ecosystem Assessment (2005) defines human well-being as the following: 1.) basic material for a good life: secure and adequate livelihoods, enough food at all times, shelter, clothing, and access to goods; 2.) Health: feeling well, healthy physical environment, clean air, and access to clean water; 3.) Good social relations: social cohesion, mutual respect, ability to help others, and provide for children; and 4.) Security: secure access to natural and other resources, personal safety, security, and freedom of choice and action. Posner et al., 2016 demonstrated that ES provides many modes that are important to humans. Increasingly, human well-being is being affected by changes in the ecosystem. The Institute for Public Policy and Research (2018) found that climate change, massive loss of species, top soil erosion, forest felling, and acidifying oceans are having an effect on ecosystem services.

Ecosystem Services can be described with many functions including natural ecosystem benefits to cultural values to aesthetics (Bolund et al., 1999). The United Nations 2014 and 2018 found that ES is vital to our existence. Existing literature ranges from the benefits of mangroves to coastal communities, honeybees as pollinators for crops, water filtration, carbon sequestration, and the cultural significance of natural settings to humans. Ecosystem services has also been described as the benefits to human welfare provided by organisms interacting in ecosystems. Ecosystem services is also known as a nature-based solution. Based on this literature review, ES is important for human and environmental health. The literature supports the concept that ES is vital to the economy and well-being of the people that utilize it on a daily basis. Frantzeskaki (2018) found that nature-based solutions must be: 1.)

Aesthetically pleasing to citizens; 2.) Green urban commons must be created; 3.) Trust in the local government and the experiment must occur; and 4.) Diversity and learning from social innovation, collaborative governance, integrating into urban agendas, and learn and replicate in the long term.

Everyone depends on the Earth's ecosystems and services. In the last 50 years, ecosystems have been changed by humans for growing demands of food, freshwater, timber, fiber, and fuel leading to the loss of Earth's diversity (Millennium Ecosystem Assessment, 2005). Raw materials provide for a diverse amount of materials such as wood, biofuels, and fibers from wild or cultivated plant and animal species (United Nations, 2018). Freshwater provides for the flow and storage of water (United Nations, 2018). Wild plants and mushrooms provide medicinal cures in popular and traditional medicine as well as pharmaceuticals (United Nations, 2018). This is the basis of all ecosystems and their services.

Lower income people rely on fishing and living off the land due to this being a cheaper way to live which can be affected by changes to ecosystem services. Also, lower income people live in floodplains and along the coast which supports their way of life. These areas are more prone to changes due to rising sea levels, floods, and more catastrophic weather events. This leads to poverty and social conflict. The slow degradation of ecosystems has not kept pace with growing pressures and demands (Millennium Ecosystem Assessment, 2005). Blaber (2007) found that mangroves which are located along coastal areas and typically on islands with people of a lower economic class are important to protect to lessen the impact from hurricanes. Danielson et al. 2005 found that mangroves helped lessen the impact from tsunamis. Oropeza et al., (2008) demonstrated that mangroves were vital to the California fishery. Tilman et al., (2001) found that agricultural driven climate change is occurring with many changes in ecosystem services. The World Resources Institute 2013 found that ES impacted assessments of habitat for the benefit or detriment of nature.

CATEGORIES OF ECOSYSTEM SERVICES

Ecosystem services are grouped into four categories which includes provisioning, regulating, supporting, and cultural. The Environmental Protection Agency 2011 and Environmental Protection Agency 2013 found that ecosystem services were vital to the Chesapeake Bay and that these ES goods provided for the environment to function properly.

1. Provisioning includes the production of food, water, timber, and fiber (United Nations, 2018). All ecosystems provide the conditions for growing, collecting, hunting, and harvesting food (United Nations, 2018). Ricketts, T.H. 2004 showed a correlation between the health of tropical forests and coffee production.

2. Regulating includes the control of climate, disease, food, waste, and water quality. Regulating services includes maintaining the quality of air and soil, providing flood and disease control, and pollinating crops (United Nations, 2018). Most regulating services are taken for granted because they are often invisible, and once lost can be impossible to repair (United Nations, 2018). Klein et al., (2006) found that pollinators were dependent on the services that the ecosystem could provide in order to pollinate plants properly.

3. Supporting includes nutrient cycles, soil formation, photosynthesis, and oxygen (United Nations, 2018). The University of Florida (2014) found that the economics of the state could be improved by investing in right of way vegetation. By not mowing rights of way along roads to provide natural habitats, less herbicides were used, and less time was spent mowing therefore saving the state money (University of Florida, 2014). White 2017 showed that marine protected areas for reef shark conservation helped the fishery and the economy on those islands. Providing

living spaces for plants and animals and for a diversity of plants and animals is the supporting portion of ecosystem services (United Nations, 2018).

4.) Cultural includes aesthetic, spiritual, and recreational benefits (United Nations, 2018). The non-material benefits that are provided by the ecosystem such as aesthetic inspiration, cultural identity, sense of home, and spiritual experience related to the natural environment (United Nations, 2018). Morcillo et al., (2013) highlighted that ecosystem services were vital to cultural ways of life. These categories cover a broad range of services provided to humans from the ecosystem. Research supports that the environment is in multiple levels of crisis (United Nations, 2014; World Wildlife Fund, 2018). This crisis has a lot to do with ES being lost.

ENVIRONMENTAL DESTRUCTION

There is a fast pace of environmental breakdown occurring, and this is affecting ES. This will have negative implications for societies which encourages us to make some transformative changes in our lifestyles and behaviors. The Institute for Public Policy and Research (2018) calls this the age of environmental breakdown with food supply issues occurring such as increased prices. This will lead to civil unrest and increased human migrations. This breakdown of the natural environment is leading to disruptions in ES such as provisioning, regulating, supporting, and cultural services. Irreversible changes are occurring with emerging disease, abrupt alterations in water quality, creation of dead zones in coastal waters, collapse in fisheries, and shifts in regional climate (Millennium Ecosystem Assessment, 2005). Typically, ES destruction affects the poor because they rely more on ES (Millennium Ecosystem Assessment, 2005).

Provisioning services affect how good our water quality is which in turn affects human health. In Coal County, West Virginia, mountain top removal for coal mining is having detrimental

effects on water quality and human health (Science of the Total Environment, 1977). Iron, arsenic, and sulfur are entering surface water and groundwater which is where many residents get their drinking water. Mountain top mining has led to the burying of streams which affects ecosystem services (ES). Groundwater wells are unregulated in this area of the United States. This leads to increased human health effects occurring such as inflammation in the body, cancer, rashes, restrictive airways, and dermatitis. This is pitting coal mining jobs against clean water and human health. Often, the economy and environment are working against each other without society realizing that we need the environment in order for the economy to function properly (Tercek et al., 2013). Loft et al., (2015) found that ES proper governance was important in order for nature to function as naturally as possible. The Massachusetts Department of Fish and Game (2012) found that ecological restoration was good for the economy. Brink et al., (2012) found that nature is the new green economy and provides ES that benefit our economy. Weihau et al., (2017) showed a correlation between protected areas in China for the benefit of ES. The environment provides ES, and many people don't realize the benefits until environmental degradation is occurring and human health is being affected. *Scientific American* (2018) reported declines in insect species that are occurring at an alarming rate.

Insects provide many of the pollination services needed to grow crops and feed people around the world. Habitat loss, pollution, and pesticide use are leading to the 2.5% decline in insect biomass. Scientific American (2018) predicts that a 40% extinction rate will occur by 2100 for insects which will directly affect the crops consumed by humans. Insects are beneficial in our ecosystem and food chain. Loss of fruits will occur due to decreased pollination services from insect decline. Many scientists refer to this as the sixth mass extinction event. A change in agricultural practices must occur if we are to prevent the sixth mass extinction event of insects. To prevent future destruction of our ES, a change in how we protect the environment will determine how the ecosystem functions with

all of its services. The Millennium Ecosystem Assessment (2005) also indicated there are many drivers of change. These include the following: 1.) Change in local land use and cover; 2.) Species introduction and removal; 3.) Technology adaptation and use; 4.) External inputs such as fertilizer use, pest control, and irrigation; 5.) Harvest and resource consumption; 6.) Climate change; and 7.) Natural, physical, and biological drivers. Cities are looking for natural solutions to these environmental issues.

Frantzeskaki (2018) offers seven lessons for planning nature-based solutions in cities. Since 80% of the world's population will be living in cities by 2050, it is important to protect ES in these areas. Many businesses are looking for ways to help the environment and lower their costs of conducting business. Businesses use services and contribute to ecosystem changes (Millennium Ecosystem Assessment, 2005). Businesses can't function if ES are degraded or out of balance (Millennium Ecosystem Assessment, 2005). Businesses experience direct and indirect impacts from the ecosystem. Ecosystem service degradation is based on consumer preferences, supplier relationships, stockholder expectations, and competitor strategies (Millennium Ecosystem Assessment 2005). Degradation of the ecosystem can lead to loss of capital asset which is an economic loss. Appleton, A.F. (2005) found that investing in the watershed upstream of New York City would save the city $250 million. Improvements in the watershed upstream of the city helped filter the water for New York City residents by planting more trees which helped filter the water and provide stream-bank stability to keep sediment out of the water. The mayor and city council decided to save money by protecting the watershed upstream of the city.

Decision making is key to establishing ES. Bagstad et al., (2013) found that ES was integrating into public and private sector decision making via seventeen ES tools. Eight evaluative criteria were used to rate the performance of ES tools for readiness in widespread applications in public and private decision making. The

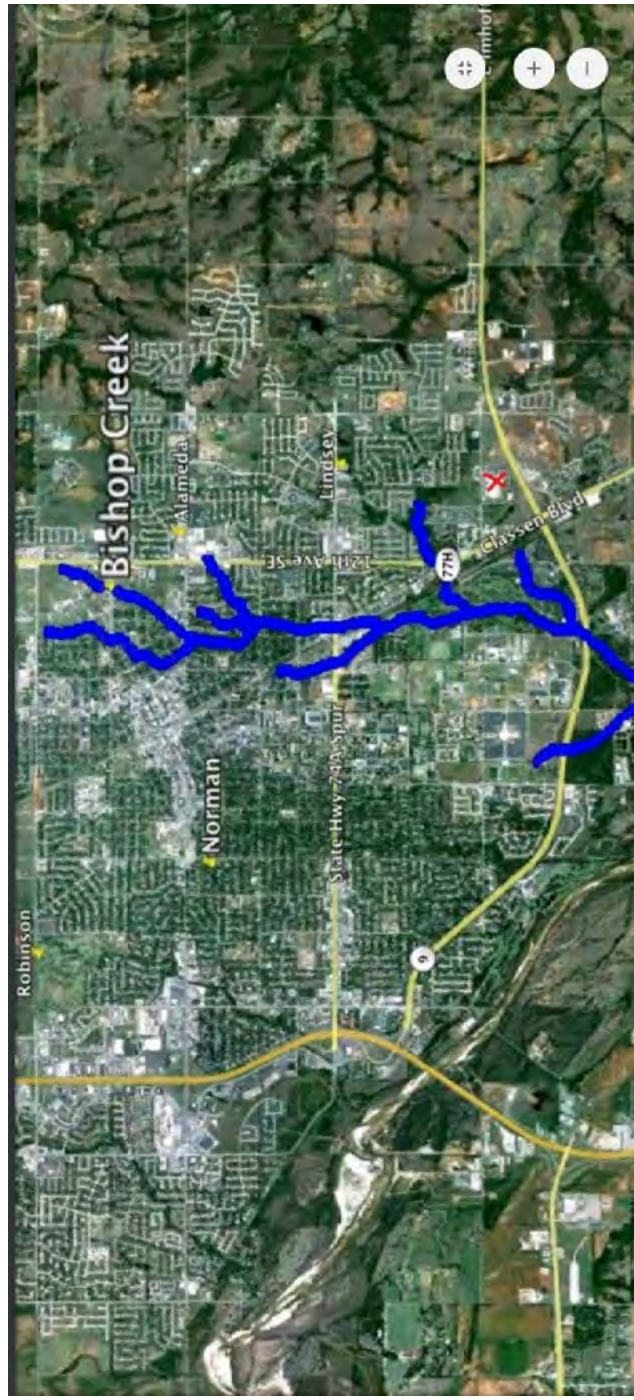
objective of this study was to grow the demand for comprehensive analyses of ecological and socioeconomic consequences of land management decisions. The hypothesis was that ES valuation was useful in decision making. As part of this project, the Bureau of Land Management launched a pilot project to assess the usefulness and feasibility of ES valuation as input into decision making. Methods consisted of secondary data with literature reviews and interviews with 77 colleagues. Seventeen ES tools were identified to assess and quantify the model value and/or map ES. An ES based management tools database was utilized. Evaluative criteria consisted of quantification, uncertainty, and time requirements. Quantification was conducted by mapping the value of ES by communicating resource management trade-offs. When conducting environmental impact assessments, what new insights does ecosystem service (ES) analysis offer versus business as usual? Each of the ES tools differ in widespread usage for ES projects depending on whether it is for the private or public sector. Decision makers felt that time and cost requirements were the deciding factors in choosing to run quantitative ES models for widespread usage. Incentives for incorporating ES can be useful to decision makers and landowners. There are many examples from around the world.

Several ES projects exist around the world. Ruckelshaus et al., (2015) looked at 20 pilot demonstration projects across the world and created six lessons with what they learned from these projects. The objective was to move from scientific knowledge to real world decision making. The hypothesis was that each science policy engagement will traverse these pathways to a different extent and stages can be used to track the progress that isn't always linear. The first pathway within the framework is scientists, local experts, stakeholders, and decision makers providing data and information. Methods used included ranking models where the transition from the current landscape to new conditions via specific activity will give the largest relative returns for several water funds objectives. A quantitative service estimation model

was used where investments will give the largest annual benefits. A fixed budget with investment portfolios using land use/land cover maps was utilized for water funds. An approach was tested to see where chances of early success and replication are high due to strong leadership and partners, clearly defined authority of decision-making pathways and demonstrated interest in using ES information in decisions. This results in producing analyses and disseminating the results. The Biodiversity and Ecosystem Services (BES) approach identified success points which can track changes, define ultimate goals of policy shifts, and improve BES and human well-being. Biodiversity and Ecosystem Services is most often achieved when indirect influence exists on long term development of policy. This indirect influence depends on the following: 1.) Who participates actively in discussions; 2.) How negotiations about an issue are framed; 3.) What goals, options, and technical knowledge are emphasized; and 4.)The visibility of the issue to the public. The lessons learned included the following: 1.) Include BES as part of science policy process; 2.) Keep it simple by easy to use and understanding of decision support tools; 3.) Empower local experts with technical tools for ongoing learning; 4.) It is not always about the money; 5.) Relate biodiversity and ES changes to livelihoods and other well-being metrics; and 6.) Clearly and honestly report the degree of uncertainty. Government is the key when deciding to incorporate ES. Sometimes, voluntary incentives will work, but some landowners will want payment for their services. Payment for ecosystem services is important to consider because it provides incentive to upstream landowners to protect the water source that is providing water to a growing city downstream.

All of the literature provided in this section supports the need to incorporate ecosystem services (ES) into our daily lives and businesses. Some of these studies were conducted in cities around the world, and a similar methodology will be applied to two cities in Oklahoma. The study area details will be presented in the next section. This study supports the gap in literature as it relates to

Figure 1


Bishop Creek
Alameda
Lindsey
12th Ave SE
Glassen Blvd
77H
Norman
State Hwy 74A Spur
Robinson

how ES can benefit businesses that want to improve these services on their lands.

STUDY AREA

One case study is located in Norman, Oklahoma (Figure 1). Norman is located in Cleveland County. This city is located in Central Oklahoma with 122,843. Norman is home to the University of Oklahoma with a student and faculty population of 31,678, and the National Weather Service Headquarters which employs 1,000 people. Hitachi computer products is also located in Norman. The economy of Norman consists of federal and state employees and private businesses. The median per capita income for Norman is $50,714. Females comprise 50% of the population and males comprise 50% of the population. Ethnic makeup of Norman is 77.4 % Caucasian, 5.2 % African American, 5.1% Asian and 13.3% other (normanok.gov/demographics/2019). Norman receives water from five lakes in Oklahoma City and Atoka (owrb.ok.gov). An additional pipeline is currently being constructed (Water Unity Agreement, 2017) to bring water to Oklahoma City from Southeastern Oklahoma (waterunityok.com).

Hitachi Vantara is located in Norman, Oklahoma and produces computer products at their facility. The facility sits on 66 acres of land with a mix of hardwood and evergreen trees along with open prairie fields (Figure 2). Hitachi Vantara is located in the Bishop Creek Watershed which eventually flows into the Canadian River. Hitachi Vantara has over 100 employees at this location. Semi-trucks arrive on a daily basis to ship computer products across the country and eventually around the world.

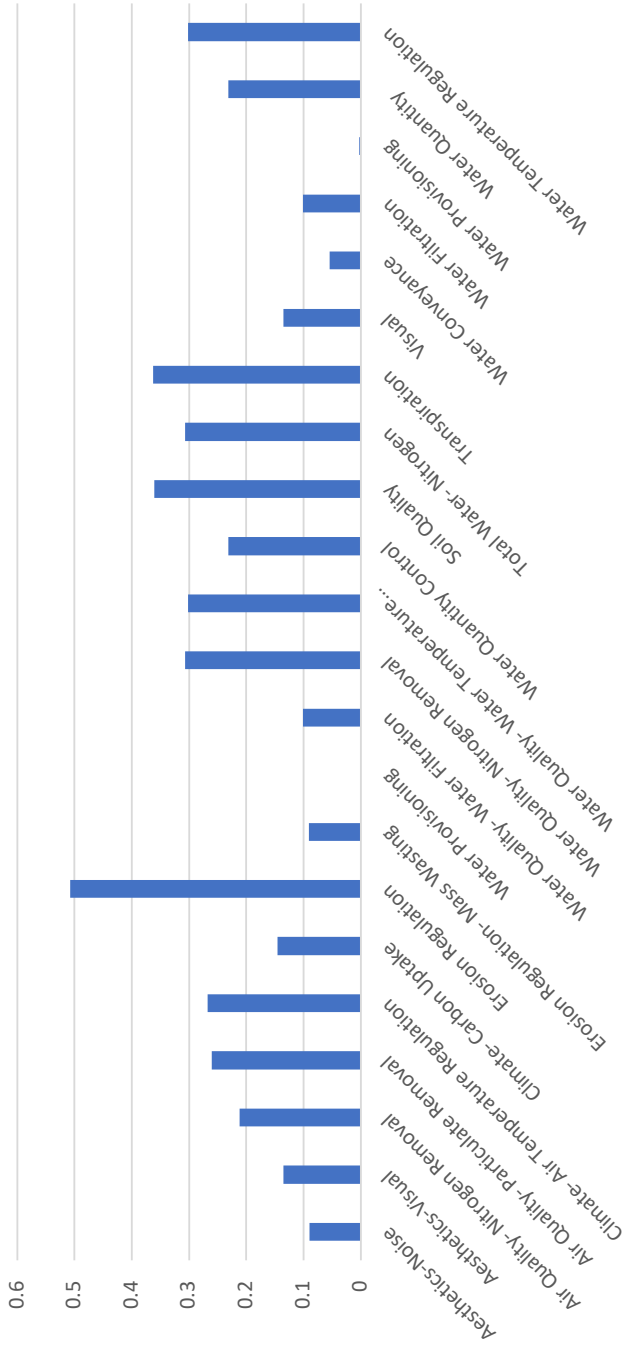
METHODS

A mixed method included qualitative data with qualitative techniques using primary and secondary data. Primary data was collected from the field at each site. YardMap (Figure 2) was utilized to identify habitat features on the property. Yardmap is

Figure 2


Habitat Network
powered by yardmap
The Nature Conservancy
The Cornell Lab
MAP
EXPLORE
LEARN
GROUPS
FORUM
ABOUT
HELP
SIGN OUT
Hitachi
TOOL SHED
SITE EXPLORER
TUTORIAL
Type an address or location
Search
Map
Satellite
Feedback
Technology Pl
Legend Care Pharmacy
Pebblebrook Park
Cimarron Dr
Kwick Stop
Elmhoff Rd
CrossPointe Church
Oakhurst Ave
Ave B Bypass
Classen Urgent Care Clinic
Classen Blvd
Oak Tree Ave
Google

Figure 3


Aesthetics-Noise
Aesthetics-Visual
Air Quality- Nitrogen Removal
Air Quality- Particulate Removal
Climate- Air Temperature Regulation
Climate- Carbon Uptake
Erosion Regulation
Erosion Regulation- Mass Wasting
Water Provisioning
Water Quality- Nitrogen Removal
Water Quality- Water Filtration
Water Quality- Water Temperature...
Water Quantity Control
Soil Quality
Total Water- Nitrogen
Transpiration
Visual
Water Conveyance
Water Filtration
Water Provisioning
Water Quantity
Water Temperature Regulation
0
0.1
0.2
0.3
0.4
0.5
0.6

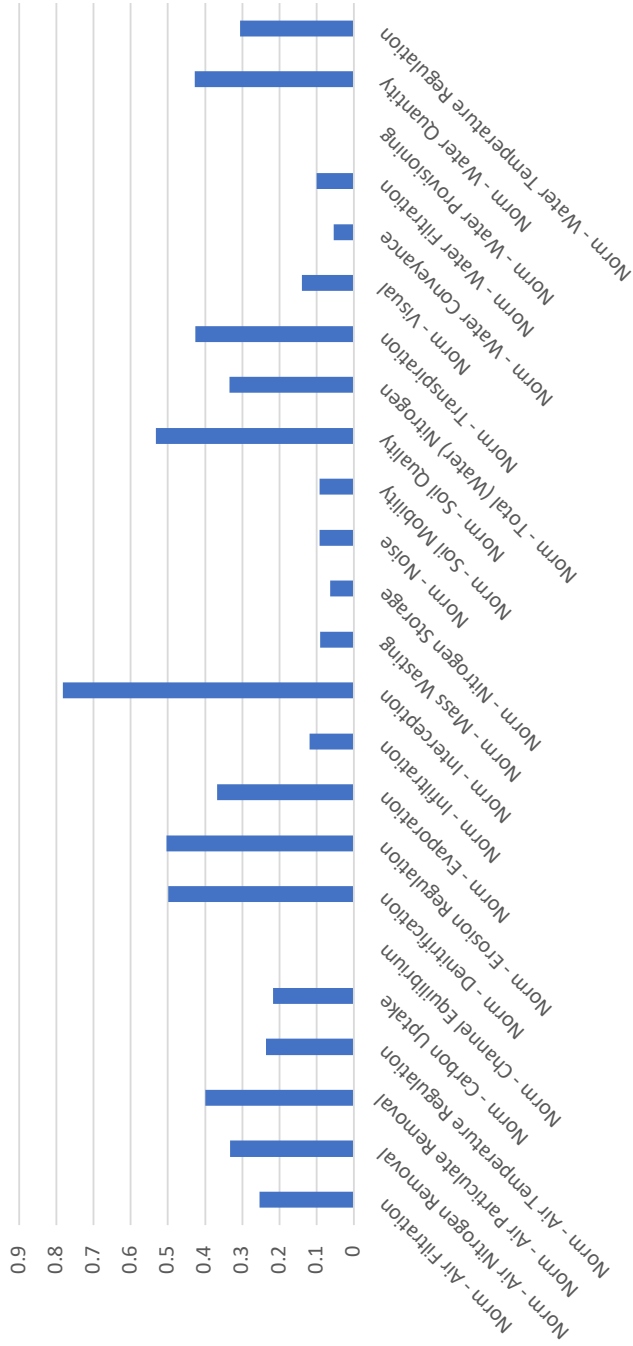
a user-friendly way to input data from a property and upload photos of progress when utilizing ways to improve habitat on that property. YardMap allows people to make observations on properties such as the type of flowers or wildlife present. YardMap can be utilized by anyone who wants to see what types of plants and animals are living in their neighborhood. It uses Google Maps to highlight where the property is located and has built in features to input plant and animal sightings. This field data was input into the Ecosystem Services Identification Tool (ESII). This tool is an iPad app and web interface that lets people understand the benefits nature provides and incorporates the value of nature into decision making. This tool helps identify baseline ES (Figure 3) and allows the user to input data for future ES scenarios (Figure 4). This will assist in development recommendations so that future development can incorporate ES benefits from nature.

Secondary data was collected using Google Scholar to find peer reviewed literature and gray literature which is not peer reviewed for this study. Ecosystem services was typed into the search engine for Google Scholar to find articles related to ES. A total of 35 articles were utilized for this study. This mixed methods approach uses qualitative and quantitative data.

JMP 13 Statistical Software is a business unit of the Statistical Analysis System (SAS) and was used to analyze the data and create statistical outputs. Data was analyzed using regression analyses to look for trends in variables such as those produced from the ESII computer program. JMP 13 utilized a spreadsheet where data was entered into columns and rows. Data was analyzed using statistics generated by the program. Statistics utilized included regression analyses to look for trends in the variables gathered from the ESII program.

JMP 13 allows the user to calculate r-squared, standard deviations, and regression analyses for both linear and multivariate functions. Linear graphs can be created along with different types of modeling

Figure 4


Norm - Air filtration
Norm - Air Nitrogen Removal
Norm - Air particulate Removal
Norm - Air Temperature Regulation
Norm - Carbon Uptake
Norm - Channel Equilibrium
Norm - Denitrification
Norm - Erosion Regulation
Norm - Evaporation
Norm - Infiltration
Norm - Interception
Norm - Mass Wasting
Norm - Nitrogen Storage
Norm - Noise
Norm - Soil Mobility
Norm - Soil Quality
Norm - Total (Water) Nitrogen
Norm - Transpiration
Norm - Visual
Norm - Water Conveyance
Norm - Water Filtration
Norm - Water Provisioning
Norm - Water Quantity
Norm - Water Temperature Regulation
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

and cluster analysis. For this research, linear regression analyses of dependent and independent variables were utilized to see if trends existed in the ecosystem service variables that were collected using the ESII tool. Independent variables were habitat type and infiltration. Dependent variables were water filtration, water quality/water temperature regulation, water quantity control, and erosion regulation. Standard deviations and r-squared values were created to see if any significant statistics existed to determine what variables were the most important to ecosystem service function.

FINDINGS

The type of habitat present has a big influence on the water quality, water filtration, water temperature, infiltration, nitrogen removal properties, erosion regulation, and water quantity. These ecosystem services and functions were found to be of statistical significance based on the ESII Tool that was utilized for this research. The ESII Tool is based on percent performance. On a scale from zero to one, how well that ecosystem service or function is performing is based on where that service or function falls along the gradient. The closer the value is to one, the better that service or function is performing. The closer that value is to zero, the worse that service or function is performing.

Infiltration and habitat type are the independent variables while percent performance and water quality parameters are the dependent variables. The habitat type is an independent variable that controls how the ecosystem services and functions will perform. Habitat controls every aspect of the environment, and when a habitat is allowed to function as naturally as possible, then the ecosystem services and functions will perform at the highest percentage possible for that habitat type.

Those features of the property with more open prairie land have the ability to absorb more water, which allows for greater percent performance of water filtration. Concrete sidewalks and asphalt roads on certain areas of the property didn't allow for water to filter

into the ground due to less water holding capacity on those parts of the property. Concrete and asphalt shed water off the property at high rates, which doesn't allow for absorption of water to occur. This leads to increased runoff events which cause excessive amounts of flooding in the city of Norman when a large amount of rain falls in a short amount of time. These types of rainfall events are occurring more frequently now. Nitrogen removal is still occurring on this property but at smaller percent performance rates than on a property with more habitat and less concrete and asphalt. Water is allowed to filter more on a property with natural features such as soil and vegetation. Figure three depicts all of the ecosystem functions and services available.

Figure five highlights the water quantity and water temperature of the Hitachi property. The ability of the land to absorb water is higher when there is a large percentage of land available to absorb rainfall. Around the office building of Hitachi, there is more concrete and asphalt due to sidewalks and parking areas for employees. Rainfall is not readily absorbed by asphalt and concrete due to non-porous structures existing in this type of material. Water quality is higher in habitats that have the ability to capture and filter pollutants such as open prairie fields and forested habitats (Figure 6). Water temperature is affected by water that runs off concrete, which is hotter than the surrounding landscape (Figure 7).

Figure 5

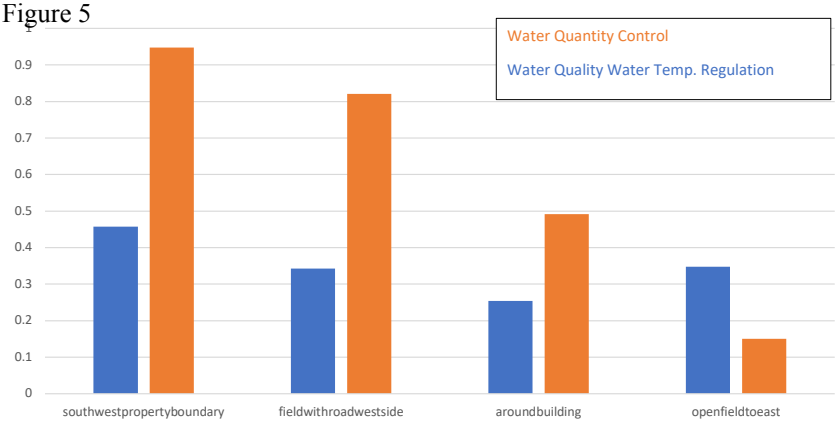
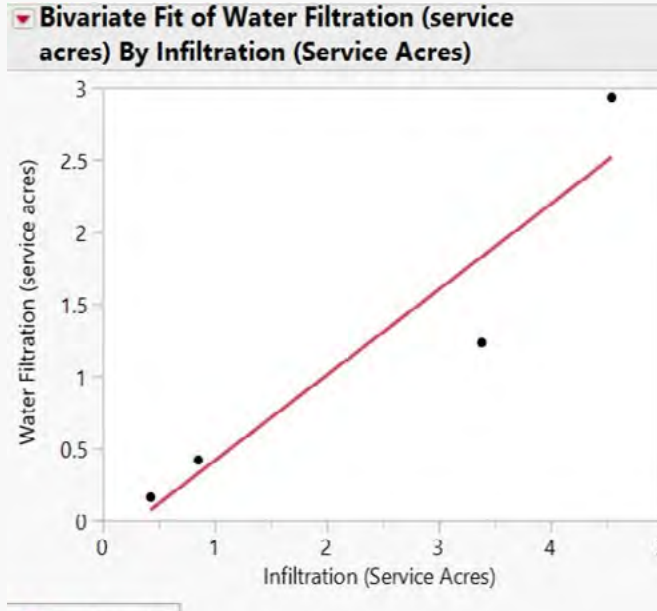
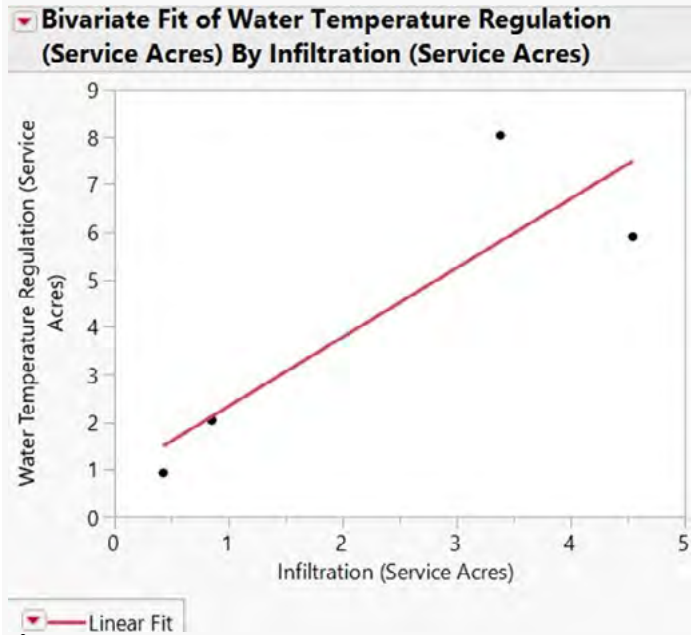


Figure 6



$R^2 = 0.88$

Figure 7



$R^2 = 0.76$

DISCUSSION OF FINDINGS

After further analysis of ES on one business property in Oklahoma, water quality, water quantity, infiltration, and erosion regulation are intricately related. Existing literature shows that water quality, water quantity, infiltration, and erosion regulation is integral in maintaining ES. Seto et al., (2011) stated that conversion of land to urban landscapes has led to ES being lost. Hitachi Vantara and the Oklahoma City Zoo have undeveloped properties that still offer ES. Protection of existing landscapes is integral to preserving ES. Water quality is affected by conversion of undeveloped land to urban centers. Runoff from developed landscapes can lead to water quality contamination in watersheds due to sediment, nutrients, chemicals, and trash washing off into the watershed.

Water quantity is also affected by developing landscapes to meet future urban demands. The ability of the landscape to allow infiltration of water and reduce erosion has been lost when development occurs. Seto et al. 2011 found that degrading landscapes led to many ecosystem service processes being lost. Zou et al., (2017) found that Eastern Red Cedars absorb large amounts of water from the landscape. Due to less fire on the landscape, this has allowed Eastern Red Cedars to take over in Oklahoma. While Eastern Red Cedar is considered a native tree in Oklahoma, it is now considered invasive due to the Oklahoma landscape being taken over by this tree. The ability of Eastern Red Cedars to absorb large amounts of water makes for limited water to a watershed (Zou et al., 2017). Eastern Red Cedar have been shown to take up as much as 26 gallons of water per day. (Zou et al., 2017). Hitachi Vantara's property had several Eastern Red Cedars leading to reduced water infiltration to the groundwater.

Soil structure is another important component of habitat. The ability to keep soil intact as much as possible is an important function of ES. This will ensure that water can be retained in the soil for future times when dry conditions persist without any

rainfall to infiltrate the soil. Soil has many components to it that are beneficial to landscapes such as microbes, water holding capacity, nutrients, and earthworms.

Foley et al. (2005) demonstrated that degradation of habitat can lead to changes in human health. Human health is intricately tied to a functioning ecosystem that can provide food and water to sustain life. Maintaining landscapes to provide for ES will allow businesses to contribute to a healthy environment.

As the Millennium Ecosystem Assessment 2005 pointed out, businesses can't function without ES. The quality and quantity of water provided is directly related to land management decisions. Urban conservation policy is an important component of any city's long-term planning. By incorporating ES into urban conservation policy, businesses have the opportunity to provide clean water and adequate water supplies for a growing population. It will take more than two businesses making changes to their land management for a cumulative positive ecosystem effect to be recognized.

Frantzeskaki (2018) demonstrated that nature-based solutions to urban conservation policy must be enacted. Nature-based solutions will provide avenues to improving water quality, water quantity, infiltration, and erosion regulation. These ES were the most important statistically when analyzing all the ES measured on the two properties in Oklahoma. With the incorporation of nature-based solutions, ES can be preserved and enhanced in order for businesses to contribute to ecosystem health. Ecosystem services (ES) are integral to the health of our environment and people. Maintaining habitat in cities will help alleviate the pressures that cities place on the environment. Ecosystem services are destroyed due to many activities that take place in a city on a daily basis. Ecosystem services will also provide a healthier environment for people. People and nature must be able to thrive together in order for ES to benefit the environment.

Figure 8


DETENTION
RAINWATER HARVESTING
GREEN ROOFS
INFILTRATION
STORMWATER PLANTERS
BIOSWALES
RETENTION
BASF SITE
PINO SITE
BLOCK 12 SITE
CONSTRUCTED WETLANDS
SUBSURFACE STORAGE

CONCLUSION

The Ecosystem Services Identification Tool (ESII) is an important program that will assess the ES of any property. Businesses will be able to identify baseline ES and can determine future ES dependent on what changes they are willing to make to their property. Government can identify ES also since they own 40% of United States lands. There also is a financial cost to implement improvements to properties to incorporate ES. Businesses must have the financial incentive and ability to implement ES on their properties.

Businesses will have to decide what ES are important to achieving their sustainability mission. Businesses will also have to look at the cost benefit analysis of incorporating changes to their property to benefit the landscape. An economic study of the environmental benefits of incorporating nature-based solutions (Figure 8) would be of importance to businesses. Nature-based solutions can be incorporated at a much lower cost to businesses than destroying those ES. Everyone has a responsibility to care for the environment in order to provide nature and people the best ecosystem that can sustain all of their needs.

Hitachi Vantara has sustainability built into their business plan. This allows for staff and financial resources to be utilized for the benefit of the environment. This business has the ability to provide staff and financial resources to this research. This allows for greater flexibility when sustainably designing properties to provide for ES.

Businesses could incorporate ES into their plans so that the impact of the business on the environment is small. Businesses have the ability to incorporate ES for a healthier environment. Hanson et al., (2012) has designed a method that allows businesses to develop strategies that assist their impact on the ecosystem. This will

help businesses equate the health of the environment with their bottom line (Hanson et al., 2012). This structured methodology helps managers develop strategies to manage business risks and opportunities arising from the dependence on ecosystems (Hanson et al., 2012).

With this methodology put in place for businesses to incorporate ES into their daily business functions, they can transform their impact on the environment which affects their bottom line. To prevent future destruction of ES, a change in how we protect the environment will determine how the ecosystem functions with all of its services.

Ecosystem service degradation is based on consumer preferences, supplier relationships, stockholder expectations, and competitor strategies (Millennium Ecosystem Assessment, 2005). Businesses could change their supply chain by investing in products that are environmentally friendly. If a business was able to promote their products as environmentally sustainable, consumers would be more apt to protect the environment in their daily lives.

POLICY IMPLICATIONS

The literature provided within this research highlights the importance of ES to the daily functioning of people and nature. The results of this research also demonstrate that certain ES must be maintained in order for the environment to function. Businesses can incorporate nature-based solutions that provide for ES in their sustainability planning. Business management plans can be updated to reflect the necessary changes needed to provide for ES on their properties.

Many cities have incorporated ES into their planning process. New York City invested in upstream land management practices to ensure that water quality and water quantity are protected for the city of New York City's water supply. Landowners upstream of New York City were paid to improve land management practices

on their property to benefit the water quality of the water supply. Hitachi Vantara is a global organization with a sustainability plan already developed. This plan can incorporate ES to provide for better watershed management activities associated with their property. The Oklahoma City Zoo has an opportunity with current construction to implement ES.

Starting at the local level, changes to ordinances and zoning laws can help cities achieve ecosystem service protection. At the grassroots local level of government, this allows for greater input from the public about how they would like to see their cities designed to benefit nature. Ecosystem services is the benefits nature provides to humans. Without ecosystem services, humans will not be able to function at their full potential. Appendix one highlights how ES can be incorporated into the design of properties when trying to capture the benefits that nature provides to humans. Local level changes can eventually lead to state policy changes. When people see projects on the ground, it provides a visual of what is possible when it comes to protecting the environment. Every business should make it their goal to protect the environment as best as possible to ensure ES are protected for future generations. Businesses have the ability to change the way they impact the environment by incorporating ES into their business plans. This will allow for action to be taken by these companies as opposed to waiting on changes at the local, state, or federal level. Also, policy implementation can start at the local level by city councils allowing landowners to incorporate ES into their business landscape. Often, people see unkept lawns as rundown and messy parts of town. If city councils allow for habitat to provide ES on properties, ES can be incorporated throughout the town improving livelihoods and the environment.

Policy changes must occur within business leadership. Leaders must emphasize the importance of ES to the sustainability of their business. To prevent future destruction of our ES, a change in how we protect the environment will determine how the ecosystem

functions with all of its services. Businesses have within their power the ability to change how their business impacts the environment. By investing in ES, businesses can change how their investments impact the natural world. By securing stronger leadership within businesses, investing in the environment, and developing environmental sustainability plans, ES can be protected for the continued protection of the environment. People like to separate the environment and the economy but without a sustainable environment to function in, the economy would cease to exist. We have to implement sustainable business practices so that the economy can flourish for generations to come. Policy changes can happen locally as well as at the state level. State level leadership in different entities of state government can advocate for ES at state owned properties. This will showcase the benefits of ES and how this improves habitat in addition to people's lives.

LITERATURE CITED

Appleton, A.F. 2005. *Water Commons*. United Kingdom

Bagstad, K.J., D.J. Semmens, S. Waage, and R. Winthrop. 2013. A comparative assessment of decision-support tools for ecosystem services quantification and valuation. Ecosystem Services. 5: e27-e39.

Blaber, S.J.M. 2007. Mangroves and fishes: Issues of diversity, dependence and dogma. Bulletin of Marine Science. 80 (3): 457-472.

Bolund, P., and S. Hunhammar. 1999. Ecosystem services in urban areas. Ecological economics. 29: 293-301.

Brink, P., L. Mazza, B.T. Kettunen, and S. Withana. 2012. Nature and its role in the transition to a green economy. Executive Summary. Contribution to Rio +20. Census.gov.2019.

Danielsen, F., M.K. Sorensen, M.F. Olwig, V. Selvam, F. parish, N.D. Burgess, T. Hiraishi, V. M. Karunagaran, M.S. Rasmussen, L.B. Hansen, A. Quarto, and N. Suryadiputra. 2005. The Asian Tsunami: A protective role for coastal vegetation. Brevia. Science. 10.1126

Eftec, 2005. The economic, social and ecological value of ecosystem services: A literature review. Final Report. Department for Environment, Food and Rural Affairs.

Environmental Protection Agency. 2011. An optimization approach to evaluate the role of ecosystem services in Chesapeake Bay restoration strategies. EPA/600/R-11/001.

Environmental Protection Agency. 2013. Final ecosystem goods and services classification system (FEGS-CS). EPA/600/R-13/ORD-004914.

Foley, J.A., R. Defries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M. T. Coe, G.C. Daily, H.K. Gibbs, J. H. Helkowski, T. Holloway, E.A. Howard, C.J. Kucharik, C. Monfreda, J.A. Patz, C.I. Prentice, N. Ramankutty, and P.K. Snyder. 2005. Global consequences of land use. Science. Vol. 309: 570-574.

Frantzeskaki, N. 2018. Seven lessons for planning nature-based solutions in cities. Elsevier, Ltd.

Goldman, R.L., B. H. Thompson, and G. C. Daily. 2007. Institutional incentives for managing the landscape: Inducing cooperation for the production of ecosystem services. Ecological Economics. 64: 333-343.

Hanson, C., J. Raganathan, J., C. Iceland, and J. Finisdore. 2012. The corporate ecosystem services review: Guidelines for identifying business risk and opportunities arising from ecosystem change. World Resource Institute.

Institute for Public Policy and Research. 2018. Environment in multiple crises.

Kearns, C.A. D.W. Inouye, and N.M. Waser. 1998. Endangered mutualisms: The conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics. Vol. 29: pgs. 83-112.

Klein, A.M., B.E. Vaissiere, J. H. Cane, I. S-Dewenter, S.A. Cunningham, C. Kremen, and T. Tscharntke. 2006. Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society. 274: pgs.303-313.

Loft, L., C. Mann, and B. Handjurgens. 2015. Challenges in ecosystem services governance: Multi-levels, multi-actors, multi-rationalities. Ecosystem Services 16: pgs.150-157.

Massachusetts Department of Fish and Game. 2012. Economic impacts of ecological restoration in Massachusetts. Division of Ecological Restoration. Industrial Economics Report.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: Synthesis. Island Press. Washington, D.C.

Morcillo-H, M., T. Plieninger and C. Bieling. 2013. An empirical review of cultural ecosystem service indicators. Ecological Indicators. 29: pgs. 434-444.

National Public Radio. 2019. Report on environmental deregulation in the Trump administration.

Normanok.gov/demographics

Tercek, M. and J. Adams. 2013. Nature's Fortune: How business and society thrive by investing in nature. Island Press.

Oropeza-A. O., E. Ezcurra, G. Danemann, V. Valdez, J. Murray, and E. Sala. 2008. Mangroves in the Gulf of California increase fishery yields. PNAS. Vol. 105. No. 30: pgs. 10456-10459.

Oklahoma Water Resources Board. Owrb.ok.gov

Posner, S., G. Vuretes, I. Koh, D. Denu, and T. Ricketts. 2016. Global use of ecosystem service models. Ecosystem Services. 17: pgs.131-141.

Ricketts, T.H., G.C. Daily, P.R. Ehrlich and C.D. Michener. 2004. Economic value of tropical forest to coffee production. PNAS. Vol. 101. No. 34: pgs.12579-12582.

Ruckelshaus, M., E. McKenzie, H. Tallis, H. Guerry, G. Daily, P. Kareiva, S. Polasky, T. Ricketts, N. Bhagabati, S.A. Wood, and J. Bernhardt. 2015. Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. Ecological Economics. 115: pgs. 11-21.

Science of the Total Environment. 1977. Effects of coal mining on ground and surface water quality, Monongalia County, West Virginia. Volume 8, Issue 1: pgs. 21-38.

Scientific American. 2018. Insect decline. Volume 319. Issue 3.

Tilman. D., J. Fargione, B. Wolff, C.D.'Antonio, A. Dobson, R. Howarth, D. Schindler, W.H. Schlesinger, D. Simberloff, and D. Swackhamer. 2001. Forecasting agriculturally driven global environmental change. Science, New Series, Vol. 292, No. 5515: pgs. 281-284.

University of Florida. 2014. Economic impact of ecosystem services provided by ecologically sustainable roadside right of way vegetation management practices. Final Report. FDOT Contract Number: BDK75-977-74.

United Nations Environment Programme. 2015. Multiple pathways to sustainable development: Initial findings from the global south. UNEP report.

United Nations. 2018. Ecosystem Services and Biodiversity. Food and Agricultural Organization.

United Nations. 2014. World Urbanization Prospects.

Water Unity Agreement. 2017. Waterunityok.com/2017

Weihua, Xu., Y. Xiao, J. Zhang, W. Yang, L. Zhan, V. Hull, Z. Wang, H. Zheng, J. Liu, S. Polasky, L. Jiang, Y. Xiao, X. Shi, E. Rao, F. Lu, X. Wang, G.C. Daily, and Z. Ouyang. 2017. Strengthening protected areas for biodiversity and ecosystem services in China. PNAS. Vol. 114. No. 7: 1601-1606.

White, T.D., A. B. Carlisle, D.A. Kroodsma, B.A. Block, R. Casagrandi, G.A. De Leo, M. Gatto, F. Micheli, and D. J. McCauley. 2017. Assessing the effectiveness of a large marine protected area for reef shark conservation. Biological Conservation. 207: pgs.64-71.

World Resources Institute. 2013. Weaving ecosystem services into impact assessment. A step by step method. Version 1.0.

World Wildlife Fund. 2018. Living Planet Report.

Zou, C., R. Will, D. Turton, and D. Engle. 2017. Water use by Eastern Redcedar. Oklahoma State University.